Notes on Intuitionistic Fuzzy Sets
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Generalized net model of a social network with intuitionistic fuzzy estimation

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Abstract: The social network is a social structure created out of specific dots (which may represent people or organizations), connected as specific types of ideas, visions, financial benefit, friendship, tradition, links, etc. In its most simple form, the social work represents a map of the connections between all of the relational dots that are studied. The offered generalized net gives different variations of use of the social networks as giving a path of work in the social network. The research is oriented towards the social network *Facebook*. The whole process is described with one of the variations of tools, which use parallel processing of information – Generalized nets.
Keywords: Generalized net, Social network, *Facebook*.
AMS Classification: 03E72.

1 Introduction and Preliminaries

The interest in the analysis of social networks has increased significantly in recent years. This growth is accompanied by the use of various methods of analysis. Models and Methods in Social Network Analysis (MMSNA) presents one of the most important stages of development and using quantitative models and methods for analyzing data in social networks. It is known that social network analysis has been used since mid-1930s, going from the social and behavioral sciences, and progressing through graph theory, diagrams and other subgroups – reflecting the significant problems in the analysis.

Almost all researchers of social networks among researchers have looked at links that are based on the activities of scientists in one field, specialty or discipline [6, 8, 11, 12]. There are some data that confirm the impression that the boundaries of research areas are much more open [7, 8]. So far Millins [12] examined the social network made up of scientists at work in different disciplines (mainly in biological sciences).

The analysis of opinions and attitudes in social networks is oriented to automatic detection of views and opinions from free text. This research area is partially motivated by the commercial purpose of giving cheap, detailed and timely customer feedback to enterprises [13]. Before the advent of the Internet, companies have relied on relatively slow and expensive methods for obtaining feedback from customers, such as telephone or mail surveys, interviews and focus groups. Online, however, they may be able to get feedback from the customer reviews on the Internet, blogs, comments, and chat discussion, suggesting that a program can filter the relevant data from the rest of the network or social network. In this context, the objective of the analysis is to identify the positive and negative opinions in free text. The objective can be detailed under identifying what is being discussed and how (e.g. people who have liked some of the car or have not liked) or the objective may be a decision under the diagnosis of nature and content of opinion (e.g., diagnosing how one critic like its online film review).

The analysis of opinions and attitudes is often divided into two tasks: detection as text segments (e.g., sentences) containing opinions and moods and analysis [13].

In order to make better assessment of the views of individual participants in social networks using intuitionistic fuzzy estimates of the degree of belonging and not belonging passivity of friends who are approved or not appropriate action. Intuitionistic fuzzy sets, (IFS, see [3, 4]) are sets whose elements have degrees of membership and non-membership. They are defined by Atanassov in 1983 as an extension of fuzzy sets of Zadeh. In the classical theory, element belongs or does not belong to the summary. Zadeh defines membership in the interval [0; 1]. The theory of intuitionistic fuzzy sets extends above concepts by comparing membership and non-membership of real numbers in the interval [0; 1] and the sum of these numbers must also belong to the interval [0; 1].

Let the universe is an E. Let A be a subset of E. Let us construct the set

$$A^* = \{\langle x, \mu_A(x), \nu_A(x)\rangle | x \in E\}$$

where $0 \le \mu_A(x) + \nu_A(x) \le 1$. We will call *A** intuitionistic fuzzy sets (IFS). The functions $\mu_A : E \to [0,1]$ and $\nu_A : E \to [0,1]$ set degree of membership (membership) and non-membership (non-membership). The function $\pi_A : E \to [0,1]$ is defined by $\pi(x) = 1 - \mu(x) - \nu(x)$, corresponding to the degree of uncertainty (uncertainty).

2 Generalized net model

For the purpose of description of the process of functioning of a social network, we need to use a tool for description of parallel processes. One possibility is to use the apparatus of Petri Nets, [10]. In this case we choose to use Generalized Nets (GN, see [1, 2]), which generalize all of the Petri Nets' modifications and extensions.

Initially the following tokens stand in the following places of the GN:

- In place $L_{1A} - \alpha_{1A}$ the token with characteristics "User's actions";
- In place $L_{2A} - \beta_{2A}$ the token with characteristics "Resources";
- In place $L_{3A} - \gamma_{3A}$ the token with characteristics "Tools for analysis";
- In place $L_{4A} - \delta_{4A}$ the token with characteristics "Activities".

The GN contains the following set of transactions *A*:

$$A = \{Z_1, Z_2, Z_3, Z_4\},$$

where transactions describe these process:

- Z_1 – Choosed actions of the user of the social network;
- Z_2 – Choosing resources-(apps);
- Z_3 – Analysis of a profile;
- Z_4 – Taking actions.

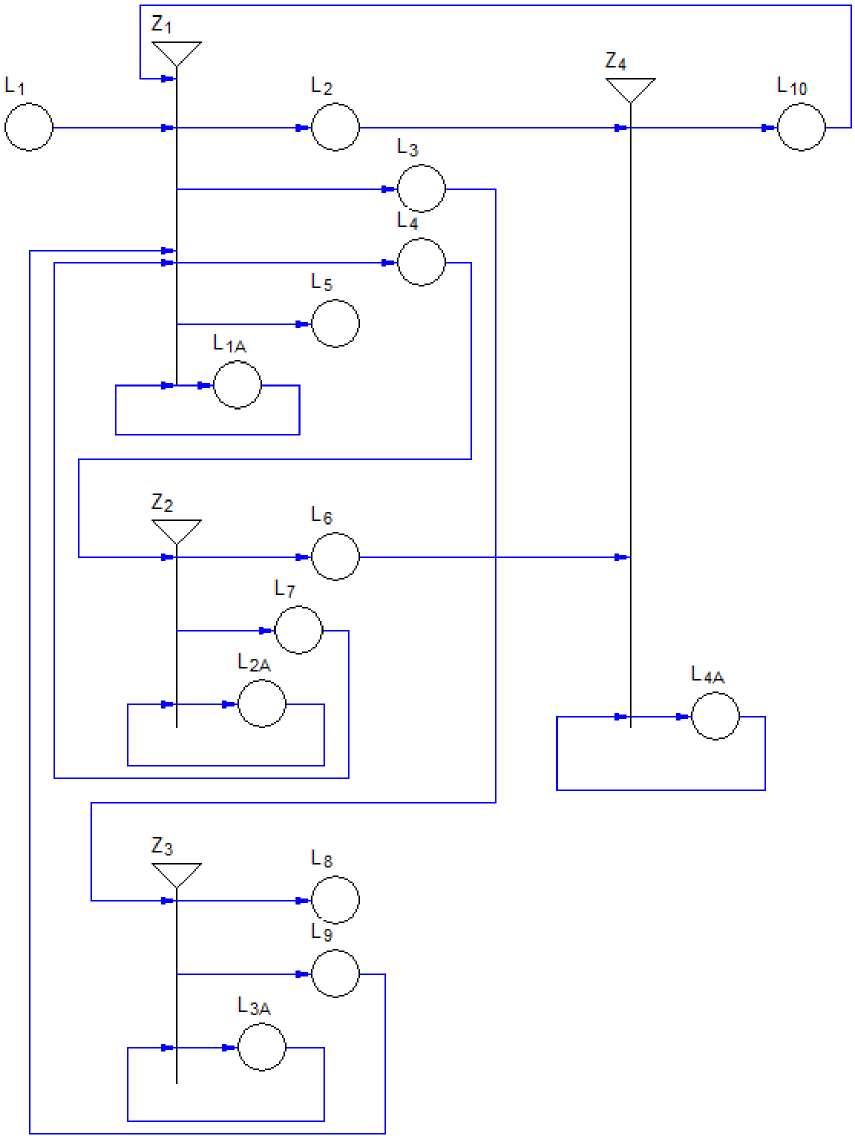

Figure 1. Generalized network model of the process of work and analysis of the social work

Transactions have the following description.

The token incoming in place L_1 enter with characteristics "User".

$$Z_1 = \langle \{L_1, L_7, L_9, L_{10}, L_{1A}\}, \{L_2, L_3, L_4, L_5, L_{1A}\}, R_1, \vee (L_1, L_7, L_9, L_{10}, L_{1A}) \rangle,$$

where

$$
R_1 = \begin{array}{c|ccccc} & L_2 & L_3 & L_4 & L_5 & L_{1A} \\ \hline L_1 & false & false & false & false & true \\ L_7 & false & false & false & false & true \\ L_9 & false & false & false & false & true \\ L_{10} & false & false & false & false & true \\ L_{1A} & W_{1A,2} & W_{1A,3} & W_{1A,4} & W_{1A,5} & true \end{array}
$$

where:

- $W_{1A,2}$ = "User decides to action";
- $W_{1A,3}$ = "User needs information";
- $W_{1A,4}$ = "User is interested in resources";
- $W_{1A,5}$ = "User leaves the social network".

The token, incoming in place L_2, L_3, L_4, L_5 are incoming tokens with characteristic: "User took action", "Information of the user", "Resources" and "Exit of the social network".

$$
Z_2 = \langle \{L_4, L_{2A}\}, \{L_6, L_7, L_{2A}\}, R_3, \vee (L_4, L_{2A})\rangle,
$$

where

$$
R_2 = \begin{array}{c|ccc} & L_6 & L_7 & L_{2A} \\ \hline L_4 & false & false & true \\ L_{2A} & W_{2A,6} & W_{2A,7} & true \end{array}
$$

where:

- $W_{2A,6}$ = "User chosen application";
- $W_{2A,7}$ = "User chosen a new action".

Through place L_6 and L_7 are incoming tokens with characteristic "Chosen application" and "New action chosen".

$$
Z_3 = \langle \{L_3, L_{3A}\}, \{L_8, L_9, L_{3A}\}, R_3, \vee (L_3, L_{3A})\rangle,
$$

where

$$
R_3 = \begin{array}{c|ccc} & L_8 & L_9 & L_{3A} \\ \hline L_3 & false & false & true \\ L_{3A} & W_{3A,8} & W_{3A,9} & true \end{array}
$$

where:

- $W_{3A,8}$ = "Chosen screen visualization";
- $W_{3A,9}$ = "New action chosen".

Through place L_8 and L_9 are incoming tokens with characteristic "Created Information about screen visualization" and "New action chosen ".

$$
Z_4 = \langle \{L_2, L_6, L_{4A}\}, \{L_{10}, L_{4A}\}, R_4, \vee (L_2, L_6, L_{4A})\rangle,
$$

where

$$
R_4 = \begin{array}{c|cc} & L_{10} & L_{4A} \\ \hline L_2 & false & true \\ L_6 & false & true \\ L_{4A} & W_{4A,10} & true \end{array}
$$

where $W_{4A,10}$ = "User tags a picture".

The token entering in place L_{10} receives characteristic "New action chosen".

3 Profile analysis

To analyze the user profiles described at Z_3, has been used program code at one of the most used social networks, 'Facebook'. We have performed own analysis of publications, using content-related and demographic indicators. In a recent research [9], Dimitrova and Petkova have been shown how demographic data can be analyzed by means of the *R* programming language, and here we use their results and build upon them.

3.1. Publications according to their kind (Figure 2)

The following denotations have been used:

- K – Sum of the publications posted on the profile
- M – Sum of the shared links posted on the profile
- N – Sum of the statuses at the profile
- G – Sum of the shared pictures posted at the profile
- R – Sum of the shared videos posted at the profile
- $M_1 = \frac{M}{K}$, where M_1 is the ratio of sum of all links to all publications;
- $N_1 = \frac{N}{K}$, where N_1 is the ratio of all statuses to all publications;
- $G_1 = \frac{G}{K}$, where G_1 is the ratio of all pictures to all publications;
- $R_1 = \frac{R}{K}$, where R_1 is the ratio of all videos to all publications.

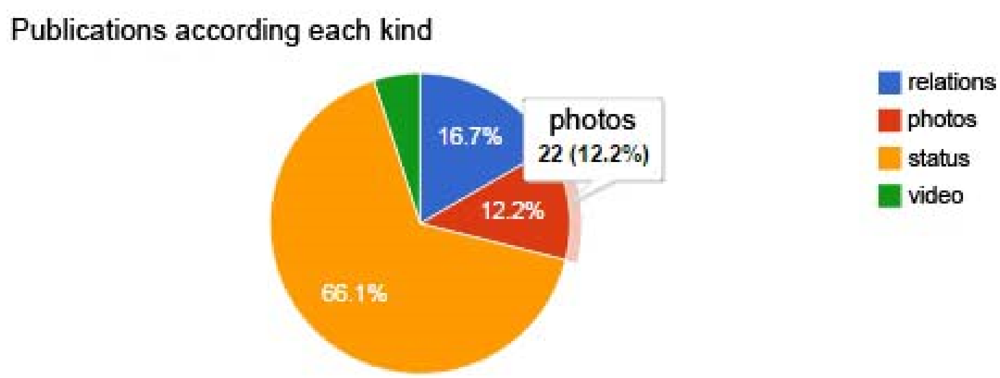

Figure 2. Publications according each kind

3.2. Publications according to the days of the week (Figure 3)

The following denotations have been used:

- $K_w(i)$ – sum of the publications of the day of the week
- $K_w(i)$, $i \in [\ 1, 7\ ]$, where i is the number of the day of the week

Example: $i = 3$ ('Wednesday').

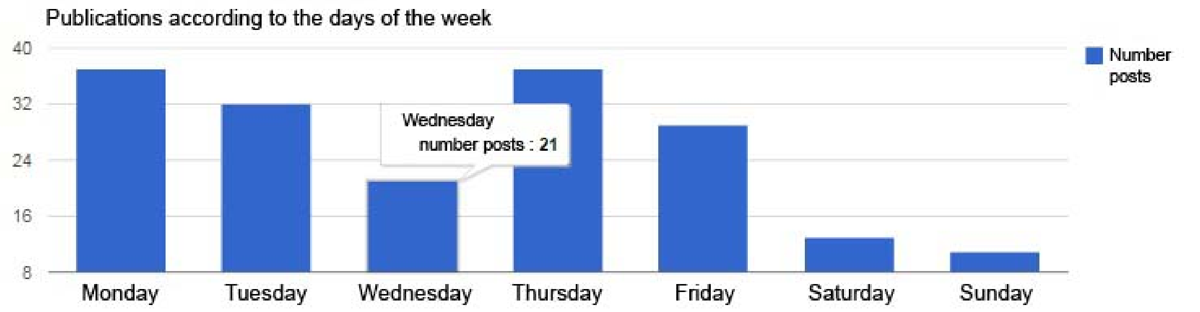

Figure 3. Publications according to the days of the week

3.3. Publications according to the hour of the day (Figure 4)

- $K_h(j)$ – sum of the publications during the hour
- $K_h(j)$, $j \in [0, 23]$, where j is the subsequent number of the hour

Example: j = 16:00 h (number of publications for this hour – 15)

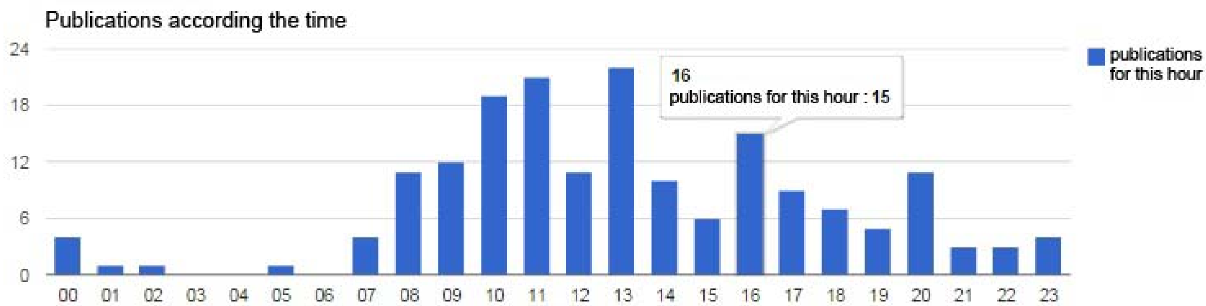

Figure 4. Publications according the time

3.4. Most used keywords (Figure 5)

- $K_t(m)$ – number of the keywords. $m \in [0, 10]$ is the number of the used keywords.

Example: $m = 2$ ('Facebook', used 2 times).

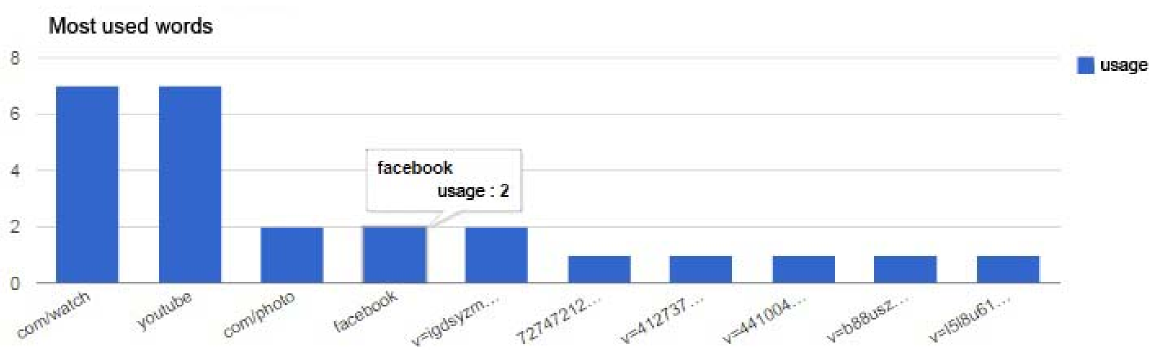

Figure 5. Most used words

3.5. Friends according to the number of liked publications (Figure 6)

- $K_l(n)$ – number of user's publications, $n \in [0, 10]$, where n is the number of the persons who most often like the user's publications;

Example: $n = 8$ ('Estir Porto').

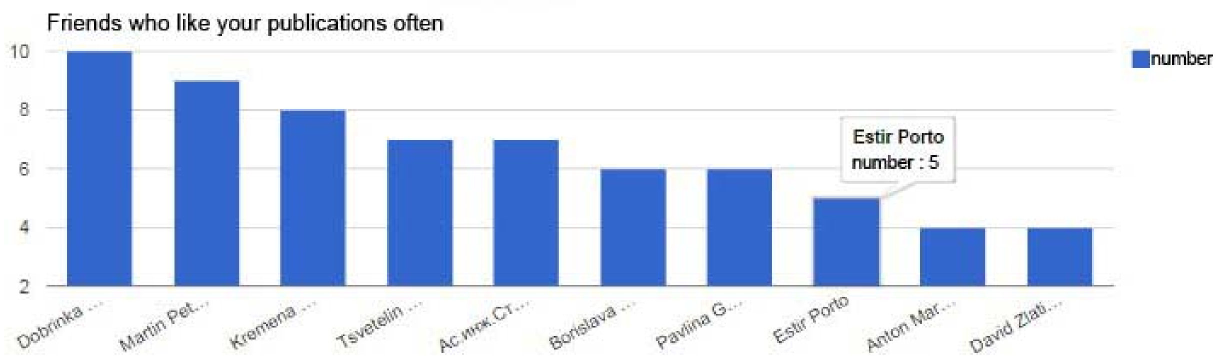

Figure 6. Friends who like your publications often

3.6. Friends according to the number of commented publications (Figure 7)

- $K_c(q)$ – number of comments, $q \in [0, 10]$, where q is the number of friends who comment on user's publications often.

Example: $q = 3$ ('Vili Pefticheva', 4 commented publications)

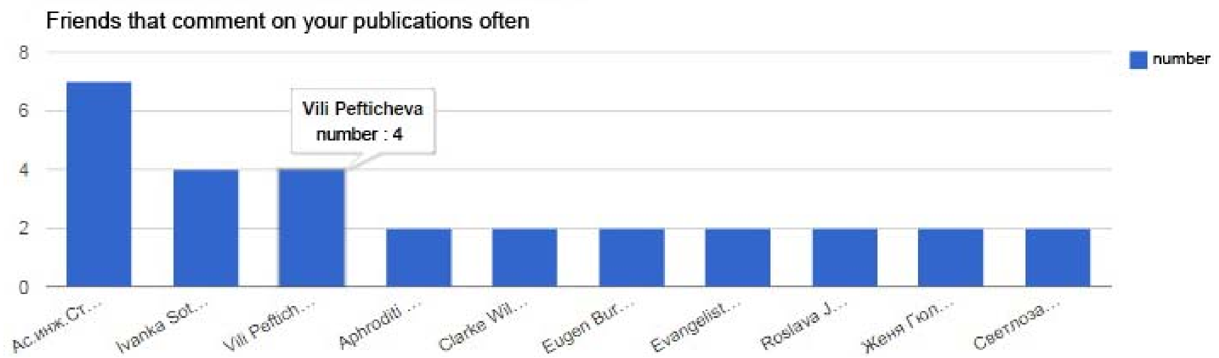

Figure 7. Friends that comment on your publications often

3.7. Friends according to gender (Figure 8)

- B – number of friends;
- $\mu = \frac{A}{B}$, where A – the number of male friends, μ – coefficient of the male friends;
- $\nu = \frac{C}{B}$, where C – number of female friends, ν – coefficient of the female friends;
- $\pi = \frac{D}{B}$, where D – number of friends who have not specified their gender, or any other case, and π reflects the level of uncertainty about friends' gender, and $\pi = 1 - \mu - \nu$.

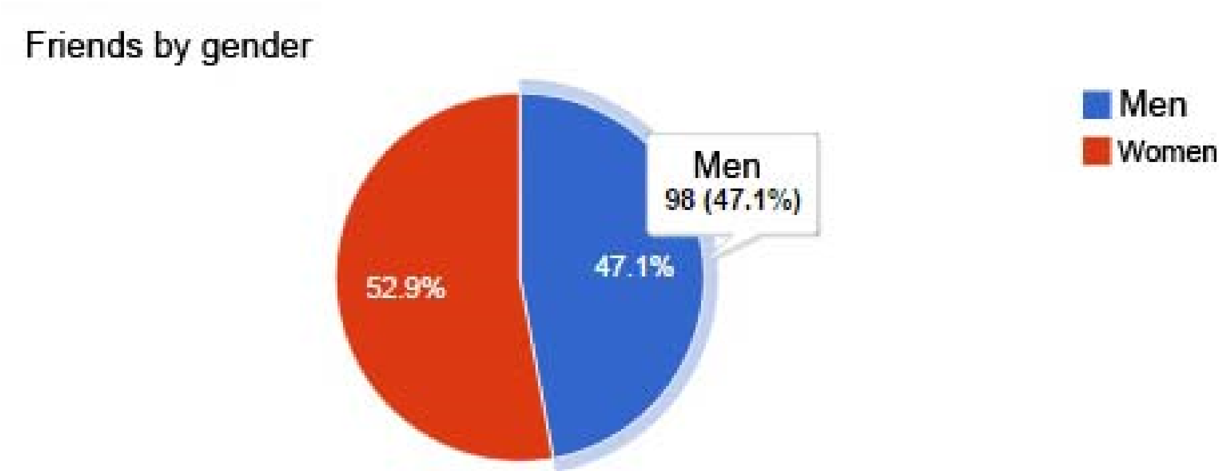

Figure 8. Friends by gender

3.8. Friends according to the month of their birth (Figure 9)

- $K_b(u)$ – number of people who are born in month u, where $u \in [0, 12]$.

Example: $u = 2$ ('February').

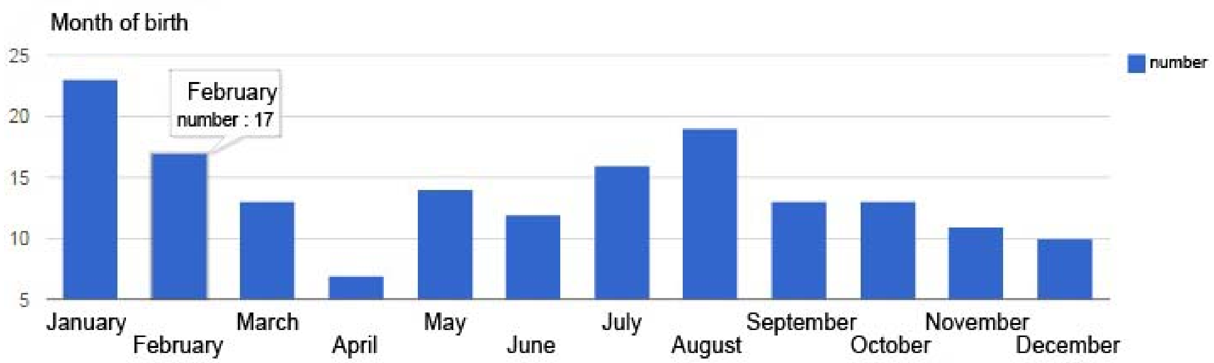

Figure 9. Month of birth

3.9. Friends according to place of living (Figure 10)

- $K_s(e)$ – number of friends who live at place e, where $e \in [0, 10]$ denotes the identifier of a city.

Example: $e = 4$ ('Varna'), $K_s(e) = 4$ (number of friends).

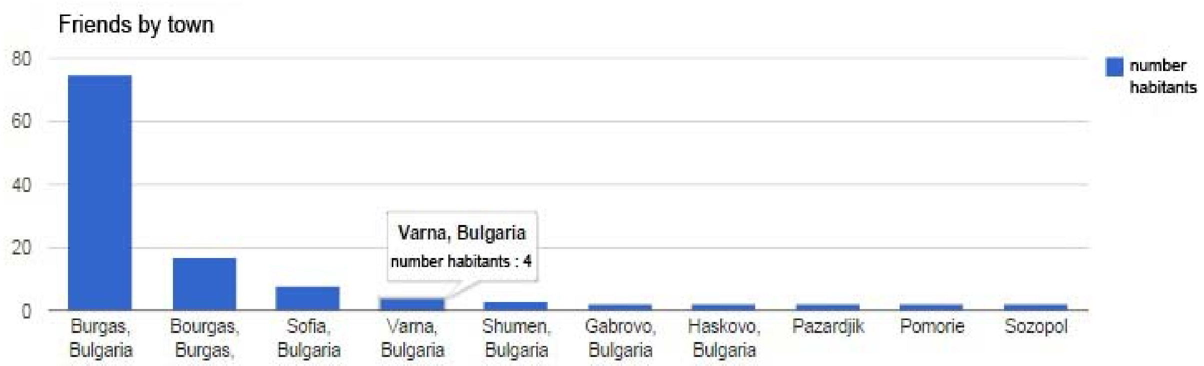

Figure 10. Friends by town

3.10. Friends according to the most common first name (Figure 11)

- $K_n(p)$ – number of most common first names, where $p \in [0, 10]$ denotes the number of 10 most common first names.

Example: $p = 6$ ('Anton').

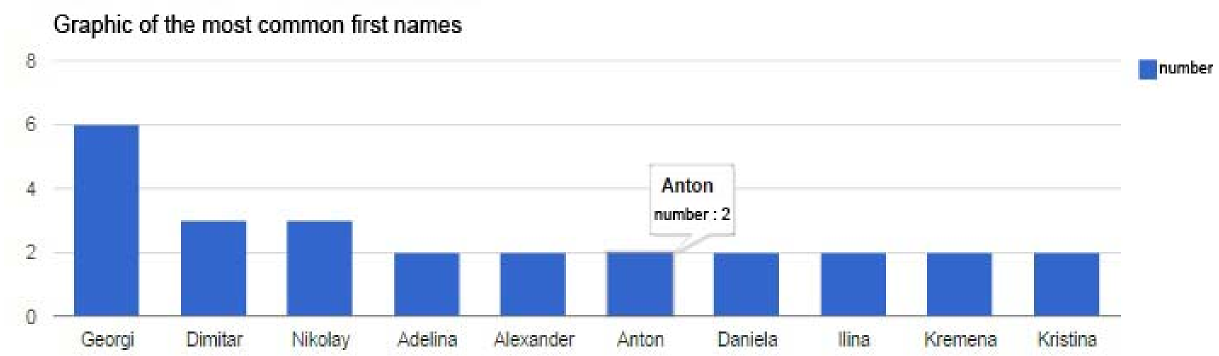

Figure 11. Graphic of the most common first names

3.11. Friends according to the most common family name (Figure 12)

- $K_a(f)$ – number of most common names, where $f \in [0, 10]$ denotes the number of 10 most common family names.

Example: $f = 6$ ('Petkov').

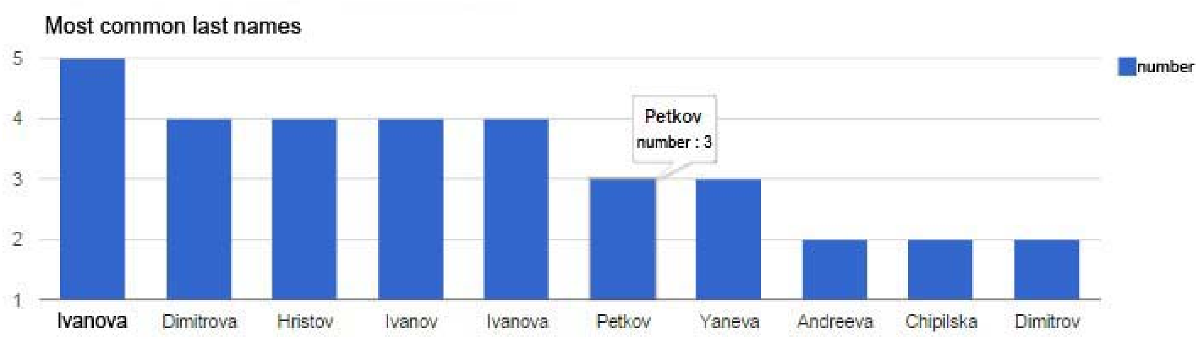

Figure 12. Graphic of the most common first names

3.12. Friends according to the most common family name (Figure 13)

- $K_s(z)$ – number of user's friends who like a given sport, where $z \in [0, 10]$ is a subsequent number of the sports.

Example: $z = 10$ ('Handball').

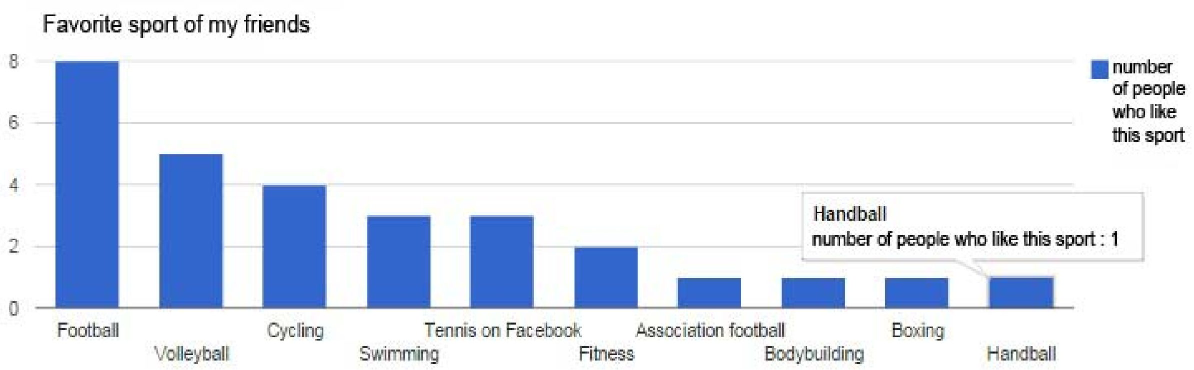

Figure 13. Favorite sport of user's friends.

4 Conclusion

The article presents the main stages for work with and in social network and analysis. The model allows research on the different stages of the progress of work and analysis in the social network and its simulation and behavior in the future. The study is oriented to the social network Facebook.

As a next step of research, the authors will investigate the network security aspects of the analysis of user profiles, because currently all Facebook applications must be hosted on secured servers in order to ensure protection of user information. At this step, we can build upon the existing experience in modelling network security issues, as done by Vardeva in [16, 17] for the purpose of modelling of virtual private networks by point-to-point protocol over secure shell.

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