INTELLIGENCE INFORMATION TECHNOLOGIES IN EMERGENCY MANAGEMENT ENVIRONMENTAL TASKS

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Abstract

Methodological issues of applying the systems approach using Knowledge Based Systems, Data Mining KDD (Knowledge Discovery in Databases) technologies to develop multidisciplinary integrated methods, and algorithms for the efficient use of large information volumes as applied to emergency management are considered.

Analytical methods in the field of mining the knowledge from raw data (data mining) are possible; they can increase capacity, reduce expenses and increase efficiency of the observation system for natural ambience.

These are considered using data mining technologies in a world ocean information problem. Some data mining algorithms are reviewed through examples of the "PolyAnalyst" software system. They are analyzed from point of view of their applicability to different types and volumes of the oceanography data.

We also discuss using the systems approach in problems of the development of technology and methods to system integration heterogeneous processes and information analysis for operative decisions support in emergency situations with the usage of the intellectual methods and computer modeling.

As an example of this approach we consider the APEC project. We discuss building an enlarged set of risk management decision support tools for evaluation and mitigation of the consequences of a terrorism attack and to demonstrate and develop skills among participants with new technologies in Geographical Information Systems, simulation and modeling of hazards and risks, and collaboration using high band-width video-teleconferencing.

Introduction

The emergency situations caused naturally and those for anthropogenesis reasons (including terrorism, SARS) are increasingly significant problems in our lives. The typical particularity of the studies presented this paper is a systems approach to considered to problem which includes a whole cycle information handling from input flow to final decision making. We have named this approach "Information Modeling Method" [Gelovani, 1980]. Recent achievements in the development of knowledge based systems (i.e., artificial intelligence systems, expert systems),

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and decision making computer methods have enhanced the capability of problem managing systems, allowing the reduction of consequences of various emergency situations by integrating experience in decision making, management and undertaking action in condition emergency situations [Gelovani, 2001].

We consider methodological issues of the use the system approach using Knowledge Based Systems, Data Mining KDD (Knowledge Discovery in Databases) technologies for development multidisciplinary integrated methods, algorithms for the efficient use of large information volumes. Using analytical methods derived in the field of mining the knowledge from raw data (data mining) it is possible to raise capacity, reduce expenses and increase efficiency of systems for the observation for natural ambience.

We consider the usage of data mining technologies in a World ocean information problem. Some data mining algorithms are stated as an example of the "PolyAnalyst" software system [Arseniev, (1997)]. They are analyzed from point of view of their applicability to different types and volumes of the oceanography data. We also considered problems using the system approach in problem to develop technology and methods for system integration of heterogeneous processes and information analysis for the operative decisions support in emergency situation with the usage of the intellectual methods and computer modeling.

As an example of this approach we consider the APEC project, which can be done by building an enlarged set of risk management decision support tools for evaluation and mitigation of the consequences of terrorism attacks and to demonstrate and develop skills among participants with new technologies in Geographical Information Systems, simulation and modeling of hazards and risks, and collaboration using high band-width video-teleconferencing.

In this paper we concentrate on decision making system development, founded on knowledge for use in emergency situation. Specifically the methodology proposed results from a multidisciplinary approach to the creation of an intellectual decision support system [Britkov, 1988], allowing the realization of efficient methods for application in the field of emergency management that are characterized by large volumes of information to analyze, poorly formalized procedure for inference in decision making and difficulty of the use the traditional multicriterial methods for optimization. Such emergency situations relate to many of the current problems: terrorism, high water and floods. These require the development and extension of existing methods for decision making and management.

The methodology reported here can be considered as continuation of efforts on system integration of computer operations and verbal lessons at a new modern level. The methods have significant importance to system integration which will allow uniting the developer efforts of various different systems. Continuously efficient systems result when there is possibility to integrate subsystems for decision making problems created in various times by various specialists using different software. In this case the resulting meta system is based on knowledge of the various people and different scientific disciplines. As a result of using this systems approach we achieve multidisciplinary knowledge [5-6], and in the same way as in traditional scientific world achieve the implementation of general use languages of descriptions and new and different decision methods in application problems. [Britkov, 1991].

The author is presenting on behalf of a group with a significant length of service and experience in informatics used for decision making. These are able to process large volumes of poor quality information, and the group has developed methods for implementing intellectual information systems that study the natural ambience processes. The group has developed a series of applied systems in this area. These are discussed in monographs considering the problem of integrating different aspect of building decision support systems in series of application domains.

The methods have great importance for system integration; they allow the efforts of different systems developers to be united. Efficient and stable systems appear when there is integration of subsystems for decision making analysis problems even if they were created in miscellaneous times by different specialists in the field of informatics, decision-making, hydrology, economy, social sciences, and transport, and on different software systems. In this case the systems, founded on knowledge of the miscellaneous of the people and different scientific discipline. As a result of using this system approach achieves the междисциплинарные of knowledge in the same way as in traditional scientific world once the problems are described in a general use context. This allows different languages, descriptions, and different methods of problem decision.

Intelligence information technology in emergency management

The key factor in emergency management is an operative's efficiently taking the correct decisions. However this quite often involves enormous volumes and complex data structures requiring processing with urgency.

Traditional access by a user to a data vault results in extraction of only small part from stored information in response to clearly assigned questions. But, when we have an enormous flow to information, we need to implement a process to use this information volume to extract hidden in data knowledge to optimize process control in an emergency situation. This task can be not solved just by a person because the gigantic volume of information leads to economic and decision inefficiency. Besides included analyst results are not always objective since people follow some considerations and a priori beliefs about subject under study.

The methods of "data mining" allow reducing the challenge of the problem. Using analytical methods in the field of mining knowledge from various sources of possibly unusual data, many organizations are able to enlarge profit, increase power, reduce expenses and improve client satisfaction. They are already used actively at analyzing markets, marketing, forecasting stock values and other business-applications. Today these methods interest the commercial enterprises discovering projects information from scanning data vaults (Data Warehousing).

Correlating various information is possible due to the volume and speeds to computer memories and the application of artificial intelligence systems KDD (Knowledge Discovery in Databases) - systems for the extraction of the knowledge from databases.

Using KDD systems requires a skilled director of the exploratory tasks since their directions must match logic and intuitive analysis. The key to successful using KDD methods is not a simple choice one or several KDD algorithms; it requires the skill of the analyst. Thus Data Mining does not obviate the need for specific knowledge of the application domain and understanding themselves data and the analytical methods.

Knowledge discovery in databases is an analytical processing of a large volume of data using automatic analysis to find information hidden in data structures or dependencies. It requires full or partial absence of a priori beliefs about nature of the hidden structures and dependencies. KDD includes the preliminary comprehension and incomplete wording of the task (in terms of target variables), possible transformations for automated analysis format and their preprocessing to find automatically these hidden structures or dependencies, and the approbation of the discovered models on new information not previously used for building the model's data and interpretation by the person of the models discovered.

Data mining is thus a study and finding "machine" (i.e., algorithm or facility of artificial intelligence) in dark and hidden structures or dependencies, which:

- earlier were not known,
- are not trivial,
- are practically useful,

- require interpretation by skilled individuals.

As a whole data mining technology exactly is defined as a process of the finding in the dark earlier unknown, nontrivial, practically useful and available interpretation of knowledge required for decision making in different sphere of emergency management. Any cognition presents itself as modeling of emergency situations. The Model – an artificially created system - reflects resemblance of the structure and functions of the original system. There are two types of models: prediction and descriptive. The first uses a given set with known results for building models; this obviously predicts the results when applied to other data sets. The second describes the dependencies in existing data. The resulting model will not be able to pretend any absolute knowledge, but will give the analyst certain advantage of the finding facts by alternative statistical significant models.

In the task of the model building, it is possible to identify two important sub ranges. The first is task categorizations - referring a new object to some class from the ensemble already available in the database given information about some other objects in these classes. The second sub range forms the tasks to forecast of some stable numeric parameters.

One of the key issues of the information modeling approach is the system integration of all possible relevant tools and systems, including GDIN (The Global Disaster Information Network.) GDIN is a public-private partnership with the primary objective of getting the *Right Information, to the Right People, On Time* in order to make the Right Decision, so as to help mitigate and effectively respond to the toll of natural and man-made disasters around the world.

Methodological Problems of Information Modeling in Emergency Management

One of the very important problems for emergency management is to increase capacity by building an enlarged set of risk-management decision support tools and procedures for standardized evaluation and mitigation of the consequences. The first point is emphasize (1) the use of a Geographic Information System to create a notional port city with air, rail and marine transportation facilities and demonstrate the notional relative proximity of critical infrastructure, (2) identification of hazard simulation and modeling tools to both superposing damage footprints across critical infrastructure and demonstrate potential consequences to the community, and (3) demonstration and econometric model evaluation of alternative mitigation and causal chain intervention strategies that are proposed by various economies. To facilitate collaboration among a maximal number of economies, high bandwidth video teleconferencing with streaming video will be used to minimize transportation costs of participants and mutually demonstrate web-accessible mapping, simulation and modeling techniques currently used by various economies.

The task is to assemble a web-accessible toolbox of hazard models and decision support simulations with using of GIS notional port communities with critical infrastructure and cross-linked hazards. It is very important to develop econometric models that can be used as decision-support tools in evaluating the relative merit of alternative strategies of mitigation, response and recovery from various types of terrorist attacks.

A key feature of this case study is collaboration over a high-bandwidth video-teleconference system. As an overall objective, analysis tools and procedures would be exportable and adaptable for mutual use by any individual economy in assessing their own economy's vulnerabilities, conducting their own terrorist attack consequence mitigation program and increasing the abilities of their own communities to survive and recover from terrorist attack. A list would also be compiled of sources for GIS hazard mapping products and video-telecommunication sites among the various economies, encouraging mutual assistance and continued collaboration [Britkov, 2002].

Information modeling in emergency management on example of oceanography information

We are developing an emergency management information decision support system as an information resource about world oceans. It will integrate to heterogeneous information and provide flexible intellectual facilities to process the given information ambience.

The key task is to validate the information base for monitoring and forecasting global and regional change in the natural ambience and climate, modeling of the climate etc. Implementing an information system about natural ambience will allow us to solve a series of problems that emerge as we analyze the processes, founded on oceanography information, influences of the change the climate, forecast of the condition of the ocean and atmosphere, etc. As a result this will facilitate the on-line access to the meta database, accessible by Web site from many sources and integrated databases -uniting different data types (numerical, spatial, graphic and others) given types of the observations (the physical oceanography, sea meteorology, currents, coast observations and others.). The integrated database is built on instrumental software programs DBMS, GIS, Web browsers. Development of such service modes will allow: greatly increased access speeds to information about the condition of the natural ambience, greatly increased mix of the users because of the simplification of the interface and allowing functioning by internet browser. This will provide information on sea parameters compatible with the other databases, and will proved a central site for reception of new knowledge; this will in turn greatly increase the circle of contributing users. The results will be an information facility integrating an information system designed using modern technologies for keeping, searching, accessing and primary processing oceanography information. It will provide: maps of the surface temperature of the waters, graphs of the change the temperature of the water, air, saltiness, level of water and other parameters of ambience; and forecasts of the temperature of the air for seaports.

Conclusion

We expect the data mining tools to render a research benefits through revealing the hidden knowledge in data. The resulting models will be possible to use both for prediction of future importance, and for description of current conditions. The result of using these methods to find new knowledge can reveal more in broader spectrum. However the systems and realizing algorithms for mining knowledge can not entirely obviate the need for an objective analystwho must understand the application domain, the data themselves, the general nature of analytical methods and must possess the ability to interpret the results.

Problems arising at practical mining, tracking, actualization and usage of the information from computer intelligence systems must be considered. Behind establishing frameworks of material there were a number of other problems, such as filtering input information, the principles and methods of analysis with the inexact information, interaction with raw and aggregated information. The statement of these problems is connected, first of all, to practical activity with intelligence systems. Many of these problems arise from actual use experience and hardly can be solved beforehand. The solution of these problems is very important and requires successful use of intelligence systems for decision-making in composite situations. There are not “off the shelf” for developing these systems. The existing methodologies of designing and creation of the integrated intelligence systems are calculated on much more formalized objects which are not unique and envision duplicating. Development requires constant methodological tracking of project evolution, acceptance of both implementation of the “soft” solutions and “fuzzy” approaches which will allow integration of new technological and system solutions that appear during project development.

To extend the possibilities of data management systems, this requires analysis and submission of the information, inclusion of statistical analysis in the program systems, classification and recognition, methods of an artificial intelligence for the analysis and interpretation of results of

processing. There is basis to expect that the further development of geo information systems will occur just in this direction.

The development of modern tools for analysis of environmental information and use of geographic information intellectual systems requires expansion of the system spectrum taking into account problems that need forecasting for development of technical and software programs which can be used for analysis environmental situations. For this it is necessary to extend the possible data management system, and facilities for analysis and presentations of information, including program systems for statistical analysis categorization and recognitions, methods of the artificial intelligence for analysis and interpretation result processing. There is basis to expect that the greatest advances will come from distributing universal tools by the internet. This will also require new knowledge-based tools for the processing and analysis of environmental data.

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