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THE SUPPORT BOT ARCHITECTURE

Abstract: We will consider the architecture of the developed bot assistant, crate a component diagram and describe the choice of development tools.

After that, we will give a description of all the services we are developing: their APIs and database schemas. We will also describe the main development points related to searching in the knowledge base, organizing security, integrating with the platform for developing user dialog interfaces and the GLPI helpdesk system.

In addition, since we are integrating with one of the messengers, specifically Telegram, we will formulate the basic requirements for the interface of the bot itself, a list of commands used and tell about the features of registering a bot in this messenger.

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Introduction

The architecture description
The chat bot that we research and develop as part of this work consists of several main parts (Figure 1).
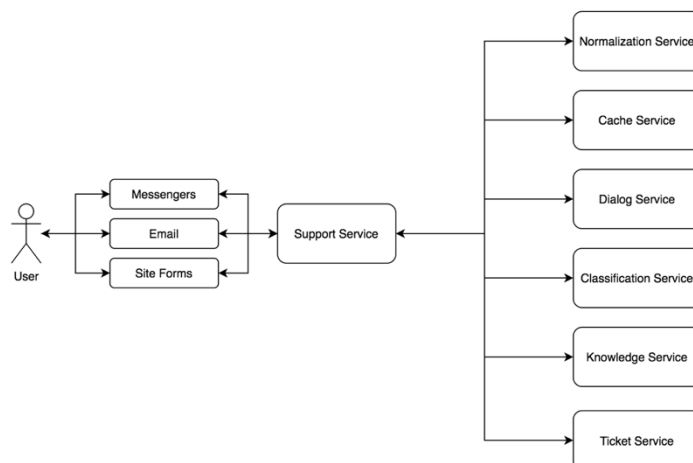
Clarivate
Analytics indexed

Figure 1. The component schema

The main element here is the user, more specifically the employee to whom the chat bot is trying to provide support. The user can contact the bot through various channels - it can be instant messengers, email, a form on the site and any other communication channel that can provide such interaction between the user and the bot. Thus, we can say that the channel is a connecting link between our user and the Support Service.

Support Service is the main service whose task is to receive a message from the user, process it, perform the necessary manipulations with it, and then send any response to the user back. In turn, the Support Service interacts with other services. Let's consider them in more detail.

Normalization Service – a service that is responsible for processing the input message, removing punctuation marks, stop words, normalizing words, that is, bringing the message to the form that the classification service will work with. Also, at this stage, keywords are selected for further work with other services.

Cache Service – a service that is responsible for the cache. After the user has entered a message, each time of the processing the message, its classification, search for an answer on it, starts a new, that is, one message - one pass along the entire processing cycle. But there are situations when users encounter the same problems and the more people use the bot service, the more the same questions may arise. To reduce the load on the service, it was decided to implement a cache service, which stores the history of each call to the support bot. After all, if the input message has already been recognized, for example, as a question and an answer has already been received that was satisfactory, then there is no need to run the service again to get the same information. We can just pull the response from the cache service and send it to the user.

Dialog Service is a service for ensuring dialog between the bot and the user. To make the bot more independent, automated, able to respond to user's unpretentious messages, you must either constantly update your hands with a collection of rules of the type "answer "hello" to the word "hello"" and etc., but such a collection is difficult to maintain, or use external tools that already know how to cope with such a task as the implementation of interactive interfaces. Dialog Service receives a user message as an input and tries to find an answer to it by using the Dialogflow platform that we have chosen.

Classification Service is a service that is responsible for classifying an input message. Everything is extremely simple here, the service receives a normalized message at the input and, through a pre-trained model, classifies the message belonging to one of certain classes: application or question. Also, this service is responsible for training models, saving training results and their further use. This means that when we launched the service, it has one model that is used constantly, and there is a method that implement additional models to check the quality of their training on new data. Launching for retraining is carried out at the moment when a certain number of new user requests will be added, on which we can conduct training. Now this process is not automated and requires human intervention to verify the classification. Also, using this service allows you to configure a certain number of models and watch how they behave when adding new data. After such an analysis, one can draw various conclusions about how a particular model architecture works, how data affects it, etc.

Knowledge Service is a service where articles are stored and also their highlighted keywords and links to the corporate Wiki resource, where you can read in

more detail about the fact that is mentioned in the knowledge base.

Ticket Service is a service responsible for working with tickets. A ticket is an application that is formed within the framework of an employee's problem and is created in a special helpdesk system. Helpdesk system is a support service, a special resource designed to automate the processing of incoming user requests. Ticket Service is the link between the bot service and various help desks, that is, it acts as a single interface that allows you to redirect applications depending on their subject or other various conditions.

In general, any Ticket Service client does not need to know which helpdesk system it interacts with, it simply sends a request and waits for a response. The advantage of such a device is that if you make Ticket Service a universal channel, then you can connect any of the existing helpdesk systems to it and there will be no need to remember all the addresses of support services that are used in the company, just use one special service. This service also has a schedule mechanism, which, at a given interval, polls all helpdesks in use for the status of applications. This will notify the user of the progress of work on the decision of his appeal.

Consider the sequence of calls to services. When a user writes his message through a bot or through any other communication channel, it arrives at a specific endpoint of the Support Service. Each channel has its own API controller.

After the Support Service received a message from one of the channels, it sends it to the Normalization Service for preprocessing: deleting punctuation, stop words, deleting some named entities, such as the names of organizations, locations, etc., word normalization also takes place here. In response, the service sends the processed text.

After a response has been received from the Normalization Service, the Support Service forms a request in the Cache Service to find out if such a request has ever appeared from a user in past requests. If the answer came from the Cache Service and it is not empty, then you need to analyze it. If the input call was already encountered in user requests and was recognized as a simple question or belongs to the category "other", that is, for example, is a greeting or goodbye - that category, with which we do not work, we can immediately send the user a response from the description of the found record. If a similar appeal was ever recognized as an application, then we can immediately send a ticket creation request to Ticket Service and inform the user that we have created a ticket for him and he can wait for service's answer.

If the response from the Cache Service came empty, which means that previously users did not contact the bot with such a request. Therefore, we can contact the Dialog Service and find out if it can respond to a user's request. Dialog Service is configured so that

it can only answer simple questions and inquiries, like "How are you?" This was done in order to automate the bot and to support a conversation with the user, this facilitates the development and saves us as developers write scripts of conversations. From Dialog Service we can also receive either an answer with the wording or an empty answer, which means that the service cannot answer this question. If there is an answer, we first save it in our service, which is responsible for the cache, and send the response to the user. Now the next time the user comes and writes the same message that the previous user sent, we will already know the answer and we can immediately send it without unnecessary actions.

If the answer from Dialog Service was empty, this is a sign that this call must be sent to the Classification Service, for its classification as a question or request using a pre-trained model. Depending on the result, the algorithm of actions is different. If the appeal was recognized as a question, then we will first try to find the answer in the Knowledge Service. The API method searches the database for keywords that were formulated in the Normalization Service. If there is an answer, then we can send it to the user and save all the necessary information in the Cache Service: the text itself, how the appeal was recognized, what response was found to it and how it was evaluated by the user. If the request was recognized as an application, then we also send a request to Ticket Service to create a new ticket.

It was also mentioned that the response is user rated. If the appeal was a question and an answer was received, we give the user to evaluate this answer to improve the state of our knowledge base. At the moment, we suggest the user to select "Yes" or "No", in the future we plan to introduce a point-based grading system. If the user evaluates the automatically found answer negatively, then you need to make a note about it so that in the future the person responsible for filling the knowledge base can look at the initial appeal and the answer found and understand what happened wrong and why the user did not like the answer.

The development tools

To implement the above listed services following development tools are selected.

The programming language is C # [1] and the .NET Core framework [2].

To develop services related to natural language processing and machine learning, the Python programming language was chosen [3]. Advantages that make Python suitable for machine learning and AI-based projects include simplicity and consistency, access to great libraries and environments for artificial intelligence and machine learning algorithms, flexibility, platform independence, and a large community of developers and specialists in data science.

PostgreSQL DBMS [4] was chosen as the support for the implementation of the data warehouse, because it is free and affordable, meets all the requirements that must be implemented for the development of current databases.

To implement Back Office's frontend, the following languages and tools were selected:

– HTML – HyperText Markup Language [5];

– CSS – Cascading Style Sheets [6];

– JavaScript [7];

– jQurey — a set of JavaScript functions for the interaction of JavaScript and HTML [8];

– Bootstarp — a set of tools for creating sites and web applications [9].

To implement the backend, we will also take advantage of the capabilities of .NET Core.

Support Service API

The service provides the following API methods.

GET method for creating clients. By client we mean an entity from a specific communication channel through which a user can contact our service. In Telegram, such a client is a bot. Several bots can be added, in which case each bot is considered a separate client and is registered as an independent entity, all that combines these bots is the Telegram channel. Similarly, for other bots can be done, for example, bots in Facebook Messenger. In addition, you can add a channel such as e-mail and its customers, individual mailboxes, or a special form for accessing the site. At the moment, when registering a client, it is necessary to transfer the name of his channel, a special access

token, in the case of Telegram - this is the bot token that is issued when registering the bot through Bot Father, and the client identifier in Ticket Service.

POST method for updating the client. For example, delete a client or change some of its parameters.

A separate controller is developed for each communication channel, because it is not possible to receive messages from different sources on one endpoint, for example, from Telegram and Facebook Messenger at the same time, because they have different data contracts. For Telegram, a separate controller with POST methods was implemented, which receives an input message of type Update and converts it into an internal data contract.

It is also important to mention that the Ticket Service, when it receives information that the ticket has been resolved, send a corresponding request to the endpoint that was specified when registering the client with Ticket Service. Therefore, the Support Service additionally implements an endpoint to which messages from Ticket Service come. Such messages are processed and, depending on the result, the user receives an appropriate response. This may be a message that the ticket has not been resolved and the time period for its stay in the active state has expired, or it may be a message with a resolution on a specific ticket.

Support Service Database

In Figure 2, you can see the database schema of the described service. Let's consider them in detail.
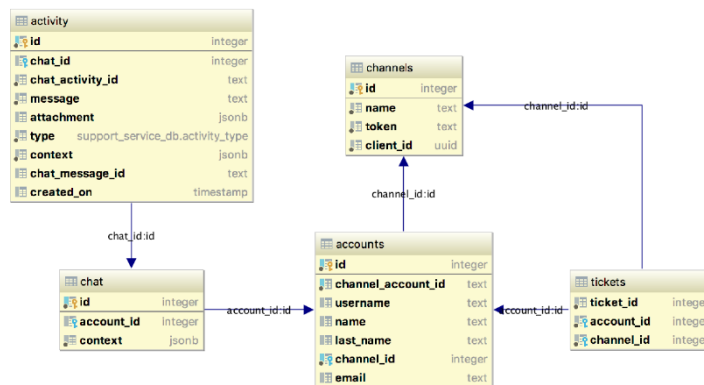

Figure 2. The Support Service database schema

Accounts - a table containing user information. Each user is given an identification, it is also necessary to fill in his first and last name so that he can be identified in the helpdesk system when creating a ticket.

Channels - a table containing information about supported channels. A channel is an interface through which a user can contact a support chat bot, for

example, a specific messenger, email, or a form on a site. The channel is added by the person in charge. This is done for security reasons. That is, if some stranger decides to connect his channel with our service, then messages coming from his channel will still not be processed, since he did not register his channel and did not add it to the database. Also, in the table there is a client_id field, which gives the right to create tickets

through this channel in the ticket system assigned to this channel.

Tickets - a table containing information about tickets that are being processed or already resolved. This table is necessary in order to link the ticket and the user from a specific channel for which the ticket was created. When any information about tickets comes to the service, the user needs to send a response. This table contains just all the information you need.

Chat - a table containing information about the chat in which the user interacts with the bot. The most important field here is context, which stores the message context of the correspondence at the current time. This was done for the purpose that if the bot service is restarted, then all current information will be saved, and we can continue the dialogue with the user without interrupting it.

Activity - a historical table that stores information about all incoming / outcoming messages. Used to view various statistics and user activity.
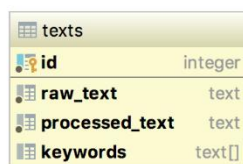
Normalization Service API

The service is responsible for normalizing the input message and highlighting keywords.

Here we highlight the following API method - this is the POST method to which the client sends a request with any text and in response receives a normalized representation, that is, cleared of punctuation marks, stop words, date values, numbers, names of organizations and products, etc. Also, along with this, the output contains separately highlighted keywords that can be searched later and can also be used with Cache Service in order to obtain information about whether such a request was encountered from other users.

Normalization Service Database

In Figure 3, you can see the normalization service database schema. It consists of a table Texts.

Texts - a table containing information about all incoming messages that have been preprocessed. In the raw_text field we write the text without processing, we also write the text that was obtained as a result of the manipulations, such as deleting stop words, removing punctuation marks, removing extra characters and notation. In addition, in the keywords field we record keywords that we were able to isolate from the input message. They, as well as processed text, will be useful in next actions.

Figure 3. The Normalization Service database schema

Cache Service API

Cache Service provides an opportunity to get information about whether other users have already asked the corresponding request of the current user. Here you can select the following API method - the GET method with the parameters by which the search is performed - keywords received from the Normalization Service.

The response to the request is a collection of relevant articles (the maximum size of the collections is set as a request parameter), according to which the Support Bot service determines its further actions described above: either we send a response to the user,

or we send a request to create a ticket and the user is notified that a ticket to the support service was created on his appeal.

Cache Service Database

In Figure 4, you can see the Cache Service database schema. It consists of a Cache table, which stores the keywords of each user's message, a vector for full-text search, the answer that was sent to the user for his input phrase, the type of this message (question, application or other), and the time that this answer is considered relevant and can be used to respond to other users.
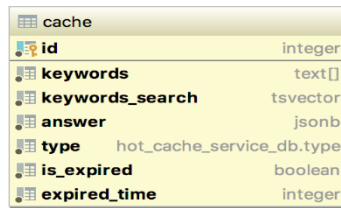
Figure 4. The Cache Service database schema

Dialog Service API

Dialog Service is a service responsible for integrating with a platform for understanding natural language and for developing Dialogflow interactive user interfaces.

In this service, we single out one API method for receiving an answer to an incoming phrase.

Classification Service API

For the Classification Service, we define the following API method - the GET method, which receives already normalized text and sends a class to which the source text could be correlated in response to a request.

In addition, there are methods for viewing statistics on retraining models - these are GET methods that allow you to see which models were launched for training, with which classifiers, what results were obtained during training. Such statistics will help

machine learning specialists analyze the state of models, look at their quality, decrease or increase with each new iteration, draw certain conclusions on the possibilities for improving the quality of models and new architectures. There are also methods for uploading data and updating it in the database. As a result of the classification, the label is assigned to the input message (the class to which the message belongs), which is saved along with the classified text. To retrain, we must be sure that the label matches this message, which of course may not be the case. Therefore, in this situation, manual marking is still required, or rather the correction of those labels that were incorrectly defined.

Classification Service Database

In Fig. 5, you can see the classification service database schema. It consists of the following tables.
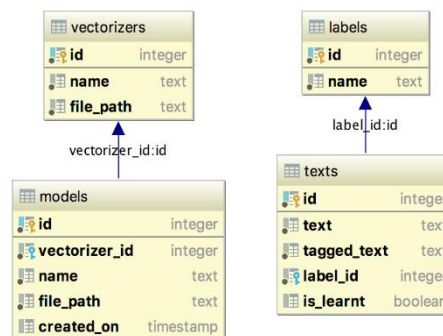

Figure 5. The Classification Service database schema

Texts - a table that contains information about the texts on which learning will be carried out using machine learning algorithms, and new texts that will be classified. There is a tagged_text field in which text tagged with parts of speech is written, this is necessary for some word2vec type vectorizers, since pre-trained models vectorize the input message depending on the

word and its part of speech. Label_id field - responsible for the class to which the text belongs, and the is_learnt field tells us whether this record participated in the training. When a sufficient number of new entries that did not participate in the training accumulate, it will be possible to restart the machine learning algorithms and watch the report. After that, it will be possible to

conclude whether to change the model to a new one or whether it is worth revising some points in the implementation.

Labels - a table that contains the categories used in the classification. So far, only two key entries are in this table - the application and the question, but in the future, we plan to carry out classification into narrower areas.

Models - contains information about trained models. For each record, the vectorizer that was used to encode the data, the name of the classifier, the file name of the saved model, and the creation time are determined. In addition, here you can see the quality metrics of each model. Such a table allows you to get a report on all trained models and compare their quality.

Vectorizers - a table containing information about the vectorizers with which we can encode data. During retraining, some vectorizers are also transformed due to the fact that new data appears - these are the untrained models that we use, for example,

CountVectorizer from scikit-learn. It is also important to note that a file with a vector model can be used in various machine learning algorithms, so a separate table was created for them.

Knowledge Service API

In the Knowledge Service, the main API method is the GET method, which implements the search for articles in the knowledge base for the given keywords. This method is public and can be used by external clients such as Support Bot Service. For internal use, there are various API methods for working with articles: a method for downloading, updating and retrieving articles, methods for collecting statistics on articles.

Knowledge Service Database

In Figure 6, you can see the database schema of the Knowledge Service. It consists of the following tables.
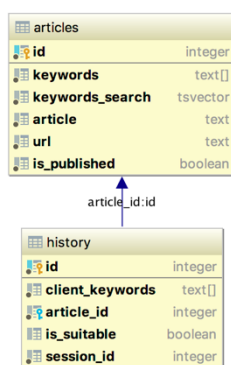

Figure 6. The Knowledge Service database schema

Articles - a table that contains information about articles available in our knowledge base. The tags field contains keywords for this article article, which will search for the final answer to a user's question using the keywords selected at the stage of contacting the Normalization Service when processing a user's request. This field is filled directly by the employee who fills the database. Article contains a short message, an excerpt that the user can read very quickly and not lose too much time to delve into the content, so for each article the url field is also filled in, which contains a link to the article in the company's information space, where you can read more about what is said in a short excerpt, if, for example, the user has something incomprehensible. In addition, an article may be active or inactive, if it is not active, it means that most likely it is awaiting revision or any additions and no search for such an article is carried out.

History - a table with the history of the issuance of search articles. After the user was asked to rate the article, we can make an appropriate note about whether

this article came up to the user's request or not. If it did not fit, then in the future the person who is responsible for filling the database will be able to see the keywords of the user's request, the article that was proposed for the answer, and decide what to do with this article. Deactivate it, fix it, send it for revision.

Ticket Service API

The Ticket Service API is quite extensive. To facilitate the registration of clients, it was decided to put all the necessary methods into a public API, and so that anyone who wants to register a client can do it on their own.

The following methods are available in the API for working with clients. The POST method for registering a client, as a result of executing a request for this endpoint, the user receives a unique identifier, by which he is subsequently entitled to use the Ticket Service functionality. There is also a PUT method for updating client settings and the settings of the helpdesk that the client uses.

To work with tickets, there is also a separate API that provides POST methods for creating an application from an external client and GET so that the external client can find out about the status in which the application is located. Also, since the ticket can be closed by the user, you must add the appropriate PUT method to update the ticket status.

Knowledge Service Database

In Figure 7, you can see the Ticket Service database schema. It consists of the following tables.

Helpdesks is a table containing information about all helpdesk systems with which the service can offer integration.

Glpi - a table in which the settings of a particular service are stored, in this case GLPI. GLPI has a ticket demarcation system - projects. For each client, we must create a separate project, which will store tickets that came only from this client. When the service will expand and new help desks will be added to it, a new table will be created for each.

Clients - a table containing information about customers. Here are all the necessary parameters, such as the name of the client, the address of the client to which the service will send information about the ticket status, the helpdesk selected by the client and other settings. One of these settings, which we still support, is the number of days after which the application can be considered expired.

Tickets - a table about tickets. This table contains information about the helpdesk in which the ticket was sent, what is its identifier in this system, display identifier (formatted identifier), for which client it was created, its status and date of creation and last change.
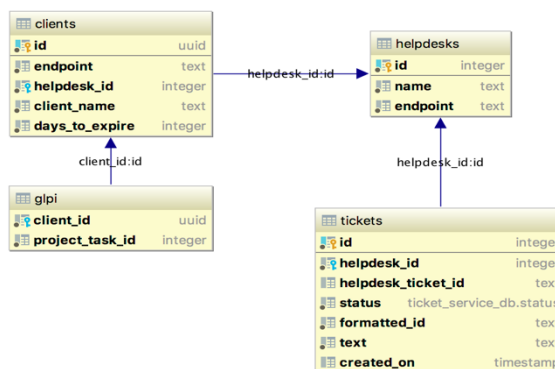

Figure 7. The Ticket Service database schema

Back Office

The back office as a unit is a part of the company consisting of administrative and support staff that is not client oriented. The functions of the back office include settlements, record keeping, accounting, etc., that is, that which provides the activity. As part of our tasks, we also need to have such a convenient auxiliary mechanism with which it will be possible to monitor the processes.

At this stage, the functionality of the developed service covers the tasks of working with articles. The main goal of this functionality is to provide operators with the ability to quickly and easily add articles, view them, observe statistics on hits to specific articles and other metrics.

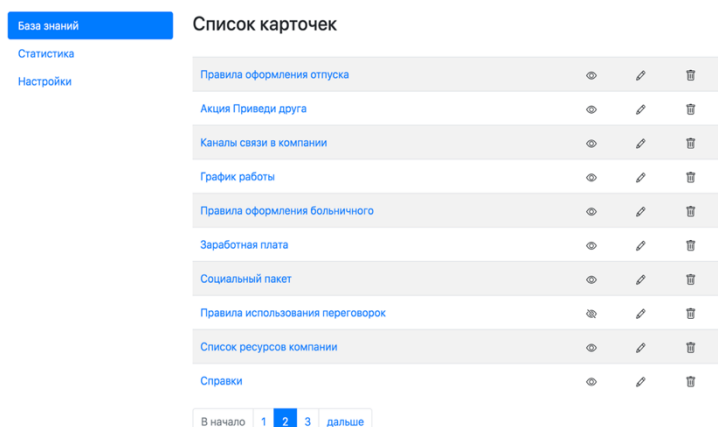Consider the features of Back Office.

Figure 8. The view of articles available in the knowledge base

In the Knowledge Service, we work with articles. Each article contains a list of keywords defined by the operator that adds the article, the answer to the user's question, a short answer to be provided to the user (preview) and a link to a more advanced version of the article in the Confluence information space. In Figure 8, you can observe the main page of our "Knowledge Base", which displays all the articles that we have. It is possible to edit and delete articles. You can also see the status of the article - whether it is published or not. If an article is published, then a search is possible on it, and it can be returned as a result of an input request. If the article is not published, then perhaps it is awaiting editing, as it was previously marked irrelevant (for various reasons). Each card with the article can be opened and you can see its contents.

Functionality for editing the article and similar for its addition is also provided (see Fig. 9).

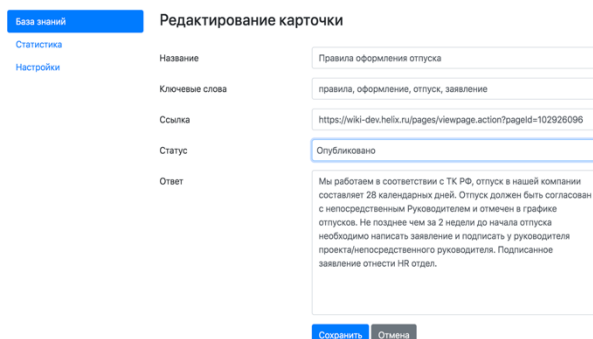**Figure 9. The form of editing cards**

In addition, as stated earlier, in Back Office, an operator can view various statistics on articles. At the moment, we are tracking the following (see Figure 10):
– number of articles uploaded;
– number of articles published;
– number of unpublished articles;
– number of irrelevant articles - articles that users mark as unsuitable for the original request.
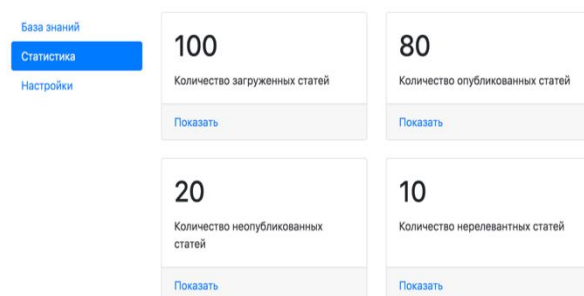
Figure 10. The statistic view

The development highlights
The full text search

As previously noted, the Knowledge Service is responsible for receiving articles on input keywords. There are various options that could be implemented for searching and displaying results, but as part of this work, it was decided to use the built-in capabilities of the PostgreSQL DBMS that we use and implement full-text search by keywords [10]. We introduce the basic concepts:

– tsvector — data type for storing prepared documents;

– tsquery — data type to represent processed requests.

To implement a search, you must use functions that allow you to create a tsvector from keywords in a stored article and tsquery from an input search query. In addition, since there may be more than one article found, and it's more important for us to show the most relevant, we will use a function that, in fact, evaluates the relevance of the article to the search query.

First, let's consider converting the keywords of a downloadable article to tsvector. To do this, you need to use the to_tsvector () function, to the input of this function we pass the name of the dictionary by which each word will be processed, and the input string from keywords. To_tsvector splits a fragment of text into separate words (tokens) and returns the value tsvector, the record of which is stored in the following form (see Fig. 11), where the recognized word is first indicated, and then its position in the input line.

```
select to_tsvector('russian', 'оформление отпуск заявление подпись')

to_tsvector
----------------------------------------------------
'заявлен':3 'отпуск':2 'оформлен':1 'подп':4
```

Figure 11.The usage of to_tsvector function

The resulting vector is stored along with the article and its other parameters. Its creation occurs at the time of loading the article.

Now that for each article we have its tsvector with keywords, consider getting tsquery from an input query. Postgres provides the functions to_tsquery, plainto_tsquery, phraseto_tsquery and websearch_to_tsquery in order to bring the search query to the form tsquery.

Consider these functions.

To_tsquery accepts the input of the query text, which should include not only words, but also logical operators, such as AND (&), OR (|), NOT (!) and FOLLOWED BY (<->), and possibly brackets for grouping. As a result of the query, we get tsquery - an expression for finding documents (see Fig. 12)

```
select to_tsquery('russian', 'оформление & отпуск')

to_tsquery
----------------------------------------------------
'оформлен' & 'отпуск'
```

Figure 12. The usage of to_tsquery function

Plainto_tsquery allows you to convert raw text to tsquery. The input text like to_tsquery, is divided and normalized, only a single AND operator is inserted between all words, that is, this function does not recognize the operators and considers them ordinary separators (see Fig. 13).

```
select plainto_tsquery('russian', 'оформление заявление |подпись')

plainto_tsquery
---------------------------------------------------
'оформлен' & 'заявлен' & 'подп'
```

Figure 13. The usage of plainto_tsquery function

Phraseto_tsquery behaves in the same way as plainto_tsquery, but instead of the AND operator between words, it inserts the FOLLOWED BY operator. This function is useful in cases where it is important not only the presence of all tokens, but also their order.

And the last websearch_to_tsquery function accepts unformatted text as input. It uses alternative syntax and allows the use of certain operators:

– text not enclosed in double quotes will be separated by AND;

– the text enclosed in double quotes will be converted into words by the FOLLOWED BY operator;

– the word "or" will be converted to an OR operator (|);

– '-' will be recognized as a NOT operator and converted to '!'.

For this Knowledge Service, it was decided to use the to_tsquery function and pre-format the input query using the OR operator. Why is that. Firstly, we cannot be responsible for which keywords for the article will be chosen by the operator responsible for filling our database. In addition, we cannot be responsible for those keywords that come to the Knowledge Service input, they may differ from all keywords specified by the operator, or they may coincide in one or two. Therefore, we cannot use the AND (&) operator rigidly and look for such a match that all search words are in the keywords of the article. The OR operator provides more search capabilities. In addition, as part of the search, we use the ranking function.

The ranking of documents is an attempt to assess how relevant the documents are to our search string and to rank the documents found in the order of their relevance. Postgres provides two ranking functions ts_rank and ts_rank_cd. The first one ranks the document by the frequency of the found tokens, the second one calculates the coverage density similarly to ts_rank but taking into account the proximity of the corresponding tokens. Since while we do not care about the position of the keywords relative to each other, we will use the ts_rank function. In addition,

since the above-described functions for converting the input string to the tsquery format return the processed word and its position in the text, which is not important to us, we will use the strip function, which will return the converted words without specifying their position. Thus, when we conduct a search and ranking of found articles, we can send this result in response to a search query.

The security

Each of the services is published in the corporate space and does not imply calculations for external use, that is, their use is possible only within the local network, except for the Support Bot Service, since it has a connection with Telegram and must be accessible from the outside. But we want to note that, firstly, the use of some of the services can still become available to external customers if we want to promote them as separate products, and it is also possible to use them by other company teams. At the same time, we cannot open access to everyone in a row, so that anyone can use the API of our services, as this can lead to an uncontrolled data flow, which may have a negative impact on the services. In order to solve this issue of security organization, it is necessary to introduce a mechanism that can determine who can have access to services and what resources can use it.

First, let's define the basic concepts related to security.

Identification is a procedure for recognizing a subject by its identifier, which uniquely identifies a subject in some kind of information space. This identifier can be login, name, number, email address, etc.

After identification of the subject, its authentication is carried out. Authentication is an authentication procedure, that is, confirmation that the subject is exactly who he claims to be. Such verification is carried out, for example, using a password, key, fingerprint, etc.

When we identified a subject by its identifier and authenticated it, making sure that it is really him, it should be determined whether we can provide this

subject with access to our resources, that is, conduct an authorization procedure.

In our case, there are two main clients that use the API of other services: Support Bot Service, which has access to all the services described above, and Back Office, which accesses the Knowledge Service API. This means that in order to access each of the services they must have a special access token. In our services we do not carry out identification and authentication of the client, we only authorize the client by its token. In order to pass identification and authentication, the client needs to contact the special Identity Service authorization service, which is already implemented in the company using technologies such as IdentityServer [11], a framework that implements the OpenID Connect [12] and OAuth2 [13] protocols, which can be used to build your own authorization services that will issue security tokens to customers. A special account is created for each client in such a service, and when applying for an access token with certain parameters, the client is identified and authenticated and checked to see if it has access to these areas, and if it does, then a token is issued to it.

In order to better understand this procedure, we introduce the basic concepts related to OpenID Connect and OAuth2.

A user is a person who uses a registered client (application) to access resources.

A client is software or part of it that requests tokens from IdentityServer, either to authenticate the user who used the client, or to obtain an access token to resources. In our case, the Support Bot Service client must request an access token in order to be able to access the API of other services with it. And similarly, for external clients who will use our services.

Resources are what we want to protect with the use of IdentityServer. For us, these are API resources - functionality that third-party clients should not have

access to. And a related concept with resources is the area. Scope is the identifier of the resource that the client wants to access.

There are two types of tokens: an identity token and an access token. An authentication token is the result of a user authentication procedure. It contains the user ID, information about how and when the user was authenticated, and other additional data. In turn, the access token allows you to access the API resource. Clients request this token and go to other services with it. Access tokens contain information about the client (and the user, if one was presented), and the APIs use this information to provide access.

You can get your access token through a special Token Endpoint access point. In Fig. 14, you can see the main parameters for obtaining a token using the Client Credentials permission type.

Grant type - permission type, determines how the client can interact with the service issuing tokens. Permission types are as follows:
– Authorization Code;
– Implicit;
– Password Credentials;
– Client Credentials.

For the Support Bot Service client, the Client Credentials permission type is used; for Back Office, Password Credentials are used, since we have the ability to specify a username and password for each operator.

Client ID is the client ID.

Client Secret is a client secret that is used to authenticate it.

Scope is the scope that the client wants to access.

When using the permission type Password Credentials, you must also specify the username and password of the user.

Token Name	Token Name
Grant Type	Client Credentials ▼
Access Token URL ⓘ	https://url-to-auth/connect/token
Client ID ⓘ	client_id
Client Secret ⓘ	client_secret
Scope ⓘ	knowledge normalization
Client Authentication	Send as Basic Auth header ▼

Figure 14. The form of receiving token in Postman [14]

Thus, security is maintained in our environment. Those who do not have rights to the areas listed in the request will not get access to them, since the service simply will not give them a token. External clients will also be unable to use our APIs until they receive an access token. Those who try to apply with an access token received from another authorization service will

still not be able to access the service's resources, since before providing this access to the client, the token is validated by the authorization service and also matches the token parameters specified in service parameters. For example, validation of the scope parameter; checking whether the client has access to exactly this requested API method, since the client, although it can

have access to the entire service, cannot delete data from the database of this service.

Dialogflow

Traditional computer interfaces require structured and predictable input for proper operation, which makes the use of such interfaces unnatural and sometimes difficult. If end users cannot understand this structured input, it is difficult for them to understand what to do at all. It was ideally if the interfaces themselves can determine what users want based on the natural language that they use.

For example, consider one simple query, for example, "Hello." Other users can also send a message in the form:
– «Good morning»;
– «Hey»;
– «Hi».

Even looking at these simple examples, you can see that it's difficult to organize a user's communication with the system. Natural language interpretation and processing requires a reliable text parser. Dialogflow [15] already processes everything for us and allows us to provide high-quality communication with the user. Let's introduce the basic concepts.

Dialogflow Agent is a virtual agent that processes conversations with the user. This is a module for understanding natural language, which understands the nuances of the human language. Dialogflow converts the text or audio of a user during a conversation into structured data that our services and applications can understand. We need to design and create an agent in order to process the necessary conversations for our system. The Dialogflow agent is like a human agent from a call center. He also trains to handle expected conversation scenarios.

Another concept is intent. For each agent, we can define a somewhat large number of intentions and all these intentions can handle the full conversation between the interface and the user. When a user writes or says something that we can call a custom expression, Dialogflow matches this expression with the agent's best intention. This comparison can also be called a classification of intentions.

For example, we can create an agent that will recognize and respond to greetings from our users. To get started, set an intent for the greeting message. If the user says "Hello," then Dialogflow will match this expression with the intent of the greeting. We can also set the intention so that some useful information can be extracted from the expression, for example, the time of day - such a sentence as "Good afternoon" or "Good evening". This retrieved data is important for the system to correctly respond to a user message.

The underlying intent contains the following:
– Training phrases: these are examples of those phrases that users can say. When a user's expression looks like one of these phrases, Dialogflow matches this expression with a specific intent.

– Action: it is possible to define a specific action for each intent. When an intent is found for an input user phrase, Dialogflow sends an action to our system and this action can be interpreted as a trigger for other internal actions of our system.

– Parameters: when an intent is found, Dialogflow provides extracted values from a user phrase called parameters. Each parameter has a type, called an entity type, that determines how the data is retrieved. Unlike raw user input, parameters are structured data that can be easily used for further actions, such as generating responses.

– Answers: we can define textual, verbal or visual answers for sending them to the user. This answer may be a simple response to a user expression, requesting additional information, or ending a conversation.

The next thing we'll talk about is entities. As mentioned earlier, each intent parameter has a type called an entity type. Dialogflow provides predefined system entities that correspond to many common data types. For example, there are entities for dates, times, colors, e-mail addresses, etc. You can also create your own data types, for example, it can be an entity of the "vegetables" type, which can match the entered types of vegetables.

Now let's talk about the integration of our Dialog Service and Dialogflow. There are two options. First, Dialogflow can integrate with a large number of popular platforms, for example, Google Assistant, Slack, Facebook Messenger, Telegram, etc.

With this integration, by default the agent responds to the recognized intent with a static response, but it is possible to provide a more detailed and dynamic response using an operation such as fulfillment. When "fulfillment" is activated for an intent, Dialogflow responds to this intention, while invoking one of the service methods. For example, if a user wants to make an appointment with a doctor on a specific day of the week, then our service can make a request to the database, check the doctor's free time on Friday and reply to the user with a message about his availability on the selected day.

In Figure 15 you can see a diagram of such an interaction:
1. User enters or speaks his message.
2. Dialogflow tries to match the input expression with specific intents and select parameters.
3. In case of coincidence and the "fulfillment" option for intent is enabled, Dialogflow sends a webhook request to the service.
4. The service performs the necessary actions for the recognized intent, for example, requests to an external API or database.

5. The service sends a response to Dialogflow containing the information that should be sent to the user.

6. Dialogflow sends a message to the user.

7. The user receives a response.

If we do not want to use the Dialogflow features for integration with external communication channels, then we need to write the appropriate code to communicate with the user and send messages for recognition to Dialogflow, and vice versa. In Figure 16, you can see the general scheme of such interactions:

1. The user types or speaks the message (expression).

2. The service sends this message to Dialogflow in a format for recognizing intent.

3. Dialogflow sends a response back to the service. This message contains information about the recognized intent, actions, parameters and response for this intent.

4. The service performs the specified actions for the recognized intent.

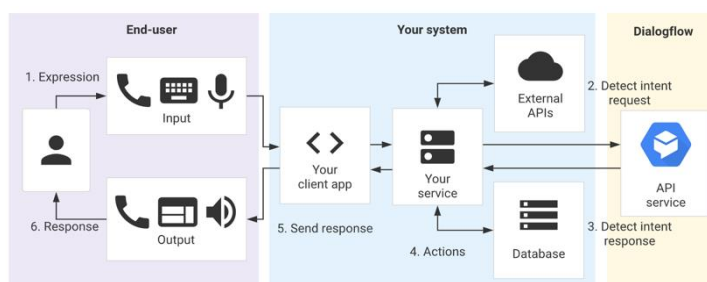5. The service sends a response to the user.

6. The user receives a message.

Figure 15. The way to intract with Dialogflow through some service

For our tasks, we will use the second approach for the following reasons. Firstly, although at this stage integration is planned only with the Telegram messenger, in the future we would like to expand communication channels - connect integration with Facebook Messenger, Slack and add a form on the company's special website. This means that if we used the first integration option with Dialogflow, we would need to configure the integration separately for each communication channel. In addition, in one communication channel, for example, in Telegram, not one bot account can be created, but several, and they all in fact communicate with a single Support Bot Service, which combines all communication channels. For us, this is an extra overhead.

Secondly, as mentioned earlier, in the first version, a request to the service is sent only if Dialogflow recognized the input expression and matched it to the specified intent. For us, on the contrary, it is important to keep the entire history of messages with the user for further analytics and improving the service. Therefore, we must first receive the user message, process it, and only then send the request to Dialogflow.

Now let's proceed directly to the Dialogflow setup for our assistant bot. First, we create an agent,

give him a name, choose a language. We also indicate the correct time zone, it is important if we want to configure recognition of such intentions as weather, time, etc.

After creating the agent, we can already create intentions and fill them with information. There are already two default intentions in our project:

– default welcome intent

– default fallback intent - intent, which starts if none of the created intentions fit.

In the welcome intent, we want to edit the answers that will be sent to the user, since we want to use these phrases to direct the user to start entering a message with an appeal - a question or request, and also to push the user to talk to the bot. Figure 17 provides an incomplete list of new responses to the user's welcome message.

Since there is a "greeting", there must be a "farewell". Therefore, we add a new intent, which will be responsible for recognizing the incoming user phrase as parting with the bot. We add a few training phrases that the user could enter and add phrases for the answer, which can also prompt the user to further calls.

Figure 16. Examples of answers

We would also like to automate the process of user identification, that is, the introduction of his first and last name. Without automatic recognition, difficulties can arise. Firstly, if we ask the user to enter his name and surname, he can do it in several ways: first enter the name and surname or vice versa, enter them with a capital letter or all with a small one. Secondly, you can go the other way and explicitly ask the user to enter the name first, then enter the surname, and ask again if we wrote down his data correctly. But we want to make the most simple interaction with the bot without unnecessary steps. Therefore, we will create the "name and surname recognition" intent and also introduce various training phrases with possible wordings, first names and surnames. In response, we will send a phrase with possibly recognized first and last names, if the user confirms that the data is recognized correctly, then we save them in our database.

In addition to the usual intents, you can configure the SmallTalk module, which contains frequently used phrases and questions, such as "Who are you" or "How are you". An agent can learn to maintain small conversations without additional processing. Using a special form, we can customize the answers to the most popular queries: questions about the agent himself, intentions related to emotional statements, with the user, etc. In Figure 18 you can see an example of such a default question and answers to it.

Figure 17. Form of a template question and its answer

Also a few words about learning. When an agent is trained, Dialogflow uses our data to build a machine learning model specifically for our agent. This usually happens by adding training phrases during the creation of intent, but it is also possible to use a special Training Tool to analyze, import and export data of current conversations and to improve the model.

Helpdesk GLPI

The developed bot assistant has a mechanism for working with tickets. Tickets are handled by a support service. It would be easy to send information about the ticket, for example, by mail to a support service employee and wait until he reads this letter, but in this case this letter may be lost in spam or simply not reach the addressee. Also in such a case it is difficult to track how the work on the application is going on.

For such cases, helpdesk is included in the work - a system for automating the processing of user requests. The introduction of a ticket management system improves the quality of support services and eliminates problems associated with a slow response to requests.

GLPI (Gestionnaire libre de parc informatique - free IT infrastructure manager) is a system for handling applications and incidents, as well as for inventorying computer equipment (computers, software, printers, etc.). It has advanced features, such as the notification tracking system and methods for creating a database with basic information about the network topology.

GLPI is a free software tool for managing IT services for free and open use, which helps to easily plan, manage and easily solve problems when they

arise for users. In addition, this system makes it easy to control the company's budget and its costs if necessary.

Let's introduce the basic concepts for working with the GLPI API.

User token - used during the login process instead of username / password. Can be found in the tab Personalization → Remote access keys → API token.

Session token - the string used in all requests to the glpi API describes the session in glpi.

Application token - an optional parameter by which you can identify access to the API. Can be found in the tab Setup → General → API → API client → Application token.

And we give a description of the basic methods of working with the GLPI API.

The first thing to say is the initiation of the session. Work with the API occurs within a certain session and the received token as a result of initiation. You can create a session by sending a GET request to the following address - apirest.php / initSession /. In the input parameters, you must pass:

– App-token - application token, it is issued upon registration of a client who will use GLPI. The token is issued specifically to the application, and not to all individual users.

– User token - the token of the user that is registered in the GLPI. The user can use different application tokens.

After the session has been initiated, we can create tickets. In order to create it, you must first form the request body with the main fields. After that, you can send a POST request to *apirest.php/Ticket/*. It is also important to specify request headers: session token and application token.

Due to the peculiarities of GLPI itself, we cannot create a ticket immediately in some space (project). There is a separate API method for this. You must send a POST request to *apirest.php/ProjectTask_Ticket/*. In the request body, we specify the ticket identifier and the identifier of the project task in which we will add the ticket.

We also want to cancel the application if the user understands that he can solve his problem himself without any help. To do this, we send a PUT request to *apirest.php/Ticket/{id}*, where id is the ticket identifier in GLPI. In the request body, it is necessary to indicate the new status, namely the "close" status, for which we want to change the current status of the open ticket. Session token and application token must also be passed to request headers.

In order to notify the user about the status in which the application is located, we will use the method of searching for information about the application. You can do this by sending a GET request to *apirest.php/search/Ticket*/. In the query parameters,

we can specify the search criteria. For example, we are looking for a ticket with identifier 5 and the status "resolved", if we find such a ticket, we can conclude that the ticket has been resolved and send the user a resolution; if there is no such ticket, we consider it unresolved, and we inform the user about this . Or we can just search for specific tickets and validate them yourself.

The Bot description

The developed bot is designed for employees to contact and receive technical and informational support. We formulate the requirements:

– It is necessary to have an employee identification mechanism, since employees who are responsible with the support system must understand who they are talking to.

– Implement a user profile, the ability to change the first name, last name, date of birth and other parameters.

– Implement the input of the message, which will be further classified as an application or as a regular question. If this is an application, then it must be created in the support service and notify the user.

– To realize the possibility of canceling the application by the user.

Commands

In Telegram, in addition to communicating with the bot using regular messages, you can also connect teams. The very first command that already exists in the chatbot is */start*. It appears when the bot opens and the user's clean communication history with the bot. When you call this command, a welcome message usually comes, which contains information about what the bot can do, its main features.

We also add the */help* command, which displays help information about the bot, its creators, contacts, how to contact the developers in case there are any problems when working with the bot, or if there are suggestions and wishes.

The Bot registration

We use the Telegram platform, which provides the opportunity to create not only ordinary user accounts, but also special thematic accounts that can automatically process and send messages - bots, for example, [16; 17].

In order to create your own bot, you must use the internal bot developed by Telegram, BotFather. With it, we create an account for the bot, assign it a name and login, and as a result we get a special token, which we will use in future for communication between the bot and our Support Bot Service. This connection is that we must indicate where the bot should redirect the user's messages and where he will receive them back.

There are two completely opposite ways to receive messages from the bot:

– manual update check by long polling;

– registration of a special webhook - notification mechanism for new events.

The second option is more convenient, so we will use it. To do this, an SSL certificate must be installed on the server, where all the program code will be posted, so that all requests pass through the secure HTTPS protocol. Thus, after registering Webhook via Telegram's API, all bot messages will come to the URL specified during registration. Also, for security, it is recommended to include a bot token in the URL, because apart from interested parties, no one can know it and therefore we can know exactly where the messages come from. Also, in the service, we can implement verification of this token from the URL of the input message, that is, whether it is in our database, which will also prevent those cases when someone registered their bot, knowing the structure of the URL for registration, and indicated the address our service.

Conclusion

In this article, we examined the architecture of the helper bot being developed, compiled a component diagram that displays all the components and described the choice of development tools - these are the C #, Python, JavaScript programming languages, HTML and CSS style and markup languages, .NET Core and Bootstrap frameworks, JavaScipt jQuery language library. To organize data storage, PostgreSQL was chosen.

In addition, we described the main points related to the development of services, such as full-text search using PostgeSQL features; integration with the platform for the development of user dialog interfaces Dialogflow; integration with the GLPI ticket system and organization of security in developing projects using the capabilities of the .NET Core IdentityServer.

We also formulated the basic requirements for the bot interface, a list of teams that we want to support and reviewed the features of registering the bot in the Telegram messenger.

References:

1. (n.d.) Obzor yazika C#: [online]. Retrieved from https://docs.microsoft.com/ruru/dotnet/csharp/tour-of-csharp/ [Accessed at 27 June 2020]
2. (n.d.) .NET Core Documentation: [online]. Retrieved from https://docs.microsoft.com/ruru/dotnet/core/ [Accessed at 27 June 2020]
3. (n.d.) Python Documentation: [online]. Retrieved from https://www.python.org/ [Accessed at 27 June 2020]
4. (n.d.) PostgreSQL 11.8 Documentation: [online]. Retrieved from https://www.postgresql.org/docs/11/index.html [Accessed at 27 June 2020]
5. (n.d.) HTML: W3C Documentation: [online]. Retrieved from https://www.w3.org/TR/html52/ [Accessed at 27 June 2020]
6. (n.d.) CSS Documentation: [online]. Retrieved from https://devdocs.io/css/ [Accessed at 27 June 2020]
8. (n.d.) Javascript Documentation: [online]. Retrieved from https://devdocs.io/javascript/ [Accessed at 27 June 2020]
9. (n.d.) jQuery Documentation: [online]. Retrieved from https://jquery.com/ [Accessed at 27 June 2020]
10. (n.d.) Bootstarp Documentation: [online]. Retrieved from https://getbootstrap.com/ [Accessed at 27 June 2020]
11. (n.d.) PostgreSQL: full text search: [online]. Retrieved from https://postgrespro.ru/docs/postgrespro/11/textsearch [Accessed at 27 June 2020]
12. (n.d.) Identity Server: [online]. Retrieved from https://identityserver.io/ [Accessed at 27 June 2020]
13. (n.d.) OpenID Connect: [online]. Retrieved from https://openid.net/connect/ [Accessed at 27 June 2020]
14. (n.d.) OAuth 2.0: [online]. Retrieved from https://oauth.net/2/ [Accessed at 27 June 2020]
15. (n.d.) Postman: The Collaboration Platform for API Development: [online]. Retrieved from https://www.postman.com/ [Accessed at 27 June 2020]
16. (n.d.) Dialogflow: [online]. Retrieved from https://dialogflow.com/ [Accessed at 27 June 2020]
17. Kozhevnikov, V. A., & Pankratova, E. S. (2019). Development of a tool for interpretation of labaratory analysis results. *ISJ Theoretical & Applied Science,* Vol. 12, no. 80, pp. 301-313.
18. Kozhevnikov, V. A., & Pankratova, E. S. (2018). Development of an intelligent recommender assistant using Telegram platform. *ISJ Theoretical & Applied Science*, Vol. 5, no. 61, pp. 77-83.