Third National Conference on computer engineering Information Technology And data processing
April 2018 Tehran Iran
www.it-com.ir

Making an Expert System for IRAN's Maritime Commerce and Fishery Industry

Seyed Muhammad Hossein Mousavi[1,*]
[1] Independent Researcher
email address: mosavi.a.i.buali@gmail.com, telephone number:00989332892726
*corresponding author : mosavi.a.i.buali@gmail.com

ABSTRACT

Using automatic expert system in any industry, could increase the service quality in that area. Also it decreases human error, increases service speed, decreases cost, increases working time with no fatigue and decreases cheating in respective field. So using theses system is so logical in some areas. Maritime commerce and fishery industry is very essential in every countries. But it could be done easier with an automatic expert system assistance. In this paper an automatic expert system for Iran's maritime commerce and fishery industry is proposed. For implementation CLIPS expert system software has been employed. Also maritime commerce and fishery process details is achieved from three human experts in this field. Validation results between human and automatic expert system using weighted Kappa factor shows high capability of the proposed system. Weighted Kappa is calculated with SPSS software. With agreement level of 0.94 using weighted Kappa factor between second human expert and proposed expert system, robustness and ability of the system validated so satisfactory. System can be used in complex models from academic science to operational advice.

Keywords: *Automatic expert system, Maritime commerce and fishery, CLIPS, Weighted Kappa, SPSS*

1. INTRODUCTION

It is clear that, using automatic expert systems in different field could make ease of use in that profession. Maritime commerce and fishery is one of those professions which this paper tries to work on it. As it mentioned in the abstract, this paper proposed an expert system as an assistant or replacement of the human expert in mentioned field. This paper consist of 5 sections. Section 1 covers the necessary knowledge for proposed method and makes us to understand the definitions better. Section 2 pays to some of the related works in this field. Proposed method is placed in section 3. Section 4 and 5, represent proposed method results and conclusion respectively. Also in section 5, some suggestion for making better expert system in this field and even others, is discussed.

1.1 Expert Systems

Expert systems are a special group of software, which are used to aid human experts, or for being as a total or partial alternative for them to be used in the specialized fields. These systems are in fact the early and simpler types of the knowledge base technology, which with gathering, processing and analyzing data are able to infer and resolve problems in the cases, which usually need the knowledge of a human expert in a special field of study. These systems usually store data as facts and rules in the knowledge base, and then using as special inference methods, needed results will be produced. Expert systems have application in a variety of fields; some of them: medicine, accountancy, industry, education, process control, human resources, financial services, archeology, radiography, engineering consultancy in architecture, juridical consultancy etc. In each of these fields, with the aid of experimental systems, more quickly and easily, it is possible to do works such: guidance, processing, classification, consultation, design, recognition, decision-making, analysis, scoring, foretelling, concept-making, detection, justification, learning, management, planning, scheduling and test [1] [2] [3]. Figure 1 represents the general structure of an expert system.

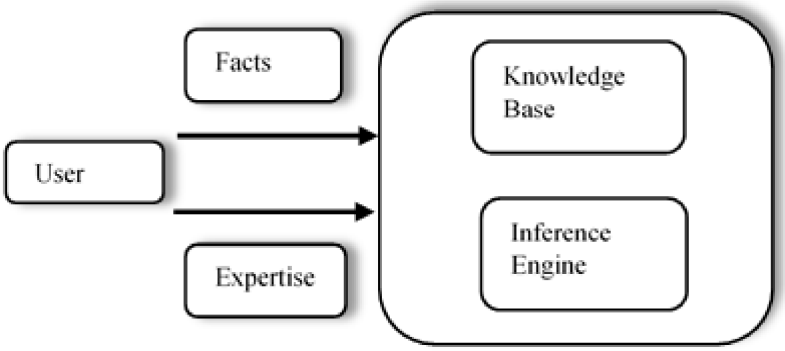

Fig. 1. *General view of an expert system*

1.2 CLIPS (software)

CLIPS is a public-domain software tool for building expert systems. The name is an acronym for "C Language Integrated Production System." The syntax and name was inspired by Charles Forgy's OPS. The first versions of CLIPS were developed starting in 1985 at NASA-Johnson Space Center until the mid-1990s when the development group's responsibilities ceased to focus on expert system technology. CLIPS is probably the most widely used expert system tool [4] because it is fast, efficient and free. Although it is now in the public domain, it is still updated and supported by the original author, Gary Riley. CLIPS incorporates a complete object-oriented language "COOL" for writing expert systems. Though it is written in C, its interface more closely resembles that of the programming language LISP. Extensions can be written in C, and CLIPS can be called from C. Like other expert system languages, CLIPS deals with rules and facts. Various facts can make a rule applicable. An applicable rule is then asserted. Software freely achievable from [5]. Figure 2 shows a screenshot from CLIPS expert system software's environment.

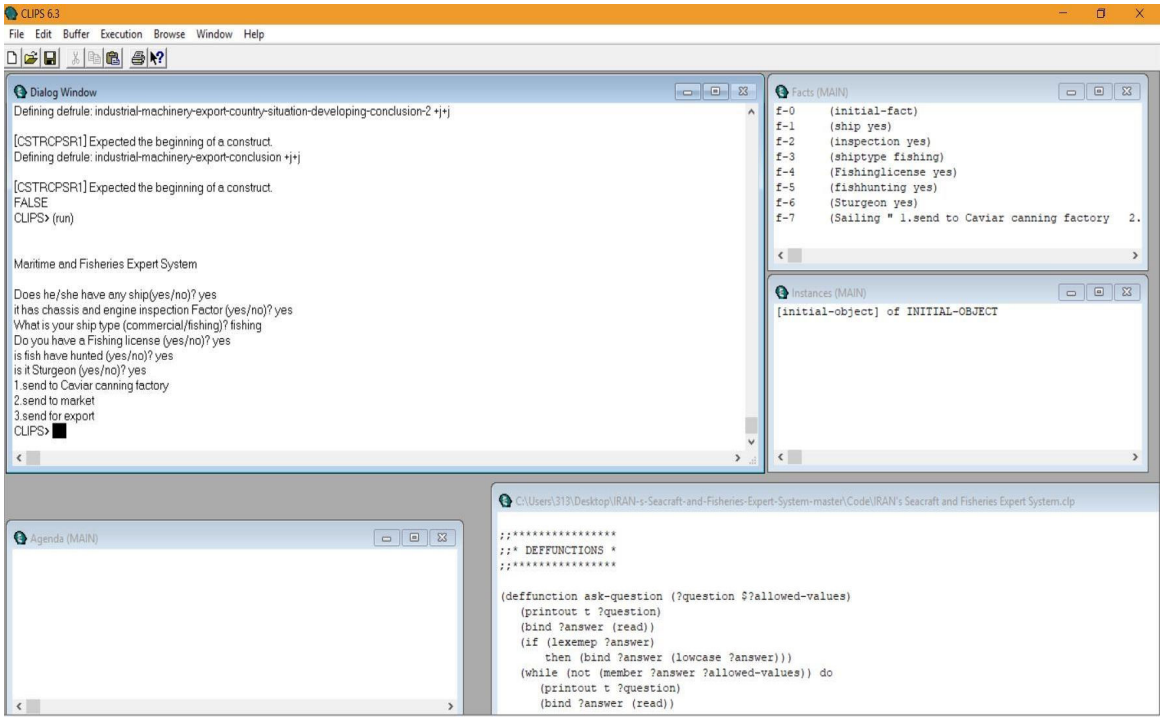

Fig. 2. *CLIPS expert system software's environment*

1.3 Fishery Industry and Maritime Commerce

Generally, a fishery is an entity engaged in raising or harvesting fish which is determined by some authority to be a fishery [6]. According to the FAO, a fishery is typically defined in terms of the "people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, purpose of the activities or a combination of the foregoing features" [7]. The definition often includes a combination of fish and fishers in a region, the latter fishing for similar species with similar gear types [8]. The fishing industry includes any industry or activity concerned with taking, culturing, processing, preserving, storing, transporting, marketing or selling fish or fish products. It is defined by the Food and Agriculture Organization as including recreational, subsistence and commercial fishing, and the harvesting, processing, and marketing sectors [9]. Maritime commerce promotes commerce for the benefit of all parties in the marine supply-chain, including ship owners/managers, suppliers and software providers. It does this by developing, maintaining, harmonizing and promoting common standards (including technical standards and protocols for interoperability between systems).

1.4 SPSS

SPSS Statistics is a software package used for logical batched and non-batched statistical analysis. Long produced by SPSS Inc., it was acquired by IBM in 2009. The current versions (2015) are officially named IBM SPSS Statistics. The software name originally stood for Statistical Package for the Social Sciences (SPSS) [10], reflecting the original market, although the software is now popular in other fields as well, including the health sciences and marketing. SPSS is a widely used program for statistical analysis in social science. It is also used by market researchers, health researchers, survey companies, government, education researchers, marketing organizations and data miners [11], and others. We use just Weighted Kappa in this software to gain agreement level between human and automatic expert system.

2. PRIOR RELATED WORKS

In 2005, Cheung, William WL et al, succeeded to make a fuzzy logic expert system to estimate intrinsic extinction vulnerabilities of marine fishes to fishing system. They employed fuzzy logic techniques for better and much understandable results [12].

Li, Daoliang et al in 2002, developed a web-based expert system for fish disease diagnosis. Their system has over 300 rules and 400 images and graphics for different types of diseases and symptoms. It could diagnose 126 types of diseases amongst nine species of primary freshwater fishes [13].

In 2010 Guisande, C., et al, made an expert system for the taxonomic identification of fishes based on machine learning techniques. They measured morphometric characters in more than 8900 individuals belonging to 6 classes, 43 orders, 192 families, 510 genera and 847 marine and freshwater species for that purpose [14].

Harrald, John R., et al in 1998, succeeded to make an expert system for modeling of human error related accident event sequences in a risk assessment of maritime oil transportation in Prince William Sound, Alaska. The ability to quantify the effectiveness of their risk reduction interventions aimed at reducing human and organizational error were limited by the level of detail described by the taxonomy of human error [15].

In 2013, Boukachour, Jaouad, Charles-Henri Fredouet, and Mame Bigué Gningue, described a project for the design of an expert-system dedicated to maritime container security risk management, present a literature review on decision-support systems dedicated to transportation risk management, and discuss the various steps of expertise modeling in a transportation risk management context [16].

Alagappan, M., and M. Kumaran in 2013, made a survey or review for advantages and disadvantages and its application in the fisheries sector. Total of 91 expert systems developed in the field of fisheries are reviewed by grouping the expert systems under six categories in their research [17].

Also Anderson, James L., et al in 2015 introduced the Fishery Performance Indicators (FPIs), a broadly applicable and flexible tool for assessing performance in individual fisheries, and for establishing cross-sectional links between enabling conditions, management strategies and triple bottom line outcomes [18].

In 2007 Grant, Sandra, and Fikret Berkes, investigated a fisher knowledge generation process in the long line fishery for large pelagic fish in Gouyave, Grenada, using techniques of participant observation, interviews, and focus group discussion. They identified nine categories of knowledge that are important for finding and catching large pelagic fish: seasons, use of bait, gear technology, weather conditions, fishing practice, fish habits and behavior, fish movement, ‘folk oceanography’ (seabirds, seawater color, current), and fish stomach contents. They extract heuristic rules (expressed as IF–THEN clauses) based on fishers’ description and made the system [19].

3. PROPOSED EXPERT SYSTEM

For the purpose of proposed expert system implementation, CLIPS software is employed. Data is collected from three human experts and converted to Facts and Rules for inference engine. All the proposed expert system's content is presented in Table 1, and there is no need to explain more. It has higher readability in the table. Also Table 2, shows some examples of Facts, Rules, Functions, Queries declaration in CLIPS software, based on proposed system. Also Figure 3 presents some of the most important maritime commerce exporting products from Iran to the world. To acquire the code pack can refer to [27].

Table 1. *Facts and Rules and structure of proposed expert system*

	Yes	No	Fishing	Commercial	Kerosene	petroleum
1	Does he/she have any ship?	Go to General Directorate of Ports and Maritime	-	-	-	-
2	It has chassis and engine inspection Factor?	Go to Administration Airframe and engine inspecti	-	-	-	-
3	What is the ship type?		Yes	Go to 18	-	-
4	Does it have a Fishing license?	Go to Watershed managemer and Ports office	-	-	-	-
5	Is fish have hunted?	Go to 8	-	-	-	-
6	Is it Sturgeon?	1. Send to Caviar canning factory 2. Send to market 3. Send for export	-	-	-	-
7	1. Send to Caviar canning factory 2. Send to market 3. Send for export	-	-	-	-	-
8	Is Shrimp have hunted?	Go to 11	-	-	-	-
9	Is it lobster?	-	-	-	-	-
10	Send for export	1. Go to the market 2. Go to the Shrimp canning factory	-	-	-	-
11	Is oyster have hunted?	Go to 14	-	-	-	-
12	Does oyster have Pearl?	-	-	-	-	-
13	Send for gold market	1. Send for Canning factory (2. Send to the market	-	-	-	-
14	Is Sea cucumber have hunted?	Go to 16	-	-	-	-
15	Send for export	-	-	-	-	-
16	Is other Sea animals hav hunted?	-	-	-	-	-
17	1.Send back to the sea 2.Export to the china an East Asia countries	Set fishing net again	-	-	-	-
18	Does it have a Trade license?	Go to Maritime Customs offi	-	-	-	-
19	Does it export fuel?	Go to 23	-	-	-	-
20	Is it tanker?	Go to the oil refinery	-	-	-	-

21	What is going to export?	-	-	-	Yes	**Yes**
22	Export success	-	-	-	-	-

	Yes	**No**	**Watermelon and cabbage**	**Saffron and pistachio**	**Persian gulf countries**	**Other continents**
23	Does it export food?	Go to 27	-	-	-	-
24	What is going to be exported?	-	Yes	Yes	-	-
25	Where it is going to be exported?	-	-	-	Yes	**Yes**
26	Export success	-	-	-	-	-

	Yes	**No**	**Essential**	**Not essential**	**Needy**	**Not needy**
27	Does it export medicatic	Go to 31	-	-	-	-
28	Is it essential or not esse	-	Yes	Yes	-	-
29	Is it going to send to the or not needy countries?	-	-	-	Yes	**Yes**
30	Export success	-	-	-	-	-

	Yes	**No**	**Undeveloped country**	**Developing country**	**100 ton**	**More than 100 ton**
31	Does it export industrial machinery?	Wait for Closing contracts or increasing Request	-	-	-	-
32	Where it is going to be exported?	-	Yes	Yes	-	-
33	How much is the amount of exchanges volume?	-	-	-	Yes	**Yes**
34	Export success	-	-	-	-	-

Table 2. *Some examples of Facts, Rules, Functions, Queries declaration in CLIPS software*

```
(deffunction yes-or-no-p (?question)
   (bind ?response (ask-question ?question yes no y n))
   (if (or (eq ?response yes) (eq ?response y))
      then yes
      else no))
```

```
(defrule print-answer ""
  (declare (salience 10))
  (doctor ?item)
  =>
  (printout t crlf crlf)
  (printout t "Suggested Opinion:")
  (printout t crlf crlf)
  (format t " %s%n%n%n" ?item))
```

```
(defrule determine-oil-export-type ""
   (ship yes)
(inspection yes)
   (not (Sailing ?))
(shiptype commercial)
(Tradelicense yes)
(fuelexport yes)
(tanker yes)
=>
   (assert (oilexporttype
      (ask-question "What is going to export
(petroleum/kerosene)? "
            petroleum kerosene))))
```

```
(defrule determine-Sturgeon-suggestion ""
    (ship yes)
(inspection yes)
   (not (Sailing ?))
(shiptype fishing)
(Fishinglicense yes)
(fishhunting yes)
(Sturgeon yes)
   =>
     (assert (Sailing " 1.send to Caviar canning factory
2.send to market   3.send for export."))
(printout t "1.send to Caviar canning factory" crlf)
(printout t "2.send to market" crlf)
(printout t "3.send for export" crlf))
```

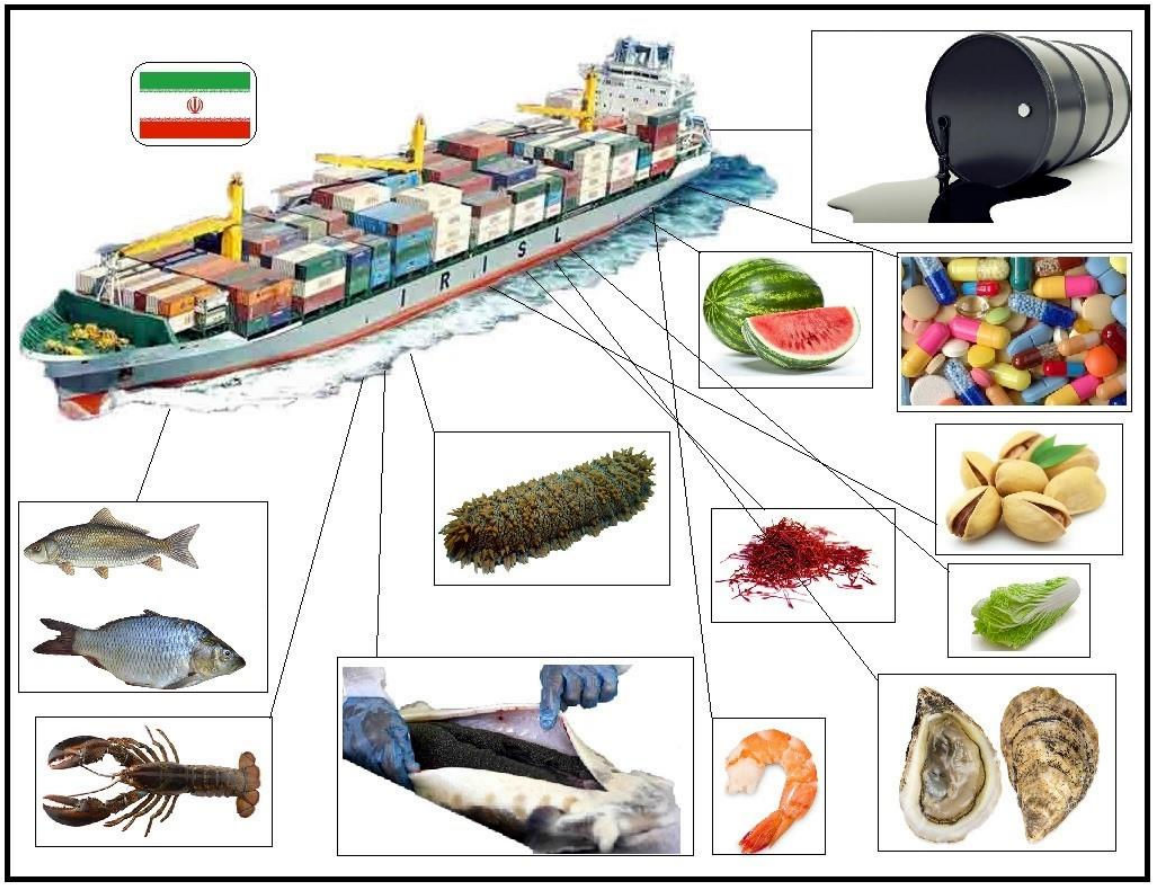

Fig. 3. *Some of the most important maritime commerce exporting products from Iran to the world*

4. VALIDATION AND RESULTS

Require data is collected from some human experts in fishery industry. These data in the form of If-Then is placed in Table 1. This data is evaluated with Weighted Kappa for estimating agreement level between human-human experts and human-system experts.

4.1 Weighted Kappa and results

Cohen's kappa measures the agreement between two raters who each classify N items into C mutually exclusive categories. The first mention of a kappa-like statistic is attributed to Galton (1892) [23] see Smeeton (1985) [24].

$$\kappa \equiv \frac{p_o - p_e}{1 - p_e} = \frac{1 - p_o}{1 - p_e} \quad (1)$$

Where p_o is the relative observed agreement among raters (identical to accuracy), and p_e is the hypothetical probability of chance agreement, using the observed data to calculate the probabilities of each observer randomly seeing each category. If the raters are in complete agreement then $\kappa = 1$. If there is no agreement among the raters other than what would be expected by chance (as given by p_e), $\kappa \approx 0$.

For categories k, number of items N and n_{k_i} the number of times rater i predicted category k:

$$p_e = \frac{1}{N^2} \sum_k n_{k1}\, n_{k2} \quad (2)$$

The agreement level or the similarity of each pair of acquired results by the human experts and system are computed by weighted kappa [20] [21] [22] method in SPSS, and available in Table 3. A strong connection in Kappa is shown with a number larger than 0.9, and a weak connection is lower than 0.6. As the table indicates, the least of agreement level with the value of 0.71 is related to human expert of 1 and 2, and the highest agreement level with the value of 0.94 relates to the expert system and human expert 2.

Table 3. *Agreement level between human-human and human-system using Weighted Kappa factor*

Agreement Level	First Human Expert	Second Human Expert	Third Human Expert	Expert System
First human expert	-	0.71	0.87	0.80
Second human expert	0.71	-	0.85	**0.94**
Third Human Expert	0.87	0.85	-	0.91
Expert system	0.80	**0.94**	0.91	-

5. CONCLUSION AND DISCUSSION

Having proper knowledge in a profession, using professional human experts in different field, it is possible to make a decent automatic expert system. We used maritime commence and fishery as the subject. Surly using these kind of systems could lower the errors and higher the performance in this industry. We employed open source CLIPS software for implementation (making facts and rules) and Weighted Kappa factor for validation as it mentioned in sections 3 and 4 and achieved agreement level of 0.94 between proposed expert system and second human expert. Also it is suggested to combine proposed method with fuzzy logic or evolutionary algorithms for having even better results. It can be referred to [25] and [26] for better understanding of the discussion's topic.

REFERENCES

[1] Joseph, Giarratano, and Riley Gary. "Expert systems principles and programming." PWS Publishing Company 2 (1998): 321.

[2] Kidd, Alison, ed. Knowledge acquisition for expert systems: A practical handbook. Springer Science & Business Media, 2012.

[3] Harmon, Paul, Rex Maus, and William Morrissey. Expert systems: tools and applications. John Wiley & Sons, Inc., 1988.

[4] Di Stefano, Antonella; Gangemi, Francesc; Santoro, Corrado (2005). Proceedings of the 2005 ACM SIGPLAN workshop on Erlang. Tallinn, Estonia: ACM. pp. 62–71. ISBN 1-59593-066-3.

[5] http://clipsrules.sourceforge.net/

[6] Fletcher, WJ; Chessonio, J; Fisher, M; Sainsbury KJ; Hundloe, T; Smith, ADM and Whitworth, B (2002) The "How To" guide for wild capture fisheries. National ESD reporting framework for Australian fisheries: FRDC Project 2000/145. Page 119–120.

[7] Blackhart, Kristan, David G. Stanton, and A. M. Shimada. NOAA Fisheries Glossary. United States Department of Commerce, National Oceanic and Atmospheric Administration, 2006.

[8] Madden, CJ and Grossman, DH (2004) A Framework for a Coastal/Marine Ecological Classification Standard Archived October 29, 2008, at the Wayback Machine.. NatureServe, page 86. Prepared for NOAA under Contract EA-133C-03-SE-0275.

[9] FAO Fisheries Section: Glossary: Fishing industry. Retrieved 28 May 2008.

[10] Quintero, Dino, et al. Workload optimized systems: Tuning power7 for analytics. IBM Redbooks, 2013.

[11] Dnuggets, K. "KDnuggets Annual Software Poll: Analytics/Data mining software used." (2013).

[12] Cheung, William WL, Tony J. Pitcher, and Daniel Pauly. "A fuzzy logic expert system to estimate intrinsic extinction vulnerabilities of marine fishes to fishing." Biological conservation 124.1 (2005): 97-111.

[13] Li, Daoliang, Zetian Fu, and Yanqing Duan. "Fish-Expert: a web-based expert system for fish disease diagnosis." Expert systems with Applications 23.3 (2002): 311-320.

[14] Guisande, C., et al. "IPez: an expert system for the taxonomic identification of fishes based on machine learning techniques." Fisheries Research 102.3 (2010): 240-247.

[15] Harrald, John R., et al. "Using system simulation to model the impact of human error in a maritime system." Safety Science 30.1 (1998): 235-247.

[16] Boukachour, Jaouad, Charles-Henri Fredouet, and Mame Bigué Gningue. "Building an expert-system for maritime container security risk management." Technological Solutions for Modern Logistics and Supply Chain Management. IGI Global, 2013. 86-108.

[17] Alagappan, M., and M. Kumaran. "Application of expert systems in fisheries sector–A review." Research Journal of Animal, Veterinary and Fishery Sciences 1.8 (2013): 19-30.

[18] Anderson, James L., et al. "The fishery performance indicators: a management tool for triple bottom line outcomes." PLoS One 10.5 (2015): e0122809.

[19] Grant, Sandra, and Fikret Berkes. "Fisher knowledge as expert system: A case from the longline fishery of Grenada, the Eastern Caribbean." Fisheries Research 84.2 (2007): 162-170.

[20] Viera, A. J., & Garrett, J. M. (2005). "Understanding interobserver agreement: The Kappa statistic. Family Medicine", 37(5), 360–363.

[21] Cohen, Jacob (1960). "A coefficient of agreement for nominal scales". Educational and Psychological Measurement. 20 (1): 37–46.

[22] Cohen, Jacob. "Weighted kappa: Nominal scale agreement provision for scaled disagreement or partial credit." Psychological bulletin 70.4 (1968): 213.

[23] Galton, F. (1892). Finger Prints Macmillan, London.

[24] Smeeton, Nigel C. "Early history of the kappa statistic." (1985): 795-795.

[25] Mousavi, Seyed Muhammad Hossein, S. Younes MiriNezhad, and Vyacheslav Lyashenko. "An Evolutionary-Based Adaptive Neuro-Fuzzy Expert System as a Family Counselor before Marriage with the Aim of Divorce Rate Reduction.", 2nd International Conference on Research Knowledge Base in Computer Engineering and IT, Education 1: 5. (2017).

[26] Mousavi, Seyed Muhammad Hossein, et al. "A PSO Fuzzy-Expert System: As an Assistant for Specifying the Acceptance by NOET Measures, at PH. D Level.", Shiraz, Iran, CSI 2017.

[27] https://github.com/programmerhosein/IRAN-s-Seacraft-and-Fisheries-Expert-System

View publication stats