Automated expert support complex based on a machine learning semantic processor

O N Chirkov¹, N V Tsipina¹, S A Slinchuk¹, and E I Vorobyev
Voronezh State Technical University, 14, Moscow av., Voronezh, 394026, Russian Federation
E-mail: chir_oleg@mail.ru

Abstract. The article is devoted to the creation of an intelligent software complex of a self-learning automated expert system for registering, accounting and executing incidents based on artificial intelligence. The creation of the software complex includes the development of an advisory support expert system based on a semantic processor for speech recognition and synthesis, which allows implementing the first line advisory support based on artificial intelligence. The obtained expert system consists of the following blocks: an input data flow module – GSM (voice address); a semantic processor – the system core in which, using special designed algorithms, the input data flow is converted into the language understood by the system for subsequent intelligent processing set by the specified skills, based on self-learning algorithms; a semantic processor language module with a protocol of recognition, analysis and extraction of input and output data context; an incident registration module with the accounting system in the Redmine platform; PostgreSQL skills database; a manual learning module and an output data flow module. The developed expert support digital ecosystem will allow to completely automate the receipt, processing, registration, accounting and decision-making of incoming requests. The complex implementation can replace first line support call centers and will have a significant economic effect on retail, banking, and consulting systems.

1. Introduction
Google, Yandex and other voice assistants are well-established, widely used in various fields, and are being improved every day. The semantic core of such services is speech recognition and synthesis algorithms [1-3]. Nowadays, numerous studies are devoted to humanizing such cyber assistants [4-8], along with evaluating the channels for data reception, processing and transmission [9-10]. Machine learning of modern developments is based on neural networks [11].

Existing services and systems for speech recognition and synthesis are not able to self-learn and provide advisory services at the appropriate level, thereby completely replace the call center operator (human) receiving a request. Thus, the task of a voice assistant with artificial intelligence remains relevant. At this moment, the Dasha.AI system [12] can make cold calls to clients and create a dialogue according to loaded communication branches, but it is not able to provide first line support services and learn skills.

2. Methods and materials
The developed digital ecosystem of expert multitasking advisory support with machine learning contains nine main modules. The diagram is presented in figure 1.
Figure 1. Modules of advisory support digital ecosystem.

2.1. Input data flow module
Designed to provide convenient incoming interaction of the user (client) with the expert system through the following communication channels:

- GSM;
- IP Telephony (Asterisk);
- Cloud ATS (Mango office, Beeline, MTS, etc.);
- CRM systems (Bitrix 24);
- Messengers (Telegram, WhatsApp, Viber, Skype);
- E-mail;
- SMS.

2.2. Semantic processor
The core of the proposed ecosystem. It includes the following submodules:

- Speech recognition and synthesis. With the help of specially developed algorithms, it converts the input data flow into a language understandable by the cyber-system, for subsequent intelligent processing set by the specified skills, based on self-learning algorithms (artificial intelligence). The developed artificial neural network is a hierarchical computational model in which the computer consists of simple nodes (neurons) with multiple inputs (synapses) and one output. Each synapse has its own weight. Values are passed to the system, propagated through interneuronal connections, multiplied by their weight and added together. Then the result is passed to the output and thus, layer by layer, the correct solution is developed. Along with the solution verification, the weights are corrected to minimize errors.
- Humanizing the cyber-system speech. It translates data from the cyber-system language into a language understandable by the user (human) for the module “Output data flow”.
2.3. **Cyber-system control module**
Provides module control set by the specified skill, synchronizes operation of ecosystem modules.

2.4. **Semantic processor language module**
Protocol and language that describes methods of semantic processor interaction with input and output data flows. Includes submodules:

- Protocol of recognition, analysis and extraction of input and output data context.
- Modernized protocol of recognition, analysis and extraction of input and output data context based on cyber-system machine self-learning (artificial intelligence).

2.5. **Incident registration module**
Main purpose:

- Registration and accounting of customer (user) requests.
- Recording of the request result (essence and decision) in the cyber-system module.

Module for online data exchange with the following systems:

- Incident and project tracking system (Redmine, Mantis);
- 1C (1C: ITIL Information technology management of the enterprise).

2.6 **Skills database**
DBMS for storing skills, languages, and semantic processor protocols, as well as additional information. Operates on the following DBMSs:

- SQL;
- PostgreSQL.

2.7. **Skills learning module**
Main purpose:

- Setting the cyber-system control algorithms;
- Automated conversion of input data into the semantic processor language;
- Extracting the essence of communication (context) from the input information understandable by the semantic processor.

Includes submodules:

- Manual learning module;
- Cyber-system self-learning module.

2.8. **Input data flow module**
Request solution implementation in the communication channel set by the skill considering the input channel and the user’s requests.

- GSM;
- IP Telephony (Asterisk);
- Cloud ATS (Mango office, Beeline, MTS, etc.);
- CRM systems (Bitrix 24);
- Messengers (Telegram, WhatsApp, Viber, Skype);
• E-mail;
• SMS;
• Alice by Yandex.

2.9. SaaS module (market skill)
Module with an open API for popularization among developers and the cyber-system monetization for end users. Includes submodules:

• Project monetization module by retail customers;
• Module that allows partners to sell created skills on Skill Market.

User account with the pre-programmed functions:

• Module selection (pricing);
• Reporting – checking service performance and quality of the cyber-system in real time.

The proposed automated expert cyber-system will allow performing the following tasks:

• Self-learning automated system for receiving first line support requests in 24/7 mode with simultaneous execution of all incoming requests, without hold mode;
• Artificial intelligence-based system of incident registration, accounting and execution with SLA support;
• Advisory services set by the specified skill.

3. Discussion
The novelty of the software complex consists in creating a platform for speech recognition and synthesis with advisory skills self-learning using the developed cyber-system language. An innovative universal language of cyber-system learning has been developed to recognize the essence of an incoming request by context without human involvement. Based on the input request context and using refining requests, the robot analyzes and selects the most optimal action until it concretizes the decision or response to match the learned skill. A decision here is a completed dialogue with the client, a registered request, or the execution of a required command. In this case, the self-learning module will allow the cyber-system to constantly analyze requests and improve the accuracy of responses, that is, the cyber-system can change or rewrite a decision tree or its branch based on the experience obtained. As a result, the platform is able to implement expert advisory support, completely replacing the call center operators.

Comparative characteristics of the technologies are shown in table 1.

Table 1. Comparative characteristics of technologies.

| Parameter                | Call center operator | Dasha.Al | Expert support complex |
|--------------------------|----------------------|----------|------------------------|
| Equipment                | telephone            | Server platform | Server platform |
|                          | headphones           |           |                        |
|                          | PC                   |           |                        |
| SLA support              | No                   | No       | Yes                    |
| Advisory support         | Yes                  | No       | Yes                    |
| Cost in relative units   | 0.3                  | 3        | 1                      |
| Multichannel line        | No                   | 15       | Easily scalable        |
| Artificial intelligence  | No                   | Yes      | Yes                    |

The technological novelty of these projects consists in combining the modules of expert advisory support cyber-system into a digital ecosystem and creating a new technology in the field of advisory support – a machine cyber-system with artificial intelligence.
4. Conclusion
The proposed automated expert support complex based on a machine learning semantic processor is a universal and flexible platform that can be used to perform various tasks, from first line support call centers to advisory and request receipt systems. The ecosystem includes the SaaS module that allows to use the created skills on Skill Market via open APIs for additional monetization and popularization.

References
[1] Kuznetsov V and Ott A 1989 Automatic speech synthesis (Tallinn, Valgus) p 135
[2] Mikhailov V G and Zlatoustova L V 1987 Measurement of speech parameters (Moscow, Radio and communication) p 168
[3] Vishnyakova O A and Lavrov D N 2011 Mathematical structures and modeling 24 12-8
[4] Vorobyova S A 2016 Young scientist 26 136-41
[5] Mon S M and Tun H M 2015 International Journal of Scientific & Technology Research 6 349-52
[6] Utane A S 2013 International Journal of Advanced Research in Computer Science and Software Engineering 3
[7] Li B, Sainath T and Narayanan A 2018 Proceedings of Interspeech 14
[8] Long Y, Li Y, Ye H and Mao H 2017 International Journal of Speech Technology 1 171-8
[9] Wang B, Martin R and Mao G 2015 International Conference od Scientific computing 192-5
[10] Chirkov O N, Romashchenko M A and Chepelev M Yu 2019 Bulletin of the Voronezh State Technical University 3 68-73
[11] Dhanashri D and Dhonde S B 2015 International Journal of Multidisciplinary Research and Development 6 226-9
[12] Dasha.AI https://dasha.AI.ru