UNIVERSITY OF ZAGREB

FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING

MASTER THESIS n. 719

User influence based on social network and telecommunication services

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Zagreb, July 2014

SVEUČILIŠTE U ZAGREBU
FAKULTET ELEKTROTEHNIKE I RAČUNARSTVA
ODBOR ZA DIPLOMSKI RAD PROFILA

Zagreb, 10. ožujka 2014.

DIPLOMSKI ZADATAK br. 719

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Zadatak: **User influence based on social network and telecommunication services**

Opis zadatka:

Social networks based on information and communication technology are not only the most popular service based on the Internet infrastructure, but also a global phenomenon that greatly affects the modern way of life. Consequently, social networks represent a significant element of today's social and business environment. Combined with telecommunication services, social networking services make a set of heterogeneous data sources whose combination and application have both scientific and industrial potential.
Your assignment is to design a method for calculating user influence using social networking services and telecommunication services as sources of input data. Your first assignment is to analyse existing algorithms for calculating user influence in social networks. Furthermore, design the architecture and functionality of a system for calculating user influence using social networking services and telecommunication services as sources of input data. Afterwards, implement the system as a software program in the laboratory environment. Lastly, define the methodology to evaluate the system performance and carry out the evaluation itself.
All of the resources will be provided to you by the Department of Telecommunications.

Zadatak uručen pristupniku: 14. ožujka 2014.
Rok za predaju rada: 30. lipnja 2014.

Mentor:

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Prof.dr.sc. Igor Sunday Pandžić

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Zadatak: **Utjecajnost korisnika zasnovana na uslugama društvenog umrežavanja i telekomunikacijskim uslugama**

Opis zadatka:

Društvene mreže zasnovane na informacijsko-komunikacijskoj tehnologiji su danas ne samo najpopularnija usluga temeljena na internetskoj infrastrukturi već i globalni fenomen koji uvelike utječe na suvremeni način življenja, a samim time i značajan element današnjeg društvenog i poslovnog okružja. U kombinaciji s telekomunikacijskim uslugama, usluge društvenog umrežavanja čine skup heterogenih izvora podataka čije kombiniranje i primjena imaju znanstveni i industrijski potencijal.
Vaša je zadaća dizajnirati postupak za određivanje utjecajnosti korisnika, koristeći usluge društvenog umrežavanja i telekomunikacijske usluge kao izvore ulaznih podataka. Najprije analizirajte postojeće algoritme za izračun utjecajnosti korisnika u društvenim mrežama. Nadalje, razradite arhitekturu i funkcionalnost sustava za izračun utjecajnosti korisnika, koristeći usluge društvenog umrežavanja i telekomunikacijske usluge kao izvore ulaznih podataka. Zatim, sustav programski izvedite u laboratorijskom okružju. Konačno, definirajte metodologiju evaluacije implementirane usluge te izvršite samu evaluaciju.
Svu potrebnu literaturu i uvjete za rad osigurat će Vam Zavod za telekomunikacije.

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INTRODUCTION

A social network is a structure made up with individuals or organizations that are connected in some way. Today the most popular type of social networks are online social networks, such as *Facebook*, *Twitter*, *LinkedIn* and many more. With the creation and rising popularity of online social networks it has become easy to spread information to a large group of people. Because of this social networking sites have become a powerful marketing and communication tool. Businesses use online social media to easily communicate with their customers. They used to only do this through their own pages on these social networking sites. Today many of them concentrate only on influential users and advertise through them. Influential users are users who influence their community. These users have a large community, information spreads faster through them and others care about their opinion. It has become very important to identify these users. Many algorithms were made to do exactly that.

This thesis introduces one algorithm that identifies influential users, but also takes it one step further by not only taking into consideration social networking services, but also telecommunication services. The modern person today has a profile on one or more social networking sites and actively uses a smartphone. Because of this taking into consideration the telecommunication services might help in better determining who the influential users are. This can also work the other way around. Most telecom operators use algorithms to try to predict which subscribers have a high probability of leaving. They concentrate on subscribers who are important when only looking at telecom services (e.g. post-paid business users who generate a lot of revenue). By adding the social network factor they will be able to identify the users who might, by leaving, influence other users to leave by using social network services.

Facebook is one of the most important social networking sites in the world. It has over 1 billion active users [5]. Individuals and businesses actively use its services. In Croatia it is the most popular social networking site. Because of this, Facebook's services were used in the algorithm when calculating the total social influence.

The first chapter introduces the social and telecommunication networks and the methods for analyzing them. The second chapter explains social network influence and telecom influence and introduces the elements used for calculating each of the influences. The third chapter explains in detail the algorithm used to calculate the total social influence using both social network and telecom services. The forth chapter describes the web application that was used to calculate the total social influence and obtain data from the social and telecom network of a user. The fifth chapter examines and evaluates the results given from a preliminary experiment of calculating user’s total social influence score on 123 users.

1. SOCIAL AND TELECOMMUNICATION NETWORK ANALYSIS

Social and telecommunication networks can be represented as a graph, where the users are nodes and their connections are the edges. In order to understand the social and telecommunication network some basic concepts need to be defined.

Figure 1 demonstrates a simple graph of users.

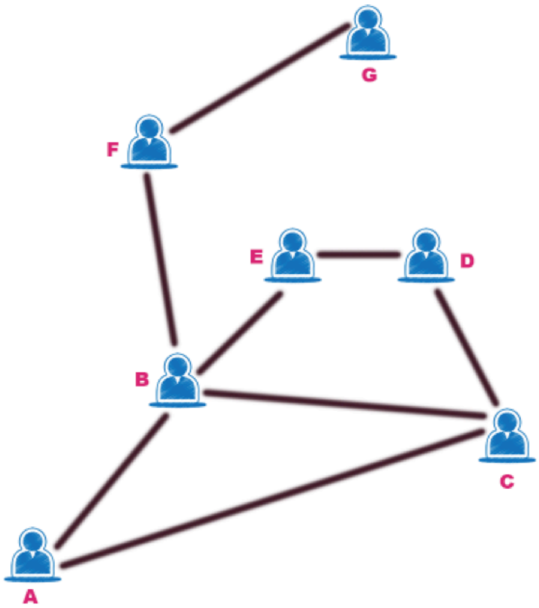

Figure 1 Simple graph of users

Every graph is a set of nodes and edges, *G (N,E)*, where *N* represents the set of nodes and *E* represents the set of edges between the nodes. The nodes represent the users and the edges represent the relationship between them. In social networks and telecommunication networks the edges define that the end users are connected.

In the graph shown on Figure 1 *node A* is connected to *node B* and to *node C*. *Node B* is connected with the most amount of nodes, with *node A*, *node C*, *node E* and *node F*. *Node G* is connected with only one node, *node F*.

1.1. TYPES OF GRAPHS

Graphs can be *directed* or *undirected* and *weighted* or *unweighted*.

1.1.1. UNDIRECTED GRAPH

In an undirected graph the edges do not have an orientation. Figure 1 represents an undirected graph. An edge that joins the *nodes* $A, B \epsilon N$ is usually denoted by (A, B) or just by AB. The order of the nodes that are connected by an edge is not important, $(A, B) = (B, A)$ [15].

1.1.2. DIRECTED GRAPH

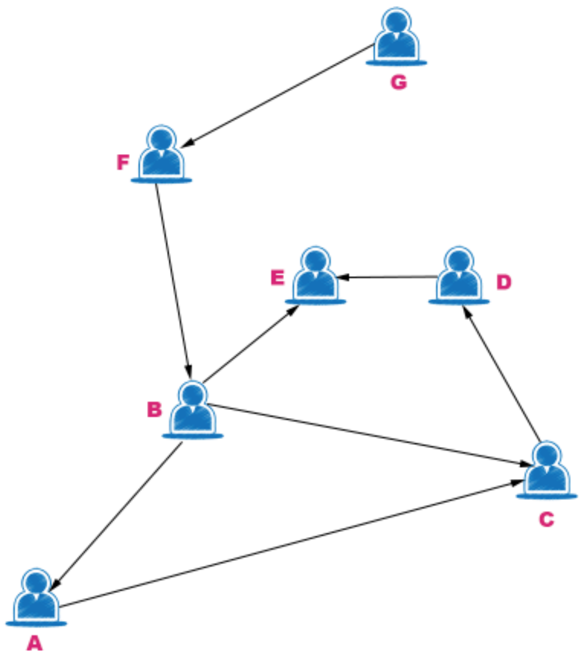

Figure 2 Directed graph of users

In a directed graph (*di-graph*) each edge has an origin and a destination. Such edges are called *directed edges* and are usually represented by lines with arrows on them. Figure 2 represents a directed graph. The order of the nodes that are connected by an edge is important, $(A, B) \neq (B, A)$ [15].

1.1.3. UNWEIGHTED GRAPH

Unweighted graphs contain unweighted edges. Unweighted edges only indicated whether an edge exists or not [15]. Figure 1 represents an unweigthed graph. From the adjacency matrix it is visible if an edge exists or not. For example, in

Figure 1, *node A* and *node B* are connected so in the adjacency matrix there connection is represented with the value 1. *Node A* and *node G* are not connected so in the adjacency matrix there lack of connection is represented with the value 0.

1.1.4. WEIGHTED GRAPH

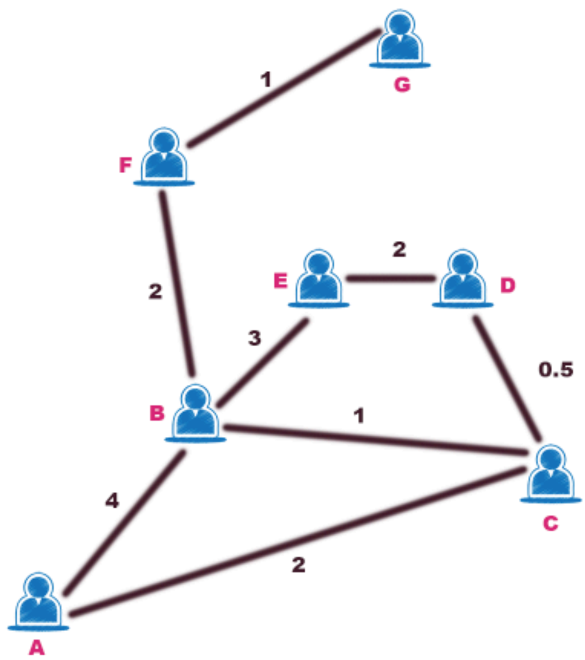

Figure 3 Undirected, weighted graph of users

In a weighted or valued graph, each edge can be assigned an additional numerical value – representing, for example cost, speed, time, data flow or the strength of a link [15].

Figure 3 represents a weighted graph. The connection between *node A* and *node B* is twice as strong as the one between *node A* and *node C*. The connection between *node A* and *node C* is twice as strong as the one between *node B* and *node C*.

In social networks the weight of an edge usually represents the trust between the users. If the trust between users is high, so is the weight of the edge between them [18]. In figure 3 users *A* and *B* have the highest trust.

1.2. TYPES OF NETWORKS

The scope, types of edges and types of nodes can differentiate networks.

1.2.1. FULL, PARTIAL AND EGOCENTRIC NETWORKS

A *full* or *complete network* contains all entities of the network and the connections among them [15]. All entities are treated equally. Figure 1 represents a complete network.

In practice, it is not always feasible (or particularly insightful) to analyze a full network. Instead, a *partial network* is created by selecting a sub-graph of the full network [15]. For example, only analyzing users who are older than 18.

It is often useful to consider a network from an entity's point of view. The individual that is the focus of attention is called the *ego* and the users it is connected to are called *alters*. An *egocentric network* only includes individuals who are connected to a specified ego [15]. More generally, an egocentric network can extend out any number of degrees from ego:

- The basic 1-degree ego network consists of the ego and its alters (Figure 4),

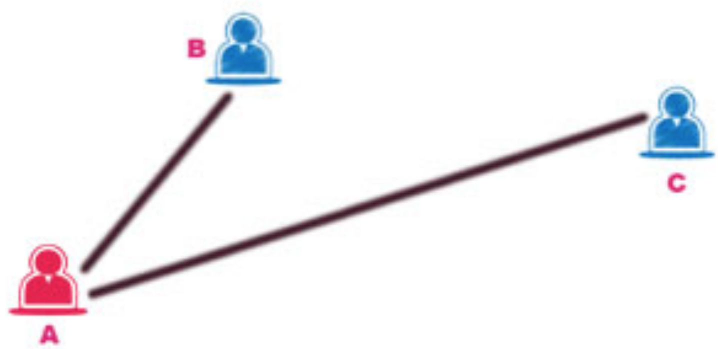

Figure 4 1-degree ego network of *user A*

- The 1,5-degree ego network extends the 1-degree network by including connections between all of the alters (Figure 5),

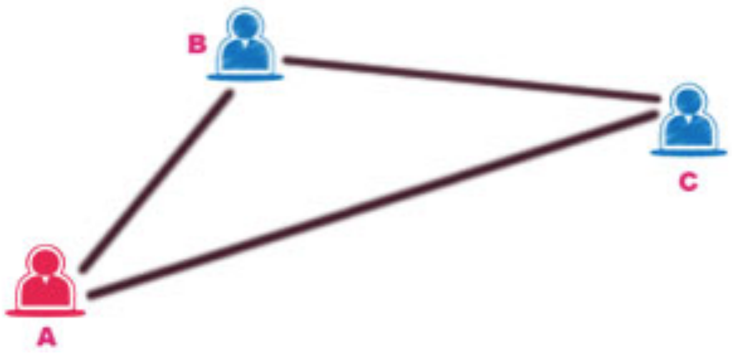

Figure 5 1,5-degree ego network of *user A*

- The 2-degree ego network extends the 1.5-degree network by including all of the alters' own alters (i.e., friends of friends), some of whom may not be connected to the ego (Figure 6).

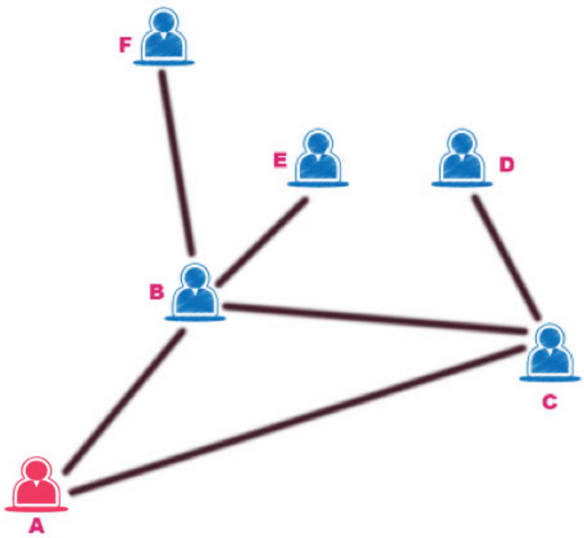

Figure 6 2-degree ego network of *user A*

1.1.2. UNIMODAL AND MULTIMODAL NETWORKS

Unimodal networks consist only of one type or mode of node, while *multimodal networks* include different types of nodes [15]. Figure 1 represents a unimodal network. Figure 7 represents a multimodal network.

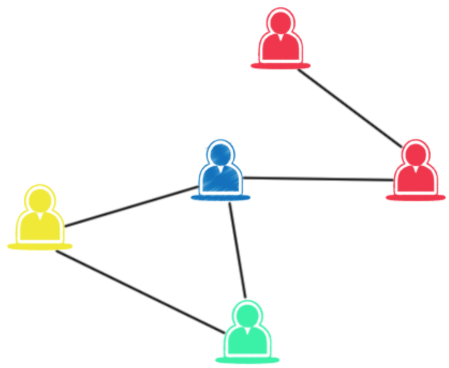

Figure 7 Multimodal network

Because most network metrics are designed for unimodal networks, multimodal networks often have to be transformed into unimodal networks.

1.1.3. MULTIPLEX NETWORKS

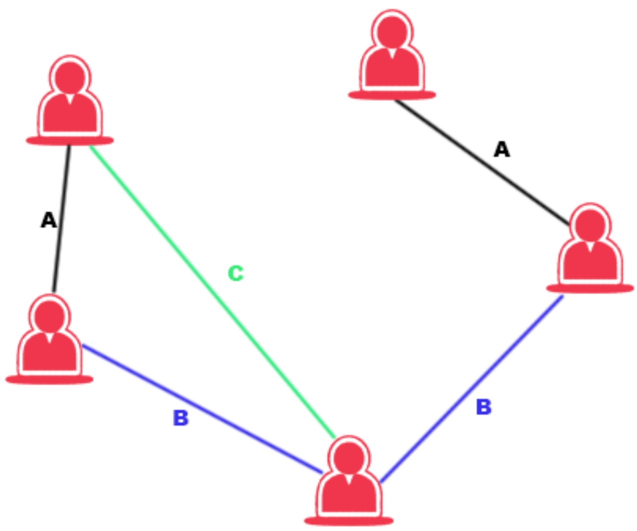

Figure 8 Multiplex network

Multiplex networks have multiple types of connections or edges [15]. Using edge labels differentiates the edges (Figure 8).

Since most network measures cannot be applied to multiplex networks, the multiple types of edges are combined to get a single one.

An example of a multiplex network is the Twitter network of a user. In this network there are 3 types of edges:

- *Following* relationship;
- *Reply to* relationship;
- *Mention* relationship.

If the edge type is not so important the multiplex network data is condensed into a standard network. This is the most common case for social networks.

1.3. ADJACENCY MATRIX

If users, nodes, are connected they are adjacent and called neighbors. The *adjacency matrix A* of an *undirected* graph with *N* nodes is the $N \times N$ matrix with elements A_{ij} such that:

$$A_{ij} = \begin{cases} 1, if\ there\ is\ an\ edge\ between\ node\ i\ and\ node\ j \\ 0, otherwise \end{cases} \quad (1).$$

The adjacency matrix for the graph in Figure 1 is

$$A = \begin{pmatrix} 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix} \quad (2).$$

For an undirected graph, A is symmetric $(A = A^T)$ $[14]$.

The adjacency matrix A of a directed graph with *N* nodes is the $N \times N$ matrix with elements A_{ij} such that:

$$A_{ij} = \begin{cases} 1, if\ there\ is\ an\ edge\ from\ node\ j\ to\ node\ i \\ 0, otherwise \end{cases} \quad (3).$$

The adjacency matrix for the graph in Figure 2 is

$$A = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad (4).$$

For a directed graph, A is asymmetric $(A \neq A^T)$ $[14]$.

1.5. NODE DEGREE

In Figure 1 *node G* has the least amount of neighbors, 1, and *node B* has the most amount of neighbors, 4. The number of neighbors a node has is called the degree of a node.

A directed graph differentiates between the *in-degree* and *out-degree* of a node. In terms of the *adjacency matrix A*, the out-degree is the number of outgoing edges emanating from a node indexed by *i*,

$$k_i^{out} = \sum_j A_{ji} \quad (5),$$

and the in-degree is the number of incoming edges onto a node,

$$k_i^{in} = \sum_j A_{ij} \quad (6).$$

An example for a directed graph is the social network *Twitter*. In Twitter the number of followers a user has is the in-degree, while the number of different users the user follows is the out-degree [1].

In an undirected graph the in and out degree are the same,

$$k_i^{out} = k_i^{in} = k_i = \sum_j A_{ij} \quad (7).$$

In the social network *Facebook* the graph of users is *undirected* and the *degree* equals the number of friends a user has [1]. For *unweighted* graphs this number is relevant in indicating the popularity of a node.

2. SOCIAL NETWORK AND TELECOM INFLUENCE

Social influence can either be defined as the impact others have on a single person or the impact one person has on others. In this thesis the latter is used to define the total social influence.

2.1. ELEMENTS FOR CALCULATING SOCIAL NETWORK INFLUENCE IN THE SOCIAL NETWORK FACEBOOK

In this chapter, elements taken into consideration for calculating social network influence in the social network Facebook will be explained. The calculation takes into account the *1-degree ego network* of a user. The network is *undirected*, *unweigthted*, *unimodal* and has *one type of edge*.

2.1.1. DEGREE CENTRALITY OF THE SOCIAL NETWORK

Degree centrality is the basic centrality measure. It takes into consideration the number of edges a node has. The degree of a node is explained in detail in chapter 1.5.

This measure indicates the popularity of a node. If a user has a lot of neighbors, information through this user is distributed to a larger audience. For example, in Figure 2, if *user B* shares content it is more likely that more users will see it than if *user G* shares the same content.

The ego network of a user in the social network Facebook is undirected, so there is no need to distinguish between in-degree and out-degree. The degree represents the number of friends a user has in its network.

2.1.2. SOCIAL NETWORK INFLUENCE OF THE USER'S FRIENDS

It is also important to take into consideration the social network influence factor of the user's neighbors. If a user is connected to influential users, the content it shares will have greater value, because important users will be able to see it. Also, it is more likely that the content will spread faster. This theory is used in constructing the popular algorithm for ranking web pages, *Page Rank*. If a web page is linked to a page with a higher score it is more relevant than a page that is linked to a page with a lower score [2].

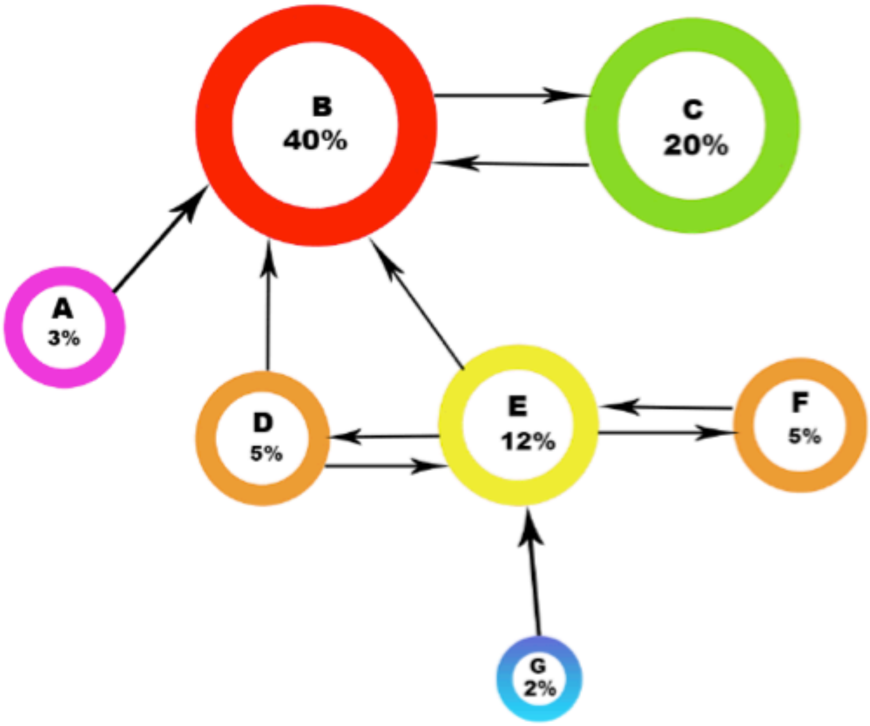

Figure 9 *PageRank* graph

Figure 9 demonstrates PageRank using percentages. *Node C* has a higher percentage than *node E*, even though it has a lower degree, because *node C* is connected to *node B* that has a high value. The percentages represent the score of the node, which can be from 0 to 100.

2.1.3. NODE ATTRIBUTES FOR THE SOCIAL NETWORK

Since the calculation of the social network influence will be done for one specific user it is important to analyze the selected node. The node represents the user profile.

Node attributes refer to information of an individual. In social networks users can have many different attributes. A user can be defined by his age, gender, religion, education etc.

When considering social network influence one of the most important attributes are user posts. The amount of posts is not as relevant as the user engagement on each post. In the social network Facebook posts can be photos, statuses or links. The user engagement can be measured through the amount of likes and comments on each post [3].

Types of posts taken into consideration:

- Photos uploaded by the user;
- Photos of the user;
- Statuses by the user;
- Links posted by the user.

2.2. ELEMENTS FOR CALCULATING TELECOM INFLUENCE OF A USER

In this chapter, elements taken into consideration for calculating the telecom influence will be explained. The calculation looks at the *1-degree ego network* of a user. The network is *directed*, *unweigthted*, *unimodal* and *multiplex*.

2.2.1. DEGREE CENTRALITY OF THE TELECOM NETWORK

The telecom network is directed (Figure 10). A user can either make a call or receive a call. A user can also send a text message and receive a text message. The in-degree represents the calls and text messages received. The out-degree represents the calls made and the text messages sent.

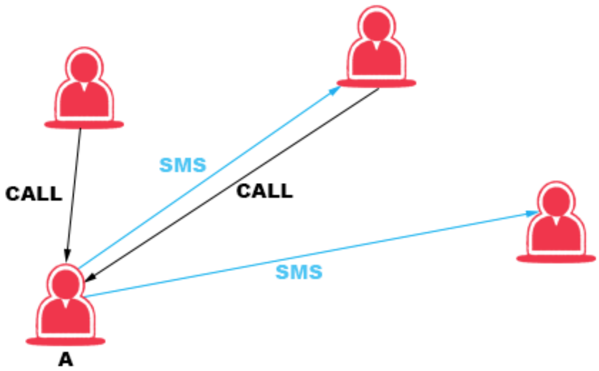

Figure 10 1-degree ego telecom network of user *A*

For the calculation of the telecom influence of a user, only the out degree centrality with be considered. When analyzing the lift[1] of several algorithms it was concluded that the simple out-degree centrality had one of the highest scores [9].

2.2.2. EDGE ANALYSIS FOR THE TELECOM NETWORK

When considering the influence of a user in the telecom network the duration of the calls made is also relevant. This parameter is attached to the edge representing the calls made.

The *word-of-mouth* (WOM) communication is considered as an important factor in spreading your opinions through the network [9]. A presumption is made that the more time you spend on a call the more your opinion affects others. An influential user in the telecom network affects many of its neighbors.

[1] The lift can be calculated as the number of nodes reached divided by the number of nodes selected.

3. CALCULATING SOCIAL INFLUENCE

The total social influence consists of two parts. The first part is the social network influence and the second part is the telecom influence.

3.1. CALCULATING THE SOCIAL NETWORK INFLUENCE

The social network influence is calculated in two parts. The first part is calculated by using the *limited recursive algorithm* and the second part is calculated by taking into consideration the number of posts a user has.

3.1.2. USER SCORE USING THE LIMITED RECURSIVE ALGORITHM

This algorithm was used to calculate social network influence for users on the social network Twitter. Since Twitter and Facebook have many common attributes the algorithm could, with some modifications, also be applied to Facebook [4]. Table 1 shows some of the similarities and differences between Twitter and Facebook.

Table 1 Similarities and differences between Twitter and Facebook

	Twitter	Facebook
Nodes	User profiles on the social network	User profiles on the social network
Node degree	In-degree: number of followers, out-degree: number of following users	Number of friends
Node attributes	Posts (statuses/photos)	Posts (statuses/photos)
User engagement	Retweets and mentions	Likes and comments
Network structure	Directed	Undirected

Since Facebook has more than 1.2 billion users it is difficult to take into consideration the whole network [5]. Because of this limitation the calculations will be limited to only examining the user's 1-degree ego network [1].

3.1.2.1. SOCIAL NETWORK MODELING DEFINITIONS

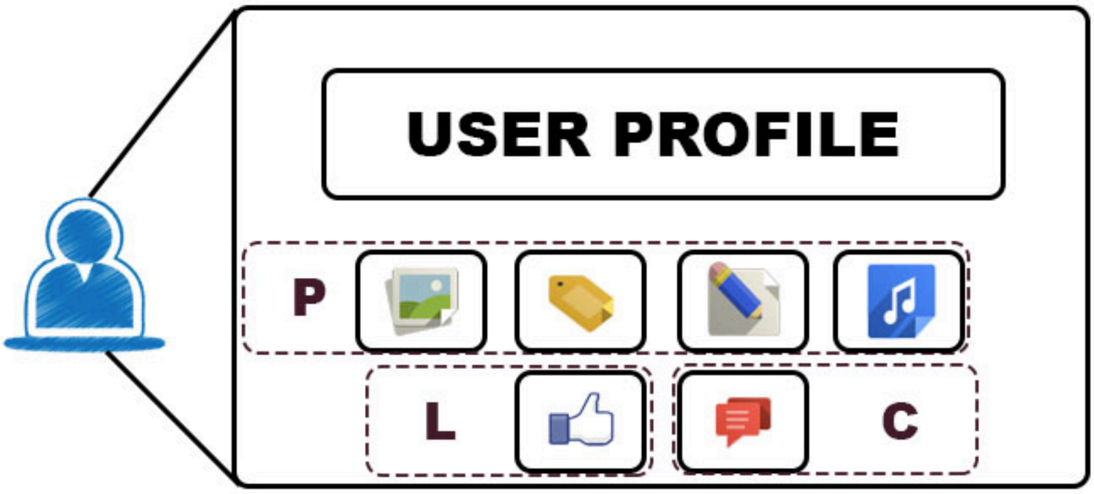

Figure 11 Structure of a node in the social network

For the calculation the social network is defined as a tuple, *SN = (G, P, L, C)*. Where each letter represents (Figure 11):

- *G* - the 1-degree ego network of the user *G* = <*N, E*>,
- *P* - the posts taken into consideration,
- *L* - the number of friends that liked a post,
- *C* - the number of friends that commented on a post.

In order to model the social network influence definitions in table 2 need to be taken into consideration [4].

Table 2 Basic definitions for modeling social network influence

Notation	Definition
$\|X\|$	Cardinality[2] of the set X
$Po(N)$	Power set[3] of the set N
$F(n)$	A mapping function from N to a set of nodes $F: N \rightarrow Po\ (N)$, returns the set of nodes which are friends of the node $n \in N$
$P(n)$	A mapping function from N to the power set of posts $P: N \rightarrow Po\ (P)$, returns the set of posts by the node $n \in N$
$L(p)$	A function that returns the set of nodes who liked the post $p \in P$, $L: P \rightarrow Po\ (N)$
$C(p)$	A function that returns the set of nodes who commented on the post $p \in P$, $C: P \rightarrow Po\ (N)$
$COMM(n,p)$	A function that determines whether a particular user has commented on a particular post, $COMM: N \times P \rightarrow \{1,0\}$. $COMM(n,p) = \begin{cases} 1 & if\ n \in L(p) \cup C(p) \\ 0 & otherwise \end{cases}$
$LIKE(n,p)$	A function that determines whether a particular user has liked a particular post, $LIKE: N \times P \rightarrow \{1,0\}$. $LIKE(n,p) = \begin{cases} 1 & if\ n \in L(p) \cup C(p) \\ 0 & otherwise \end{cases}$
Time period	The time period for the calculation is three months.

3.1.2.2. MODELING SOCIAL INFLUENCE ON THE SOCIAL NETWORK FACEBOOK

Social network influence is calculated as a combination of several metrics. These metrics are dependent of one another [8].

---

[2] The cardinality of a set is a measure of the number of elements of the set.

[3] The power set of any set *S* is the set of all subsets of *S*, including the empty set and *S* itself.

3.1.2.2.1. NUMBER OF FRIENDS A USER HAS IN ITS NETWORK

This metric represents the popularity of a node in a network [6]. The popularity ($\delta\ (n)$) is indicated with a non-linear function in the range of [0, 1], using the ratio of the number of friends a user has to the maximum number of friends a user can have [4].

$$\delta\ (n) = \frac{\ln(\,|F\ (n)| - min_{n' \in N}|F\ (n')|)}{\ln(\,max_{n'' \in N}\ |F\ (n'')| - min_{n' \in N}|F\ (n')|)} \quad (8)$$

When calculating the popularity, the value taken for $max_{n' \in N}\ |F(n')|$ is 1000. If a user has more than 1000 friends the value of $\delta(n)$ is scaled down to 1.

$$if\ \ max_{n' \in N}\ |F(n')| \geq 1000\ then\ \delta(n) = \ 1 \quad (9)$$

In 2011 Facebook performed a study, *Anatomy of Facebook*, on all of the active users at that time. The number of users was 721 million, which was over 10% of the global population. In that study they analyzed friendships among users. One of the results of the study was that 90% of active Facebook users have less than 1000 friends (Figure 12) [7]. Because of this when calculating the popularity of a user the number of maximum friends is limited to 1000. The number of minimum friends is 0.

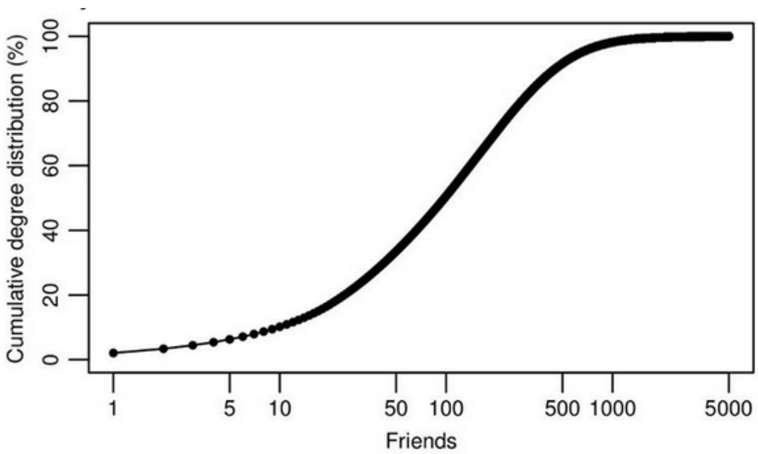

Figure 12 Distribution of the amount of friends users have on Facebook

3.1.2.2.2. USER ENGAGEMENT RATE ON POSTS

This metric represents the user engagement rate (*UER*) on each post. It is indicated using the ratio of the number of friends which liked/commented on a post to the total number of friends a user has.

$$UER\ (n,p) = \frac{\sum_{n' \in F(n)} LIKE\ (n,p) + \sum_{n' \in F(n)} COMM\ (n,p)}{|F(n)|} \quad (10)$$

UER is a function in the range of [0, 1]. In order for a user to achieve a *UER* of 1 all of his friends need to like/comment his post. For most posts this is not the case. When looking at Facebook pages a user engagement of over 1% is considered good. The average is 0,5% - 0,99% [8]. For Facebook profiles the situation is a bit different. For this experiment photos and statuses of over 1500 Facebook users were analyzed. Figure 13 displays the results. It is visible that more than 90% of Facebook users have an average user engagement rate of less than 12%.

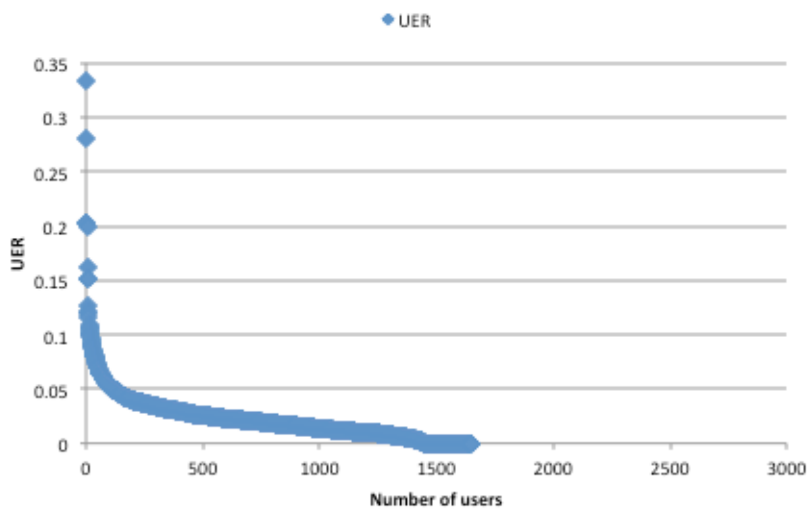

Figure 13 Distribution of the user engagement rate

Because of this every post with a *UER* higher than 0.12 has been scaled to 1. Which means that in order to have a maximum *UER*, 12% or more of the users friends need to like/comment a post. This factor can be changed in the future depending on the results.

3.1.2.2.3. MAGNITUDE OF INFLUENCE

This magnitude of influence (*MOI*) indicates the impression that a user makes on his entire 1-degree ego network. A statistical measure of the magnitude of a varying quantity is the root mean square. With this measure it is possible to see the size of the affect a user had on its network. If the magnitude is high that means that most of the user's friends saw and agreed with his post. His opinion was spread widely.

$$MOI\ (n) = \sqrt{\frac{\sum_{p' \in P(n)} (UER(n,p'))^2}{|P(n)|}} \quad (11)$$

3.1.2.2.4. INFLUENCE RANK

This metric indicates the social network influence of the user calculated using the limited recursive algorithm. Influence rank (*IR*) is a function in the range of [0, 1]. It is dependent on all the factors mentioned above and on the *IR* of the user's friends. A user with a high *IR* is considered an opinion leader [4]. By connecting to other influential users the *IR* of the user rises. This was previously explained using the *PageRank* algorithm. *IR* also rises if the user's impression on its network also rises. $\delta(n)$ is the dynamic damping factor.

$$IR\ (n) = \big(1 - \delta(n)\big)\frac{\sum_{n' \in F(n)} IR(n')}{|F(n)|} + \ \delta(n) \cdot MOI\ (n) \quad (12)$$

3.1.2.3. PSEUDOCODE OF THE LIMITED RECURSIVE ALGORITHM

The algorithm will be explained step by step, with examples (Figure 14).

Figure 14 Steps of the *limited recursive algorithm*

STEP 1:

- Get the number of friends a user has,
    - User *A* has 30 friends.

STEP 2:

- Calculate the popularity of the user,

$$\delta(A) = \frac{\ln(30-0)}{\ln(1000-0)} = 0.49$$

STEP 3:

- Calculate the *UER* for all of the user's posts from the last three months,
  - Figure 15 shows all of user A's posts from the last three months.

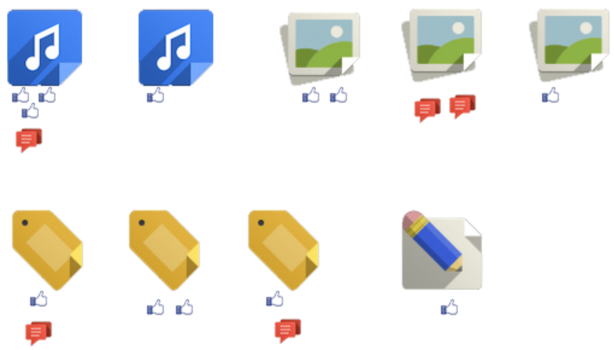

Figure 15 User *A*'s posts from the last three months

$$UER\ (link1) = \frac{4}{30} > 0.12 = 1$$

$$UER\ (link2) = \frac{1}{30}$$

...

STEP 4:

- Calculate the user's *MOI*,

$$MOI\ (A) = \sqrt{\frac{1^2 + \frac{1}{30}^2 + \frac{2}{30}^2 + \frac{2}{30}^2 + \frac{1}{30}^2 + \frac{2}{30}^2 + \frac{2}{30}^2 + \frac{2}{30}^2 + \frac{1}{30}^2}{9}} = 0.34$$

STEP 5:

- Get the *IR* of the user's friends,
  - Check in the database how many of user *A*'s friends have defined *IR*'s.
    - Only friends that have previously done the calculation for their influence are in the database.

- User *A* only has five friends with defined *IR*'s (Figure 16).

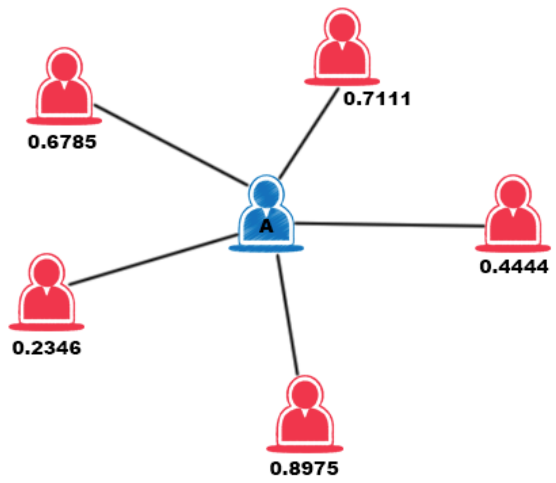

Figure 16 Defined IR's of user *A*'s friends

STEP 6:

- Calculate the user's IR,

$$IR\ (A) = (1 - 0.49)\frac{0.2346 + 0.8975 + 0.4444 + 0.7111 + 0.6785}{30} + 0.49\ \cdot 0.34$$
$$= 0.2170$$

3.1.3. USER SCORE DEPENDING ON THE AMOUNT OF POSTS A USER HAS

In order to calculate the total social network influence, it is important to also take into consideration the number of posts a user has in the defined time period of three months.

The ideal number of posts in three months is from 60 to 130 [10]. Because of this the function for calculating $IP\ (n)$ is as follows,

$$IP\ (n) = \begin{cases} \dfrac{number\ of\ posts}{60}, if\ number\ of\ posts < 60 \\ 1, if\ number\ of\ posts\ [60, 130] \\ \dfrac{number\ of\ posts}{-60} + \dfrac{19}{6}, if\ 130 < number\ of\ posts < 190 \\ 0, if\ number\ of\ posts \geq 190. \end{cases} \quad (13)$$

Below is a visual representation of the $IP\ (n)$ function (Figure 17).

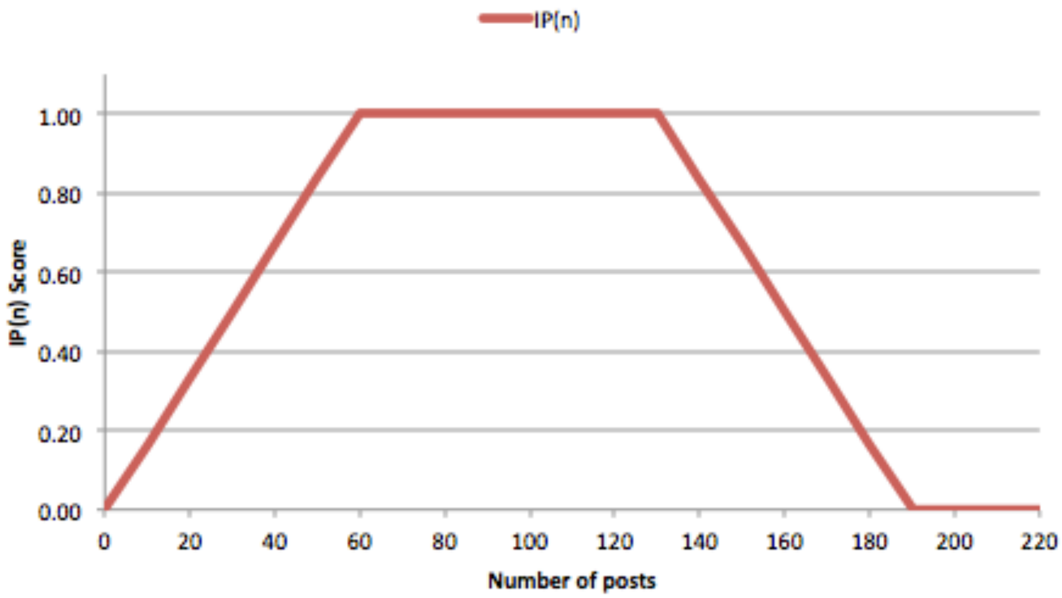

Figure 17 IP(n) function

3.1.4. TOTAL SOCIAL NETWORK INFLUENCE

The function for calculating the user's total social network influence, $ISN\ (n)$, is as follows,

$$ISN\ (n) = \left(w_{IR} \cdot IR(n) + w_{IP} \cdot IP(n)\right) \cdot 100 \quad (14).$$

In this calculation the parameter $w_{IR} = 0.75$ and the parameter $w_{IP} = 0.25$. Because the function $IR(n)$ takes into consideration more parameters and by itself also gives a valid influence rate the factor for multiplying $IR(n)$ is 3 times higher than the one for multiplying $IP(n)$. These factors are variable and can be changed depending on the results.

3.2. CALCULATING THE TELECOM INFLUENCE

The telecom influence is calculated by taking into consideration some of the out-degree parameters of the user's telecommunication network. These parameters are the number of outgoing calls, the total duration of the outgoing calls and the number of sent text messages for a period of one month. The out-degree is considered to be sufficient in calculating influence in the telecom network [9].

The function for calculating the user's telecom influence consists of three scores (Table 3):

$$IT(n) = (w_{SC} \cdot SC\ (n) + w_{SD} \cdot SD\ (n) + w_{ST} \cdot ST\ (n)) \cdot 100 \quad (15).$$

Table 3 Definition of the telecom scores

Notation	Definition
$\boldsymbol{SC\ (n)}$	The score based on the number of calls made.
$\boldsymbol{SD\ (n)}$	The score based on the total duration of the outgoing call.
$\boldsymbol{ST\ (n)}$	The score based on the number of sent text messages.

Each score is calculated as a normalized ratio of the value of each parameter made by the user and the maximum value of each parameter in the network.

$SX\ (n)$ represents the score. $NX\ (n)$ represents the number of calls, the total duration or the number of sent text messages, depending on which score is being calculated.

$$SX\ (n) = \frac{\ln(\ NX\ (n) - min_{n' \in N}\ NX\ (n'))}{\ln(\ max_{n'' \in N}\ NX\ (n'') - min_{n' \in N}\ NX\ (n'))} \quad (16)$$

In this calculation all of the factors are equal, $w_{SC} = w_{SD} = w_{ST} = \frac{1}{3}$. These factors are variable and can be changed depending on the results.

3.3. TOTAL SOCIAL INFLUENCE

The function for calculating the total social influence is as follows,

$$I_{Total}\ (n) = w_{ISN} \cdot ISN\ (n) + w_{IT} \cdot IT\ (n) \quad (17).$$

In this calculation the factor $w_{ISN} = 0.75$ and the factor $w_{IT} = 0.25$. The factor for multiplying the social network influence is 3 times higher than the one for multiplying the telecom influence because the time period for the input parameters taken into consideration when calculating the social network influence is 3 times longer than the period for calculating the telecom influence. Also, the input parameters for calculating the social network influence are more detailed and more accurate than the ones for calculating the telecom influence. These factors are variable and can be changed depending on the results.

4. WEB APPLICATION FOR CALCULATING SOCIAL INFLUENCE

In this chapter the web application *Social Influence,* made for calculating the total social influence, will be described. This application is used to calculate the total social influence as explained in the previous chapters. The application was written in PHP and HTML (*HyperText Markup Language*). For the database MySQL was used.

4.1. CALCULATING SOCIAL NETWORK INFLUENCE WITH THE WEB APPLICATION *SOCIAL INFLUENCE*

The first part of the application calculates the users social network influence in the social network Facebook. The first page of the application is shown on Figure 18. The steps for using the application and a short explanation of how the application works are explained in the left sidebar on this page.

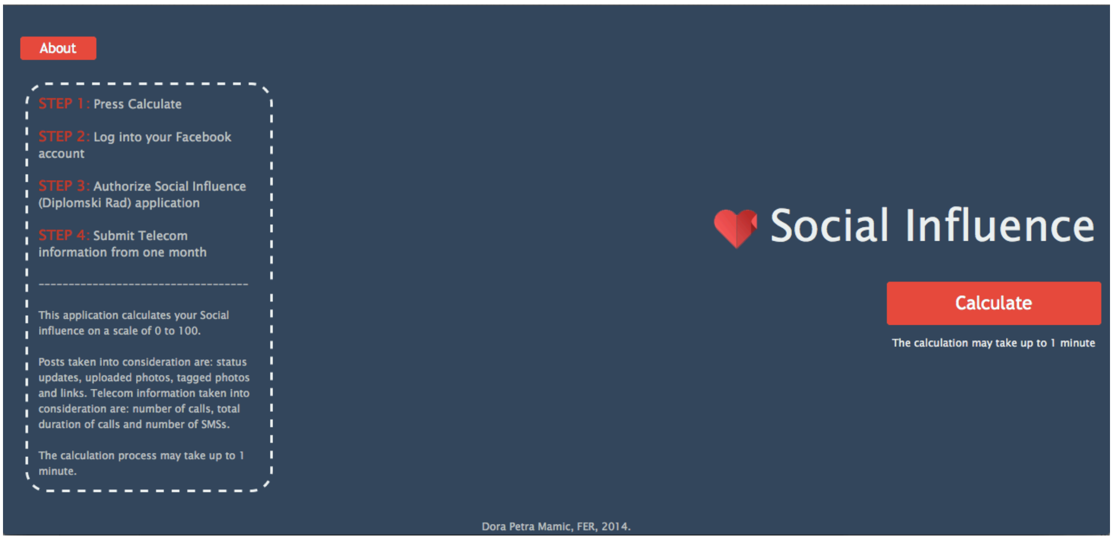

Figure 18 First screen of the web application

By pressing the button *Calculate* the application attempts to connect with Facebook. If the user is not logged into Facebook the application will ask him to login (Figure 19).

Figure 19 Facebook login request

Once the user logs in, he must first accept the application for gathering data on Facebook, *Social Influence (Diplomski Rad)*. For all Facebook applications it is necessary for every user that uses it to accept it and grant permissions to the owner of the application (Figure 20). This application needs the following permissions: the user's friend list, email address, *News Feed*[4], status updates and photos. No semantic data from the statuses, photos and links was taken, only the explicit number of posts and likes and comments on them from the user's friends. Once the user has accepted the Facebook application the process for calculating the social network influence starts.

[4] News Feed is a constantly updating list of stories from people and Pages that you follow on Facebook. News Feed stories include status updates, photos, videos, links, app activity and likes.

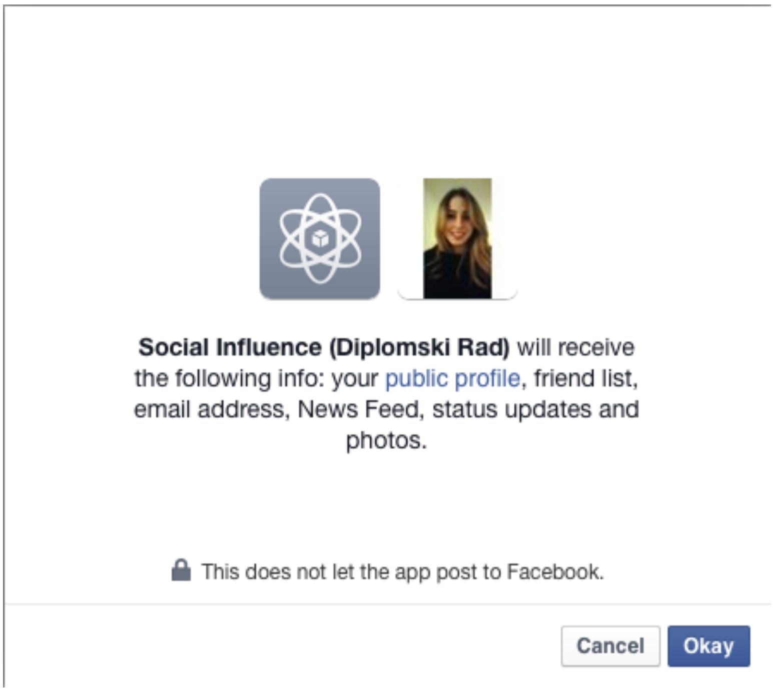

Figure 20 Facebook application permissions

The calculation may take up to one minute, depending on how much information is being collected. Once the calculation is done the social network influence score is shown to the user along with the information of how many posts were taken into consideration (Figure 21).

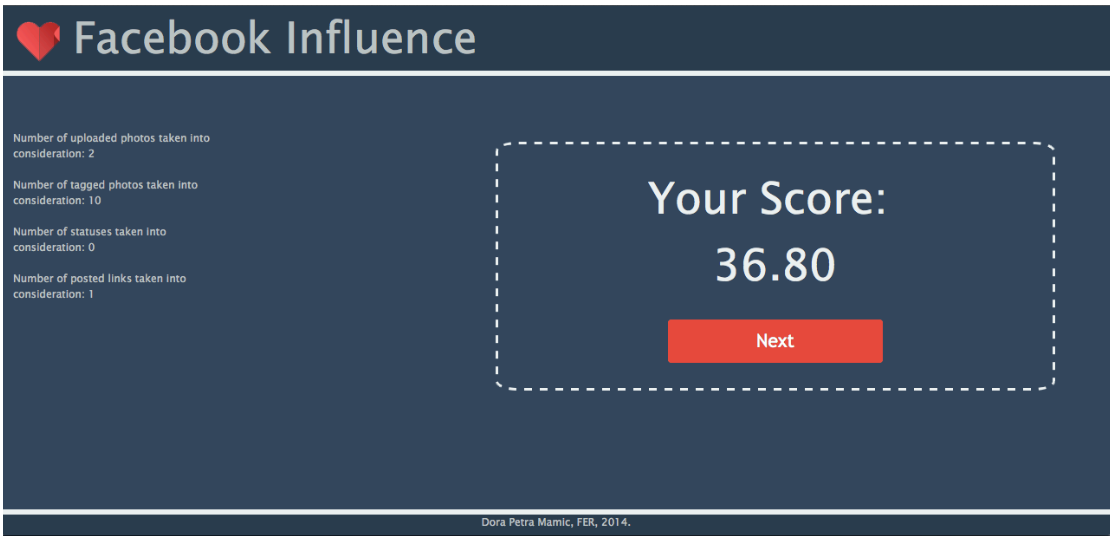

Figure 21 Social network influence score

4.2. CALCULATING TELECOM INFLUENCE WITH THE WEB APPLICATION *SOCIAL INFLUENCE*

After clicking the button *Next*, the user will be asked to input the necessary parameters for calculating the telecom influence (Figure 22). The parameters are the number of calls made, the total duration of those calls and the number of text messages sent in one month. The user can acquire this information from his phone bill or from his operator's website. The left sidebar contains links guiding to websites of Croatian operators.

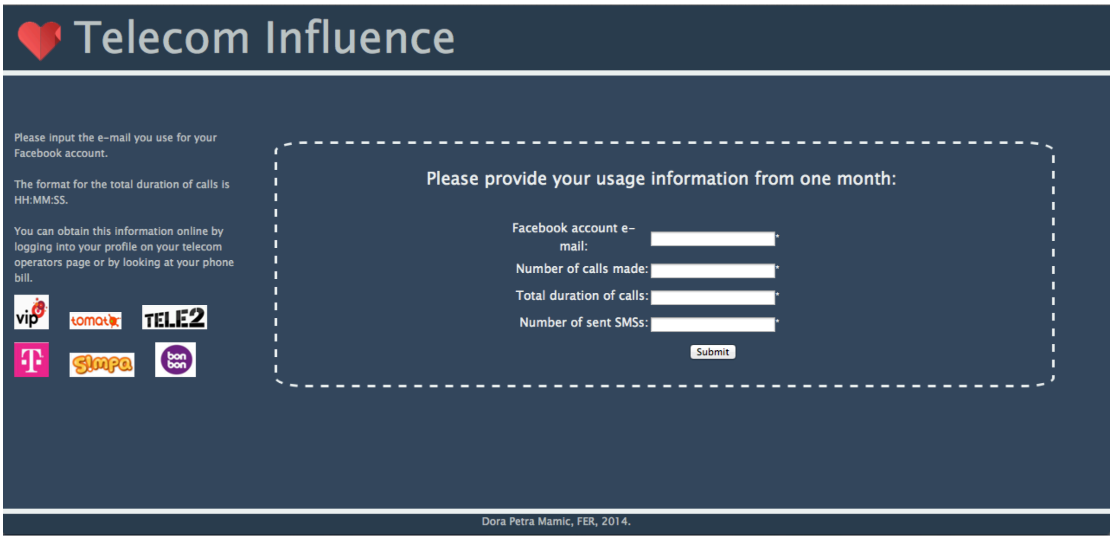

Figure 22 Calculating telecom influence

If the user enters the wrong format of the parameters he will be prompted and asked to correct it.

4.3. CALCULATING TOTAL INFLUENCE WITH THE WEB APPLICATION *SOCIAL INFLUENCE*

Once the user clicks *Submit* his social network influence, telecom influence and total social influence will be shown (Figure 23).

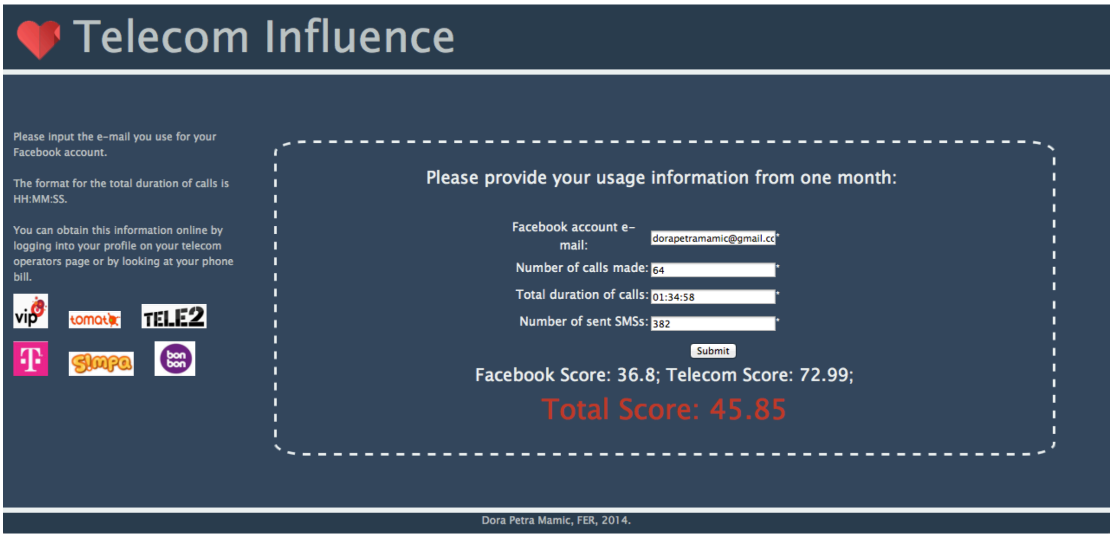

Figure 23 Calculating total influence

4.3. DATABASE OF THE WEB APPLICATION *SOCIAL INFLUENCE*

All of this information is stored in a MySQL database, so it can be used for further analysis. The database contains one table, *Users*. Table 4 shows the structure of the table *Users*.

Table field	Definition
user_id	Id of the user on the social network Facebook
user_email	Email of the user on the social network Facebook
user_first_name	First name of the user on the social network Facebook
user_last_name	Last name of the user on the social network Facebook
user_calls	Number of calls the user made in one month
user_duration	The total duration of those calls
user_sms	Number of text messages sent by the user in one month
user_friends	Number of friends the user has on the social network Facebook
user_photos	Number of photos the user posted on the social network Facebook in the past three months
avg_ue_photos	Average user engagement on those photos
user_status	Number of statuses the user posted on the social network Facebook in the past three months
avg_ue_statuses	Average user engagement on those statuses
user_links	Number of links the user posted on the social network Facebook in the past three months
avg_ue_links	Average user engagement on those links
user_tagged	Number of photos the user was tagged in on the social network Facebook in the past three months
avg_ue_tagged	Average user engagement on those tagged photos
user_fb_influence	The total social network influence of the user
user_telco_influence	The total telecom influence of the user
user_total_influence	The total social influence of the user

Table 4 Structure of the table *Users*

5. EXPERIMENTAL ANALYSIS OF DESIGNED ALGORITHM FOR TOTAL SOCIAL INFLUENCE CALCULATION

Using the web application described in chapter 4, data of 148 users was collected. Out of those users, 123 provided both social network and telecom information. The analysis will be done on these users.

5.1. EXISTING SERVICES FOR CALCULATING SOCIAL INFLUENCE

Before starting the analysis it is important to see how other solutions work.

5.1.1. KLOUT

Klout is a website and mobile app that uses social media data to generate a user's *Klout Score*, which is a numerical value between 1 and 100. The score is based on different social networks the user adds to his profile. Klout uses 400 signals from 8 different social networks to calculate the score. The majority of the signals used to calculate the Klout Score are derived from combinations of attributes, such as the ratio of reactions you generate compared to the amount of content you share. Klout also considers factors such as how selective the people who interact with your content are [11].

There are some similarities between the Klout score and the social influence score described in this thesis. The scale is a bit different; the social influence score has a scale from 0 to 100, while the Klout score scale starts from 1. In calculating both scores the user engagement rate plays an important role, as well as the amount of shared content.

The distribution of Klout scores is shown on figure 24. The distribution is *bi-modal*.

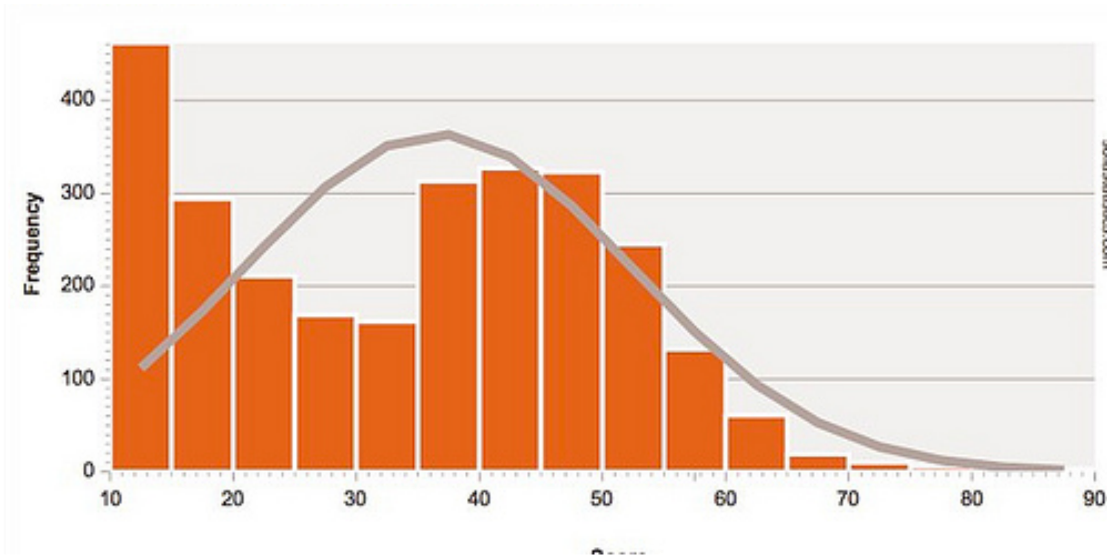

Figure 24 Klout score distribution

5.1.2. KRED

Kred is a website that calculates social influence on social networks Facebook and Twitter. Kred contains two scores, influence and outreach. On Kred influence is defined as the ability to inspire action. It is scored on a scale to 1000. Influence is calculated by assessing how frequently other users interact with the user for whom the score is being calculated. The outreach score measures how much the user helps other users spared their message. This score is infinite, cumulative and constantly increases. Currently the highest outreach score is 12.

Even though the scale is different there are some similarities between the influence score on Kred and the one described in this thesis. They both make use of similar data collected from Facebook. The user engagement is important for calculating both scores.

Figure 25 shows the distribution of the Kred score.

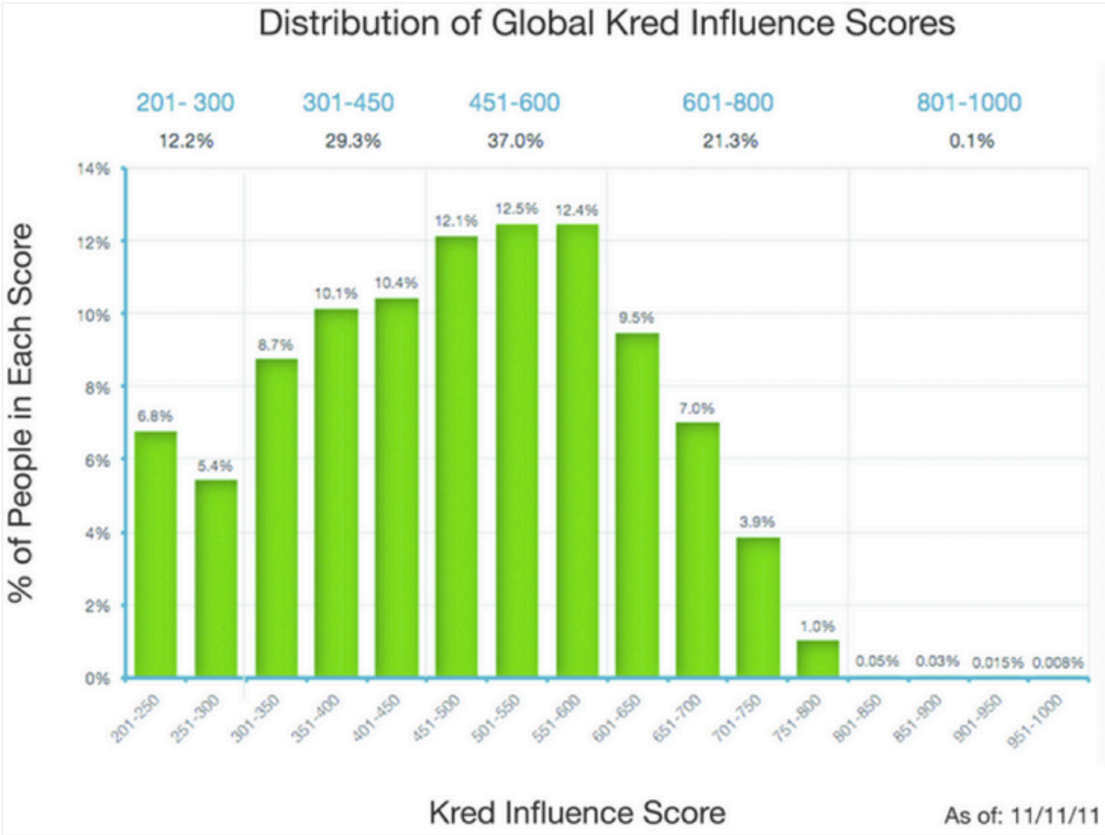

Figure 25 Kred influence score distribution [13]

5.2. ANALYSIS OF THE TOTAL SOCIAL INFLUENCE SCORE

The main difference between the total social influence score and the scores described in chapter 5.1. is that the total social influence score enables utilization of an additional, unique data source – telecom operator's network.

A preliminary experiment of calculating user's influence scores was conducted on 123 modern ICT users during June 2014. The distribution of the total social influence score, as well as the sub-scores, social network influence and telecom influence is shown on figure 26.

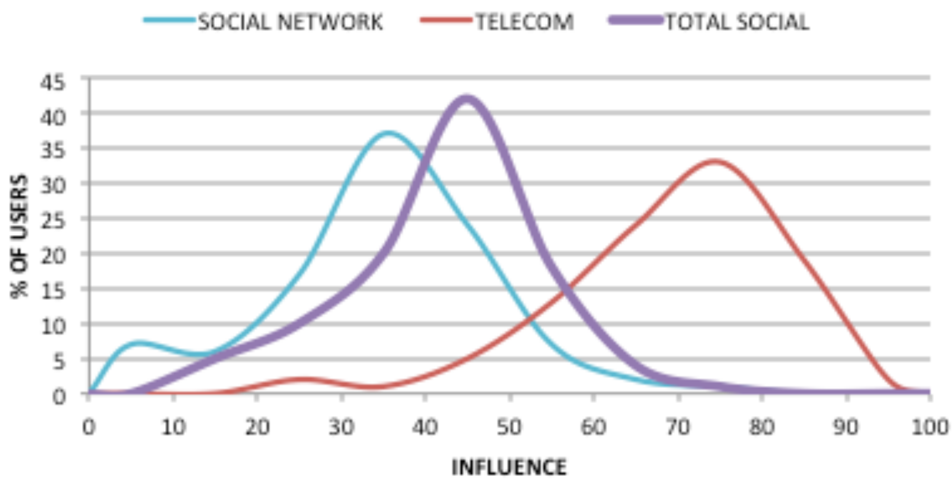

Figure 26 Distribution of scores

The telecom and social network influence distributions are bi-modal, while the total social influence distribution is normal with the median at 45, which is almost half of the maximum possible score. The average is below the median, which means that more users have lower scores than higher ones. This is not surprising since it is difficult to achieve the higher scores.

The social network distribution is similar to the Klout and Kred distributions. The two peaks in the social network influence distribution are for values of 5 and 35. Users under the first peak do not contribute when using social media – they just observe others. The users under the second peak are the ones that create content.

The telecom influence distribution is a bit different. The two peaks are for the values of 25 and 75. This means that most users actively use the telecom services and only a small number of users are passive.

The users with the highest social network influence scores also have high telecom influence scores (Figure 27).

ID	Social	Telecom	Total
675809486	75,52	82,03	77,14
100001175623464	64,73	55,52	62,43
1071042279	60,87	64,88	61,87
100003175518597	58,85	78,87	63,85
658433808	56,81	80,28	62,68

Figure 27 Users with the highest social network influence score

Since most users actively use telecom services and the use of social network services can be accessed through the user's smartphone it is highly plausible that influential social network users are also influential in the telecom domain.

Users with the highest telecom influence score have an around average social network influence score (Figure 28).

ID	Social	Telecom	Total
1042193010	47,80	94,06	59,36
1119980573	45,38	93,06	57,30
1039519307	44,93	91,11	56,47
100001226041351	32,36	89,74	46,70
699395160	36,70	89,06	49,79

Figure 28 Users with the highest telecom influence score

This means that they are very active when using telecom services and are present when using social network services. They might not be the most influential ones, but their presence should not be ignored. Most users have a higher telecom influence score than social network influence score. This is also not surprising since it was already established that most of the users actively use the telecom services. Social network services are relatively new, while the services used to calculate the telecom influence score have been here for a while and almost everybody uses them. With the growing popularity of social networking sites the use of social network services will also grow and these results might change.

5.3. ANALYSIS OF OTHER FACTORS

Below are the analyses of factors included in calculating the total social influence score.

5.3.1. NUMBER OF POSTS

The average number of posts created in three months by a user is 41. The median, however, is 19. It was calculated that the optimal amount of posts in three months if from 60 to 130 [10]. In this dataset only 13% of users have the optimal amount of posts. Most users have posts well below this range (Figure 29).

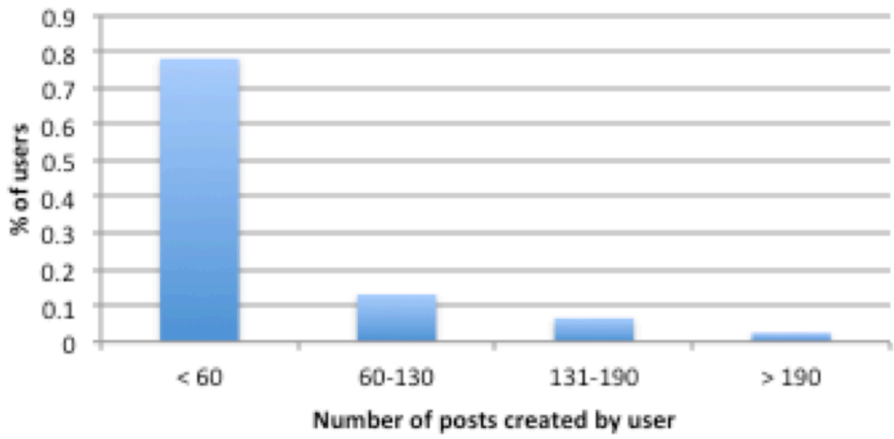

Figure 29 Distribution of created posts by user in three months

Table 5 shows the average and median number of different posts by a user in three months.

Table 5 The average and median number of different posts by a user

Type of post	Average number	Median
Photos uploaded by the user	14.8	5
Photos of the user	11	4
Statuses by the user	3.9	1
Links by the user	11.7	3

Users mostly post photos and rarely post statuses. This is not surprising since statuses are not that popular among Facebook users. The median is much lower than the average in all cases. This means that there are more users with a low number of posts than there are users with a high number of posts.

5.3.2. NUMBER OF FRIENDS

The average number of friends a user has is 465 (Figure 30). The median is 429. This number is almost three times higher than the one calculated by Facebook in

2011 [7]. Since this dataset does not contain many users it is possible that most of the users are similar and have many friends. It is also possible that the average number of friends per user on Facebook has grown since 2011 [16]. Since the study conducted by Facebook contained almost 10% of the global population it is still considered to be the most accurate.

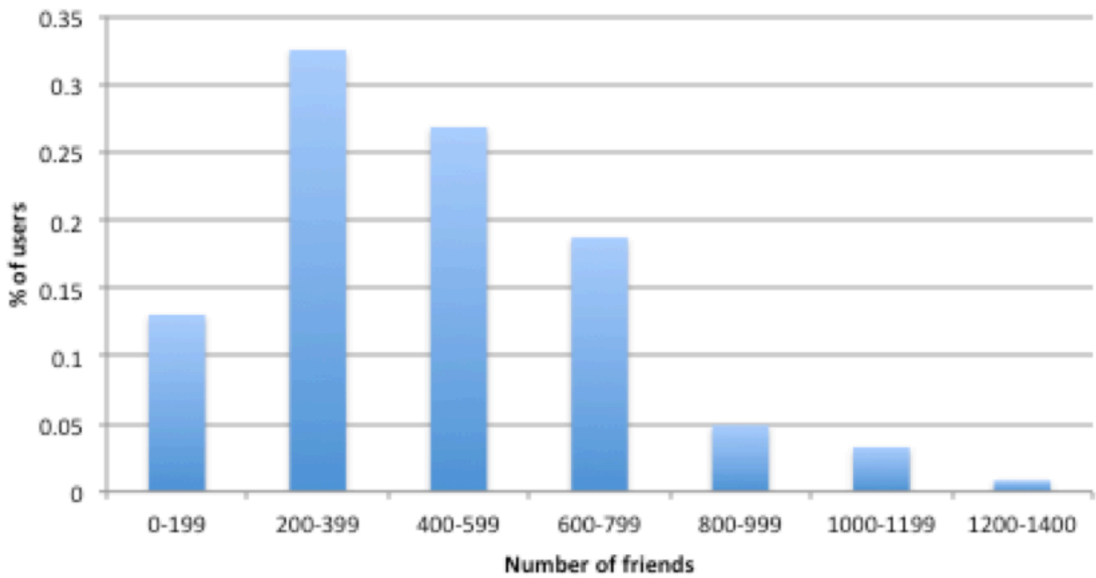

Figure 30 Distribution of the number of friends a user has on Facebook

5.3.3. NUMBER OF CALLS, TEXT MESSAGES AND THE TOTAL DURATION OF THE CALLS

Since the use of the telecom domain in calculating the users total social influence has not been previously used it is important to analyze the telecom parameters involved.

Table 6 shows the average and median number of these parameters.

Table 6 The average and median number of the telecom parameters

Parameter type	Average number	Median
Number of calls made	117.6	92
Total duration of calls made	06h 36min 29s	03h 56min 57s
Number of sent text messages	229	109

More text messages were sent than calls made. The median for each of the parameters is lower than the average. The average number of calls made per day by a user is 3.92, the average duration of a call is 3 minutes and 22 seconds and the average number of sent text messages per day by a user is 7.63. These numbers seem pretty low, especially the number of sent text messages. This could be due to the fact that many smartphone users have switched to mobile messaging applications, such as *Whatsapp*, rather than using *SMS* (Short Message Service). The same can be said for the number of calls made. Since the ages of the users are not visible from the dataset it is difficult to positively conclude whether these figures are high or low. In the US an average teen sends in one month ten times as many text messages as users over 55 [17]. In further research the age of the users should also be included.

CONCLUSION

The preliminary experiment has shown that the users on Facebook are divided into two categories: *i) users who create content;* and *ii) users who only observe*. Influential users are the ones that create content. It has also shown that users actively use telecom services. The total social influence has a normal distribution with the median at almost half of the maximum score. The results that were given confirm that the described algorithm enables calculation of social influence with a similar score distributions as today's leading commercial solutions with hundreds of millions of users. This validates the proposed model, which possesses several differences when compared to other state-of-the-art approaches: *i) improved completeness* (due to inclusion of telecom data in calculations); and *ii) scalability* (due to restricting input data only to data generated in the user's ego-network).

Improvements can be made by adding more input data from different sources and by calibrating algorithm weights through benchmarking based on iterated real-user experiments.

LITERATURE

[1] Social Network Analysis Utilizing Big Data Technology, Jonathan Magnusson, Uppsala University, January 2012

[2] Networks, Crowds, and Markets: Reasoning about a Highly Connected World, Chapter 14 Link Analysis and Web Search, David Easley and Jon Kleinberg, Cambridge University Press, 2010

[3] SocialRank: Social Network Influence Ranking Method, Zhengqiu Yang, Xiaozhe Huang, Jiapeng Xiu, Chen Liu, China, 2012

[4] Modelling Influence in a Social Network: Metrics and Evaluation, Behnam Hajian and Tony White, Carleton University, Ottawa, Canada, 2011

[5] Facebook's 10th birthday: from college dorm to 1.23 billion users, The Guardian, http://www.theguardian.com/technology/2014/feb/04/facebook-10-years-mark-zuckerberg, date accessed: May 5th, 2014

[6] Measuring user influence in twitter: The million follower fallacy, M. Cha, H. Haddadi, F. Benevenuto, K. Gummadi, The 4th International Conference on Weblogs and Social Media, 2010.

[7] Anatomy of Facebook, Lars Backstorm, November 22nd, 2011, https://www.facebook.com/notes/facebook-data-team/anatomy-of-facebook/10150388519243859, date accessed: April 9th, 2014

[8] What is a good Engagement Rate on a Facebook Page?, Michael Leander, Direct Marketing Consulting and Speaking, http://www.michaelleander.me/blog/facebook-engagement-rate-benchmark/, date accessed: May 12th, 2014

[9] Identification of influencers – Measuring influence in customer networks, Christine Kiss, Martin Bichler, TU München, Germany

[10] How often should you post on your Facebook pages?, Socailbakers, http://www.socialbakers.com/blog/147-how-often-should-you-post-on-your-facebook-pages, date accessed: June 7th, 2014

[11] The Klout Score, Klout, http://klout.com/corp/score, date accessed: June 7th, 2014

[12] Kred Scoring Guides, Kred, http://kred.com/rules, date accessed: June 7th, 2014

[13] The influence report: How do Klout and Kred measure up?, Pivot, http://pivotcon.com/a-non-compete-clause-kred-and-klout-just-doing-things-differently, date accessed: June 7th, 2014
[14] Analyzing social media networks with NodeXL: insights from a connected world, D. Hansen, B. Shneiderman, M. Smith, Morgan Kaufmann, 2011.
[15] Networks: An introduction, M. Newman, Oxford University Press, 2011.
[16] 6 new facts about Facebook, PewResearchCenter, http://www.pewresearch.org/fact-tank/2014/02/03/6-new-facts-about-facebook/, date accessed: June 16th, 2014
[17] Chart of the day: Kids send a mind boggling number of texts every month, Business insider, http://www.businessinsider.com/chart-of-the-day-number-of-texts-sent-2013-3, date accessed: June 14th, 2014
[18] How to Calculate Trust between Social Network Users?, V. Podobnik, D. Striga, A. Jandras, I. Lovrek, SoftCom, 2012
[19] Calculating user's social influence through the SmartSocial platform, V.Podobnik, V. Smailovic, D. Striga, D. Mamic, SoftCom (awaiting review), 2014

SUMMARY

Social influence of a user is a measure of how one person's opinions and thoughts affect others around him. This influence can be considered in many different environments. In this thesis user's social influence was described and analyzed on a *modern information and communication technology (ICT) user.* This user has a smartphone, uses the basic telecommunication services and also uses the services of the social networking site *Facebook*. An algorithm for calculating the user's social influence based on the basic telecommunication services and Facebook services will be described and implemented. Finally, a preliminary experiment will be done on 123 modern ICT users and the results will be analyzed.

SAŽETAK

Društveni utjecaj korisnika je mjera koliko mišljenja i uvjerenja jednog korisnika utječu na druge korisnike oko njega. Ovaj utjecaj se može razmatrati u različitim okruženjima. U ovom diplomskom radu društveni utjecaj korisnika je opisan i analiziran na modernom korisniku informacijske i komunikacijske tehnologije. Ovakav korisnik ima pametni telefon, koristi osnovne telekomunikacijske usluge te također koristi usluge društvene mreže *Facebook*. Algoritam za računanje korisnikovog društvenog utjecaja na temelju telekomunikacijskih usluga i usluga društvene mreže Facebook će biti opisan i implementiran. Za kraj će biti napravljen i analiziran preliminarni eksperiment predloženog algoritma na 123 korisnika informacijske i komunikacijske tehnologije.

KEYWORDS

social networks, social media, social networking sites, Facebook, telecommunication networks, telecommunication services, social influence, social network influence, telecom influence, social network analysis

ICT - information and communication technology