Approaches to the implementation of information-analytical processes in complex technical-organizational systems

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The Operator of the system (the person who is responsible for the correctness and consistency of data coming into the system), checks input data manually.

The quality of the assessment highly depends on the qualification of the employee performing the data verification. To improve the result, multiple cross-validation by different operators is required. It is not economically feasible when data verification operations are regular.
Incoming data is verified by specially developed subsystem, which operates with the rules of varying complexity.

Thus, for each subject area, it is necessary to develop its own data verification algorithm. The effectiveness of the algorithm highly depends on the experience and competence of the expert, forming the logical conditions for identifying distorted information.
Using this approach verification subsystem should form data-clusters, allowing to fix the "outliers", i.e. significantly different data.

The high efficiency of this approach is manifested when checking incoming information from various measuring devices.

The disadvantages include a significant decrease in the effectiveness of the approach when significantly different (for example, archival) information is received in the system.
The technological basis of this group of approaches are neural networks, which are hierarchical system consisting of artificial neurons destined for processing information. While interacting, interconnected network elements are capable of solving problems and checking and correcting data, in situations there the approaches described above, have a little effectiveness.

Disadvantages of that group of approaches are high demands on the skills and experience of the developers.
Comparison of approaches to implementation of data verification subsystem

<table>
<thead>
<tr>
<th></th>
<th>Manual</th>
<th>Automated</th>
<th>Data clustering</th>
<th>Neural Network Approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Efficiency copy</strong></td>
<td>Depends on qualifications</td>
<td>Depends on the type of possible incoming data errors</td>
<td>Depends on the type of possible incoming data errors</td>
<td>High</td>
</tr>
<tr>
<td><strong>Performance when working with large amounts of data</strong></td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Development cost</strong></td>
<td>Low</td>
<td>Low</td>
<td>Average</td>
<td>High</td>
</tr>
</tbody>
</table>
Implementation of information-analytical processes by developers in the program code of the system

Algorithms of information-analytical processes are formed by experts based on existing documentation, techniques, personal experience. Then, a knowledge engineer, interacting with an expert, forms a technical task for developers who implement the generated algorithms in the program code of the system.

The disadvantages of this approach include semantic gaps in the transfer of information from an expert to a knowledge engineer and from a knowledge engineer to developers.
System developers are creating an interface: program syntactic structure, identifying the relations between objects. Than designing of a classes and developing of an interfaces is tantamount to developing a specification (the set of methods that each class using an interface must implement). The expert creates a class that must inherit from this interface and methods of the class and it sets the logic of the information-analytical process.
Developers create a software-instrumental environment based on the ontological approach (tools can operate on the informational entities of the system), and the expert, using the capabilities of the environment that implement the principles of linear programming and include basic algorithmic constructs, forms informational and analytical processes.
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#### Implementation of information and analytical processes by experts in the software and instrumental environment of the system

<table>
<thead>
<tr>
<th></th>
<th>Implementation by developers in the program code of the system</th>
<th>Implementation by experts in the program code of the system</th>
<th>Implementation by experts in the software-instrumental environment of the system</th>
</tr>
</thead>
<tbody>
<tr>
<td>The level of expert’s programming skill</td>
<td>Missing</td>
<td>Tall</td>
<td>Base</td>
</tr>
<tr>
<td>Security</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Developer dependence</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>The complexity of developing specialized software</td>
<td>Missing</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Versatility and flexibility</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>
Comparison of approaches to implementation of evaluation of the results of information-analytical processes

<table>
<thead>
<tr>
<th></th>
<th>Calculation on request</th>
<th>Calculation in the background</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time to obtain result</strong></td>
<td>Depends on complexity, as a rule, much higher than when calculating in the background</td>
<td>Equal to data reading time</td>
</tr>
<tr>
<td><strong>Data relevance</strong></td>
<td>Data is always up to date.</td>
<td>Update within a few minutes</td>
</tr>
<tr>
<td><strong>Development cost</strong></td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>
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System implementation example

Based on years of experience and analysis of the existing systems for industrial safety, specialists of the enterprise ZAO «GIAP-DISTcenter» had set up the following tasks:

✓ the information system should be cross-platform;
✓ the expert himself should be able to set and adjust the logic for calculating analytical parameters;
✓ the values of the analytical parameters should be updated within 3 hours.

To verify the correctness of the data, a neural network approach was chosen and the subsystem «Neural Network Supervisor» was implemented.

Ontological and analytical components form a software-instrumental environment for the implementing of the information-analytical processes.

The results of information-analytical processes can be calculated both on request and in the background, using the subsystem «Process queue».
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Components of the software-instrumental environment

- Ontological component
  - Type tree
    - Enumerations
    - Directories

- Analytical component
  - Internal language
  - Processes queue
  - Neural Supervisor
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Screen form «Type tree» environment
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The «Internal language» screen form environment

```
doc = if ( empty (@Документы (ссылки)), return (NULL), @Документы (ссылки) );
cont = count ( array (doc));
i = 0;
r = array (i);
mark (rela);
d = elem (doc,i);
typeD = if (d.@Тип документа = = str (Протокол),true, goto (i));
pr = if ( empty (d.@Вид контроля), goto (i), if (d.@Вид контроля = = str (УЗТ),true, goto (i)));
date = if ( empty (d.@Дата составления), str (Нет даты ) + d.
@Номер документа,d.@Дата составления + str (i));
r = array (r,date);
mark (i);
i = i + 1;
isEnd = if (i < cont, goto (rela));
pr = if ( empty (r), return ( array ( str ( - ))), sort (r));
```
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Neural Supervisor

A neural network data correctness control module “Neural Network Supervisor” was developed, which allows to improve the quality of input data and tightening control over the results of analytical calculations. After the implementation of the Neural Network Supervisor module, it was possible to reduce the amount of incorrect data in the system by 19%. If a problem is detected, authorized users will receive a notification.

Warning

Received value -7 in object 1 from sensor 2. This value is suspicious. Is it true?

[NO] [YES]
Conclusion

- The approaches to verification of data correctness and approaches to the implementation of models of information-analytical processes and their processing options are considered.

- The only right choice is unavailable, and, usually, only the combination of the considered approaches can be the right choice.

- The example of implementation of the information-analysis process system, comprising a neural network approach to validating information, and approach to the implementation of analytical information and processes in the software-instrumental environment was considered.
Thank you for attention!

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