Intelligent system of planning support and project management

A Piskarev and N Zarikovskaya

SoftInform LLC, Tomsk, Russia, 634055

E-mail: artemeugpiskarev@gmail.com

Abstract. The article describes implementation of an intelligent system that aims to solving planning and project management tasks. There are neuromorphic algorithms and deep machine learning in the solution's fundament. Also there is a description of the developed product and its characteristics, as well as its component implementation scheme is considered.

1. Introduction

In the conditions of the modern market, automated project management systems are used for prompt decision-making when carrying out projects at enterprises of all sectors and scales. Project management is an interdisciplinary and multicomponent activity for managing goals, time, cost, resources, team, risks, and project integration. It is impossible to carry out such activities qualitatively without the use of automation tools. Modern projects and conditions for their implementation are becoming more complicated, the range of tasks solved in them is expanding, and current existing software for project management does not cover the whole range of issues assigned to them.

For many years of experience in solving planning and project management tasks, an extensive database of historical data has accumulated (actual project status and results, costs and resources used for each type of activity), which is the so-called "Big Data" and can be used to develop prognostic models using machine learning methods such as neural networks, decision trees, and more. The first attempts to create systems with artificial intelligence support for solving planning and project management tasks were made in the second half of the twentieth century and were mainly represented by expert systems that resolved the issues of "What if?". Thanks to the development of computing power and reduction of data storage costs, over the last decade, interest in solving project management problems has increased with the possibility of using deep learning methods based on neural networks. The modern application of machine learning methods has found itself in various areas of project management – quality, resources, risks, time, planning tasks, work, communications, budget and knowledge bases – and are full-fledged virtual assistants-agents that model human behavior and activities. Virtual assistants are trained based on the best practices of human experience, which allows you to automate complex repetitive processes, detect errors before they occur and save you from routine work, reducing the time and financial costs of finding and implementing a solution to the problem. The application of artificial intelligence to project activities has a lot of advantages in comparison with traditional paradigms and methods, including the possibility of analyzing various development scenarios in real time, adjusting plans depending on the environmental impacts on the system, reducing and predicting the risks of an existing project, placing orders for materials and equipment, efficient allocation of resources and deadlines, alerts about problems, objective reports and

more, allowing you to make more reasonable and accurate decisions based on precise data analysis and advanced technologies.

2. Related works

A review of more than 100 modern software implementations of the methods by project activities showed that they provide and support a wide range of possibilities for data accounting, communication and solving relevant planning and management tasks. However, most of them, including such popular packages as Wrike, Megaplan, Bitrix24, MeisterTask, MindMeister, Trello, Jira, TeamLab, Wunderlist, GanttProject, GanttPRO, FreeMind, MS Project, MS Planner, Teamwork, Pivotal Tracker, Worksection, ProjectMate, Simple business, Advanta, Spider Project, Horizon, ELMA Projects+, OpenPlan, Cobra, WelcomHome, Welcom-Portfolio, WelcomRisk, Primavera, Rubius Project Manager, mainly rely on traditional approaches, do not cover all the needs for planning and project management, are narrowly focused and tend to create a more colorful and convenient interface, wizard assistants s, managing the sequence of necessary actions, without the support and implementation of artificial intelligence (AI). Despite this, there are many theoretical assumptions and forecasts for the development of the industry due to the integration of neuromorphic algorithms into design activities made in the last 5 years by various design and survey institutes and organizations.

Having a clear idea of the target segment, we can confidently say that a peculiar niche has formed in the current market for using a product with the support of artificial intelligence technologies in planning and project management tasks for design and survey work in construction. The main competitive advantage of the developed system is the support of a modern stack of technologies, scientific methodology and innovative ideas, including deep machine learning, which will provide:

- reduction of time and financial costs for planning;
- improving the accuracy of resource requirements planning;
- forecasting and recommendations for the prevention of risks associated with project activities;
- support for processing natural language information;
- reduction of costs for adaptation of the decision support system in project management, due to the created neuromorphic algorithms and a unified project model.

An extremely important factor affecting the software market is not only the development, but also the promotion of the product. It is easy to notice that the product being created is original, which in turn should ensure the proper demand with competent implementation and promotion.

3. Justification of the proposed solution

In difficult situations, due to a large number of various factors influencing the project life cycle, specialists do not always find the optimal solutions, their opinions are subjective and contradictory. In this case, the probability of an error increases significantly with an increase in the number of factors and frequent changes in their quality and composition, which can lead to irreversible consequences. Based on the foregoing, the solution to existing problems of project management can be the creation of an analytical system based on artificial intelligence and neural network technologies, which will significantly reduce the human factor in the development of control solutions through a comprehensive analysis of production situations and predicting their development in the processes of formation and implementation of optimal modes project management.

The main functions of the existing variety of specialized project management programs are automation of the main processes of calendar and resource planning, linear and network modeling, planning and monitoring the status of work on the project, determining resource requirements and building charts for them. The analysis of the most famous project management software packages showed that they lack the necessary and sufficient support to solve many important issues and tasks: multicriteria and poorly formalized. This will especially affect projects whose planning and implementation is carried out under conditions of incomplete or inaccurate information that requires specialized processing, for example, using the methods of the theory of fuzzy logic and intellectual processing of information.

The rationale for the proposed solutions is supported by the technologies used in the following context. The use of expert systems based on knowledge bases, which can be presented in the form of production models of fuzzy inference, provides for an effective project activity assessment of requirements, duration of work and resource requirements. Using the methods of the theory of fuzzy logic when planning a project, it becomes more reasonable to determine the priorities of the work, tasks and the project as a whole, balance the time costs, assess the risks for modeling the probability distribution. Genetic algorithms allow you to optimize the cost and time parameters of the project life cycle, to minimize total costs with resource restrictions, using various combinations of available data. Artificial neural networks, in turn, can solve almost any optimization problem, including predicting the effectiveness and success of an initiated project, automating the sequence of actions for a project based on functional requirements, determining the type of activity, scope of work, and assessing risks and project scope.

4. Product and its characteristics

The developed product is an automated system for the intellectual analysis of the text of tasks for the project and decision support for managing the life cycle of projects in construction for design and survey work with the ability to scale for various types of human activities, which, by its functional purpose, is an assistant with artificial intelligence for specialists, managers and managers who develop and make decisions in planning and project management tasks.

The developed algorithms and technologies allow us to provide computer support for solving a wide range of tasks of the project life cycle in various initial conditions and make more informed decisions on project management. The proposed solution provides:

- analysis, interpretation and classification of projects;
- determination of the types, composition and content of work;
- assessment of risks and necessary resources for the implementation of the project;
- creating alternative scenarios for the project's work and evaluating their cost and time parameters, building the most feasible network model of the project, determining the optimal duration of the tasks and stages of the work and the project as a whole;
- project management by issuing tasks to units for timely execution of work in accordance with a comprehensive project implementation schedule.

As part of the implementation of these technologies, the following software modules have been developed:

- input, accumulation and storage of data;
- recognition and interpretation of data;
- decision making and visualization of the results of intellectual analysis (as shown in figure 1).
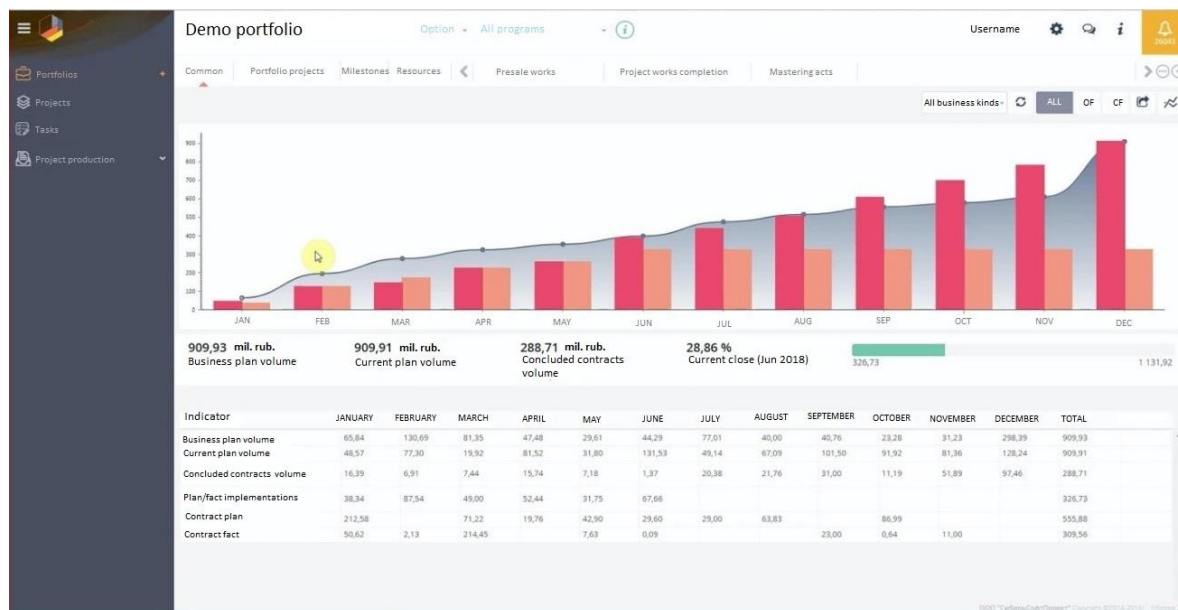
Figure 1. Window of graphical user interface of developed software modules.

The developed system implements an intellectual analysis of textual information presented in the form of an archive of assignments for projects and data on the projects themselves (both successfully completed and not), based on modern methods of neural network technologies, with the help of which the classification of data on projects is ensured, dependencies between various characteristics of projects, predicted time, cost and other criteria that allow you to interpret the list of project activities.

Implementation is accompanied by the creation of a simulation model of the project, which can be adapted to different areas of human activity, which will further expand the range of potential consumers of products. A generalized diagram of the processing process developed by the system of project tasks and actual data is presented in figure 2. Incoming documents and data in them are reduced to a unified project model, classified into various categories and interpreted (parameters, work content, risk assessment are determined). As a result, on the basis of neural network technologies and production models of fuzzy inference, including the results of the intellectual analysis of the project assignment and actual data, a new project model is formed, which will consist of several project management and development scenarios (depending on optimality criteria). Each scenario is a project plan (as a set of individual management plans, including the execution of work) and contains a calendar-network schedule of the project work and reasonable forecast data on the progress of the project.

Actual data that can be provided by an external project management system means information on available: material, financial, human resources and the possibilities of their replacement, counterparty bases, etc.

The development of system algorithms was carried out on the basis of neural network modelling methods that can reduce the influence of the human factor in making the best decisions in the tasks of project activities. The created product also allows you to evaluate the quality and effectiveness of decisions made by a specialist on the basis of various criteria for optimizing resources and to forecast possible consequences. The implementation of the described functions of an automated program complex is ensured by developing a technology for text mining based on machine learning methods and integrating it into a project management decision support system using project management methods, decision theory and fuzzy sets, system analysis and neural network technologies [1]. This will allow to support the solution of a wide range of multicriteria problems that appear during the implementation of the project life cycle in conditions of uncertainty and fuzzy data.
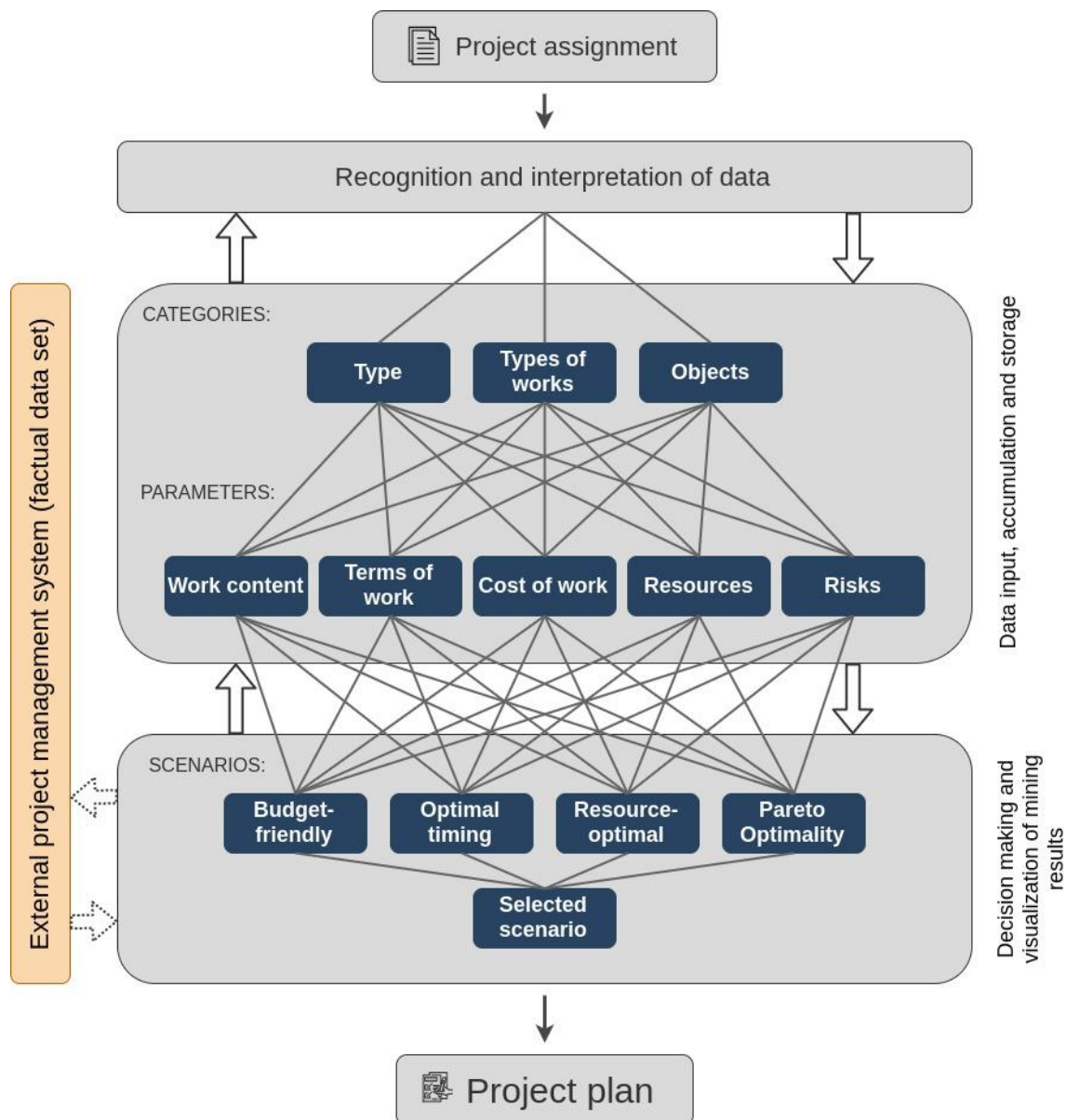
Figure 2. A generalized functional diagram of a system of text mining and decision support based on neuromorphic algorithms and deep machine learning.

5. Component implementation scheme

When implementing the product, the component implementation scheme shown in figure 3 was taken as a basis, which illustrates the methodology for achieving scientific and practical value through the development of mathematical models and their software implementation, including:

- a method for presenting, extracting and processing information from project assignments that is unified for various spheres of human activity based on the methods of intellectual processing of text data and system analysis of regulatory documents, which will allow determining factors and characteristics that affect the project life cycle and planning and management processes;

- a simulation model [2] of the project, obtained on the basis of a unified method of presenting, extracting and processing information from tasks for the project, and representing a set of project parameters divided by categories of influence on the project management process:

project type, types of work, time and financial costs , personnel characteristics, risks and the like;

- a neural network model [1] for interpreting and classifying a project into various categories (for example, type of project, types of work, etc.) based on the mathematical model of the project, deep learning algorithms and intelligent text processing;

- fuzzy decision support systems [3-5] for constructing project management and development scenarios in the form of schedules and a planned list of tasks obtained as a result of evaluating project parameters (resources, timelines, cost) and risks, based on neural network technologies and production fuzzy inference models, including the results of the intellectual analysis of the project assignment and actual data on temporary, human and material resources.
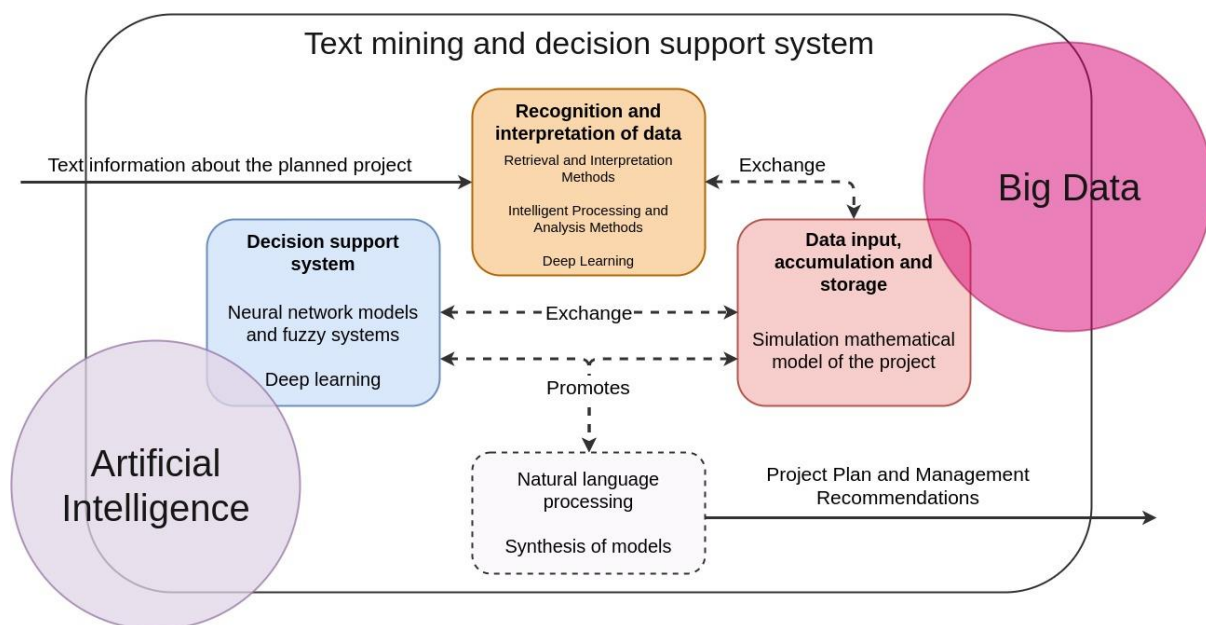

Figure 3. A component diagram of the implementation of a system of text mining and decision support based on neuromorphic algorithms and deep machine learning.

6. Ways to solve the tasks

As part of the project, many different modern algorithms and modelling methods were tested, based on which the optimal ones for the tasks were chosen.

The collection and creation of a database in the form of an archive of assignments for projects and data on the projects themselves was carried out by systematic and statistical analysis of quantitative and qualitative factors affecting the management and development of projects.

The development of neuromorphic artificial intelligence modelling algorithms was carried out on the basis of mathematical statistics methods, pattern recognition theory, fuzzy set theory, as well as numerical methods and neural network technologies, algorithms for deep and genetic training of systems with artificial intelligence support.

When implementing the software product, algorithms for processing text and raster data, computer graphics, the principles of object-oriented design and programming, a modern stack of applied technologies were used.

7. Conclusion

The result of the work is an automated system of text mining and decision support for managing the life cycle of projects for different areas of human activity, which is an assistant with artificial intelligence for specialists, managers and managers who develop and make decisions in planning and project management tasks.

The system described above is implemented as a web application using the client-server architecture and the following technology stack: REST, Django, Tensorflow (Python), React, React Router, Redux, Redux Saga, Axios (JavaScript).

During further work, it is planned to form training, test and control samples based on expert assessment using methods of control theory, interdisciplinary modelling and design, system analysis and intellectual processing of text information, standardization procedures (including stemming) and minimization of feature spaces for describing objects.

References

[1]   Tarkhov D 2014 Neural network models and algorithms. Directory (Radiotekhnika Publishing House), p 352

[2]   Reshmin B 2016 Simulation and control systems. Training manual (Moscow: Infra Engineering), p 74

[3]   Brazovskaya N, Brazovskaya O 2004 Mathematical Methods of Making Management Decisions: A Training Manual (Barnaul: Altai State Technical University named after Polzunov I I, AltGTU), p 153

[4]   Chernov V 2010 Fuzzy decision trees (fuzzy positional games), *Information and control systems* **5** 8-14

[5]   Kulchin Y, Kim A, Notkin B, Lukhter A 2014 The construction of an algorithm of a fuzzy decision tree based on experimental data during processing of RVOIS signals (Informatics and Control Systems, Intellectual Systems)