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DECISION-MAKING SUPPORT SYSTEM TO SUPPORT OF SOCIAL NETWORKS USERS BASED ON SIMILAR COMMON INTERESTS AND PREFERENCES

Today, the socialisation of individuals with common interests is an extremely important process in the isolation of people due to the prolongation of the global pandemic. At the same time, most people are always trying to simplify and automate all the basic life processes that usually take up a lot of free time. The same applies to the individual socialisation process. Machine learning and SEO technologies are extremely important in IS development and Big data analysis. Virtually every IP popular among many people uses appropriate socialisation mechanisms. The primary function of the IS of socialisation of individuals by common interests is to find relevant users, so the main task is to write an optimised algorithm that automates the process of users' socialisation. In this case, a special algorithm was created based on Levenstein's algorithm, sample extension, N-grams and the Noisy Channel model.

Key words: *social network, convolutional neural network, siamese neural network, Levenshtein distance, Noisy Channel model, fuzzy search*

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СИСТЕМА ПІДТРИМКИ ПРИЙНЯТТЯ РІШЕНЬ ДЛЯ ПІДТРИМКИ КОРИСТУВАЧІВ СОЦІАЛЬНИХ МЕРЕЖ НА ОСНОВІ ПОДІБНИХ СПІЛЬНИХ ІНТЕРЕСІВ ТА ВПОДОБАНЬ

На сьогодення соціалізація особистостей за спільними інтересами є надзвичайно важливим процесом під час ізоляції людей із-за подовженості світової пандемії. Паралельно більшість людей завжди намагаються спростити та автоматизувати всі основні життєві процеси, які зазвичай займають багато вільного часу. Це ж стосується і процесу соціалізації особистості. Машинне навчання та SEO-технології на даний момент є надзвичайно важливими в контексті розроблення ІС опрацювання та аналізу великих даних . Практично кожна популярна серед великої кількості людей ІС використовує відповідні механізми соціалізації. Головною функцією ІС соціалізації особистостей за спільними інтересами є пошук релевантних користувачів, тому основним завданням є написати оптимізований алгоритм, який максимально автоматизує процес соціалізації користувачів. В даному випадку створений спеціальний алгоритм на основі таких алгоритмів, як алгоритм Левенштейна, розширення вибірки, N-грам та моделі Noisy Channel. До наукової новизни одержаних результатів варто віднести розроблення нового алгоритму аналізу користувацької інформації та пошуку найбільш релевантних користувачів ІС відповідно до проаналізованого тексту повідомлень профілю на основі вже існуючих алгоритмів Левенштейна, розширення вибірки, N-грам та моделі Noisy Channel. Для створення динамічної ІС соціалізації використано шаблон асинхронного програмування. Удосконалено згорткову нейронну мережу, що дозволило ефективно здійснювати пошук людських обличь на фото та перевіряти наявність вже існуючих людей в БД ІС. Система дозволить ефективно та швидко здійснювати підбір, аналіз, опрацювання текстових даних та формування кінцевого результату. В системі використовуються SEO-технології для ефективного та якісного інтелектуального пошуку та опрацювання відповідних даних за потребою конкретного користувача. Нейронна мережа дозволяє ефективно здійснювати ідентифікацію користувача по його фото. Загалом використовувані алгоритми дозволяють створити зручну ІС соціалізації з використанням необхідних для цього алгоритмів. Варто зазначити важливість оптимізації наявної в ІС, в першу чергу це повна асинхронність системи, що дозволить уникнути всіх довгих очікувань та важких в плані опрацювання та аналізу запитів, система дозволяє ефективно та динамічно працювати з різними обсягами великих даних, здійснювати їх аналіз, опрацювання та формування нових даних необхідних користувачам ІС. Також використовується хмарний сервіс, який дозволить здійснити розподіл даних, відповідно можна буде зберігати всі найбільш важкі дані в хмарному середовищі і з використанням простого програмного інтерфейсу ІС за допомогою запитів здійснювати завантаження всіх необхідних даних. Таким чином, можна стверджувати, що створення даної ІС є важливим як і в соціальному плані, так і в плані реалізації всіх алгоритмів, які забезпечують необхідний функціонал ІС.

Ключові слова: *соціальна мережа, згорткова нейронна мережа, сіамська нейронна мережа, відстань Левенштейна, модель Noisy Channel, нечіткий пошук*

Introduction

Creating an intelligent system of socialisation of individuals is an urgent task. In today's world, people are trying to optimise all life processes to save time and, accordingly, for a more appropriate implementation of the time reserved. When searching for specific programs, users choose the ones that save time, optimise work, and are automated enough to perform most actions instead of the user system. This information system combines two critical tasks: socialisation of users and optimises and automates the socialisation process. Creating an intelligent system that would allow effective analysis and selection of users is an important task, as there are currently no such systems. The socialisation system will optimise the process of finding and meeting people on the Internet. To implement this system, you need to use a convolutional neural network to search for faces in photographs. It is also necessary to use fuzzy search algorithms and the Noisy Channel model to analyse user information and create a list of relevant users. To successfully create an intelligent system of socialisation of individuals with common interests, the most important task is to understand and process a task of user socialisation properly.

Related Works

There are quite a several articles on this topic. For example, the authors in [1-2] propose a new system of ranks among social network users and an adaptive network model for easy interaction between users. The authors propose improving the aggregation and sorting of information in social networks. The authors in articles [3-4] propose to improve the capabilities of social networks in terms of analysis of user data and the formation of user characteristics and improve the capabilities of social networks in terms of finding similarities between users and, subsequently, identifying relevant coincidences in the subsequent search for information on the social network. Also, the article [5] also suggests a new approach to sorting / storing data in the cloud and their issuance when searching using a new flexible model of data delivery in social networks. First of all, if we talk about the advantages of intelligent systems over analogues, it should be noted that there are almost no analogues with a similar system [6-10], among which are Tinder and Badoo. The similarity of the system with them in the convolutional neural network uses checks for similar users and is used to identify users in the system [7]. The main disadvantage is that Tinder and Badoo provide the most limited socialisation mechanism, allowing you to filter users by gender, age and location, which is not optimised and does not save much time spent on socialisation [7].

Materials and Methods

In the course of system analysis, we can say that the system of socialisation of individuals with common interests based on SEO technologies and methods of machine learning has one external essence, namely: User and the four primary inner beings to which they belong as Browser, System controller, Database and System service.

During the operation of the system, there is a constant interaction between external and internal entities, so when initialising the system, the external entity the user enters the system using the internal entity - Browser. The Browser entity authorises the user in the middle of the system if he is already registered or registers otherwise, and authorisation and registration take place using the internal entity System Controller. After successful registration or authorisation, the System Controller entity sends a session token to the Browser entity and saves the current token inside the browser for the session duration. Then the User entity uploads its photo to verify its authenticity using the Browser entity, which adds the picture using the System Controller entity. The System Controller entity uses neural networks to check the presence of a face in the user's entity photo. Also, it contains similar images inside the system. The System Controller entity stores all received user data and sent the generated data to another internal entity, namely the database.

After that, the Database entity stores all the information using the internal System Service entity. The System Service starts processing this information and creates a list of unique system users. After that, the System Service entity uses fuzzy search algorithms to analyse user data that currently work inside the system and other registered users. And as a result of fuzzy search algorithms, the System Service entity creates a list of users formed according to current user data and generated by decreasing interest similarities between users. Next, the System Service entity performs a final check of the received data for the presence of damaged and inaccurate data and saves the received information using the Database entity. Then, with the help of a user query, the generated data from the Database entity is sent to the User entity. The user reviews the provided information and selects the profile of the user who liked him the most using the essence of the Service system. Next, the user's identity acts as putting the preference of another user so that another user of the system could see that the current user selected him. After completing the preference process, the System Service entity with the System Controller entity starts chatting with another user. It thus forms a dialogue, which is stored as stored information with the System Controller and Database entities. And it exists inside the system as a stream of messages stored in a session running within the system to display all user data and messages within the system dynamically, and a session running at a specific point in time to display data. The System Service entity sends a Database entity request to check data availability. One of the most important aspects of the system is users' security and information. In case of specific problems with data processing, it is also necessary to ensure fully asynchronous processing and data transfer for the fastest operation of the program, which will allow users to use the system optimally quickly.

It is also worth paying more attention to the essence of the database because working with data is an essential element of the system and, therefore, should seriously analyse how this entity should work and what components it should consist of. In this case, the internal essence of the database consists of seven essential elements, which will allow you to safely and quickly process user information, namely: Check the data; Check for backup files; Save data; Save user dialogue; Create a data package; Check that the request is correct; Send data on request.

After that, the System Controller entity sends a request for the System Service. Asynchronous Data Processing entity, the System Service entity uses dynamic events to constantly check the state of the system in which it is located and responds to all system changes at a particular time. The System Service entity, from time to time, in a separate thread, checks the system for errors on exceptions that have not been registered in the system log and tries to correct them or send for processing the essence of the System Controller for further processing.

It is also necessary to describe in more detail the essence of the System Controller, and it has just such functions: User data processing; System data processing; Data verification; Check session availability; Verification of identifiers; Display an error message; Store system links; User token checks; Checking for updates. It is also

necessary to describe the essence of the Service system in more detail. It contains the following functions: Creating a user list; List analysis using algorithms; Creating a percentage; Processing user correspondence; Creating a message flow; Message flow processing; Creating custom tokens. It is also worth describing in more detail the essence of the browser, which is not fundamental, but it contains the following functions: Authorisation; Registration; Save token; Session check; Display messages to the user; Read custom messages; Add a user photo; Send user requests to the Server; Display of client errors/ After the System Service entity has generated a message flow request, it sends a System Controller entity request, which requests a dialogue token in the System Service entity, and the System Service entity sends a current token that contains data about the current session. Next, the essence of the System Controller displays the generated dialogue of the user essence through the browser essence. The user continues to either work or log out of the system.

Statement and justification of the problem

How to state and substantiate the problem can be divided into two main parts, namely the implementation of two neural networks: convolutional and Siamese, which will search for the human face and reproduce algorithms of SEO technologies, namely Levenstein's algorithm and Noisy Channel model, which are necessary for the socialisation of users of common interests within the system. Using machine learning in modern information systems is undoubtedly important. Nowadays, all systems operate with a large amount of data. It is often necessary to distribute data, optimising and speeding up the work of system processes. This can be achieved by processing part of the data using machine learning. It is also important not to forget about the peculiarities of creating server programs, namely the optimisation of algorithms for the interaction of server programs, to implement an algorithm for optimised packet data transmission of different sizes. It is necessary to implement algorithms for analysing text data in social networks, create a neural network that compares user photos and text information left by the user, and form a sample based on the analysed data. Implementing optimal data storage on mobile devices is important to create basic templates for saving, processing and constructing a data sample using the current model. It would be best if you optimised information retrieval algorithms. It is also necessary to implement data extraction mechanisms, create a neural network that analyses all submitted social information at the input, and use input parameters to throw out all irrelevant information, saving only the necessary data at a given time. We must also remember to optimise the processes within the system, namely the storage of data on system servers and in the device's local database and the optimisation of transmission and storage algorithms.

Description of the subject area

According to the analysed text, the system's primary purpose is to create a new algorithm for analysing user information and finding the most suitable users based on existing algorithms such as Levenstein's algorithm, sampling algorithm, N-gram algorithm, and Noisy Channel model. The template of asynchronous creation of a software product that will allow the design of an almost completely dynamic system also underwent further development. It is necessary to improve the convolutional neural network, which will allow the efficient and dynamic search of human faces in the photo, and check the presence of existing people in the system's database.

The research object is the socialisation process of individuals because nowadays, the task of socialisation is very important, and all modern social networks try to optimise and automate the socialisation of various users using all popular modern technologies such as neural networks and user text analysis algorithms. For the successful creation of an information system for the socialisation of individuals with common interests, the most important task is to understand and create the process of socialisation of users properly.

The subject of research, in this case, is inside the object of study. It is the user of the information system, the primary purpose of which is the implementation of socialisation. Accordingly, the system user is studied, namely the identification of the user by searching the human face in custom photos using neural networks and analysing user information using fuzzy search algorithms and the Noisy Channel model.

In addition, important tasks are the use of primary methodologies needed to build an information system, namely the construction of DFD data flow diagrams using the Gain-Sarson methodology, modelling data using "ERD-Entity Relationship Diagrams" (ERD-Entity Relationship Diagrams), construction STD (State Transition Diagrams).

Entity-to-relationship (ERD) charts are designed to develop data models and provide a standard means of defining data and their relationships. ERD details the data warehouses of the designed system, as well as documents the essence of the system and the means of their interaction, including the identification of objects important to the subject area (essence), properties of these objects (attributes) and their relationships with other objects (connections). This notation was introduced by Chen and was further developed in the works of Barker. Chen Notation provides a rich set of data modelling tools, including ERD, attribute charts, deck position charts. Entity-relationship diagrams have been built. The system has four entities: User, System service, User session and Server. Entity User has five attributes: User_ID, Login, Password, Personal data, Average score. Entity System service has five attributes: Server_session_ID, Name of the operation, Query parameters, Users rating, Value of the average parameter. Entity Server has two attributes: Data package, Identifier. Entity User session is a weak entity with five attributes: Session_ID, Token.

Weak entity User session has two weak links to the User entity, namely "Token request" and "Response to request". The User entity has three connections to the Server entity, namely "Search for users", "Send information", and "Select the user from the list". Weak entity User session has a weak connection to the server entity, namely: "Transmits session data". Entity Server has four links to the essence of the System service, namely: "Saves intermediate settings", "Sends a request to the user", "Saves the flow of user dialogue", and "Generates a list of users". User Entity and Weak Entity User sessions have weak one-to-many connections. Soft entity User session has a weak reference to the Server one many-to-entities. Entity User has links to the Server one-to-many entities. The Server essence is related to the System service essence, namely many-to-each other.

With the help of STD you can model the future operation of the system based on its previous and current processes. Over time, it can change its state, and the transitions between states must be clearly defined. A state transition diagram has been created that shows a system at exactly one of a finite set of states at a given point in time. The diagram consists of transitions that contain six main stages:

- User login is the user logs in, registers and authorises.
- Add a photo is the user adds his photo, the system checks the presence of a face in the photo, verifies the user's authenticity, and searches for photos in the database. Then if you successfully add a photo, it is stored in the database, and the user accesses user lists.
- Forming a users list is the system analyses all user data and, on their basis, performs fuzzy algorithms to search for textual information of other users, thereby forming a list of suitable users by percentage, sorting the list in descending order and sending for viewing to the user.
- View the selected profile - the user views the profile chosen, views the photos, general information and interests of the selected user, and, because of success, sets the profile preferences and starts correspondence.
- Chatting is a separate message flow is created for correspondence between two users, dynamically updated and stored in the system database.
- Data storage and log out are after correspondence, the token is checked, and the session is limited. All generated data, user information, message flow and logging are saved in the system database, after which the user goes to the main menu of the system.

Creating entity-relationship diagrams

Entity-relationship diagrams have been built. The system has four entities:

- The user is responsible for adding personal information, finding relevant system users, adding a photo and engaging in dialogue with the selected user.
- System service is the entity responsible for the selection of operations, the implementation of responses to the request, the implementation of algorithms for analysing textual information, authentication of users and the formation of a sorted list of users by interests.
- A user session is a weak entity that displays the current user's session and contains all the necessary parameters for the user to work within the session.
- Server – an entity that contains only the generated data and identifiers, but is fundamental because it is through the Server that the interaction between other entities takes place. All data is stored on the Server because of work.

The main attribute diagrams are shown in Fig. 1-3, and the main entity-relationship diagram is shown in Fig. 4.

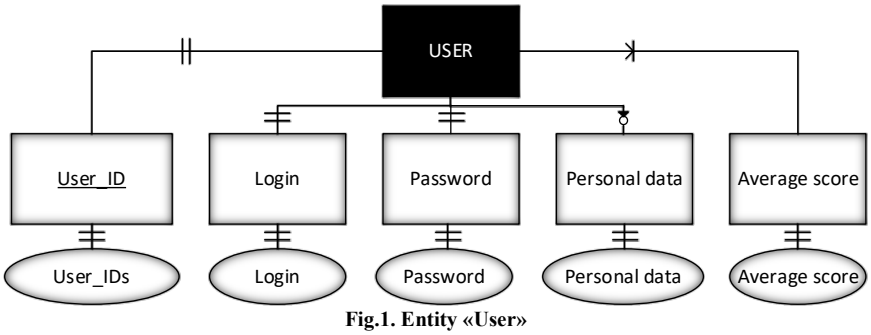


Fig.1. Entity «User»

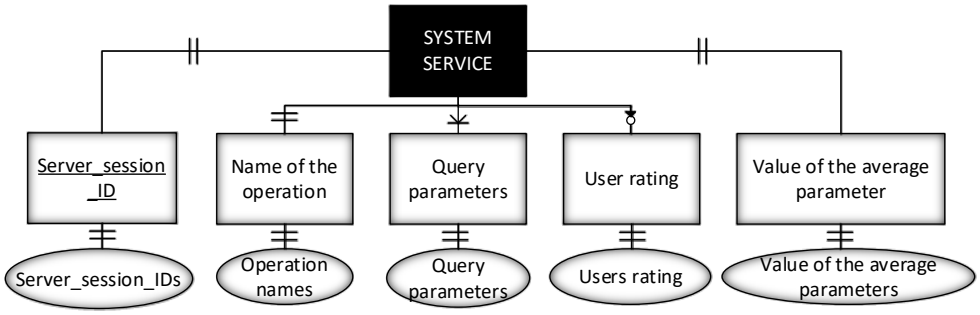
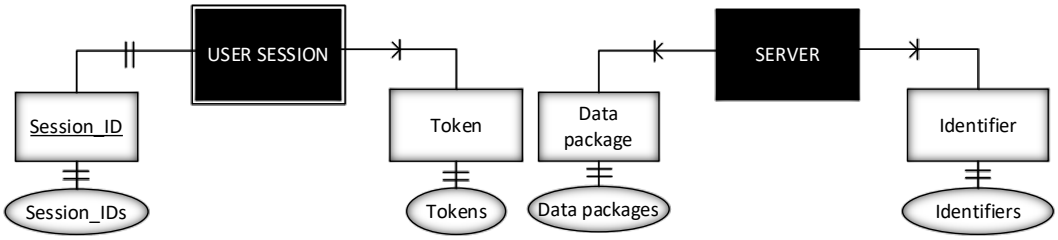


Fig.2. Entity «System service»



a) **b)**

Fig.3. Entity: a) «User session»; b) «Server»

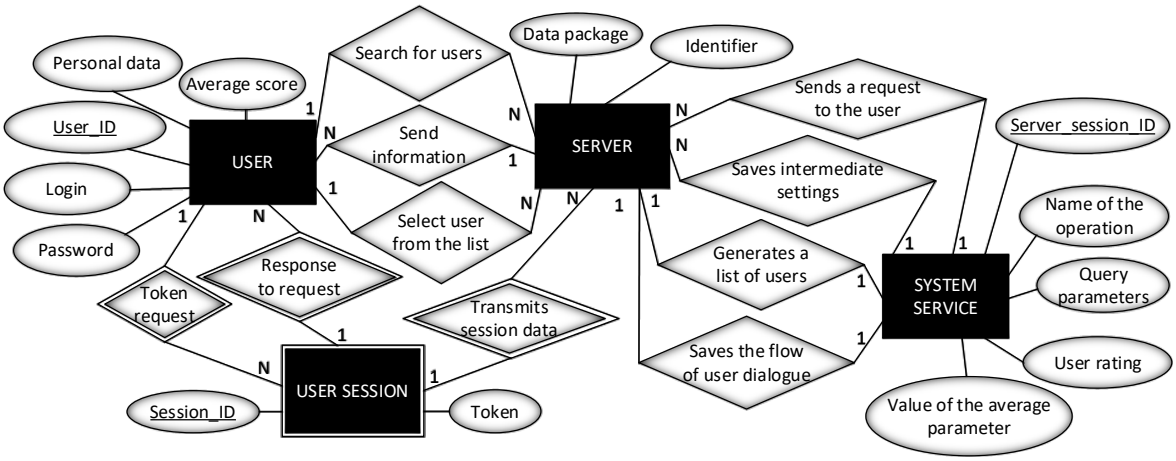
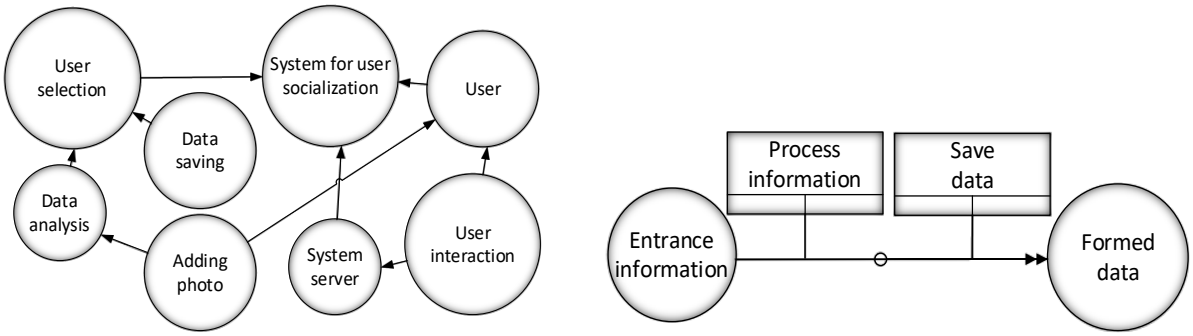


Fig.4. Entity-relationship diagram

Experiments

Figure 5a shows the compositional scheme of the information system, Fig. 5b shows the state diagram, figure 6 shows the classification diagram of the types of information required for the operation of the information system, and figure 7 shows the diagram of the information system scenario. A state transition diagram has been created that shows a system at exactly one of a finite set of states at a given point in time. The state transition diagram is shown in figure 8, and a transition matrix was created, shown in table 1.



a) **b)**

Fig.5. a) Compositional scheme of the information system; b) state diagram

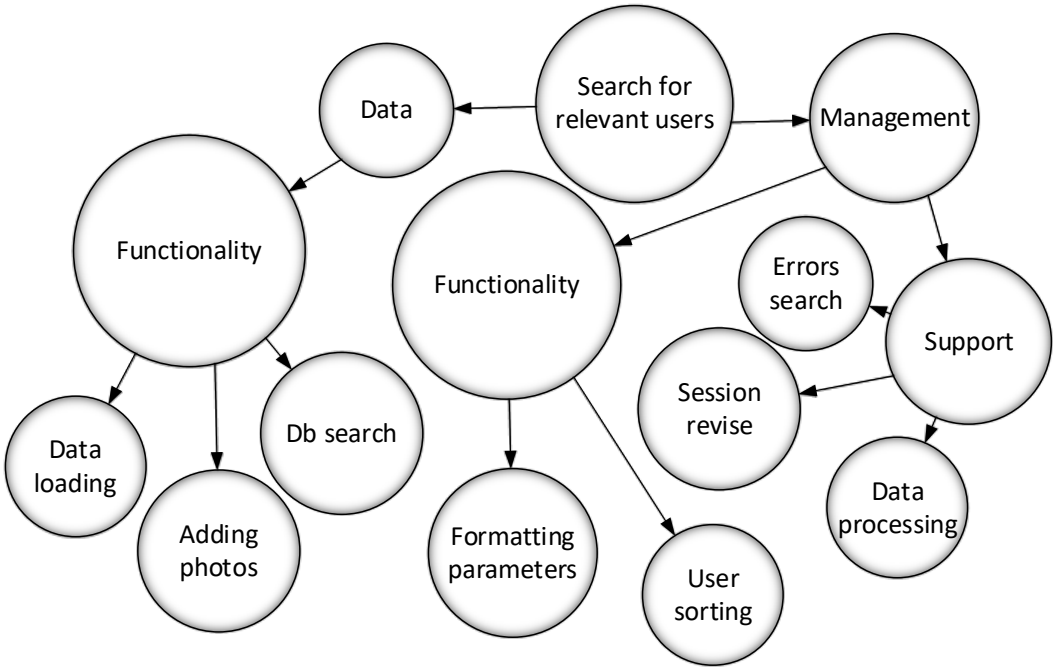


Fig.6. Classification diagram of the types of information

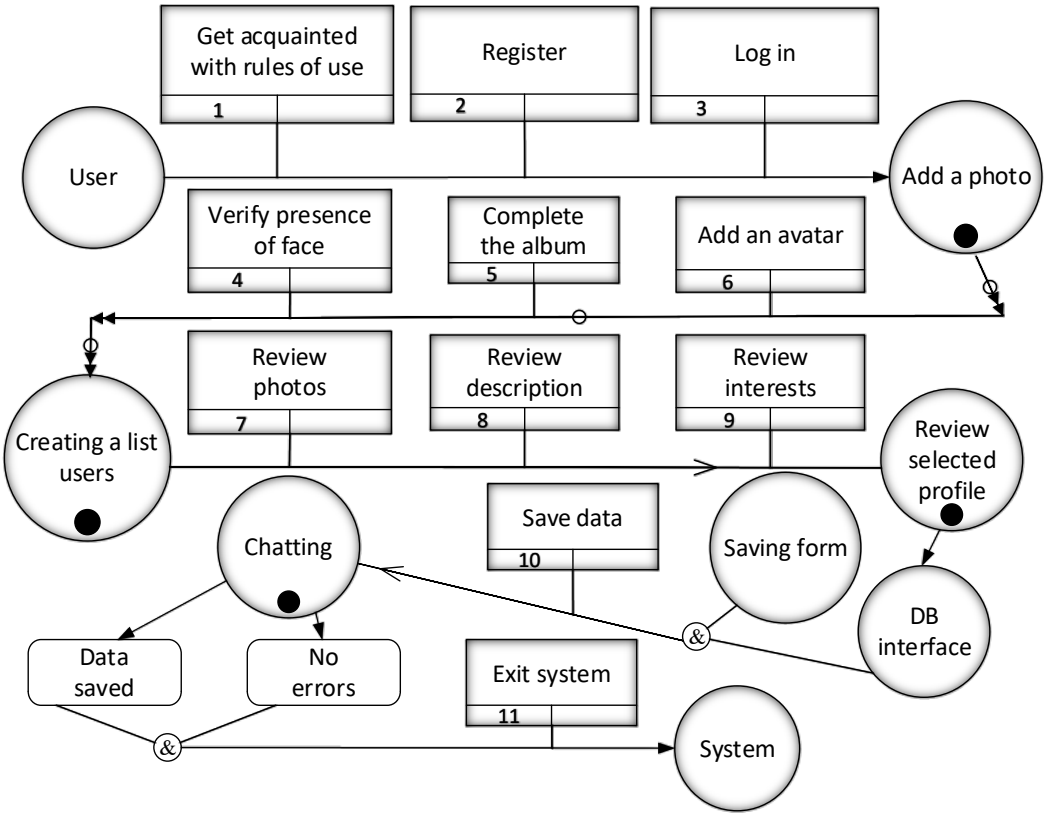


Fig.7. Diagram of the information system scenario

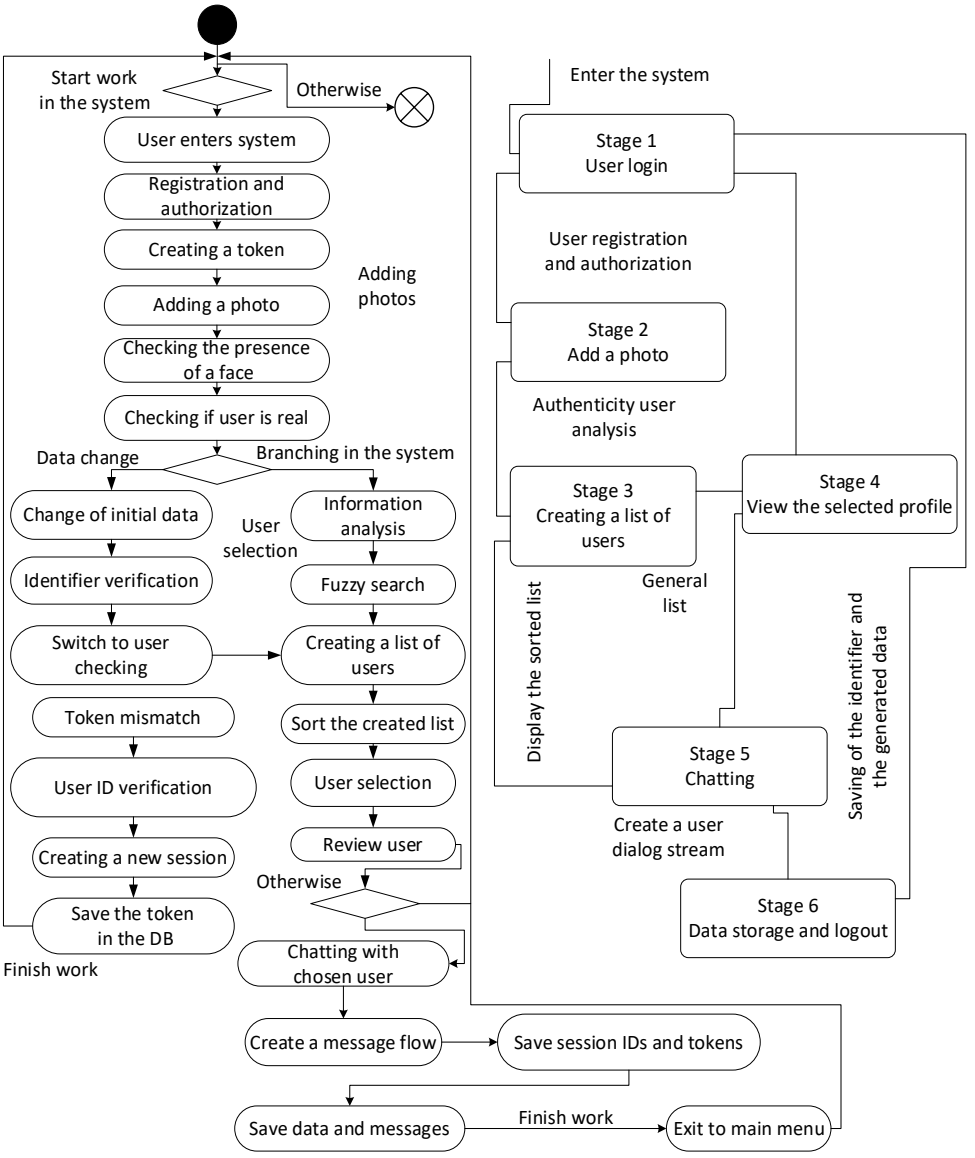


Fig.8. State transition diagram

Table 1

System state transition matrix

Current state	Condition	Action	The next state
1	2	3	4
INITIAL STATE	User login	Load the system	EXPECTATION
EXPECTATION	The system is loaded	Registration	PROCESSING
PROCESSING	Registered	User authorization	EXPECTATION
EXPECTATION	Authorized	Creating a user token	PROCESSING
PROCESSING	Token created	Send the token to the browser for saving	EXPECTATION
EXPECTATION	Saved token	User login to the main page	FINAL STATE
INITIAL STATE	User in the system	Upload a photo	EXPECTATION
EXPECTATION	Photo uploaded	Search for a face in a photo	PROCESSING
PROCESSING	Face found	Face check	EXPECTATION
EXPECTATION	The face is checked	Comparison of faces with others in the DB	PROCESSING
PROCESSING	User face verified	Save a photo	EXPECTATION
EXPECTATION	Saved photo	Creating an album	PROCESSING
PROCESSING	Add a photo to an album	Save the album in DB	EXPECTATION
EXPECTATION	Saved album	Finish working with photos	FINAL STATE
INITIAL STATE	Information entered	Data processing	EXPECTATION
EXPECTATION	Generated text data	Text processing	PROCESSING
PROCESSING	Text data processed	Start a fuzzy search among all users	EXPECTATION
EXPECTATION	Generalization of fuzzy search between users	Creating a list	PROCESSING
PROCESSING	The list is formed	Sort list	EXPECTATION
EXPECTATION	The list is sorted	Filter the list by external parameters	PROCESSING
PROCESSING	Filtered list	Output information to the user	EXPECTATION
EXPECTATION	The information is processed	Completion	FINAL STATE
INITIAL STATE	Received list	View a list of all users	EXPECTATION

1	2	3	4
EXPECTATION	The list has been revised	User selection	PROCESSING
PROCESSING	User selected	View user's photos	EXPECTATION
EXPECTATION	Photos viewed	View user description	PROCESSING
PROCESSING	Description reviewed	View user interests	EXPECTATION
EXPECTATION	Interests reviewed	Presenting the user	PROCESSING
PROCESSING	Preferences are set	Start chatting with user	EXPECTATION
EXPECTATION	Chatting started	Create a message flow	PROCESSING
PROCESSING	Stream created	Saving ID in DB	EXPECTATION
EXPECTATION	ID saved	Save session token	PROCESSING
PROCESSING	Session token saved	Save the flow of messages in the DB	EXPECTATION
EXPECTATION	Stream saved	Session token check	PROCESSING
PROCESSING	Token checked	Saving parameters in DB	EXPECTATION
EXPECTATION	Settings saved	Check for errors	PROCESSING
PROCESSING	Errors checked	Save logging in DB	EXPECTATION
EXPECTATION	Logging saved	Checking a local DB	PROCESSING
PROCESSING	Local DB checked	Output data to the user	EXPECTATION
EXPECTATION	Output information	Exit to the main menu	FINAL STATE

The general algorithm of the work of the intelligent system is shown in Fig. 9 in the form of use case diagrams and Fig. 10 in the form of activity diagrams. The basic screenshots of the work of the intelligent system are shown. Fig. 11 shows are adding information about the user and the description, interests, and general information about what and whom the user is looking for content. Fig. 12 shows the process of adding photos of the user manually or through the explorer, one or several photos, so in the process of adding, you can stop and delete unnecessary photos.

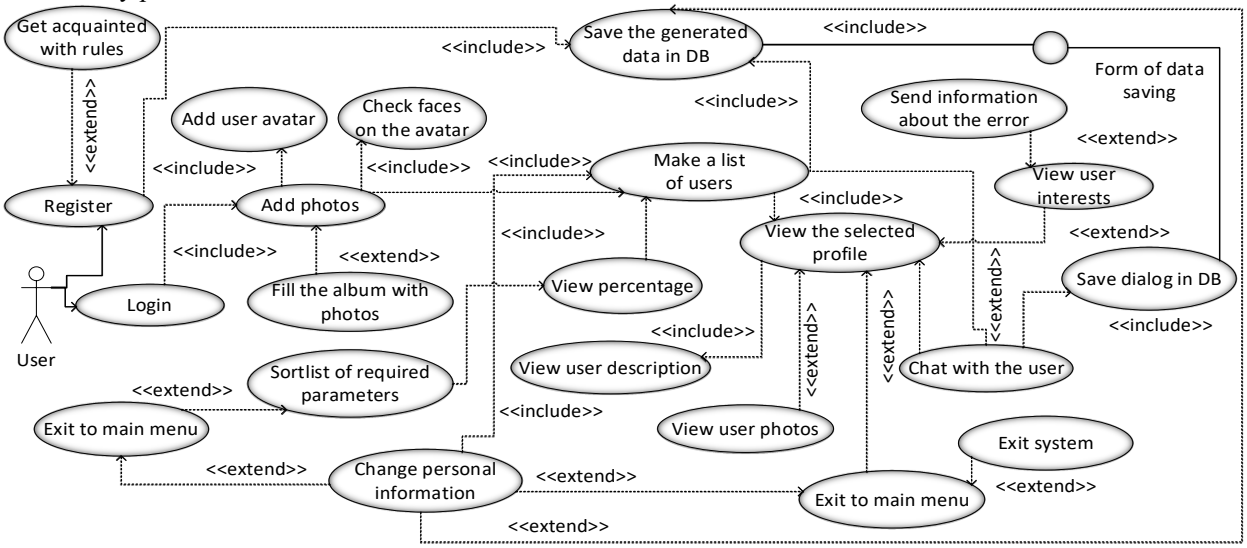


Fig.9. Use Case diagram

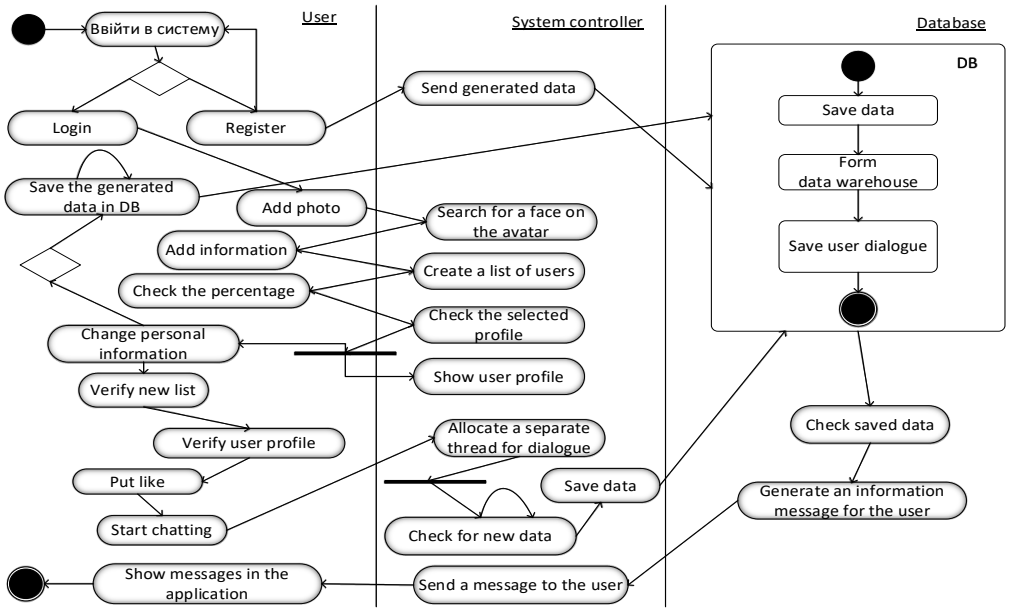


Fig.10. Activity diagram

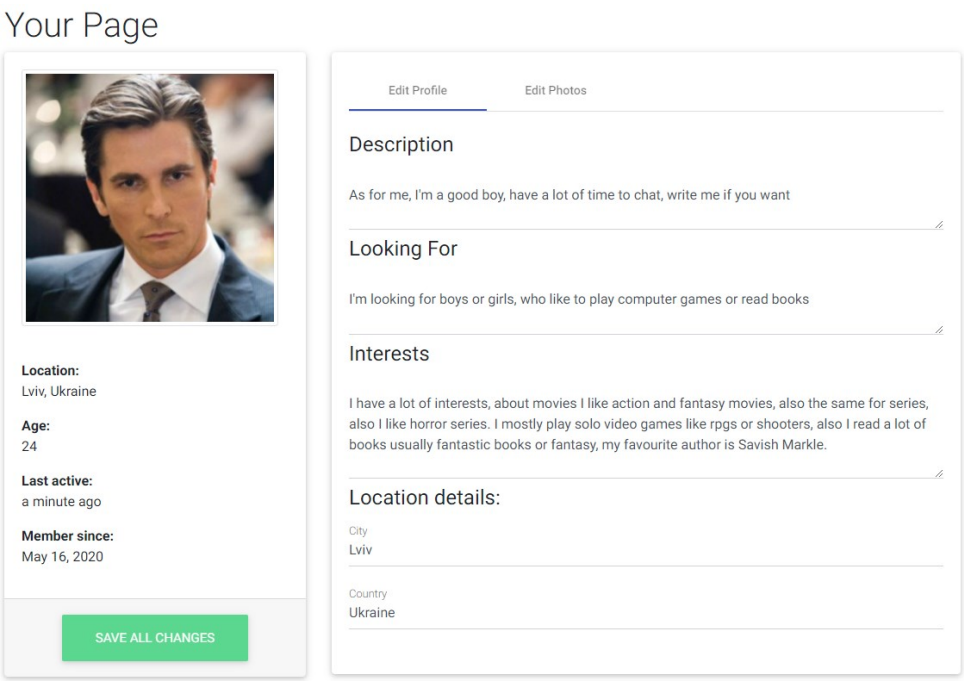


Fig.11. Adding user information

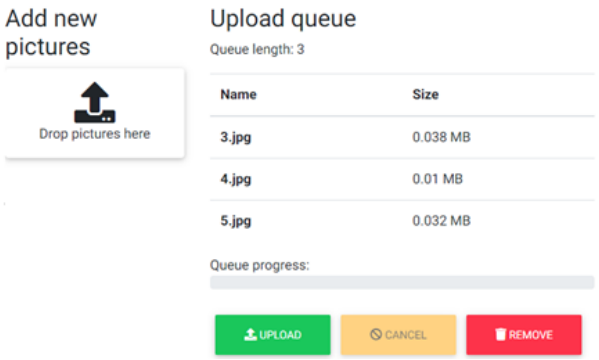


Fig.12. Uploading user photos

Fig. 13 shows the currently added photos and the use of the convolutional neural network. A convolutional neural network consists of two types of layers: convolutional layers and subsampling layers. In it, each layer has a topographic structure. Each neuron is associated with a fixed point of the original image and the input image area, which this neuron processes. There are several different neurons at each layer's location, each with its own set of input weights associated with the neurons in the rectangular fragment of the previous layer. The convolutional neural network allows you to determine whether such a user is already in the database and whether the face is depicted in the photo (as seen in the selected fragment of the screenshot). The system does not allow putting a picture on the avatar with no face.

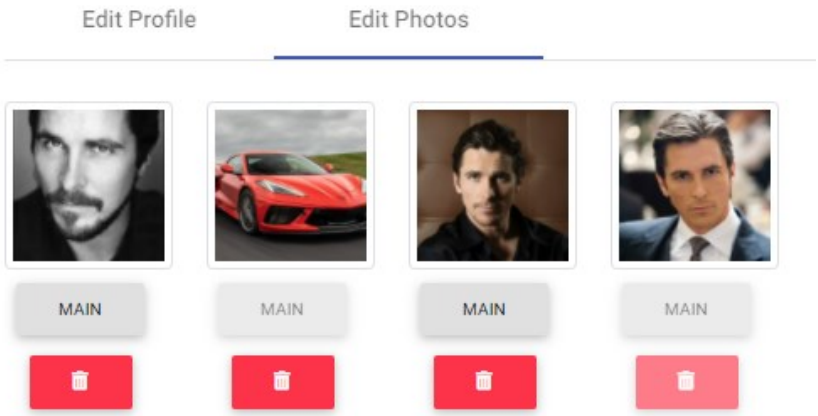
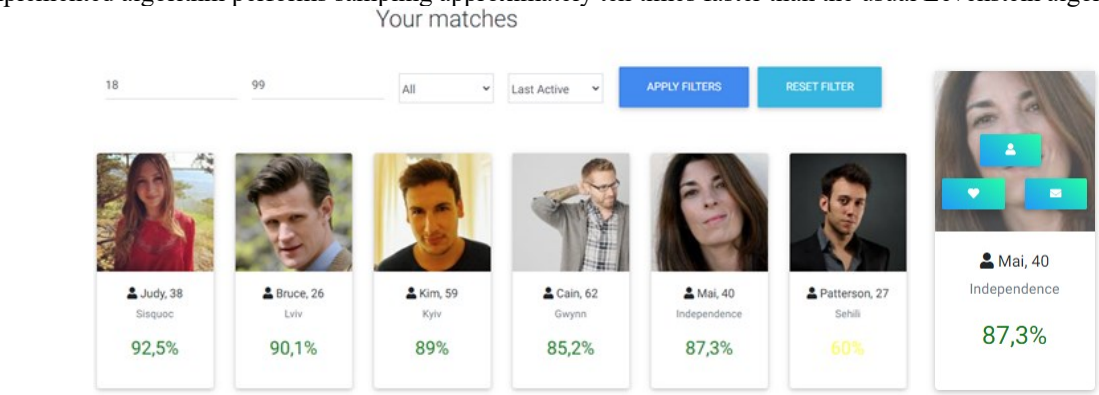


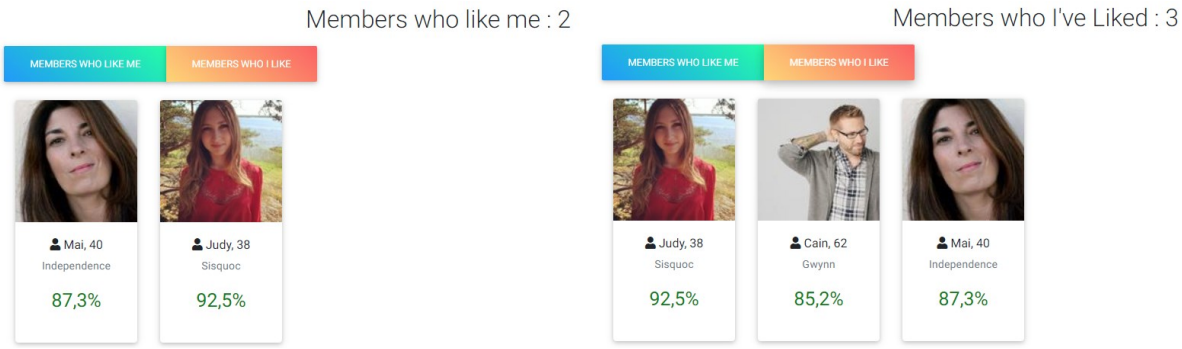
Fig.13. Adding user photos

Fig. 14a shows the generated list of users using fuzzy search sorted by the calculated percentage of similarity between users. A linear search is chosen among the fuzzy search algorithms - a simple sequential application of metrics (in this case, Levenstein's metrics) to words from the input text. To calculate the optimal distance between words in the text, you need to modify the algorithm to find the usual Levenstein distance. It needs to save not two but the last three rows of the matrix and add condition - in case of transposition when calculating the distance, also take into account its Value. Thus, modifying the algorithm, the Noisy Channel model was used. It allowed optimising the information analysis process, first creating a matrix of user parameters. Then asynchronously using a linear search to compare current parameters and form a similarity percentage for each parameter. The last step is to find the average percentage of similarities between users. Figures 14b-17 show the user's selection, liking the user, viewing the list of selected users and the users who selected us, viewing the profile and photos of the selected user, and starting chatting. It was found that the algorithm implemented in the system for forming a sample of users is more efficient and accurate by about 25-30% compared to the usual Levenstein algorithm. Also, the implemented algorithm performs sampling approximately ten times faster than the usual Levenstein algorithm.



a) **b)**

Fig.14. a) Generated list of users; b) user's selection



a) **b)**

Fig.15. a) Users who selected us; b) selected users

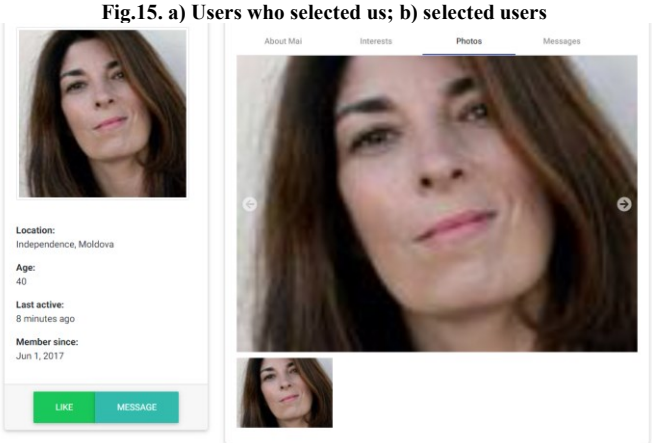


Fig.16. Viewing the profile and photos of the selected user

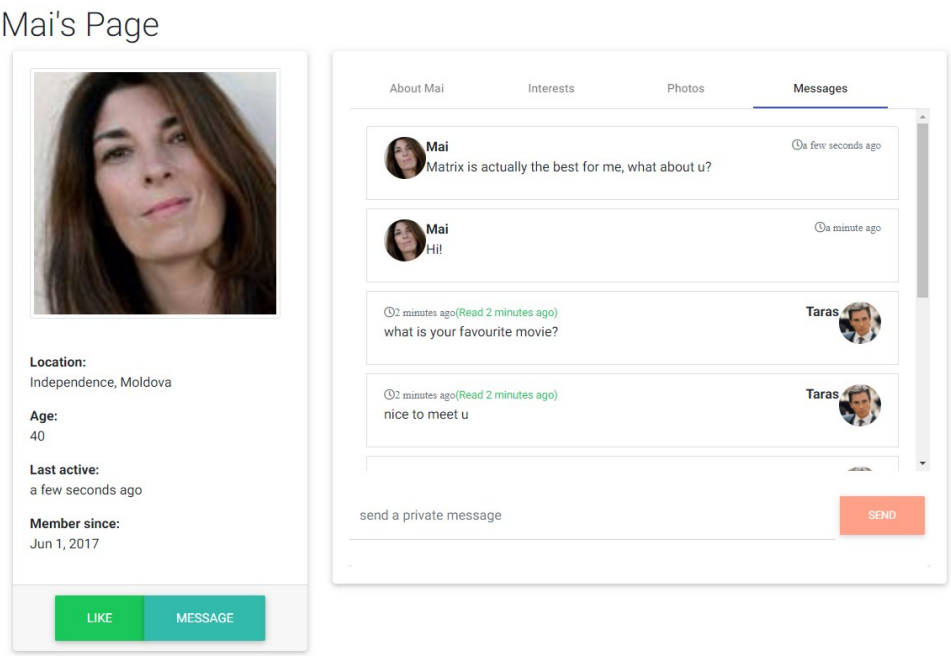


Fig.17. Chatting with user

Conclusions

Nowadays, the socialisation of individuals with common interests is an extremely important process, as most people try to simplify and automate all basic life processes, which usually take up a lot of free time. The same applies to the socialisation process based on SEO technologies, and machine learning methods play an important role in this, as it optimises the process of socialisation. During the implementation, an analytical review of literature sources was conducted, among which was briefly described all aspects of modern socialisation of individuals, namely information about neural networks for facial recognition and fuzzy search algorithms for processing textual information. It also described the main purpose of the created system, why it was created, and the main problems solved by creating this type of system. The reasons and factors that are important for creating this system were analysed. The existing systems and analogues of the created system were described; their advantages and disadvantages concerning the created system of socialisation of individuals on common interests were described. A systematic analysis of the object of study was conducted, the methodology of research of the subject area was described in detail. And new information about this system creation was supplemented. Important statement and substantiation of the problem of creating this system was made the shortcomings of the use of the developed information system. The research object and subject of the system and their description were indicated. The necessary diagrams were also constructed: use case and activity diagrams, entity-relationship diagrams, and state transition diagrams. It allowed to fully carry out a systematic analysis of the individual's socialisation system by common interests, allowing further implementation of the software product.

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