POSSIBILITIES OF IMMUNE INTELLIGENT SYSTEMS APPLICATION FOR INFORMATION SYSTEM ON RAILWAY

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Abstract. *The paper considers the concept of "intelligent immune algorithms" in the context of rail transport data processing. The article examines the data flow involved in the processing of transit railcars with processing at the marshalling yard. Typical business processes are described. Errors encountered when interpreting the data by typical business processes are classified. The principles of immune intelligent systems functioning are described. The possibility of using such systems for data flow scanning in the ES of JSC "Russian Railways" was considered. When writing the work, such methods as collection and analysis of information, data processing were used. The main conclusion of the work is that the intelligent immune systems are a good way for the development of the infrastructure of the railway transport in the future. The results of scientific research presumably can be used in JSC "Russian Railways" for the design of new information systems.*

Keywords: *immune algorithms, immune intelligent systems, data protection, information security, intrusion detection.*

Immune intelligent systems were first mentioned in the mid-1980s. They were described in the article by Jay Doyne Farmer (American scientist in the field of complex systems, a professor of mathematics at Oxford University), Norman Harry Packard (physicist of chaos theory, is a graduate of Reed College and the University of California, Santa Cruz) [1]. However, it was not until the mid-1990s that IIS became an independent industry. Forrest (negative selection) and Kephart published the first paper on immune systems in 1994, and after that Dasgupta D. did considerable research on negative selection algorithms. In 1999, the first book on artificial immune systems was published under Dasgupta. In 2008, Dasgupta and Nino published a textbook that presents a collection of recent work related to immune-based methods [2].

The purpose of this study is to evaluate the capabilities of IIS when dealing with data in Russian Railways.

The objectives of the research are to:

- To present an overview of immunity-based algorithms;
- Identify problems that could be solved by researching intrusion detection and providing information for identifiers;
- To investigate information on current solutions for immune intelligent systems;
- Investigate the feasibility of applying these systems to railways.

The relevance of the research is that immune systems are currently being successfully applied to data optimization and classification problems, information compression, clustering, anomaly search, machine learning, unstructured data processing and information extraction, computer security and adaptive control. Such a concept can be developed and successfully used in improving the activities of Russian railways.

Results and Discussion

Intelligent immune systems are actively developing in different directions of artificial intelligence use. When implementing them, problems arise that hinder rapid development. It is difficult to achieve one hundred percent correct pattern recognition, to create effective and simple training techniques for intelligent systems, to learn how to process large

amounts of data. It is necessary that the system extracts informative signs from a variety of factors, learns and evaluates the progress of learning [3].

The immune system is a system of biological processes and structures in the body that protects it from infections, viruses, toxins, and malignant cells. For the immune system to work properly, it needs to be able to recognize a wide range of pathogens and distinguish them from the body's own healthy tissues. Many living species have two subsystems: innate and acquired (adaptive) immune systems. One of the main tools of the adaptive immune system is immunological memory, which is why the body is able to develop a stronger immune response to a pathogen when encountered again. Immunological memory is the basis of vaccination [4].

The principle of the body's defense system should be considered; it consists of several points:

1) When foreign particles (antigens) enter the body, B-lymphocytes begin to secrete special antibodies, which are specific proteins capable of blocking the antigen.

2) Next, T-lymphocytes are activated and start secreting cells that can destroy the blocked antigen.

3) The antigen is then memorized, the antibodies produced by the white blood cells remain in the body. This helps prevent a similar infection [5].

Now let us consider the types of cells in the immune system:

T-lymphocytes. There are several types: T-killers kill microorganisms, T-helpers help recognize and kill germs.

B-lymphocytes. Their main purpose is to produce antibodies. Antibodies are the substances that bind to the proteins of microorganisms, inactivate them, and are removed from the human body, thereby killing the infection inside the body.

Neutrophils. They destroy the foreign cell, while also destroying themselves. This is followed by a purulent discharge. A clear example of neutrophils at work is an inflamed skin wound with purulent discharge.

Macrophages. They also destroy germs, but do not destroy and destroy them in themselves or pass them on to T-helpers for recognition.

Eosinophils. Cells that produce substances to destroy parasites in the body. [6]

Let us consider as an organism one of the information systems of JSC Russian Railways ASU ST, and as an incoming stream - the data that enters it.

The ASU ST is a very large, multi-user system that includes a huge amount of data. The data (cells) must be fed to certain workplaces (bodies) and comply with the norm (normalization). At the same time when entering the data into the system a person can misprint or miss something or enter it incorrectly. This in turn could lead to incorrect calculation of indicators and, as a consequence, losses of the company (the organization as a whole). Therefore, we believe that the introduction of IIS in the IS of JSC Russian Railways is relevant.

The system should have the ability to check the entered data for correctness, not to introduce contradictory data or to change them unreasonably. All this is very similar to the human immune system.

An immune intelligent system is an adaptive computing system, uses the models, principles, mechanisms and functions from theoretical immunology, applied to solve the applied problems. An artificial immune system uses affinity measures as a description of the interaction of system components (antibodies) and immune algorithms as adaptation mechanisms [7].

The immune system is of great interest to experts in programming and computer science; it is essentially an example of decentralized information processing, performing a large volume of complex "calculations" in parallel [2].

There are three algorithms for intelligent immune systems, but we will consider two of them. They rely on the theories concerning natural immune systems. These theories describe the interaction of elements in the system and its very functioning:

1) The clonal selection algorithm is a class of algorithms based on the theory of clonal selection [8].

2) Negative selection algorithm – refers to finding and removing negatively reacting cells [2].

An examination of the data associated with trains arriving for processing at the marshalling yard revealed the following anomalies in the data:

1) The appearance of a train without an arrival marker (carriage action starts immediately).

2) Arrival time recorded, but no departure mark.

3) Errors in entering the train geolocation (park number, track number).

4) Repetition of the same operations.

5) Finding two objects on the same track at the same time.

6) Changing data on the cargo, wagon, etc.

Analysis of the data showed that there are errors in the data entry, leading to an incorrect interpretation of the data and the reproduction of processes using neural networks. These errors can be handled by a negative selection algorithm and train the EIS with a clonal algorithm.

The immune intelligent system that is being created should track errors in the existing data and match it to its database. Already existing abnormal data, the system can either delete or suggest options for the user to deal with this data.

To implement the IIS, the decision was made to use multi-agent systems.

A multi-agent system is a system that is formed by several interacting intelligent agents [9]. Usually, these systems are used to solve the problems that are difficult or impossible to solve with a single agent or monolithic system [10].

Agents in a multi-agent system have the characteristics of:

- autonomy (agents are always, at least partially, independent);
- limited representation (no agent has representation of the entire system as a whole);
- decentralization (there are no agents that control the whole system) [11].

As already mentioned, there are several main types of cells in the human immune system: T-lymphocytes, B-lymphocytes, neutrophils, macrophages, eosinophils. And they all perform certain functions of the immune intelligent system. In the creation it is proposed to consider each individual cell type as one agent in a multi-agent system.

Let us consider the main ability of the intellectual system - the ability to recognize correctly (our own) or incorrectly (alien) entered data (antigens) with their subsequent classification and triggering of appropriate defense mechanisms. Also based on the results of recognition, the system will learn and form a memory for the antigen. The knowledge of the antigens will be used when new similar threats arise. The system will create and improve the knowledge base as it works.

Let us find the similarities between the functions of the natural immune system and the main functions our data recognition system should perform:

- detection and logging of events that have the characteristics of an incident;
- incident identification based on a rapid analysis of the situation and decision making under the conditions of incomplete certainty of the available information;
- handling and correcting the consequences of the error by warning the person and removing (replacing) the incorrect data [12].

This system will be designed using immune-multi-agent technology.

Detector agents correspond to macrophages and other antigen-presenting cells that expose antigen particles on their surface, attracting the attention of B-lymphocytes for recognition. Identifying agents correspond to B-lymphocytes that recognize the antigen and have been "negatively selected" in advance in the thymus. Coordinator agents correspond to lymphokines secreted by T-lymphocytes to activate B-lymphocytes. Reactor agents correspond to phagocytes that have antibodies to destroy the antigen.

Let us distinguish the following steps of incident management with an immune intelligent system:

1) Identification by the detection agents of any abnormal input;

2) Recognition of abnormal input as a certain type of incident by the identifying agents, provided the appropriate signature is found in the knowledge base, or identification of the

abnormality with respect to the behavioral reference;

3) The response subsystem receives a signal from the IDS about an identified known or unknown incident;

4) Identification of the attacker's incident threat set, provided there is a correlation in the knowledge base between the characteristics of the received incident signal and the records of the incorrect data sets;

5) Decision-making regarding the selection of an incident-oriented set of protection mechanisms;

6) Issuance of a control signal by the processing subsystem to respondent agents regarding incident handling with an incident-oriented set of protection mechanisms;

For the system to work as a single organism, the agents must provide homeostatic regulation of the system as a whole.

Conclusions

The implementation of IS algorithms is possible using the agent-based technologies, it is the agents that detect errors, each agent performs a different function.

Implementation of this system is planned in the Python programming language.

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ВОЗМОЖНОСТИ ПРИМЕНЕНИЯ ИММУННЫХ ИНТЕЛЛЕКТУАЛЬНЫХ СИСТЕМ ДЛЯ ИНФОРМАЦИОННОЙ СИСТЕМЫ НА ЖЕЛЕЗНОЙ ДОРОГЕ

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Аннотация. *В статье рассматривается концепция «Интеллектуальных иммунных алгоритмов» в контексте обработки данных на железнодорожном транспорте. В статье рассматривается поток данных, связанный с обработкой транзитных железнодорожных вагонов при обработке на сортировочной станции. Описаны типичные бизнес-процессы. Ошибки, возникающие при интерпретации данных с помощью типичных бизнес-процессов, классифицируются. Описаны принципы функционирования иммунных интеллектуальных систем. Была рассмотрена возможность использования таких систем для сканирования потоков данных в ИС ОАО «РЖД». При написании работы использовались такие методы, как сбор и анализ информации, обработка данных. Основной вывод работы заключается в том, что интеллектуальные иммунные системы являются хорошим способом развития инфраструктуры железнодорожного транспорта в будущем. Результаты научных исследований предположительно могут быть использованы в ОАО «РЖД» для проектирования новых информационных систем.*

Ключевые слова: *иммунные алгоритмы, иммунные интеллектуальные системы, защита данных, информационная безопасность, обнаружение вторжений.*