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THE DECISION ACCORDING TO CRITERIA IN THE EXPERT SYSTEM INFERENCE ENGINE FOR AIRLIFTING

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There is described in this article a basic concept of the inference engine designed using decision according to criteria, the basic concept of an artificial intelligence and the main parts of expert systems (designed and created by the author) especially – Communication module, Basis of knowledge, Inference engine, Basis of facts, Module for getting information. There are results of described expert system in praxis in the airports and hardware and software requirements for expert system realization.

Keywords: *the artificial intelligence, the expert system, inference engine, communication module, basis of knowledge, inference engine, basis of facts, module for getting information, aircraft, failure rate, flying hours costs*

1. Introduction

Using of informatics technologies is indispensable trend in the all areas of our life. In this time we cannot imagine any activity without up-to-date technologies using. One of the most important trends in informatics is artificial intelligence and its expert systems development.

Expert systems are sets of computer programs and appropriately chosen and structured data, which nature and quality of its functions can in some cases equally substitute qualified and skilled work of experts in the field of their specialization.

Expert systems have got legitimate place also in operating of aircrafts, as is described in the further parts of the article.

The aircraft operator is asking these questions when purchasing a device – how is the device able to fulfil its function, is it better to operate older device or buy new, what is the maintenance quality comparing to other operators? Expert system described in this article helps to find the right answers to these questions.

2. Basic Concept of the Artificial Intelligence and Inference Engine of a Knowledge or Expert System

2.1. Artificial Intelligence (AI)

Artificial Intelligence is the area of computer science focusing on creating machines that can engage on behaviours that humans consider intelligent. The ability to create intelligent machines has intrigued humans since ancient times and today with the advent of the computer and 50 years of research into AI programming techniques, the dream of smart machines is becoming a reality. Researchers are creating systems which can mimic human thought, understand speech, beat the best human chess player, and countless other feats never before possible. Find out how the military is applying AI logic to its hi-tech systems, and how in the near future Artificial Intelligence may impact our lives. A big success of artificial intelligence was an expert system's creation.

2.2. Knowledge-based expert systems or simply expert systems

Knowledge-based expert systems use human knowledge to solve problems that normally would require human intelligence. These expert systems represent the expertise knowledge as data or rules within the computer. These rules and data can be called upon when needed to solve problems.

An **expert system** is software that attempts to provide an answer to a problem, or clarify uncertainties where normally one or more human experts would need to be consulted. Expert systems are most common in a specific problem domain, and are a traditional application and/or subfield of artificial intelligence.

A wide variety of methods can be used to simulate the performance of the expert however we can write a common configuration of expert system that is used as a model for the present study:

- Communication module
- Basis of knowledge
- Inference engine
- Basis of facts
- Module for getting information

As a premiere application of computing and artificial intelligence, the topic of expert systems has many points of contact with general systems theory, operations research, business process reengineering and various topics in applied mathematics and management science.

3. Design of Expert System for Evaluation of Transport Devices

A main target of science of the safeness and reliability problem is to find out methods and procedures that enable practise analysis safeness and reliability already of the existing systems. These methods are included in the expert systems modules that are able to perform this analysis using the given values and „advise“ to the operator to find out answers to the listed above questions.

Described expert system can give well-knit view over ability several types of devices from the point of view of many different criteria – it can be safeness, operating economic, fitness for using for specific operator and a lot of others. Expert system executes calculations inscribed characteristics and then is able to evaluate types of devices according to computing results.

It enables to choose the importance of single criteria according to what criteria is now most important and it allows inserting another criteria and by them it would be possible to evaluate devices. It enables perform another evaluations, for example, comparing of operating electivity of the same device types from various operators. The comparison width will depend on entry values quantity into the expert system.

This expert system has a very important property – it can work very simply with available information and user need not a lot of money for getting this information.

4. Expert System Architecture for Airlifting

Basis of knowledge is created by:

Mc. Crackens model of aircraft operating reliability for calculation of smartness and the probability of failure-free operating.

Function for failure rate calculation for failure evaluation.

Standard method for straight operating expense evaluation – SBAC for calculating of flying hour expense

Basis of facts included

Technical data about aircraft periodical maintenance on University of Žilina

Total air-raid in spotted periods in operator of university of Žilina

Average daily air-raid

Average daily count of starts

Inputs from the maintenance „expert“

Inputs about failures and repairs of individual aircraft in ŽU and SNA

Data for tax calculating of a flying hour

5. Description of the Inference Mechanism

If we are available to a big amount of values that are of different character it is very difficult to compare them without any transformation or data handling into the form, that would suffer realizing this transformation automatically. Problems of this type are solved by application of the more-criteria decision method, for example, by the concordant analysis. But in this case are expected accounts with matrix of values what is very complicated problem and especially we achieve the same regular result with more simple solution.

In described expert system is used school marks principle. Each area is evaluated particularly so that the type of the airplane that fly in the given area (according the criteria of the given area) obtains the best result, obtains mark 1. The other types get mark by degrees lower. It enables to use this criteria processing method because amount of aircraft the expert system is processing with is not very large, i.e. the count of the device types is relatively little.

Final valuation is the mark that is composed by arithmetic average of the all marks.

It may occur at the situation that all results will be the same for all the aircraft types or almost the same. In this case the user can enter to weight for any criteria. To put the weight for any criteria is possible whenever, it depends on the criteria important.

If it isn't important any criterion in decisive moment, expert system will allocate to this criteria value 0 as the mark for every type of an aircraft.

For using this expert system in the future is suitable opening this expert system for the choice of other criteria. It is designed in such way that will be possible put in it certain amount of the criteria while the user will have to execute calculations for the particular aircraft types without expert system, if the calculation algorithms are not known in this time.

6. Realization of the described expert system in the airport Žilina and SNA Bratislava

To filling my expert system I have used actual data from airports Žilina and SNA Bratislava. At first an expert system has made the following account:

6.1. Failure evaluation of the same types of aircrafts at operators Žilina and SNA Bratislava

Input data are – number and type of a failures and the air raid number of aircrafts Z 42, Z 142, L 200 a Z 43 in the Table 1.

Table 1. The aircrafts Failure comparison at Žilina and SNA Bratislava

Year 2001	Failure rate - Žilina	Failure rate – SNA	Lower failure rate has:
Aircraft Type	Light	Light	
Z - 43	0,022528442	0,002684564	**SNA**
Z - 42	0,030176533	0,055555556	**Žilina**
Z - 142	0,015168857	0,005008347	**SNA**
L - 200	0,037243948	0,016260163	**SNA**

6.2. Field reliability evaluation of several types of aircraft at operator in Žilina

To get the final evaluation values of the several criteria for all of aircraft types have been calculated and the best aircraft type for each evaluated. Criteria are the following:

failure rate evaluation,

flying hours costs evaluation,

evaluation of the no-failure operation expectation,

the ground alert evaluation.

6.3. Final evaluation according all of criteria – the weight of criteria is the same (Tables 2-6)

Table 2. Comparison of aircrafts

Failure rate	Flying hours costs	No-failure operation	Severability
Z - 142	**Z - 42**	**Z - 142**	**Z - 142**
Z - 43	Z - 142	Z - 42	Z - 42
L - 200	Z - 43	L - 200	Z - 43
Z - 42	L - 200	Z - 43	L - 200

Table 3. Marks assignment according to particular criteria without weight of criteria

Aircraft type	Failure rate	Flying hours costs	No-failure operation	Severability	Final mark
L - 200	3	4	3	4	3,5
Z - 142	1	2	1	1	1,25
Z - 42	4	1	2	2	2,25
Z - 43	2	3	4	3	3

Table 4. Marks assignment according to particular criteria using weight of criteria

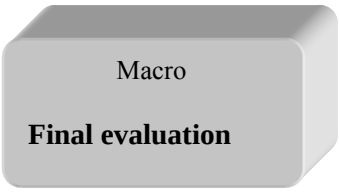
Aircraft type	Failure rate	Flying hours costs	No-failure operation	Severability	Final mark
L - 200	3	4	3	4	3,5
Z - 142	1	2	1	1	1,25
Z - 42	4	1	2	2	2,25
Z - 43	2	3	4	3	3

Table 5. Final evaluation

Failure rate	Final mark
Z - 142	1,25
Z - 42	2,25
Z - 43	3
L - 200	3,5

Table 6.

Criteria	Weight of criteria
Failure rate	1
Flying hours costs	1
No-failure operation	1
Severability	1



6.4. Final evaluation according all of criteria –the weight of criteria Flying hours costs is changed (Table 7-11)

Table 7. Comparison of aircrafts

Failure rate	Flying hours costs	No-failure operation	Alert
Z - 142	**Z - 42**	**Z - 142**	**Z - 142**
Z - 43	Z - 142	Z - 42	Z - 42
L - 200	Z - 43	L - 200	Z - 43
Z - 42	L - 200	Z - 43	L - 200

Table 8. Setting of marks according several criteria without weight of criteria

Aircraft type	Failure rate	Flying hours costs	No-failure operation	Alert	Final mark
L - 200	3	4	3	4	3,5
Z - 142	1	**2**	1	1	1,25
Z - 42	4	1	2	2	2,25
Z - 43	2	3	4	3	3

Table 9. Setting of marks according several criteria with weight of criteria

Aircraft type	Failure rate	Flying hours costs	No-failure operation	Alert	Final mark
L - 200	3	40	3	4	12,5
Z - 142	1	20	1	1	5,75
Z - 42	4	10	2	2	4,5
Z - 43	2	30	4	3	9,75

Table 10. Final evaluation

Failure rate	Final mark
Z - 42	4,5
Z - 142	5,75
Z - 43	9,75
L - 200	12,5

Table 11.

Criteria	Weight of criteria
Failure rate	1
Flying hours costs	10
No-failure operation	1
Alert	1

Macro

Final evaluation

6.5. Software and hardware requirements for expert system realization

I have used programme tools of fly Microsoft – programming language Visual Basic and operating system Windows. Functions for calculating of individual criteria are executed in Excel using macros VBA and using macros are started all of comparisons and final evaluation of several aircraft types.

7. Conclusions

Expert system scheme is possible to use at operators of arbitrary devices that means in all the cases, when it is needed to compare several objects according to a lot of different and mutually inconsequent criteria. The user can choose arbitrary the evaluated objects count, the count of the criteria is eligible too, and weights are regulated according to neediness. In this case is important suitable choosing of other models for examined characteristics calculating, to choose such formulas and computing functions to realize them as simple as possible and input data to be available at operator.

It is possible to use it in diagnostics of devices. The user have to know some diagnostic methods that are allowed to use, the Basic of knowledge should be filled in with them.

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