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TASKS` ANALYSIS OF THE INTELLIGENT SYSTEM CONDUCT OF PROJECT COMPETITIONS

Abstract. *Practical experience with project competitions shows that this is a complex multidimensional task. Competitions are usually characterised by a whole range of features that significantly affect their rules and technology, criteria and forms of evaluation. Objective evaluation of projects requires the involvement of a wide range of experts, which is not always possible. The use of artificial intelligence by humans is a key factor in achieving optimal results in many industries, from business to science and technology. The article is devoted to the problems of building an intelligent decision-making system for project competitions for a wide class of practical problem areas. The article provides an overview of scientific works in this area. The analysis of scientific publications has shown that there are several modes of application of artificial intelligence technologies in human activity, which determine the degree of its use. Based on the practical experience of developing and implementing intelligent systems gained by the authors of this paper, the main problems arising in the process of processing intelligent data are summarised, a number of tasks are identified, and solution schemes are proposed. The stages of competitions that require support by means of an intelligent decision support system are considered in detail. The authors provide a list of tasks that should be formalised in further research, algorithmised, and software should be created to support them. The authors classify these tasks to be solved when creating a system of intellectual support for project competitions. The authors propose to use a scheme of sequential analysis of the options for a set of projects at the stage of preliminary analysis for formal selection of projects. The set of tasks formed by the authors is a prerequisite for further formalisation and development of a mathematical model of the decision-making support task in organising and conducting project competitions The proposed system will ensure a significant increase in the efficiency and objectivity of project competitions.*

Keywords: intelligent decision support system; projects competition; stages of competition

Introduction

The tasks of supporting project competitions are diverse and arise in a wide range of subject areas. Such tasks a priori contain a subjective component, are potentially dangerous for corruption, and often require strict adherence to deadlines.

As a rule, a competition is characterized by a number of features that significantly affect its importance, the accuracy of compliance with the competition rules, the consequences of decisions, the legitimacy of results, etc. Here are just a few of the attributes of contests that are common in many practical situations: high stakes, which are used to distribute among the winners of the competition; ambiguity in the

interpretation of certain definitions, terms, approaches to procedures, etc; vagueness of certain concepts, which can significantly affect the results; subjectivity at all stages of decision-making; high labor costs for organizing the tender, complying with all requirements, maintaining confidentiality, ensuring the reliability of scores, aggregating scores, publishing them, reviewing appeals and satisfying reasonable claims of participants; the possibility of third-party influence on the course of the competition at all stages, which may distort the reliability of the results or raise suspicions about the legitimacy of the competition; the high role of individuals in the results of the competition, which can offset the efforts of entire teams involved in organizing, conducting and participating in the competition; potential dissatisfaction of the tender participants due to reasonable or far-fetched reasons of an objective and subjective nature; possible psychological pressure on the organizers, competition teams, participants and other stakeholders involved in the competition; potentially unequal opportunities for some contestants due to the multitude of connections in society and the possible influence of these connections on the preparation, organization, conduct and summarizing of the contest; ambiguous criteria laid down in the tender regulations, which may allow for manipulation of the selection and other types of unfair practices.

Given the above reasons and in order to minimize the risks of these and other reasons affecting the organization, course and results of the tender, it is extremely important to create an intelligent decision support system in the processes of ensuring the conduct of tenders. Designing, creating, implementing and regularly using such a system will significantly reduce the risks associated with providing support for all stages of tenders in various fields of human activity.дистанційного навчання.

Literature review

The peculiarity of the tasks of organizing and supporting competitions to determine the best projects is that the range of their application is extremely wide. The specificity of such tasks lies in the uniqueness of each particular problem. Despite the fact that the tasks of holding competitions in different industries have many common features, the tools for ensuring them cannot be automatically transferred to other industries. Therefore, virtually every tender is unique, and for each tender, appropriate regulatory support is created at a high management level, approved and requires strict compliance.

We live in an era that is increasingly defined by rapid, large-scale change. Technological advances and the Fourth Industrial Revolution are changing the way we work and the very tasks that professionals perform. Until recently, unskilled or routine tasks were mainly subject to automation. The complication of industrial production, rapid technological progress, a rapid increase in the flow of information, changes in the dynamics of processes in all spheres of human activity, acquisition of information of strategic importance have led to an increase in the need for information and knowledge. These requests led to the emergence of a new type of information systems – intelligent information systems.

Today there are many definitions of intelligent information systems [1; 2]. Intelligent information systems are a type of automated information systems often referred to as "knowledge-based systems". They are complex complexes of software, linguistic and logical-mathematical tools designed to support human activity and search for information in the mode of extended dialogue in natural language [3].

An intelligent information system is a system that provides solutions to informal user tasks in a certain subject area and organises his interaction with a computer in familiar concepts, terms, and images [4].

Intelligent information systems are systems that allow building programmes of purposeful activity in solving their tasks based on the specific situation that is currently developing in the environment. At the same time, intelligent systems should remain operational in the event of unforeseen changes in the properties of the managed object, management objectives or the environment (be adaptive) [5].

Intelligent information systems are complex software products that use artificial intelligence methods and technologies to collect, analyse, process, interpret and use information from various sources to make decisions or automate various tasks [7].

In recent years, the capabilities of intelligent technologies have expanded significantly due to the emergence of new models of knowledge representation, new theories and ideas about artificial intelligence. The use of intelligent information systems can be found in various types of human activity [3–7].

The results of statistical surveys demonstrate the widespread implementation of intelligent systems with AI elements in all areas of human activity.

The results of the IBM Global AI Adoption Index 2023 study, conducted by Morning Consult on behalf of IBM, showed that the adoption of artificial intelligence has remained stable in large organisations over the past few years: 42% of IT professionals in large organisations report that they are actively deploying artificial intelligence, and another 40% are actively exploring this technology; 59% of IT professionals in companies that are deploying or exploring artificial intelligence say their company has accelerated its investment in or deployment of artificial intelligence in the past 24 months; for IT professionals, the two most important changes in AI in recent years are solutions that are easier to deploy (43%) and the increasing prevalence of data, AI and automation skills (42%).

Intelligent information systems accumulate the most knowledge-intensive technologies with a high level of automation not only in the processes of preparing information for decision-making, but also in the processes of developing decision options based on the data received by the information system [7; 8].

The results of a survey [6] show five ways in which humans and AI interact within intelligent systems.

Statistics show that organisations usually implement several modes of human-AI interaction. Organisations that successfully use all five modes are more likely to gain significant financial benefits than those that can use only one or two. In addition, companies benefit most when they increase their expertise in four to five modes (see Figure 1). Broader competencies allow organisations to adapt a wider variety of interaction modes to a greater variety of situations.

The importance and prospects of different modes of cooperation between artificial intelligence and humans lie in the complementarity of their strengths [9–12]. Humans have a unique ability to understand intuitively context and complex situations, while AI can analyse large amounts of data and perform fast computations. The combination of these abilities allows for more accurate and efficient solutions Moodle.

Purpose of the article

The purpose of this work is to analyze the features of project contests from a wide range of subject areas, formulate generalized technology and stages of conducting contests, determine the functions and tasks of an intellectual system for organizing and conducting contests.

The main material of the article

The authors believe that in order for an information system to have signs of intelligence, it can obtain intelligent features from one or more sources from the following list:

- Using the intelligence of analysts and experts. Their knowledge, through formalization and appropriate processing, is integrated into the algorithmic support of computer systems [13; 14].
- Expert decision-making and data processing technologies [15; 16]. Expert evaluation of alternatives, in particular its subset "Processing and convolution of partial evaluations" and "Multidimensional scaling of pairwise comparison results"; simulation modeling based on semantic networks.
- Use of artificial intelligence methods [17; 18]. Modeling the biological basis of human intellectual activity (for example, using artificial neural networks).
- Evolutionary foundations of the development of biological systems [19]. It is used, in particular, in the form of genetic algorithms.
- Fundamentals of the logic of human thinking [20; 21]. Modeling using the theory of fuzzy sets and measures, as well as by organizing fuzzy inference systems.
- The results of research by knowledge engineers used in the generation and accumulation of knowledge, as well as in data processing [21; 22].
- Statistical methods of data analysis [23; 24]. Correlation, regression, variance, discriminant, factor, cluster and other types of analysis.
- OLAP, online analytical processing [25; 26]. Real-time analytical processing is an interactive system that allows you to view various summaries of multidimensional data: results are obtained within seconds, without a long wait for the query result.
- Data Mining [27; 28]. Data mining, business analysis, deep data analysis, analysis of large databases to find useful facts: previously unknown, non-trivial, interpretable facts.
- Machine Learning [29; 30]. Algorithms for building databases and rule trees, building associative rules, Bayesian networks, etc.

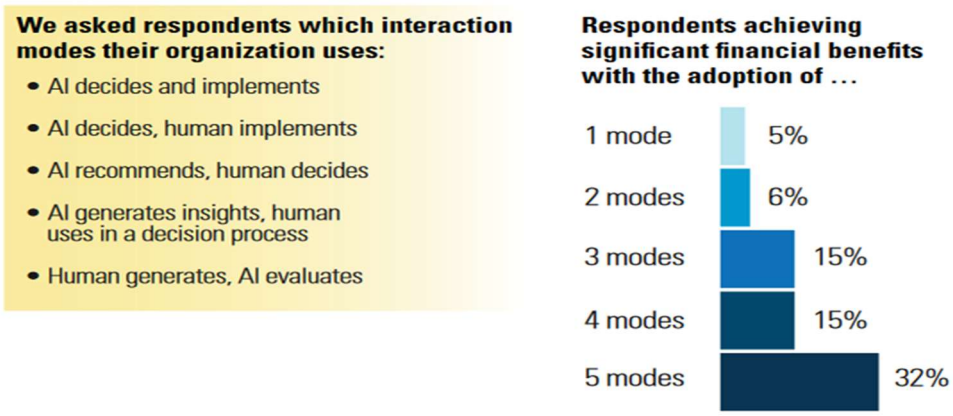

Figure 1 – Percentage of leaders who reported success in each mode [6]

The computer system, the concept of which is presented in this study, is intelligent because its creation and operation involves the use of several sources of intelligence: extensive use of the intelligence of analysts and experts; application of expert decision-making and data processing technologies; use of artificial intelligence methods at various stages of the creation and operation of an intelligent system; application of evolutionary algorithms in the development and improvement of certain subsystems; formalizing the interaction of various actors in the course of competitions and using the basics of human thinking; widespread use of statistical methods of data analysis to reliably determine the quality of projects submitted for consideration and evaluate them on cardinal measurement scales; use of machine learning methods in those program modules where it is appropriate and effective.

According to the authors, the main problems that arise when creating intelligent systems include the following: the theoretical foundations for the creation of algorithmic tools and software components of computer systems for intelligent data processing are not sufficiently developed; the problem of correct and adequate formalization and presentation of the results of knowledge engineering in computer systems has not been solved; the results of data processing often do not lead to the extraction of dependencies of sufficient specificity and usefulness for active agents of organizational and technical complexes and systems; almost every software component for intelligent data processing is developed to perform a specific data analysis task; there is no universal methodology for solving a wide range of problems.

It is necessary to generalize heterogeneous mathematical and algorithmic methods for extracting hidden dependencies from data, which are necessary for forecasting and supporting decision-making in organizational and technical complexes and systems.

Expert technologies are not developing at a fast enough pace.

Insufficient interaction between specialists in psychology, mathematics, economics, and business.

The generalized technology of conducting competitions involves the following stages: preparation (including preliminary and preparatory stages), conducting, summarizing and analysis.

Tasks of the preliminary stage

The peculiarity of automating the complex of tasks related to the organization of tenders is that almost every tender is unique. The importance of this area of research is influenced by such factors as the significant finances involved in this activity; the participation of large teams of specialists to ensure the conduct of and participation in tenders, long terms of tenders, etc.

The main tasks of the preliminary stage of the competition, which require detailing, formalization, further description and development of the relevant software: automated creation of the tender structure according to the approved tender regulations, definition of the roles of all stakeholders, creation of an oriented schedule for all stages of the tender; building a matrix of relationships between the contestants: places of work, co-authorship, direct and indirect influences; dormalizing the history of the contestants' participation in previous competitions, facts of losses, awards, etc; building a rating of contestants and contest managers based on the following characteristics: management of participants in previous competitions, participation in competitions as an expert, places taken in previous competitions, ratio of positive expert opinions to projects that lost previous competitions; consistent analysis and screening of projects among the set of projects participating in the competition.

Tasks of the preparatory stage

List of the main tasks of the preparatory stage of the competition:

- the selection of a group of experts is an independent task, and can be either a one-time process or a regular procedure with the identification and consideration of the dynamics of experts' performance, etc;
- distribution of projects of the contest participants among experts based on different approaches: randomly, by the degree of coincidence of keywords in publications;
- distribution of projects of the contest participants among experts based on different approaches: randomly, by the degree of coincidence of keywords in publications;
- ensuring the identification of conflicts of interest and minimizing their impact on the organization and conduct of the tender;
- determining the weighting coefficients of consultants involved in the organization of the expert evaluation in order to regulate the impact of their assessments on the results of the expert evaluation;
- bringing the ratings received from experts to a single scale by further structuring the overall scale, i.e., using sub-criteria scales;
- minimize the possibility of manipulating the assessment and the resulting score when aggregating individual expert opinions;
- application of preferential voting procedures to determine the characteristics of the expert group, its structuring, identification of coalitions of experts, etc;
- procedures for determining the limits of experts' competence through self-assessment, mutual assessment of experts, analysis of keywords in studies, a posteriori determination of the quality of assessment, etc;
- training sessions for experts to determine the level of their confidence in their assessments;

- determination of quantitative values of the coefficients of good faith, integrity, adequacy or manipulation of expert assessments;
- determination of coefficients of relative competence of experts – documentary, a priori and a posteriori;
- using of testing tasks to determine the aggregate scores of both contestants and experts;
- building and applying a neural network to identify experts who tend to overestimate, underestimate, or be neutral;
- constructing functions for a fuzzy set that reflect the degree of propensity of experts to make adequate assessments or deviations from the collective resulting assessment.

Tasks of the main stage

The main stage of the competition plays an important role in the quality organization, full support, adequate conduct of the competition and fair summarization of its results. Here are the tasks of the main stage of the competition: Ensuring the confidentiality of the competition participants and the anonymity of the expert evaluation of the projects submitted to the competition by using, in particular, double secret evaluation; use of procedures for smoothing individual expert opinions, crushing measurement scales, and other standard practices to minimize conflicts; use of structured expert evaluation schemes with a mandatory determination of the level of confidence of the expert in the adequacy of his or her assessment; a procedure for regular but tactful reminders to tenderers of deadlines for performing their functions by all available means of communication;identification and application of administrative levers to ensure that the competition team fully performs its functions of organizing and conducting the competition, and to ensure temporary functional subordination of the competition team; providing anonymous feedback to all participants of the competition, which is an important factor in timely information, minimizing conflicts, constructive decision-making, initiating a dialogue if necessary, etc; automatic checking of the use of any materials related to the websites of the aggressor country, detection of links to the authors of the aggressor country, etc; automated determination of the area of research, the industry to which the project belongs, based on the use of NLP and the calculation of text similarity measures; determining the quality indicators of the review of projects submitted for the competition based on the comments provided by experts or their absence – identifying the attitude to the review procedure, for example, using sentiment analysis; automated checking of papers for plagiarism and application of anti-plagiarism procedures; apply additional evaluation of projects based on participants' reports and obtain evaluations from a wider range of listeners; automated evaluation of project managers by formally assessing the structure of the project description against the description requirements specified in the call for proposals, for example, by identifying text reference points; Formalizing the rules for engaging additional experts in the evaluation of controversial projects for which standard procedures were not sufficient.

Tasks of the final stage

The need for reasonable formalization and justified application of certain tasks also arises at the final stage of competitions, when summarizing the results of this important, comprehensive and responsible process. Here are some of the tasks that are relevant at the final stage of the competition: determining the aggregate score for each project and justifying the use of convolutions that should be applied to obtain the final aggregate score for each project and each bidder; formalization and determination of the level of adequacy or degree of unreasonableness of expert evaluation of projects; determining the coefficients of leniency, unreasonable rigor, or irresponsibility of individual experts in evaluating projects; static and dynamic tasks of identifying formal indicators of the adequacy of project evaluation; determining the threshold for evaluating the rejection of weak projects based on the axiom that subjective assessments are constructive only when compared to the set of all submitted projects. Tasks of the tender analysis stage.

An important and necessary condition for the constructive completion of any competition is the formulation, formalization and solution of the tasks of analyzing the competition. Among the tasks of this stage, the most important and relevant ones should be noted:

- determination of the levels of consistency of expert assessments of each project in an independent secret evaluation by experts;
- determining the level of consistency of each expert's assessments when evaluating projects – if the expert's assessments of all current projects are stable, his or her weight may be reduced, as the heuristic of the normal distribution of project quality applies;
- estimation of permissible fines and additional rewards for evaluated projects for a correct expert assessment issued without manipulation;
- developing a procedure for stabilizing the benefits to determine a generalized assessment of each project based on the levels of competence and integrity of experts.

The assembled set of tasks forms the basis for further formalization and the development of an informational and mathematical model for a decision support system for organizing and conducting project competitions.

Conclusions

The tasks of supporting the conduct of project competitions are diverse and arise in a wide range of subject areas. The task of automating the conduct of project tenders is complex and multifaceted.

Based on the authors' analysis of project tendering schemes, a generalized tendering technology, highlighted stages and their main characteristics are proposed. Considered the possibilities of using artificial intelligence tools to increase the efficiency and objectivity of such competitions.

The authors defined a range of tasks that require formalization, algorithmization and creation of software within the framework of the automated system of conducting project competitions.

The set of problems formed by the authors is a prerequisite for further formalization and development of a mathematical model of decision-making support in the organization and conduct of project competitions. The proposed system will increase the efficiency and objectivity of project tenders.

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АНАЛІЗ ЗАДАЧ ІНТЕЛЕКТУАЛЬНОЇ СИСТЕМИ ПРОВЕДЕННЯ КОНКУРСІВ ПРОЄКТІВ

Анотація. *Практичний досвід проведення конкурсів проєктів засвідчує, що це складна багатовимірна задача. Конкурси, як правило, характеризуються багатьма особливостями, які суттєво впливають на правила і технологію їх проведення, критерії та форми оцінювання. Об'єктивне оцінювання проєктів вимагає залучення широкого кола експертів, що не завжди можливо. Використання штучного інтелекту людиною є ключовим фактором досягнення оптимальних результатів у багатьох галузях, від бізнесу до науки і техніки. Стаття присвячена проблемам побудови інтелектуальної системи прийняття рішень для конкурсів*

проєктів для широкого класу практичних проблемних областей. У статті наведено огляд наукових праць у цій галузі. Аналіз наукових публікацій засвідчив, що є декілька режимів застосування технологій штучного інтелекту в діяльності людини, які визначають ступінь його використання. На основі практичного досвіду розроблення та впровадження інтелектуальних систем, отриманого авторами цієї статті, узагальнено основні проблеми, що виникають у процесі обробки інтелектуальних даних, визначено низку завдань та запропоновано схеми їх вирішення. Детально розглянуто етапи проведення змагань, які потребують підтримки за допомогою інтелектуальної системи підтримки прийняття рішень. Наведено перелік завдань, які необхідно формалізувати в подальших дослідженнях, алгоритмізувати та створити програмне забезпечення для їх підтримки. Здійснено класифікацію цих завдань, які необхідно вирішити у процесі створення системи інтелектуальної підтримки проєктних конкурсів. Для формального відбору проєктів пропонується використовувати схему послідовного аналізу варіантів множини проєктів на етапі попереднього аналізу. Сформований авторами комплекс завдань є передумовою для подальшої формалізації та розробки математичної моделі для задачі підтримки прийняття рішень під час організації та проведення конкурсів проєктів. Запропонована система забезпечить суттєве підвищення ефективності й об'єктивності проведення конкурсів проєктів.

Ключові слова: інтелектуальна система підтримки прийняття рішень; конкурс проєктів; етапи конкурсу

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