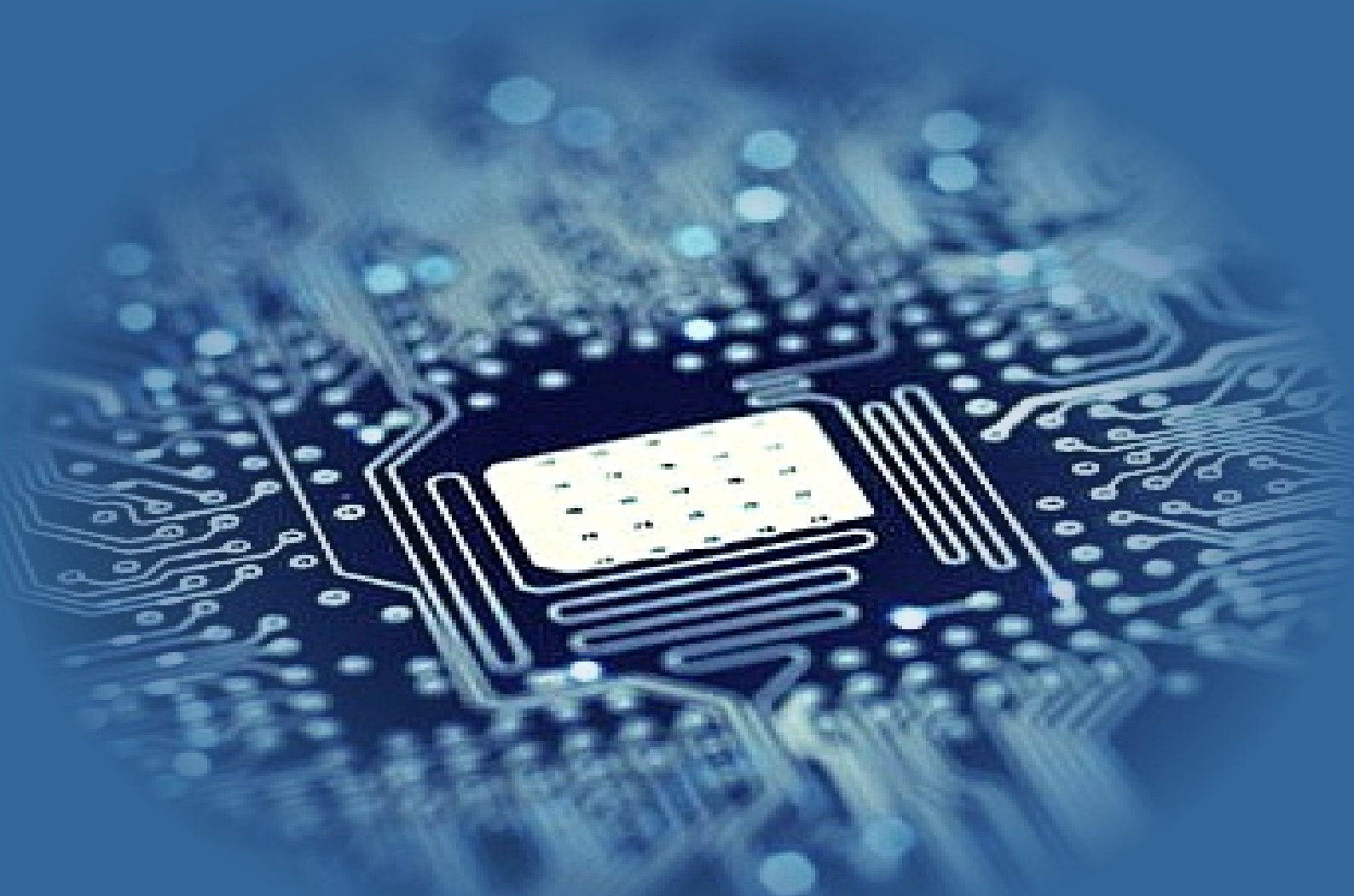

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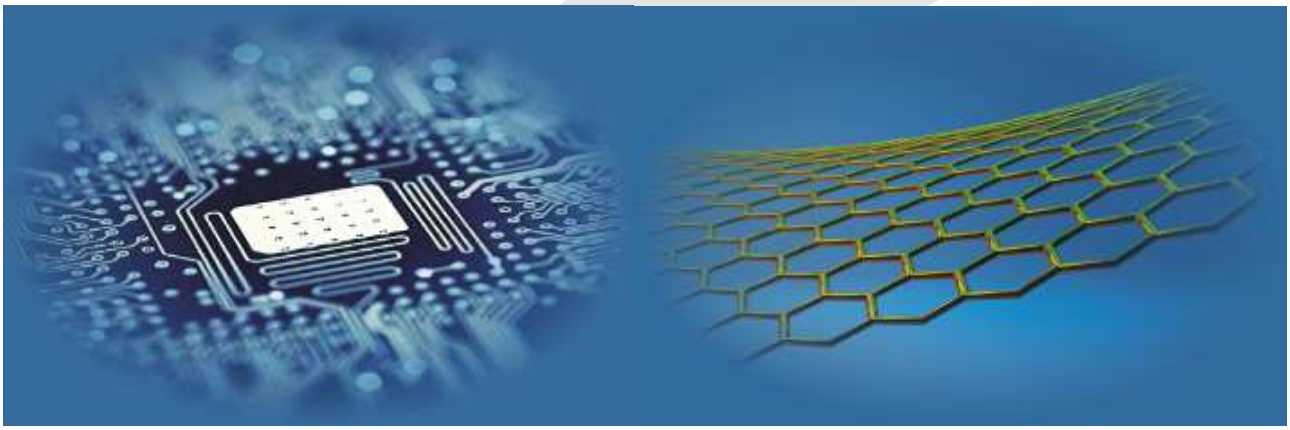

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Editors' Remarks

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Clouds and Waves

by Rabindranath Tagore

Mother, the folk who live up in the clouds call out to me-"We play from the time we wake till the day ends.

We play with the golden dawn, we play with the silver moon".

I ask, "But how am I to get up to you?"

They answer, "Come to the edge of the earth, lift up your hands to the sky, and you will be taken up into the clouds".

"My mother is waiting for me at home", I say, "How can I leave her and come?"

Then they smile and float away.

But I know a nicer game than that, mother.

I shall be the cloud and you the moon.

I shall cover you with both my hands, and our house-top will be the blue sky.

The folk who live in the waves call out to me - "We sing from morning till night; on and on we travel and know not where we pass". I ask, "But how am I to join you?"

They tell me, "Come to the edge of the shore and stand with your eyes tight shut, and you will be carried out upon the waves".

I say, "My mother always wants me at home in the everything - how can I leave her and go?"

They smile, dance and pass by.

But I know a better game than that.

I will be the waves and you will be a strange shore.

I shall roll on and on and on, and break upon your lap with laughter.

And no one in the world will know where we both are.

Rabindranath Tagore (1861-1941)♣

****

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Our journal policy is directed to fundamental and applied scientific researches, innovative technologies and industry, which is the fundamentals of the full-scale multi-disciplinary modelling and simulation. This edition is the continuation of our publishing activities. We hope our journal will be of interest for research community and professionals. We are open for collaboration both in the research field and publishing. We hope that the journal's contributors will consider collaboration with the Editorial Board as useful and constructive.

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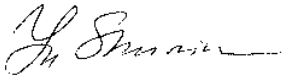
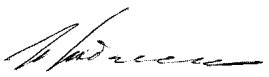


Yuri Shunin



Igor Kabashkin

♣ **Rabindranath Tagore (7 May 1861 – 7 August 1941),** was a Bengali poet, novelist, musician, painter and playwright who reshaped Bengali literature and music. As author of Gitanjali with its "profoundly sensitive, fresh and beautiful verse", he was the first non-European and the only Indian to be awarded the Nobel Prize for Literature in 1913. His poetry in translation was viewed as spiritual, and this together with his mesmerizing persona gave him a prophet-like aura in the west. His "elegant prose and magical poetry" still remain largely unknown outside the confines of Bengal.

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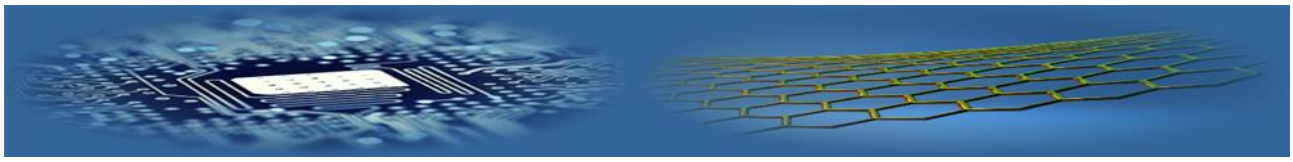

Comparative analysis of environments for logic programming in the Prolog language

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Abstract

This paper presents the results of a survey of basic characteristics and parameters of logic programming environments. The object of the analysis are four systems: Strawberry Prolog [1], SWI Prolog [6], Visual Prolog 5.3 [4, 8], Visual Prolog 7.3 [2] and the C ++ compiler Visual [3]. The analysis represents different generations of systems for logic programming of the language Prolog comparing their parameters in the implementation of application for solving the problem: "The Tower of Hanoi" [8] by a recursive algorithm. There are criteria for classification, comparison and evaluation of community programming that can be applied to their choice in the implementation of a specific project.

Keywords:

environment for logic programming
Prolog
predicate recursion

1 Introduction

Prolog belongs to the group of non-procedural (declarative) programming languages, which is a characteristic that describes in detail the subject area of the problem. The language is closely related to predicate logic tier and the study of it helps us to understand better its nature and application.

The power of Prolog is manifested primarily in solving problems specific to artificial intelligence, such as: planning, modeling of complex systems, natural language understandding and computational linguistics, symbolic calculations, expert systems and others [4].

WEB-design and programming in such an environment is not a strong point of Prolog despite the advanced capabilities of some of conversions [5]. Along with academic and teaching examples language allows building of complex models and software systems with commercial application. Prolog is a comprehensive, powerful and elegant language, which facilitates the development of advanced intelligent systems.

Choosing the proper implementation depends on many factors and criteria that are the subject of further exposure. The approach used primarily allows a comparison of the practical possibilities of languages in solving specific tasks. This allows immediate assessment and well-founded selection of an appropriate environment for the realization of a similar project.

2 Research

2.1 FORMULATION OF "THE TOWER OF HANOI" TASK IN PROLOG

The Tower of Hanoi is a logical game, authored by the French mathematician Edward Luke [8]. The game consists of three pillars on the left one - L the discs are stacked in order of size, the largest is at the bottom and the smallest - on top. The aim is to move the discs to the right column - R. You can move only one disc and it can be placed on top of a larger disc or moved to empty pillars. Each move consists of taking the upper disk from one of the pillars and placing it on top of another pillar. Let us analyze the task of moving the n number of disks from pillar L (left) to pillar R (right). It can be used pillar M (average) in terms of the above conditions.

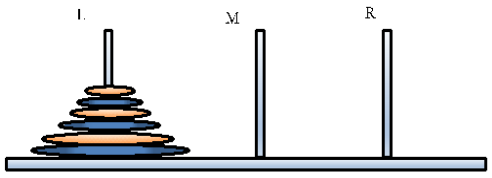

FIGURE 1 The Tower of Hanoi task

- ***Complexity***. The task of course is a recursive solution, but it is not trivial, and complexity increases with the number of discs
- **Dimension**. The complexity of the problem depends on the number of discs, which is clearly associated with the requested dimension number of the disks which have to be moved.
- The task has a dimension **n,** can easily be reduced to two tasks of the same type, but with smaller dimensions:
  - to move n-1 discs from pillar L to pillar M (the same task with a dimension n-1).
  - to move the last remaining disk from pillar L to the pillar R (non-recursive task).
  - to move the set of n -1 discs from pillar M to pillar R (the same task with a dimension n-1).

- The task has simple recursive solution at zero dimension just do not need to do anything. In the beginning all disks are arranged in the leftmost column, as shown.

2.2 RECURSIVE STRATEGY FORMULATION

You have to move n discs from pillar L to pillar R. The function is defined as follows: X (n-1, (L), (M)), so that the task can be solved. Firstly, you move n-1 disc from the pillar L to the pillar M, applying the function X, and then move the n-th disc from the pillar L to the pillar R (defined in this function: P ((L), (M)) and finally move n-1 discs from M to R. The algorithm can be written as follows:

1) X(n-1, (L), (M))
2) Π((L),(R))
3) X(n-1, (M), (R))

Now here is a case which is not recursive. If the disc is only one, it can be rapidly moved from pillar R to pillar L, so that the following equation is implemented: X (1, (L), (M)) = P ((L), (R)). The algorithm can be represented with the following diagram:

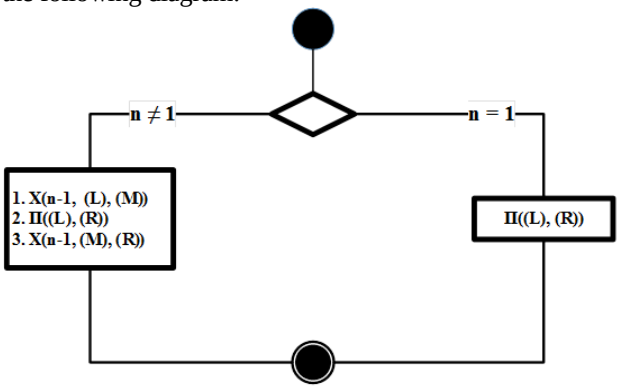

FIGURE 2 Algorithm for moving the discs
(The Tower of Hanoi task)

One exemplary strategy for solving the problem is as follows:

- only one disc can be moved at a time
- you can transfer n disk in the following three steps:
  - transfer n-1 disks to the pillar in the middle
  - transfer disk N to the right column
  - transfer n-1 from the middle pillar to the right one.

2.3 IMPLEMENTATION OF VISUAL PROLOG 5.2

The Prolog program [2, 9], which solves the problem of The Tower of Hanoi uses three predicates:

- ***hanoi*** - with one parameter that determines the number of discs;
- ***move*** - describes the moving of the n-disk from one pillar to another using the middle pole
- ***inform*** - describes each step of the transfer of the disks.

The code is as follows:

```
DOMAINS
loc =right;middle;left

PREDICATES
hanoi(integer)
move(integer,loc,loc,loc)
inform(loc,loc)

CLAUSES
hanoi(N):-
        move(N,left,middle,right).
move(1,A,_,C):-
        inform(A,C),
        !.
move(N,A,B,C):-
        N1=N-1,
        move(N1,A,C,B),
        inform(A,C),
        move(N1,B,A,C).
inform(Loc1, Loc2):-
        write("\nMove a diskfrom ", Loc1, " to ", Loc2).

GOAL
        hanoi(3).
```

2.4 IMPLEMENTATION OF SWI – PROLOG

In this compiler [7] program code again three predicate: hanoi, dohanoi, moveit. The program code is shown in the following lines:

```
/*
 * The Towers Of Hanoi
 * Prolog
 * Testedunder SWI-Prolog 2.9.10
 */

hanoi(N) :- dohanoi(N, 3, 1, 2).

dohanoi(0, _ , _ , _ )          :- !.
dohanoi(N, A, B, C)             :-
  N_1 is N-1,
dohanoi(N_1, A, C, B),
moveit(A, B), dohanoi(N_1, C, B, A).

moveit(F, T) :- write([move, F, -->, T]), nl.
```

2.4 IMPLEMENTATION OF STRAWBERRY PROLOG

The code of the program here [2] is very similar to the code of Swi - Prolog. There is a little difference in the embedded predicate write. The code is as follows:

```
% The Towers Of Hanoi

hanoi(N):- dohanoi(N, 3, 1, 2).

dohanoi(0,_ ,_ ,_ ):- !.
dohanoi(N, A, B,C):-
  N1 is N - 1,dohanoi(N1, A, C, B),moveit(A,B), dohanoi(N1, C, B, A).

moveit(F, T):- write([move, F, T]),nl.
?- hanoi(8).
```

2.5 IMPLEMENTATION OF VISUAL PROLOG 7.3

In this version of the logic programming language Prolog [2, 7] is used graphical user interface. After the Planning menu has been activated from the menu bar, we can choose Hanoi.

The screen displays a program window with a description of the Tower of Hanoi task. Under the description there is a field in which the user enters the number of the discs which he/she wants to use in order to test the task and then presses the button StartHanoi.

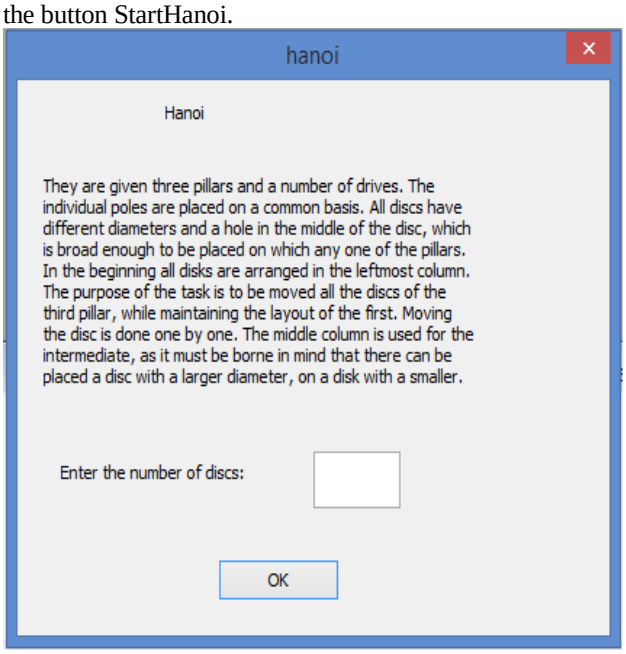

FIGURE 3 Dialog of the task Hanoi Towers in Visual Prolog 7.3

Codebase is the following lines:

```
Implement hanoi
inherits dialog
open core, vpiDomains

constants
className="TaskWindow/hanoi".
classVersion="".

clauses
classInfo(className, classVersion).

clauses
display(Parent) = Dialog:-
Dialog=new(Parent),
Dialog:show().

clauses
new(Parent):-
dialog::new(Parent),
generatedInitialize().

domains
loc=right;middle;left.

predicates
hanoi:(integer).
move:(integer,loc,loc,loc).
nform:(loc,loc).

clauses

hanoi(N):-
move(N,left,middle,right).

move(1,A,_,C):-
inform(A,C),
!.
move(N,A,B,C):-
N1=N-1,
move(N1,A,C,B),
inform(A,C),
move(N1,B,A,C).

inform(Loc1, Loc2):-stdio::nl,
stdio::write("Move a disk from", Loc1, "to", Loc2).

predicates
onPushButtonClick: button::clickResponder.
clauses
  onPushButtonClick(_Source)=button::defaultAction:-
Br=toterm(edit_ctl:gettext()), hanoi(Br).

%This code is maintained automatically, do not update it
manually.14:41:54-29.10.2015
facts
edit_ctl: editControl.
pushButton_ctl: button.

predicates
generatedInitialize:().
clauses
generatedInitialize():-
setFont(vpi::fontCreateByName("MS Sans Serif", 8)),
setText("hanoi"),
setRect(rct(50,40,346,232)),
setModal(true),
setDecoration(titlebar([closeButton])),
setState([wsf_NoClipSiblings]),
StaticText_ctl=textControl::new(This),
StaticText_ctl:setText("Ханойски кули"),
StaticText_ctl:setPosition(96, 6),
StaticText_ctl:setSize(104, 16),
  StaticText1_ctl=textControl::new(This),
  StaticText1_ctl:setText("Въведете брой дискове"),
  StaticText1_ctl:setPosition(44, 128),
  StaticText1_ctl:setSize(84, 16),
  StaticText2_ctl=textControl::new(This),
  StaticText2_ctl:setText("Theyaregiventhreepillars and a number of
drives. Theindividualpolesareplacedon a commonbasis.
Alldiscshavedifferentdiameters and a holeinthemiddle of thedisc,
whichiswideenoughtobepositionedonany of thepillars.
Inthebeginningalldisksarearrangedintheleftmostcolumn. Thepurpose of
thetaskistobemovedallthediscs of thethirdpillar,
whilemaintainingthelayout of thefirst. Movingthediscisdoneone by one.
Themiddlecolumnisusedfortheintermediate,
asitmustbeborneinmindthattherecanbeplaced a discwith a
largerdiameter, on a diskwith a smaller."),
  StaticText2_ctl:setPosition(16, 34),
  StaticText2_ctl:setSize(252, 86),
edit_ctl:=editControl::new(This),
edit_ctl:setText(""),
edit_ctl:setPosition(152, 128),
edit_ctl:setWidth(40),
edit_ctl:setHeight(16),
edit_ctl:setMultiLine(),
edit_ctl:addModifiedListener(onEditModified),
pushButton_ctl:=button::new(This),
pushButton_ctl:setText("Start Hanoi"),
pushButton_ctl:setPosition(96, 158),
pushButton_ctl:setSize(80, 18),
pushButton_ctl:defaultHeight:=false,
pushButton_ctl:setClickResponder(onPushButtonClick).
%end of automatic code
end implement Hanoi
```

2.6 IMPLEMENTATION OF C++

After reviewing the code of Prolog, we include to the research the testing the same task - Hanoi towers - of the algorithmic programming language C ++ [3]. The program code in this case is the following:

```
#include
using namespace std;
voidHanoj(int n, int a, int b, int c)
{
if (n>0)
{
Hanoj(n-1, a,c,b);
cout<<a<<"-->"<<c<<endl;
Hanoj(n-1, b,a,c);
 }
 }
int main ()
{
int n;
cout<< "Number of disks: "; cin>>n;
int a=1, b=2, c=3;
Hanoj(n, a,b,c);
return 0;
}
```

3 Results from analysis of environments for programming

The experiment includes the source code of the task described above of each of the aforementioned realizations of Prolog. For this purpose, it is used the hardware configuration of the notebook processor Intel Core i3-4005U 1.70 GHz, RAM - DDR3L 1333 MHz, 4 GB, HDD 1000 GB 5400, SATA, under the operating system MS Windows 7.0 Professional. Programming environments installed: Strawberry Prolog ver. 3.0, SWI-Prolog 7.2.3 for Windows XP / Vista / 7/8, Visual Prolog 5.2 for Windows XP, Visual Prolog 7.3 for Windows XP / Vista / 7/8; MS Visual Studio 2008. The data obtained are shown in Table 1.

Table 1. Memory and program execution time

Program environment	Memory	Execution time
SWI - Prolog	220 bytes	1 sec
Strawberry Prolog	210 bytes	1 sec
Visual Prolog 5.2	1 KB	3 sec
Visual Prolog 7.3	3.89 KB	3 sec
MS Visual Studio 2008	1,34 MB	4 sec

For Strawberry Prolog and SWI Prolog have studied interpreters, and for other –compilers

From the survey of the environments for logic programming can be seen (Figure 4 and Figure 5) that the interpreters of Strawberry Prolog and SWI Prolog have minimal memory requirements and they are fast during the performance.

The price of modern features and beautiful graphics capabilities in Visual Prolog 7.3 is cost almost four times greater amount of memory than the Visual Prolog 5.2.

The comparison between the compilers of Prolog and Visual C ++, which is part of the 2008 MS Visual Studio is based on projects of type console application in the given task.

There is a huge difference between the amount of code and longer and equal execution time, regardless of the lack of graphical elements in the project.

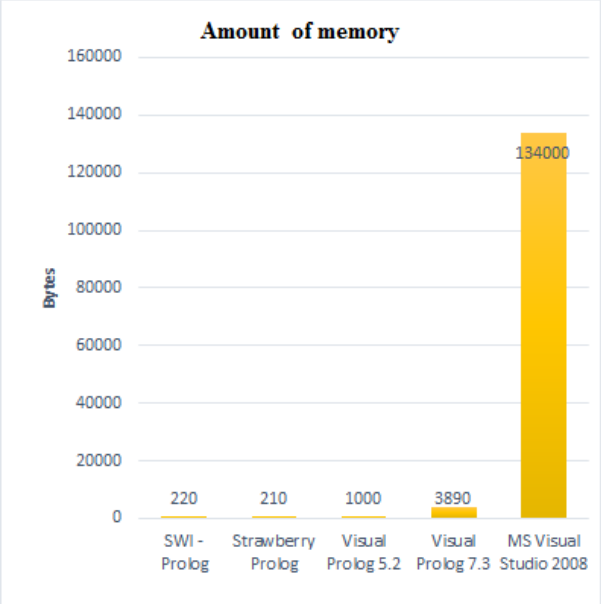

FIGURE 4 Memory of the program code in different programming environments

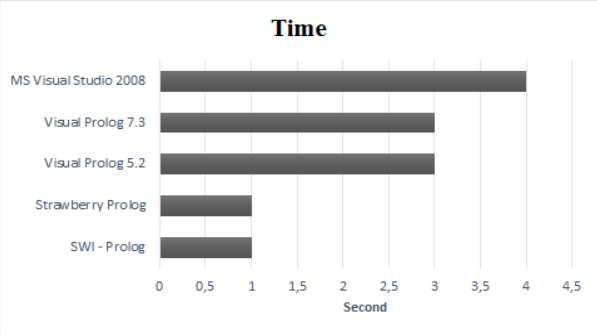

FIGURE 5 Execution time of the application

Prolog Compilers show a higher degree of efficiency with respect to that task, which has an exponential complexity in the increase of the dimension (the number of the disks). In conclusion, Visual Prolog is suitable for modeling and solving problems regarding the artificial intelligence field with the given characteristics

4 Conclusion

The analysis of the considered environments for logic programming shows some practical conclusions. There are similarities in the characteristics and the capabilities of SWI - Prolog and Strawberry Prolog. It could be said that having simple syntax close to the paradigm of the logic programming both languages are especially valuable for teaching logic programming and problem solving with less complexity and requirements.

Visual Prolog compilers are suitable for more advanced programmers. They could be used to design and build more complex systems with higher requirements to the interface and the range of the tasks

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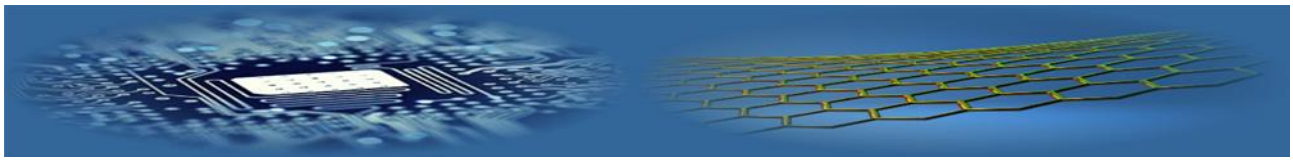

Research of neural network simulators through two training data sets

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Abstract

In the present study our aims is to analyze and test two neural networks simulators - Joone and NeuroPh. This will be accomplished by establishing a neural network of 4 layers constituting a multilayer perceptron with sigmoid links. For the purpose of the study were selected two test data sets, which contain integers. Through sequential training the neural network with each of them and subsequently the test results will be obtained for analysis. The study seeks to show how much these two simulators are similar and how different in their characteristics, what neural networks is suitable to be made by them, what are their advantages and disadvantages, how they can be used interchangeably to give certain desired result.

Keywords:

neural network
neural network simulator
data set
training set
neural network architecture

1 Introduction

Both the simulator selected for the study are Java - based and object - oriented simulators. The used simulators are Joone 4.5.2 and NeuroPh 2.92. Joone is object - oriented frameworks allows to build different types of neural networks. As of 2010 Joone, NeuroPh and Encog are main component - based environments for neural networks of java - platforms. [1, 2] Joone can be considered not only as a simulator of neural networks such frameworks were, but as a fully integrated development environment. Unlike its trading partners, it has a strong focus on the code, building a neural network, but not on the visual design. In theory Joone can be used to build a wide range of adaptive systems (including those with maladaptive elements) but generally his focus is on building backpropagation - neural networks.

NeuroPh is lightweight frameworks allowed to simulate neural networks. It is java - based and can be use basic for the development of standard types of neural network architectures. It contains well designed open source library and a small number of core classes that correspond to basic concepts in neural networks. There is a good graphics editor to quickly build java - based components of neural networks [3].

2 Methodology

At the beginning we will present two test sets, which is based on study.

Two training sets selected for the study are:

TABLE 1 Data set 1

Input 1	Input 2	Input 3	Input 4	Output
1.0	1.0	1.0	1.0	1.0
3.0	3.0	2.0	3.0	2.0
2.0	2.0	3.0	4.0	3.0
7.0	7.0	5.0	2.0	4.0
4.0	8.0	7.0	5.0	5.0
11.0	6.0	8.0	6.0	6.0
10.0	9.0	4.0	17.0	7.0
6.0	5.0	14.0	38.0	8.0
26.0	4.0	32.0	37.0	9.0
8.0	10.0	10.0	10.0	10.0
5.0	11.0	26.0	25.0	11.0
13.0	12.0	11.0	28.0	12.0
19.0	13.0	17.0	8.0	30.0
14.0	16.0	21.0	29.0	29.0
25.0	15.0	12.0	36.0	28.0
17.0	20.0	9.0	27.0	27.0
18.0	22.0	22.0	7.0	26.0
15.0	21.0	13.0	24.0	25.0
22.0	18.0	20.0	20.0	24.0
20.0	19.0	38.0	15.0	23.0
31.0	14.0	27.0	9.0	22.0
12.0	23.0	37.0	14.0	21.0
16.0	25.0	16.0	31.0	20.0
35.0	27.0	6.0	33.0	40.0
9.0	28.0	31.0	35.0	39.0
21.0	26.0	39.0	16.0	38.0
39.0	24.0	24.0	22.0	37.0
40.0	17.0	15.0	26.0	36.0
38.0	29.0	18.0	18.0	35.0
27.0	31.0	30.0	34.0	34.0
34.0	30.0	35.0	12.0	33.0
28.0	32.0	36.0	13.0	32.0
23.0	36.0	33.0	39.0	31.0
32.0	33.0	25.0	23.0	30.0
36.0	35.0	23.0	11.0	50.0
37.0	34.0	34.0	40.0	49.0
24.0	36.0	40.0	21.0	48.0
29.0	37.0	29.0	32.0	47.0
30.0	39.0	28.0	30.0	46.0
33.0	40.0	19.0	19.0	45.0

TABLE 2 Data set 2

Input 1	Input 2	Input 3	Input 4	Output
2.0	3.0	1.0	1.0	1.0
4.0	5.0	3.0	4.0	2.0
6.0	4.0	7.0	2.0	3.0
9.0	6.0	2.0	3.0	4.0
1.0	1.0	5.0	18.0	5.0
13.0	8.0	10.0	5.0	6.0
5.0	2.0	9.0	23.0	7.0
11.0	12.0	8.0	8.0	8.0
16.0	9.0	14.0	6.0	9.0
8.0	11.0	12.0	14.0	10.0
19.0	7.0	13.0	13.0	11.0
7.0	10.0	11.0	34.0	12.0
15.0	13.0	15.0	7.0	13.0
14.0	22.0	4.0	10.0	20.0
18.0	19.0	6.0	17.0	21.0
10.0	16.0	20.0	11.0	22.0
24.0	17.0	21.0	9.0	23.0
22.0	14.0	17.0	19.0	24.0
3.0	32.0	35.0	16.0	25.0
17.0	30.0	16.0	12.0	26.0
23.0	15.0	23.0	29.0	27.0
12.0	25.0	36.0	21.0	28.0
20.0	18.0	22.0	28.0	29.0
30.0	24.0	28.0	15.0	30.0
25.0	21.0	18.0	27.0	40.0
33.0	20.0	32.0	20.0	39.0
21.0	26.0	19.0	26.0	38.0
29.0	23.0	30.0	24.0	37.0
26.0	28.0	27.0	33.0	36.0
32.0	27.0	24.0	30.0	35.0
34.0	29.0	25.0	31.0	34.0
28.0	33.0	26.0	32.0	33.0
27.0	35.0	31.0	25.0	32.0
35.0	34.0	29.0	22.0	31.0
36.0	31.0	33.0	35.0	30.0
31.0	36.0	34.0	36.0	50.0

These data sets are used by Mahmoud Iskandarani in "Disparity in Intelligent classification of Data Sets Due to Dominant Pattern Effect "(Mahmoud, 2015).

In the tables are shown input values and the corresponding output.

Now we have to realize neural network through simulators NeuroPh and Joone.

The neural network that we will use for the study is multilayered perceptron with sigmoid relations and consists of four layers - entry (4 neurons) hidden layer (9 neurons), 2 hidden layer (6 neurons) and output layer (one neuron).

In each of the simulators we will conduct training with the first test set (in this case, the learning set) and then we test with the first data set and with the second data set. We will then conduct training with the second test set (in this case, the learning set) and then re-test with the first data set and with a second data set.

- NeuroPh

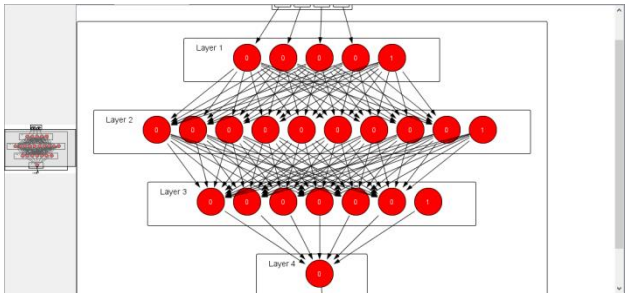

FIGURE 1 Neural Network in NeuroPh

Neural networkis trained with training set 1 (learning set in this example) and then tested it on the two test sets.

Then neural networkis trained with training set 2 (learning set in this example) and then tested it on the two test sets.

In the following tables are shown the results from tests on two training sets - its been described input values for each example (1 - 4), complying with him output, and the actual output of the system - NeuroPh. In the last column is the error on the system - the difference between actual and desired output.

Learning with the training set 1

TABLE 3 Result by testing with the training test 1

Inputs				Outputs		Error
1	2	3	4	Actual	Desired	
1	1	1	1	1	1	0
3	3	2	3	1	2	-1
2	2	3	4	1	3	-2
7	7	5	2	1	4	-3
4	8	7	5	1	5	-4
11	6	8	6	1	6	-5
10	9	4	17	1	7	-6
6	5	14	38	1	8	-7
26	4	32	37	1	9	-8
8	10	10	10	1	10	-9
5	11	26	25	1	11	-10
13	12	11	28	1	12	-11
19	13	17	8	1	30	-29
14	16	21	29	1	29	-28
25	15	12	36	1	28	-27
17	20	9	27	1	27	-26
18	22	22	7	1	26	-25
15	21	13	24	1	25	-24
22	18	20	20	1	24	-23
20	19	38	15	1	23	-22
31	14	27	9	1	22	-21
12	23	37	14	1	21	-20
16	25	16	31	1	20	-19
35	27	6	33	1	40	-39
9	28	31	35	1	39	-38
21	26	39	16	1	38	-37
39	24	24	22	1	37	-36
40	17	15	26	1	36	-35
38	29	18	18	1	35	-34
27	31	30	34	1	34	-33
34	30	35	12	1	33	-32
28	32	36	13	1	32	-31
23	36	33	39	1	31	-30
32	33	25	23	1	30	-29
36	35	23	11	1	50	-49
37	34	34	40	1	49	-48
24	36	40	21	1	48	-47
29	37	29	32	1	47	-46
30	39	28	30	1	46	-45
33	40	19	19	1	45	-44

Total Mean Square Error: 819.225

TABLE 4 Result by testing with the training test 2

Inputs				Outputs		Error
1	2	3	4	Actual	Desired	
2	3	1	1	1	1	0
4	5	3	4	1	2	-1
6	4	7	2	1	3	-2
9	6	2	3	1	4	-3
1	1	5	18	1	5	-4
13	8	10	5	1	6	-5
5	2	9	23	1	7	-6
11	12	8	8	1	8	-7
16	9	14	6	1	9	-8
8	11	12	14	1	10	-9
19	7	13	13	1	11	-10
7	10	11	34	1	12	-11
15	13	15	7	1	13	-12
14	22	4	10	1	20	-19
18	19	6	17	1	21	-20
10	16	20	11	1	22	-21
24	17	21	9	1	23	-22
22	14	17	19	1	24	-23
3	32	35	16	1	25	-24
17	30	16	12	1	26	-25
23	15	23	29	1	27	-26
12	25	36	21	1	28	-27
20	18	22	28	1	29	-28
30	24	28	15	1	30	-29
25	21	18	27	1	40	-39
33	20	32	20	1	39	-38

21	26	19	26	1	38	-37
29	23	30	24	1	37	-36
26	28	27	33	1	36	-35
32	27	24	30	1	35	-34
34	29	25	31	1	34	-33
28	33	26	32	1	33	-32
27	35	31	25	1	32	-31
35	34	29	22	1	31	-30
36	31	33	35	1	30	-29
31	36	34	36	1	50	-49

Total Mean Square Error: 620.0833333333334

Learning with the training set 2

TABLE 5 Result by testing with the training test 1

Inputs				Output		Error
1	2	3	4	Actual	Desired	
1	1	1	1	1	1	0
3	3	2	3	1	2	-1
2	2	3	4	1	3	-2
7	7	5	2	1	4	-3
4	8	7	5	1	5	-4
11	6	8	6	1	6	-5
10	9	4	17	1	7	-6
6	5	14	38	1	8	-7
26	4	32	37	1	9	-8
8	10	10	10	1	10	-9
5	11	26	25	1	11	-10
13	12	11	28	1	12	-11
19	13	17	8	1	30	-29
14	16	21	29	1	29	-28
25	15	12	36	1	28	-27
17	20	9	27	1	27	-26
18	22	22	7	1	26	-25
15	21	13	24	1	25	-24
22	18	20	20	1	24	-23
20	19	38	15	1	23	-22
31	14	27	9	1	22	-21
12	23	37	14	1	21	-20
16	25	16	31	1	20	-19
35	27	6	33	1	40	-39
9	28	31	35	1	39	-38
21	26	39	16	1	38	-37
39	24	24	22	1	37	-36
40	17	15	26	1	36	-35
38	29	18	18	1	35	-34
27	31	30	34	1	34	-33
34	30	35	12	1	33	-32
28	32	36	13	1	32	-31
23	36	33	39	1	31	-30
32	33	25	23	1	30	-29
36	35	23	11	1	50	-49
37	34	34	40	1	49	-48
24	36	40	21	1	48	-47
29	37	29	32	1	47	-46
30	39	28	30	1	46	-45
33	40	19	19	1	45	-44

Total Mean Square Error: 819.225

TABLE 6 Result by testing with the training test 2

Inputs				Output		Error
1	2	3	4	Actual	Desired	
2	3	1	1	1	1	0
4	5	3	4	1	2	-1
6	4	7	2	1	3	-2
9	6	2	3	1	4	-3
1	1	5	18	1	5	-4
13	8	10	5	1	6	-5
5	2	9	23	1	7	-6
11	12	8	8	1	8	-7
16	9	14	6	1	9	-8
8	11	12	14	1	10	-9
19	7	13	13	1	11	-10
7	10	11	34	1	12	-11
15	13	15	7	1	13	-12
14	22	4	10	1	20	-19
18	19	6	17	1	21	-20
10	16	20	11	1	22	-21
24	17	21	9	1	23	-22
22	14	17	19	1	24	-23
3	32	35	16	1	25	-24
17	30	16	12	1	26	-25
23	15	23	29	1	27	-26
12	25	36	21	1	28	-27
20	18	22	28	1	29	-28
30	24	28	15	1	30	-29
25	21	18	27	1	40	-39
33	20	32	20	1	39	-38
21	26	19	26	1	38	-37
29	23	30	24	1	37	-36
26	28	27	33	1	36	-35
32	27	24	30	1	35	-34
34	29	25	31	1	34	-33
28	33	26	32	1	33	-32
27	35	31	25	1	32	-31
35	34	29	22	1	31	-30
36	31	33	35	1	30	-29
31	36	34	36	1	50	-49

Total Mean Square Error: 620.0833333333334

- Joone

The neural network is showed on the figure bellow.

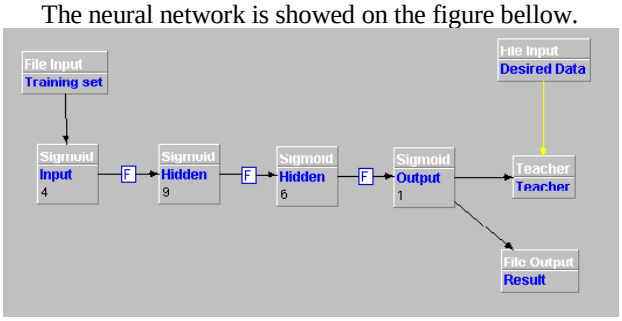

FIGURE 2 Neural network in Joone

Neural networkis trained with training set 1(learning set in this example) and then tested it on the two test sets.

Then neural networkis trained with training set 2 (learning set in this example) and then tested it on the two test sets.

In the following tables are shown the results from tests on two training sets - its been described input values for each example (1 - 4), complying with him output, and in the last column the actual output of the system - Joone.

Learning with the training set 1

TABLE 7 Result by testing with the training test 1

Inputs				Output	
1	2	3	4	Desired	Actual
1.0	1.0	1.0	1.0	1.0	0.9999999744607189
3.0	3.0	2.0	3.0	2.0	0.9999999745996135
2.0	2.0	3.0	4.0	3.0	0.9999999745929045
7.0	7.0	5.0	2.0	4.0	0.9999999746185853
4.0	8.0	7.0	5.0	5.0	0.9999999746359067
11.0	6.0	8.0	6.0	6.0	0.9999999746386214
10.0	9.0	4.0	17.0	7.0	0.9999999746368382
6.0	5.0	14.0	38.0	8.0	0.9999999746380515
26.0	4.0	32.0	37.0	9.0	0.999999974636465
8.0	10.0	10.0	10.0	10.0	0.9999999746394257
5.0	11.0	26.0	25.0	11.0	0.9999999746386334
13.0	12.0	11.0	28.0	12.0	0.9999999746394863
19.0	13.0	17.0	8.0	30.0	0.999999974639435
14.0	16.0	21.0	29.0	29.0	0.9999999746394899
25.0	15.0	12.0	36.0	28.0	0.999999974639489
17.0	20.0	9.0	27.0	27.0	0.9999999746394719
18.0	22.0	22.0	7.0	26.0	0.9999999746393415
15.0	21.0	13.0	24.0	25.0	0.999999974639489
22.0	18.0	20.0	20.0	24.0	0.9999999746394899
20.0	19.0	38.0	15.0	23.0	0.9999999746394899
31.0	14.0	27.0	9.0	22.0	0.9999999746394697
12.0	23.0	37.0	14.0	21.0	0.999999974639489
16.0	25.0	16.0	31.0	20.0	0.9999999746394899
9.0	28.0	31.0	35.0	39.0	0.9999999746394743
21.0	26.0	39.0	16.0	38.0	0.9999999746394899
39.0	24.0	24.0	22.0	37.0	0.9999999746394901
40.0	17.0	15.0	26.0	36.0	0.9999999746394899
38.0	29.0	18.0	18.0	35.0	0.9999999746394899
27.0	31.0	30.0	34.0	34.0	0.9999999746394901
34.0	30.0	35.0	12.0	33.0	0.999999974639489
28.0	32.0	36.0	13.0	32.0	0.9999999746394896
23.0	36.0	33.0	39.0	31.0	0.9999999746394901
32.0	33.0	25.0	23.0	30.0	0.9999999746394901

36.0	35.0	23.0	11.0	50.0	0.9999999746394872
37.0	34.0	34.0	40.0	49.0	0.9999999746394901
24.0	36.0	40.0	21.0	48.0	0.9999999746394901
29.0	37.0	29.0	32.0	47.0	0.9999999746394901
30.0	39.0	28.0	30.0	46.0	0.9999999746394901
33.0	40.0	19.0	19.0	45.0	0.9999999746394899

Result by testing with the training test 2:

0.9999999745277177

0.9999999746261485

0.9999999746163228

Learning with the training set 1

TABLE 8 Result by testing with the training test 1

Inputs				Output	
1	2	3	4	**Desired**	**Actual**
2.0	3.0	1.0	1.0	1.0	0.9999999856334327
4.0	5.0	3.0	4.0	2.0	0.9999999857114681
6.0	4.0	7.0	2.0	3.0	0.9999999857077682
9.0	6.0	2.0	3.0	4.0	0.9999999857221205
1.0	1.0	5.0	18.0	5.0	0.9999999857318369
13.0	8.0	10.0	5.0	6.0	0.9999999857333697
5.0	2.0	9.0	23.0	7.0	0.9999999857323729
11.0	12.0	8.0	8.0	8.0	0.9999999857330646
16.0	9.0	14.0	6.0	9.0	0.9999999857321902
8.0	11.0	12.0	14.0	10.0	0.9999999857338417
19.0	7.0	13.0	13.0	11.0	0.9999999857334032
7.0	10.0	11.0	34.0	12.0	0.999999985733889
15.0	13.0	15.0	7.0	13.0	0.9999999857338677
18.0	19.0	6.0	17.0	21.0	0.9999999857339166
10.0	16.0	20.0	11.0	22.0	0.9999999857339192
24.0	17.0	21.0	9.0	23.0	0.9999999857338597
22.0	14.0	17.0	19.0	24.0	0.9999999857339577
3.0	32.0	35.0	16.0	25.0	0.9999999857339741
17.0	30.0	16.0	12.0	26.0	0.9999999857339912
23.0	15.0	23.0	29.0	27.0	0.9999999857339978
12.0	25.0	36.0	21.0	28.0	0.9999999857340278
20.0	18.0	22.0	28.0	29.0	0.9999999857340482
30.0	24.0	28.0	15.0	30.0	0.9999999857338666
25.0	21.0	18.0	27.0	40.0	0.9999999857340818
33.0	20.0	32.0	20.0	39.0	0.9999999857341153
21.0	26.0	19.0	26.0	38.0	0.99999998573414
29.0	23.0	30.0	24.0	37.0	0.9999999857341697
26.0	28.0	27.0	33.0	36.0	0.9999999857341979
32.0	27.0	24.0	30.0	35.0	0.9999999857342261
34.0	29.0	25.0	31.0	34.0	0.9999999857342536
28.0	33.0	26.0	32.0	33.0	0.9999999857342818
27.0	35.0	31.0	25.0	32.0	0.9999999857343091
35.0	34.0	29.0	22.0	31.0	0.999999985734336
36.0	31.0	33.0	35.0	30.0	0.9999999857343604
31.0	36.0	34.0	36.0	50.0	0.9999999857343873

TABLE 9 Result by testing with the training test 2

Inputs				Output	
1	2	3	4	**Desired**	**Actual**
2.0	3.0	1.0	1.0	1.0	0.999999985670389
4.0	5.0	3.0	4.0	2.0	0.9999999857257089
6.0	4.0	7.0	2.0	3.0	0.9999999857202295
9.0	6.0	2.0	3.0	4.0	0.9999999857187547
1.0	1.0	5.0	18.0	5.0	0.9999999856848016
13.0	8.0	10.0	5.0	6.0	0.9999999857325841
5.0	2.0	9.0	23.0	7.0	0.9999999857213497
11.0	12.0	8.0	8.0	8.0	0.9999999857331825
16.0	9.0	14.0	6.0	9.0	0.9999999857330106
8.0	11.0	12.0	14.0	10.0	0.9999999857332278
19.0	7.0	13.0	13.0	11.0	0.999999985733175
7.0	10.0	11.0	34.0	12.0	0.9999999857331963
15.0	13.0	15.0	7.0	13.0	0.9999999857331912
14.0	22.0	4.0	10.0	20.0	0.9999999857318056
18.0	19.0	6.0	17.0	21.0	0.9999999857330908
10.0	16.0	20.0	11.0	22.0	0.9999999857333006
24.0	17.0	21.0	9.0	23.0	0.9999999857333339
22.0	14.0	17.0	19.0	24.0	0.999999985729922
3.0	32.0	35.0	16.0	25.0	0.9999999857333666
17.0	30.0	16.0	12.0	26.0	0.9999999857333852
23.0	15.0	23.0	29.0	27.0	0.9999999857334039
12.0	25.0	36.0	21.0	28.0	0.9999999857334243
20.0	18.0	22.0	28.0	29.0	0.9999999857334452
30.0	24.0	28.0	15.0	30.0	0.9999999857334667
25.0	21.0	18.0	27.0	40.0	0.9999999857334914
33.0	20.0	32.0	20.0	39.0	0.999999985733518
21.0	26.0	19.0	26.0	38.0	0.9999999857335458
29.0	23.0	30.0	24.0	37.0	0.999999985733574
26.0	28.0	27.0	33.0	36.0	0.9999999857336022
32.0	27.0	24.0	30.0	35.0	0.9999999857336304
34.0	29.0	25.0	31.0	34.0	0.9999999857336581
28.0	33.0	26.0	32.0	33.0	0.9999999857336854
27.0	35.0	31.0	25.0	32.0	0.9999999857337121
35.0	34.0	29.0	22.0	31.0	0.999999985733738
36.0	31.0	33.0	35.0	30.0	0.9999999857337634
31.0	36.0	34.0	36.0	50.0	0.999999985733738

3 Conclusions

After the conducted tests it shows that both the simulator for neural networks have some peculiarities. At the same architecture of the neural network (the same number of layers and neurons) and identical sets of test data, the both simulator give different results.

In testing, it appears that the simulator Joone gives a little - good results in the training with both data sets. The simulator NeuroPh gives a less - poor output through education.

It can be argued in this case that Joone is suitable for the realization of any neural network to implement a certain number of test data. So it can be used by programmers of neural networks to create new types of neural network architectures as well as new algorithms for learning.

As the results, NeuroPh can be used in the implementation of standard architectures of neural networks and standard algorithms. Novice programmers can be familiar by him with the basics of neural networks.

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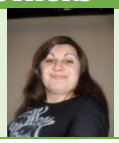
AUTHORS



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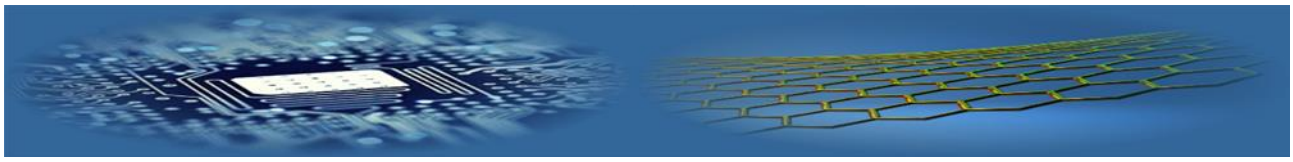

Comparative analysis of simulators for neural networks Joone and NeuroPh

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Abstract

This paper describes a comparative analysis of two simulator neural networks - Joone and NeuroPh. Both simulators are object-oriented and java - based. The analysis seeks to show how much these two simulators are similar and how different in their characteristics, what neural networks is suitable to be made through them, what are their advantages and disadvantages, how they can be used interchangeably to give certain desired result. For the purpose of comparative analysis of both the simulator will be realized logic function, which is not among the standard, and relatively complex and is selected as a combination of several standard logical operations.

Keywords:

neural network
neural network simulator
logical function
exclusive OR
neural network architecture

1 Introduction

Both the simulator selected for the study are Java - based and object - oriented simulators. The used simulators are Joone 4.5.2 and NeuroPh 2.92. Joone is object - oriented frameworks allows to build different types of neural networks. It is built on combining elements which can also be expanded to build new training algorithms and architecttures for neural networks. The components are interchangeable with programming code modules that connect to be performed on the data stream and be deriving obtained information and relevant results. New components that the user adds, can be planned and again. Beyond simulation, Joone has opportunities for multiplatform deployment. Joone has a graphical editor for graphically deployment and testing of each neural network, and the teaching and testing of many examples, the network is configured and can be trained even from multiple remote machines. As of 2010 Joone, NeuroPh and Encog are main component - based environments for neural networks of java - platforms. [1, 2]

Joone can be considered not only as a simulator of neural networks such frameworks were, but as a fully integrated development environment. Unlike its trading partners, it has a strong focus on the code, building a neural network, but not on the visual design. In theory Joone can be used to build a wide range of adaptive systems (including those with mal-adaptive elements) but generally his focus is on building backpropagation - neural networks.

NeuroPh is lightweight frameworks allowed to simulate neural networks. It is java - based and can be use basic for the development of standard types of neural network architectures. It contains well designed open source library and a small number of core classes that correspond to basic concepts in neural networks. There is a good graphics editor toquickly build java - based components of neural networks [3].

2 Methodology

To be tested and analyzed both the simulator will realize logical function, and which is relatively complex and is not among the standard. The generated neural network calculate the result of the following logical function:

((((A XOR B) AND C) OR D) → ((((E XOR F) AND G) OR H)) ↓ I)) AND (((J XOR K)↓(L XOR M)) OR (N ↓O))

The logical function implemented in the neural network includes several logical operators:

- AND - Provides value 1 (TRUE) if both inputs are 1 argument.
- OR - Provides value 1 (TRUE) if at least one input argument is 1.
- XOR - EXCLUSION OR - Provides value 1 (TRUE) if the two input arguments are different.
- → (implication) - Provides a value of 0 (FALSE) if the first argument is 1, the second 0. In other cases, 1.
- ↓ (Peirce's arrow NOR) - negation of the disjunction (in logical circuits can be represented as a combination OR - NOT). Gives a value of 1 (TRUE) if both input argument is

First we will make the realization of simulator neural networks Joone.

The neural network is built by JOONE 4.5.2.0.
Contains: an input layer - Input - 15 neurons,
4 hidden layers respectively:
I 15 neurons
II with 10 neurons
III 8 neurons
IV with 15 neurons
And one output layer 10 neurons.
Learners data are taken from the file: xor1. Txt
Test examples are taken from the file: test_pattern.txt
The results are recorded in the file: results.txt

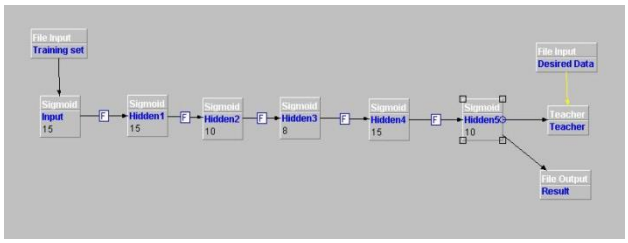

FIGURE 1 Layers of the neural network in Joone

Development of the model to reach the optimal architecture is as follows:

First, we test neural network with I hidden layer with 15 neurons and output layer with one neuron:

After 10,000 epochs: RMSE - 7.75

After 20,000 epochs: RMSE - 6.83

Then, we test neural network with II hidden layer (15 neurons - 10 neurons), and an output layer with 1 neuron:

After 10,000 epochs: RMSE - 4.64

After 20,000 epochs: RMSE - 3.97

It is seen that the search it textures do not give a good enough value of error. Therefore, the development of the model should be continued. This is done by testing successively on following architectures:

II hidden layers (15 neurons - neurons 15) and output layer with one neuron:

After 10,000 epochs: RMSE - 5.57

After 20,000 epochs: RMSE - 4.77

III hidden layer (15 neurons - 10 neurons - neurons 10) and an output layer with 1 neuron:

After 10,000 epochs: RMSE - 4.57

After 20,000 epochs: RMSE - 3.93

III hidden layers (15 neurons - neurons 10 - 8 neurons) and output layer with one neuron:

After 10,000 epochs: RMSE - 4.27

After 20,000 epochs: RMSE - 3.03

IV hidden layers (15 neurons - neurons 10 - 8 neurons - neurons 8) and output layer with one neuron:

After 10,000 epochs: RMSE - 4.51

After 20,000 epochs: RMSE - 3.88

IV hidden layers (15 neurons - 10 neurons - neurons 8 - 10 neurons) and output layer with one neuron:

After 10,000 epochs: RMSE - 4.38

After 20,000 epochs: RMSE - 3.76

IV hidden layers (15 neurons - neurons 10 - 8 neurons - neurons 15) and output layer with one neuron:

After 10,000 epochs: RMSE - 4.18

After 20,000 epochs: RMSE - 3.57

IV hidden layers (15 neurons - neurons 10 - 8 neurons - neurons 15) and output layer 10 neurons:

After 10,000 epochs: RMSE - 0.001

It is seen that the last result is satisfying and we can stop the development of the model.

The learning set consists of 100 training examples that we taken from the file xor1.txt. Test cases are 20 and are located in the file test_pattern.txt.

The following table shows the results of testing with learning set. Below are the input values - from 1 to 15, the expected result of these inputs and the actual result. The expected result is determined by a complex logical function, which we described above. The actual result is the output of the system - Joone.

TABLE 1 Result on learning set in Joone

Inputs															Outputs	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	**Desired**	**Actual**
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00185941651318
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00171267854721
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.00174068713052
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.00171297868822
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.00171263203490
1.0	0.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	1.0	0.99819065530154
0.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	0.99874748651663
1.0	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.99840020882580
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.00171176387902
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00171063441000
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.001711942825887
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00170547142383
0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.001704159243449
1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.998690422813351
0.0	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.99825801114161
0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.99859104574956
1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1.0	0.99866411324620
0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00170372477138
0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00170383697555
0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00170418058508
0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00170950487012
0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00171284151805
0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00171307490515
0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	1.0	0.99868704088361
0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	1.0	0.99886986914373
0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.99879712659079
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00181573650909
1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00181573650909
1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00181828998258
1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.00196073740338
1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.99831946230466
1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.998699389310955
1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.998776103873972
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.996709046387602
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.004418785357284
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00182640654367
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.00179886966065
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.00178497066089
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.00178017710286
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.001723142165490
1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	0.00170867604999

1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	0.00171115476091
0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.00194277916844
0.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	0.0	0.00180661004916
1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.00170405227369
0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.99872473082876
1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.00345636992553
0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.001706998074978
1.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.99820203498989
0.0	0.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.99876787843303
1.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0	0.00201477197411
0.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00170808545531
0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001862992242455
0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00208965556292
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0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00208866209964
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0.0	0.0	0.0	0.0	0.0	0.0	0.0	0,0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00171707163438
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00194790523692
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.00181551577185
1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00181828998258
0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.998664650256829
0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00231109937107
0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00171578793161
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00172035245579
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.001794173831323
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.00172606629957
1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00196073740338
0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.99875045408016
0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00170605685128
0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00172491821548
0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00172441171231
1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.99876893064456
0.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.998708135281306
0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.99862109900078
0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00171646520616
0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00170500832053
0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00170441208624
0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00170422833047
0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00170494386384
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.001707391479248
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00172391240963
0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00179535552546
0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00175517036174
0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.001707701495688
0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.001706150804015
0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.001705704003614
0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00170749323605
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.00171540639749
0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.00175856759291
0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.00170792028372
0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.00170627806636
0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.001705806627616
0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.00170767275065
0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.99864765385988
1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.998167383168365
0.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.99875043991273
1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.998158499362219

Testing the examples of training set gives result described in the table below.

TABLE 2 Results on training set in Joone

Inputs															**Output**	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	**Desired**	**Actual**
0.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0017054441008677 28
0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0017365073818188474
0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0017126790834616611
0.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0017221518565343809
0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0017881340101438775
1.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	1.0	0.8408661190565192
1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0017213972306672999
1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0018150456091549265
1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0017396394623614357
1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0017129149981214703
0.0	0.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.022991489166898076
0.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0018174232780409597
0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.9987247308287605
0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.9935189616059639
0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	1,0	0.0	0.0	1.0	0.0	0.0	1.0	0.8113680710622061
1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0017054508579993635
1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0017108325172039915
1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.00170405227369 8014
1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0017046034834530507
1.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0017054124015384057

In the above table are again described input values which have already from training set. Here we have 20 examples. In the last two columns are the result which must be prepared according to the logical function, and actual result from the system - Joone.

The designed neural network can be used to predict the output of the implemented logic function. It gives good results on learning set and on examples of the test set.

It is follows to implement the same architecture of the neural network simulator NeuroPh.

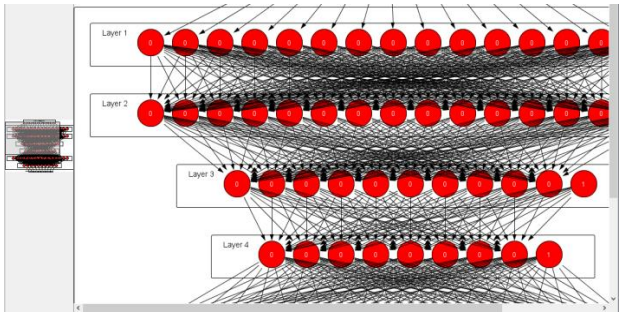

FIGURE 2 Neural network in NeuroPh

The neural network has again four hidden layer neurons. Its structure is as follows - input layer (15 neurons), output layer (10 neurons), I hidden layer (15neurons), II hidden layer (10 neurons), III hidden layer (8 neurons), IV hidden layer (15 neurons).

In testing and training with the same learning set it proved that the neural network is not trained and cannot properly classify examples of the test set. Training and learning set are the same as those used in the previous simulator Joone.

To be completed research we including an example of realization of the standard logical function - exclusive or (XOR). This is a logical function which gives true when one of the input statements is true and the other is false.

Neural network, realize this logical function is shown in the following figure. It has one neuron in the input layer, two neurons in the hidden layer and one neuron in the output layer.

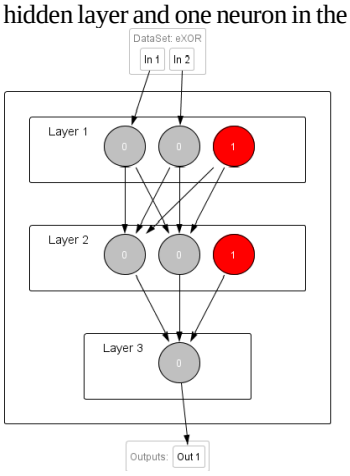

FIGURE 3 Neural network realizes a logical function "exclusive or" in NeuroPh

On the structure of the neural networkis used the results from "Research of simulators for neural networks through the implementation of multilayer perceptron". (Zdravkova, 2015).

The network is fully trained after 1900 iterations. After learning of the network supplying as input values 1 1. The results are as follows - the value of neurons in the hidden layer are 0.101 and 0.902; value of the neuron in the output layer is 0.125. Conduct a second test with values 1, 0. The results are as follows - the value of neurons in the hidden layer are respectively 0.839 and 0.998; value of the neuron in the output layer is 0.871.

We see here that the results are good. Unlike the previous function that failed to give good result after training.

Now test the neural network with the same architecture in simulator Joone [4].

Result after 20,000 epochs: RMSE - 0,29.

The following table shows the input values of the standard logical function and the corresponding result for these input values. The last column shows actual output from the system - Joone.

TABLE 3 results on Exclusive OR in Joone

Inputs		Output	
1	2	**Desired**	**Actual**
0	0	0	0.010592225910198724
0	1	1	0.6618289936765938
1	0	1	0.6718835779208182
1	1	0	0.6819571896978877

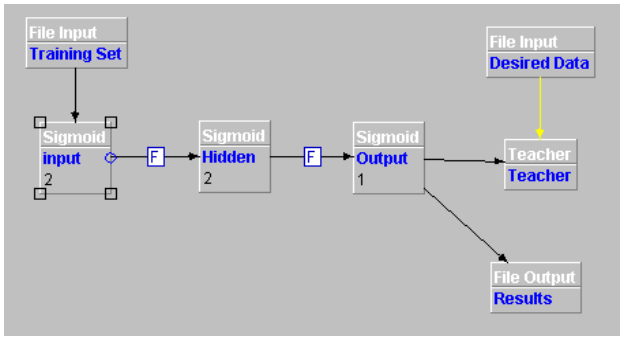

FIGURE 4 Neural network realized "exclusive or" in simulator Joone

It is noted that the results for this logical function here are not as good as in the simulator NeuroPh.

The first logical function here also gave a good result.

3 Conclusions

After the conducted tests it shows that both the simulator for neural networks have some peculiarities. Both simulators are java - based and object - oriented. But they have different results in tests with certain types of neural networks. At the same architecture of the neural network (the same number of layers and neurons) and identical sets of test data, the both simulator give different results.

As the results shows, the simulator Joone gives much better results in the testing of arbitrary complex logical function, which is not among the standard. In this simulator there is a very good opportunities to create new types of algorithms and architectures of neural networks.

The simulator NeuroPh does not give good results in tests with random set, complex logic functions. Basic on a tests we can observe, that NeuroPh can be used in standard logic operations and it is suitable for beginners in the creation of neural networks programmers. The simulator Joone can be used by advanced programmers of neural networks.

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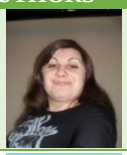
AUTHORS



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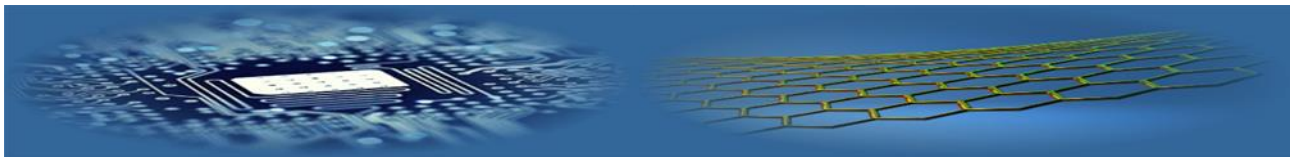

Some issues of expert systems in healthcare and education

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Abstract

A very significant and essential part of the development of an expert system is the creation of its knowledge base. The knowledge base includes not only the rules and the facts that form a part of the declarative knowledge, but also functions and procedures, which are responsible for the optimization of the algorithms used in the expert system. However, there is no clear and universal idea of creating knowledge base. This thesis will describe the attempt to develop ontology of the creation of knowledge base for different expert systems.

Keywords:

expert systems
knowledge base [KB]
medicine
education
future profession

1 Introduction

Today healthcare and education sectors are ones of the most developing spheres in Kazakhstan. The government has set the goal to improve the quality level of giving help to citizens and a significant improvement in existing services. All this is reflected in the letters of the president of Kazakhstan, in particular, the message called "Kazakhstan-2030" [1]. Therefore, we decided it would be very useful to develop expert systems in the spheres of healthcare and education. The thesis will describe the construction of knowledge base structure methods for these two systems.

2 Expert systems

An expert system is a software which uses expert knowledge for providing high-level solution of nonformal problems. The foundation of the expert system is a knowledge base in specific areas, which build during developing system.

Nowadays the value of information support of different medical technologies steadily increases. Use of the modern information technologies becomes a critical factor in the development of the majority of branches of knowledge and areas of practical activities. Therefore, development and deployment of information systems are one of the most actual tasks [2].

The system will identify the problems and give out the most probable disease. The system will define diseases based on rules which were set by experts.

Let's see the expert system for determining the future profession. Today a large percentage of high school graduates do not know who they want to be in the future, but even those who have already decided, and want to go in IT, do not clearly know the specifics of all specialties. There are tests to determine the future profession, but most of them give a very general answer without taking into account lots of implicit factors that may influence the choice. Hobby, zodiac sign or even enthusiasm of closest friends can influence the choice, and all these factors must be considered. So, this is how the idea of an expert system for determining the most suitable future profession for people who want to connect lives with IT appeared. So what makes this expert system different from the existing ones? First of all, it is narrowly specialized in the field of IT. All questions will be connected with information technologies and closely related aspects [3]. And in the end the answer will be clearly formulated within this sphere of activity. Again, the answer will be given very close to the reality.

3 Ontology

Perhaps the most important advantage is the fact which shows the ontology leading to creation of health systems able to support the integration of knowledge without replacement of data [7].

In this paper we consider the ontology that can cover cardio - vascular disease (CVD), as an object, and several classes as symptoms and diagnosis of treatment methods. Each class has its own parameters and terms (Figure 1).

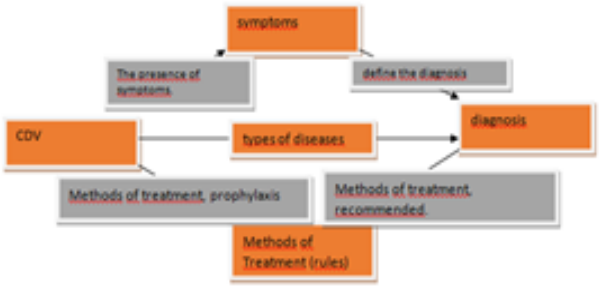

FIGURE 1

On the figure we can see some information about the ontology structure such as basic information about Symptoms (for example, shortness of breath on slight exertion or at rest, weakness, low endurance, heartbeat), Diagnosis (for instance, arrhythmia, cardiovascular failure, angina), Treatment (as an example - Complete blood count - specify the number of red blood cells and hemoglobin , as well as other cells for subsequent detection of diseases (leukemia , anemia , etc ECG or electrocardiogram, which is recorded using electrical impulses characteristic of the heart).

4 Construction ontology and knowledge base for Expert system determine future profession

If you have a problem or a challenge that you can not solve on your own - you refer to knowledgeable people, or to the experts, to those who have the knowledge.

Expert systems have appeared in studies on artificial intelligence (AI). In place of the search for a universal algorithm of thinking and solving problems the researchers got the idea to simulate specific knowledge experts. So in the US the first commercial systems based on the knowledge or expert systems appeared. These systems are the first intelligent systems on the right, and so far the only criterion is the presence of intelligence work with the knowledge of mechanisms.

The most widespread is the rule-based model of knowledge representation. The knowledge base in this type of model consists of a set of rules; and the program that controls the rules is called the output machine.

Expert systems are effective only in the specific "expert" areas where the empirical experience of experts is important.

One of the most important components of the expert system is a *knowledge base*. *The knowledge base* consists of rules of analysis of the information from the user on a particular issue. The expert system analyses the situation and, depending on the orientation expert system, make recommendations to resolve the problems.

As a rule, the expert system knowledge base contains facts (static information about the domain) and the rules – a set of instructions, which apply to the known facts, you can get new facts.

The most widespread is the rule-based model of knowledge representation. The knowledge base in this type of model consists of a set of rules; and the program that controls the rules is called the output machine.

The inference machine is a program that simulates the logical conclusions of experts, uses a given knowledge base for the interpretation of the data received by the system.

It usually has two functions:

- review of existing data (facts) of working memory (database) and the rules of the knowledge base and the addition (to the extent possible) in the working memory of new facts;
- determining the order of viewing and application of the rules. This mechanism controls the process of consultation, keeping the user information on the receipt of the opinion, and asks him for additional information when working memory has no sufficient data.

Also, the inference machine determines the order of application of the rules and should provide:

1) Matching- sample is compared with the existing rules of evidence.
2) Choice - if in a particular situation can be applied several rules, one of them, the most suitable for a given criterion (conflict resolution), is selected
3) Operate - if the sample by comparing the rules coincided with any of the working memory of the facts, the rule is triggered.
4) Action - working memory is subject to change by adding it to enter into the rule triggered. If the right side of the rule contains an indication of an action, then it is executed (for example, in information security systems).

The main factors affecting the viability and effectiveness of ES development (partly [Waterman, 1989]):

- Lack of specialists spent a lot of time to help others;
- A small task requires numerous team of specialists, because none of them has sufficient knowledge;
- Reduced performance because the task requires a complete analysis of a complex set of conditions, and one specialist is not able to see (in the allotted time) all of these conditions;
- Large discrepancy between the decisions of the nicest and the worst performers;
- Availability of experts ready to share their experiences. Suitable problem have the following characteristics:
  a) Can not be solved by traditional means of mathematical modeling;
  b) There is "noise" in the data - incorrect definitions, inaccurate, incomplete information;
- Are highly specialized;
- Do not depend heavily on universal knowledge or common sense.

Currently, there are several thousand industrial ES in the world to give advice:

- in the management of the complex control, for example, electricity distribution network;
- when making a medical diagnosis;
- in troubleshooting in electronic devices, diagnostics of failures of the equipment;
- in the design of integrated circuits;
- in the movement control;
- in forecast operations;
- in the formation of the investment portfolio, the evaluation of financial risks, taxation, and so on.

In general, the process of operation of the expert system can be represented as follows: A user who wishes to obtain information via the user interface sends a request to ES. Solver, using the knowledge base, generates and outputs an appropriate recommendation to the user, explaining the course of its reasoning with the help of explanation subsystem.

Today a large percentage of high school graduates do not know who they want to be in the future, but even those who have already decided, and want to go in IT, do not clearly know the specifics of all specialties. There are tests to determine the future profession, but most of them give a general answer without taking into account lots of implicit factors that may influence the choice. Next part will show the construction of expert system that considers different aspects of students' lives for determining the specialty the most suitable for students who want to continue getting education in IT sphere. It will help high school students to choose their future profession in the field of IT.

The implementation of the knowledge base for determining the future profession is based on building competent ontology.

Ontology is explicit formal specifications of the terms in the domain and relations among them (Gruber 1993).

Ontology, simply, is a description of the knowledge, made quite formally to be processed by computers. Ontology of the content of knowledge base in the expert system is needed to improve the quality of the search engine in the knowledge base.

While creating the knowledge base to determine the profession three main parameters were considered: IT

competence, specialty and skills.

IT competence: describes the quality of making people "potentially" competent in IT. IT competence can be divided into 2 parts: functional and behavioral, that constructs the personality of a person.

Skills can be represented asfunctional (the possibilities of people) and behavioral (characteristic).

Speciality: the most appropriate speciality for the person based on the IT competence and skills the student has.

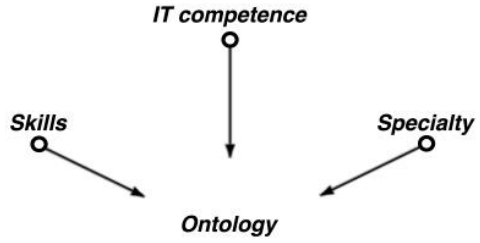

FIGURE 2 Simple ontology scheme for expert system for future profession

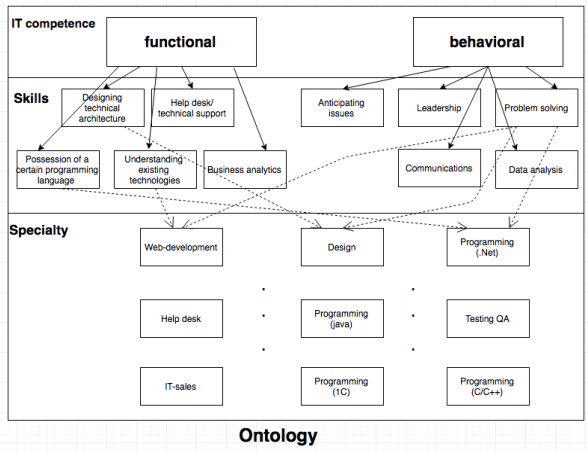

FIGURE 3 Ontology for expert system to determine the future profession

Questions are focused on the identification of potential future professional competence in a particular specialty with respect to skills that are necessary and skills that the person already has.

For example, the question "How much are you stable to stress?" can be answered as "Highly", "Low" and "Don't know". The level of stability to stress is a skill. On the basis of his reply specialties will be screened. If a person gives the answer "Low", the probability that he will be, for example, an IT-manager is reduced, because this specialty needs more resistant to stress people. Through the competent approach to ontology unnecessary specialties can be removed, leaving the person only the most suitable ones.

Using Mamdani inference system means that the information processed by the expert system is not entirely accurate, but is probabilistic in nature. The user does not need to be convinced of the absolute truth or falsity of the evidence; it can respond to requests from the system some degree of confidence. In turn, the system displays the results of the consultation in the form of occurrence probabilities of outcomes.

Example of the rule base of Mamdani inference system:

IF helpdesk is high AND communications is high THEN helpdesk_profession is highly possible.

IF designing_technical_architecture is high AND problem_solving is low THEN web_development is less possible.

The inference system gets data from two inputs that represent IT-competence in functional and behavioral ways. Then it constructs the rules for making the precise picture of student's skills. The result it the possible future profession.

5 Knowledge base

The knowledge base – is a set of the facts and inference rules allowing a logical output and intelligent information processing. The events are provided by depth (fundamental) knowledge of medicine, such as the hierarchy of diseases and hierarchy of parameters for the description of symptoms. Inference rules are surface (managing directors, practical) knowledge, such as rules of diagnosis of illness on symptoms and differentiation of disease [4].

There are a lot of method of elicitation knowledge, but for build our knowledge base we use two methods of elicitation knowledge from an expert. We use one of the active methods is Interview and the second one passive Document analysis. Why we chose two methods? In order to be sure that knowledge base consist truthful data. As this is medical expert system of course the main expert is a doctor. And document analysis method was chosen for the reinforcement of knowledge for this paper we interviewed tree doctors and in order have right results we prepare questions and ask doctor to give for every parameters (symptom) weight. For example for heart rate, we cannot exactly say that if rate less than 60 rate per one minute it is low or normal, because it depend on age, stay and individual characteristics of human, and in order to avoid *Table 1*. After we fill KB by if/then rules (Figure 4).

TABLE 1

Heart rate	Low	Normal	High	Hypertony
>60	80%	20%	0%	0%
60-80	5%	75%	20%	0%
80-100	0%	10%	85%	5%
100-140	0%	0%	5%	95%
140<	0%	0%	0%	100%

The implementation of the knowledge base for determining the future profession is based on building competent ontology. While creating the knowledge base to determine the profession three main parameters were considered: IT competence, specialty and skills.

Questions are focused on the identification of potential future professional competence in a particular specialty with respect to skills that are necessary and skills that the person already has. For example, the question "How much are you stable to stress?" can be answered as "Highly", "Low" and "Don't know". The level of stability to stress is a skill. On the basis of his reply specialties will be screened. If a person gives the answer "Low", the probability that he will be, for example, an IT-manager is reduced, because this specialty needs more resistant to stress people. Through the competent approach to ontology unnecessary specialties can be removed, leaving the person only the most suitable ones [6].

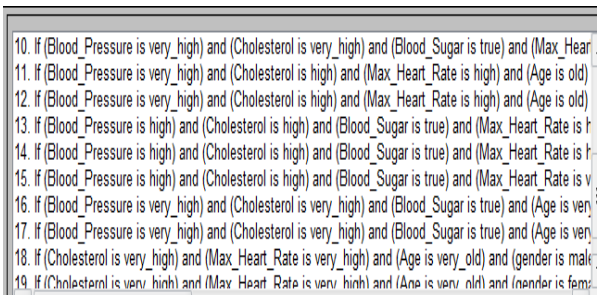

FIGURE 4 KB by if/then rules

4 Conclusion

The knowledge base is one of the most important components of an expert system. That's why the proper construction of knowledge base improves the efficiency and quality of the expert system. This thesis describes ways to build knowledge base for experts systems, particularly in healthcare and education areas, which are ones of the main issues in Kazakhstan.

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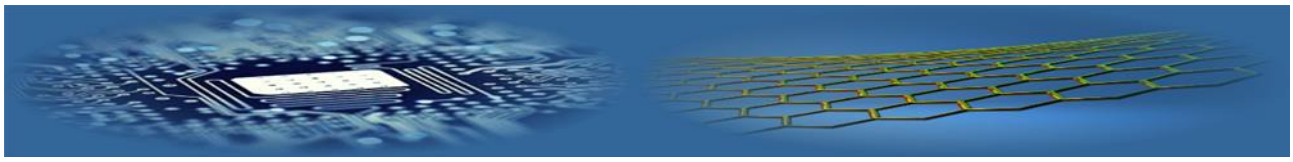

Jeans instability and hydrodynamic roots of Landau damping

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Abstract

Landau damping of Langmuir waves is shown to have hydrodynamic roots, and, in principle, might have been predicted (along with Langmuir waves) several decades earlier, soon after Jeans (1902) paper appeared.

Keywords:

Jeans instability
hydrodynamic roots
Landau damping

1 Introduction

The Jeans dispersion relation is

$$\omega^2 = (kc_s)^2 - \Omega^2 = \Omega^2(\gamma k^2 \mathrm{D}_j^2 - 1), \quad (1)$$

where k is the wavenumber, $C_s^2 = \gamma v_T^2$ is the squared sound velocity, γ is the ratio of specific heats, $\Omega = (4\pi Gp)^{1/2}$ is the Jeans gravitational frequency, v_T is the average thermal velocity, and $D_j = v_T / \Omega$ is the gravitational analog of the Debye radius (which, of course, is not associated with screening, in contrast to plasma) (Jeans 1902). Equation (1) was obtained within Hydrodynamics, by using the Jeans model for infinite, homogeneous self-gravitating gas at rest in the equilibrium. This model is under severe criticism for decades (e.g. Binney and Tremain, 2008) as allegedly inconsistent because at the equilibrium it does not obey the Poisson law for the gravitational potential. We have shown, however, (Trigger et al., 2004; Ershkovich 2011) that the Jeans model is quite self-consistent as in uniform infinite fluid at rest the gravity force vanishes due to symmetry reason, and, hence, Poisson equation in the equilibrium is just irrelevant. Well, the Jeans model, of course, is not realistic but theoretical models (sometimes extremely useful) represent an idealization which seldom is quite realistic. After all, ideal fluid, perfect gas, Maxwell demons, etc. do not exist either.

Consider now an infinite, uniform electronic gas at rest. Taking into account similarity between Newton gravitational and Coulomb laws in electrostatics, we replace the squared Jeans frequency Ω^2 in equation (1) by $-\omega_0^2$, where ω_0 is the Langmuir (1926) frequency, and obtain the dispersion relation for Langmuir waves

$$\omega^2 = \omega_0^2(3k^2 \mathrm{D}_e^2 + 1), \quad (2)$$

where $D_e = v_T / \omega_0$ is the Debye radius of electronic gas. Equation (2) also may be derived for plasma in hydrodynamic approximation (e.g. Krall and Trivelpiece, 1973), one-dimensional treatment when $\gamma = 3$ is justified for Langmuir waves (Krall and Trivelpiece, 1973). Equation (2) yields a real part of the wave frequency a in the kinetic treatment of the Langmuir waves (Landau, 1946; see also Krall and Trivelpiece, 1973). The Jeans model above for dusty plasma has been considered in Ershkovich and Israelevich (2008) by using Boltzmann-Vlasov equation in kinetics.

Consider now a simplified picture: three identical particles (charged or not) are located along the same line at the points A, B, and C (so that in the equilibrium the distances AB = BC). A small sporadic displacement of the particle B toward the particle C violates the balance of forces (gravitational or electrostatic), because the distance between particles B and C becomes less than between A and B. As a result, an interaction between particles B and C grows, and between A and B diminishes. In case of self-gravitation, due to violation of symmetry, a particle B continues to approach the particle C (it corresponds to Jeans instability) whereas Coulomb repulsion tends to return a charged particle B at its original position, with small oscillation around the equilibrium state (with the frequency a0).

Chaotic thermal motion, naturally, tends to destroy this idealized picture, hinders an organized, regular motion (waves and instability), giving rise to collisionless damping of oscillations. This effect is illustrated by equation (1): when thermal velocity is small $(\gamma k^2 D_j^2 << 1)$ the increment of the Jeans instability $(\mathrm{Im}\,\omega = \Omega)$ is maximal. If the thermal velocity v_T grows, the increment diminishes, and with $\gamma v_T^2 = \Omega^2 / \mathrm{k}^2 (kD_j \sim 1)$ the instability vanishes for any finite value of the wave number k.

An organized motion is suppressed by the chaotic one. The damping is caused by thermal motion. Indeed, equation (2) points to the same conclusion: with $(\mathrm{kD}_e)^2 >> 1$

equation (2) describes thermal oscillations of the electronic gas: $\omega / k \approx \sqrt{3v_T}$ (i.e. electronic acoustic waves), whereas Langmuir waves almost disappear (this case corresponds to strong collisionless damping of these waves).

In the opposite limit, $(\mathrm{kD}_e)^2 << 1$, equation (2) reduces to $\omega \approx \omega_0$. This is a condition of Landau damping. Thus, results of hydrodynamic and kinetic treatments happen to be qualitatively very similar, namely, strong damping of Langmuir waves within the Debye sphere and small damping outside of it. Moreover, the central idea of resonance between particles and fields, with the energy exchange between them, resulting in collisionless energy dissipation is implicitly present in equation (2), being associated with relation $\left(\mathrm{kD}_e\right)^2 \sim 1$, that is $\omega / k \sim v_T$ (which is indicative of resonance). From here it is not far to Landau (1946) damping (with its interpretation as reverse Cherenkov effect).

Of course, some questions cannot be answered by means of hydrodynamic approximation, for instance, what happens with $(kD_e)^2 \approx 1$?

If chaotic thermal motion causes the wave damping what is the decrement? These questions may be elucidated only by means of exact kinetic approach. Landau damping of Langmuir waves proportional to $\exp(\mathrm{Im}\,\omega t)$, $\mathrm{Im}\,\omega < 0$ was obtained by Landau (1946) with $(kD_e)^2 << 1$, $|\mathrm{Im}\,\omega| << \mathrm{Re}\,\omega$ (see also, e.g., Krall and Trivelpiece, 1973).

Of course, Landau damping is of tremendous heuristic value. This effect is generally (and fairly) believed to be a corner-stone, an axiom of plasma kinetics. We have to say, however, that the Landau (1946) rule of a pole bypass direction was chosen in Landau (1946) *ad hoc*, as if specially in order to describe mathematically a damping (rather than instability). An assumption of Maxwell distribution seems also not to be quite well consistent with the collisionless character of damping.

The effect of Landau damping of Langmuir waves is very small ($|\mathrm{Im}\,\omega| << \mathrm{Re}\,\omega$).

According to Ecker (1972), it may be experimentally observed only in a very narrow interval $0.2 \le kD_e \le 0.4$.

To resume, the chaotic thermal motion must hamper the regular, organized motion like waves and instabilities resulting in wave damping. This effect is seen from equation (1) for Jeans instability and should also be present in equation (2) for Langmuir waves. Therefore we believe that our qualitative picture above (including Langmuir waves and their collisionless damping), in principle, might have been predicted several decades earlier, soon after Jeans (1902) pioneering paper appeared.

2 Conclusion

Thermal motion was shown to suppress the regular one, thereby resulting in wave damping. Kinetic treatment also supports this (almost obvious) statement. But, according to Landau (1946) (see also Krall and Trivelpiece (1973)) both $\mathrm{Re}\,\omega$ and $\mathrm{Im}\,\omega$ depend on kv_T terms. We remind that $\mathrm{Re}\,\omega$ obeys the dispersion relation (2) which is obtained in hydrodynamical approximation.

The origin of thermal terms (depending on kv_T) both in $\mathrm{Re}\,\omega$ and $\mathrm{Im}\,\omega$ is the same: it is the distribution function. Thus, there is genetic connection between Landau damping and Hydrodynamics. The arguments above allow us to arrive at the conclusion that this damping might have been predicted (of course qualitatively) long before the plasma kinetics arose. Landau damping is generally believed to be purely kinetic effect. To our opinion, it looks similar to the statement that bacteria arose together with Leeuwenhoek microscope.

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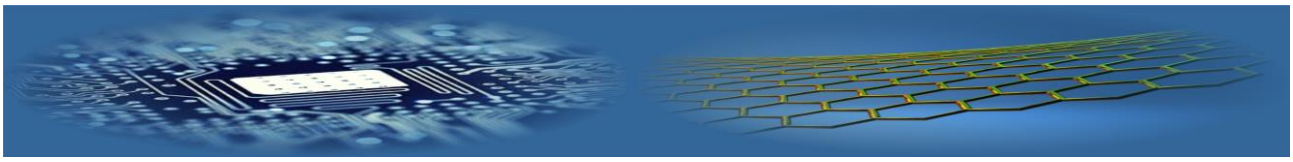

Evaluating the strategic directions of innovative development of the shipbuilding industry in Latvia

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Abstract

The shipbuilding industry in Latvia – the construction, repair and maintenance of ships and boats – plays an important role in the country's economy. In the context of globalization, there is quite tough competition for orders and sales markets among shipbuilding companies of the world at the regional and global levels. Goal of the research – the analysis of the condition of the Latvian shipbuilding industry and the evaluation of main strategic directions of its innovative development. The research has allowed identifying the most important directions of innovative development of the shipbuilding and ship repair industry. It has been found that at present the most topical directions of innovations in the shipbuilding industry are the development of workers' skills and improvement of the marketing system. There is an urgent need for the construction of new production facilities and repair of the existing ones. These main directions of innovations meet the first priority requirements of the industry and are necessary to improve its competitiveness. Without progress in the first three main directions of innovations, the successful development of the industry in all other directions is not possible.

Keywords:

shipbuilding industry
innovative development
competitiveness

1 Introduction

The shipbuilding industry in Latvia – the construction, repair and maintenance of ships and boats – plays an important role in the country's economy and has deep historical roots. The number of companies in the industry accounts for several dozen; mostly they are small and medium-sized enterprises. There are only two relatively large shipbuilding factories on a scale of Latvia: Riga Shipyard and Liepaja Tosmare Shipyard. The number of workers in the industry reaches 7–8 thousand people in the seasonal periods (in the spring and summer). At present, national and international regulatory organisations, marine registers and other agencies impose increasing demands on the quality of shipbuilding products. The requirements for environmental protection, crew qualification and navigational safety are considerably increased. This should be taken into account when companies of the industry execute the orders. To maintain successful performance in contemporary business conditions, shipbuilding companies both in Latvia and abroad should constantly improve their products and increase their quality. This implies the introduction of advanced materials for ships, manufacturing and repair technologies, computer hardware, modern designs, etc.

2 Subject and relevance

In the context of globalization, there is quite tough competition for orders and sales markets among shipbuilding companies of the world at the regional and global levels [1]. Competition takes many forms: it may be subject, functional; price, non-price and integral ways of competition are used. Often there are cases of illegal unfair competition; control methods are applied that violate generally accepted standards: poaching highly qualified specialists, posing artificial obstacles in obtaining credit, and others.

Global experience shows that the successful and rapid economic development of developing countries, to which Latvia can be attributed, took place when the country and its economic sectors, respectively, managed to find their own original solutions to overcome the backwardness and to increase competitiveness [2]. The experience has demonstrated that good progress is achieved by countries that use development models based on the perfect human capital and innovations [3, 4]. Countries by all means contributed to such a development. The main conditions for innovation and investment development of economic sectors in any country are: a high level of development of science and technology; a large proportion (up to 7%) of budget allocated to research and development (R & D); innovation projects on a global scale with the state support; a favourable legal framework and the availability of funds as the financial basis of innovation. Scientific and technological progress is introduced into production in the form of innovations [5]. Without the participation of highly qualified specialists, the introduction of innovations is impossible [6].

Unfortunately, Latvia occupies one of the last places in the EU by research and innovation: the number of innovative companies is insufficient, only slightly above 20%. In the EU, on average the innovative companies and industries account for more than 50%. According to the World Bank, the most successful companies in terms of innovations are medium and large enterprises that employ more than 250 people. Small enterprises that make up a large part of the companies of the

shipbuilding industry in Latvia are less successful in the area of innovations. Lack of financial resources for introducing innovations is the main reason for a low innovation activity. In Latvia, there is also an acute shortage of qualified specialists in shipbuilding, ship repair, and in other sectors of the economy. The current low level of salary of majority of people employed in Latvia and a large income gap between the rich and the majority of population at relatively high prices for goods of daily consumption force most of the able-bodied young people and professionals to leave the country and go abroad to work [7].

The authors believe that the mission of the shipbuilding and ship repair industry in Latvia is as follows. The shipbuilding industry should be based on knowledge, information, and become one of the key leaders in the transition of Latvia to post-industrial, knowledge-based economy; it should take a worthy niche market in the Baltic Sea region, in a qualitative manner meet the needs of customers on a global scale and ensure the welfare of all workers in the sector. The choice of competitive strategies of the industry, i.e., a system of actions of its constituent companies, is made depending on the role and informative functions of these companies. Depending on the role function, major companies in the shipbuilding industry can be attributed to the "candidates for leadership". They occupy about 30% of market share in their niche of the Baltic Sea region and seek to take a monopolistic position. In accordance with the informative function, the main companies in the industry can be attributed to the "patients" that specialize in certain niche markets. For example, recently in Latvia the company has been founded operating in the construction of yachts of medium size for relatively wealthy clients.

The originality of the research lies in the fact that the strategic directions of innovative development of the Latvian shipbuilding industry have been estimated for the first time, aimed at increasing its competitiveness for successful operation of the industry in the context of globalization. Object of the research is the shipbuilding and ship repair industry in Latvia. Goal of the research – the analysis of the condition of the Latvian shipbuilding industry and the evaluation of main strategic directions of its innovative development. Methods of the research are the analysis of statistical data and the expert estimation method based on traditional methods of computation and application of the fuzzy set theory.

3 Computation and analysis

The total number of companies involved in the construction, repair and maintenance of vessels in Latvia has been increasing steadily since the beginning of the 21st century [8]. For example, from 2005 to 2011, it increased by more than 1.5 times – up to 33. Although the number of permanent workers in the industry declined, sales volumes increased by more than 2 times – up to 81.5 million € from 2000 to 2012. The highest rate of sales was achieved before the crisis in 2008. Then, during the crisis period from 2009 to 2011 sales volumes significantly dropped by more than 2 times. Since 2012, there has been a steady increase in sales of shipbuilding and ship repair products. The downside is the fact that there is a decrease observed in the investment in real assets of the companies within the industry for the repair and maintenance of vessels. The decline was strongly affected by the crisis of 2008–2010: investment fell by almost 3 times. If we analyse the performance of small and medium-sized enterprises operating in the construction of sports boats and small boats for recreation, it can be said that the volume of their production greatly changed in the period of 2005–2011 due to the financial and economic crisis. In 2010 compared to 2007 they decreased by more than 3 times. This indicates that the industry is largely dependent on demand fluctuations in the world markets, since most of the production is exported. In general, it can be concluded that the analysis of statistics shows that the number of workers in the shipbuilding industry and the volume of sales are closely correlated with the respective indicators of the Latvian economy as a whole (the calculated correlation coefficients are 0.766 and 0.638, respectively). The industry and the national economy are integrated into the global economy; products are mainly exported.

The Latvian shipbuilding industry faces the same problems as other sectors of the national economy. Apart from the need to develop and improve human capital, and increase the number of highly qualified professionals in the industry, in order to enhance competitiveness it is necessary to develop innovations also in other areas: to introduce new modern ship designs and mechanisms, materials, construction and repair technologies, etc. This requires investment in fixed assets of enterprises: the acquisition and development of new equipment, machine tools, overhaul maintenance and construction of new production facilities, etc. At the same time, it is necessary to improve the marketing system of companies in the industry as well as finding sales markets. It is necessary to carry out an active search for commissioning clients all over the world, taking into account the global nature of competition in the shipbuilding and ship repair industry.

The need for innovative development of the Latvian shipbuilding industry is recognised by all the leading experts of the industry. However, as the survey has shown there is a great divergence of views on strategic priorities of innovative development. Taking into account limited financial resources of companies in the industry and the virtual absence of assistance from government agencies, for successful functioning in the context of global competition it is necessary to establish a unified development policy of innovative directions of the Latvian shipbuilding industry. This will help to coordinate the cooperation among the companies within the industry in terms of innovations, to apply the Japanese experience of cooperation, to establish constructive cooperation with state institutions in providing practical assistance to companies within the industry. Training and educating specialists for the industry at the public educational institutions can serve as an example.

There are many theories of decision making, starting with the well-known theory of Neumann and Morgenstern based on the construction and use of utility functions [9]. However, this theory is often not confirmed in practice [10, 11]. Therefore, it has not been used within the present research. Taking into account the wide divergence in expert

opinions on the priorities in the directions of innovative development of companies within the shipbuilding and ship repair industry as well as vagueness of the information field, the expert estimation method has been used to perform the analysis and formulate recommendations in the research. This reduces the risk of making wrong decisions. By the expert estimation method, the group of competent experts measures the characteristics of the studied phenomena to develop optimal recommendations. The expert group included the principal specialists of the leading companies within the industry and professors at the Latvian universities (RTU, BSA); a total of 12 experts. As a result of the survey, six main directions of innovative development of the companies within the industry have been identified (Table 1). Each expert was asked to assess the directions of innovative development taking into account the greatest possible number of factors: the availability of funding, government assistance, economic viability, social implications, ecology and others. Experts rated the directions of innovative development using a universal quantification scale [1, 10]: 1 – the worst ranking (the lowest priority), 10 – the best ranking (the highest priority). The results of the survey of experts are presented in Table 1. The survey was carried out anonymously; experts answered the questions without consulting each other to eliminate the mutual influence on the results.

TABLE 1 The results of the survey of experts

Designation	Directions of innovative development	Expert estimates											
		1	2	3	4	5	6	7	8	9	10	11	12
A	Construction of vessels of new designs: for the transport of live fish, catamarans, etc.	7	4	6	10	6	10	5	6	6	5	9	6
B	The introduction of advanced materials and technologies	8	6	5	8.5	7	9	7	5	5	6	8	5
C	Development of workers' skills	10	10	9	10	10	10	10	9	10	10	9	10
D	Improving the marketing system	9	9	7	8	8	9	9	10	7	8	9.5	9
E	The construction of new production facilities and repair of the existing ones	6	5	8	8	4	10	8	7	8	8	7	8
F	The introduction of modern equipment and machinery	5	8	4	10	9	8	6	4	4	9	8	7

Estimates obtained as a result of the survey of experts demonstrate sufficiently large differences in their opinions. Thus, the problem arises to generate consolidated findings and recommendations in the face of uncertainty. The probability theory is not consistent with subjective categories of human thinking, and in this situation it does not suit. The fuzzy set theory allows evaluating the fuzzy concepts and information, carrying out the relevant calculations and making valid conclusions [12]. The success of its application is based on the Fuzzy Approximation Theorem proved in 1993 that states that any system can be approximated based on fuzzy logic. Fuzzy logic is much closer to human thinking than traditional logic. This allows successfully using it in management to make grounded decisions.

Within the research, the authors have carried out the multi-criterion estimation and analysis of alternatives for the case, when criterion estimation is determined as a degree of confirmity of alternatives to the concepts defined by criteria. The convolution operation has been used on the basis of fuzzy set intersection [13]. If there a set of *m* alternatives $(\alpha_1, \alpha_2, \ldots \alpha_m)$, a fuzzy set can be considered for criterion C [14]:

$$\tilde{C} = \sum_{i=1}^{m} \frac{\mu_c(\alpha_i)}{\alpha_i}, \quad (1)$$

where $\mu_c(\alpha_i) \in [0,1]$ – the estimation of alternative α_i by criterion C, which describes the degree of confirmity of an alternative to the concept defined by the criterion; i=1, 2, …12; $\sum$ is the sum of pairs $\mu_c(\alpha_i)$ and α_i.

From *n* criteria, it is assumed that the best alternative is the one that satisfies all the criteria $C_1, C_2, \ldots C_n$. The rule for choosing the best alternative is written as the intersection of the corresponding fuzzy sets:

$$D = C_1 \cap C_2 \cap \ldots \cap C_n. \quad (2)$$

The given operation of the intersection of fuzzy sets corresponds to the minimization operation applied to their membership functions:

$$\mu_D(\alpha_j) = min\mu_{ci}(\alpha_j), i = \overline{1,n}; \quad j = \overline{1,m}. \quad (3)$$

The best alternative is assumed to be α^*, which has the maximum value of the membership function [15, 16]:

$$\mu_D(\alpha^*) = max\mu_D(\alpha_j), j = \overline{1,m}?. \quad (4)$$

The construction of membership functions of fuzzy sets has been performed by the method of paired comparisons based on the processing of estimator matrices that reflect expert opinion on the expressiveness of a set element property formalised by this set [17, 18]. A special scale has been used to determine matrices of estimates with qualitative assessments of importance from "1" (equal importance) to "9" (extreme importance). Let the set of *n* elements be X = {x}. Let us assume that the estimate of element x_i compared to element x_j in terms of property S is α_{ij}. For concordance, it is assumed that $\alpha_{ij} = 1/\alpha_{ji}$. Estimates α_{ij} form matrix A = $\| \alpha_{ij} \|$. Solving equation Aw = λw, where λ – the eigenvalue of matrix A, we find the eigenvector of matrix A: $W = (w_1, w_2, \ldots w_n)$. The calculated values of w_i, forming eigenvector w, are taken to be a degree of confirmity of elements *x* to set S:

$$\mu_s(x_i) = \omega_i, \qquad i = \overline{1,n} \quad (5)$$

For example, matrix A_3 of paired comparisons of responses by expert No. 3 based on the scale of importance of estimates [14, 17] is as follows:

$$A_3 = \begin{pmatrix} 1 & 3 & 4 & 5 & 7 & 9 \\ 0.33 & 1 & 2 & 3 & 5 & 8 \\ 0.25 & 0.5 & 1 & 2 & 4 & 7 \\ 0.2 & 0.33 & 0.5 & 1 & 2 & 5 \\ 0.14 & 0.2 & 0.25 & 0.5 & 1 & 2 \\ 0.11 & 0.12 & 0.14 & 0.2 & 0.5 & 1 \end{pmatrix}. \quad (6)$$

As a result of calculations, eigenvalues of matrix A_3 are obtained: $\lambda_1 = 6.177$, $\lambda_2 = -4.781*10^{-4} + 1.084i$; $\lambda_2 = -4.781*10^{-4} - 1.084i$; $\lambda_4 = -0.064$; $\lambda_5 = -0.056 + 0.129i$; $\lambda_6 = -0.056 - 0.129i$, where $\lambda_{max} = \lambda_1 = 6.177$.

Then, it is necessary to find the eigenvector of matrix A_3 based on the equation:

$$\begin{pmatrix} 1-6.177 & 3 & 4 & 5 & 7 & 9 \\ 0.33 & 1-6.177 & 2 & 3 & 5 & 8 \\ 0.25 & 0.5 & 1-6.177 & 2 & 4 & 7 \\ 0.2 & 0.33 & 0.5 & 1-6.177 & 2 & 5 \\ 0.14 & 0.2 & 0.25 & 0.5 & 1-6.177 & 2 \\ 0.11 & 0.12 & 0.14 & 0.2 & 0.5 & 1-6.177 \end{pmatrix} * \begin{pmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \\ \omega_5 \\ \omega_6 \end{pmatrix} = 0. \quad (7)$$

Consider the introduction of the normalization requirement: $\omega_1 + \omega_2 + \omega_3 + \omega_4 + \omega_5 + \omega_6 = 1$. A system of equations is obtained:

$$\begin{aligned} &-5.177\omega_1 + 3\omega_2 + 4\omega_3 + 5\omega_4 + 7\omega_5 + 9\omega_6 = 0 \\ &0.33\omega_1 - 5.177\omega_2 + 2\omega_3 + 3\omega_4 + 5\omega_5 + 8\omega_6 = 0 \\ &0.25\omega_1 + 0.5\omega_2 - 5.177\omega_3 + 2\omega_4 + 4\omega_5 + 7\omega_6 = 0 \\ &0.2\omega_1 + 0.33\omega_2 + 0.5\omega_3 - 5.177\omega_4 + 2\omega_5 + 5\omega_6 = 0 \\ &0.14\omega_1 + 0.2\omega_2 + 0.25\omega_3 + 0.5\omega_4 - 5.177\omega_5 + 2\omega_6 = 0 \\ &0.11\omega_1 + 0.12\omega_2 + 0.14\omega_3 + 0.2\omega_4 + 0.5\omega_5 - 5.177\omega_6 = 0 \end{aligned} \quad (8)$$

System of equations (8) has only a trivial solution. To determine eigenvector W, one of the equations of system (8) is substituted by the normalization requirement. Having solved the new system of equations, eigenvector W of matrix A_3 is obtained:

$w_1 = 0.451$; $w_2 = 0.229$; $w_3 = 0.153$;
$w_4 = 0.092$; $w_5 = 0.048$;
$w_6 = 0.027$, $(at \lambda_{max} = 6.177)$.

$$\sum_{i=1}^{6} w_i = 1$$

Values w_i (i = 1, 2, ... 6), forming eigenvector W, are taken to be a degree of confirmity of responses by expert No. 3 for the fuzzy set.

Having calculated the eigenvectors of the matrices of paired comparisons of expert responses, the following sets are obtained:

$$\begin{aligned} C_1 &= \{0.089/A;\ 0.152/B;\ 0.414/C;\ 0.254/D;\ 0.059/E;\ 0.032/F\} \\ C_2 &= \{0.024/A;\ 0.079/B;\ 0.405/C;\ 0.286/D;\ 0.046/E;\ 0.16/F\} \\ C_3 &= \{0.092/A;\ 0.048/B;\ 0.451/C;\ 0.153/D;\ 0.229/E;\ 0.027/F\} \\ C_4 &= \{0.239/A;\ 0.132/B;\ 0.239/C;\ 0.076/D;\ 0.076/E;\ 0.239/F\} \\ C_5 &= \{0.057/A;\ 0.132/B;\ 0.324/C;\ 0.181/D;\ 0.027/E;\ 0.278/F\} \\ C_6 &= \{0.23/A;\ 0.121/B;\ 0.23/C;\ 0.121/D;\ 0.23/E;\ 0.07/F\} \\ C_7 &= \{0.032/A;\ 0.089/B;\ 0.414/C;\ 0.254/D;\ 0.152/E;\ 0.059/F\} \\ C_8 &= \{0.094/A;\ 0.049/B;\ 0.277/C;\ 0.412/D;\ 0.143/E;\ 0.025/F\} \\ C_9 &= \{0.098/A;\ 0.053/B;\ 0.453/C;\ 0.139/D;\ 0.228/E;\ 0.029/F\} \\ C_{10} &= \{0.038/A;\ 0.066/B;\ 0.375/C;\ 0.143/D;\ 0.143/E;\ 0.236/F\} \\ C_{11} &= \{0.214/A;\ 0.088/B;\ 0.214/C;\ 0.349/D;\ 0.046/E;\ 0.088/F\} \\ C_{12} &= \{0.059/A;\ 0.032/B;\ 0.414/C;\ 0.254/D;\ 0.152/E;\ 0.089/F\} \end{aligned} \quad (9)$$

Then, the choice rule is used:

$$\begin{aligned} D = \{&min\begin{pmatrix} 0.089;\ 0.024;\ 0.092;\ 0.239;\ 0.057;\ 0.23; \\ 0.032;\ 0.094;\ 0.098;\ 0.038;\ 0.214;\ 0.059 \end{pmatrix}/A; \\ &min\begin{pmatrix} 0.152;\ 0.079;\ 0.048;\ 0.132;\ 0.132;\ 0.121; \\ 0.089;\ 0.049;\ 0.053;\ 0.066;\ 0.088;\ 0.032 \end{pmatrix}/B; \\ &min\begin{pmatrix} 0.414;\ 0.405;\ 0.451;\ 0.239;\ 0.324;\ 0.23; \\ 0.414;\ 0.277;\ 0.453;\ 0.375;\ 0.214;\ 0.414 \end{pmatrix}/C; \\ &min\begin{pmatrix} 0.254;\ 0.286;\ 0.153;\ 0.076;\ 0.181;\ 0.121; \\ 0.254;\ 0.412;\ 0.139;\ 0.143;\ 0.349;\ 0.254 \end{pmatrix}/D; \\ &min\begin{pmatrix} 0.059;\ 0.046;\ 0.229;\ 0.076;\ 0.027;\ 0.23; \\ 0.152;\ 0.143;\ 0.228;\ 0.143;\ 0.046;\ 0.152 \end{pmatrix}/E; \\ &min\begin{pmatrix} 0.032;\ 0.16;\ 0.027;\ 0.239;\ 0.278;\ 0.07; \\ 0.059;\ 0.025;\ 0.029;\ 0.236;\ 0.088;\ 0.089 \end{pmatrix}/F\} = \\ &= \{0.024/A;\ 0.032/B;\ 0.214/C;\ 0.076/D;\ 0.027/E;\ 0.025F\} \end{aligned} \quad (10)$$

According to the rule of max(min), it has been found that the highest priority of the directions of innovative development considered by experts on the basis of the fuzzy set theory is alternative C (development of workers' skills). The second place is taken by alternative D (the improvement of the marketing system) and the third place – by alternative B (the introduction of advanced materials and technologies).

The other three alternatives (E – the construction and repair of production facilities, F – the purchase and installation of modern equipment, A – the production of vessels of new designs) occupy the places from 4 to 6, respectively, and in respect to preference they differ little from each other.

To make conclusions that most accurately reflect the consolidated opinion of the expert commission, it is necessary to follow the general scientific concept of stability [19]. The concept of stability is based on the use of different methods of mathematical processing of expert opinions to highlight similar recommendations obtained by these methods. A significant change in recommendations from method to method would indicate a high degree of their dependence on expert subjectivity. Therefore, apart from the fuzzy set theory, to obtain a consolidated opinion of experts three methods of mathematical processing of the responses have also been used: an arithmetic average rank method, a median rank method and the method of group decision making [20] based on the geometric average values of the ranks. In the paper, these three methods are not described in detail as they are traditional. A comparative analysis of the results of processing expert opinions has been performed using all the four methods.

Table 2 shows the ranks of the expert responses to the question about the priorities of alternatives. Rank "1" is assigned to the best alternative, and rank "6" – to an alternative that should be implemented lastly. If an expert considers that two alternatives are equal, have the same estimates and should take the first and second places by preference, they are assigned the same rank – 1.5: (1+2) / 2=1.5.

TABLE 2 The ranks of the expert responses

Directions of innovative development	**Experts**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
A	4	6	4	2	5	2	6	4	4	6	2.5	5
B	3	4	5	4	4	4.5	4	5	5	5	4.5	6
C	1	1	1	2	1	2	1	2	1	1	2.5	1
D	2	2	3	5.5	3	4.5	2	1	3	3.5	1	2
E	5	5	2	5.5	6	2	3	3	2	3.5	6	3
F	6	3	6	2	2	6	5	6	6	2	4.5	4

The final ranks of alternatives are calculated as follows. Using the method of arithmetic average of ranks, the sums of ranks assigned by experts to different alternatives are calculated (Table 2). The sums are divided by the number of experts, and the arithmetic average of ranks is obtained. Final rank of "1" is assigned to the smallest sum, and the final rank of "6" – to the largest one. By the median method, ranks of the expert responses for each alternative initially are located in non-decreasing order. Then, the sum of ranks in the mean position (the sixth and seventh places) of variational series is divided in two, and a median of ranks is obtained. The final ranks obtained by the median method as well as by the arithmetic average method are assigned by using the same rule. By the method of group decision making, geometric average of ranks for different alternatives has been calculated. The final ranks have been assigned according to the described rule. Results of calculation of the final ranks of alternatives are presented in Table 3.

TABLE 3 Final ranks of alternatives calculated by different methods

Alternatives	**A**	**B**	**C**	**D**	**E**	**F**
The final rank by the arithmetic average	4	6	1	2	3	5
The final rank by medians	4	5	1	2	3	6
The final rank by the geometric average	4	6	1	2	3	5
The final rank by the fuzzy set theory	6	3	1	2	4	5
The grand total by the geometric average	4	5	1	2	3	6

It has been found that the final ranks of alternatives by the arithmetic average method and the geometric average method completely coincide (Table 3). Final ranks by the median method differ from the two mentioned above for alternatives B and F (5th and 6th ranks, respectively rather than 6^{th} and 5^{th} ranks). As a result of the four methods of calculation, alternatives C and D have taken the first place. For the grand total ranking of alternatives, the method of group decision making has been used, which enables one to obtain results that are equidistant from the maximum and minimum estimates. According to the grand total, alternative E has taken the third place. As far as the third place is concerned, there is only a slight deviation by the fuzzy set theory. Therefore, it can be stated that for the first three places the consolidated expert opinion rather well complies with the concept of stability. For the 4th, 5th and 6th places, there are some discrepancies in the final ranks obtained by different methods of calculation. In general, it can be stated that the consolidated opinion of independent experts, according to the calculations, is quite unanimous. The authors understand that this opinion is not the final authority, as in the final decision-making process the enterprises within the industry should take into account the specific conditions, the availability of funding, the market situation, etc.

4 Conclusions

The research has allowed identifying the most important directions of innovative development of the shipbuilding and ship repair industry. It has been found that at present the most topical directions of innovations in the shipbuilding industry are the development of workers' skills and improvement of the marketing system. There is an urgent need for the construction of new production facilities and repair of the existing ones. These main directions of innovations meet the first priority requirements of the industry and are necessary to improve its competitiveness. Without progress in the first three main directions of innovations, the successful development of the industry in all other directions is not possible.

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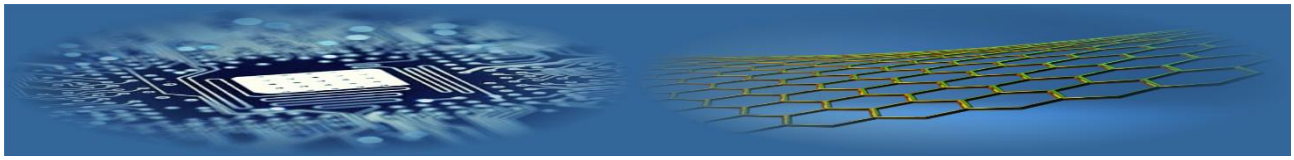

Comparative analysis of GIS in sight of view of renewable energy sources monitoring

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Abstract

At present there exists a great deal of GIS providing data on renewable energy on local and international level. In case of lack of field measurements the idea of using open source data along with field actinometrical measurements on the certain (or existing) sites seems to be efficient from the point of view of accuracy and costs. An overview of GIS commonly used in Russia and USA is given below. All the data used in the overview is available as project descriptions given on the web portal being discussed. All the systems have been analysed from the point of view of the data used on the portal, visualization tools and maps (wind, solar etc.).

Keywords:

renewable energy sources
monitoring
visualization tools
geospatial data

1 Introduction

Nowadays, the amount of data being produced and stored increases rapidly. Due to the rapid development and low cost of data transmission and storing tools the amount of stored data is steadily reaching enormous values. Naturally, in order to process all this data and process information 'usefully' it is necessary to develop more complicated methods and, in some cases, new fields of study. Moreover, from the point of view of processing speed more powerful calculation capacity is required.

Modern development of cloud computing allows to access, in the short period of time, almost unlimited resources for data processing and representation, and, in case of shortage, to broaden and deepen the needed data.

2 Data gathering and data processing used in modern GIS from the point of view of green energy monitoring

Data is the main valuable source of such systems. If certain data is confidential there exist several open source datasets providing correct data on renewable energy, and in some cases, with relatively high precision. Table 1 provides a brief overview of some datasets with information on solar energy.

Besides using these datasets it is also possible to use NASA SSE, open source datasets on solar energy, providing information about the whole Earth surface on the (1 x 1) grid. According to the researches held on the territory of Russia during several years, the NASA SSE data provides a sufficient accuracy level [1].

3 Visualization tools commonly applied in energy monitoring

The comparative analysis of different GIS is an essential part of defining proper functional parameters and requirements needed for creating a renewable energy monitoring system. The main issue in creating geographical information systems is finding the way of representing features being visualized (geographic parameters in this particular case) [2].

There exist several ways of describing geographical features.

Firstly it is necessary to recognize the data types. Normally two data types are defined:

- Spatial data (data describing the location)
- Attribute data (data specifying the characteristics of the spatial data i.e. what, when or how much) [3]

Secondly, it is needed to find the way of representation of the data in the GIS. Digitally it is possible to represent the data by grouping it into layers or by selecting appropriate data features.

Data grouping by layers is focused on finding similarities or relevant features in the target data (these features may be the source type as hydrography, elevation, water lines, sewer lines, grocery sales). In this case it is possible to use one of the following data models:

- vector (data model using coverage in ARC/INFO, shapefile in ArcView)
- raster data model (GRID or Image in ARC/INFO & ArcView) [4]

Selecting data properties should be done for for each layer separately [5]. Features are chosen with respect to projection, scale, accuracy and resolution

Finally it is necessary to find the means of data incorporation into a computer application system.

TABLE 1 Solar energy datasets

Charac-teristics	E.S.R.A. 1996	E.S.R.A. 2000	METEONORM 6,0	Climate 1	WRDC	S@tel-Light
Availableas	Book with CD	Two books with CD attached	CD and catalog	CD	Internet	Internet
Distribution	Paid	Paid	Paid	Paid	Free	Free
Web address	-	www.ensmp.fr/Fr/Services/ Presses ENS	www.meteotest.chl	www.climate-one.de	http://wrdc.mgo.rssi.ru	www.satellight.com
Application scale	Europe and North Africa	Europe and North Africa	Worldwide	Worldwide	Worldwide	Europe and North Africa
Supported parameters	S, D	Paid	S, D, T, V, W, P	S, T, V, W	S, D	S, D
Measure-ments period	1966-1975	www.ensmp.fr/Fr/Services/ Presses ENS	1961-1990 and 1996-2005	Different	1964-2009	1996-2000
Parameter extension	M	Europe and North Africa	m, h	m	M	h h
Number of observation sites	340	586	7756	>1200	1195	-
Spatial interpo-lation	No	No	Yes	No	No	Yes

S – total solar radiation, D – diffuse solar radiation, T – air temperature, P - atmospheric pressure, V – wind velocity, W - humidity in air, m – mean monthly parameters, h – mean hourly parameters, h h – half hourly parameters

It is needed to discuss each data type separately.

Spatial data types are represented as continuous, areas, networks and points.

Continuous data types are divided into elevation, rainfall and ocean salinity.

Areas are generally defined as:

- unbounded: land use, market areas, soils, rock type
- bounded: city/county/state boundaries, ownership parcels, zoning
- moving: air masses, animal herds, schools of fish

Networks may be classified as roads, transmission lines or streams.

Points are generally described as:

- Fixed ones: wells, street lamps, addresses
- Moving ones: cars, fish, deer

Attribute data types are generally defined as special data tables that contain locational information in the form of addresses, a set of longitude/latitude coordinates (or x/y) etc. Systems like ArcView consider these data tables as event tables [6]. However, the spatial data in the real system is described as a shape file. Thus, all the event tables are to be converted to the strict format. In order to convert data to a shape file format, it is possible to use geocoding, and later display the data as a map.

4 Maps categorization and comparative analysis of the existing representation models

In common case all the maps provided by renewable energy monitoring systems are classified with respect to the energy source they are representing. They are also classified concerning the means of their creation (i.e. raster and vector data model) [7].

Raster data is simple and faster to realize but in certain cases the map resolution may not be sufficient enough for proper analysis.

Vector data model requires more complicated and sophisticated tools but it is, in turn, a correct way of weather data representation. Thus, vector data model provides high quality resolution which may be extremely important in certain cases.

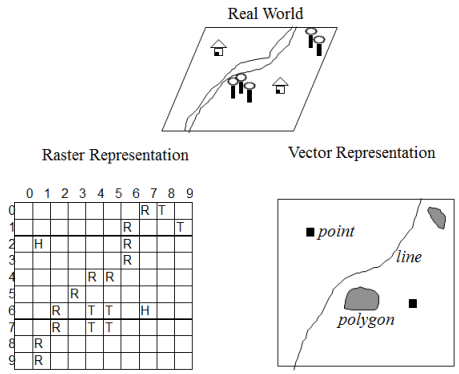

Figure 1 Differences in representation between raster and vector data models (http://www.utdallas.edu/~briggs/)

5 Comparative analysis of existing GIS

The analysis is carried out according to the defined parameters as data being represented, visualization tools and maps applied for data visualization.

5.1 RUSSIA'S RENEWABLE ENERGY SOURCES

According to the description provided on the "Renewable Energy Sources" GIS (RRES GIS) official website [8] the

project is accomplished in cooperation with following scientific research centres:

- Moscow State University's Faculty of Geography
- Joint Institute for High Temperatures of the Russian Academy of Sciences, (research institute in the fields of high energy densities physics, shock wave physics, thermodynamics databases, numerical simulations and cluster computing, dusty plasma, applied electrodynamics, combustion, green power (JIHT))
- Renewable Energy Sources and Energy Conservation Laboratory.

Data provided on the website is based on the Global Atlas for Solar energy in Russia and climate databases (special datasets applied in renewable energy monitoring in Russia). Data provided by the GIS may also be used in constructing mathematical models, including dynamic ones, of power stations working on renewable energy.

The Global Atlas for Solar energy in Russia is a set of maps of total solar radiation on the whole surface of Russia. Mean values of solar radiation are calculated from radiation sums of different periods of time. It should be noticed that the data format is defined by heliotechnical equipment requirements [9]. Data for the Global Atlas is provided by Russian weather stations (multiyear solar radiation measurements), Meteonorm RetScreen and NASA SSE(NASA Surface meteorology and Solar Energy) databases. Data taken from NASA SSE, is satellites measurements values used to calculate the Earth's Radiation Energy Balance. Using these values solar radiation distribution models are developed. In these models the following weather parameters are considered:

- Earth's surface albedo
- Cloud coverage
- Humidity in air
- Atmospheric aerosols concentration

Together all these parameters allow determining mean solar radiation streams with a little inaccuracy. It still should be mentioned that these parameters have been calculated in accordance with USA surface specifications.

On the basis of NASA SSE datasets wind annual average velocities distribution maps have been constructed (50 and 10 m heights), which are also included in the Global Atlas. These are map are essential in calculating wind velocities in different regions of Russia. Data taken from the maps is later used in defining power stations' potential efficiency (including those ones that are integrated into combined solar and wind power stations). Nevertheless, due to the dependency of actual wind velocity and direction from the region's geographic conditions, it is obligatory to verify all the data, i.e. wind parameters are measured directly at the site of the planned power station. Multiyear data of the surrounding weather station may also be taken into consideration.

Thus, data used in 'Russia's Renewable Energy Sources' GIS is a special dataset that includes statistical information and results of processing this data.

Statistical data is obtained from weather stations all over the country and from the NASA SSE weather database, created on the basis of long-term surface observations with Earth satellites.

Using this statistical data direct (beam), diffuse and reflected solar radiation indices have been calculated for multidirectional horizon degrees and different time periods (including the daily distribution indices of the total amount of solar radiation striking the horizontal surface on the earth) [10].

All these indices may be used afterwards to evaluate the efficiency of solar power stations working on luminescent solar concentrators.

As the studied GIS uses raster map representation the following features fully describe the system visualization policy. Firstly, the whole area is covered by grid with equal-size cells. Location of every cell is calculated simultaneously relatively to the origin of the matrix. The majority feature is an attribute. Every cell on the grid is assigned a single value in the cell (e.g. land use type) in accordance with its majority attribute. This is how the attributes are recorded. Among the advantages it is possible to mention its simplicity. The system is relatively easy and fast to implement. All the calculations overlay and analysis are done fast because of the grid structure. Thus, in order to calculate certain value it is only needed to combine the corresponding cells.

The upper left of the grid is commonly defined as its origin, but there are certain features to be mentioned:

- State Plane and Universal Transverse Mercator UTM have their orign at the lower left
- Latitude/longitude and Cartesian coordinates are defined to have an origin at the center

There are certain notations that are commonly applied while constructing the raster model, as class, zone and neighbourhood:

- class is a combination of cells with the similar value (values may be defined by the object type, as for example the cells defining sandy soil, i.e. having the same type)
- unlike the class a zone is a combination of contiguous cells having the similar value
- neighbourhood is a combination of cells adjacent to a target cell(cells may be adjacent in a certain systematic manner)

All the maps provided by the system may be divided into several categories.

Maps are also divided with the respect to the energy sources they are representing. Thus, all the maps are divided into solar, wind, hydro and bio energy. The division is provided explicitly and is highly understandable.

From the point of view of representation concepts the majority of the maps are raster with a certain number of vector maps. It should be mentioned that this division is not unequivocal (i.e. there is no separation evident to the user). Yet, it is possible to find these categories as subdivisions. Thus, there are raster, resource and object maps.

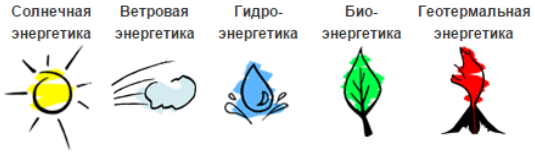

FIGURE 2 Explicit map classification of RRES GIS

FIGURE 3 Inexplicit map categorization in the RRES GIS subcategories

5.2 NATIONAL RENEWABLE ENERGY LABORATORY, NREL

The National Renewable Energy Laboratory (NREL) is the main USA scientific laboratory center implementing researches on renewable energy, efficient energy use (or energy efficiency) and sustainable development.

All the data obtained during the researches is freely available on www.nrel.gov. The data has been visualized, but especially for the power station engineers, it is also available in a table format. All the information presented on the official website has been obtained from one of three research centers:

- The National Center for Photovoltaics
- The National Bioenergy Center
- The National Wind Technology Center - NWTC

All the data obtained during field and indoor measurement is published at Renewable Resource Data Center. For instance, 10 km data maps show hourly solar activity data obtained from field weather stations, daily data on snow coverage, monthly air humidity data, data on greenhouse gases, and a total amount of aerosols in atmosphere in order to let calculate daily surface insolation level [11]. The same maps, but with 40 km data provide information on cloud coverage, atmosphere higher levels humidity, greenhouse gases concentration and a total amount of aerosols in atmosphere in order to allow calculation of the total insolation level. It is still should be mentioned that satellite data is to be verified by field measurements whenever it is possible. For example, a cloud map is a height year histogram of satellite data taken in a 40 x 40 km resolution. Thus, the accuracy and the space map resolution are defined by the database itself.

Besides providing raster maps the NREL represents some data by means of vector model. To create its raster model NREL commonly applies square or rectangular grid. Naturally, that square grid (creating each cell with equal length sides) is conceptually much simpler than any other. In this case, it is possible to divide cells recursively into squares (cells) of same shape. The location is defined by neighborhood, i.e. left/right, above/below directions. This is commonly referred as rook's case. As all the cells (at least neighborhood ones) are equidistant, the calculation may be simplified. It is also possible to apply a queen's case, meaning that neighborhood includes 8 connections (including diagonals), But in this case all the cells may not be equidistant. Diagonal cells are 1.41 points away from the cell center (square root of 2).

For example NREL wind data (50 meter height above ground/surface) is obtained from original raster data that varied in resolution from 200-meter to 1000-meter cell sizes. Then, this data have been modified to produce geographic shapefiles. Thus, these shapefiles have been applied to create 50 meter wind maps. There are two distinct groups of data provided in this section: data produced by NREL and data produced by AWS Truepower but validated by NREL.

NREL provides datasets that may be later modified by other tools. For example solar data of Colorado is provided as a shape file that is later possible to be used in such tools as QGIS. In QGIS this shape file may be added as vector layer. These shapefiles are geometry records and attributes corresponding to each record. The information about records/columns and their explication are provided in the metadata. In order to visualize dataset provided by NREL it is necessary to use data based on attributes.

It should be also mentioned that points are commonly referenced as nodes (and arcs as lines). To sum up, it is possible to define key features common to different representation tools.

As it has been mentioned above the polygon edges are described by listing ID numbers like walking around the outside boundary of the area. There is also another file that contains information of all the points and their respective coordinates (an array of IDs). The second file's efficiency is proved by the following reasons:

- there is a problem with the duplicate coordinates and double borders; using the second file helps to solve this problem
- as there is a list of IDs in the second file lines can be manipulated directly as polygons, but still there is a problem with networks representation
- even if the second data file gives sufficient information there is still lack of topological data
- the second generation mapping package, from the Laboratory for Computer Graphics and Spatial Analysis at Harvard, called CALFORM was the first to apply second data file in their vector model.

Unlike 'Russia's Renewable Energy Sources' GIS the maps provided by NREL are explicitly divided into several categories.

The team responsible for map development is NREL's Geospatial Data Science Team that creates tools for various renewable energy sources and for certain specific tasks (e.g. certain projects). As a benefit to the public, a majority of static maps are offered and Google Map (KML/KMZ) files on a tool called MapSearch To be beneficial for the public a majority of static maps and Google Map files (KML/KMZ) are available on a special tool created by NREL and called MapSearch. The main categories of maps in a public access are:

Biomass Maps

The biomass resources in the United States data provided in the map form shows the information throughout the county. [12].

Federal Energy Management Program

The main goal of the Federal Energy Management Program (FEMP) in cooperation with with Geospatial Analysis staff at NREL was to update the analysis for the development project. Working together they have finally composed an interactive FEMP Screening Map application [13]. Nevertheless, the earlier map versions have been saved and archived. Thus all of them are still available and may be accessed by contacting the NREL's Webmaster.

Geothermal maps

There are available maps showing not only favorable resources for enhanced geothermal systems, but also identified hydrothermal sites. Besides providing data on currently developed projects there are also sites on the map showing the planned geothermal power plant projects.

Hydrogen Maps

A tool known as GIS modeling is applied in analyzing and visualizing the spatial relationship between supply and demand. For instance, supply in the form of resources (renewable and traditional), hydrogen production facileties, and transportation infrastructure, from one side and hydrogen demand centers from another [14]. This tool is a powerful facility allowing processing large and complex datasets, siting hydrogen production facilities and refueling stations on the map, and analyzing diversity of resources for hydrogen production throughout the United States.

International Maps

NREL provide powerful analysis Geospatial Toolkits and maps created in collaboration with with various countries. The maps are available through the MapSearch tool and as a separate category on the official web site (international maps).

Marine and Hydrokinetic Maps

There are several viable sites of marine and hydrokinetic resources in the United States. Maps of marine and hydrokinetic (MHK) resources are available on the NREL's website. Some of them are: Nonpowered Dams Assessment, Wave Resource Assessment, Tidal Streams Resource Assessment, Wave Energy Resource Atlas, and Tidal Streams Resource Maps [15].

Solar Maps

Data for solar maps (solar radiation resources) has been obtained via several photovoltaic collector orientations in the United States [16]. Among the available maps are: PV Solar Radiation Maps, Direct Normal Solar Radiation Maps, Map of U.S. Solar Measurement Station Locations, and the United States Solar Atlas.

Wind Maps

The wind power density is the main factor determining the wind resource potential [17]. Thus, wind maps are based on these calculations. The wind energy resources are estimated for the maps and are represented as maps. The data is available only for the United States and its territories. It should be mentioned that these maps indicate general areas where a high wind resource may exist [18].

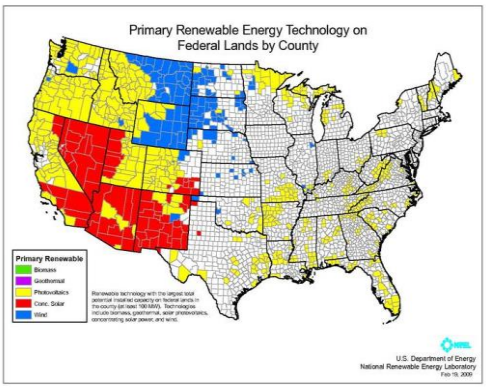

FIGURE 4 NREL renewable energy technology visualization sample

5.3 INTERNATIONAL RENEWABLE ENERGY AGENCY, IRENA

Created in 2009 the organization's main goal is to develop and support the renewable energy sources utilization. The organization is aimed to provide a free access to the renewable energy sources data for public and for potential power station developers. IRENA was established on the 26-th of January, 2009 in Bonn, Germany, when 75 states signed an IRENA official statute, which entered into force on the 8-th of July, 2010. IRENA is promoting sustainable development, usage of renewable energy and distributes all the obtained knowledge in order to increase the interest rate in this particular field [19].

Data visualized on the IRENA is taken from different international sources the majority of which belong to NREL and Global Geographic catalogues as Wind resource maps of the Global Atlas, USA bioenergy data, Full Merra dataset, Spanish National Renewable Energy Centre (CENER) - www.cener.com,World Data base on Protected Areas, WDPA http://www.protectedplanet.net/country/KZ) [20].

Certain generic models used inn IRENA are implemented by several software vendors in specific computer file formats As IRENA represents data in raster and vector format (including data provided by NREL), there is a set of specific file formats commonly applied during data representation.

Coverage: specific vector data format developed in 1981 by ArcInfo

- coverage format supports multiple physical files (approximately 12) in a single folder [21]
- this data format is proprietary, thus there are published specifications allowed and for any change ArcInfo is required

Shape 'file': specific vector data format developed in 1993 by ArcView

- extensions supported: .shp, .shx, .dbf; shape file data format comprises several physical disk files (3 and more); it is required for all of the files to be present
- open-source, thus it is allowed to publish own specifications; commonly used by other vendors
- Geodatabase: specific vector data format created in 2000 by ArcGIS 8.0
- geodatabase supports multiple layers saved in a single file with .mdb extension (similar to MS Access)
- geodatabase format is proprietary; being a recently introduced data format, it is commonly referred as the next generation spatial data file format

The following map systems are used for data representation:

- Google Hybrid Map
- Google Satellite Map
- Google Street Map
- Google Terrain Map
- Bing Hybrid
- Bing Satellite Map
- Bing Street Map
- Open Street Map

7 Conclusions

The comparative analysis of different GIS is an essential part of defining proper functional parameters and requirements needed for creating a renewable energy monitoring system. A brief overview of existing GIS and their comparative analysis allow determining the following requirements list:

1. Data gathering. As it has been mentioned above the NASA SSE datasets prove to be sufficiently accurate and satisfy all the requirements. But still, all the GIS have their own weather stations (or at least data of field actinometrical measurements) to verify the NASA data. Thus, it is strongly recommended to obtain local weather data along with using open source information.
2. Data visualization and shape files. It has been mentioned that certain GIS provide their own shape files to be later used in other visualization platforms. In this case the data on local renewable energy sources is platform independent and allows the information to be later used for further researches. As the renewable energy monitoring system is used both for public and professional usage it is necessary to provide raster data for public (for easier access) and vector data for developers and researchers (for more accurate calculations).
3. Maps. During the overview the problem of inexplicit map categorization has been revealed as it is quite possible for user to be confused. Consequently, the maps are to be explicitly divided by quality and by energy types (as on the NREL website).

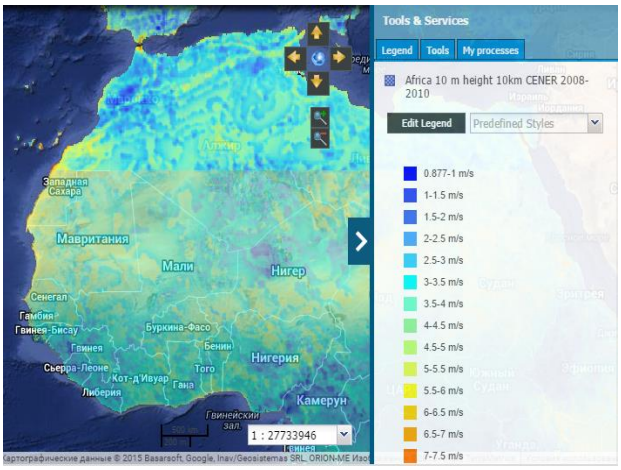

FIGURE 5 CENER data visualization sample on the IRENA portal

To sum up, it is possible to claim that for regions with high renewable energy potential the problem of energy monitoring is considered as an essential part of further development. In case of lack of field measurements the idea of using open source along with field actinometrical measurements on the certain (or existing) sites seems to be efficient from the point of view of accuracy and costs. In this case, the renewable energy monitoring systems may be considered as the strong foundation for alter development of alternative energy in the regions with high potential and high energy demands.

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INFORMATION AND COMPUTER TECHNOLOGIES

Comparative analysis of environments for logic programming in the Prolog language

N Nenkov

Computer Modelling & New Technologies 2016 ***20****(6) 7-11*

This paper presents the results of a survey of basic characteristics and parameters of logic programming environments. The object of the analysis are four systems: Strawberry Prolog [1], SWI Prolog [6], Visual Prolog 5.3 [4, 8], Visual Prolog 7.3 [2] and the C ++ compiler Visual [3]. The analysis represents different generations of systems for logic programming of the language Prolog comparing their parameters in the implementation of application for solving the problem: "The Tower of Hanoi" [8] by a recursive algorithm. There are criteria for classification, comparison and evaluation of community programming that can be applied to their choice in the implementation of a specific project.

Keywords: environment for logic programming, Prolog, predicate recursion

Research of neural network simulators through two training data sets

E Zdravkova, N Nenkov

Computer Modelling & New Technologies 2016 ***20****(1) 12-15*

In the present study our aims is to analyze and test two neural networks simulators - Joone and NeuroPh. This will be accomplished by establishing a neural network of 4 layers constituting a multilayer perceptron with sigmoid links. For the purpose of the study were selected two test data sets, which contain integers. Through sequential training the neural network with each of them and subsequently the test results will be obtained for analysis. The study seeks to show how much these two simulators are similar and how different in their characteristics, what neural networks is suitable to be made by them, what are their advantages and disadvantages, how they can be used interchangeably to give certain desired result.

Keywords: neural network, neural network simulator, data set, training set, neural network architecture

Comparative analysis of simulators for neural networks Joone and NeuroPh

E Zdravkova, N Nenkov

Computer Modelling & New Technologies 2016 ***20****(1) 16-20*

This paper describes a comparative analysis of two simulator neural networks - Joone and NeuroPh. Both simulators are object-oriented and java - based. The analysis seeks to show how much these two simulators are similar and how different in their characteristics, what neural networks is suitable to be made through them, what are their advantages and disadvantages, how they can be used interchangeably to give certain desired result. For the purpose of comparative analysis of both the simulator will be realized logic function, which is not among the standard, and relatively complex and is selected as a combination of several standard logical operations.

Keywords: neural network, neural network simulator, logical function, exclusive OR, neural network architecture

Some issues of expert systems in healthcare and education

N Ibrayeva, A Duisenbyeva, L Atymtayeva

Computer Modelling & New Technologies 2016 ***20****(1) 21-24*

A very significant and essential part of the development of an expert system is the creation of its knowledge base. The knowledge base includes not only the rules and the facts that form a part of the declarative knowledge, but also functions and procedures, which are responsible for the optimization of the algorithms used in the expert system. However, there is no clear and universal idea of creating knowledge base. This thesis will describe the attempt to develop ontology of the creation of knowledge base for different expert systems.

Keywords: expert systems, knowledge base [KB], medicine, education, future profession

NATURE PHENOMENA AND INNOVATIVE ENGINEERING

Jeans instability and hydrodynamic roots of Landau damping

A Ershkovich, A Kiv

Computer Modelling & New Technologies 2016 ***20****(1) 25-26*

Landau damping of Langmuir waves is shown to have hydrodynamic roots, and, in principle, might have been predicted (along with Langmuir waves) several decades earlier, soon after Jeans (1902) paper appeared.

Keywords: Jeans instability, hydrodynamic roots, Landau damping

OPERATION RESEARCH AND DECISION MAKING

Evaluating the strategic directions of innovative development of the shipbuilding industry in Latvia

Yu Kochetkov, B Aliev

Computer Modelling & New Technologies 2016 ***20****(1) 27-32*

The shipbuilding industry in Latvia – the construction, repair and maintenance of ships and boats – plays an important role in the country's economy. In the context of globalization, there is quite tough competition for orders and sales markets among shipbuilding companies of the world at the regional and global levels. Goal of the research – the analysis of the condition of the Latvian shipbuilding industry and the evaluation of main strategic directions of its innovative development. The research has allowed identifying the most important directions of innovative development of the shipbuilding and ship repair industry. It has been found that at present the most topical directions of innovations in the shipbuilding industry are the development of workers' skills and improvement of the marketing system. There is an urgent need for the construction of new production facilities and repair of the existing ones. These main directions of innovations meet the first priority requirements of the industry and are necessary to improve its competitiveness. Without progress in the first three main directions of innovations, the successful development of the industry in all other directions is not possible.

Keywords: shipbuilding industry, innovative development, competitiveness

Comparative analysis of GIS in sight of view of renewable energy sources monitoring

A Y Jakupov

Computer Modelling & New Technologies 2016 ***20****(1) 33-39*

At present there exists a great deal of GIS providing data on renewable energy on local and international level. In case of lack of field measurements the idea of using open source data along with field actinometrical measurements on the certain (or existing) sites seems to be efficient from the point of view of accuracy and costs. An overview of GIS commonly used in Russia and USA is given below. All the data used in the overview is available as project descriptions given on the web portal being discussed. All the systems have been analysed from the point of view of the data used on the portal, visualization tools and maps (wind, solar etc.).

Keywords: renewable energy sources, monitoring, visualization tools, geospatial data

