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A Hybrid Architecture for Web-based Expert Systems

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Abstract

A recent technique is to represent the knowledge base of an expert system in XML format. XML parsers are then used to convert XML data into expert system language code. The code is executed or interpreted when providing responses to user queries. Web-based expert system (WBES) architectures may be characterized according to where the application knowledge base resides. Applications of both client and server-sided WBES architectures appear in the literature. A hybrid architecture is proposed where servers provide responses to complex queries using server-based processing of code, and clients handle simple queries using data from the XML knowledge base file. That is, both client and server have access to the knowledge base and share the processing of handling user queries. These concepts are illustrated by a comprehensive description of a small passenger information system, deployed in the hybrid web architecture. A server hosts an XML file describing the passenger network, services, stations and connections. This version of the knowledge base is imported by the client generic web page and used to provide a custom-built user interface consisting of entities derived straight from the knowledge base. At the server, the XML format is converted to Prolog code for handling of complex queries.

Keywords: Web-based Expert Systems, Prolog, XML, Client-Server Architecture.

1. INTRODUCTION

This Despite its longevity, Expert Systems continues to be a popular area of research and as a software engineering paradigm for building intelligent information systems (see [1] and [2] for comprehensive reviews). Some recent application areas include industrial processes [3], agriculture [4] and marine technology [5]. The World Wide Web has increased the reach and accessibility of information systems including those providing expert system services. In [6], [7] and [8] aspects of implementing web-based expert systems (WBES) are discussed. These include knowledge acquisition and representation, inference methods, and system architecture. Although Duan et al. [7] lists use of server and client side inferencing as a challenge, there has been little recent discussion in the literature of WBES of the issues surrounding the choice of client or server-sided approaches and a lack of identifying which approach is used by various applications and development technologies. The more general issue of client and server-side programming is discussed in [8]. The authors cite communications latency and load caused by multiple clients as problems for server-side programming and security and representation of structured information as problems for client-side programming.

In this paper, the client and server approaches to WBESs are explored and a sample of WBES applications are categorized according to their diverse client-server architectures and implementation technologies. A new hybrid architecture that shares query processing between client and server is described. This new approach relies on the knowledge based starting out as an XML file of facts and rules. It is argued that the access to the knowledge base by both client and server permits a balancing of query processing duties as well as a customized user interface.

The method is illustrated by describing a small application including the XML knowledge base, expert system (ES) language code, interaction between client and server and inference engine.

2. WEB-BASED EXPERT SYSTEM ARCHITECTURES

WBES architectures are illustrated in the following figures. Figure 1 shows a typical client-sided architecture where the web page comes with embedded expert system (ES) application code, that is, the knowledge base and any associated code for handling supported queries. This requires the client to have a suitable interpreter for the ES language used. In possession of both application code and interpreter, the client is able to handle user queries without further reference to the server.

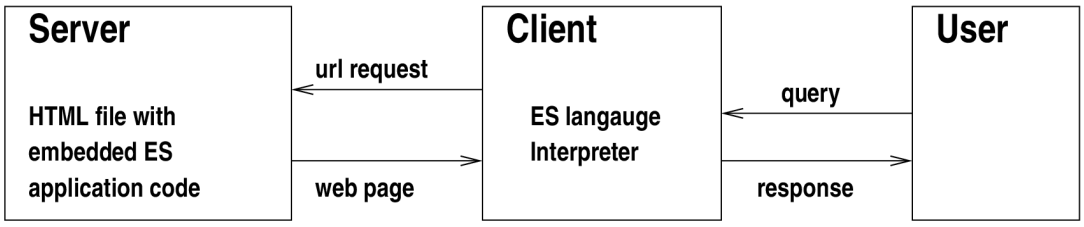

FIGURE 1: Client-sided WBES architecture.

Figure 2 shows a typical server-sided architecture where both ES application code and interpreter reside at the server. The client must refer to the server in order to handle user queries.

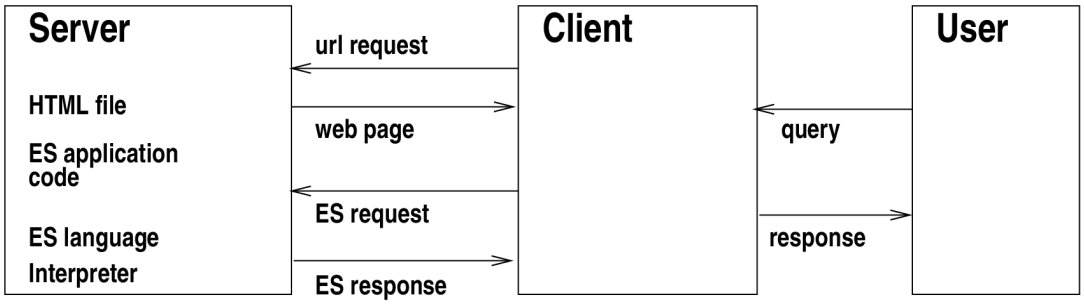

FIGURE 2: Server-sided WBES architecture.

The server-sided approach has the benefit of being able to guarantee service regardless of whether or not the client browser has the necessary software enabling it to process the ES application code. Moreover, the server may tailor the format of its response to queries in order to support service to low-level mobile devices that may have restricted display capabilities. However, the quality of service may be compromised by network load and latency problems. The client-sided processing approach is not effected by network issues (once the web page is loaded) but requires specialized software at the client, which may restrict the range of browsers and devices able to receive the service.

The most commonly used technique to develop WBESs is to use Java Expert System Shell (JESS) [10], which interprets a CLIPS-like language and utilizes the Rete inference algorithm. Applications are server-sided, requiring Java servlets and the Tomcat Servlet Engine. A more general server-sided technique is simply to use Common Gateway Interface (CGI) programs to deliver HTML form data to an expert system (with the ES application knowledge base and inference engine) residing at the server and send the response in HTML back to the client's browser. This more general depiction of the server-side approach is illustrated in Figure 3.

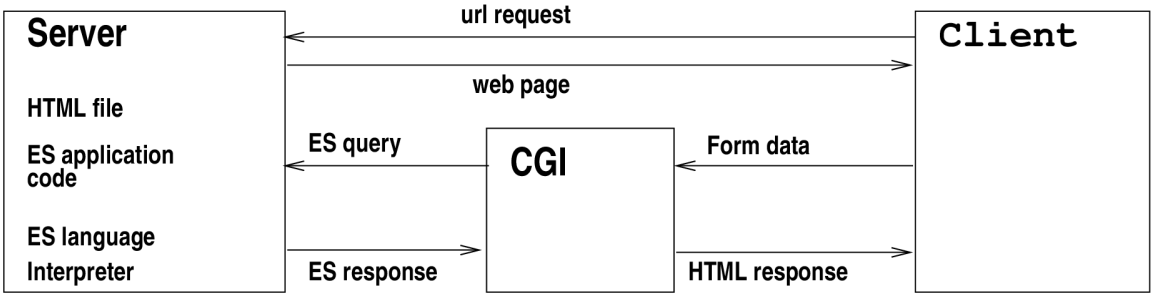

FIGURE 3: Server-sided WBES architecture with CGI.

The CGI program can massage the form data into an appropriate query to the ES as well as convert the response into a convenient form for viewing by the user in the client browser. In a JESS implementation, this is the job of the servlet.

3. WEB-BASED SYSTEMS APPLICATIONS

In this section a sample of WBES applications from the literature are described. They are chosen in order to illustrate diverse implementation technologies and web architectures. They are summarized in Table 1.

Application	Knowledge Base	Inference Engine	Web Architecture
LogicWeb	Prolog	SWI-Prolog	Client-sided
WITS	Javascript	Javascript	Client-sided
CSP	JESS	Rete	Server-sided
ET	XML/Prolog	SWI-Prolog	Server-sided

TABLE 1: WBES application summary.

3.1 Client-sided Applications

LogicWeb [9] was developed using SWI-Prolog [11] and the Mosaic web browser for logical programming on the web. A LogicWeb module consists of a graphical user interface (the browser) and a Prolog query processing engine. It is capable of interpreting web pages containing embedded Prolog code. The issue of the security of this client-sided approach is addressed in [12]. Another client-sided approach is provided by the application Web-based Intelligent Training and support System (WITS) [7]. This system uses Javascript to represent the knowledge base and to conduct inferencing. That is, the web page contains the knowledge base as embedded Javascript code, as well as the code to process it. This is essentially different from the architecture of LogicWeb because the client is only expected to be able to interpret Javascript rather than have some more specialized ES language interpreter.

3.2 Server-sided Applications

Class Schedule Planner [13] is a JESS based system for building class schedules appropriate to individual student's interests and course requirements. Also of interest is the use of XML to communicate user requests to the server-based controller. This is translated into JESS code for processing. CSP also allows real-time updating of course rules via an administration web page. A similar application is Enrolment Tool (ET) [14] which is based on the method described in Dunstan [15] for generating domain-specific WBESs. This method uses a domain-specific XML parser to generate a Prolog knowledge base, web page and associated CGI programs from XML data files describing the knowledge base of an application from the domain. In the case of ET, the domain is course rules, so a WBES to act as an enrolment guide for students can be generated automatically for each course. The CGI programs compose a Prolog query from form

data and execute it via an SWI-Prolog script, reading back the response and sending it as HTML to the client browser. This method corresponds to the architecture shown in Figure 3.

4. A HYBRID WEB-BASED EXPERT SYSTEM ARCHITECTURE

It has been noted that the facts and rules of a knowledge base can be stored in XML format that can be translated into ES language code, that in turn can be processed by an appropriate inference engine. XML can also be read by a web application and stored using the Javascript Document Object Model (DOM). This presents the opportunity to allow a client web page to conveniently access the knowledge base and solves the problem of representing structured information at the client. At the same time, the translated version in ES language code is available for processing by an inference engine at the server. That is, the XML data file representing the knowledge base is used both at the client and at the server. Its use by the client has two purposes:

- to customize the web page and user interface; and
- to permit handling of simple queries.

This new web architecture is illustrated in Figure 4.

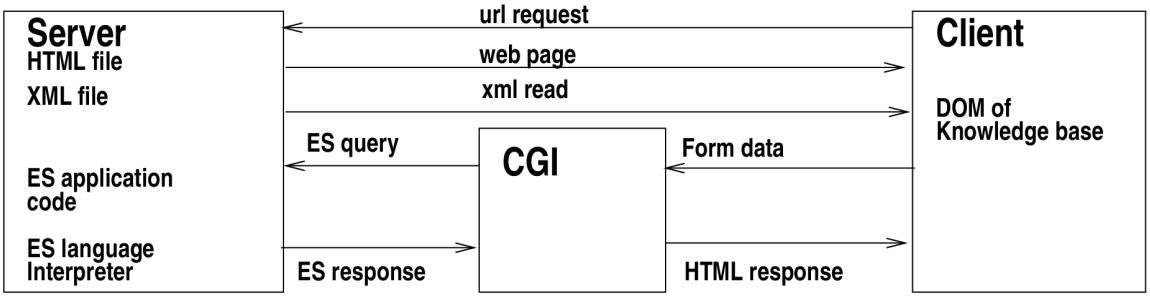

FIGURE 4: Hybrid WBES architecture.

An advantage of this web architecture is that the client is able to avoid referring simple queries to the server, while also avoiding the need for specialized software. Here, simple queries means those that can be handled by looking up DOM arrays of the knowledge base. Only a Javascript interpreter is required of the browser.

A small passenger information ES deployed in the hybrid architecture is now described. The knowledge base consists of a description of the passenger network in XML and stored in the file passenger.xml:

```
<?xml version=”1.0”>
<!DOCTYPE passenger_network SYSTEM “passenger_network.dtd”>
<passenger_network>
 <service>
  <name> coastal </name>
  <number> 312 </number>
  <connection>
   <source> walcha </source>
   <days> [monday, wednesday, friday] </days>
   <depart> 9:00 </depart>
   <destination> uralla </destination>
   <arrive> 10:15 </arrive>
  </connection>
  <connection>
```

```
      <source> uralla </source>
      <days> [monday, wednesday, friday] </days>
      <depart> 10:30 </depart>
      <destination> hillgrove </destination>
      <arrive> 11:05 </arrive>
    </connection>
  </service>
  <service>
    <name> inland </name>
    <number> 320 </number>
    <connection>
      <source> hillgrove </source>
      <days> [monday, saturday] </days>
      <depart> 19:10 </depart>
      <destination> guyra </destination>
      <arrive> 20:05 </arrive>
    </connection>
    <connection>
      <source> guyra </source>
      <days> [monday, saturday] </days>
      <depart> 20:20 </depart>
      <destination> walcha </destination>
      <arrive> 21:25 </arrive>
    </connection>
  </service>
</passenger_network>
```

A generic (to this domain) web page uses Javascript to read this data file from the server:

```
    if (window.XMLHttpRequest) {         // read the data file
      xhttp=new window.XMLHttpRequest()
    } else {
      xhttp=new ActiveXObject("Microsoft.XMLHTTP")
    }
    xhttp.open("GET","passenger.xml",false);
    xhttp.send("");
    xmlDoc = xhttp.responseXML;
```

The resulting xmlDoc can be used to access the elements of the knowledge base by straightforward access to data arrays. For example:

```
    stations = xmlDoc.getElementsByTagName( "source" );
```

The DOM can be used to provide a user interface customized for this knowledge base as shown in Figure 5 where information required to build html buttons and forms are extracted directly from DOM arrays. The DOM is also used to handle basic queries, for example displaying passenger service information about services from individual stations. This is also illustrated in Figure 5, where the services from the selected station are currently being displayed. That is, using Javascript, the client has the capacity to handle basic queries of the knowledge base without the need to refer to the server.

At the server, the XML knowledge base is converted to Prolog by an XML parser and stored in the file passenger.pl:

```
service( coastal, 312, [monday, wednesday, friday],
```

```
    connection( walcha, 9:00, uralla, 10:15 ),
    connection( uralla, 10:30, hillgrove, 11:05 ) ).
service( inland, 320, [monday, saturday],
    connection( hillgrove, 19:10, guyra, 20:05 ) ).
    connection( guyra, 20:20, walcha, 21:25 ) ).
```

More complex queries requiring the use of the inference engine are referred to the server via a CGI program. For example, should there be no direct connection between two locations it may be possible to find a route based on more than one connection and possibly from more than one service. The Prolog rule is:

```
route( Src, Src, [], _ ).
route( Src, Dest,
      [ (Src, Dtime, Dest1, Atime, Serv, Numb) | RestRoute ], Max ) :-
  Max > 0,
  Max1 is Max -1,
  route( Dest1, Dest, RestRoute, Max1 ),
  service( Serv, Numb, _, CL ),
  member( connection( Src, Dtime, Dest1, Atime ), CL ),
  not( member( ( _, _, Src, _, _, _ ), RestRoute ) ),
  write( Src ), write( ' to ' ), write(Dest1), nl.
```

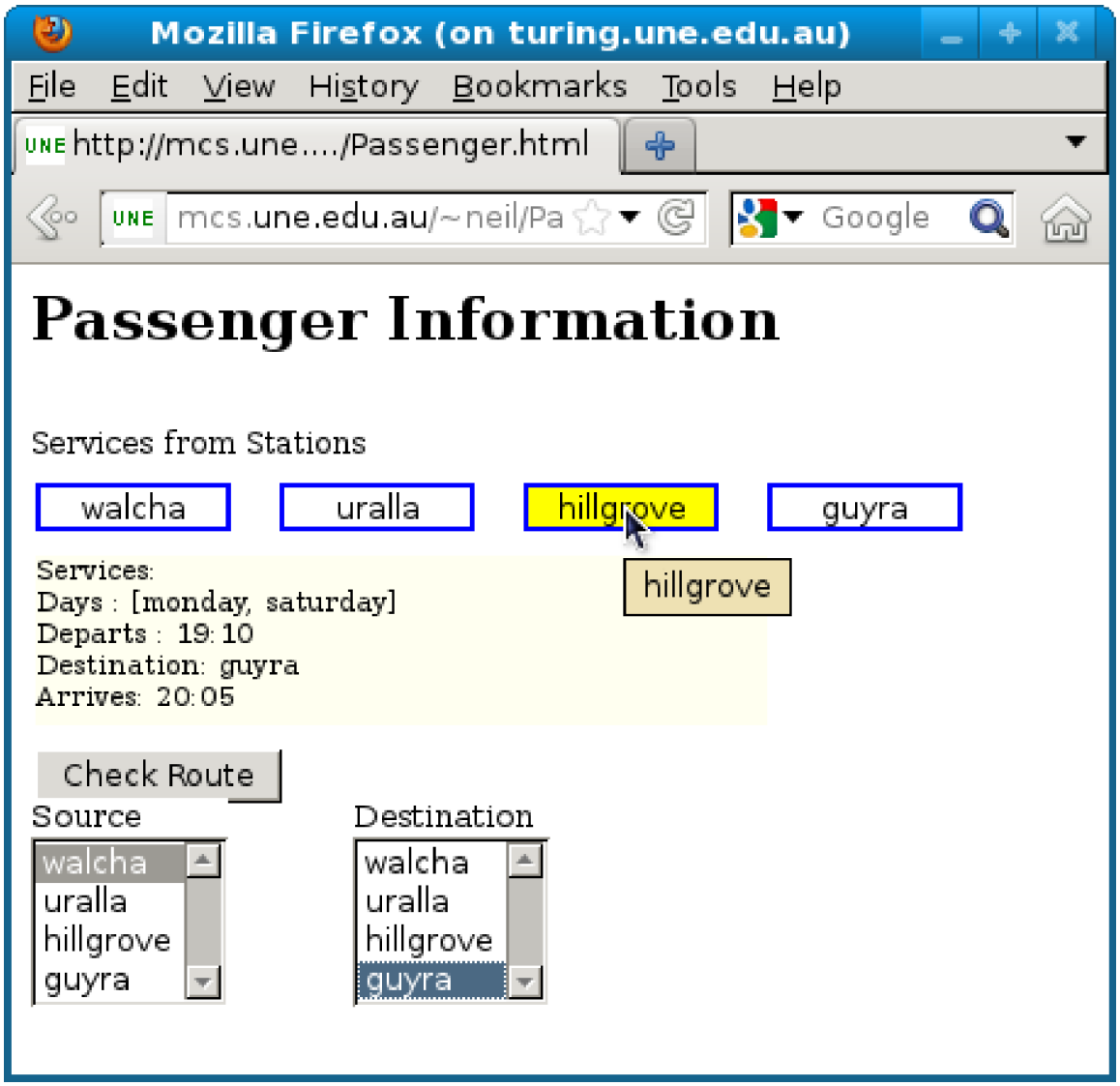

FIGURE 5: Web interface customized from the XML knowledge base.

A query to find a route from locations walcha to guyra limited to 4 stops has this response:

```
?- route( walcha, guyra, R, 4 ).
R = [ (walcha, 9:00, uralla, 10:15, coastal, 312),
      (uralla, 10:30, hillgrove, 11:05, coastal, 312),
      (hillgrove, 19:10, guyra, 20:05, inland, 320)] .
```

The CGI program constructs a Prolog query from the form data and interacts with the SWI-Prolog interpreter via a script:

```
#!/usr/bin/swipl -q -t main -f
% This script file loads passenger.pl and passnet.pl
% It executes a query given by the first command line arg
% Example: passenger_script 'route( walcha, guyra, R, 4 ).'
main :-
       ['passenger.pl'],
```

```
        ['passnet.pl'],
        current_prolog_flag(argv, Argv),
        append(_, [--|Args], Argv),
        concat_atom(Args, ' ', SingleArg),
        term_to_atom(Term, SingleArg),
        config_term_to_object(_,Term,Object),
        Object,
        halt.
main :-
        halt(1).
```

where passnet.pl contains the rule augmented with write statements to output the intermediate destinations. The flags of the script suppress all SWI-Prolog output except those from write statements. The CGI program then reads the SWI-Prolog output and constructs a response to the client in HTML. The response is shown in Figure 6. Of course the response could be more detailed and the passenger network more complex.

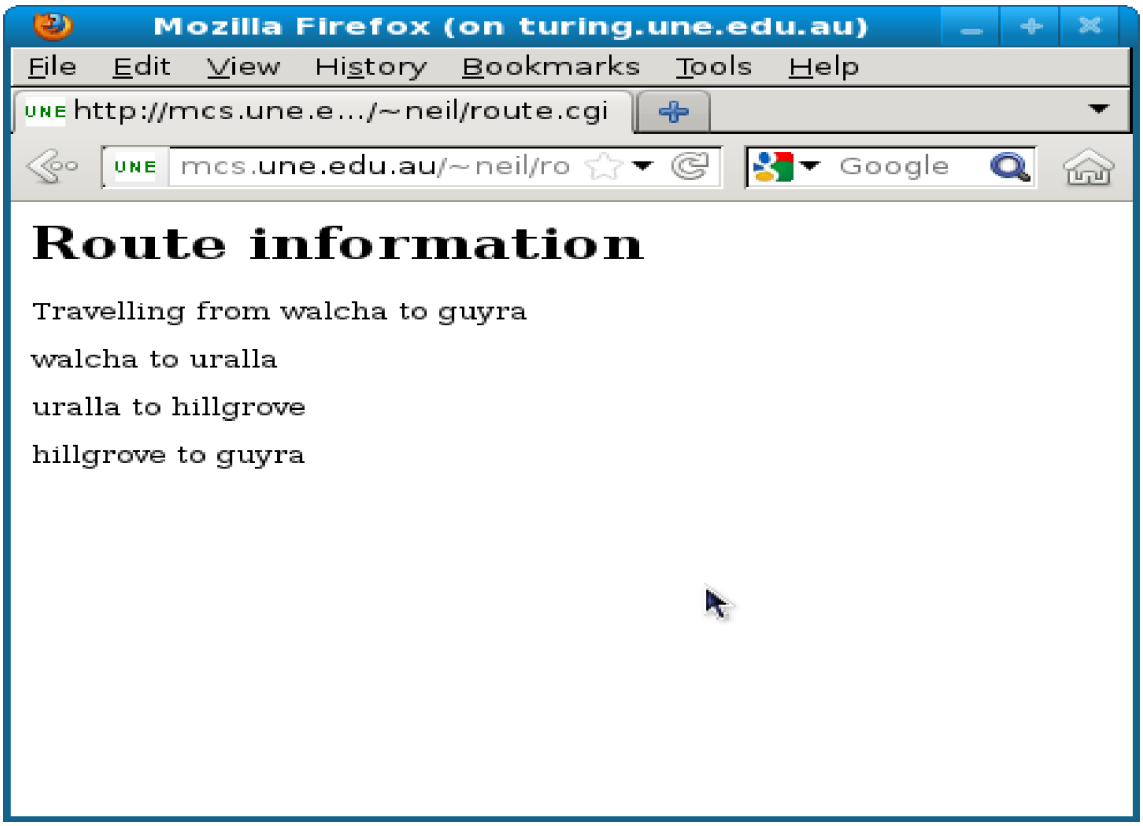

FIGURE 6: HTML response from the CGI program.

5. CONCLUSIONS

Although web-based expert systems are common and survey papers found in the literature provide comprehensive analysis of their respective features and methods of implementation, there has been a lack of discussion regarding their architecture in regard to how query handling is distributed between web client and server. Most applications deploy the expert system knowledge base at the server, although examples were found that are client-based. Both techniques have advantages and disadvantages although the server-side approach has the benefit of being able to guarantee expert system services over the web even to low capability

browsers and devices by tailoring its output accordingly. This paper has provided descriptions of a sample of applications with diverse architectures and implementation technologies.

A hybrid architecture is proposed that deploys the knowledge base at both client and server, allowing them to share the processing of user queries. A way to implement this technique is to use XML as the original form of representing the application's knowledge base. The XML file is read by the client web page Javascript code into a Document Object Model variable so that the structured data of the knowledge base is conveniently available. This permits both a customized web page to be constructed for the application as well as simple queries to be handled locally. This approach therefore only requires that the client browser has a Javascript interpreter rather than any more specialized software. The XML file is also translated into expert system language code at the server so that more complex queries can be handled there using specialized expert system language interpreters and auxiliary code. A small application was described to illustrate the method, using SWI-Prolog as the inference engine.

6. REFERENCES

[1] S. Loao, “Expert system methodologies and applications – a decade review from 1995 to 2004”, Expert Systems with Applications, 28(1), pp. 93-103, 2005.

[2] S. Kumar and B. Mishra. “Web-based expert systems and services”, The Knowledge Engineering Review, 25(2), pp. 167-198, 2010.

[3] K. V. Babu, R. G. Narayanan, and G. S. Kumar. “An expert system for predicting the behavior of tailored welded blanks”, Expert Systems with Applications, 37(12), pp. 7802-7812, 2010.

[4] F. Witlox. “Expert systems in land-use planning: an overview”, Expert Systems with Applications, 29(2), pp. 437-445, 2005.

[5] S. Helvacioglu and M. Insel. “Expert system applications in marine technologies”, Ocean Engineering, 35(11-12), pp. 1067-1074, 2008.

I. M. Dokas. “Developing web sites for web based expert systems: A web engineering approach”, in Proceedings of the Information Technologies in Environmental Engineering, September, Germany, 2005, pp. 202-217.

[6] Y. Duan, J. S. Edwards, and M. X. Xu. “Web-based expert systems: benefits and challenges”, Information & Management, 42(6), pp. 799-811, 2005.

[7] M. Grzenda and M. Niemczak. “Requirements and solutions for web-based expert systems” in, Artificial Intelligence and Soft Computing – ICAISC 2004, Lecture Notes in Computer Science, Volume 3070/2004, 2004, pp. 886-871.

Davison and S. W. Loke, S. W. “LogicWeb: Enhancing the web with logic programming”,
[8] The Journal of Logic Programming, 36(3), pp. 195–240, 1998.

[9] E. J. Friedman-Hill. “JESS, Java Expert System Shell”, Sandia Nation Laboratories, Livermore, CA, http://herzberg.ca.sandia.gov/jess, 1997, [May,2012].

[10] J. Wielemaker. “An Overview of the SWI-Prolog Programming Environment”, in Proceedings of the 13th International Workshop on Logic Programming Environments, 2003, pp. 1-16.

[11] S. W. Loke and A. Davison. “Secure Prolog Based Mobile Code”, Theory and Practice of Logic Programming,1(3), pp. 321-357, 2001.

[12] K. K. L. Ho and M. Lu, M. “Web-based expert system for class schedule planning using JESS”, in Information Re-use and Integration, Conf, IRI-2005 IEEE International Conference, 2005, 166-171.

[13] N. Dunstan. “ET: An Enrolment Tool for generating expert systems for university courses”, in Expert Systems, P. Vizureanu, Ed. Croatia: Intech, 2010, pp. 35-46.

[14] N. Dunstan. “Generating domain-specific web-based expert systems”, Expert Systems with Applications, 35(3), pp. 686-690, 2008.

Collocation Extraction Performance Ratings Using Fuzzy Logic

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Abstract

The performance of Collocation extraction cannot quantified or properly express by a single dimension. It is very imprecise to interpret collocation extraction metrics without knowing what application (users) are involved. Most of the existing collocation extraction techniques are of Berry-Roughe, Church and Hanks, Kita, Shimohata, Blaheta and Johnson, and Pearce. The extraction techniques need to be frequently updated based on feedbacks from implementation of previous methods. These feedbacks are always stated in the form of ordinal ratings, e.g. "high speed", "average performance", "good condition". Different people can describe different values to these ordinal ratings without a clear-cut reason or scientific basis. There is need for a way or means to transform vague ordinal ratings to more appreciable and precise numerical estimates. The paper transforms the ordinal performance ratings of some Collocation extraction techniques to numerical ratings using Fuzzy logic.

Keywords: Fuzzy Set Theory, Collocation Extraction, Transformation, Performance Techniques, Criteria.

1. INTRODUCTION

There is no widely accepted definition of collocation. More discussions are going on in the linguistics literature on the exact nature of collocation [1]. It is necessary to ensure generation of lexically correct expressions. Collocations are abundant in language and vary significantly in terms of length, syntactic patterns and offset [2]. Measurement ratings of these techniques are ordinal and are subject to ambiguity. This means that these ratings have some elements of uncertainty, ambiguity or fuzziness.

When humans are the basis for an analysis, there must be a way to assign some rational value to intuitive assessments of individual elements of a fuzzy set. There is need to translate from human fuzziness to numbers that can be used by a computer.
Some researchers in natural language processing have proposed computationally tractable definitions of collocation accompanying empirical experiments seeking to validate their formulation such as [3-11] recently.

Berry-Roughe (1973) uses the expected frequency of two words mentioning the slight modification in the window size of the word [3]. **Church and Hanks** (1990) measures the co-occurrence of two words and it becomes unstable when the counts of the words are small [4]. **Kita et al.** (1994) used the idea of the cognitive cost of processing a sequence of words [5]. The technique of **Shimohata et al**. (1997) is capable of extracting both interrupted and uninterrupted collocations [6]. **Blaheta and Johnson** (2001) technique has the effect of trading recall for precision of the words [10]. **Pearce** (2001) technique is a supervised technique based on semantically compositional words [11].

Lofti A Zadeh introduced **Fuzzy Set Theory** (FST) in the early1960's as a means of modeling uncertainty, vagueness, and imprecision of human natural language. It was built on the basis that as the complexity of a system increases, it becomes more difficult and

eventually impossible to make a precise statement about its behavior, eventually arriving at a point of complexity where the fuzzy logic method born in humans is the only way to get at the problem. **Fuzzy Set Theory** is concerned with application of approximate methods to imprecisely formulated problems, data or real world systems, which are of computational complexity [16]. **Performance** is effectiveness of a system which is assessed or judged. **Transformation** is a process by which one mathematical entity can be derived from one another. **Criteria** are accepted standards used in making decisions or judgments about something.

[12] described *Fuzzy Set Theory (FT)* as the extension of classical set theory. The basic idea is that the membership of a value to a set cannot only assume the two values "yes" or "no", but can be expressed by gradual membership function within a range from zero to normally "1" in case of full membership degree. Membership function can assume several forms, and in practice triangular or trapezium forms are often used (Figure 1).

2. PROBLEM DEFINED

The Collocation extraction techniques used in the paper are of 1) Berry-Roughe, 2) Church and Hanks, 3) Kita, 4) Shimohata, 5) Blaheta and Johnson, and 6) Pearce. These techniques are in rough (imprecise, inexact or fuzzy) ranges, reflecting the variability in how each technique could be implemented and the uncertainties involved in projecting the impacts of the techniques. For a meaningful numerical research, as stated in the introduction, these ordinal ratings need to be transformed to numerical ratings and this forms the thrust of the paper. That is, to transform opinion held by human beings, which would be "fuzzy" (e.g. low, mid-high performance) to being very precise (e.g. 15%, 80% performance), that is not "fuzzy" using fuzzy set theory [12], [13].

3. THEORETICAL FOUNDATION

A fuzzy system is a system whose variable(s) range over states that are approximate. The fuzzy set is usually an interval of real number and the associated variables are linguistic variable such as "most likely", "about", etc. [13]. Appropriate quantization, whose coarseness reflects the limited measurement resolution, is inevitable whenever a variable represents a real-world attribute. Fuzzy logic consists of Fuzzy Operators such as "IF/THEN rules", "AND, OR, and NOT" called the *Zadeh operators* [14].

The Membership Function is a graphical representation of the magnitude of participation of each input. It associates a weighting with each of the inputs that are processed, define functional overlap between inputs, and ultimately determines an output response. Once the functions are inferred, scaled, and combined, they are defuzzified into a crisp output which drives the system. There are different memberships functions associated with each input and output response. Some features of different membership functions are: SHAPE - triangular is common, but bell, trapezoidal, haversine and, exponential have been used also; HEIGHT or magnitude (usually normalized to 1); WIDTH (of the base of function); SHOULDERING; CENTER points (centre of the member and OVERLAP (Figure 1) [15].

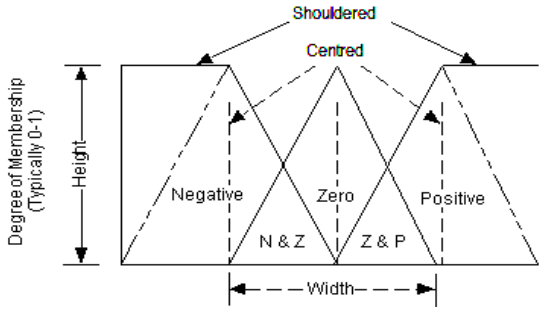


FIGURE 1: Triangular membership function

The Degree of Membership (DOM) is the placement in the transition from 0 to 1 of conditions within a fuzzy set. The degree of membership is determined by plugging the selected input

parameter into the horizontal axis and projecting vertically to the upper boundary of the Membership function(s). Fuzzy Variable includes words like red, blue, good and sweet are fuzzy and can have many shades and tints. A Fuzzy Algorithm is a procedure, usually a computer program, made up of statements relating linguistic variables.

4. METHODOLOGY

The relative effectiveness of these collocation extraction techniques is shown in Table. 1 in terms of four basic criteria: (1) Cost Effectiveness, (2) resolving power, (3) plausibility and (4) Mutual dependency. In the table, assuming, collocation extraction technique of Berry Roughe performs between ***medium to high (m-h)*** on cost effectiveness, ***high (h)*** in terms of resolving power, ***medium to high (m-h)*** on plausibility and ***medium to high (m-h)*** on mutual dependency. Similarly, Church and Hanks technique performs between *medium to high (m-h)* of all the basic criteria. And technique of Kita performs between *low to medium (l-m)* on cost effectiveness and resolving power, *medium (m)* on plausibility, *high (h)* on mutual dependency. Other techniques are also indicated in table 1.

5. NOTATIONS

CRIT	Criteria
CT	Collocation Technique
Coll.	Collocation
CTPER	Collocation Technique Performance
CF	Cost Effectiveness
RP	resolving power
Pl.	Plausibility
MD	Mutual Dependency
m	medium
h	high
l	low

Multi-objective Evaluation of collocation Techniques				
	Ratings on Criteria (high = best)			
Coll. extraction techniques	cf (P)	rp (N)	pl (Q)	md (X)
Berry-Roughe (a)	m-h	h	m-h	m-h
Church and Hanks (b)	m-h	m-h	m-h	m-h
Kita (c)	l-m	l-m	m	h
Shimohata (d)	l-m	l	m	h
Blaheta and Johnson (e)	l-m	l	m	m
Pearce (f)	l-m	l	m	l-m

TABLE 1: Collocation extraction techniques ratings

6. FUZZY VARIABLES

In the paper, the adjectives describing the fuzzy variables and the range of performance are shown in Table 2. The Range of Performance for the individual fuzzy variables is substituted in Table 1 to obtain Table 3.

Fuzzy Variables	Range of Performance %
High(h)	75 – 100
Med-High (m-h)	55 - 80
Medium (m)	35 - 60
Low-Medium(l-m)	15 - 40
Low(l)	0 - 20

TABLE 2: Fuzzy Variables and their ranges.

Multi-objective Evaluation of collocation Techniques				
	Ratings on Criteria (high = best)			
Coll. extraction techniques	cf (P)	rp (N)	pl (Q)	md (X)
Berry-Roughe (a)	55 - 80	75 – 100	55 - 80	55 - 80
Church and Hanks (b)	55 - 80	55 - 80	55 - 80	55 - 80
Kita (c)	15 - 40	15 - 40	35 - 60	75 – 100
Shimohata (d)	15 - 40	0 - 20	35 - 60	75 – 100
Blaheta and Johnson (e)	15 - 40	0 - 20	35 - 60	35 - 60
Pearce (f)	15 - 40	0 - 20	35 - 60	15 - 40

TABLE 3: Fuzzy Range of Performance for the individual fuzzy variables.

7. FUZZY MAPPING

The fuzzy variables in Table 1 were transformed to numerical ratings using *Fuzzy Set Theory* as shown in Figures 2–6.

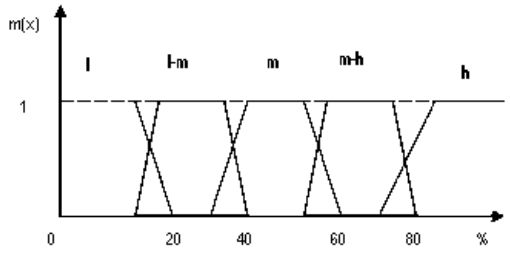


FIGURE 2: Trapezoidal membership function

8. AGGREGATION OF FUZZY SCORES

Using Figure 3, for each Collocation Technique (CT) *i* and each criterion (CRIT) *j*,

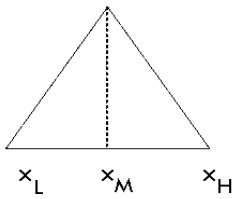


FIGURE 3: Aggregation of Fuzzy Scores.

i = 1, 2, 3, ...6. and *j* = 1, 2, 3, 4.

For CRIT (*j*) when CT (*i*, *j*) = x_L THEN CTPER (*i*, *j*) = L

For CRIT (*j*) when CT (*i*, *j*) = x_M THEN CTPER (*i*, *j*) = M

For CRIT (*j*) when CT (*i*, *j*) = x_H THEN CTPER (*i*, *j*) = H

Where, CRIT (*j*) ≡ Criterion *j* (*j* = 1, 2, 3, 4)

CT (*i*, *j*) ≡ Coll. Techniques *i* under Criterion *j*

CTPER(*i*, *j*) ≡ Coll. Performance Techniques *i* under Criterion *j* Performance

$$\mathrm{CTSCORE(i)} = \sum_{\mathrm{j}} \frac{\mathrm{CT(i,\,j)}}{4} \tag{1}$$

9. MEMBERSHIP FUNCTIONS OF THE FUZZY SETS

Using Aggregation methods for the fuzzy sets to reduce it to a triangular shape for the membership function, overlapping adjacent fuzzy sets were considered with the membership values shown in Figure 4.

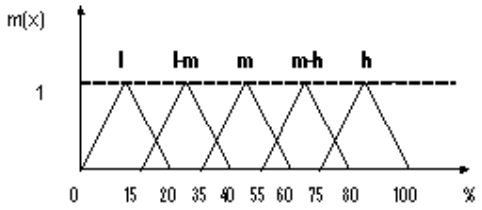
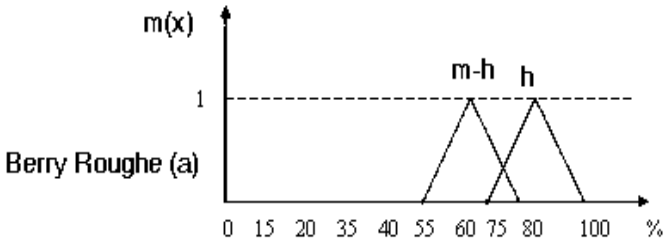
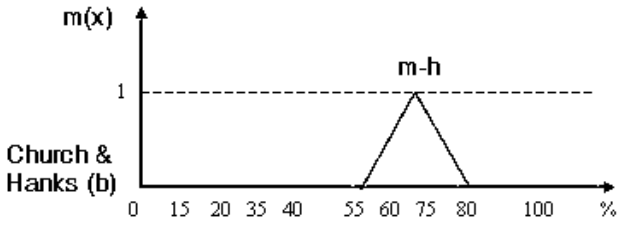


FIGURE 4: Derived Triangular membership function

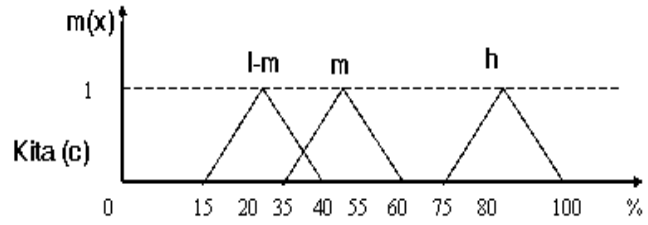
For the techniques and their performances, the membership functions shown in Figure 5 of the fuzzy sets were assigned.



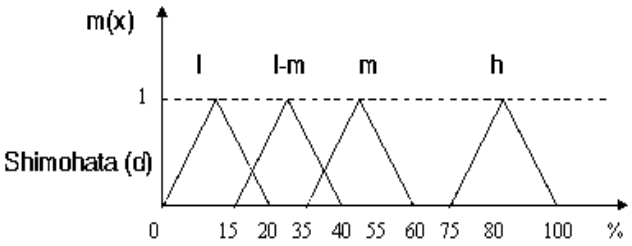
Criteria: (P, Q, X = med-high; N = high)



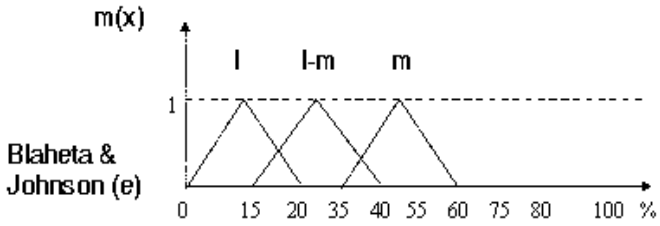
Criteria: (P, N, Q, X = med-high)



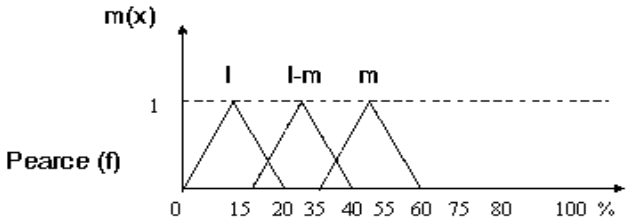
Criteria: (P, N = l-m; Q = m; X = h)



Criteria: (P = l-m; N = l; Q = m; X = h)



Criteria: (P = l-m; N = l; Q, X = m)



Criteria: (P, X = l-m; N= l; Q = m).

FIGURE 5: Derived triangular membership functions for the techniques and the criteria

The ranges in figure 4 and figure 5 were aggregated to singletons. For the average performance of all the techniques, we have the fuzzy scaled rating as shown in Figure 6.

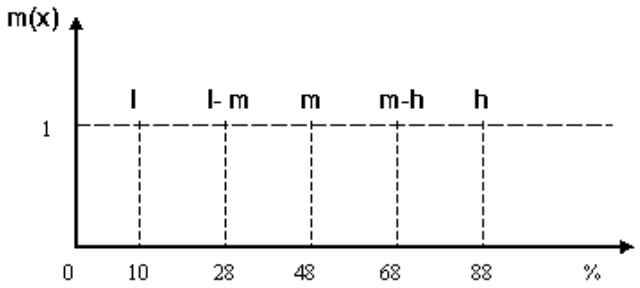


FIGURE 6: Singleton aggregation of the ratings in table 1.

From Figures 2–6, the Membership Values assigned to each set of Universe of Discourse can be tabulated as shown in Table 3.

Coll. extraction techniques	Criteria											
	cf (P)			rp (N)			pl (Q)			md (X)		
Berry-Roughe(a)	m-h			h			m-h			m-h		
	X	Y		X	Y		X	Y		X	Y	
	55	0		75	0		55	0		55	0	
	68	1		88	1		68	1		68	1	
	80	0		100	0		80	0		80	0	
Church and Hanks (b)	m-h			m-h			m-h			m-h		
	X	Y		X	Y		X	Y		X	Y	
	55	0		55	0		55	0		55	0	
	68	1		68	1		68	1		68	1	
	80	0		80	0		80	0		80	0	
Kita (c)	l-m			l-m			m			h		
	X	Y		X	Y		X	Y		X	Y	
	15	0		15	0		35	0		75	0	
	28	1		28	1		48	1		88	1	
	40	0		40	0		60	0		100	0	
Shimohata (d)	l-m			l			m			h		
	X	Y		X	Y		X	Y		X	Y	
	15	0		0	0		35	0		75	0	
	28	1		10	1		48	1		88	1	
	40	0		20	0		60	0		100	0	
Blaheta and Johnson (e)	l-m			l			m			m		
	X	Y		X	Y		X	Y		X	Y	
	15	0		0	0		35	0		35	0	
	28	1		10	1		48	1		48	1	
	40	0		20	0		60	0		60	0	
Pearce (f)	l-m			l			m			l-m		
	X	Y		X	Y		X	Y		X	Y	
	15	0		0	0		35	0		15	0	
	28	1		10	1		48	1		28	1	
	40	0		20	0		60	0		40	0	

TABLE 4: Fuzzy performance ratings of Membership Values assigned to each set of Universe of Discourse.

10. RESULTS

In figure 3 above, for all the collocation extraction techniques, x_L values, x_M values, and x_H values are referred to as *Minimum Performance* (Table 5), *Average Performance* (Table 6) and *Maximum Performance* (Table 7) respectively in the transformation.

10.1 Minimum Performance: The transformed result shows that all the techniques (i.e.of Berry-Roughe, Church and Hanks, Kita, Shimohata, Blaheta and Johnson, and Pearce) have average ratings of 60%, 55%, 35%, 31%, 21% and 16% respectively at Minimum Performance.

Multi-objective Evaluation of collocation Techniques					
	Ratings on Criteria (high = best)				Average Rating on all Criteria
Coll. extraction techniques	cf (P)	rp (N)	pl (Q)	md (X)	
Berry-Roughe (a)	55	75	55	55	60
Church and Hanks (b)	55	55	55	55	55
Kita (c)	15	15	35	75	35
Shimohata (d)	15	0	35	75	31
Blaheta and Johnson (e)	15	0	35	35	21
Pearce (f)	15	0	35	15	16

TABLE 5: Numerical transformation for Minimum Performance

10.2 Average Performance: The transformed result shows that all the techniques (i.e. of Berry-Roughe, Church and Hanks, Kita, Shimohata, Blaheta and Johnson, and Pearce) have average ratings of 73%, 68%, 48%, 43%, 33% and 28% respectively at Average Performance.

Multi-objective Evaluation of collocation Techniques					
	Ratings on Criteria (high = best)				Average Rating on all Criteria
Coll. extraction techniques	cf (P)	rp (N)	pl (Q)	md (X)	
Berry-Roughe (a)	68	88	68	68	73
Church and Hanks (b)	68	68	68	68	68
Kita (c)	28	28	48	88	48
Shimohata (d)	28	10	48	88	43
Blaheta and Johnson (e)	28	10	48	48	33
Pearce (f)	28	10	48	28	28

TABLE 6: Numerical transformation for Average Performance

10.3 Maximum Performance: The transformed result shows that all the techniques (i.e. of Berry-Roughe, Church and Hanks, Kita, Shimohata, Blaheta and Johnson, and Pearce) have average ratings of 85%, 80%, 60%, 55%, 45% and 40% respectively at Maximum Performance.

Multi-objective Evaluation of collocation Techniques					
	Ratings on Criteria (high = best)				Average Rating on all Criteria
Coll. extraction	cf	rp	pl	md	

techniques	(P)	(N)	(Q)	(X)	
Berry-Roughe (a)	80	100	80	80	85
Church and Hanks (b)	80	80	80	80	80
Kita (c)	40	40	60	100	60
Shimohata (d)	40	20	60	100	55
Blaheta and Johnson (e)	40	20	60	60	45
Pearce (f)	40	20	60	40	40

TABLE 7: Numerical transformation for Maximum Performance

11. ANALYSIS:

11.1 Comparison Between the Ordinal Fuzzy Ratings and the Transformed Ratings of all the Different Criteria.

The performance ratings for Collocation Extraction Techniques in terms of cost effectiveness (cf) were fuzzy Table 1, but the performance ratings of all the techniques in terms of cost effectiveness (cf) have been transformed into unique three categories of performances (Minimum, Average, and Maximum) in Table 5-7.

Collocation Extraction Techniques	Ordinal Performance (Fuzzy Ratings)	Minimum Performance (Transformed Ratings)	Average Performance (Transformed Ratings)	Maximum Performance (Transformed Ratings)
Berry Rough	m-h	55	68	80
Church and Hanks	m-h	55	68	80
Kita	l-m	15	28	40
Shimohata	l-m	15	28	40
Blaheta and Johnson	l-m	15	28	40
Pearce	l-m	15	28	40

Similarly, comparisons between the ordinal ratings and the transformed ratings on resolving power (rp), plausibility (pl) and mutual dependency of the criteria can also be shown.

12. CONCLUSION

Using equation (1), we can calculate the Average Scores of different Collocation extraction performance techniques for all the four criteria in respect of x_L referring to as the Minimum Performance, in respect of x_M referring to as the Average Performance, and in respect of x_H referring to as the Maximum performance. Hence their performances ratings can be shown such as $x_L < x_M < x_H$. Fuzzy logic was used to transform ordinal collocation extraction performance ratings that are imprecise and fuzzy in nature to precise and defuzzified numerical ratings that are used in the analysis of performance ratings of different collocation extraction performance techniques. The Technique used is the only way for solving any highly complex problem and can designed its system analysis.

13. REFERENCES

[1] D. Pearce. “A Comparative Evaluation of Collocation Extraction Techniques”. Available: http://www.irec-conf.org/proceedings/irec2002/pdf/169.pdf [Jan. 23, 2011].

[2] A. Thanopoulos, N. Fakotakis, and G. Kokkinakis. “Comparative Evaluation of Collocation Extraction Metrics”. Available: http://www. irec-conf.org/proceedings/irec2002/pdf/128.pdf [Jan.26, 2011]

[3] L.M.Berry-Rogghe. "The computation of collocations and their relevance to lexical studies" in A.J.Aitken, R.W.Balley, and N.Hamilton-Smith, *The Computer and Literacy Studies*, pp.103-112, University Press, Edinburgh, New Delhi, 1973.

[4] K. Ward Church & P. Kanks. "Word association norms, mutual information, and lexicography". *Computational Linguistics*, 16(1):22-29, Mar. 1990.

[5] K. Kita, Y. Kato, T. Omoto, and Y. Yano. "A comparative study of automatic extraction of collocations from corpora: Mutual Information vs. cost criteria". *Journal of Natural Language Processing*, 1(1):21-33, 1994.

[6] S. Shimohata, T. Sugio, and J. Nagata. "Retrieving collocations by co-occurrences and word order constraints". In 35th Conference of the Association for Computational Linguistics (ACL'97),pp 476-481,Madrid, Spain 1997.

[7] F. Smadja. "Retrieving Collocations from Text:Xtract", *Computational Linguistics*, 19(1):143- 177, Mar. 1993.

[8] J.P. Goldman, L. Nerima, and E. Wehril. "Collocation extraction using a syantactic parser", in 39th Annual Meeting and 10th Conference of the European Chapter of the Association for Computational Linguistics (ACL39), pp.61-66, CNRS, Institut de Recherche en Informatique de Toulouse, and Universite des Sciences Sociales, Toulouse, France, Jul., 2001.

[9] D. Lin. "Extracting collocations from text corpora", in First Workshop on Computational Terminology, Montreal, Canada, Aug., 1998.

[10] D. Blaheta and M. Johnson. "Unsupervised learning of multi-word verbs", in 39th Annual Meeting and 10th Conference of the European Chapter of the Association for Computational Linguistics (ACL39), pp.54-60, CNRS, Institut de Recherche en Informatique de Toulouse, and Universite des Sciences Sociales, Toulouse, France, Jul., 2001.

[11] D. Pearce. "Synonymy in collocation extraction", in NACCL 2001 Workshop: WordNet and Other Lexical Resources: Applications, Extensions and Customizations, Carnegie Mellon University, Pittsburgh, Jun., 2001.

[12] L.A. Zadeh. "Fuzzy sets". *Information and Control*, 8, pp. 338 – 353, 1965.

[13] L.A. Zadeh. "Toward a theory of fuzzy information granulation and its Centrality in human reasoning and Fuzzy logic". *International Journal of Soft Computing and Intelligence*, 90, 2, pp. 111 – 127, 1997.

[14] T. Sowell. *Fuzzy-Logic*. [Online]. Available : http://www.fuzzy logic.com/ch3.htm, 2005 [Jan.15,2011].

[15] S.D.. Kaehler: *Fuzzy Logic*.[Online]. Available : http://www.seattlerobotics.org/ encoder/mar98/fuz /flindex.html, (1998) [Jan.28, 2011].

[16] After Reviewing:

[17] E.A., Shyllon."Techniques for Modelling Uncertainties Inherent in Geomatics Data", *First International Symposium on Robust Statistics and Fuzzy Technics in Geodesy and GIS*, Zurich: Swiss Federal Institute of Technology Zurich (ETH), Institute of Geodesy and Photogrammetry, pp. 139-143, 2001.

Protocol Type Based Intrusion Detection Using RBF Neural Network

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Abstract

Intrusion detection systems (IDSs) are very important tools for information and computer security. In IDSs, the publicly available KDD'99, has been the most widely deployed data set used by researchers since 1999. Using a common data set has provided to compare the results of different researches. The aim of this study is to find optimal methods of preprocessing the KDD'99 data set and employ the RBF learning algorithm to apply an Intrusion Detection System.

Keywords: RBF Network, Intrusion Detection, Network Security, KDD Dataset.

1. INTRODUCTION

With the growth in the use of computer and internet, the number of computer and network attacks has increased. Therefore many companies and individuals are looking for solutions and deploying software's and systems such as intrusion detection systems (IDSs) to overcome with the network attacks. Due to the high need of such systems, many researchers' attentions are attracted by IDS [1-4].

KDDCUP'99 is the mostly widely used data set for the evaluation of intrusion detection systems [5-8]. Tavallaee et al. [5] examined and questioned the KDDcup'99 data set, and revised it by deleting the redundant records and applied 7 learners on the new data set. The seven learners are J48 decision tree learning, Naive Bayes, NBTree, Random Forest, Random Tree, Multilayer Perceptron (MLP), and Support Vector Machine (SVM). They also labeled each record with its difficulty and present it publicly on their website. Sabhnani and Serpen [6] evaluated the performance of pattern recognition and machine learning algorithms on KDD'99 data set. In their paper the following algorithms are tested; MLP, Gaussian classifier, K-means, nearest cluster algorithm, incremental RBF, Leader algorithm, Hyper sphere algorithm, Fuzzy ARTMAP and C4.5 decision tree. They mainly focused on comparing the performances of the applied classifiers for the attack categories. Bi et al. [7] picked 1000 records from KDDcup'99. They used Radial Basis Function (RBF) Network on the selected data after preprocessing it. Sagiroglu et al. [8] applied Leverberg Marquardt, Gradient Descent, and Resilient Back-propagation on the KDD'99 data set.

The other machine learning algorithms are also used for intrusion detection. Yu and Hao [9] presented an ensemble approach to intrusion detection based on improved multi-objective genetic algorithm. O. A. Adebayo et al. [10] have presented a method that uses Fuzzy-Bayesian to detect real-time network anomaly attack for discovering malicious activity against computer network. Shanmugavadivu and Nagarajan [11] presented fuzzy decision-making module to build the system more accurate for attack detection using the fuzzy inference approach. Ahmed and Masood [12] proposed a host based intrusion detection architecture using RBF neural network which obtained better detection rate and very low training time as compared to other machine learning algorithms.

In this study, the KDD'99 data set has been pre-processed and divided into three sections according their protocol type; TCP, UDP and ICMP. Conversion of string to numerical value is applied in three different ways and is saved as three different data sets. RBF neural network learning algorithm is used for each data set.

2. DATA SET DESCRIPTION AND PREPROCESSING

2.1. KDD'99 Data Set

In our experiments we have used the KDD'99 data set which has been developed based on the data captured in DARPA'98 [13]. The KDD'99 data set (corrected version) has over 1 million training data and over 300 thousands of test data. Each data consists of 41 attributes and one target (see Figure 1). Targets indicate the attack names. The data set covers over 30 different attack types as outputs which belong to one of four major categories; Denial of Service, User to Root, Remote to Local, and Probing Attacks (see Table 1) [4].

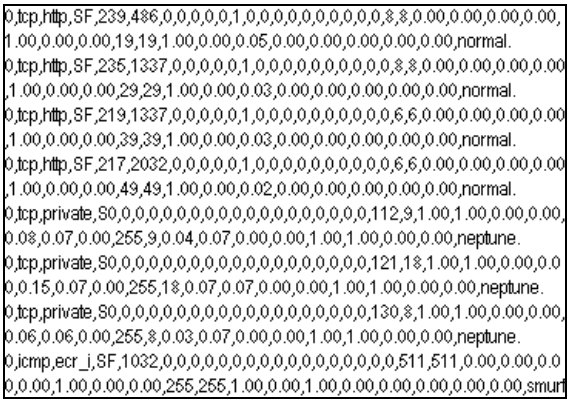

FIGURE 1: Sample data of KDDcup

2.2. Deleting Repeated Data

We used MATLAB on a PC with 4 GB of memory and 2.27 GHz of processing speed. Because of the limited memory and speed of the PC we decided to decrease the number of data of the training sets to around 6,000. Therefore repeated data has been deleted. After this process 614,450 of training and 77,290 of testing data was left.

2.3. Dividing Data into Three Sections

As shown in Figure 1, one of the attributes is the protocol type which is TCP, UDP or ICMP. We divided both training and testing data into these three protocol types in order to train and test our data separately.

Table 2 shows the number of remaining data after repeated data has been deleted. The number of training data for TCP and UDP is still large. Therefore some number of data was deleted randomly. The data to be deleted were chosen mostly from "normal" labeled data.

There were also some attacks in testing data set that were not in the training data set. Since RBF is a supervised learning technique, we had to train the network for all attacks which are going to be tested. Therefore we copied some of these attacks into the training data set. But the testing data sets were untouched (see Table 3).

Category	Attack Name	TEST	TRAIN
Normal	normal.	595,797	60,593
Remote to Local (R2L)	ftp_write.	8	3
	guess_passwd.	53	4,367
	httptunnel.	0	158
	imap.	12	1
	multihop.	6	18
	named.	0	17
	phf.	3	2
	sendmail.	0	17
	snmpgetattack.	0	7,741
	snmpguess.	0	2,406
	warezmaster.	20	1,602
	worm.	0	2
	xlock.	0	9
	xsnoop.	0	4
Probing	ipsweep.	7,579	306
	mscan.	0	1,053
	nmap.	2,316	84
	portsweep.	2,782	354
	saint.	0	736
	satan.	5,393	1,633
Denial of Service (DoS)	apache2.	0	794
	back.	2,002	1,098
	land.	17	9
	mailbomb.	0	5
	neptune.	204,815	58,001
	pod.	40	87
	processtable.	0	759
	smurf.	227,524	164,091
	teardrop.	199	12
	udpstorm.	0	2
User to Root (U2R)	buffer_overflow.	5	22
	loadmodule.	2	2
	perl.	2	2
	ps.	0	16
	rootkit.	0	13
	sqlattack.	0	2
	xterm.	0	13
	TOTAL	1,048,575	311,029

TABLE 1: Attack categories for test and training data sets

Protocol Name:	TCP		UDP		ICMP	
	TRAIN	TEST	TRAIN	TEST	TRAIN	TEST
Normal	529,517	43,908	28,435	3,770	1,324	233
Attack	50,499	27,214	866	922	3,809	1,242
Total	**580,016**	**71,122**	**29,301**	**4,692**	**5,133**	**1,475**

TABLE 2: Data information after separating it into three different protocol types.

Protocol Name:	TCP		UDP		ICMP	
	TRAIN	TEST	TRAIN	TEST	TRAIN	TEST
Normal	2,698	43,908	5,134	3,770	1,325	233
Attack	3,302	27,214	942	922	3,838	1,242
Total	**6,000**	**71,122**	**6,076**	**4,692**	**5,163**	**1,475**

TABLE 3: Data information after deleting some data randomly and copy some attacks from test to train data set

2.4. Normalization

In order to normalize the data, we need to make sure that all values are in numerical formats. There are three inputs (attributes) and one output given in string formats. One of these attributes is the protocol name. Since the data is divided according their protocol names, there is no need to convert the protocol types to numeric values. We deleted the column which belongs to the protocol name, since one set of data has always the same protocol name. The output has been converted to 1 if it is an attack and to 0 (zero) if it is a normal communication data. The other two attributes are the service and flag name. They are converted to numerical values with respect to their frequency in the test set. We applied three different conversion techniques. We differentiated these techniques by naming them as Type-A, Type-B and Type-C.

Flag	Frequency	Type-A	Type-B	Type-C
SF	6765	1	11	10
S0	3986	2	10	6
REJ	1488	3	9	2
RSTR	633	4	8	5
RSTO	307	5	7	3
S3	272	6	6	9
SH	182	7	5	11
S1	58	8	4	7
S2	29	9	3	8
RSTOS0	25	10	2	4
OTH	4	11	1	1

TABLE 4: Conversions of Flag Names to Numerical Values (for TCP Data set)

Service Name	Frequency	Type-A	Type-B	Type-C
private	3156	1	57	40
http	3012	2	56	17
telnet	1669	3	55	50
ftp	910	4	54	13
other	864	5	53	35
ftp_data	821	6	52	14
smtp	765	7	51	44
finger	507	8	50	12
pop_3	401	9	49	38
imap4	227	10	48	19
auth	177	11	47	1
sunrpc	113	12	46	47
IRC	110	13	45	20
time	88	14	44	51
domain	52	15	43	8
remote_jo	40	16	42	41
sql_net	39	17	40	45
ssh	39	18	41	46
X11	32	19	39	56
discard	29	20	36	7
echo	29	21	37	9
systat	29	22	38	49
gopher	28	23	34	15
link	28	24	35	25
iso_tsap	26	25	28	21
mtp	26	26	29	27
netbios_n	26	27	30	30
netstat	26	28	31	32
pop_2	26	29	32	37

Service Name	Frequency	Type-A	Type-B	Type-C
rje	26	30	33	42
daytime	25	31	24	6
netbios_dgm	25	32	25	29
supdup	25	33	26	48
uucp_path	25	34	27	53
bgp	24	35	20	2
ctf	24	36	21	5
netbios_ssn	24	37	22	31
whois	24	38	23	55
csnet_ns	23	39	17	4
name	23	40	18	28
vmnet	23	41	19	54
hostnames	22	42	15	16
Z39_50	22	43	16	57
nntp	18	44	13	34
pm_dump	18	45	14	36
ldap	15	46	12	24
uucp	10	47	11	52
login	9	48	10	26
nnsp	7	49	7	33
printer	7	50	8	39
shell	7	51	9	43
kshell	6	52	6	23
courier	5	53	3	3
exec	5	54	4	11
http_443	5	55	5	18
efs	4	56	2	10
klogin	3	57	1	22

TABLE 5: Conversions of Service Names to Numerical Values (for TCP Data)

Service Name	Frequency	Type A	Typle B	Type C
domain_u	3679	1	5	1
ntp_u	1373	2	4	3
private	795	3	3	5
other	152	4	2	2
tftp_u	0	5	1	4

TABLE 6: Conversions of Service Names to Numerical Values (for UDP Data)

In Type-A, we gave the highest number to the attribute with most frequency and 1 with less frequency. We did this in the opposite way for Type-B, and random numerical values were given in Type-C.

Service Name	Frequency	Type A	Typle B	Type C
eco_i	2990	5	1	1
ecr_i	1727	4	2	5
urp_i	270	3	3	2
urh_i	146	2	4	4
tim_i	0	1	5	3

TABLE 7: Conversions of Service Names to Numerical Values (for ICMP Data)

There is only on Flag name in ICMP and UDP data sets; therefore the columns belong to the flag names are deleted for both ICMP and UDP. There were also some other columns with only one value. These columns (inputs) are also deleted because they have no influence on the outputs. The final number of inputs and outputs of the data sets can be seen in Table 8.

Protocol Name:	TCP	UDP	ICMP
Input #	31	20	18
Output #	1	1	1

TABLE 8: Number of Output and Input after preprocessing the data sets

After converting text to integer and deleting columns with same data, the data sets are normalized.

3. RBF NETWORK

Radial Basis Function (RBF) Network is a type of Artificial Neural Network for supervised learning [14]. It uses RBF as a function which is usually Gaussian and the outputs are inversely proportional to the distance from the center of the neuron [15]. The traditional RBF function network can be seen in Figure 2. MATLAB provides functions to implement RBF Network within their Neural Network Toolbox. The training function newrb() and simulation function sim() is used to train and test the network [15-16].

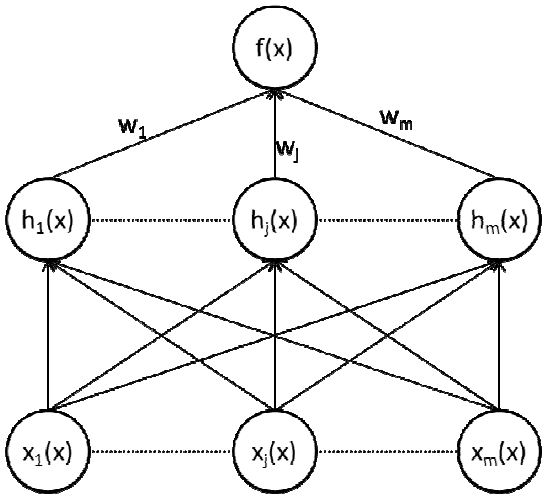

FIGURE 2: A single layer radial basis function network

4. EXPERIMENTS

The experiments are applied for all three types of string to integer conversations to see if there is any difference. For all trainings the maximum number of neurons is set as 1000.

4.1. Training Results

Training results can be seen in Table 9, 10 and 11. The results are shown as mean squared error (MSE) which represents the performance (or accuracy).

The best training results are Type-C for TCP, Type-A for UDP and Type-B for ICMP.

TCP TRAINING			
# of Neurons	Type-A	Type-B	Type-C
50	0.02702	0.02718	0.02985
100	0.01540	0.01575	0.01648
150	0.01127	0.01097	0.01275
200	0.00900	0.00869	0.00927
250	0.00772	0.00722	0.00680
500	0.00321	0.00335	0.00295
750	0.00165	0.00157	0.00151
1000	0.00101	0.00097	0.00089

TABLE 9: Training results (MSE) of the TCP data set

UDP TRAINING			
# of Neurons	Type-A	Type-B	Type-C
50	0.00410	0.00410	0.00259
100	0.00175	0.00175	0.00138
150	0.00108	0.00108	0.00085
200	0.00079	0.00079	0.00065
250	0.00062	0.00062	0.00057
500	0.00033	0.00034	0.00032
750	0.00023	0.00022	0.00022
1000	0.00018	0.00020	0.00021

TABLE 10: Training results (MSE) of the UDP data set

ICMP TRAINING			
# of Neurons	Type-A	Type-B	Type-C
50	0.00617	0.00617	0.00625
100	0.00382	0.00382	0.00264
150	0.00183	0.00184	0.00211
200	0.00183	0.00182	0.00210
250	0.00183	0.00182	0.00208
500	0.00099	0.00053	0.00080
750	0.00087	0.00036	0.00052
1000	0.00073	0.00030	0.00043

TABLE 11: Training results (MSE) of the ICMP data set

The training performances are plotted to set the results of one type of conversion against the other types of conversion (see Figure 3, 4, and 5). It can be seen that the learning performances for each type is very close to each other.

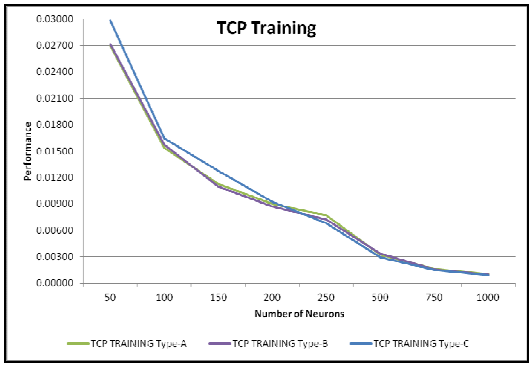

FIGURE 3: Graphical training results of the TCP data set

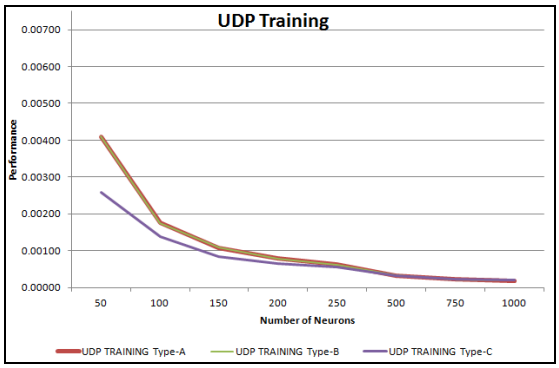

FIGURE 4: Graphical training results of the UDP data set

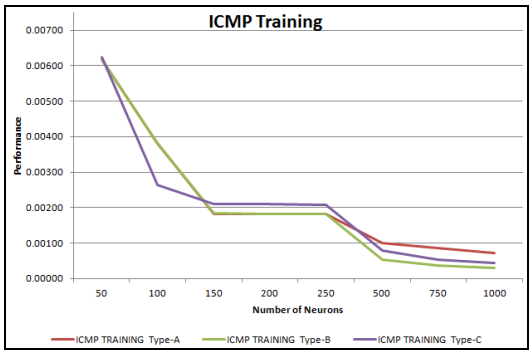

FIGURE 5: Graphical training results of the ICMP data set

4.2. Testing Results

The best performance is obtained with Type-C conversion of all three data sets. The MSE and FAR values are 95.65%, 79.39%, 62.96% and 2.6%, 4.72%, 7.85% for TCP, UDP and ICMP respectively.

Figure 6 and Figure 7 show the comparison of the performances and False Alarm Rates for TCP, UDP and ICMP testing data sets with their three different Type of conversions (Type-A, Type-B and Type-C).

		Type-A	Type-B	Type-C
TCP	Performance	90.86%	94.28%	95.65%
	False Alarm	3.45%	3.38%	2.60%
UDP	Performance	61.42%	65.09%	63.96%
	False Alarm	8.78%	10.29%	7.85%
ICMP	Performance	88.95%	83.46%	79.39%
	False Alarm	16.31%	15.88%	4.72%

TABLE 12: Testing Results for TCP, UDP and ICMP data sets.

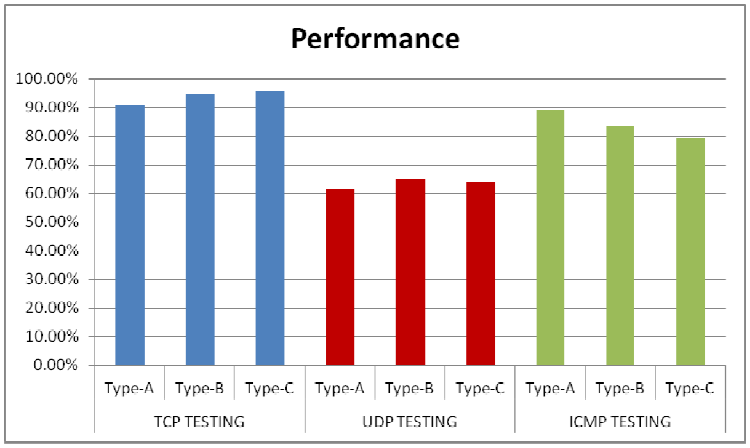

FIGURE 6: Testing result of Performances.

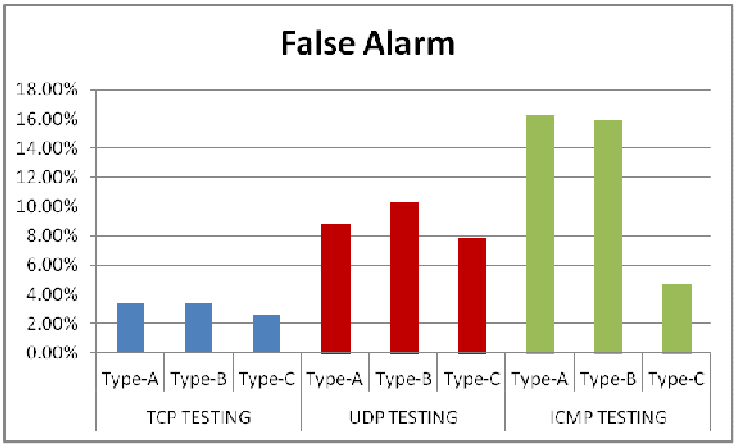

FIGURE 7: Testing results of False Alarm Rates (FARs)

False alarm rates of all type of conversions have been observed similar for both TCP and UDP testing datasets. The FAR results for ICMP testing dataset have an appreciable amount of differences. It is observed that FARs are over 15% for type-A and type-B while it is less than 5% for type-C.

According to experimental results, false alarms are always the highest percentage for type-A and type-B data sets. This shows that converting strings to numbers with respect to their frequency may not be a good solution.

Learning and testing the TCP dataset gives good results and can still be improved, while the results for UDP and ICMP datasets are very poor. More training data or more attributes may improve the results.

In this paper the overall MSE and FAR values are calculated as 93.42% and 2.95% respectively. These results are better than the results in some other papers where different methods have been applied. For instance in [5] the performance values are 81.66%, 92.79%, 92.59%, 92.26% and 65.01% with Naïve Bayes, Random Forest, Random Tree, Multi-Layer Perceptron, and SVM respectively. Again in the same paper the performance values of some other methods (J48 and NB Tree) are very close to our overall results which are 93.82% and 93.51% respectively. In [7] the performance is 89% and FAR is 11% with RBF neural network.

5. CONCLUSION AND DISCUSSION

In this study, the most widely used data set (KDD'99) is pre-processed. Some duplicated data is deleted then training and testing data is divided into three sections according the protocol types. Afterwards strings in the data sets are converted to numerical values using three different techniques as Type-A, Type-B and Type-C. All preprocessed data sets are trained and tested with RBF network using MATLAB toolbox. It is experimented that the preprocessing phase plays an important role on the performance of the learning system.

It is also observed that applying learning algorithms on divided data (with respect to their protocol types) enables better performance.

As mentioned in the testing results section, the accuracy of testing results is more satisfied than the literature studies. However this proposed learning algorithm and alternative string to integer converting techniques need more research to find optimal solutions.

6. REFERENCES

[1] K. Ilgun, R.A Kemonerer and P.A Porras, "State Transition Analysis: A Rule Based Intrusion Detection Approach", IEEE Transaction on Software Engineering, Vol.21(3), March 1995, pp.181-199.

[2] S. Capkun. Levente Buttyan. "Self-Organized Public Key Management For Mobile Ad Hoc Networks", IEEE Transactions on Mobile Computing, Vol. 2(1), January -March 2003, pp. 52-64.

[3] Yao, J. T., S.L. Zhao, and L.V. Saxton, "A Study On Fuzzy Intrusion Detection", In Proceedings of the Data Mining, Intrusion Detection, Information Assurance, and Data Networks Security, SPIE, Vol. 5812,pp. 23-30, Orlando, Florida, USA, 2005.

[4] R. P. Lippmann, D. J. Fried, I. Graf, J. W. Haines, K. R. Kendall, D.McClung, D. Weber, S. E. Webster, D. Wyschogrod, R. K. Cunningham, and M. A. Zissman, "Evaluating Intrusion Detection Systems: The 1998 DARPA Off-Line Intrusion Detection Evaluation," in Proc. DARPA Inf. Survivability Confer. Exposition (DISCEX), Vol. 2, 2000, pp. 12–26.

[5] M. Tavallaee, E. Bagheri, W. Lu, and A. Ghorbani, "A Detailed Analysis of the KDD CUP 99 Data Set," in Proc. 2009 IEEE International Conference on Computational Intelligence for Security and Defense Applications. pp. 53-58.

[6] M. Sabhnani and G. Serpen, "Application of Machine Learning Algorithms to KDD 1999 Cup Intrusion Detection Dataset within Misuse Detection Context", International Conference on Machine Learning, Models, Technologies and Applications Proceedings, Las Vegas, Nevada, June 2003, pp. 209-215.

[7] J. Bi, K. Zhang, X. Cheng, "Intrusion Detection Based on RBF Neural Network", Information Engineering and Electronic Commerce, 2009, pp. 357 - 360

[8] Ş.Sagiroglu, E. N. Yolacan, U. Yavanoglu, "Designing and Developing an Intelligent Intrusion Detection System", Journal of the Faculty of Engineering and Architecture of Gazi University, Vol. 26 (2), June 2011, pp. 325-340.

[9] Yu Y, and Huang Hao, "An Ensemble Approach to Intrusion Detection Based on Improved Multi-Objective Genetic Algorithm", Journal of Software, Vol.18 (6), June 2007, pp.1369-1378.

[10] O. Adetunmbi Adebayo, Zhiwei Shi, Zhongzhi Shi, Olumide S. Adewale, "Network Anomalous Intrusion Detection using Fuzzy-Bayes", IFIP International Federation for Information Processing, Vol. 228, 2007, pp. 525-530.

[11] R. Shanmugavadivu and N. Nagarajan, "An Anomaly-Based Network Intrusion Detection System Using Fuzzy Logic", International Journal of Computer Science and Information Security, Vol. 8 (8), November 2010, pp. 185-193.

[12] U. Ahmed and A. Masood, “Host Based Intrusion Detection Using RBF Neural Networks”, Emerging Technologies, ICET 2009, 19-20 Oct. 2009, pp. 48-51.

[13] The UCI KDD Archive, University of California, KDD Cup 1999 Data, http://kdd.ics.uci.edu/databases/kddcup99/kddcup99.html, October 28, 1999, [Feb 2012].

[14] J. Mark and L. Orr, “Introduction to Radial Basis Function Networks”, Technical Report, April 1996.

[15] Z. Caiqing, Q. Ruonan, and Q. Zhiwen, “Comparing BP and RBF Neural Network for Forecasting the Resident Consumer Level by MATLAB,” International Conference on Computer and Electrical Engineering, 2008 (ICCEE 2008), 20-22 Dec. 2008, pp.169-172.

[16] A. Iseri and B. Karlık, “An Artificial Neural Networks Approach on Automobile Pricing”, Expert Systems with Applications, Vol. 36 (2), March 2010, pp. 2155-2160.

Performance Comparison of Musical Instrument Family Classification Using Soft Set

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Abstract

Nowadays, it appears essential to design automatic and efficacious classification algorithm for the musical instruments. Automatic classification of musical instruments is made by extracting relevant features from the audio samples, afterward classification algorithm is used (using these extracted features) to identify into which of a set of classes, the sound sample is possible to fit. The aim of this paper is to demonstrate the viability of soft set for audio signal classification. A dataset of 104 (single monophonic notes) pieces of Traditional Pakistani musical instruments were designed. Feature extraction is done using two feature sets namely perception based and mel-frequency cepstral coefficients (MFCCs). In a while, two different classification techniques are applied for classification task, which are soft set (comparison table) and fuzzy soft set (similarity measurement). Experimental results show that both classifiers can perform well on numerical data. However, soft set achieved accuracy up to 94.26% with best generated dataset. Consequently, these promising results provide new possibilities for soft set in classifying musical instrument sounds. Based on the analysis of the results, this study offers a new view on automatic instrument classification.

Keywords: Traditional Pakistani Musical Instruments Sounds, Classification, Soft Set, Fuzzy Soft Set.

1. INTRODUCTION

Classification is one of the most important and significant machine learning areas, capable of handling musical data effectively and efficiently, once the dataset is categorized into different families. In general, the need for musical data analysis arises in different contexts, which leads to many practical applications such as effective data arrangement, music transcription, indexing and comprehensive digital libraries [1].

Generally, audio signal classification can be cast into musical genre, musical instruments, composer, artist, music segmentation and so on. Thus, musical instruments classification is not only subject matter for musicologists but also become an important research field for Music Information Retrieval (MIR) [2]. Much of existing research focuses on the achievable classification accuracy of different machine learning algorithms. The studies have shown that a number of different algorithms are able to achieve high classification accuracy rate. Such as support vector machine [3], [4], [5], artificial neural networks [6], [7] and rough set [8].

Even though in the work of Ali & Smith [9], they conducted comprehensive study on eight different classification algorithms. The author compared different eight classification algorithms with hundred different datasets. The relative weighted performance measurers showed that there was no single classifier to solve all classification problems with best performance over the different experimental setups. This leads that no single method has been found to be superior over all datasets. Nevertheless, rough set has been successfully applied for musical instruments sounds data [10], [11], [12]. Therefore, it is interesting to see the application of soft set theory for classification of musical instruments sounds. Moreover, to observe the viability, efficiency and effectiveness of soft set, while performing this classification task.

Molodtsov [13] introduced the notions of a soft set as a collection of approximate description of an object. The initial description of an object has as approximate nature, and there is no need of to introduce the notions of exact solution. The applications of this theory boom in recent years and are extended to data analysis [14], [15], decision-making [16], [17], [18] to texture classification [19].This furnishes motivation from the advancement in soft set to apply classification algorithm based on notions soft set theory (named as soft set classifier), which was proposed by [19] for texture classification. This paper focuses to asses the performance of soft set classifier towards classification of musical instruments. Moreover, the contemporary study expands the usual work of using western musical instruments to the non-western musical instruments i.e. Traditional Pakistani musical instruments.

The reminder of paper is organized as follows: Section 2 presents the dataset details. Feature extraction producer is discussed in Section 3. Section 4 illustrates an overview of classification algorithms followed by results and discussion in the Section 5. Finally the conclusions are made in Section 6.

2. DATASET

Musical instruments have universal appeal, richness and soothing tones without language and regional barriers. The history of Traditional Pakistani musical instruments (TMPI) can be gathered from various sources such as literature (folk, music), visual representation (painting, sculptures, and models). Interestingly, most of the Pakistani musical instruments remain still in use. Pakistani music is represented by a wide variety of forms. It ranges from traditional styles such as qawwali, sufism and ghazal to more recent shapes that is fusion of traditional music with western music.

Generally, these instruments can be cast into religious, geographic and tribal categories. For instance: harmonium and tabla comes under the religious category and their purpose is for spiritual uplifts. Likewise, under the umbrella of geographic category, instruments are: algoza, dhol, dholok and ektara. Benjo, rubab, gheychak, santoor are under the tribal category. TPMI play a significant role in Pakistani culture. They are used in wedding ceremonies, in traditional dances such as bhangra, jhumar and khattak. The primary instrument that defines bhangra and jhumar is the dhol. Whilst, the instruments for qawwali and sufism are harmonium and tabla [20].

Traditional Pakistani musical instruments play a significant role in Pakistani culture. In order to perform classification of Traditional Pakistani musical instruments a dataset is designed. Table 1 shows the taxonomy of TMPI based on Hornbostel and Sachs system. Dataset consists of three families which are string, woodwind, percussion and nine musical instruments. The dataset consist of 104 pieces of Traditional Pakistani musical instruments from compact disks and via internet. All pieces were solo music from three instrument families. The sampling rate was 44.1 kHz which was later resample to 22.1 kHz with mono .wav files. Table 1 presents the three families with their description which is partially based on Sachs-Hornbostel system [21].

Family	Instruments
String	Benju, Ghaychak, Rubab, Sarood, Tumbi
Woodwind	Bainsuri, Harmonium
Percussion	Tabla, Dholok

TABLE 1: Description of musical instruments

3. FEATURE EXTRACTION

Feature extraction is the significant phase in musical instrument classification. Depending on the characteristics of the problem domain; the crucial step in the classification is to identify the relevant features. Though, 'feature", "attribute" or "variable" refers to the aspect of data. Moreover, feature can be discrete, continuous or nominal. Therefore, usually during data collection, features are specified or chosen. As, extracted features are an input to the classifier (machine learning algorithm), therefore it is important to extract the right features which can help classifier to produce encouraging results.

Many feature schemes have been proposed in the literature for audio classification. It is worth to state that improving feature extraction process will be probably enhancing performance of the classification algorithm. As mention earlier, diverse features have been proposed and identified by different studies; each study either work on individual features or combination of features [7]. In general, designing a classification algorithm for musical instrument, feature extraction techniques are mostly taken from speech and speaker recognition system as they have proved a significant role to extract valuable information from the dataset [6], [7]. For this study, Mel–Frequency Cepstral Coefficient (MFCCs) and perception based are adopted from the work of [6] for extracting features. On the other hand, these features are reflecting different aspects of signal spectrum, which are discussed in the following sub-section.

3.1 Perception–Based

The most popular features related to perception based are spectral centroid (brightness), spectral flux and bandwidth (spectral range), which have popularity across the literature. These spectral features are computed from the Fast Fourier Transform (FFT) of the segmented signals. Besides, time domain zero crossing and root mean square are also included which reflects the temporal properties of the signals.

3.2 Mel-Frequency Cepstral Coefficients

Mel-frequency cepstral coefficients are proven to be useful in an extensive range of classification tasks such as speech classification [22], speaker identification [23] and musical genre classification [24]. MFCCs proved to be a successful candidate for classification and recognition For MFCCs, the steps derived in the work of [6] are adapted. The input signal is first divided into frames. Afterwards, fast Fourier transform (FFT) is used to get the power spectrum of the each frame. Finally, the Mel filter bank is generated to scale the frequencies logarithmically. To conclude, the mean and standard deviations has been then calculated for each of the feature vectors. Table 2 provides the depiction of features utilized

No.	FEATURES
1	Zero Crossings
2-3	Zero Crossing Rate(Mean and Standard deviation)
4-5	Root Mean Square(Mean and Standard deviation)
6-7	Spectral Centriod(Mean and Standard deviation)
8-9	Bandwidth(Mean and Standard deviation)
10-11	Spectral Flux(Mean and Standard deviation)
12-37	MFCC (Mean and Standard deviation of the first 13 values)

TABLE 2: Features Descriptions

Prior to the classification stage, vector normalization was done to make sure that data must lie between the ranges of $[0,1]$.

4. CLASSIFICATION ALGORITHMS

As it was mentioned in Section 1, automatic classification of musical audio data can be performed in many ways. However, in the described research, two algorithms have been used. The reason for considering soft set is to see the viability of this mathematical tool, even though rough set has been successfully applied to audio signal classification. Moreover, soft set theory is straightforward, simple and it allows reducing important problems to well-known Boolean ones using model assumptions. On the other hand, Maji *et al* [16] proposed an algorithm for decision making problems. This algorithm has similarity with soft set classifier proposed by Mushrif *et al*, [19] I in particular for texture classification.

While in case of fuzzy soft set, this algorithm has similarity with the work of Mushrif *et al*, [19], where building the model is same (training set), however for the classification phase which involves construction of comparison table is replaced by the similarity measurement function. Next subsection provides an overview of soft set and fuzzy soft set.

4.1 Soft Set

In 1999, Molodtsov [13] introduced the notion of a soft set as collections of approximate descriptions of an object. This initial description of the object has an approximate nature, and hence there is no need to introduce the notions of exact solution. The absence of restrictions on the approximate description in soft set makes this theory suitable and easily applicable in real world problems. Soft set theory is a newly emerging mathematical tool to deal with uncertain problems. The applications of this theory boom in recent years and are extended to data analysis [14], [15], decision-making [16], [17], [18], classification [19].

Maji, Roy & Biswas [16] presented some new definitions on soft set in decision making problems. Afterwards, Mushrif [19] offered a novel method for classification of natural texture using the notions of soft set theory. All features from the natural textures were consists of real numbers. For the dataset, 25 texture classes with 14 textures features were used. Out of 49 images, 14 images were randomly selected for training and 35 remaining for testing. The proposed method successfully classifies natural textures. In this section, soft set classifier has been explained in details.

The soft set classifier learns by calculating the average value of each attributes (features) from the entire objects. In other words, an object in the universe represents data which is derived from the same class label. Afterwards, to classify the test data, first to construct a comparison table as designed in the case of decision making problem.

Soft Set Classifier (SSC)

Training phase

1. Given *N* samples obtained from the data class w.
2. Calculate the cluster center vector $E_{wi}, i = 1,2,..,N$.
3. Obtain soft set model (F, E) which is $W \times D$.
4. Repeat the process for all W classes.

Classification phase

1. Obtain the unknown class data.
2. Obtain a soft set (F, A) which have elements p_{wd}.
3. Compute comparison table of soft set (F, A)
4. Compute the score vector S.
5. Assign the unknown data to class *w* if $w = \max S$

For calculating cluster center vector, the following expression is used [19].

$$E_w = \frac{1}{N} \sum_{i=1}^{N} E_{wi} \tag{1}$$

where E_w is mean of feature vectors in the same class label. Moreover, $W \times D$ is table in which element of each table is g_{wd}, where $w = 1,2,..,W$ and $d = 1,2,..,D$. In this way, a row g_{wd} is a cluster center vector for every class w having D features.

Similarly, for calculating element p_{wd}, the following expression is used [19].

$$p_{wd} = 1 - \frac{g_{wd} - Efd}{\max(g_{wd})} \tag{2}$$

where $w = 1,2,..,W$ and $d = 1,2,..D$.

The comparison table is constructed (for more details please refer to [19]). Afterwards, the score S is computed. The score vector S is a vector containing largest element in S. The score vector expression is as follows [19].

$$w = \arg\left[\max_{w=1}^{W}(S)\right] \tag{3}$$

4.2 Fuzzy Soft Set

In 1965, Zadeh [25] introduced the concept of fuzzy set, where he stated that fuzzy set is a kind of soft set. Let A be a fuzzy set and μ_A be a member function where μ_A be a mapping of U into $[0,1]$. Later, fuzzy set has been studied by Roy *et al*. [27] where this general concept has been combined with soft set, named as fuzzy soft set. The results from fuzzy soft set further expand the scope of applications of soft set theory.

Interestingly, Maji *et al* [16] proposed an algorithm for decision making problems. This algorithm has similarity with soft set classifier proposed by Mushrif *et al* [19] I in particular for texture

classification. In addition, the concept of measuring similarity between two soft set has been studied by [28], [29] and [30].

4.2.1 Similarity Between Two Soft Sets

Measuring similarity between two entities is a key step for several data mining tasks such as classification and clustering. The similarity measure calculates the extent to which different image or signal patterns are alike [30]. Later, Majumdar & Samanta [28] defined and studied the generalised fuzzy soft sets where the degree is attached with the parameterization of fuzzy sets while defining a fuzzy soft set and provides similarity measured of soft set and fuzzy soft set. Next sub-section provides the preliminaries for general fuzzy soft sets

a) Preliminaries

In this sub-section, similarity between the two general fuzzy soft sets are explained by Majumdar & Samanta [28]. Let $U = \{x_1, x_2, ..., x_n\}$ be the universal set of elements and $E = \{e_1, e_2, ..., e_m\}$ be the universal set of parameters. Let F_ρ and G_δ be two general fuzzy soft sets over the parameterized family universe (U, E). So

$F_\rho = \{(F(e_i), \rho(e_i)), i = 1,2,...,m\}$ and $G_\delta = \{(G(e_i), \delta(e_i)), i = 1,2,...,m\}$.

Therefore, $\tilde{F} = \{F(e_i), i = 1,2,..,m\}$ and $\tilde{G} = \{G(e_i), i = 1,2,..,m\}$ are two families of fuzzy soft sets. As a result, similarity between $\tilde{F}$ and $\tilde{G}$ is determined and it is denoted by $M(\tilde{F}, \tilde{G})$. Next the similarity between the two fuzzy soft sets ρ and δ is found and is denoted by $m(\rho, \delta)$. Later, the similarity between the two fuzzy soft sets F_ρ and G_δ is denoted as $S(F_\rho, G_\delta) = M(\tilde{F}, \tilde{G})$ and $\rho = \delta = 1$. Now the formula for similarity measure is

$$S(F_\rho, G_\delta) = M_i(\tilde{F}, \tilde{G}) = 1 - \frac{\sum_{j=1}^{n} |\tilde{F}_{ij} - \tilde{G}_{ij}|}{\sum_{j=1}^{n} (\tilde{F}_{ij} + \tilde{G}_{ij})} \quad (4)$$

where F and G are two families of fuzzy soft sets.

5. RESULTS AND DISCUSSION

Sample data from compact disks and via internet was set up for the different experiments. Seven datasets were utilized. Table 3 sums up the characteristics of different experimental sets carried out during dataset formations. In the first experimental setup, the parameter audio length (duration) will be evaluated to the performance of classification algorithm. Since, there is lack of uniform approach for audio length of sounds. Therefore, this study investigates three audio lengths which are 10 seconds, 20 seconds and 30 seconds. Likewise, this is done in order to generate diverse datasets and to examine whether this identified parameter plays major role in determining the classification results [6].

Afterwards, the second set focused on finding the optimal frame size (window analyzes). For feature extraction it is assumed that only short-term audio streams are present. For classifying longer audio streams, segmentation is necessary. Each of the audio samples is divided into frames [31]. In addition, the reason to look into the frame size 256 samples and 1024 samples, these two frame sizes have been commonly used, when it comes to expands the usual work of using western musical instruments to non-western musical instruments such as in the work of [6], [32]. Moreover, for analyzing features of audio and speech algorithms, they are computed on frame basis. By doing so, the amount of data to be processed may possibly reduce.

The remaining of the datasets dealt with finding the best starting point of audio files by providing the overall better classification results in terms of accuracy rate. The reason for taking this parameter into consideration is to look into the problem of locating the beginning of the sound. The purpose is observed and to identify whether noise is there at the beginning of the sound or not [8]. Therefore; the starting points of each dataset were altered to 0 second, 0.05 seconds and 0.3 seconds. The small size of the starting points are considered since, few of the original sounds in the datasets have shorter length (less then 1 second).

NO.	PARAMETERS	DATASET	VALUES
1	Audio Length (Duration)	L1	0.1 to 10 Seconds
		L2	0.1 to 20 Seconds
		L3	0.1 to 30 Seconds
2	Frame Size (Segmentation)	FS1	256 Samples
		FS2	1024 Samples
3	Starting Point Of Audio File	SP1	0 Second
		SP2	0.05 Second
		SP3	0.3 Second

TABLE 3: Experimental setup designed for study

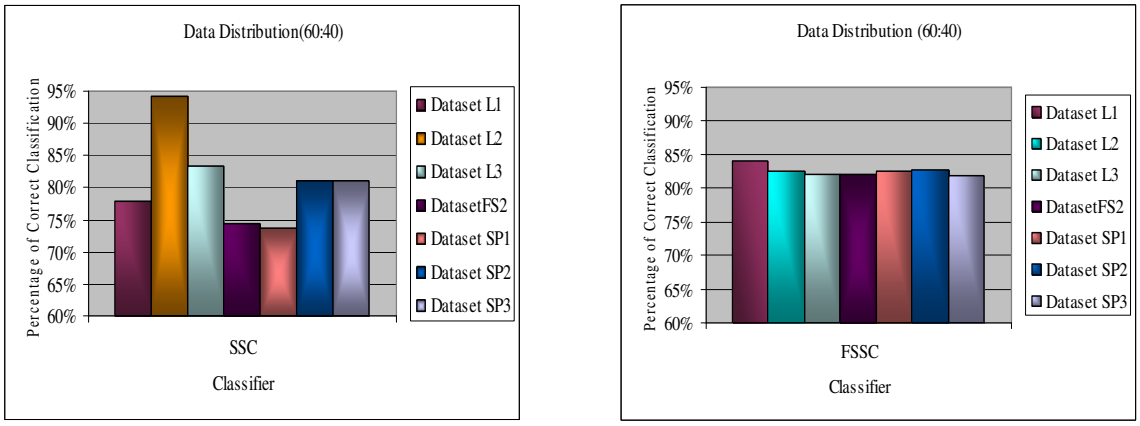
The experiments were performed on two different models: comparison table and similarity measure of two soft sets. For the comparisons of both classification algorithms, performance measurement was classification accuracy. Table 4 shows the classification accuracy. As mentioned earlier, the dataset consists of three families with nine musical instruments. Feature extraction in these experiments are implemented in an overlapped analysis window of 256 samples at 22050Hz, calculated the means and standard deviations of all 37 attributes. After feature extraction, we utilize soft set classifier and fuzzy soft set classifier on those extracted features.

Comparison Table (SSC)			Similarity Measure (FSSC)	
Data Distribution	60:40	70:30	60:40	70:30
DatasetL1	77.91	86.84	83.97	84.20
DatasetL2	94.26	92.27	82.44	81.87
DatasetL3	83.45	85.98	82.15	81.90
DatasetFS2	74.29	69.83	82.03	82.58
DatasetSP1	73.75	81.22	82.47	82.41
DatasetSP2	81.19	88.23	82.63	82.05
DatasetSP3	81.13	88.34	81.80	81.50

TABLE 4: Percentage of correct classification for all datasets

Figure 1 presents the performance comparison of classification accuracy of different datasets with SSC and FSSC. In case of SSC, the classification accuracy gradually increases when the modified starting points are used, instead of zero. The highest achievement occurred in the Dataset L2 with accuracy 94.26%, while, the lowest achievement 73.75% occurred in the DatasetSP1. In case of FSSC, the highest classification hit rate was 83.97%, while the lowest achievement was 81.80%.

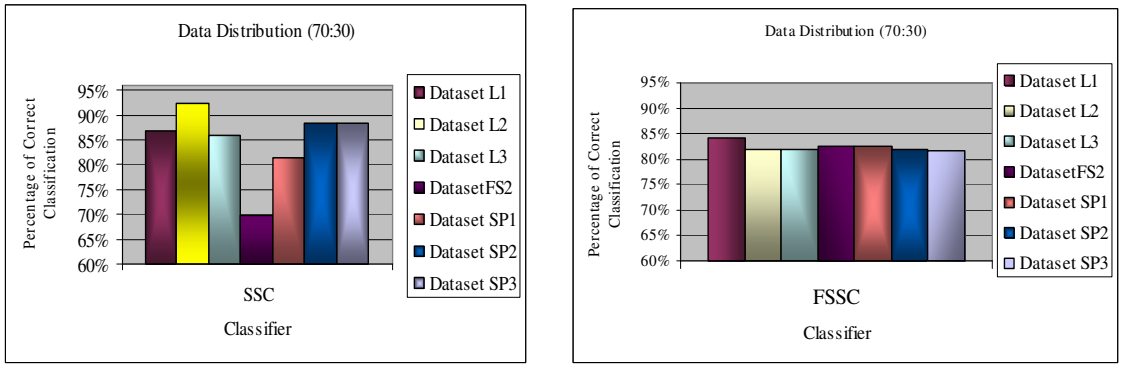
Though, the results for FSSC are about 1.64% better on mean average with data partition 60:40. Some what the results from SSC are little weaker then of that sophisticated method (FSSC). However, the simplicity of SSC makes it appealing and can be pretty helpful in classifying musical instruments sounds.



(a) (b)

FIGURE 1: Classification performance of both classifiers (a) and (b) with data distribution 60:40

While, Figure 2 shows the graphical comparison with data fraction 70:30 for both classifiers. It can be seen that classification range is 69.83% to 92.27% for SSC. Whilst, for FSSC the range from 81.50% to 84.20%. Interestingly, the results for SSC are about 2.32% better on mean average. And the hypothesis that larger the training set make sure classifier to gain knowledge of data, this graph plots the evidence of that myth.



(a) (b)

FIGURE 2: Classification performance of both classifiers (a) and (b) with data distribution 70:30

6. CONCLUSIONS

Classification is a key intervention for initiating process of labeling monophonic sounds. Most of the studies conducted to find differences and similarities with features schemes, afterwards evaluate and compare with various classifiers. At the same time as, the right extracted features can simplify the design of a classification algorithm, whereas lousy features can hardly be compensated with any of the classification algorithm. Therefore, it is likely to state that appropriate parameterization of audio sounds allows efficacious classification of musical instruments. Additionally, the choice of classification algorithm makes a quite sophisticated approach towards classification task. However, despite the massive research has been carried

out on this filed, studies have mainly dealt with western musical instruments and few works can be found on non-western musical instruments. However, individual musical instrument has different behavior and so does Pakistani musical instruments. Therefore, this study incorporates soft set theory for classification of Traditional Pakistani musical instrument and investigates the impact of three factors, which are length of audio file, frame size and starting point towards classification performance of soft set classifier.

A small–scale database of instrumental music was built, in line with popular taxonomy known as Sachs & Hornbostel, categorizing instruments into three families: string, woodwind and percussion. With experiments on 37 features and two classifiers, all music clips were automatically classified by instrument families. In the light of obtained results from the both classifiers, provides a relatively new picture about instrument classification. The experiments testified that FSSC suits well for automatic instruments classification, while applied SSC best to it.

In addition, based on the obtained results, this study offers a new view on automatic instrument classification. Thus, the soft set can be considered to be employed in musical instrument classification problem. Nevertheless, it is experimentally demonstrated that this classification algorithm yields better accuracy when compared with fuzzy soft set. These results have further expanded the scope of soft set for real world problems. Future work will consider the selection of the most relevant features in discriminating between different instruments and extension of the present feature set.

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REFERENCES

[1] Kotsiantis, S.B. Supervised machine learning: A review of classification techniques. *Informatica 31,* pages 249-268. (2007)

[2] McKay, C. & Fujinaga, I. Automatic music classification and the importance of instrument identification. *In: Proceedings of the Conference on Interdisciplinary Musicology* (CIM05). Montreal, Canada (2005).

[3] Mierswa, I., & Morik, K. Automatic Feature Extraction for Classifying Audio Data. *Journal of Machine Learning:* Volume 58 Issue 2-3 (2005).

[4] Essid, S., Richard, G., & David, B. Musical Instruments Recognition by pair wise classification strategies. *Audio, Speech and Language processing, IEEE Transaction on Speech and Audio Processing*, 14(2), 1401-1412 (2005).

[5] Liu, J. & Xie, L. Comparison of Performance in Automatic Classification between Chinese and Western Musical Instruments. *In: Proceeding of WASE International Conference on Information Engineering. Beidaihe,Hebei,* (2010)

[6] Senan, N., Herawan, T., Mokji, M.M., Nawi, N.M., & Ibrahim, R. The Ideal Data Representation for Feature Extraction of Traditional Malay Musical Instrument Sounds Classification. *Advanced intelligent computing theories and applications: Lecture Notes in Computer Science*, 2010, Volume 6215/2010,pages 345-353

[7] Ding, Q., Zhang, N. Classification of Recorded Musical Instruments Sounds Based on Neural Networks. *In: IEEE Symposium on Computational Intelligence in Image and Signal Processing.* Pp 157-162. Honolulu, HI (2007).

[8] Wiezorkowska, A. Towards Musical Data Classification via Wavelet Analysis. *In Proceeding of the 12th International Symposium on Foundations of Intelligent Systems*, Springer–Verlag London Uk. (2000)

[9] Ali, S. & Smith, K.A. On learning algorithms selection for classification. Applied Soft Computing 6, pages119-138 (2006).

[10] Wieczorkowska, A. Rough Sets as a tool for audio signal classification. *Lecture Notes in Computer Science, Volume 1609/1999*, 367-375, (1999) DOI: 10.1007/BFb0095123.

[11] Wieczorkowska, A. & Czyżewski, A. Rough Set Based Automatic Classification of Musical Instrument Sounds. *In: International Workshop on Rough Sets in Knowledge Discovery and Soft Computing*. pp. 298-309, (2003).

[12] Senan, N., Ibrahim, R, Nawi, N. M., Yanto, I. T. R.& Herawan, T. Feature Selection for Traditional Malay musical instruments sounds classification using rough set. .*Journal of Computing Volume 3, Issue 2, (*2011).

[13] Molodtsov, D. Soft set theory –first results. *Computer and mathematics with applications*. Pp19-31. (1999).

[14] Zou, Y.& Xiao, Z. Data analysis approaches of soft sets under incomplete information. *Knowledge-Based System* 21, 2128-2137 (2008).

[15] Herawan, T. Deris, M. M. A Direct Proof of Every Rough Set is a Soft Set. *In Third Asia International Conference on Modeling & Simulation*, AMS '09 pages119–124, Bali (2009).

[16] Maji, P. K., Roy, A. R., Biswas, R. An application of soft sets in decision making problem. Computers and mathematics with applications. pp 1077-1083. (2002).

[17] Roy, A. R. & Maji, P. A fuzzy soft set theoretic approach to decision making problems.*Journal of Computational and Applied Mathematics. Volume 203(2), pp.540-542* (2007).

[18] Jiang, Y., Tang, Y. & Chen, Q. An adjustable approach to intuitionistic fuzzy soft sets based decision making. *Applied Mathematics Modeling*. Volume 35 (2), pp. 824-836 (2011).

[19] Mushrif, M., M, Sengupta, S., Ray, A.K. Texture Classification Using a Novel Soft Set Theory Based Classification Algorithm. *In: LNCS*, vol.3851, pp.246-254.Springer, Heidelber (2006).

[20] Ziagham, N. (2003). Forms of Pakistan Music. Retrieved March, 9, 2011 from http://www.maighmalhaar.com/IntroductionPage1.html

[21] Marshall, P. (2011). Sachs Hornbostel System of instrument classification. Retrieved December 8, 2010 from website http://www.drumdojo.com/sachshornbostel.htm

[22] Davis, S.B. and Mermelstein, P. Comparison of parametric representations for monosyllabic word recognition in continuously spoken sentences. *IEEE Transaction on Acoustics, Speech and Signal Processing,* Volume number 28, issue 4:357-366 (1980).

[23] Sarimollaoglu, M., Dagtas, S., Iqbal, K., Bayrak, C. A text–independent speaker identification system using probabilistic neural networks. *International conference on computing, communications and control technologies (CCCT),* Austin, USA, pages 407-411(*2004).*

[24] Tzanetakis, G., Cook, P. Musical genre classification of audio signals. *IEEE Transaction on Speech and Audio Processing:* Vol. 10, No. 5 (2002).

[25] Zadeh, L. Fuzzy sets. *Inform. Control. V*olume number 8: 338-353. (1965).

[26] Maji, P. K., Biswas, R. & Roy, A. Fuzzy soft sets. *Journal of Fuzzy Mathematics* 9(3), pp.589-602 (2001).

[27] Roy, A. R. & Maji, P. A fuzzy soft set theoretic approach to decision making problems. *Journal of Computational and Applied Mathematics*. Volume 203(2), pp.540-542 (2007).

[28] Majumdar, P. & Samantra,S.K.(2010). Generalized fuzzy soft set. *Journal of Computational and Applied Mathematics*. Pp. 1279-1286.

[29] Kharal, A. Distance and similarity measurement for soft set. *New Math.. & Nat. Com.(NMNC).* Volume (6), pp. 321-334 (2010).

[30] Handaga, B. & Deris M. M**.** Similarity approach on fuzzy soft set based numerical data classification. *Communications in Computer and Information Science.* Volume 180(6), pp. 575-589 **(**2011).

[31] Kumari, R. S. S., Sugumar, D. & Sadasivam,V. Audio signal classification based on optimal wavelet and support vector machine. *Proceeding of International conference on computational intelligence and multimedia applications*. Volume 2, pp: 544 – 548. (2007)., ISBN:0-7695-3050-8

[32] Gunasekaran, S. & Revathy, K. Fractal dimension analysis of audio signals for Indian musical instrument recognition*. International Conference on Audio, Language and Image Processing, Shanghai, ISBN: 978-1-4244-1723-0,* pp. 257-261 (2008).

A Knowledge-based System for Classifying Particle Reaction and Decay Processes

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Abstract

In particle physics conservation laws have been devised to explain allowed and forbidden particle reactions and decays. They can be used to classify particle reactions and decays into strong, electromagnetic, and weak interaction processes. This article describes a computational system, which tests conservation rules to find allowed and forbidden reaction and decay processes, and to classify allowed processes into strong, electromagnetic, and weak interactions.

Keywords: Particle Interactions, Particle Decays, Expert System, Knowledge-based System

1. INTRODUCTION

To date, many hundreds of different particles have been discovered. These can decay in many different ways as listed in [1]. The standard model [2] explains why some particles decay into other. Strong, electromagnetic, and weak interactions all cause these decays. Conservation laws that are summarized in Table 1 [3] the various additive and multiplicative quantum numbers and which interactions conserve them are used to classify the decay. All quantum numbers [2] are conserved in strong interactions (SI). Isospin and G-parity are violated in the electromagnetic interaction (EM). In weak interactions (WI), some of the quantum numbers are violated with some restriction. The largest listing of particles has been compiled by the particle data group (PDG) [4]. To know the interaction type for a given reaction or decay one needs to acquire knowledge of the quantities that can be conserved, check the conservation rules, and thereby determine the interaction type. For non experts this is not an easy task. This process is time consuming as well. A possible solution for this is to use artificial intelligence techniques. In this paper we describe a knowledge-based system, popularly known as an expert system that can be used for this task. While expert systems are not able to think, they do have some advantages over the human expert in terms of consistency in delivering answers and not jumping to conclusions without considering all details. An expert system usually consists of knowledge base and inference engine [5]. The knowledge base itself consists of the knowledge that is specific to the domain of application including facts about the domain, and rules that describe relation in the domain. The inference engine examines the facts and determines whether or not they are satisfied by using the rules in the rule-base. It also determines the order in which these rules are fired. We have developed our knowledge-based system using the CLIPS language [6]. CLIPS supports for rule-based, object-oriented, and procedural programming [7]. The default interface for CLIPS language is command-line interpreter. CLIPS is a rule-based production language. The paper is organized as follows: section 2 describes the knowledge representation and CLIPS rules, section 3 presents the results with a figure, section 4 concludes the paper, and section 5 gives the references.

Conserved Quantity	Interaction (Yes = quantity is conserved)		
	SI	EM	WI
Energy/Momentum	Yes	Yes	Yes
Q – Charge	Yes	Yes	Yes
j - Angular Momentum	Yes	Yes	Yes
L - Lepton number	Yes	Yes	Yes
L_e - Electronic number	Yes	Yes	Yes
L_μ - Muonic number	Yes	Yes	Yes
L_τ -Tauonic number	Yes	Yes	Yes
□ - Baryon number	Yes	Yes	Yes
S - Strangeness	Yes	Yes	No ($\|\Delta S\| = 0,1$)
C - Charm	Yes	Yes	No ($\|\Delta C\| = 0,1$)
B - Bottom	Yes	Yes	No ($\|\Delta B\| = 0,1$)
T - Top	Yes	Yes	No ($\|\Delta T\| = 0,1$)
I - Isospin	Yes	No	No ($\Delta I = 1, 1/2$)
I_3 - 3rd component	Yes	Yes	No
P – Parity	Yes	Yes	No
C - Charge conjugation	Yes	Yes	No
CP (or T)	Yes	Yes	No (rare violations)
CPT	Yes	Yes	Yes
G – Parity	Yes	No	No

TABLE 1: Summary of conservation rules [3]

2. KNOWLEDGE REPRESENTATION

We used the computer readable data of particle properties as listed in [8] for this work. According to the instructions provided there, particle properties of anti-particles were added to the list. All particle properties and those of their anti-particles were stored in a text file. Some names were changed in order to be readable by CLIPS. For example 'rho(770)' was changed to 'rho[770]'. We converted about 240 particles, and their properties into facts in CLIPS syntax, and stored them in the knowledge base of the CLIPS language. Conservation rules that are shown in Table 1 were written as rules in CLIPS, and stored in a file. The following piece of code shows the structure of a CLIPS facts template. Note that this illustrates the syntax for the CLIPS programming language defined in [5].

```
(deftemplate particle " "
(slot mass (default 0))
(slot width (default 0))
(slot I (default ND))
(slot G (default ND))
(slot J (default 0))
(slot P (default ND))
(slot C (default ND))
(slot A (default 0))
(slot PDG-MC (default 0))
(slot Chrg (default 0))
(slot B (default 0))
(slot name (default "0"))
(slot quarks (default "0"))
(multislot qflavor-qn (default 0 0 0 0))
(multislot LF-qn (default 0 0 0 0))
```

The particle reaction $a + b \rightarrow c + d + e + f$ is added to the fact list at run-time, where a, b, c, d, e , and f represent particle names. The template is as follows

(deftemplate reaction " reaction" (multislot lhs (default 0)) (multislot rhs (default 0)))

While the left hand side 'lhs' can take one or two arguments, the right hand side 'rhs' can take a maximum of four arguments. A particle reaction or decay is stored as a fact by taking a, b, c, d, e, and f from user input. The rules (knowledge) are used to check conservation rules. A CLIPS rule is something like an "if----then" statement in procedural language, but it is not used in a procedural way. When the "if" parts are satisfied, given only that the rule engine is running. CLIPS rules were written to fire in a specific order. For example, the following CLIPS rule checks the strangeness conservation [9] of a reaction or decay and then takes actions for executing other rule(s).

```
(defrule rule-Strangeness-conservation " checking Strangeness conservation "
?st <- (state (value 1))
?sa <- (conserved (Charge yes)(Mass yes)(Lepton-number yes)(Electronic-number yes)
(Muonic-number yes)(Tauonic-number yes)(Baryon-number yes)(Strangeness no)
(Angular-momentum yes))
(reaction(lhs ?a1 ?a2)(rhs ?b1 ?b2 ?b3 ?b4))
(particle (name ?a1&~"nil")(qflavor-qn ?qa1 $?))
(particle (name ?a2)( qflavor-qn ?qa2 $?))
(particle (name ?b1&~"nil")(qflavor-qn ?qb1 $?))
(particle (name ?b2&~"nil")(qflavor-qn ?qb2 $?))
(particle (name ?b3)(qflavor-qn ?qb3 $?))
(particle (name ?b4)(qflavor-qn ?qb4 $?))
=> (retract ?st)
(bind ?*DeltaStrange* (difference ?qa1 ?qa2 ?qb1 ?qb2 ?qb3 ?qb4))
(if (= ?*DeltaStrange* 0) then
(retract ?sa)
(modify ?sa (Strangeness yes))
(format t "%-25s %5s" "Strangeness" "Yes")
(printout t crlf crlf)
else
(format t "%-25s %1d" "DeltaS" ?*DeltaStrange*)
(printout t crlf crlf) )
(modify ?st (value 2)) )
```

The relationship between 3rd component (I_3) of isospin, electric charge (Q), and hypercharge (Y) $I_3 = Q - Y/2$ [10]was used to calculate I_3. Conservation of I_3 is similar to the conservation of charge, lepton numbers, baryon number, strangeness, charm, beauty, and top. To check the conservation of angular momentum and isospin, which are different from the others, the procedure as mentioned in the note [11] was followed. We did not require checking for G-parity, CP, and CPT conservations. Once the conservation rules were checked, we required additional rules to check for distinguishing allowed and forbidden decays. If a reaction or decay process is allowed, then this expert system gives interaction type; otherwise, it gives a reason for forbidding the process. In SI and EM, charge conjugation and parity are conserved. Parity and charge conjugation conservations were checked to identify forbidden decays. Parity violation decays [12], for example, $\eta^0 \nrightarrow \pi^+ + \pi^-$ and $\eta^0 \nrightarrow \pi^0 + \pi^0$ can be expressed as a single rule $0^- \nrightarrow 0^- + 0^-$ with $J^P = 0^-$ representing the standard convention for labeling a spin and intrinsic parity of a particle. In these, the symbol ($\nrightarrow$) implies that the decay is not allowed. These forms of rules were written, by examining, for parity violating decays which are listed in [1], and implemented as CLIPS rules. Similar forms of rules were written for charge conjugation violating decays as well. As an example, charge conjugation violating decays $\pi^0 \nrightarrow 3\gamma$ and $\omega \nrightarrow 2\gamma$ can be expressed as $0^+ \nrightarrow 1^- + 1^- + 1^-$ and $1^- \nrightarrow 1^- + 1^-$ respectively, where 0^+ and 1^- represent spin and charge conjugation with the notation J^C [12]. The decays $\Lambda^0 \rightarrow \pi^- + p$, $n \rightarrow p + e^- + \overline{\nu_e}$, and $\mu^- \rightarrow e^- + \nu_\mu + \overline{\nu_e}$ represent allowed hadronic, semi-leptonic, and

leptonic weak processes respectively. As note [12] selection rules for I_3 and S violation for the above first two decay processes can be written as follows: (i) $|\Delta I_3| = 1/2$, $|\Delta S| = 1$ for hadronic decays (ii) $|\Delta I_3| = 1, |\Delta S| = 0$ for strangeness-saving semi-leptonic decays and $|\Delta I_3| = 1/2$, $|\Delta S| = 1$ for strangeness-changing semi-leptonic decays. In other words, the allowed strangeness-changing semi-leptonic decays are given by the $\Delta S = \Delta Q$ rule [1], where ΔQ is the change of charge of hadrons. Corresponding selection rules [1] for charm and beauty changing decays are $\Delta C = \Delta Q$ and $\Delta B = \Delta Q$ respectively. In the standard model the processes involving $\Delta S = 2$, $\Delta C = 2$, and $\Delta B = 2$ are forbidden in first order weak interactions [1]. Also the flavor changing ($\Delta S = 1$, $\Delta C = 1$, and $\Delta B = 1$) neutral current decays [1] are forbidden. As an example, the strangeness changing decays $K^+ \nrightarrow \pi^+ + \nu_l + \bar{\nu}_l$ is forbidden, where l is either e, μ, or τ . Those rules were written in CLIPS form as well.

3. RESULTS

Comparative tests were done by selecting interaction type known decays and reactions listed in [1]. All the expert system findings are consistent with them. For illustration, some of the decays and reactions are listed in Table 2. The first column of Table 2 shows some of the particle reactions or decays in usual notation. While the second column shows user inputs to the expert system for respective reactions or decays in our particle notation, the third column shows the expert system's finding for them. The detail outputs of this system for the decay $\Lambda^0 \rightarrow \pi^- + p$ and $\Xi^- \rightarrow n + \pi^-$ are shown in Figure 1.

Particle reaction/decay	User input	The expert system output
$\mu^- \rightarrow e^- + \nu_\mu + \overline{\nu_e}$	mu- → e- + nu[mu] + nu[e]bar	leptonic weak interaction
$n \rightarrow p + e^- + \overline{\nu_e}$	n → p + e- + nu[e]bar	semi-leptonic weak interaction
$\Lambda^0 \rightarrow \pi^- + p$	Lambda[P01]0 → pi- + p	hadronic weak interaction
$\Xi^- \rightarrow \Lambda^0 + \pi^-$	Xi[P11]- → Lambda[P01]0 + pi-	hadronic weak interaction
$\Xi^- \rightarrow n + \pi^-$	Xi[P11]- → n + pi-	forbidden, violating ($\Delta S = 0, \pm 1$) rule
$\rho^0 \rightarrow \pi^+ + \pi^-$	rho[770]0 → pi+ + pi-	strong interaction
$K^- + p \rightarrow \Xi^- + K^+$	K- + p → Xi[P11]- + K+	strong interaction
$\Sigma^0 \rightarrow \Lambda^0 + \gamma$	Sigma[P11]0 → Lambda[P01]0 + gamma0	electromagnetic interaction
$\eta^0 \rightarrow \pi^0 + \pi^0$	eta0 → pi0 + pi0	forbidden, (P,CP violating)
$\eta^0 \rightarrow 3\gamma$	eta0 → gamma0 + gamma0 +gamma0	forbidden, (C violating)
$\Sigma^- \rightarrow p + e^- + \overline{\nu_e}$	Sigma[P11]0 → n + e- + nu[e]bar	Strangeness-changing semi-leptonic weak interaction
$K^+ \rightarrow \mu^+ + \nu_\mu$	K+ → mu+ + nu[mu]	Strangeness-changing semi-leptonic weak interaction
$\rho^0 \rightarrow \pi^0 + \pi^0$	rho[770]0 → pi0 + pi0	forbidden, (C violating)
$\pi^- + p \rightarrow K^- + \pi^+ + \Lambda^0$	pi--+p → K- + pi+ + Lambda[P01]0	forbidden, violating ($\Delta S = 0, \pm 1$) rule

TABLE 2: This shows the expert system rule-based decision for given particle reactions and decays.

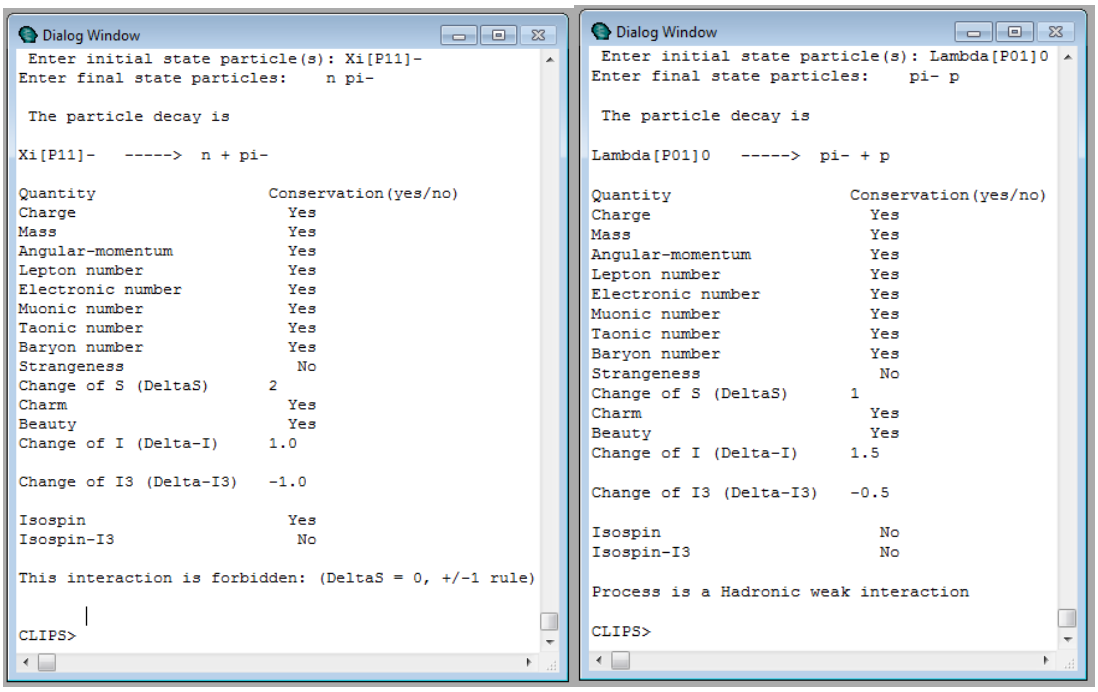

FIGURE 1: Screenshots of the expert system output for $\Xi^- \rightarrow n + \pi^-$ decay (left) and $\Lambda^0 \rightarrow \pi^- + p$ decay (right).

4. CONCLUSION AND FUTURE WORK

The paper we have presented provides the design and development of a proposed knowledge-based system to classify particle reactions and decays into interaction types. Our knowledge-based system is a rule based system, and we used CLIPS language to store our knowledge base. The interface of this system is the CLIPS default interface. This can be integrated with other higher languages to have graphical user interface (GUI). Finally, more importantly, we would like to mention that this system can be extended to find particle decay channels of a decaying particle.

5. REFERENCES

[1] K. Nakamura, et al.(Particle Data Group), "Journal of Physics G37, 075021," 2010.

[2] R. Michael Barnett, Henry Muhry, Helen R. Quinn, "The Elusive Trail to the Standard Model," in *The charm of Strange Quarks*, New York, Springer, 2000, pp. 37-91.

[3] J. Hinson, "Axial Vector and Pseudoscalr Hadronic Structure," in *Ph.D thesis*, Purdue, Purdue University, 2001, p. 64.

[4] J. Beringer et al.(Particle Data Group), "Phys, Rev. D86 010001," 2012.

[5] G. Giarratano J. Riley, Expert Systems Principles and Programming, Third Edition ed., Boston: PWS Publishing Company, 1998, pp. 327-470.

[6] Wikimedia , "CLIPS," Wikimedia Foundation, Inc, 7 7 2012. [Online]. Available: en.wikipedia.org/wiki/CLIPS. [Accessed 9 7 2012].

[7] Muhammad Zaheer Aslam,Nasimullah, Abdur Rashid Khan, "A proposed decision support system/expert system for guiding fresh students in selecting a faculty in Gomal university,Pakistan," *Industrial Engineering Letters,* vol. 1, no. 4, pp. 33-40, 2011.

[8] W.M. Yao et al.(Particle Data Group)J,Phys. G33, 1, "http://pdg.lbl.gov/2006/mcdata/mass_width_2006.csv," 2006. [Online]. [Accessed 09 09 2011].

[9] G.D. Coughlan,J.E. Dodd, "The idea of Particle physics," 1991.

[10] Wikimedia , "Hypercharge," Wikimedia Foundation, Inc., 25 4 2012. [Online]. Available: http://en.wikipedia.org/wiki/Hypercharge. [Accessed 2 5 2012].

[11] J.S. Kovacs, W.C. Lane, "Conservation laws for Elementary Particle Reaction," 2001.

[12] T.Ferbel, A. Das, Introduction to Nuclear and Particle Physics, second ed., Singapore: World Scientific Publishing Co. Pte. Ltd., 2005, pp. 207-343.

Verification and Validation of Knowledge Bases Using Test Cases Generated by Restriction Rules

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Abstract

Knowledge based systems have been developed to solve many problems. Their main characteristic consists on the use of a knowledge representation of a specific domain to solve problems in such a way that it emulates the reasoning of a human specialist. As conventional systems, knowledge based systems are not free of failures. This justifies the need for validation and verification for this class of systems. Due to the lack of techniques which can guarantee their quality and reliability, this paper proposes a process to support validation of specific knowledge bases. In order to validate the knowledge base, restriction rules are used. These rules are elicit and represented as *If Then Not* rules and executed using a backward chaining reasoning process. As the result of this process test cases are created and submitted to the knowledge base in order to prove whether there are inconsistencies in the domain representation. Two main advantages can be highlighted here: the use of restriction rules which are considered as meta-knowledge (these rules improve the knowledge representation power of the system) and a process that can generate useful test cases (test cases are usually difficult and expensive to be created).

Key-words: Knowledge Based Systems, knowledge Base Inference, Restriction Rules, Validation, Verification.

1. INTRODUCTION

Initial research efforts in Artificial Intelligence (AI) were done towards general models for problem solving. One example of this was the General Problem Solver (GPS) [10].The search for such general models was a great challenge. In the evolution line, a new approach was a kind of system that could deal with specialist knowledge. Those systems are knowledge based systems (KBS).Knowledge presented in a KBS is restricted to a unique domain or competence. The architecture of a KBS is composed by three fundamental components: (1) A user interface that allows the interaction of the user to the system; (2) an inference engine which performs the search in the knowledge base to solve the problem; (3) a knowledge base in which knowledge is stored in some kind of formal representation, usually production rules.

The process of collecting, organizing and representing knowledge is called knowledge acquisition and it is one of the most difficult phases in the construction of a KBS[1]. The professional responsible for this phase is the knowledge engineer [5]. The knowledge acquired is stored in the knowledge base. It is possible to observe the presence of several factors that can compromise the consistency of a knowledge base such as: knowledge inconsistency resulting from specialists interviewed or sources as books; misinterpretation of the domain by the knowledge engineer; errors in knowledge representation; insufficient knowledge to solve problems among others.

Considering those factors the processes of Validation and Verification (V&V) become a fundamental phase for the development of KBS. The processes of V&V for the interface and the inference engine

can be done by traditional techniques of software engineering, however V&V for the knowledge base need specific techniques. This is due to the declarative nature of the knowledge base representation, instead of procedural algorithms as in traditional systems.

This paper proposes a process for V&V and tests of knowledge bases in KBS based on restriction rules and generation of test cases. Section 2 describes concepts of V&V; section 3 mentions related works; in section 4 a description of restriction rules is done; section 5mentions works of restriction rules for V&V process of KBS; section 6 presents the process proposed in this article; section 7shows the trace of the process using a practical example; section 8 presents a comparison of our work to other approaches and section 9 concludes the paper.

2. VALIDATION AND VERIFICATION

Validation and verification are part of a series of techniques and methodologies applied to the evaluation of a system with the purpose of defining whether its construction is correct (verification); and for defining whether the system corresponds to its initial specifications (validation) [3].

In [8], validation process is defined as the process of assuring that a system satisfies user requirements; and verification as an activity in the validation process which aims to verify whether the system attends formal requirements. In other terms, validation is the process that evaluates the system capacities to solve problems. On the other hand, verification process evaluates whether the system is appropriately developed.

Verification is widely associated to the question: "are we constructing the system correctly?". The V&V process focus on assuring that a system can present characteristics such as quality and reliability in an acceptable level in order to be considered as a real system in a situation in which it is common the existence of risks and losses in consequence of system failures.V&V techniques applied to software development can be classified, in general, among the following types [3]:

- **Informal**: are based in the human interpretation and experience, and take as principles good sense practices, but, sometimes, become inefficient;
- **Static**: are based on techniques applied to the representation model verifying its data flows, control flows and syntax;
- **Dynamic**: are based on techniques applied to the functions or modules of the software. They are usually applied to complement the use of static techniques;
- **Formal**: consist in the mathematical proof of the software.

Most V&V techniques in KBS are dedicated to evaluate inference rules in knowledge bases representation [16]. Some of the problems which can be presented in the knowledge base are [17]:

- Subsumption Rules: occur when the antecedent part of a rule is a subset of the antecedent of another rule and both rules present the same consequent. The rule with fewer predicates in the antecedent (more general) is considered and the others (more specific) left aside. In the example:R_1: p ^ k → q and R_2: p → q, R2 would be maintained in the knowledge base.
- Duplicated rules: occur when two or more rules in the knowledge base are identical.
- Inconsistency: occur when two rules have the same antecedents, but different consequents. In the following example: R_1: p→q and R_2: p → ¬ q contains a paradox.
- Rules in Circles: occur when the execution of a chain of rules leads to the first hypothesis creating some kind of looping. This can be noticed in the example: R_1:p→q; R_2: q →k and R_3: k → p.
- Unreferenced inputs: occur when there are not values for all predicates present in the rule base.
- Impossible rules: when the antecedent of a rule cannot be satisfied. Example: R_1: p ^ ¬ p → q.

According to [17], such anomalies are source of problems and let the knowledge base susceptible to possible inefficiencies. However, by treating the problems mentioned there is no guarantee of the

knowledge validation. When those anomalies are corrected is possible to say that we are treating those anomalies in terms of verification (are we constructing the knowledge base correctly?) but we are not answering the question: are we constructing the right system?, i. .e, we are not validating knowledge in the knowledge base. This work addresses the validation problem by considering domain restriction rules as a way to validate a specific knowledge base.

3. VERIFICATION AND VALIDATION IN KBS

Because of this lack of techniques for V&V for KBS several works have been developed in this area. Some of them are briefly mentioned as follows. In [16], it is possible to find points related to KBS development. They point some common problems related to KBS development such as: (1) absence of requirements documents; (2) difficulty to generate test cases to validate the system; (3) use of prototypes as a way to elicit requirements; (4) absence of a life cycle; (5) difficulty to maintain the system as new rules are included in the knowledge base.

A study about an overlapping area between KBS and Databases technologies is presented in [2]. This work presents the possibility of using V&V techniques of KBS in Databases. On the other hand, [4] presents a study of the use of V&V and integrity techniques of databases to KBS.

In [14], authors propose the use of cover analysis for V&V of KBS. Cover analysis is one technique applied to V&V in software engineering. It can be classified as a dynamic approach once it implies the execution of the software product. Using cover analysis is possible to know the extension of the software that was tested. Besides, it can demonstrate how efficient a set of test cases is when applied to the software being tested. An ideal set of test cases is the one that, with a minimal amount of test cases, finds the biggest amount of defects. In the approach used by [14], the concept of cover analysis is adapted to KBS using the concept of cover as being the number of rules executed by each test case and for the total number of rules executed during the test activity.

In [11], test cases are created and selected as a way to refine knowledge. If a test case is used and it is not able to detect a violation then the method proposes that a new test case can be generated. They affirm that since test cases are difficult or hard to obtain it would be necessary a strategy to choose them in order to accept or refuse a system refinement

The work in [7] proposes the use of data flow as a graphical representation of a rule base. This graphical form, called a logical path graph, captures logical paths through a rule base. These logical paths create the abstractions needed in the testing process.

4. RESTRICTION RULES FOR V&V

Several works have proposed the use of restriction rules to validate and to maintain the integrity of data. In [16], authors use restriction rules to validate the content of data in XML messages in applications based on the service oriented architecture (SOA). In SOA, where traffic of complex data is common, the consistency of private data is done in the application level. Here, data and content consistencies, which are susceptible to privacy, are performed in the application level. In this approach, restriction rules are defined in a specific XML file and define restriction conditions and actions to be performed when a restriction is detected.

In system development, inconsistencies between the final system and its initial specification of architecture can be a problem. The authors in [9] propose a language to the specification of restrictions rules for system architecture. The rules can be used to automatically check the system development and its initial architecture specification.

Another application of restriction rules involves scenarios containing Web services. A Web service must perform transactions from different organizations. Besides, a business transaction can involve operations using several sources. In the case of failures or exceptions, more dynamic mechanisms of recovery must be applied once several sources of data are involved in the transaction. In [6], authors propose the use of restriction rules in business transactions during failure occurrences. In

this case, restriction rules represent business logic more appropriately by improving recovering and consistency maintenance of business transactions.

5. RESTRICTION RULES FOR V&V of KBS

The present work proposes the application of restriction rules as a way to generate test cases to V&V of KBS. Restriction would be constructed based on valid inputs and valid outputs for the rules in the knowledge base. These restrictions would be dependable on the problem domain and on the inference process expected from the KBS.A specific domain could be, for instance, a KBS to help users to choose an appropriate configuration of hardware for their needs. Possible restriction rules could be: 1)if one of the inputs is "user works with 3D modelling" then one of the outputs must be "include a 3Dgraphic card"; 2) if "basic knowledge user" is one of the outputs then "developer user " must not be another input.

Observe that the first example illustrates a restriction rule which express a restriction about an incoherent conclusion according to a given input. In the second example, a restriction rule is used to point out a conflicting input. Considering these two types of restriction, two types of restriction rules are proposed here: restriction rules for input values (*IRR)* and restriction rules for invalid inferences (*InfRR*).

Restriction rules are represented in the same way as *IF-Then* rules of the knowledge base. However, because the consequent part of the rule represents a domain restriction which must be imposed when the antecedent is satisfied, a restriction rule is represented as an*IF - Then Not* rule. The consequent of the rule indicates a knowledge restriction.

For *IRR*, both antecedent and consequent parts refer to input variables; for *InfRR* the antecedent part refers to input values and the consequent part refers to output values. *IRR* and *InfRR* can be respectively represented by: **IF**<inputvariable1>**THEN NOT**<inputvalue2>; **IF** <inputvalue>**THEN NOT**<outputvalue>. Next section presents how the proposed approach can use restriction rules to generate test cases for V&V of *IF-Then* rules in KBS.

6. GENERATION OF TEST CASES USING IF THEN NOT RESTRICTION RULES

In order to perform V&V processes of KBS, this work proposes an approach to generate test cases of*If-Then* rules from a set of *If- Then Not* restriction rules. Restriction rules specify the expected behaviour of the KBS. In KBS, restriction rules can be seen as part of the knowledge representation that is expected from the system. They should be created according to the domain problem restrictions, therefore should be acquired during the knowledge acquisition process. As they express knowledge about the knowledge base, it is possible to classify then as a meta-knowledge base [1].

The approach proposed here allows to generate test cases to KBS which uses forward chaining reasoning. The forward chaining inference method considers an initial set of facts and, by the execution of *IF Then* rules of the knowledge base, fires the rules to which the antecedent is satisfied. New facts are stored in the working memory and the inference motor seeks for new rules to be satisfied according to the new state of the working memory. This process continues until there is no more facts to be inferred or a stop condition is reached.

The algorithm used to generate test cases is based on the inverse of the forward chaining reasoning method. Considering an invalid conclusion, *i. e.*, a conclusion that violates an inference restriction rule, the algorithm tries to prove that this conclusion can be obtained from valid input values. Figure 1 presents the main steps of the algorithm.

For each ruleR_i in {*InfRR*} /*Inference Restriction Rules Set*/
Set proof goal $\delta \leftarrow rhs(R_i)$; (*right hand side* (*rhs*))
$\Upsilon \leftarrow backwardChaining(\delta)$; /* Y : set of proofs from backward chaining reasoning executed in /* the knowledge base
For each *v* in Υ
$Input \leftarrow lhs(R_i) \cup v$; /* l*eft hand side* (*lhs*) of the R_i */
If $Input$ satisfies ({*IRR*} and { $\forall input, input \in Input \rightarrow \neg input \notin Input$})
/* input must be a valid input according to the Input Restriction Rules set*/
/* Input must not contain contradictory inputs */
O$utput \leftarrow \delta$ /* proof goal */
generate test case $\tau \leftarrow (Input, Output)$;
End
End
End

FIGURE 1. Algorithm main steps

As the first step, the first *InfRR* is executed. The negation of its consequent is considered as a proof goal and applied to the knowledge base using a backward chaining inference process. The antecedent of this *InfRR* is then included in the Input set to be part of the input values of the test case. This process tries to prove that a violation of an *InfRR* can be supported by input variables in the knowledge base.

All antecedents of successful rules in the knowledge base, which are valid inputs according to the *IRR*, are included in the Input set which will be used to create the first part of the test case. The output of the test case is the proof goal. The result is a test case which contains valid inputs and outputs which can demonstrate a violation or a non-violation of the knowledge base as they were generate considering a violation of an *InfRR*. A test case is a pair of sets which contain valid inputs and valid outputs: $\tau \leftarrow (Input, Output)$.

The idea here is to generate useful test cases by selecting some of the values from the input value set of a KBS. If all possibilities of input values were considered to generate test cases, the test process could have a very high cost because of the combinatory explosion of values [11].

Once test cases were generated, it is important to verify the extension of the knowledge base that was validated. In order to do that a cover metric can be used[14]. A simple way of measuring the cover of a test case can be the ratio between the number of rules tested and the total number of rules in the knowledge base. A low ratio means that the test case set was not able to test most of the knowledge base rules. This indicates that more inference restriction rules should be created.

The following steps summarize the proposed approach of test case generation:

(1) Restriction rule specification: should be acquired during the knowledge acquisition process;
(2) Test case generation: test cases are generated from the execution of the backward reasoning algorithm whose input data are restriction rules;
(3) Test case execution: generated test cases are used as inputs to the knowledge base execution;
(4) Cover measure calculation of the test case set: for the set of executed test cases a measure of how much of the knowledge base was tested must be applied;
(5) Results presentation: a report containing violated restriction rules, cover measure and test cases should be presented.

7. A SAMPLE TRACE OF THE ALGORITHM

In order to illustrate the backward chaining algorithm execution a practical example is presented which uses a fictitious knowledge base. Such knowledge base contains expertise about the decision

problem of whether or not to grant credit for a given credit applicant. Figure 2 contains the rules that compose our sample knowledge base.

1. *if age < 18 then grant_credit = no : stop*
2. *if credit_exp = good and employed = yes then score >= 10*
3. *if credit_exp = bad then score <= 10*
4. *if age > 18 and age < 21 then score <= 5*
5. *if rent = yes and dependants = yes and age > 18 and age < 21 then score <= 30*
6. *if rent = yes and dependants = no and age > 18 and age < 21 then score <= 20*
7. *if rent = yes and dependants = no and age > 21 then score <= 10*
8. *if rent = yes and dependants = yes and age > 21 then score <= 15*
9. *if employed = yes and employed_time> 12 then score >= 10*
10. *if credit_exp = bad and score < 20 then grant_credit = no : stop*
11. *if score >= 20 grant_credit = yes : stop*

Figure 2. Sample knowledge base

Our approach requires the knowledge engineer to specify a collection of constraint rules. These rules serve as inputs for the validation algorithm, which is responsible for generating test cases which will be use in the V&V process of the sample knowledge base. Figure 3 presents the set of constraint rules related to the sample knowledge base.

An iteration of the algorithm will be outlined next, in order to illustrate our approach. Since the algorithm iterates through the constraint rules, we begin by selecting *InfRR* number one. This rule specifies that there is a violation of the restriction rule when debtor=yes and grant_credit =yes. The only rule in the knowledge base that supports this conclusion is the rule number eleven (*if score >= 20 grant = yes : stop*).

1. *IRR := if credit_exp = good then not age < 18*
2. *IRR := if employed_time<= 0 then not employed = yes*
3. *IRR := if employed = no then not employed_time> 0*

1. *InfRR := if debtor = yes then not grant_credit = yes*
2. *InfRR := if employed = no then not grant_credit = yes*
3. *InfRR := if age < 18 then notgrant_credit = yes*
4. *InfRR := if score < 10 then notgrant_credit = yes*

FIGURE 3. Restriction rules for the sample knowledge base of Figure 2.

Following the backward chaining strategy, our new goal is to prove the premises in the antecedent portion of rule eleven. In order to do that, rules two and nine need to be fired (R2*if credit_exp = good and employed = yes then score += 10; R9 if employed = yes and employed_time> 12 then score += 10).*

It turns that the conditions in the antecedent of rules two and nine are formed only by input variables (*credit_exp = good; employed = yes and employed_time> 12)*.We assign the input set accordingto the antecedent of rules two and nine, respecting the backward chaining procedure. The *InfRR* constraints express that a given output should not occur when a certain input is used. So, we also assign the value *debtor = true* specified in the InfRR number one as part of the input.

At this point we have the following set of values: Input= {credit_exp = good; employed = yes; employed_time> 12; debtor = yes}. For each value in Input it is necessary to verify whether the input value does not violate the *IRR* set and simultaneously does not violate the antecedent of the current *InfRR*. As values satisfies both conditions then the test case would be:

testcase=*<(credit_exp = good; employed = yes; employed_time> 12; debtor=yes); (grant-credit=yes)>*(I).

After this step, the algorithm would continue iterating through the remaining *InfRR* rules. At the end of this process all test cases would be generated. After that they would be submitted to the knowledge base. The forward chaining execution of test case (I) in the knowledge base was successful what indicates a violation. The test case produced a set of valid inputs according to the *RRI* set and produced an invalid output according to the*InfRR*. The test case (I) produced grant_credit = yes when one of the inputs was debtor=yes. This violates the first *InfRR*.To solve this, a new rule such as: " IF *debtor = yes THEN grant_credit = no : stop";* would be necessary to grant the knowledge base consistency.

8. COMPARISON WITH OTHER APPROACHES

In [18], a WEB-based expert system to evaluate suppliers is presented. In this work, knowledge acquisition is guided using interviews with experts and knowledge is represented by if-then production rules. In order to validate the system, a comparison between the solution obtained by the system and the solution proposed by the expert is done. As mentioned by the author, the two solutions were the same.

Although this validation can be seen as satisfactory in some situations, it can be insufficient in others. Time spent by experts can be a considerable cost to the system. Besides, there are no evidences that indicate how to define a set of real cases that can result in a total cover of possible test cases that can guarantee system validation. The author mentions as future works, the need to use other approaches of test to validate the system.

In [12], a tool to V&V process called Veritas is presented. Veritas has a domain-independent modular architecture which is based on production rules to represent knowledge. It is used to detect structural anomalies in knowledge bases as the ones mentioned in section 2.

A direct comparison between Veritas and the proposed approach cannot be done as the methods are conceptually different. In the proposed approach, knowledge behavior and knowledge restrictions are applied to the knowledge base. This allows a V&V process which takes into account the semantic of the domain problem. Although structural anomalies can compromise the performance of an expert system, their detection does not validate the knowledge representation of domain problem.

The Veritas tool also allows the creation of a model with all possible combinations of tracks that can be taken during the inference process. Here, in the proposed approach, the space of combinations is pruned using restriction rules.

The work in [14] presents a tool for V&V process called Valens. The tool is based in meta-rules and in an inference method of hypothesis verification. The verification process is made in steps: 1)a meta-model is constructed according to the knowledge base rules to offer a more convenient structure of inference; 2) possible anomalies are elicited using the meta-rules; 3) using the inference method, candidate anomalies are verified in order to detect and prove the presence of problems.

The proposed approach shares two characteristics with the method applied by the Valens tool: 1) the use of a set of rules to support the V&V process; and 2) the use of an inference mechanism to prove the presence of problems. However, the approach differs from the approach of Valens in the kind of problem to be detected. As previously mentioned, knowledge domain is tested according to requirements of the system behavior. The method proposed by [14] aims to verify consistency, circularity and redundancy.

The approach proposed here is a declarative V&V process to be applied to knowledge bases in expert systems. This declarative characteristic is fundamental for two reasons: 1)knowledge engineer is not necessarily a knowledge engineer, i. e., he/she does cannot detent knowledge about V&V techniques used in tests of conventional software processes; and 2)It is more difficult to apply conventional techniques of V&V to expert systems given their knowledge declarative nature.

9. CONCLUSION

KBS are one of the most known techniques in Artificial Intelligence. However, to use them to solve real practical problems maintaining a trustable knowledge representation, it is necessary to have an efficient V&V process. Because of the declarative form of the knowledge base, which contrasts with the procedural form of classical algorithms and databases, these systems demand more specialized techniques to perform their V&V process.

In this work an approach to support V&V process of KBS was proposed. This approach consists on the generation of test cases from restriction rules. Restriction rules can be seen as meta-knowledge of a specific domain problem.

Problems such as the ones mentioned in section II can be detected through the inspection of the expert systems rules. However, given the fact that the knowledge based systems approach requires a model of expertise, the direct inspection of the rules is not enough to detect problems in the knowledge engineering process. The constraint rules are proposed in order to add knowledge to the validation process, attempting to enable the automation of the V&V process of knowledge based system.

In the same way that V&V techniques are used to validate and verify traditional systems, the use of restriction rules to generate test cases to validate KBS is not a technique able to prove that a system is free of violations, but it is a technique used to detect inconsistencies about the expected system behaviour. In our case, to detect inconsistencies about the domain knowledge.

A practical example showed that using restriction inference rules it is possible to detect inconsistencies in the knowledge base. As inconsistency is detect it is possible to the knowledge engineer proposes the inclusion of new rules in the knowledge base in order to solve the problem.

As future works authors indent to verify whether knowledge engineers can incorporate the acquisition of restriction rules as part of the knowledge modelling process.

REFERENCES

[1] AKERKAR, R.; SAJA, P. Knowledge Based Systems. Jones and Bartlet Publishers. 2010.

[2] COENEN, F. Verification and Validation Issues in Expert and Database Systems: The Expert Systems Perspective. Proceedings. Ninth International Workshop on Database and Expert Systems Applications, 1998.

[3] DEBBABI, M.; HASSAÏNE, V. F.; JARRAYA, Y.; SOEANU, A.; ALAWNEH, L..Verification and validation in Systems Engineering: Assessing UML/SYSML Design Models. Springer, 2010.

[4] EAGLESTONE, B. ; RIDLEY, M.Verification, validation and integrity issues in expert and database systems: the database perspective. Proceedings of the Ninth International Workshop on Database and Expert Systems Applications, 1998.

[5] GIARRATANO, J.; RILEY, G..Expert Systems Principles and Programming. Third ed. PSW Pub., 2005.

[6] JIUXIN C.; BIAO, Z.; BO, M.; BO, L.. Constraint Rules-based Recovery for Business Transaction. In: Grid and Cooperative Computing (GCC), 2010 9th International Conference, Pg. 282 – 289, 2010.

[7] KIPER, J. D..Structural Testing of Rule-Based Expert Systems. In: ACM Transactions on Software Engineering and Methodology, Vol. 1, No. 2, Pg. 168-187, April 1992.

[8] LIU, G.; LIU, Q.; XIE, P.Model-based testing and validation on knowledge-based systems. In: Grey Systems and Intelligent Services, 2007. GSIS 2007. IEEE International, 2007. pp. 1242-1245.

[9] MARINESCU, R.; GANEAIN, G..Code.Rules: An Agile Approach for Defining and Checking Architectural Constraints. In: ICCP '10 Proceedings of the Proceedings of the 2010 IEEE 6th International Conference on Intelligent Computer Communication and Processing,2010.

[10] NEWELL, A.; SHAW, J.C.; SIMON, H. A..Report on a general problem-solving program. In Proceedings of the International Conference on Information Processing. Paris: UNESCO House, Pg. 256-264, 1959.

[11] PALMER, G., & CRAW, S. The Role of Test Cases in Automated Knowledge Refinement. 16th BCS SGES Expert Systems Conference, Cambridge, UK. 1996.

[12] SANTOS, J.; RAMOS, C.; VALE, Z. A.; MARQUES, A.. VERITAS-an application for knowledge verification. In: Tools with Artificial Intelligence, 1999. Proceedings. 11th IEEE International, 1999, pp. 441-444.

[13] SMITH, S.; KANDEL, A..Verification and validation in fuzzy expert systems. In: Systems, Man and Cybernetic. Intelligent Systems for the 21st Century. Vol. 4: Vancouver, BC, 1995.

[14] SPREEUWENBERG, S.;GERRITS, R.;BOEKENOOGEN, M.: VALENS: A Knowledge Based Tool to Validate and Verify an Aion Knowledge Base. In W.Horn (ed.): ECAI2000, Proceedings of the 14th European Conference on Artificial Intelligence, IOS Press, Amsterdam, 2000, pp.731-735.

[15] TERAGUCHI, M.; YOSHIDA, I.; URAMOTO, N.. Rule-based XML Mediation for Data Validation and Privacy Anonymization. In: IEEE International Conference on Services Computing, 2008.

[16] TSAI, W.; VISHNUVAJJALA, R.; ZHANG, D..Verification and Validation of Knowledge-Based Systems. In: IEEE Transactions on Knowledge and Data Engineering, vol. 11, no. 1, January/February 1999.

[17] VERMESAN, A. I..Software Certification for Industry: Verification and Validation Issues in Expert Systems. In: Proceedings of the 9th International Workshop on Database and Expert Systems Applications: Washington, DC, 1998.

[18] WANGPHANICH, P..A Simple Web-based Expert System for a Supplier Assessment: A Case of a JIT production environments. In: Proceedings of 2011 International Conference on System Science and Engineering, Macau, China, 2011.

Design And Implementation Of An Expert Diet Prescription System

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Abstract

Expert Diet Prescription System (EDPS) is proposed to identify an ailment by its name or symptoms, and return a result prescribing an appropriate diet corresponding to that ailment. The system has three access levels to the database, the; patient, doctor and an administrator. A database was created consisting of Seven known ailments, these ailments includes; Cancer, Diabetes, Measles, Cholera, Malaria, Goiter and Enlarged heart disease. The knowledge base for the database created was obtained from the experts. Wamp server, PHP and MYSQL and code charge studio was used to design the database, interface and graphics for the system. The introduction of expert diet system has become very necessary because of the long term devastating effect of drugs either as a result of drug abuse or its reaction on certain patient with exceptional cases. This will readdress the issue of adverse reaction of drugs, by the use of food/fruit as an alternative treatment to drugs.

Keywords: Ailment**,** Database, Expert System, Symptoms, Nutrition

1. INTRODUCTION

The expert diet prescription system is an expert medical system, which, is centered on Nutrition/Diet. The system is meant to provide direct, non artificial treatment which is readily absorbed into the bloodstream of human beings.
A lot of drugs are effective, but the long term use of these drugs has devastating results. Hence, lead to more harm than good. Example of such adverse reactions could be skin disease; rupture of internal organs, stomach upsets stiffness palpitation and many more. Sometimes it could even be o f high severity thereby leading to death of the patient if not checked in due cause.

Instead of taking analgesic drugs such as Aspirins, Paracetamol, and Panadol in order to stop a persistent headache, one could try a cold glass of milk and adequate rest. It could work perfectly without having to go through the stress of swallowing pills, thus, leaving behind a refreshed feeling. It Is very rare for natural foods to cause any severe adverse reactions, rather, they enhance the general well being of the entire body, thereby leaving one healthy, refreshed and vibrant.

2. EXPERT SYSTEMS

Expert systems have developed from a branch of computer science known as artificial intelligence (AI). AI is primarily concerned with knowledge representation, problem solving, learning, robotics, and the development of computers that can speak and understand humanlike languages (Townsend, 1987). An expert system is a computer program that uses knowledge and reference procedures to solve problems that are difficult enough to require significant human expertise for their solution (Townsend, 1987). Simply stated, expert systems are computer programs designed to mimic the thought and reasoning processes of a human expert.

3. REVIEW OF RELATED EXPERT SYSTEMS

Several notable expert systems have been developed in recent years. For example;

3.1 CALEX

CALEX is an expert system which was developed for the diagnosis of peach and nectarine disorders by the University of California (Plant et al., 1989). Like most experts systems, CALEX is rule-based system and uses certainty factors, so that the knowledge-base consists of production rules in the form of IF, THEN statements. The inference engine pieces together chains of rules in an attempt to reach a conclusion. The knowledge base of the CALEX/Peaches diagnostic system contains approximately 600 rules for the diagnosis of 120 disorders of peaches and nectarines, representing most of the disorders in California (Plant et al., 1989).

The structure of the CALEX knowledge base language makes it particularly appropriate for complex problems like irrigation scheduling, and the expert system shell was designed with applications such as this in mind. The first large-scale implementation of a CALEX-based crop management decision support system is CALEX/Cotton for irrigated crop management in the San Joaquin Valley, California. The irrigation scheduling module of CALEX/Cotton can use a variety of methods to generate either the estimated date of the next irrigation or, at the user's request, a complete irrigation schedule for the remainder of the season. The methods used include scheduling based on leaf water potential, growing degree-days, the water budget method, last irrigation based on estimated cutout date, and last irrigation based on observed optimal dates. Here we give a brief summary of the functioning of the CALEX expert system shell and then describe in detail the methods of irrigation scheduling used in CALEX/Cotton and how the shell is coupled with appropriate knowledge bases to form an expert system for implementing these methods.

3.2 CITPATH

CITPATH, a computerized diagnostic key and information system, was developed to identify five major fungal diseases of citrus foliage and fruit in Florida (Ferguson et al., 1995). CITPATH also utilizes a rule-based approach which provides hypertext-linked descriptions and graphic displays of symptoms with reference to chemical control methods (Ferguson et al.)

CITHPATH expert system makes diagnosis on the basis of response/responses of the user made against queries related to particular disease symptoms. The knowledge base of the system contains knowledge about symptoms and remedies of 14 diseases of Indian mango tree appearing during fruiting season and non-fruiting season. The picture base of the system contains pictures related to disease symptoms and are displayed along with the query of the system. The result given by the system has been found to be sound and consistent.

3.3 THE PENN STATE APPLE ORCHARD CONSULTANT (PSAOC)

The Penn State Apple Orchard Consultant (PSAOC) is an example of another type of expert system which has demonstrated the advantage of using specialists from different areas to develop large integrated modules. Horticultural applications presently developed include modules for weed control, foliar analysis interpretation, trickle irrigation scheduling and visual diagnosis of nutrient deficiencies (Crassweller et al., 1989).

Agricultural production has evolved into a complex business. It requires the accumulation and integration of knowledge and information from many diverse sources, including marketing, horticulture, insect, mite, disease and weed management, accounting and tax laws. To alleviate this problem, current information must be structured and organized into an accessible system for growers and agricultural specialists. Because no organized structure is available for information storage and retrieval, technical information is often lost or unavailable to potential users. The use of electronic decision support systems is one way to make this information readily available.

3.4 VITIS

VITIS, a grape disease management expert system, has also been developed similarly in cooperation with specialists from Pennsylvania, New York, Ohio, and Michigan (Travis et al., 1992b). The VITIS model was also used as a model for AustVit, an Australian viticultural management expert system. AusVit uses the same logic in the approach to decisions and integrates viticultural, entomological, and plant pathological decision making to arrive at an integrated recommendation (Travis et al., 1992c). Several other notable prototype expert systems with applications in agriculture have also been developed but few have been released commercially (Beck et al., 1989; Bergsma et al. 1991 ; Drapek et al., 1990; Heinemann et al., 1993; Holt, 1989; Kable, 1991; Muttiah et al., 1988; Sullivan et al., 1992; Rogowski and Ranquist, 1992; Travis et al., 1992a).

VITIS presents new models for predicting bilberry and cowberry yields from site and stand characteristics. These models enable one to evaluate the future states of forests in terms of berry yields. The modeling data consisted of visual field estimates of site and tree stand characteristics, as well as berry yields from 627 forest stands. Berry yields were estimated using a scale from 0 to 10. Using these data, models were prepared which predict the berry yield scores from those sites and stand characteristics which are usually known in forest planning calculations. The model predictions correlated positively and often quite strongly with earlier models. The results were in line with previous studies on the effects of site and tree cover on berry production. According to the models, sites of medium and rather poor fertility produce the highest bilberry yields. Increasing, tree height increases, and the basal area of spruce and proportion of deciduous trees decrease, bilberry yield. With mineral soils, cowberry yields are best on poor sites. A high proportion of pine improves cowberry yields. The yields are the highest in open areas and very young stands, on the one hand, and in sparsely populated stands of large and old trees, on the other hand. In pine swamps, the yields are best on rather poor sites. Increasing basal area of deciduous trees decreases cowberry yields.

3.5 KNOWLEDGE REPRESENTATION

After the domain has been identified and knowledge acquired from a participating expert, a model for representing the knowledge must be developed. Numerous techniques for handling information in the knowledge-base are available; however, most expert systems utilize rule-based approaches (Townsend, 1987). The knowledge engineer, working with the expert, must try to

define the best structure possible (Jones, 1989). Other commonly used approaches include decision trees, blackboard systems and object oriented programming.

4. RESEARCH METHODOLOGY

The design of the expert diet prescription system is based on case base, which makes it easier to make diagnosis based on the knowledge of previous experiences of one or more similar case(s). This design works by storing a list of past case of ailments, which include the ailment name, description, symptoms and the corresponding diet prescription. The database is constantly queried using a structured query language (SQL), to get the stored information. Ailments can be searched by inputting symptoms if it is a patient querying the database or simply inputting the ailment name, by an experienced doctor to get possible list of symptoms related to the ailment name provided by the doctor.

Literature review on expert system was conducted, knowledge of samples of certain aliments, together with their associated symptoms and diet prescription where obtained from the internet. Database for these aliments were created together with an application program for accessing the database.

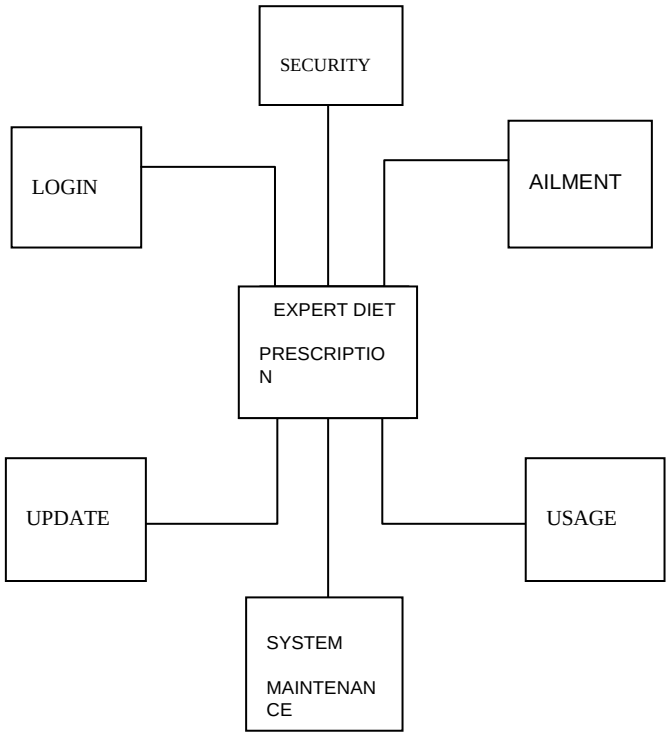

FIGURE.1: Conceptual model of the expert diet prescription system.

5. DATABASE DESCRIPTION

The database of the expert diet prescription system was designed to constitute 8 tables in general. The tables contained in the database are namely;

- Access
- Doctor

- Patient
- Administrator
- Ailment
- Symptoms
- Mailbox
- Users

Each table is represented as an entity in the database, associated with its attributes.

Ailment name	Ailment Number
Cancer	1
Cholera	2
diabetes	3
Enlarged heart disease	4
Goiter	5
Malaria	6
Measles	7

Table 1: Ailments available in the database

6. ENTITY RELATIONSHIP DIAGRAM

The entity relationship model depicts the data in terms of the entities and relationships described in the data. The entity-relationship model (ERM) for the expert diet prescription system is an abstract conceptual representation of its structured data. Entity-relationship modeling is a relational schema database modeling method, used in software engineering to produce a type of conceptual data model of a system, often a relational database, and its requirements.

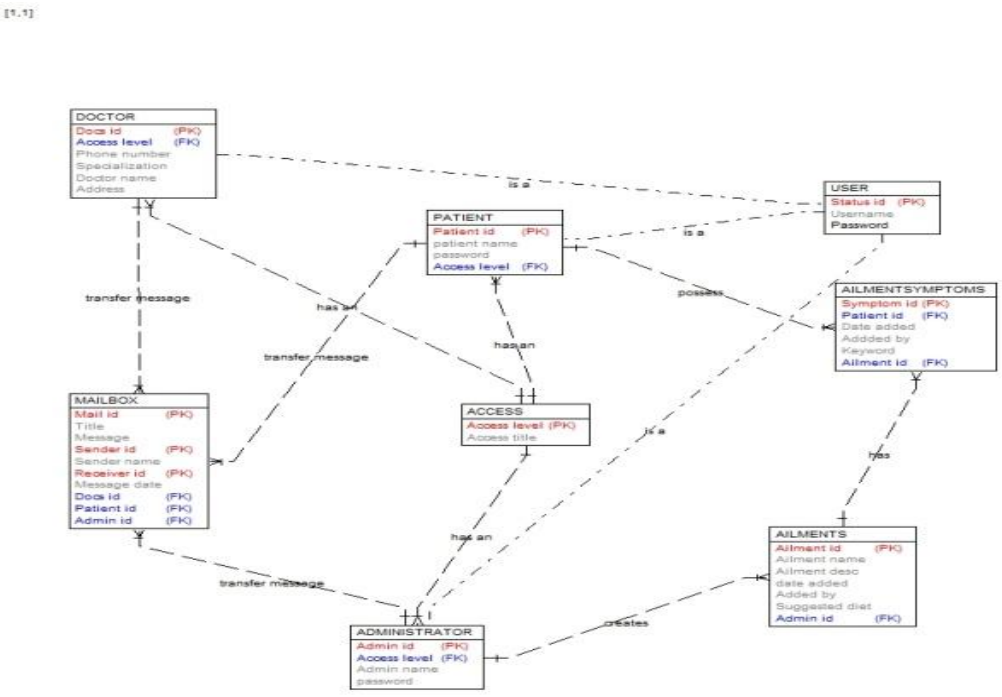

FIGURE2: An entity relationship diagram of the expert diet prescription system

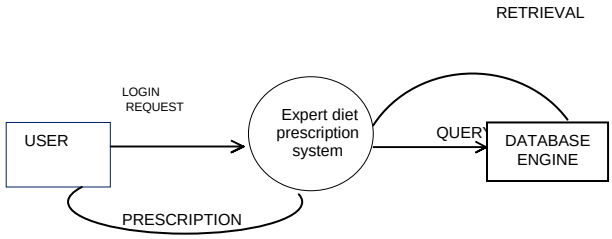

FIGURE3: Dataflow diagram of the expert diet prescription system.

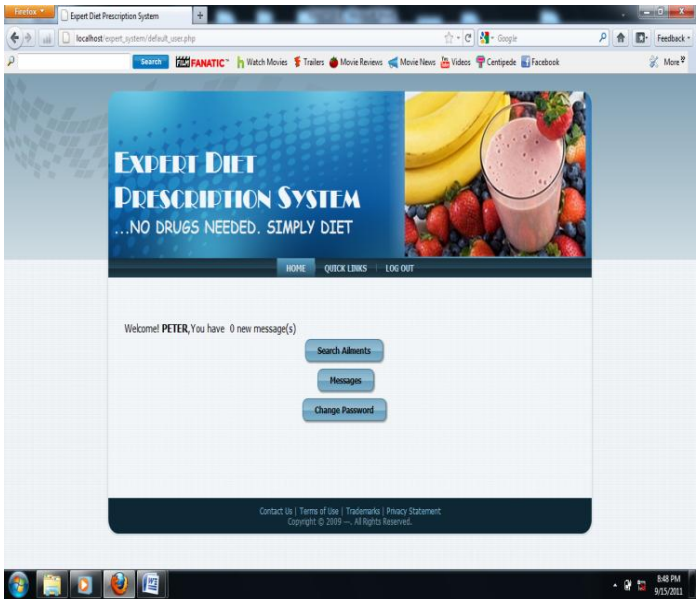

FIGURE4: patient's home page

Figure.4 above shows the home page after logging in as a patient. A patient can only perform operations such as search ailments, view or send messages and change password. A patient cannot add or update an ailment or create a user account for anyone.

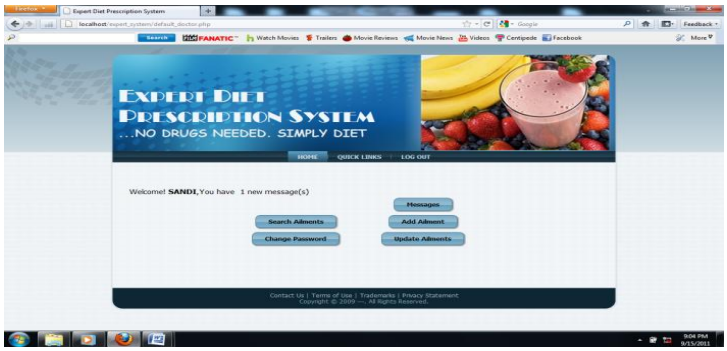

FIGURE5: Doctor's home page

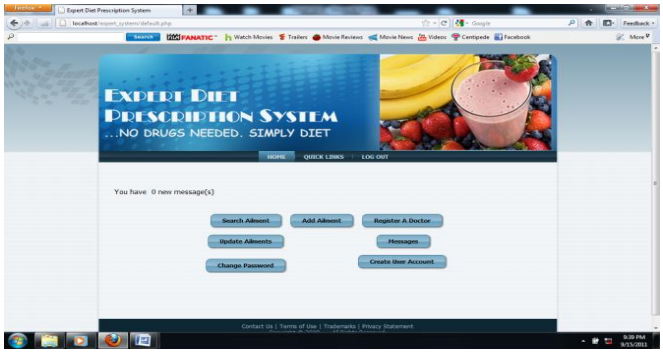

FIGURE6: Administrator's page.

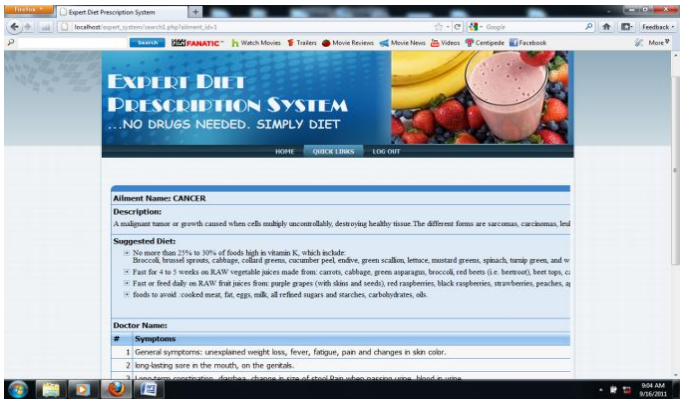

FIGURE 7: A result of search by symptoms

7. CONCLUSION

Expert diet prescription system can be configured for home or commercial use by any number of persons. A method of treatment by nature's finest fruits, vegetables and food, compared to drugs, has no adverse reactions or side effects. The system will be of great benefit to the society at large, thus, promoting a very healthy life style for any age distribution from infants to the aged, if properly utilized.

From the result obtained from this work, the following recommendation can be made;

The system should be configured for use in hospitals, at home and even in eateries because of its enormous benefits to health and the length of queue in hospitals today is quite alarming, if people have systems like this configured in their various homes, it would go a long way in improving the situation.

8. REFERENCES

[1] H.W. Beck, P.H. Jones and J.W. Jones. 1989. SOYBUG: "An expert system for soybean insect pest managment. Agricultural Systems". 30:269-286

[2] K.A. Bergsma, S.A Sargent, J.K. Brecht, and R.M. Peart. 1991. "An expert system for diagnose chilling injury symptoms on fresh fruits and vegetables". pp 262-267.

[3] D.G. Watson, F.S. Zazueta, and A.B. (Del) Bottcher (eds). "Computers in Agriculture Extension Programs". Am. Soc. Agric.

[4] K.A. Bergsma 1993 *Developing and testing an expert system for diagnosing chilling injury of fresh fruits and vegetables.* University of Florida. pp.213.

[5] R.M. Crassweller, P.H. Heinemann, and E.G. Rajotte. 1989. "An expert system on a microcomputer for determining apple tree spacing". HortScience pp. 24:148.

[6] R.M. Crassweller, J.W. Travis, P.H. Heinemann, and E.G. Rajotte. 1993. "The future use and development of expert system technology in horticulture". HortScience Vol. 24:203-205.

[7] R. J. Drapek, J.A. Calkin, and G.C. Fisher. 1990. "A hazelnut pest management expert systems". Acta Horticulturae. Vol. 276: pp. 21-25.

[8] R.A Edmunds. 1988. *The Prentice Hall Guide to Expert Systems*. Prentice Hall, Englewood

[9] N,J Cliffs, E.A. Feigenbaum 1977. ‘‘The art of artifical intelligence’’, Proceedings of the Fifth International Joint Conference on Artificial Intelligence. Vol. 2: pp. 1014-1029.

[10] J.J. Ferguson, F.S. Zazueta, and J.I. Valiente. 1995. CITPATH:’’ Diagnostic and hypertext software for fungal diseases of citrus foliage and fruit. HortTechnology’’. Vol. 5(3): pp. 277-278.

[11] P.H. Heinemann, T. Morrow, J.D. Matsolf, R.M. Crassweller, and K.B. Perry. 1993. ‘‘A decision support program for the protection of crops from frost’’. Acta Hort. pp. 313

[12] D.A. Holt 1989. *The growing potential of expert systems in agriculture*. pp. 1-10.

[13] J.R, Barrett and D.D. Jones (eds). *Knowledge Engineering in Agriculture*. No. 8, Amer. Soc. of Agric. Eng., St. Joseph, MI.

[13] P.F. Kable 1991. ‘‘An expert system to assist orchardists in the management of rust diseases of French prunes’’. AI Appl. in Nat. Res. Mgmt. vol. 5: pp.59-61.

[14] J. Liebowitz, and D. DeSalvo. 1989. Structuring Expert Systems. Yourdon Press, Englewood Cliffs, NJ.

[15] Muttiah, R.S., C.N. Thai, S.E. Prussia, R.L. Shewfelt, and J.L. Jordon. 1988. ‘‘An expert system for lettuce handling at a retail store’’. Trans. Amer. Soc. Agr. Eng. Vol.31: pp. 622-628.

[16] R.E. Plant, F.G. Zalom, J.A. Young, and R.E.Rice. 1989. CALEX/Peaches, ‘‘An expert system for the diagnosis of peach and nectarine disorders’’. HortScience vol.24(4): pp. 700.

[17] J.D Rogowski and W. Ranquist, 1992. A decision support system for apple thinning in Colorado. HortScience vol. 24: pp. 702.

[18] G.H. Sullivan,, W.J. Ooms, G.E. Wilcox and D.C. Sanders. 1992. ‘‘A expert system for integrated production managment in muskmelon’’. HortScience vol. 27: pp. 302-307.

[19] C. Townsend 1987. *Mastering Expert Systems with Turbo Prolog*. Macmillan, Inc. Indianapolis.

From TION-EMO Theory To A New Beginning Of Artificial Emotions

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Abstract

The author has proposed a new theory: the Tion–Emo Theory (TET) [1, 2]. The TET concept makes it possible to build artificial emotions because the TET is a simple system and provides an organised structure with a nucleon that controls the emotional scheme with the self-object. This emotional system seems to depend on three objects that are particular to three regions: the intellectual object (IO) in the intellectual region, the social object (SOO) in the semi-intellectual region and the self-object (SEO) in the non-intellectual region. Connecting these three objects at their different levels of function appears to be a requirement for forming a self-sustainable system and producing emotion. The system needs two forces, the positive IO and the negative SEO; the SOO is necessary to mediate between the two. Self-survival hierarchy censorship systems regulate all survival matters, and the emotional energy that gives rise to the system is underlied by the SEO. Social hierarchy censorship sorts and regulates the social information that is also regulated by the SEO. Physiological neural network research supports the TET.

Keywords: Artificial emotion; emotional energy; objects; TET; function of basic emotions; intellectual region and intellectual object; semi-intellectual region and social object; non-intellectual region and non-intellectual object; self-survival hierarchy censorship and social hierarchy censorship.

1. INTRODUCTION

Scientists from disciplines as varied as psychology, neuroscience and intelligent systems have endeavored to build a biologically-based artificial system [3, 4, and 5]. Animal researchers have gathered information from ethnology, psychology, neurobiology and evolutionary biology, and their studies frequently begin with low-level sensorimotor abilities and then work up to higher cognitive functions [6].

Other researchers are working on an evolutionary robotic basis for artificial evolution [7, 8]. In Nolfi's preliminary work, he stated that his work with evolutionary robots would "…involve a population of autonomous elementary robotic units that are left free to interact and to self-assemble. The possibility of self-assembling and propagating their genotype into the body of assembled units leads to a spontaneous evolutionary process without the need for an explicit selection criterion." [9] (pp.224*).*

Numerous researchers in embodied and cognitive science and in artificial and evolutionary robotics are taking into account the crucial interactions of the brain, the body and the environment for the development of artificial, intelligent and adaptive behavior [10].

Recently, there have been great strides in human computer interaction through advances in our understanding of the relationship between cognition and the affective state. By taking into account many aspects of body measures [11, 12]), the component process model (CPM) has made an impact on artificial emotion with a cognitive mechanism [13]. Asynchronous Learning by Emotion and Cognition (ALEC) with emotion-based architecture (EBII) is an attempt to perform according to a goal system; this helps to make the emotional system more abstract [14]. Database is another system in the endeavor to

produce artificial emotions [15]. It seems reasonable that research in the artificial area should be dedicated to find a new theory of emotion to build a self sustainable system.

The question of the primacy of affect and cognition has been a subject of much debate [16, 17, 18, and 19] on the interrelationship between cognition and emotion. Emotion appears to be dominated by cognition because cognition appears logical to our intellectual side. Despite this assumption, Panksepp [20] is among the researchers who argue that emotion should be studied independently from cognition through neuroscience (in both animals and humans). The studies of artificial emotions and psychology have always been subject to cognitive science (or other related disciplines); this is likely due to the fact that there is no genuine theory of emotion that would allow researchers to study emotion without the direct intervention of cognitive science.

Emotions first evolved in our species to produce a self sustainable system (in other words, to increase survival). Panksepp states that "Emotional systems have an integrity that was created through evolutionary selection rather than simply through the life experiences of organisms." [20], (p.12). We should already have a self sustainable system. This paper proposes to describe the beginning of a self sustainable system. This work is based by examining Freud works in the last one half decade [2], and working two and half decade with Tion-Emo Theory (TET) and two decade of clinical work with TET therapy [1]. For better understanding it is recommended to read [1]; [2]. Since working with this new theory for decades it has accumulated vast amount of information even the author is trying to keep it as minimum as possible.

To study emotion from a non-cognitive point of view we must consider Freud theories. Even though he did not directly study emotion, he still offers some knowledge on how our psyches work. However, everything needs to be translated through the TET to be comprehended in artificial emotion (Table 1.) Freud has explained human psychology in many different fashions, making complicated to understand his theories properly; see [2] for a comparison of the TET with Freud's theories.

The author proposes the creation of a self sustainable system based on the emotional mechanisms of the TET. At first, we need to build a nucleon with a mechanism for non- intellectual information and the self-object (SEO), or the internal object (the author prefers to use the term SEO, because elucidate that SEO is more an executive object). The SEO mechanism enables it to be compared with both the intellectual object (IO) that represents the external object in the brain and the social object (SOO) that is not only semi-intellectual but is also an object of compromise between internal life and the social life [2] (Figure 1). It also seems that SOO may melt with the IO to form the other object of comparison. Another possibility is simply that the SOO is underlie by SEO and compared with IO. Furthermore, the self-survival hierarchy censorship and the social hierarchy censorship are regulated by the SEO and the other TET mechanisms [1]; [2] (Figure 1). For this endeavor, we must integrate computer science, neural architecture, neuroscience and physiology, as well as an understanding of the evolution of emotion from an untainted point of view. We have plenty of technology; we just need to direct it towards emotional mechanisms.

2. SOME BASIC OF TION-EMO-THEORY

2.1. TET regions, therapy and objects regions

TET regions are like a big kingdom in which the king names a governor and an adviser in order to better govern his kingdom. The self-object (SEO) is the king. The intellectual object (IO) is the governor of the external world ruled over by the SEO. The IO is the governor and other officials who provide information to the social SOO to filter the information to the king**.** The social object is the close adviser of the king, located in the semi-intellectual region. In the transition between the intellectual and the non-intellectual regions, the adviser provides information to the king (SEO). The SOO helps the king regulate his instinctive energy, despite the fact that he may not be realistic in his decisions, because the nature of the

SEO is excessive motivation while lacking contact with the outside world. Even though all of these objects are under the king-SEO mechanism, to be a good kingdom it needs a good adviser.

The three regions seem to be at three different levels of function, beginning with the non-intellectual region to the intellectual region (Table 1). In relation to emotion, every region may have its own object, own mechanism, physiological organs [1]; [2], own neural network connection, own neurochemicals and own evolution. The intellectual region may house the intellect and/or cognition along with the IO. Panksepp [20] and [14] Gadanho both propose that cognition may be situated in the cortical region.

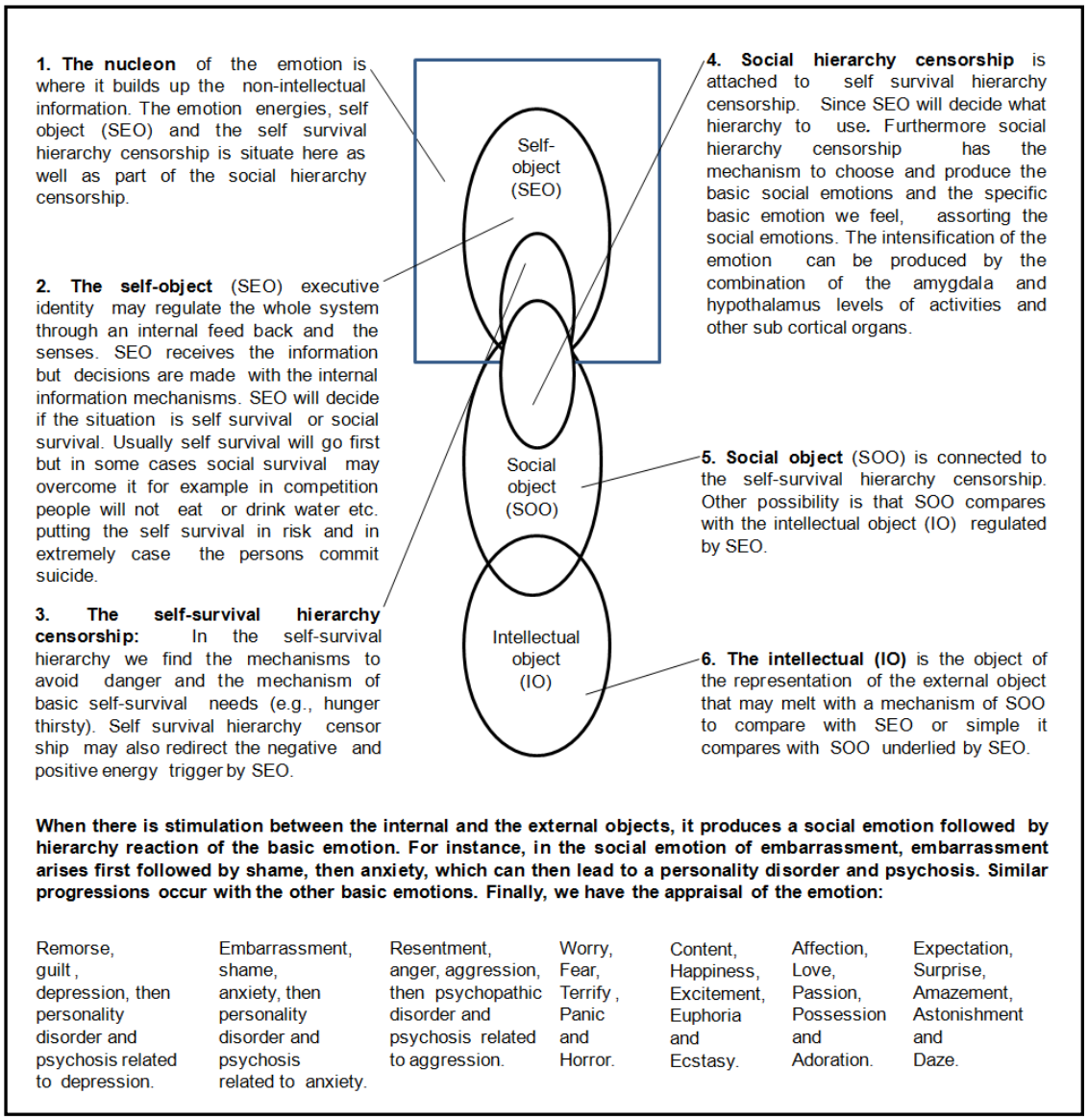

FIGURE 1: Represents the function of the nucleon and self-object in the relation to self-survival hierarchy censorship and social hierarchy censorship in connection to the comparison of the intellectual object, social object and the hierarchies' reaction of basic or social emotions.

The semi-intellectual region can be considered to be the transition between the intellectual and non-intellectual regions; this region seems to be the seat of basic, and social, emotions (Figure 1 and Table 1). Panksepp [20] has proposed that the sub-cortical region seems to be the seat of emotions. The author view, the sub-cortical region is divided into two accentuated regions: the non-intellectual region and the semi-intellectual region. There might be rudimentary cognition in the outer part of the semi-intellectual region as a result of brain evolution that has united the intellectual and non-intellectual regions**.** In this case, the non-intellectual region (which should be located in the sub-cortical area, in a more primitive section) could be situated in the hypothalamus or adjacent organs, where we also find self-survival emotions that all species share to some extent [2] (Figure 1 and Table 1). Damasio et al. consider that [21], "Some of these maps, such as those in brainstem and hypothalamus, are coarse, and their information is perhaps not directly accessible to consciousness." (p.1051).

2.2. TET therapy

The object in TET was born when the author found after using cognitive method for years that cognitive therapy did not have the expected effects on emotion. He discovered that by imaging the SEO, and imaging the IO, he could make a bridge between the internal and external worlds [1]. In TET therapy, we simultaneously image the IO (that may melt with SOO) and the SEO, and then we find "the helping words" from the semi-intellectual regions and iterate them. Furthermore, "the helping words" are very limited, but it is difficult to state how many exist (probably about 20-50**);** they are from the semi-intellectual area and they need to fit in the situation of the conflict (see also, [1]). At the beginning of TET therapy, we seek only to image and feel the IO, (SEO, probably was implied when we image the IO). Then we use some of the "the helping words" (e.g., it does not help to worry, we say bad things when we are mad etc.) [1]. After that, we reiterate the "nucleon sentence" by imaging IO while stating that: "it is not worthwhile to compare or to feel envy"; we repeat this 3 or 4 times, then repeat "the helping words", and so on [1]. Now in the TET therapy it is not necessary to use the "nucleon sentence" anymore because if we image and feel the two objects simultaneously (SEO and IO), we can continuously repeat as many "helping words" as we want. "The helping words" come from the social emotional mechanism, not from the cognition area or mechanism, and they need to fit the situation of the conflict [1]. The TET method and therapy have not spread thus far because the scientific community does not have good access to the TET.

3. SOME RELATION BETWEEN FREUD THEORY AND TION-EMO-THEORY

3.1. Object

The object seems to appear even before a child has born. It is present in their genes, first for self-survival reasons and then for social survival as Freud [22] considers: "In this way the mother, who satisfies the child's hunger, becomes its first love-object and certainly also its first protection against all the undefined dangers which that threaten it in the external world – its first protection against anxiety, we may say." (p. 24). So, when the child begins to interact with his or her caretaker, it marks the beginning of the formation of the IO and SOO that is attached to the mechanism of self-survival and is regulated by the SEO.

SEO is a nucleon image of oneself that can execute the direction of the organism [1]; [2]. It should have its own neural networks, neurochemistry, neurodynamics and physiological organ where the emotions are seated (from Freud's point of view). "The object [Objekt] of an instinct is the thing in regard to which or through which the instinct is able to achieve its aim.... The object is not necessarily something extraneous: it may equally well be a part of the subject's own body." [23] (pp. 122-123).

In the TET, the social object requires being a person and needs to be a whole object in order to produce a basic emotion or social emotions [1]. According to the TET, the appearance of objects results from early period of evolution since the organism's need to adapt, survive, safeguard and manage the internal and external worlds and therefore need the objects [1]; [2]. As Panksepp [20] points out, the emotional

function is from an early stage of evolution, and most creatures are self sustainable despite the lack of a cognitive system.

The external objects in self-survival can be inanimate; these are the objects that the organism can identify as good, bad, dangerous or real as the internal mechanism (and anatomy and physiology) permits. The internal object (or SEO) may be the object that all animals and humans share and its sophistication and function is dictated by either evolution or genetic predisposition.

In the therapy, the Self-object (SEO) appears when we imagine ourselves as whole, and the external object is the person who we compare ourselves to as whole; this leads to the expression of social emotions [1]. The SEO is the only object that can give the specific executive command in this area. Humans have a sophisticated system that presumably does not function without internal directions. Panksepp points out that "…a natural neurobiological function of the brain is to generate a menagerie of positively and negatively valence affective states, of various degrees and type of arousal, that help guide organisms in life-sustaining activities." [20], (p. 12). Batter Slade [24] has proposed the importance of the objects, postulating that infants cannot think without simultaneously acting on objects. Freud considered the object to be transcendental, for instance, by carrying psychic energy within the individual and between individuals [1]. Freud believed that individuals became sick when they lost the love object [25].

The three systems serve different functions (Figure 1 and Table 1). One system processes intellectual information by comparing inanimate objects for possible intellectual growth; emotion has its own neural network connections. The second system processes the semi-intellectual function; it obtains an assortment of information in cooperation with social hierarchy censorship, transforms it to semi-intellectual information, and then gives that information to the SEO in a less intellectual manner [1]. The social and basic emotions seem be produced only by comparison with the human object [1] (Figure 1 and Table 1). SOO is semi-intellectual mechanisms possibly as well convert the non-intellectual information in more intellectual structure for IO and mechanism to comprehend. The third system processes the non-intellectual information and the SEO redirect the non-intellectual information for the purpose of motivation. The SOO or mechanisms mediate social emotion, and ultimately, the emotional system is produced.

These objects imply an easy link among systems (Table 1).This feature gives the impression that these objects of comparison, combined with the TET mechanisms, make a marvelous entity that forms a self-sustainable system. When these objects interact with or stimulate each other within a fountain of energy, emotions are produced (Figure 1).

3.2. Freud psychic energy: instinct libido and cathexis and TET emotional energy

The TET developed independently of Freud's theory, and the author has interpreted Freud through the TET. In Freud's works, there are three forms of energy that this author identifies: the instinct, the libido and the cathexis. Instinct seems to be characterized by dual functions: sexual instinct vs. ego instinct as well life instinct vs. death instinct (see also Author), [2]. Freud [23] also described the relationship between a stimulus and an instinct in the following manner: "There is nothing to prevent our subsuming the concept of 'instinct' under that of 'stimuli' and saying that an instinct is a stimulus applied to the mind." (p. 118). This could mean that the emotional energy stimuli SEO and it redirect the energy after that SEO makes the comparison with IO and produces the emotion (Figure 1). Laplanche defined life and death instincts as follows, "…the death instincts, which are opposed to the life instincts, strive towards the reduction of tensions to zero-point. In other words, their goal is to bring the living being back to the inorganic state." [26], (p. 97).

In TET we produce tension reduction through the object by reducing comparison. All of these instincts are viewed in the TET as emotional energy that relies on neural networks and specific neurochemical and physiological makeups to form this emotional energy. These functions could be regulated by the SEO and assisted by social objects mechanism: social hierarchy censorship and self-survival hierarchy censorship (see also Author, [2] (Figure 1 and Table 1). We need to understand the emotional energy

and its dynamic to further understand the SEO's executive role in the emotion system. In therapy, the SEO has been shown to be responsible for these functions [1]. It is important to mention here that this emotional energy or instincts may not follow the law of the physic energy; this should be taken into account when constructing artificial emotions and observing how this energy interacts with objects. Emotional energy should be neurochemical with emotional logic.

Theories	TET Objects and Freud divisions	TET Regions and Freud divisions	TET Emotions	Brain structures
TET	External object	Intellectual Region	"Cognitive emotions" appraisal and cognition	Hippocampus
FREUD	Ego	Consciousness		
TET	Social object	Semi-intellectual region	Social emotions	Amygdala
FREUD	Super ego	Pre-consciousness		
TET	Self-object	Non-intellectual region	Self-survival emotions	Hypothalamus
FREUD	ID	Unconsciousness		

TABLE 1: This table shows that there are some apparently similarities between Freud's theories and the TET and TET emotions. There are brain structures that have their own place and levels in emotion. Terms begins form external (upper row) to the internal function (lowest row). The external object, may be considered to be a parallel to the ego, the social object (SOO), corresponds to the superego, and self-object (SEO), could correspond to the Id. The intellectual area can coincide with the consciousness, the semi-intellectual area can be compared to the pre-consciousness, the non- intellectual area also corresponds to the unconsciousness. In the hippocampus there might be appraisal and cognition and "cognitive emotions". the social emotions: guilt, shame, anger, happiness, love, etc. might be located in the amygdala. The self-object may be situated in the hypothalamus. Even thought, there are many other subcortical regions, that play a great role in self sustain emotion system. The self-survival emotions: pleasure, panic/anxiety might also be located in the hypothalamus and controlled by the self-object (SEO).

3.3. Libido

Libido could be the unification of all of the instincts. As Freud [27] wrote, "Libido is an expression taken from the theory of emotions. We call by that name the energy, regarded as a quantitative magnitude (though not at present actually measurable)…" (p. 90). Therefore, this energy should be based in a sub-cortical mechanism and involve specific neurochemistry as point out Panksepp [20]. What the author calls emotional energy which reside in the nucleon of emotion. Freud [25] pointed out that: "… we are constantly detaching our libido in this way from people or from other objects without falling ill." (p. 72). This means that SEO is continuously interacting with external objects through the comparison after which SEO makes negative or positive energy producing negative or positive emotions in the system according to the dominant energy. In the TET, we use the two objects to resolve the conflict by reducing the comparison between the objects (see also the author [1]; [2]) with the help of the SOO or better to say with SOO mechanism. The reduction of the comparison probably reduces the activity organs and/or produces more or less a neurochemical which decrease in the negative energy. Zald [28] considers by examinations, that amygdala activity augmented more in response to negative, rather than positive, emotional stimuli. Because negative emotions are instrumental in reducing negative emotion, we are left with more positive energy [1].

3.4. Cathexis

Cathexis is another term that Freud uses to explain psychic energy, pointing out: “The nucleus of the Ucs. consists of instinctual representatives which seek to discharge their cathexis; that is to say, it consists of wishful impulses.” [23], (p. 186). The author speculated that the nucleon of emotion is the main source of the emotional energy that is regulated or redirect by the SEO and by the help other mechanisms (Figure 1 and Table 1). This cathexis could mean that the energy between the objects (that is the comparison energy) which facility is charged into objects by SEO mechanism [1]; [2]. The comparison of objects facilitates the stimulation of internal and external emotional energy help the organism to life sustain that is motivated by the SEO. Panksepp, [20] believes in various quantities and category of arousal that can help the organism in life self sustain.

Laplanche [26] claims that, according to Freud, “…cathexis is not withdrawn from the object – on the contrary, the object is heavily ‘cathected’ as an object-to-be-avoided.” (p. 64). This is quite evident in phobias in which the individual cannot see that the real object of comparison is a person. A car phobia could appear for one of two reasons. In one case, it can be generated by self-survival, and in therapy we need to use only the image of the Self-object, but it is also possible that the phobia of driving a car can be caused by shame [1].This stems from the urge towards social self-survival. If this is the case, we also need the social object that fuse with the IO in addition to the SEO [1].

3.5. The three TET systems with their objects and Freud geographic divisions of psychic

The three systems described in the TET show similarities to Freud’s psychic topographic divisions (Table 1). However, the author does not use Freud's terminology because ultimately the concepts are not the same (see also author [1]; [2]). The intellectual area corresponds to Freud’s consciousness, the intellectual object (IO) to the ego, the semi-intellectual area to the pre-consciousness, and the social object (SOO) to the super ego [1]. The social object mechanism should have the capacity to understand the demands of the SEO. Because humans are motivated to survive socially and have the predisposition to be outstanding, a compromise system is needed to understand the mechanism of the SEO [2]. The non-intellectual area (which is the unconscious) and the non-intellectual object or (SEO) form the Id but among other things the id does not have executive function and TET objects and regions have many different mechanism that Freud objects energy and regions may not contain the same functionality (Figure 1 and Table 1). The SEO may be shared by all species, with specific levels of development according to the species. Panksepp [20] states that a basic neural architecture could generate internal experiences. In order to function artificially, we will need to develop a new configuration or architecture because it seems according to the TET, that emotion has its own mechanism.

4. SOME PHYSIOLOGY IN THE SELF-SURVIVAL AND SOCIAL SURVIVAL HIERACHY AND EMOTIONS

4.1. The relationship of the hypothalamus to emotions, self-survival hierarchy censorship and the self-object

The non-intellectual area seems to be located in the more primitive areas of the sub-cortical region; this could correspond to the hypothalamus and nearby organs (Table 1). Here, we may find the self-survival hierarchy censorship emotions of anxiety (panic) and pleasure (and their mechanisms), the SEO with the mechanisms of safeguarding and decision making, the self-survival hierarchy censorship mechanism of danger and the self-survival censorship mechanism of basic needs (e.g., hunger) that all species share to some extent [2] (Figure 1 and Table 1). Panksepp [20] believes that “In sum, one guiding premise of ‘affective neuroscience’ is that a natural neurobiological function of the brain is to generate a menagerie of positively and negatively valence affective states, of various degrees and types of arousal, that help guide organisms in life-sustaining activities.”(p. 12).

We have for a long time recognized that the hypothalamus controls at least some basic biological functions of self-survival (for example, hunger and thirst) while taking into consideration that these function are underlied by the evolutionary emotional system and safeguarded by the SEO. Numerous studies have shown the significance of the sub-cortical regions in human affective experiences, such as

the craving for money [29]; [30] (a, b), the enjoyment of music [31], orgasm [32], and air starvation [33] (table 1). The author considers these functions to be the product of emotional self-survival mechanism that motivates and safeguards the organism to self-survival that is accomplished by the SEO and that this energy is the result of evolution. Panksepp [20] has stated that "Emotional systems have an integrity that was created through evolutionary selection rather than simply through the life experiences of organisms." (p. 12). Even though social emotions are stimulated by social interactions and modified by life experiences, the author considers them to be the foundation of the neural, evolutionary and authentic emotion mechanisms. Social emotions seem to be produced by the interaction between objects and regulated by social hierarchy censorship that is probably attached to self-survival hierarchy censorship and allowed by the SEO [2] (Figure 1).

In addition, Straub [34] points out that the fetus already experiences emotions and sensations before birth. The author has postulated that pleasure and panic/anxiety are the two basic emotions of self-survival [2]. Panksepp [20] points out that "…the fundamental ability of neural tissue to elaborate primary-process forms of affective experience evolved long before human brain evolution allowed us to think and to talk about such things." (p. 7). Emotions or sensations appear to be regulated directly by the SEO by directing the organisms to react when the SEO seems it necessary and may be assisted by other mechanisms such as the SOO mechanisms and self-survival hierarchy censorships [2] (Figure 1 and Table 1). Additionally, the SEO determines if a situation is not related to self-survival and seems to emerge as the decision-maker for the whole emotional system [2].Thus, the author of this paper hypothesizes that self-survival hierarchy censorship emotions reside in the hypothalamus (possible other sub cortical area) and that the SEO connects to other cortical areas through other neural emotional mechanisms (Figure 1 and Table 1). Panksepp [20] considers emotions to interact in the cortical regions of the brain but thinks they should be viewed as a different class.

The author suggests that the self-survival hierarchy censorship has two functions, one for meeting basic needs such as hunger thirsty etc. and another for avoiding danger [2]**.** Valenstein, Cox, and Kakolewski [35] found that electrical stimulation of the hypothalamus triggered a wired-in hierarchy of conduct that was particular to the species being tested. For example for a child or creature to learn, that snakes are dangerous by forming an image of a dangerous snake, he/she/ it creates the object of the snake in the self-survival hierarchy censorship region and uses it to compare with other snakes or other animals in order to escape or to practice how to respond; (these objects are attach to the existing self-survival mechanism) are used as references that are interrelated to each other to form a system of self-survival hierarchy censorship; the more sophisticated the species, the further this interrelation is refined [2]. In humans, the interrelation goes further to form a social self-survival hierarchy censorship mechanism.

4.2. The relationship of the amygdala to the social object and basic emotions

Figure 1 shows the hierarchy of emotions. We can see in the first parallel line remorse, embarrassment and resentment etc. emotions that could take the place of the basic emotions. Nevertheless we recognize the second parallel line as the basic emotions. All the emotions in TET hierarchy are called social emotions including basic emotion. The author speculates that basic emotions are situated in the amygdala and other sub-cortical regions. In human evolution, as we have advanced socially, we have developed sophisticated basic or social emotions. However, the social emotions continue to be underlied by the basic mechanism of self-survival hierarchy censorship (which was crucial during earlier stages of evolution), while being safeguarded and directed by the SEO and sorted by social hierarchy censorship created because of need to survive socially (Figure 1). First, according to the TET, in order for an emotion to be social emotion of the self-sustain system, it needs to involve a hierarchy; for example, disgust does not seem to form a hierarchy (Figure 1). Sander [13] finds that several studies demonstrate that signals of fear and disgust are processed by distinctive neural substrates. This could mean that disgust is not a basic (social) emotion. Some of these feelings and sensations could be from the cognitive area of later development.

Adolphs [36] has organized emotions quite differently from the TET; he does not use a coordinated mechanism like the TET to regulate emotions. In TET we call social emotion all the emotions that are

produced through the comparison of the objects including basic emotion. Adolphs [36] uses the term social emotion with different meaning. Adolphs [36] "motivational states" might be analogous to the self-survival hierarchy censorship of basic needs in TET; he also considers two of the basic emotions as "social emotions" to be guilt and shame (Figure 1). These are two important basic emotions (or social emotion according to TET) in human pathology and in everyday life (see author [1]) and they seem to form a hierarchy if you see figure 1. Two other "social emotions" that he describes are: pride and jealousy [36]. In TET pride and jealousy are consider the mechanism of comparison that sparked the beginning of emotions, so that at first, they were even considered to be the nucleon of emotion but were later supplanted by the objects. Jealousy seems to originate in humans from a comparison between the internal object and the external object to produce emotion [1], and "pride" may be a more primitive form that sparks the self-survival hierarchy censorship but plays the same role of jealousy or it might also spark a comparison in the TET social emotions or basic emotions.

Most studies show that basic emotions seem to reside in the amygdala and in other sub-cortical regions (Figure 1). LeDoux [37] suggested that the amygdala was a crucial in the organization of the affective network, and Rolls [38] stated that the amygdala seems to be involved in emotional and social responses to faces. Furthermore, Rolls [38] described consistent evidence that the amygdala is involved in emotions. Kalin found that monkeys with specific lesions affecting the cell bodies of the amygdala showed deficits in their expressions of fear [39]. Similarly to the animal studies, patients with amygdala injuries are more likely to have problems in dealing with static, negative, emotional stimuli [40]. These results support the hypothesis that the SOO and hierarchy emotions are either located in the amygdala or spread among different subcortical areas (Figure 1 and Table 1). Panksepp [20] suggested that the origin of emotion is in the sub-neocortical region.

We may consider that the basic emotions, such as guilt, shame, fear, anger, happiness, surprise, love and the other emotions within the same hierarchies (Figure 1 and Table 1), are situated in the amygdala and probably in other sub-cortical regions (naturally, there should be other basic emotions). The author identifies this region as the semi-intellectual region; therefore, it needs a mechanisms and a region to unite the other two regions to produce homeostasis (Figure 1). The generations of these emotions are based on the evolution of the species and they should have their own neural structure, neurochemistry, and neurodynamics and they are grounded in the emotion mechanism of comparison with the objects and all other mechanisms that the author of this paper has proposed [2]. Buck considered that primes: "… are based on innate mechanisms organized in the subcortical and paleocortical regions of the brain…" [41], (p. 391). Panksepp considered, "Thus, even though emotions and cognitions interact massively, especially in the higher regions of the brain, there are many reasons to view them as distinct species." [20], (pp.11).

The basic (social) emotions should be connected to the SEO through cooperation from social hierarchy censorship and other mechanism. After that, they react in a hierarchical manner as the author has proposed (Figure 1) [42]; [2]. Zald [28] found that in fMRI studies, amygdala activity increased more in response to negative, rather than positive, emotional stimuli. This author concludes that because negative emotions are instrumental, their reduction allows more positive emotions to be available [1]. The author of this paper has also proposed that when we reduce comparisons, positive emotions increase [1]. This function is likely specific to the sub-cortical region.

4.3. The function of basic emotions and social hierarchy censorship emotions

The basic emotion mechanisms of emotions should be regulated by social hierarchy censorship attached to the self-survival hierarchy censorship mechanism then to SEO (Figure 1) [2]. The child needs to learn to survive socially. For example, he must learn that he cannot punch other people for no reason and must continue to store the object of the person in the existing mechanism of social survival in the situation for later comparisons through association mechanisms [2]. The reactions and feelings of the person who senses that he cannot survival socially are quite similar to feelings involving physical self-survival, because it is attached to self-survival hierarchy, except that in social situations, we cannot see

the social objects of as dangerous because of our shame of feeling inferior [1], but we can be aware easily of the objects of our physical dangerous.

It is valuable to understand how the basic emotions, such as guilt, shame, anger, happiness, or love, are produced. We need to hypothesize how we feel a specific emotion. There should theoretically be a comparison between objects (Figure 1) [1]; [2], which may mean that we first need to artificially create the conception of the basic emotion or they can be already in the social censorships. For example, guilt is a feeling that we have wronged another person, shame is feeling ridiculed, anger is feeling that somebody has committed a wrong against us. In love, the object belongs to us and we "own" it. We need to explore whether there is a specific organ (e.g., the amygdala or the hypothalamus) that forms each of these concepts and produces the neurochemical, neural network and genetic ability to form different emotions. Another subsystem, the social hierarchy censorship, then sorts and chooses emotions. The social hierarchy censorship was created and directed by the SEO to aid in social survival (Figure 1 and Table 1) (see also [2]).

Additionally, we should determine whether there is a genetic predisposition to express emotions. As previously highlighted by Straub [34], the fetus experiences some primary sensations, such as pleasure, simple tactile enjoyment, fear and panic (self-survival emotions). One possibility is that the self-survival hierarchy censorship gives rise to the social emotions; pleasure being the positive basic emotions and anxiety being the negative social emotions, then the social hierarchy censorships will form the different basic emotion if it has the conception of basic emotion (Figure 1 and Table 1). For example, decreasing anxiety increases pleasure through reducing comparison of the objects. In relation to the negative and positive energy of the self-survival hierarchy censorship, we can only speculate that decreasing the activity of the hypothalamus (or part of it) will lead to more positive energy or pleasure (decrease anxiety) and that increasing its activity would generate more negative energy or anxiety.

The amygdala can be related to the social emotions. Zald [29] already found that the activity of the amygdala generally increases with negative emotions and decreases with positive emotions. Then, the social hierarchy censorship with his conception mechanism chooses the basic emotion that we feel from the positive or negative according to the dominant energy and then SEO executes or permitted it. For example it can choose from happiness, guilt and shame (Figure 1 and Table 1). The magnitude of the increase or decrease of the specific emotion and its hierarchy will function according to the activity of the organ (e.g., the amygdale, brainstem thalamus hypothalamus etc.*)*. An example of the hierarchy function involving shame is that initially you feel ridicule, then shame, followed by anxiety, then anxiety that is related to a personality disorder, and finally psychosis that is related to the anxiety; the last two stages have more organic causes. The same logic applies to the other basic emotions (Figure 1) [42]; [2]. This could be the pattern of an efficient functional form, or there may be other prototypes to discover. The Social hierarchy censorship resides between the IO and the SEO [2].

5. IMAGE

Image is important to the development of artificial emotions because it is a basic part of the non-intellectual function (and possibly also of the intellectual area), the intellectual system also needs to be compared between the inanimate objects to create an intellectual meaning. We have an abundance of information in relation to the camera and other optical discovery so we need to make artificial mechanism that IO can form images of the external objects that can compare with the SEO to further stimulate the emotional system and be able to image the external objects without their presence. When making an image of SEO as defines by the author with the executive mechanism, then we need the image and the mechanism of the SEO to compare to the IO (or SOO and IO) images. Image and mechanism that compromise between the two objects and social hierarchy censorships and self-survival hierarchy censorship mechanism that regulated in formations and energy and other mechanism propose here (Figure 1). Images have been used in the healing process and in therapy, and we have not given it significance from the point of view of a TET object.

Can we make this information work? Yes, even by using the knowledge we already have. However, we need more knowledge about the mechanism of the organ that is responsible for making these images of the SEO, the SOO and the IO. We need to know if the images of all of the objects in the system involve the same mechanisms.

6. SOME PHYSIOLOGICAL MODELIN THE FUNCTION OF EMOTION

6.1. TET and other theories of physiological emotions, neural network and robots

There are several models of how neural networks may work in emotions. Ledoux considers that [43] neuroscience is enchanting again the interest in emotion for example, by using two neural, emotional and cognitive relations and connecting the two networks. Ledoux [37]; Parvizi and Damasio [44] postulated the existent of consciousness in neurobiological conditions. The brain makes patterns of object and sense of self. Fellow has a model [45]; [46] that is oriented to the peripheral model. Damasio et al., [47] regards emotion as a dynamic pattern of neuron modulation**.** Canamero [48] proposes an approach that depends on an internal mechanism and a value system model to regulate external positive and negative actions and stimuli. Most of these approaches are oriented towards cognitive functions, but some of their features can be appropriated to create a more authentic self sustainable emotional system by combining an unadulterated theory of emotion with the internal object, the external objects and the other mechanisms of the TET. Each of these models misses the elements of the TET, which emerge as a unified and organized theory of emotion (Figure 1).

Some authors (Balkenuis and Moren) have created a set of sophisticated connections for the neural model of emotion. These researchers have put together a computational model of emotional learning that employs neural networks in diverse brain regions and unifies them with specific regions, such as the amygdala, the thalamus, the sensory cortex and the orbitofrontal cortex; however, this sophisticated system had not yet been set into operation [49]; [50]. The neural model may be improved by the addition of a simple and more reliable theory of emotion that takes into account the different parts of the brain with an efficient and lucid emotional approach but considers emotion to be independent from cognition; otherwise the system may be too chaotic (Figure 1 and Table 1). Many studies suggest that emotions function in a neural network but they do not have a unified system. Basic neural studies should help to develop a system of emotion according to the TET principle by connecting the TET emotional mechanisms with neurochemical and neural networks and constructing the TET regions, objects, social censorship, self-survival hierarchy censorship, and the basic emotions within the system. In reality, this is a difficult prospect because we need to start with a new mechanism but as soon as we find the logic development can be fast.

The fight-or-flight response is a common model that has been the subject of research for a long time; it is a model of basic homeostatic control. Lately involves some neural connections and neurohormones assembly related to flee and fight [51]; [52]; [53].The culmination of the fight-or-flight response seems to be a dual response mechanism. The author concludes that it is missing a control centre, especially because we are organisms with a self-sustainable emotional system. The fight-or-flight response may resemble the self-survival hierarchy censorship mechanism reaction in the TET that involves the emotions of pleasure and panic (anxiety), but they are different. The TET has a clear self-survival hierarchy censorship system that is theoretically controlled by the SEO. Furthermore, there is a social system or basic emotion attached to the nucleon, controlled by the SEO, mediated by the SOO and sorted by the social hierarchy censorship (Figure 1).

In the development of artificial emotions, in addition to a computer, we need a robot or some sort of machine to embody all of the artifacts and mechanisms that are needed to produce artificial emotions. At this moment, there have been many advances in artificial intelligence, as well as in robotic movements, in the visual area, in consciousness and in other related areas. Nolfi, as well as Cliff et al., has done preliminary work involving spontaneous evolutionary robotic processes [7]; [8]. When emotion is placed as a factor in the current evolution of the robot (allowing changes in neurochemistry, neurodynamics and early evolution), we may be able to begin the evolution of artificial emotion as the SEO will produce the

genuine motivation and arousal for the system in its interactions with the internal and external objects. The other mechanisms of TET will produce self sustain system and as we advance we will see the need of other devices (Figure 1). Buck considers primes to "...generally require internal or external stimuli to become activated…" [41], (p. 391).

Canamero [48] concludes that the robot model does not offer much insight into how the internal or external mechanisms should be stimulated in order to produce emotions. However, it is obvious for the TET that at least two objects are needed to stimulate the internal and external environments: IO, SEO and SOO mechanism for homeostasis. The IO is a representation of the external world within the brain. The SOO is the object or mechanisms of compromise, and the SEO is the object of motivation and execution. Once we have a self-sustainable system, the evolution of an autonomous robot will make more sense because the robots may have decision-making system and self-sustain system. Panksepp has strongly consider that affective and cognitive types of consciousness come from lower regions (subcortical) where executive schemes for emotional responses are ordered and organized in different manner then cortical area [20]; [54]; [55]; [56]; [57].

Therefore, one could propose in hypothetical rough manner to unite the emotion system using the following scheme: the intellectual regions and the external object with the hippocampus, brain hemispheres, the semi-intellectual region and the social object with the amygdale, other subcortical areas, the non- intellectual region, the SEO and nucleon with the hypothalamus and brainstem etc. (Table 1). Naturally there are numerous other regions and organs that are exploring and many other needs to be explored and see how they function interconnect. After that, emotions sometime need to be appraised in the higher regions such as the intellectual region (IO) (which corresponds with the hippocampus and the left and right hemispheres) (Figure 1 and Table 1). Panksepp considered [20], "Thus, even though emotions and cognitions interact massively, especially in the higher regions of the brain, there are many reasons to view them as distinct species." (p. 11).

7. COMPUTER AND EMOTION

7.1. Computer interactions with humans

Recently, there have been great advances in human-computer interactions through an improved understanding of the interactions between cognition and affective states, along with the use of miniature cameras, physiological measures with various types of electrodes and posture detector monitors, as well as the measurement of artifacts such as Galvanic Skin, EEG, ECG, measurement of the recognition of facial expressions and many other body measurements [11]. Furthermore, many researchers are looking for efficient body markers for affective states with the aim to develop a better understanding of the interactions between computers and humans, taking into consideration the influence of cognitive affective states.

The intelligent tutoring system (ITS), developed by the tutoring research group (TRG) at the University of Memphis, features an automatic tutor that can interact with the students in a natural manner, like a real tutor, even though the computer behaves in an automatic fashion [58]; [59]. Another area where an intelligent tutor system is useful is in autism. The Interactive Socio-Emotional Toolkit (iSET) has been developed to help with the various difficulties that are faced by autistic patients; it is based on the recognition of facial expressions and the emotions of oneself and of others [60]. This is a great advance in computer and human interaction but not in self sustain system of emotion.

Woolf et al., [61] has proposed to repair the inequity that exists between the cognitive and affective states. D'Mello et al., [62] has described some emotions or sensations in learning such as boredom, flow/engagement, confusion, frustration, flow and neutral state. Because learning is a cognitive state, these feelings are more cognitive and therefore influence the learner. The basic and social emotions and self-survival emotions are a self sustainable system; they have to do with social self-survival and physical self-survival, so they influence learning in a different manner (Figure 1). Relatively speaking, there have been considerable advances and positive movement in these areas resulting from the cognitive and

affective learner but they have moved from the genuine emotions theories of the self sustainable system. Computer interaction with human knowledge could be useful in the future in order to produce a more complete human-like robot. It would be great if we could integrate a self sustain system as propose here.

7.2. The component process model (CPM), Asynchronous Learning by Emotion and Cognition (ALEC) and Database

There are many exceptional computational systems that are oriented to cognitive theory, like the component process model (CPM) and the stimulus evaluation check (SEC); Sander [13] proposes that "…the CPM assumes that emotion differentiation is produced by the results of the SEC sequence, it follows that the latter should also be the key to predicting modal emotions."(p. 325). Even though this knowledge is oriented more towards the cognitive, it could be integrated to be used in an emotional human self sustainable system. Sander et al., [13] point out that despite the fact that the computational model of CPM does not exists in real life, Sander et al., proposed the prospect "…of constructing computational models of emotion using neural networks…" (p. 325).

Scherer has suggested architecture of emotion with fundamental mechanisms that can be applied to both emergence and the specific role of consciousness in emotional processing [63]; [64]. The component process model (CPM) and the stimulus evaluation check (SEC), in conjunction with the neural network, might help to develop a more untainted artificial emotion if we were able to find a new theory of emotion that encompassed these theories and allowed them to be modified by each other.

The Asynchronous Learning by Emotion and Cognition (ALEC) with the emotion-based architecture (EBII) is an attempt to make a system that performs with a goal system, helping to make the emotion system more abstract; ALEC also endorses developments in the advancement of artificial emotion. Furthermore, Gadanho points out [14] "The reported experiments test ALEC within a simulated autonomous robot which learns to perform a multi-goal and multi-step survival task when faced with real world conditions..." (p.385)

Database is another system in the endeavor to produce artificial emotions. "One of the key developments is a growing recognition that the task of assembling adequate databases is a major challenge, intellectual as well as practical, with links to fundamental issues in the theory of emotion." [15] (p. 37); furthermore, Sander et al., [13] believes that "… such modeling promises to do a better job in explaining a number of intuitively obvious characteristics of emotional responses (such as abrupt changes that are difficult to explain by linear functions or dependency of the response on the origin or departure point)." (p. 344).

The stimulus evaluation check (SEC), the emotion-based architecture (EBII), the emergence and specific roles of consciousness in emotional processing and the rules system (and other similar systems) seem to be an attempt to make a self sustainable mechanism at the cognitive level. However, it may not be possible to have such a system at the cognitive level. As Panksepp [20] points out, the emotional function is from an early stage of evolution, and most creatures are self sustainable despite the lack of a cognitive system.

These systems are sophisticated, but they seem to demote the idea of genuine independent emotion and a self sustainable system that takes into account earlier evolution and sub-cortical area as a main source of emotion, while also taking into consideration comparisons between these objects self-survival hierarchies and emotion mechanism. As mentioned, all species should have some mechanism of comparison in order to understand the difference between good and bad and danger. Furthermore, the ideal system would take into account other mechanisms of the TET and the neurochemical and neural network attributes that allow the self sustainable system to function.

In order to build a goal system, to assembly emotion more abstract, creating intuitive device, generating consciousness, understand stimuli functions, assembly databases etc. we need to have internal and external interaction system and other mechanism to assist these functions and direction in self sustain manner.

8. CONCLUSION

The TET could be the key to artificial emotion, since it provides a systematic and organized system that can be applied to building artificial emotions. It has limitations, but it is a good starting point. At first, we need to make an image of the SEO with executive mechanisms and an internal object (or Self-object) to compare against the external world IO (Figure 1 and Table 1). In the nucleon (or non-intellectual region), we also need a self-survival hierarchy censorship mechanism that motivates us to regulate our basic needs (e.g., hunger) and avoid danger. We also need a mechanism for the interaction between objects.

The semi-intellectual region and SOO have the mechanisms for producing homeostasis because the friction between the internal and external objects. The semi-intellectual region has more to do with human social interaction and is underlied by the internal object (or SEO). Here we can find in addition, the mechanisms of the social hierarchy censorship, the devices or mechanism that choose the dominant emotion, and mechanism to choose the right basic emotion and the emotional hierarchy functions also need to be built up.

Next, we must represent the IO (which is the representation of the external object) and the intellectual region, which may be situated in the nucleon of cognition. In addition, we should look for the most efficient functions and interactions between and within each of the functions. It is expected that we need to integrate knowledge from computer science, neurochemistry and neural networks. The fields of evolution, physiology and other sciences will also help to build a self sustainable system. This means that the TET and other sciences must influence each other without losing the vision of a self sustainable system from an untainted emotional theory point of view.

The TET proposes an embodied system with artificial organs that resemble biological organs as much as possible. The main critiques of the TET focus on its simplicity, but the author believes that this system should be simple since evolution is a process that selects for an efficient system. It is necessary to postulate more daring theories with other mechanisms (e.g., an object's self-survival hierarchy censorship and social hierarchy censorship system) and to move in other directions. Canamero [48] indicates the need for more theories of emotions, and the author has proposed one, [1]; [2]. Meanwhile, clinical work shows the objects' existence. It has taken over two and a half decades to develop this theory and more than two decades of clinical work spent exclusively working with the TET comprising thousands of hours spent working with clients [1].

Logically, building artificial emotions will provide immense information about emotional systems. This is especially true when using the TET model because it offers a new way to perceive emotions and its organization seems logical. Emotion has been relegated to the cortical region in the past, although it belongs in the sub-cortical region. We view intellectualization as a more significant function of human beings. However, the emotional system has great transcendental importance to us. What make possible the self-sustainable system among other mechanisms are three forces, one illogical, the other logical and the third mediating. Through comparison or friction between the objects, emotions arise and stimulate the energy of the system.

Most theories appear to look for sophisticated schemes of the self-sustain system but one of the greatest problems is, that most emotion theories are cognitive oriented but self-sustain system of emotion does not have anything to do with cognition. If you think an animal, you notice that every animal have a self-sustain system, which indicates, that self-sustain system cannot be too complex. If wanted to build an artificial life, that resembles a human, cognition, social and self-survival emotions are needed but after that, we are facing a problem since there has not been theories which could guide us to build unadulterated separated self-sustain system. The emotional theories do not use image neither non-intellectual system and self-survival and social survival hierarchy according to TET theory. Additionally, emotion theories do not show good schema how to stimulated and connect internal and external world neither mechanisms of how choose and to regulated the social and self survival emotions.

Computer has solely cognitive function and now there is development of affective emotion, which seems to have more cognitive emotions than emotions of the self-sustain system since they do not form hierarchy and they have more to do with learning process. The lack of organized system without a nucleon will lead us at end with chaotic and unpractical system. Physiological emotions theories, neural network and robots theories cannot present theory with a nucleon to organized and redirect information. TET presents an ordered system with a nucleon, hierarchies and different stages of organization which can even be used as a starting point of constructing a less sophisticated self-sustain system.

9. REFERENCES

[1]R.Navia. **"**Emotions have a Nucleon that can be directly regulated by TET". International journal of psychotherapy. No 12, Vol. 1, pp. 38-49, Mar.2008.

[2]R. Navia. From Freud to the TET, psychic energy is emotional energy and can be directly regulated by the TET method. [Submitted]

[3]R.A. Brooks., C. Breazeal., M. Marjanovic., B. Scassellati., and M. Williamson. "The Cog project: building a humanoid robot" *In Lecture Notes in Computer Science*, vol. 1562. D. Hutchison, T. Kanade., J. Kittler., J.M. Kleinberg., F.Mattern., J.C. Mitchell., M.Naor., O.Nierstrasz., C.P. Rangan., B. Steffen., M. Sudan., D. Terzopoulos., D. Tygar., M.Y. Vardi. and G. Weikum. Eds. Berling: Springer, 1999. pp. 52–87.

[4]G. Metta., G. Sandini. and J. Konczak. "A developmental approach to visually-guided reaching in artificial systems." Neural Networks, vol. 12, pp. 1413–1427, Dec. 1999.

[5]J. Weng., J. McClelland., A. Pentland., O. Sporns., I. Stockman. "Autonomous mental development by robots and animals." Science, vol. 291, pp. 599–600, Jan. 2001.

[6]D. Jeffrey. "Animats and what they can tell us." Trends in Cognitive Sciences, Vol. 2, pp. 60-67, Feb. 1998.

[7]D. Cliff., I. Harvey. and P. Husbands. "Explorations in evolutionary robotics." Adaptive Behavior, vol. 2, pp. 73-110, Jun. 1993.

[8]D. Floreano., P. Husband. and S. Nolfi. "Evolutionary Robotics," in B. Siciliano., K. Oussama (eds.), Handbook of Robotics, Berlin: Springer Verlag, 2008. pp. 1423-51

[9]S. Nolfi. "Evolutionary robotics: looking forward." Connection Science, Vol. 16, pp. 223-225. Dec. 2004.

[10]T. Ziemke., N. Bergfeldt. and G. Buason. "Cognitive scaffolding; evolutionary robotics; artificial intelligence; brain; body; environment adaptation." Connection Science, Vol.16, pp. 339-350, Dec. 2004.

[11]R.W. Picard. and S.B. Daily. "Evaluating Affective Interactions: Alternatives to Asking What Users Feel," CHI Workshop on Evaluating Affective Interfaces: Innovative Approaches, Portland, 2005.

[12]S.K. D'Mello., S.D. Craig., B. Gholson., S. Franklin., R.W. Picard, and A.C. Graesser, "Integrating Affect Sensors in an Intelligent Tutoring System," In Affective Interactions: The Computer in the Affective Loop Workshop at 2005 International Conference on Intelligent User Interfaces, New York: AMC Press, 2005, pp. 7-13

[13]D. Sander., D. Grandjean. and K.R. Scherer. “A systems approach to appraisal mechanisms in emotion.” Neural Networks, vol. 18, pp. 317–352, May 2005.

[14]S.C. Gadanho. **“**Learning Behavior-Selection by Emotions and Cognition in a Multi-Goal Robot Task.” Journal of Machine Learning Research, vol. 4, pp. 385-412, Jan. 2003.

[15]R. Cowie., E. Douglas-Cowie. and C. Cox. "Beyond emotion archetypes: Databases for emotion modeling using neural networks.” Neural Networks*,* vol. 18, pp. 371–388, May 2005.

[16]R.S. Lazarus. “On the primacy of cognition.” *American Psychologist*, vol. 39, pp. 124–129, Feb. 1984a.

[17]R.S. Lazarus. “Thoughts on the relations between emotion and cognition.” In *Approaches to emotion*, K. R. Scherer and P. Ekman Eds. Hillsdale, NJ: Erlbaum, 1984b, pp. 247–257

[18]R.B. Zajonc. “Feeling and thinking: Preferences need no inferences.” American Psychologist, vol. 35, pp. 151–175, Feb. 1980.

[19]R. B. Zajonc. “On the primacy of affect.” American Psychologist, vol. 39, pp. 117-123, Feb. 1984.

[20]J. Panksepp. “At the interface of the affective, behavioral, and cognitive neurosciences: Decoding the emotional feelings of the brain.” Brain and Cognition*,* vol. 52, pp. 4–14, Jun. 2003.

[21]A. R. Damasio., T. J. Grabowski., A. Bechara., H. Damasio., L. L.B. Ponto., J. Parvizi and R. D. Hichwa. "Subcortical and cortical brain activity during the feeling of self-generated emotions.” Nature neuroscience*,* vol. 3 pp. 1049-1056, Oct. 2000.

[22]S. Freud. (1927-1931). “The future of an illusion, civilization and its discontents and other works.” Standard Edition, Vol. 21, London: The Hogarth Press, 1975, pp. 3-260.

[23]S. Freud. (1914-1916). “On the history of the psycho-analytic movement, papers on metapsychology and other works.” Standard Edition, Vol. 14, London: The Hogarth Press, 1975, pp. 3-342

[24]B. Batter Slade. “Assessing children’s mental construction of the object.” In Assessing object relations phenomena, M. Kissen, Ed. Madison: International Universities Press, 1986, pp. 143-171.

[25]S. Freud. (1911-1913). “The case of Schreber, papers on technique and other works.” Standard Edition, Vol. 12, London: The Hogarth Press, 1986, pp. 3-346.

[26]J. Laplanche. The language of psycho-analysis. London: Karnac Books, 1988, pp.1- 511.

[27]S. Freud. (1920-1922). “Beyond the pleasure principle group psychology and other works.” Standard Edition, Vol. 18, London: The Hogarth Press, 1975, pp. 3-274.

[28]D. H. Zald. “The human amygdala and the emotional evaluation of sensory stimuli.” Brain Research Reviews, vol. 41, pp. 88–123, Jan. 2003.

[29]B. Knutson., C. Adams., G. Fong. and D. Hommer. “Anticipation of monetary reward selectively recruits nucleus accumbens.” Journal of Neuroscience*,* vol. 21, pp. 1–5, Aug. 2001a.

[30]B. Knutson., C. Adams., G. Fong. and D. Hommer. “Dissociation of reward anticipation and outcome with event-related fMRI.” Neuroreport, vol. 12, pp. 3683–3687, Dec. 2001b.

[31]A. J. Blood. and R. J.Zatorre. “Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion.” Proceedings of the National Academy of Sciences vol. 98, pp. 11818–11823, Sep. 2001.

[32]G. Holstege., J. R. Georgiadis., A. M. Paans., L. C. Meiners., F. H. van der Graaf and A. A. Reinders. “Brain activation during human male ejaculation.” Journal of Neuroscience, vol. 23, pp. 9185–9193, Oct. 2003.

[33]M. Liotti., S. Brannan., G. Egan., R. Shade., L. Madden., B. Abplanalp., R. Robillard., J. Lancaster., F. E. Zamarripa., P. T. Fox. and D. Denton. “Brain responses associated with consciousness of breathlessness (air hunger).” Proceedings of the National Academy of Sciences, vol. 98, pp. 2035–2040, Feb. 2001.

[34]M. F. Straub. “A theory of the psychophysiological consequences of umbilical cord manipulation by the fetus.” Pre-and-Peri-Natal-Psychology-Journal, vol.7, pp. 61-71, Oct. 1992.

[35]E. S. Valenstein., V. C. Cox and J. K. Kakolewski. “Re-examination of the role of the hypothalamus in motivation.” Psychological Review, vol. 77, pp. 16-31, Jan. 1970.

[36]R. Adolphs. “Neural systems for recognizing emotion.” Current Opinion in Neurobiology. vol. 12, pp. 169-177, Apr. 2002.

[37]J. LeDoux. “Cognitive–emotional interactions in the brain.” Cognition and Emotion, vol. 3, pp. 267–289, Oct. 1989.

[38]E. T. Rolls. “A theory of emotion and its application to understanding the neural basis of emotion.” Cognition and Emotion, vol. 4, pp. 161-190, Sep. 1990.

[39]N. H. Kalin., S. E. Shelton., R. J. Davidson., A. E. Kelley. “The primate amygdala mediates acute fear but not the behavioral and physiological components of anxious temperament.” Journal of Neuroscience, vol. 21, pp. 2067–2074, Mar. 2001.

[40]R. Adolphs, D. Tranel., S. Hamann., A. W. Young., A. J. Calder., E. A. Phelps. A. Anderson., G. P. Lee. and A. R. Damasio. “Recognition of facial emotion in nine individuals with bilateral amygdala damage.” Neuropsychologia, vol. 37, pp. 1111–1117, Sep. 1999.

[41]R. Buck. “Prime Theory: integrated View of Motivation and emotion.” Psychological Review, vol. 92, pp. 389-413, Jul. 1985.

[42]R. Navia. “Tion-emo theory: The nucleus controls emotions.” Paper presented at the meeting of the 1st World Congress for Psychotherapy, Vienna, Austria, 1996.

[43]J. E. LeDoux: “Emotion circuits in the brain,” Annual Rewiew of Neuroscience, pp. 155-184, Mar. 2000.

[44]J. Parvizi. and A. Damasio. “Consciousness and the brainstem.” Cognition, vol. 79, pp. 135-159, Apr. 2001.

[45]J. M. Fellous. “The neuromodulatory basis of emotion.” The Neuroscientist, vol. 5, pp. 283–294, Sep. 1999.

[46]J. M. Fellous. “From human emotions to robot emotions.” Architectures for modeling emotions: Cross-disciplinary foundations. Papers from the 2004 AAAI Spring Symposium. Menlo Park, CA: AAAI Press, 2004. pp. 37–47.

[47]A. Damasio. The feeling of what happens: *Body, emotion and the making of consciousness.* London: Vintage, 1999, pp. 133-167.

[48]L. Canamero. “Emotion understanding from the perspective of autonomous robots research.” Neural Networks, vol. 18 pp. 445–455, May. 2005.

[49]C. Balkenius. and J. Moren. “Emotional learning: A computational model of the amygdala.” Cybernetics and Systems, vol. 32, pp. 611–636, Sep. 2001.

[50]J. Moren. “Emotion and learning: A computational model of the amygdala.” PhD thesis, Lund University Cognitive Studies, 93, 2002.

[51]O. Avila-Garcıa and L. Canamero. “Using hormonal feedback to modulate action selection in a competitive scenario.” In S. Schaal, A. J. Ijspeert, A. Billard, S. Vijayakumar, J. Hallam, and J.-A. Meyer Eds., From animals to animats 8: Proceedings of the Eighth International Conference on the Simulation of Adaptive Behavior. Cambridge, MA: The MIT Press, 2004, pp. 243–252.

[52]O. Avila-Garcıa. and L. Canamero. “Hormonal modulation of perception in motivation-based action selection architectures.” In L. Canamero (Ed.), Agents that Want and Like: Motivational and Emotional Roots of Cognition and Action, AISB 05. University of Hertfordshire, UK: SSAISB Press, 2005, pp. 9-16.

[53]M. Neal. and J. Timmis. “Timidity: A useful emotional mechanism for robot control?” Informatica, vol. 27, pp. 197–203, Mar. 2003.

[54]J. Panksepp. “The neuro-evolutionary cusp between emotions and cognitions: Implications for understanding consciousness and the emergence of a unified mind science.” Consciousness and Emotion, vol. 1, pp. 15–56, Sep. 2000a.

[55]J. Panksepp. “On preventing another century of misunderstanding: Toward a psychoethology of human experience and a psychoneurology of affect.” Neuro-Psychoanalysis, vol.2, pp. 240–255, Dec. 2000b.

[56]J. Panksepp. “Emotions as viewed by psychoanalysis and neuroscience: An exercise in consilience.” Neuro-Psychoanalysis, vol. 1, pp. 15–38, Jul. 1999.

[57]J. Panksepp. “The periconscious substrates of consciousness: Affective states and the evolutionary origins of the SELF.” Journal of Consciousness Studies, vol. 5, pp. 566–582, Jan. 1998.

[58]A.C. Graesser., K. VanLehn., C. Rose., P. Jordan. and D. Harter. “Intelligent tutoring systems with conversational dialogue.” AIMagazine, vol. *22*, pp. 39-51, Winter 2001.

[59]A.C. Graesser., S. Lu., G. T. Jackson., H. Mitchell., M. Ventura., A. Olney., and M. M. Louwerse. “Methods, Instruments, and Computers AutoTutor: A tutor with dialogue in natural language.” Behavioral Research, vol. 36, pp. 180-193, May 2004.

[60]M. Madsen., R. el Kaliouby., M. Eckhardt., M. E. Hoque., M. Goodwin., R. W. Picard., “Lessons from Participatory Design with Adolescents on the Autism Spectrum.” Proceedings of the 27th

international conference, CHI '09 Extended Abstracts on Human factors in computing systems, 2009, pp. 3835-3840.

[61]B. Woolf., W. Burleson., I. Arroyo., T. Dragon., D. Cooper. and R. Picard. “Affect-aware tutors: recognising and responding to student affect.” Int. J. Learning Technology, Inderscience Enterprises Ltd., vol. 4, pp. 129-163, 2009.

[62]S. D'Mello., T. Jackson., S. Craig., B. Morgan., P. Chipman., H. White., N. Person., B. Kort., R. el Kaliouby, R. W. Picard. and A. Graesser. “AutoTutor Detects and Responds to Learners Affective and Cognitive States.” Presented at the Workshop on Emotional and Cognitive Issues at the International Conference of Intelligent Tutoring Systems, Montreal, Canada, 2008.

[63]K. R. Scherer. “On the nature and function of emotion: A component process approach.” In Approaches to emotion. K. R. Scherer and P. Ekman, Eds. Hillsdale, NJ: Erlbaum. 1984, pp. 293–317.

[64]K. R. Scherer “Appraisal considered as a process of multi-level sequential checking.” In Appraisal processes in emotion: Theory, methods, research .K.R. Scherer, A. Schorr and T. Johnstone, Eds. New York: Oxford University Press. 2001, pp. 92–120.

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