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MATHEMATICAL RATIONALE FOR CREATING AN APPLICATION FOR CONDUCTING RANDOM MEETINGS «COFFEE BREAK»

Modern society is facing an increasing trend of social isolation, as people increasingly rely on social media for interaction instead of face-to-face communication. This lack of in-person contact often leads to feelings of loneliness and disconnection. This study proposes the concept of a mobile application, CoffeeBreak, designed to counteract these trends by offering users a platform to arrange brief, in-person meetings, such as a quick coffee chat. By encouraging users to meet in real life, the application aims to foster meaningful social connections and combat the sense of isolation prevalent in today's digital world. The core innovation of CoffeeBreak lies in its unique approach to matchmaking. Instead of presenting users with an overwhelming array of choices, the app offers a single match within a specified timeframe, thus addressing the common issue of decision paralysis that can arise when users are presented with too many options. By simplifying the process, CoffeeBreak allows users to spend less time making selections and more time connecting with others. This approach is inspired by practices adopted within large companies, where employees use bots in work chat groups to find a partner for a short meeting. These interactions help raise awareness about the activities in other departments and foster informal and professional connections. Expanding this practice to a broader societal level, CoffeeBreak is intended to provide individuals with the opportunity to network beyond their immediate professional circles. This research has established a conceptual system model and developed the mathematical frameworks necessary to support this type of meeting arrangement. Specifically, the study has defined the concept of the CoffeeBreak mobile application, outlined the system model with detailed subsystems and environment interactions, and formulated mathematical models to form the basis of the candidate selection algorithm. The model ensures that users are matched in a way that promotes engagement, as each participant can be assured that their matched partner is equally motivated for the encounter. As the application continues to evolve, it can incorporate additional scheduling criteria to enhance the quality of matches and distribution. For example, if a user attends a meeting within the first two days, they could unlock the potential for additional matches by the end of the week. Ultimately, CoffeeBreak aims to broaden users' horizons, help them form new professional and informal connections, and enhance their social skills. This study's findings lay the groundwork for a new tool that encourages in-person interactions, enabling individuals to expand their social networks in a balanced and purposeful manner.

Keywords: mobile app facilitating random meetings, socialization, networking, information system, conceptual model, mathematical model.

Introduction. In today's world, humanity is increasingly immersed in online life and social media. Although these platforms were initially created with the purpose of building social connections and fostering societal unity, over the years, their actual impact has shown somewhat of a reverse effect – an increase in social isolation [1]. Additionally, the loss of social skills has been exacerbated by the relatively recent COVID-19 pandemic. As a result, the need for tools to facilitate the search for new acquaintances in the real world is now more urgent than ever.

In addition to the new challenges brought about by technological advancements, old issues persist. Most of a person's social interactions still occur with individuals from their own or adjacent professional fields and social groups. This significantly limits the expansion of one's horizons, a goal often pursued by those seeking new connections. Meeting people from different perspectives can foster powerful collaborations for solving various problems, as individuals from diverse backgrounds approach issues from different angles [2]. Many ambitious people actively seek such acquaintances to generate new ideas in areas as diverse as solving professional challenges, addressing personal issues, or brainstorming business concepts.

Therefore, there is a growing need for a new and effective tool that can help people broaden their horizons, find both professional and informal connections, and improve their social skills. This mobile app facilitating random meetings should offer society a novel approach to expanding their social networks and should also encourage users to engage in real, face-to-face communication.

Analysis of recent research and publications. Currently, there are numerous dating services available on the market [3-6]. The most popular ones are primarily focused on finding a romantic partner, such as apps like Tinder, Badoo, Blendr, Bumble, and Wink. All of these apps operate on the principle of browsing through a list of profiles and voting «like» or «dislike». If both users react positively to each other's profiles, the app provides contact information for further communication. A similar concept is employed by other apps that have more specific themes, for example:

- Hey! VINA – primarily aimed at women looking for new female friendships;
- Peanut – designed for mothers who want to connect with other moms;
- ATLETO – useful for those seeking a partner or opponent for team or competitive sports activities.

There are also other, more distinctive solutions:

- Down – bases the list of potential meeting candidates on the user's social media friends list.
- Happn – shows people with whom the user has crossed paths in the city.

All of the aforementioned solutions have their own advantages, each offering a unique user experience and catering to a specific audience. However, they share a common feature: each app provides the ability to choose from a vast number of potential candidates for dating [7]. While having a large selection might seem beneficial, it can actually have the opposite effect. A large number of options can lead to decision paralysis and reduce satisfaction with the choices made. Additionally, users often spend a significant amount of time filtering candidates based on photos, age, or an inappropriate joke in the profile description. Even when a match is achieved, it does not guarantee that the person on the other side is interested in meeting or engaging in real-life communication.

The aim and tasks of the research. The aim of this research is to develop conceptual and mathematical models for a system that provides an innovative approach to finding new acquaintances through a mobile application.

To achieve this aim, the following tasks must be completed:

- Define the concept of the future system.
- Create a conceptual model of the future system.
- Develop the mathematical models for the meeting arrangement information system (mobile app facilitating random meetings).

Presentation of the main material. The project idea is based on a widely adopted practice among employees of large companies. In work chat groups, bots are created where employees can submit requests to find a partner for a brief meeting. These sessions help raise awareness among employees of large corporations about what is happening in other departments and the activities of colleagues in different areas. Employees thus have the opportunity to establish new informal and professional connections. Simply put, this practice broadens employees' horizons and expands their social networks within the company.

If we extend this practice to a global society, such a solution has the potential to address both the problem of limited social interaction and the challenges of networking. Individuals will be able to expand their social networks beyond just a single company workforce. Importantly, this solution avoids the «overchoice» problem found in many leading apps on the online networking and dating market. Users will have only one match within a set timeframe, encouraging them to take action, knowing that they won't have another candidate for a noticeable period. Additionally, they can rest assured that the person on the other side is in exactly the same situation. Of course, as the product develops, it will be enhanced with additional features, but the core concept of limiting the number of potential matches within a specific timeframe will remain. For example, if a user attends a meeting within the first two days, they could unlock the possibility of up to two additional matches by the end of the week.

Formation of the concept. The idea for this system is based on a widely adopted practice among large companies' staff. In workplace chat environments, bots are created where employees can submit requests to find a candidate for a brief meeting. These practices help improve employees' awareness of what is happening in other departments of their company, what activities other people might be engaged in, and so on. Employees have the opportunity to form new informal and professional connections. In simpler terms, this practice broadens employees' horizons and enhances their social networks.

If this practice is extrapolated to a global society, it suggests that such a solution could address issues of social interaction and networking. People would be able to expand their social networks beyond just the group of workers in their company. Additionally, this solution would avoid the problem of choice overload that is common in many leading online dating apps. Users would only have one match at a given time, which would encourage them to take action, as there would not be another candidate available for a noticeable period, and they would understand that the person on the other side is in a similar situation. As the product develops, it will be enhanced with new features, but the core concept of limiting the number of candidates for a given period will be maintained. For example, if a user goes on a meeting within the first two days, they will be able to get two more matches by the end of the week [8].

Since modern people always have their smartphones with them, it makes sense to develop this system as a mobile application. We will call it CoffeeBreak. The interface should be as simple as possible: fill out a profile, press a button to start searching, and wait for a candidate for a meeting.

Development of a conceptual model. To understand all the components of the future application, it is necessary to identify all subsystems of the CoffeeBreak product, including the internal and external environments, as well as the overarching system within which CoffeeBreak operates. Together, these components and their interactions form the system composition model [9].

First, we will outline the subsystems of the CoffeeBreak application. At this stage, it is crucial to have well-defined functional requirements for the application, as the subsystems will reflect how the system meets these requirements. The subsystems of CoffeeBreak include:

- User Management. Responsible for managing user accounts and profiles. Key functions of this subsystem include: registration of new users (user authentication and authorization); profile management (updating information, adding interests, changing settings); ensuring user data security (encryption, password protection).
- Random Meeting Generation. Responsible for organizing random meetings between users. Key functions of this subsystem include: Randomly pairing users for meetings; considering time and geographic constraints when generating meetings.
- Meeting Management. Responsible for managing all aspects of organizing and conducting meetings. Key functions include: creating, editing, and canceling meetings; managing meeting locations; sending reminders and notifications about changes in meeting schedules; integrating with mapping services to provide navigation to the meeting location.
- Messaging. Handles communication with users and sending various types of notifications. Key functions include: sending notifications about new meetings,

reminders, and updates; supporting push notifications and email; informing users about new features, app updates, and other important events.

- Analytics and Reporting. Ensures the collection, analysis, and visualization of data related to app performance and user interactions. Key functions include: collecting statistical data on app usage; analyzing user activity and the effectiveness of app features; generating reports for administrators and developers.
- Partner Management. This subsystem is designed for collaboration with partner cafes that will offer their services for meetings. Key functions include: registering and managing profiles of partner cafes; integrating with cafe booking systems; providing cafes with access to information about scheduled meetings; allowing cafes to offer special deals and discounts to CoffeeBreak users; tracking user reviews and ratings of partner cafes.
- Chat. Provides the ability for users to exchange messages before and after meetings. Key functions include: sending text messages and media files between users; storing chat history; notifying users of new messages from other users.

The internal environment of the system includes Administrators, who can assist users in case of unusual situations. Administrators will have access to the «Analytics and Reporting», «Meeting Management», «User Management», and «Partner Management» subsystems.

In the external environment, we should consider Partners and Competitors. Partners have access to the «Partner Management» subsystem to monitor and manage the special partner functionalities. Competitors, on the other hand, do not have direct influence on the application but may affect users and the development progress of the application.

The overarching system in the original concept is the global society; however, this solution could also be applied within large corporations that wish to implement such a system within their company, thereby providing a more convenient tool than a bot in a workplace chat.

Thus, the results of the model creation can be presented graphically, clearly indicating the relationships between the components of the model (fig. 1).

Let us also briefly outline the tools that will be used for the app development. Flutter was selected for the app development. This modern open-source framework enables seamless deployment across both mobile platforms, Android and iOS, eliminating the need to write separate applications for each platform [10].

For servers and web panels, Python [11] will be used in combination with the Flask framework. This setup provides a straightforward and widely adopted toolkit, allowing for the rapid and efficient development of a modern solution.

MySQL was chosen as the database management system (DBMS), as its simplicity and reliability make it ideal for creating the CoffeeBreak product [12].

Development the conceptual model of a mobile app facilitating random meetings. To develop the CoffeeBreak mobile application, it is necessary to formalize the main processes and tasks in mathematical terms. This will help define the algorithms that will underpin the application's operation.

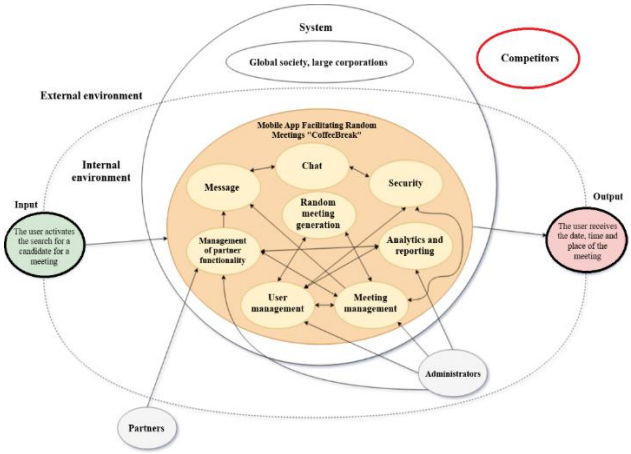

Fig. 1. Conceptual model mobile app facilitating random meetings CoffeeBreak

The primary objective of the application is to maximize the number of scheduled meetings between users (1).

Let:

$$U = \{u_1, u_2, \ldots, u_n\}, \tag{1}$$

where U – set of users.

We will introduce a binary variable x_{ij}, which equals 1 if a user u_i is assigned to a meeting with user u_j, otherwise the variable will be 0.

The formulation of the problem is as follows (2):

$$\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} \longrightarrow \max, \tag{2}$$

with conditions (3-5):

$$\sum_{j=1}^{n} x_{ij} \leq 1, \ \forall i \in [1, n]. \tag{3}$$

$$\sum_{i=1}^{n} x_{ij} \leq 1, \ \forall j \in [1, n]. \tag{4}$$

$$x_{ij} \in \{0, 1\}, \ \forall i, j \in [1, n]. \tag{5}$$

The objective function maximizes the number of assigned meetings, and the constraints ensure that each user can only participate in one meeting at a time.

As an extension of the basic functionality for selecting candidates for a meeting, it would be useful to provide the ability to set location constraints where it is convenient for the user to hold a meeting, as well as time constraints. This way, the system will only select candidates for the user who are geographically convenient and available at a mutually suitable time (6-7).

Let:

$$T = \{t_1, t_2, \ldots, t_m\}, \tag{6}$$

where T – set of time intervals;

$$L = \{l_1, l_2, ..., l_k\}, \quad (7)$$

where L – set of locations.

To take into account time and geographical constraints, we introduce the user availability function $A\{u_i, t, l\}$, which is equal to 1, if the user u_i is available in the time interval t at the location l, and 0 otherwise.

A user's accessibility function can be defined as:

$$A\{u_i,t,l\} = \begin{cases} 1, & \text{if the user } u_i \text{ is available in } t \\ & \text{at the location } l, \\ 0, & \text{otherwise.} \end{cases} \quad (8)$$

Let's enter the binary variable x_{ijtl}, which is equal to 1, if the user u_i is scheduled to meet with the user u_j in the time interval t at the location l, and 0 otherwise.

Then the new formulation of the problem will have the following form:

$$\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{t=1}^{m}\sum_{l=1}^{k} A(u_i, t, l) \cdot x_{ij} \longrightarrow \max, \quad (9)$$

with conditions (10-12):

$$\sum_{j=1}^{n}\sum_{t=1}^{m}\sum_{l=1}^{k} x_{ijtl} \le 1, \ \forall i \in [1, n]. \quad (10)$$

$$\sum_{i=1}^{n}\sum_{t=1}^{m}\sum_{l=1}^{k} x_{ijtl} \le 1, \ \forall j \in [1, n]. \quad (11)$$

$$x_{ijtl} \in \{0, 1\}, \ \forall i, j, t, l \in [1, n]. \quad (12)$$

In general, the objective function is the same as in the base model, the number of assigned meetings, and the constraints ensure that each user can only participate in one meeting at a time.

Application of interval distribution. In order to make it easier for users to start communicating during a meeting, you can expand the functionality of the application and allow users to add categories of interests and views on life to their profile, thus the system will prioritize candidates for the meeting that best match each other according to a set of categories. For this, we introduce the similarity function (13):

$$S(u_i, u_j) = \frac{|I_i \cap I_j|}{|I_i \cup I_j|}, \quad (13)$$

where I_i – set of user interests u_i;

I_j – set of user interests u_j.

As you can see, this function will give a value between 0 and 1, depending on how similar the sets of users are. Now let's apply this function to modify our problem formulation.

Then the new objective function will have the following form (14):

$$\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{t=1}^{m}\sum_{l=1}^{k} S(u_i, u_j) \cdot A(u_i, t, l) \cdot x_{ij} \longrightarrow \max. \quad (14)$$

The conditions remain the same as in the previous paragraph, they are given by formulas (10), (11), (12).

Conclusions. This research has proposed a concept and models that can form the basis for a new tool aimed at expanding one's horizons, finding new professional and informal connections, and enhancing social skills. The application will offer an innovative approach to finding connections by randomly selecting a candidate for a brief meeting, such as for coffee. This solution will help avoid decision paralysis and significantly reduce the time spent on selection.

The research has achieved all of the set objectives:

- The system concept has been defined. It will be the CoffeeBreak mobile ap-plication, designed to easily provide users with a candidate for a short meeting.
- A conceptual model of the system has been created, reflecting all subsystems, the overarching system, and the application environment.
- Mathematical models for the meeting scheduling system have been developed. These models will form the basis of the algorithm for selecting candidates for meetings.

Further research in this area is advisable, as meeting scheduling algorithms may in-corporate new criteria to improve how users are matched and distributed.

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МАТЕМАТИЧНЕ ОБҐРУНТУВАННЯ СТВОРЕННЯ ДОДАТКУ ДЛЯ ПРОВЕДЕННЯ ВИПАДКОВИХ ЗУСТРІЧЕЙ «COFFEE BREAK»

Сучасне суспільство зіштовхується зі зростаючою тенденцією соціальної ізоляції, оскільки люди все більше покладаються на соціальні мережі для взаємодії замість спілкування віч-на-віч. Відсутність особистого контакту часто призводить до почуття самотності та відірваності. У цьому дослідженні пропонується концепція мобільного додатку CoffeeBreak, розробленого для протидії цим тенденціям, пропонуючи користувачам платформу для організації коротких особистих зустрічей, наприклад, швидкої бесіди за кавою. Заохочуючи користувачів зустрічатися в реальному житті, програма спрямована на розвиток значущих соціальних зв'язків і боротьбу з почуттям ізоляції, поширеним у сучасному цифровому світі. Основна інновація додатку CoffeeBreak полягає в його унікальному підході до пошуку партнерів. Замість того, щоб надавати користувачам величезну кількість варіантів вибору, програма пропонує єдиний збіг протягом визначеного періоду часу, таким чином вирішуючи поширену проблему паралічу прийняття рішень, яка може виникнути, коли користувачам пропонується забагато варіантів. Завдяки спрощенню процесу CoffeeBreak дозволяє користувачам витрачати менше часу на вибір і більше часу на спілкування з іншими. Цей підхід натхненний практиками, прийнятими у великих компаніях, де співробітники використовують ботів у робочих групах чату, щоб знайти партнера для короткої зустрічі. Ці взаємодії допомагають підвищити обізнаність про діяльність інших відділів і сприяють неформальним і професійним зв'язкам. Розширюючи цю практику на ширший суспільний рівень, додаток CoffeeBreak має на меті надати людям можливість спілкуватися за межами їхніх безпосередніх професійних кіл. В рамках дослідження було побудовано концептуальну модель системи та розроблено математичну структуру додатку. Зокрема, в дослідженні визначено концепцію мобільного додатку CoffeeBreak, окреслено модель системи з детальними підсистемами та взаємодією середовища, а також сформовано математичні моделі, які склали основу алгоритму відбору кандидатів. Модель забезпечує підбір користувачів таким чином, щоб сприяти взаємодії, оскільки кожен учасник може бути впевнений, що його підібраний партнер однаково мотивований для зустрічі. В подальшому додаток буде удосконалюватися. Він буде доповнений додатковими критеріями планування для підвищення якості збігів і охоплення все більш широкої аудиторії користувачів. Наприклад, якщо користувач відвідує зустріч протягом перших двох днів, він може розкрити потенціал для додаткових збігів до кінця тижня. Зрештою, CoffeeBreak має на меті розширити кругозір користувачів, допомогти їм створити нові професійні та неформальні зв'язки та покращити їхні соціальні навички. Результати цього дослідження закладають основу для нового інструменту, який заохочує особисту взаємодію, дозволяючи людям розширювати свої соціально-комунікативні навички.

Ключові слова: мобільний додаток для проведення випадкових зустрічей, соціалізація, нетворкінг, інформаційна система, концептуальна модель, математична модель.

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