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A Study regarding the Use of Expert Systems in Economics Field

Claudiu-Leonardo Stoia[a1]

[a]*Department of Engineering & Management, Lucian Blaga University of Sibiu, Romania*

Abstract

Expert systems simulate the formal reasoning of human expert in a narrow field like stock trading. The traditional method is using IF-THEN rules. Nowadays, Belief Rule Base (BRB) expert systems are capable to perform reasoning based both qualitative and quantitative information. The paper presents a SWOT analysis of expert systems, emphasizing the opportunities the use of expert systems offers to economics field. Using expert systems in economics field provides strategic benefits like: competitive financial advantages, investment advisory, better organisation of workflow, back-up for key experts, training tool for new employees, diagnosis of critical aspects, prognosis of economic trends.

Keywords: expert systems; SWOT analysis; strategic benefits; economics.

1. Introduction:

Let's replace the hard work with the smart work (Peter Drucker).

The smart work is the main factor behind the productivity's boom. The capital investments and the technology have been as abundent both in the first century of The Industrial Revolution as in the next hundred years after. Just in the same time with the arrival of the smarter work, the productivity of the stuff manufacturing and deplacement has begun its meteoric ascension (Drucker, 2006, p. 140).

2. Short history:

Expert systems (ES) represent a type of intelligent systems, among fuzzy systems (FS), neural networks (NN) and genetic algorithms (GA). According to Negnevitsky (2005), *an expert system is a computer program capable of performing at the level of a human expert in a narrow domain.*

[1]* Corresponding author:
E-mail address: claudiu.stoia@ulbsibiu.ro

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The first rule-based expert system is considered *The Advice Taker* (a general-purpose ES), presented by John McCarthy in 1958. He was one of the organisers of the Dartmouth workshop in 1956. That workshop sponsored by IBM was the foundation of the new science called 'artificial intelligence' (McCarthy was the inventor of the term).

The 1970s were a prolific period for the development of ESs. Early seventies have brought the first successful ES : DENDRAL. His creators : Feigenbaum, Buchanan and Lederberg, have manged to understand that the key to success was to narrow the domain of ES to a very restricted area. For instance DENDRAL has proved its ability in chemistry/spectral analysis field.

A 1986 survey by Donald Waterman found about two hundred expert systems in areas such : chemistry (e.g.DENDRAL), medicine (e.g.MYCIN), geology (e.g.PROSPECTOR), electronics, military, management .

Seven years later a similar survey reported over 2500 expert systems (Durkin, 1994, Negnevitsky, 2005).

A survey based on the classification of articles from 1988 to 2010 reveals an increase in the recent number of publications which is an indication of popularity gaining on the part of hybrid expert systems.This increase is mainly in neuro-fuzzy and rough neural expert systems (Sahin; Tolun; Hassanpour, 2012).

3. Structure:

Expert systems have five basic components : the knowledge base, the data base, the inference engine, the explanation facilities and the user interface.

A knowledge base contains a set of statements expressed in the IF (antecedent/condition) THEN(consequent/action) form, statements also named production rules.

The data base is a collection of structured data (particular data of a narrow field).

The inference engine matches the rules from the knowledge base with the facts from the database. It draws conclusions/inferences from the particular facts designed in the data base.The reasoning works like this :

IF ' the price is low'=True
And 'the price is low' ⇒ 'buy a stock'
THEN 'buy a stock' = True

A key factor is the design of the user interface. The dialogue's role is to acces the rules and the facts.

The user is ask to input the data needed for the problem solving.

For instance : **Expert system** : What is the level of price-to-earnings ratio of the stock?
User : High

The explanation facilities' module shows the flow of the expert system's reasoning. This module may lack in the case of a neural network, one of the mates of the expert system in artificial intelligence field.

A solution is to combine the neural network with a rule-based system in order to benefit both from strenghts : the learning ability of the neural network and the explanation facilities of the rule-based expert system.

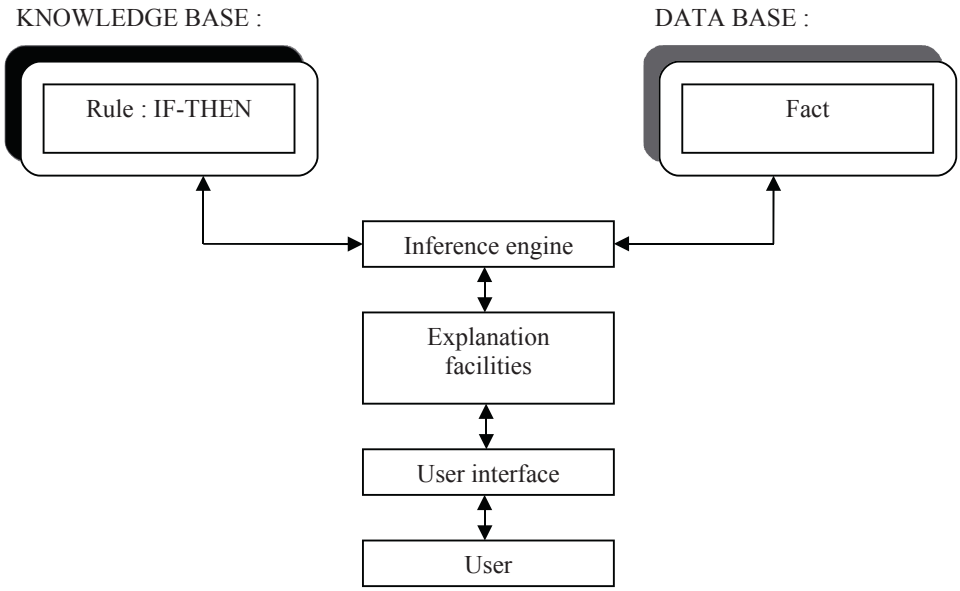

Fig. 1. Basic structure of a rule-based expert system

Source : Negnevitsky, 2005, p.31

4. SWOT analysis of the rule-based expert systems

4.1. Strenghts :

One of the main advantage of ES is the natural and regularized knowledge representation due to the IF-THEN rules. Computing with words makes the dialogue between user and ES more easy and friendly.

The separation of knowledge from the reasoning process allows the creation of the expert system shell.This represent the ES without the defined knowledge base. E.g. the EMYCIN shell is the MYCIN expert system with the knowledge of medicine removed (EMpty MYCIN).

ES has the ability to work with incomplete information, unlike an ordinary computer program which needs complete data to perform.

Another important benefit using ESs is capability to solve a complex problem such the stock trading. There are mechanical trading systems or STES (stock trading expert system) successfully used in systems for automatic trading (Dymova; Sevastianov; Kaczmarek, 2012).

Some of the more typical benefits include (Mattei, 2001):

- an objective and consistent customer service;
- a backup for a key employee in the case he quits;
- a training tool for employees, especially for high-turnover positions;
- a reduction in ordinary or banal tasks for an expert employee;
- and consistent advice based upon established organizational procedures.

4.2. Weaknesses :

The lack of hierarchical knowledge representation due to the uniformisation of the IF-THEN rules, makes it hard for the user to understand the role of each statement in the whole reasoning process.

Another disadvantage is the slow speed of ES in case of numerous rules. Real-time applications are not suitable for rule-based ESs which own hundreds of rules or more.

One of the main weaknesses is the expert system's inability to learn, unlike the human expert who does learn from experience. This disadvantage makes ES unsuitable for even a little creative problems solving.

4.3. Threats :

There are corporations where expert systems have failed. Failures may be caused by a wrong selection of the problem's field, inappropriate knowledge model, insufficient system testing and doubtful understanding of the knowledge provided by experts (Stanciu; Krager, 2008). There is a restricted number of narrow problems addressed by intelligent system (Negnevitsky, 2005) :

Table 1. Typical problems addressed by intelligent systems

Problem type	Description
Diagnosis	Inferring malfunctions of an object from its behaviour and recommending solutions.
Selection	Recommending the best option from a list of possible alternatives.
Prediction	Predicting the future behaviour of an object from its behaviour in the past.
Classification	Assigning an object to one of the defined classes.
Clustering	Dividing a heterogeneous group of objects into homogeneous subgroups.
Optimisation	Improving the quality of solutions until an optimal one is found.
Control	Governing the behaviour of an object to meet specified requirements in real-time.

Source : Negnevitsky, 2005, p.303

4.4. Opportunities of using experts systems in economics field :

A big opportunity for business applications is to combine a rule-based expert system with a neural network (a fuzzy system/or genetic algorithms), resulting a hybrid intelligent system. A neural expert system, for instance, overpasses both the lack of ES's inability to learn and the explanation facilities of neural network.

The Belief Rule Base (BRB) is an ES developed from IF-THEN rule base, which can handle both qualitative and quantitative information. A structure learning is proposed to handle a combinatorial explosion problem when there are too many alternative for each attribute in the BRB (Chang, et al., 2013). One of the most important applications of the BRB is the Rule-base Inference Methodology using the Evidential Resoning (RIMER) approach (Yang, et al., 2006). The applications of RIMER include the Multiple Attribute Decision Analysis problem, group decision making, risk analysis and trade-off analysis (Chang, et al., 2013).

In the belief rule system, each possible consequent of a rule is associated with a belief degree. Such approach allows the capture of complicated and continuous causal relationships between different factors than classical IF-THEN rules (Dymova;Sevastianov;Kaczmarek, 2012).

For instance, a rule from an stock trading expert system (Dymova, et al., p.7154), looks like :

R_1 : if IB is Big_{IB} and IS is Big_{IS} and CBP is Big_{CBP} then Buy

Where : IB= Index base on Buying price levels; IS=Index base on Selling price levels; CBP= index base on the changes of Bid prices; **Big**=a class representing a fuzzy concept, among **Low** and **Medium**.

A critical problem has arrived since the 1970s. Feigenbaum faced the 'knowledge acquisition bottleneck' problem or how to extract the know-how from human experts to apply to expert system.

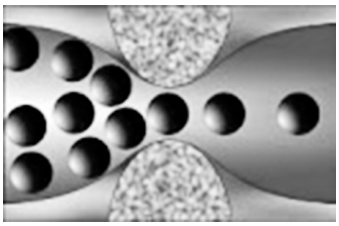

Fig. 2. The knowledge acquisition bottleneck

Source : www.qualitytesting.info

Nowadays, there are improved solutions. Among others, there is the cooperation between expert knowledge and data mining, maximizing their individual capabilities: data mining discovered knowledge represents a complementary source of knowledge for the ES and, in counter part, expert knowledge guides the data mining process (Alonso, et al., 2012) .

A 2002 valuable survey (Nedovic; Devedzic, 2002) presented five of well-known expert systems in the domain of finance. The all working systems considered were : FINEVA (from the field of financial analysis), PORT-MAN (banking management), INVEX (investment advisory), FAME (financial marketing) and DEVEX, an expert system for currency exchange advising in international business transactions.

Table 2. Summary of the five systems described by the above survey (Nedovic; Devedzic, 2002)

System	**FINEVA**	**PORT-MAN**	**INVEX**	**FAME**	**DEVEX**
Domain	Financial analysis	Portfolio management in banks	Investment management	Financial marketing	Currency exchange advising
Output	Ranking of firms, according to a class of risk	Select a range of bank products that will satisfy the criteria for investment	Determine whether a project is acceptable and, whether it is the best alternative	Recommend changes to a marketing proposal	Assessment of the priorities for payments
Used at	The ETEVA Bank, in Greece	The ASK bank in Australia	N/A	IBM US Marketing & Services	The Cacanska Banka, in Yugoslavia
Tool/Shell	M4	XL	BEST	K-Rep	EXSYS Professional
Knowledge acquisition and representation	Decision tables, decision tree, rules, meta-rules	Production rules, frames, hierarchical tree	Fuzzy set, Excel spreadsheet, concept	Heterogeneous system, semantic networks, concepts, binary relation	Production rules

Reasoning	Forward chaining, backward chaining	Grouped and attached rules in the control and objective frames, depth first search manner	Multiple criteria decision-making, sensitivity analysis, demons associated on slots	Hybrid analytical techniques	Forward chaining, backward chaining
Uncertainty	N/A	N/A	Uncertain-random variable, rough model and fine-grain model	N/A	N/A
Size	1693 rules	N/A	N/A	2000 objects	320 rules
Status	Usable system	Usable system	N/A	Usable system	Prototype
Reference	Matsatsinis et al., 1997	Chan, Dillon. & Saw, 1989	Vranes et al., 1996	Apte et al., 1989	

Source : http://devedzic.fon.rs/publications/ESwA2002-1.pdf, accessed at 04.01.2013

5. Conclusion

The optimum way to get started with expert systems is to select a high-potential application, start small, and grow the system. As the organization becomes more confident and experienced, the application can be developed adding more knowledge and complexity. These systems lend themselves to an approach known as "prototyping" and incremental development (Mattei, 2001).

Building an expert system requires a few ingredients :

- an human expert willing to share his know-how;
- a P.C. or a Mac;
- a little knowledge engineering;
- and the choice of an ES shell from the aspect of next four criteria (Vujovic et al., 2012): programmability, comprehensiveness, universality and price.

Using expert systems in economics field provides strategic benefits like: competitive financial advantages, investment advisory, better organisation of workflow, back-up for key experts, training tool for new employees, diagnosis of critical aspects, prognosis of economics trends.

Expert systems are an area of special importance with rise trends in modern business conditions (Win et al., 2005). They have special significance in a highly developed countries where is actual knowledge based economy (Vujovic et al., 2012).

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