# User Mining to Find Important Facebook Users

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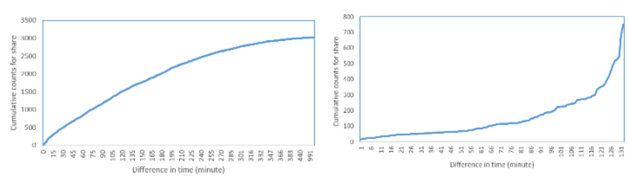
## ABSTRACT
Social media website such as Facebook have become even more popular. Receiving information from Facebook and generating or spreading information on Facebook every day has become a general lifestyle. The civil movements led by college students were across the globe through the Internet in the past years. In Taiwan, on March 18 2014, some students occupied the Taiwanese Parliament Building in order to resume the negotiation for the Cross-Strait Service Trade Agreement. These students shared information on some social media websites such as Facebook. In this paper, we work on the data of the sunflower student movement and our goal is to mine important users on Facebook. Existing network based approaches proposed to mine important Facebook users in civil movements cannot be applied to our data, because there is no network structure in our data. We use cross-analysis in the mining task. We mine users who change the speed of diffusion of posts as well as find users who share and comment on the maximal posts. We think that these users are important Facebook users. We find that three users are active and important users through sharing-reaction, and we also find that other three users are important users, and they handle comments and draw conclusions.

## CCS Concepts
• **Human-centered computing~User studies** • **Human-centered computing~Social media** • *Human-centered computing~Social networking sites*

## Keywords
"Civil movements", "Sunflower student movement", "Facebook".

## 1.INTRODUCTION
The Internet rapidly develops during the past decades. It has revolutionized communications and enriched our life. Today, social media websites generate a prodigious wealth of real-time content at an incessant rate [1]. Social networks have appeared as major platforms for hundreds of millions of interactions created by users every day [2]. In Taiwan, Facebook had 1.8 million monthly active users in the second quarter of 2016 and the penetration rate of Facebook is 76.7% [3]. It is the most popular social media website in Taiwan. Facebook's users can create profiles, post status updates and photos, and share videos on their walls. There have been many studies regarding Facebook, while most are concerning the structures and/or dynamics of the social networks. There also have been many studies regarding Twitter, a microblogging and social networking platform, while most are concerning how messages are spread. Facebook is the most representative social networking platform for our study.

In the early 21st century, we saw revolutions or movements led by young people across the globe through the Internet [4, 5, 6, 7, 8, 9, 10, 11]. The most prominent example was Arab Spring or the Occupy Wall Street movement in 2011. When a civil movement or revolution happens, people use social media and networking websites to publish as well as spread what they see and/or hear. In Taiwan, the sunflower student movement is to resume the negotiation for the Cross-Strait Service Trade Agreement (CSSTA). March 18, 2014 is an important day in Taiwan's history, because many college students occupied the Taiwanese Parliament Building on this day. CSSTA is thought to cast huge impacts on the life of ordinary people, including considerable job losses or worsen working condition in several enterprises [12]. The sunflower student movement was a protest movement driven by a coalition of college students and civil groups between March 18 and April 10, 2014. These Taiwanese students employed the Internet and shared information on some social media websites such as Facebook. They also shared what is seen through posts, photos, and videos on Facebook during the sunflower student movement.



(a) Post A (b) Post B

**Figure 1. The cumulative sharing-reaction counts for two posts.**

We collect data from fan pages on Facebook during this movement. We find some users who change the speed of diffusion of posts through sharing-reaction. Figure 1 shows that there are 2 posts with difference in time and the cumulative sharing-reaction counts. The difference between the time when the post is created and the time when any share appears. In general, the speed of diffusion of posts through sharing-reaction is fast when this post is just created. After some time, the speed is becoming progressively slow, such as Post A. However, the speed of diffusion of Post B shows that the speed of diffusion becomes fast when a user shares Post B. After this user shares Post B, Post B is shared by more Facebook users. On the other hand, while a user comments on a post, the speed of diffusion becomes fast. We think that his or her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comment brings more comments. These users are important on social media because their reactions bring more topics or actions. They maybe leaders of the movement. However, we cannot identify these important Facebook users. It is hard to verify these users who maybe leaders of the sunflower student movement in the real world. This is our research limitation.

Our contribution is to find important Facebook users through reactions during the civil movement. Although we cannot know who are the leaders of this movement, we know these users are important Facebook users. In addition, we need to propose an approach to solve the problem because our dataset does not contain any network structure, which is required by existing approaches.

The remainder of this paper is organized as follows: We will briefly review the related works in Section 2, describe our method in Section 3, report results from experiments in Section 4, and finally conclude this paper in Section 5.

## 2.RELATED WORKS

In recent years, due to the rise of social media websites on the Internet, people can easily and frequently publish their statuses and messages to social media at any place. Facebook is an online social media and social networking service.

New technologies have changed our political and social activities all over the world, such as social networking services in the Jasmine revolution in Tunisian and Egypt's 2011 revolution [4, 5, 8, 9]. When a civil movement or revolution happened, people use such websites to publish anything that they see at any time. People notice that social media plays a crucial role in recent civil movements and the most prominent example is Arab Spring or the Occupy Wall Street movement in 2011 [13]. Using social media for mobilizing is not a recent phenomenon. In 1994, a group of indigenous people called Zapatistas in Mexico made use of the Internet technology [14]. Indeed some have been so bold as to label them as the 'Twitter Revolutions' or 'Facebook Revolutions [11]. In North American, the main issues raised by Occupy Wall Street, a protest movement, were social and economic inequality, greed, corruption on the government in 2011 [15]. Social media have an important tool in diffusing messages and help protesters not only to mobilize but also to gain international attention and prolong the movement over a long period.

On March 17, 2014, Taiwan's ruling Kuomintang party attempted a move in the Legislative Yuan to force CSSTA to be passed without giving it a clause-by-clause review as previously established in a June 2013 agreement with the opposing Democratic Progressive Party. This agreement is expected to cast huge impacts on the life of ordinary people, including considerable job losses or worsen working condition in several enterprises [12]. Students saw off the police's serial breaching attempt around the Taiwanese Parliament Building on March 17, 2014. It was only the beginning of the resistance for these students. They attempted to stop the undemocratic coalition of some political elites in both Taiwan and China. Students spread messages and videos to whoever is committed to the principle of democracy, transparency, and participation. They posted as well as shared posts on Facebook and even created fan pages on Facebook to fight against CSSTA. Students spread messages and shared thoughts on the fan pages established by supporters on Facebook and other social media. Facebook is the most popular social media website in Taiwan. Therefore, we mine important Facebook users in this movement.

In comparison to other media, social media's influence in political campaigns has increased tremendously. One of the most consistent narratives from civil society leaders in Arab countries has been that the Internet, mobile phones, and social media such as Facebook and Twitter made the difference this time [16]. Social media create new issues or important users. The trigger of Tunisian Revolution was the self-immolation of Mohamed Bouazizi. After his self-immolation, Bouazizi's image flooded social media which lead to worldwide discourse. He did not plan to start a revolution. No one could have predicted that Bouazizi would play a role in unleashing a wave of protest for democracy in the Arab world [17]. Facebook groups in support of political leaders, as well as some online media outlets in the region that appear to be independent, have come under scrutiny as being co-opted by their own government's influence [10]. In [18], they refer to the behavior of social media users. The political change (such as the initial protests associated with the Arab Spring) leads to changes in the use of social media (e.g., more people signing up and using social media for political content), which can lead to further changes in the political environment (such as more people participating in protests). Our study is to mine important Facebook users during the sunflower student movement.

## 3.METHOD

Our dataset contains posts generated by 20 selected fan pages that fight against CSSTA during the sunflower student movement. Our dataset includes 2,533 posts, 256,027 shares, and 176,942 comments. Sharing and commenting on posts are reactions. We define the acceleration of diffusion of posts through sharing-reaction and commenting-reaction from the selected fan pages, according to [3]. We refer to the acceleration definition to mine users who change the speed of diffusion of posts. We propose an algorithm to mine important users by using cross-analysis, as shown in Figure 2.

The notations used in this paper are summarized in Table1.

**Table 1. Notations for a post P with n shares and m comments**

| Name | Notation | Note |
|---|---|---|
| *i*-th share | $Sp(i), 0 < i < n$ | |
| *i*-th comment | $Cp(i), 0 < i < n$ | |
| Difference in time for share or comment | $TD(Sp(i), Sp(j))$ or $TD(Cp(i), Cp(j))$ | Between *i*-th and *j*-th share or ccomment |
| Share or comment distance | $D(Sp(i), Sp(j))$ or $D(Cp(i), Cp(j))$ | Between *i*-th and *j*-th share or comment |
| Sharing segment acceleration | $SA(Sp(i), Sp(i+1))$ | From *i*-th to (*i*+1)-th share |
| Commenting segment acceleration | $CA(Cp(i), Cp(i+1))$ | From *i*-th to (*i*+1)-th comment |

### 3.1.The Sharing-reaction

Acceleration, in physics, is the rate of change of speed of an object. Acceleration is the change in speed per unit time. When an object is rising, this object has a positive acceleration.

**Definition 1.** *Let the distance between any two adjacent (consecutive) shares be 1 (i.e. D(Sp(i), Sp(i+1))=1). For a post P with n shares, the segment acceleration of the post P is defined the change of the segment speed from the i-th to the (i+1)-th, for 0 < i < n. The associated calculation is shown in (1).*

$$SAp(Sp(i), Sp(i+1) = \frac{Dp(Sp(i),Sp(i+1))}{TD(Sp(i),Sp(i+1)) \times TD(Sp(i),Sp(i+1))} \quad (1)$$

We use Figure 2 to present the algorithm of cross-analysis. It is to find important users who share the maximal posts and speed up the diffusion of posts through sharing-reaction.

```
Algorithm important_user_sharing(source, r, k)
Input: these posts data S with their shares and comment; r: r users share posts; k: rank k users
Output: top-k users for maximal influence;
Method:
    FOR EACH POST p ∈ S DO
      Users_g1[i] ← Σ t  group by user's id  /* For a post p, it has t shares. */
    END FOR EACH
    sort r from large to small
    FOR EACH POST p ∈ S DO
      FOR EACH SHARE DO
        BSp ← compute the difference in time between p created time and share created tine
      END FOR EACH
      Sort BSp;
      FOR i=1 TO t DO  /* For a post p, it has t shares */
        IF (i>1) THEN
          BAp[i] ← 1/(BSp[i]—BSp[i-1])²  /* BA is computed the acceleration for a post p */
        END IF
      END FOR
      sort BAp from large to small
      FOR j=1 TO k DO   /* For a post p, choose top-k users */
        BAp_users[j] ← BAp[j] corresponding user
      END FOR
    END FOR EACH
    sort BAp and BAp_users from large to small
    FOR j=1 to k DO    /* rank top_k users for all posts */
      Users_g2 ← BAp_users
    END FOR
    FOR j=1 to r DO
      FOR i=j+1 to r DO
        IF (Users_g1[j] = Userr_g2[i] ) THEN
          top-k ← User_g1[j]
        END IF
      END FOR
    END FOR
    RETURN top-k
```

**Figure 2. Algorithm for top-k users for maximal influence for sharing-reaction.**

## 3.2.The Commenting-reaction

**Definition 2.** *Let the distance between any two adjacent (consecutive) comments be 1 (i.e. D(Cp(i), Cp(i+1))=1). For a post P with m comments, the segment acceleration of the post P is defined the change of the segment speed from the i-th to the (i+1)-th, for 0 < i < n. The associated calculation is shown in (2).*

$$CAp(Cp(i), Cp(i+1) = \frac{Dp(Cp(i), Cp(i+1))}{TD\big(Cp(i), Cp(i+1)\big) \times TD\big(Cp(i), Cp(i+1)\big)} \quad (2)$$

We use an algorithm to find important users who comment on the maximal posts and speed up information through commenting-reaction. It is similar to that for sharing-reaction.

# 4.EXPERIMENTS

Observing our data, we find that there are 950,484 users liking posts, 84,781 users sharing posts, and 72,196 users commenting on posts during the sunflower student movement. We use public data collected from fan pages on Facebook. The accounts of users are set to public. Consequently, 987,420 users have at least one reaction for posts and 36,936 users who have never liked posts but shared or commented on posts. We draw the following conclusions: 1) Percentage of users sharing posts is about 9% and percentage of users commenting on posts is about 7%; 2) On average, a user likes 7 times, shares 3 times, and comments 2.5 times. For a user, the liking-reaction is easier to give or have than other reactions. Commenting on a post is harder than sharing or liking it. It shows that the cost of commenting on posts is higher than that of sharing or liking posts.

Table 2 reports top 10 users. Uid is user id and it is virtual in Table 2. We find top-10 users who like the maximal posts in Table 2(a). The user U1 who likes 1,079 times is the most active user. For a post, a user likes only one time but could share or comment more than one time on Facebook. Therefore, the user U1 likes 1,079 posts among 2,533 posts. On average, the user U1 likes about 45 posts every day. Then, the user U2 likes 1,044 posts and this user likes about 44 posts every day. Among 950,484 users liking posts, 441,966 users like just one post. For a user, the maximal number of the liking-reaction is 1,079, and the average number of the liking-reaction is 7.64.

In our dataset, 84,781 users share posts. The user U9 shares 441 times and takes part in 13 fan pages to fight against CSSTA from Table 2(b). It shows that some users join in many fan pages. For the top-10 users, the number of fan pages through sharing-reaction is almost over 10 fan pages. Among 84,781 users sharing posts, 51,534 users share one time. For a user, the maximal number of the sharing-reaction is 441, and the average number of the sharing-reaction is 2.12. In our dataset, 72,196 users comment on posts. In Table 2(c), the user U201 comments on 267 times and takes part in 8 fan pages to comment on posts. The user U205 takes part in 12 fan pages to comment on posts. For the top-10 users, the number of fan pages through commenting-reaction is under 10 fan pages except the user U205. Among 72,196 users commenting on posts, 49,354 users comment one time. 68% of users comment on a post during the sunflower student movement. For a user, the maximal number of the commenting-reaction is 267, and the average number of the commenting-reaction is 2.12.

**Table 2. Top-10 users who like, share or comment on maximal posts.**

(a) liking-reaction (b) sharing-reaction (c) commenting-reaction

| Uid | Number of Facebook likes | Uid | Number of shares | Number of related fan pages | Uid | Number of comments | Number of related fan pages |
|---|---|---|---|---|---|---|---|
| U1 | 1,079 | U9 | 441 | 13 | U201 | 267 | 8 |
| U2 | 1,044 | U102 | 402 | 10 | U202 | 244 | 9 |
| U3 | 966 | U103 | 309 | 11 | U203 | 204 | 9 |
| U4 | 870 | U104 | 268 | 12 | U204 | 173 | 7 |
| U5 | 846 | U105 | 267 | 9 | U205 | 170 | 12 |
| U6 | 814 | U106 | 263 | 11 | U10 | 169 | 7 |
| U7 | 774 | U107 | 241 | 10 | U207 | 142 | 7 |
| U8 | 759 | U108 | 202 | 9 | U208 | 137 | 9 |
| U9 | 748 | U109 | 193 | 13 | U209 | 123 | 6 |
| U10 | 738 | U110 | 189 | 10 | U210 | 119 | 5 |

In summary, each user likes 7.64 posts, shares 2.94 posts, and comments on 2.11 posts voluntarily. It shows that users often like posts but rarely share and comment on posts. Therefore, the liking-reaction is easier to give or have than the sharing-reaction or commenting-reaction on Facebook. For the sharing-reaction and commenting-reaction, users are more interested in sharing posts than commenting on posts. No one is both top-10 who shares and comments on the maximal posts. However, the user U9 appears in both Table 2(a) and (b); U9 is an active user who likes and shares posts. Furthermore, the user U10 is an active user who likes and comments on posts; U10 appears in both Table 2(a) and (c). It also shows that the liking-reaction is easy. These users positively and voluntarily participate in the movement, and they may influence their friends. They are active and important users.

We discuss some users who change the speed of diffusion of posts further. After someone shares or comments on a post, the speed of diffusion of posts will significantly change for this post. This user may be a particular or important user. The rate of change in the speed of an object is acceleration. We analyze who may react to posts as quickly or slowly as other users do. Then, we discuss that these users associate with top-*k* users who like, share or comment on the maximal posts.

## 4.1.The Sharing-reaction

Table 3 reports simple statistics for acceleration of the sharing-reaction for posts. When the *i*-th share is ranked as the top-*k* positive acceleration, the user of the *i*-th share is a special user who can spread messages soon. If a user changes the speed of diffusion of posts, this user could be an important user on social networks. Each post chooses top-*k* maximal and minimal acceleration of sharing-reaction. We aggregate all users from the selected posts and then rank users according to the value of acceleration. We find top-*k* users who share posts to cause the maximal change of speed, and the top-*k* users are called the top-*k* creators for maximal acceleration; the acceleration is a positive number. On the contrary, the acceleration may be negative. It shows that some users decrease the speed of information diffusion through sharing-reaction. We use the top-*k* creators to distinguish different groups of the top-*k* users. Therefore, in this paper, the top-*k* users are found by ranking users according to the numbers of their Facebook likes, shares, or comments. The top-k creators are found by ranking users according to the maximal or minimal change of speed. The top-*k* creators for minimal acceleration may have fewer friends on Facebook, or their friends have shared the posts before the top-*k* creators for minimal acceleration share the posts.

**Table 3. The acceleration of the sharing-reaction.**

| | Mean | Maximum | Minimum | Median | Mode | Standard deviation | Q1 | Q3 |
|---|---|---|---|---|---|---|---|---|
| Positive acceleration | 3.30 | 19 | 0.02 | 2 | 1 | 3.01 | 0.02 | 4 |
| Negative acceleration | -4.23 | -0.1103 | -17 | -3.5 | -3 | 2.95 | -5 | -2 |

Using cross-analysis, we aggregate the top-*k* creators for maximal acceleration and the top-*k* users who share the maximal posts; we set *k* to 100. The first user U102 in Table 2(a) is a top-10 creator for maximal acceleration. The other two users (U158 and U172, top-100 users who share the maximal posts) have the same acceleration. The value of acceleration is 14. The three users are active and important users for diffusion of posts and speed up diffusion through sharing-reaction.

We aggregate the top-*k* creators for minimal acceleration and the top-*k* users who share the maximal posts. Nobody is a top-10 user who shares the maximal posts and a top-10 creator for minimal acceleration. However, two users are the top-*k* users and the top-*k* creators, when *k* is 100. The first user (U152) is a top-*k* creator for minimal acceleration. For this user, the value of acceleration is -16 for one post. However, for the other user (U179), the value of acceleration is -16 for two posts. The two users may have fewer friends on Facebook or they may share posts in the unsuitable time. Because the two uses shared the posts, their sharing-reaction timestamps of the posts have reached over the timestamp corresponding to 90% cumulative count of shares, according to [3]. In other words, their friends have shared the posts before the two users share the posts. Therefore, the two users (U152 and U179, top-100 users who share the maximal posts) share the posts late. Nobody is a top-*k* creator and a top-*k* user with regard to liking and commenting on posts. Similarly, nobody appears in the list of the top-*k* creators for minimal acceleration and the list of the top-*k* users with regard to liking and commenting on posts.

## 4.2.The Commenting-reaction

Table 4 reports simple statistics for acceleration of the commenting-reaction for posts. We consider top-*k* maximal and minimal acceleration of commenting-reaction. We aggregate all users from posts and then rank users according to the value of acceleration. Similarity, we build top-*k* users who comment on posts to cause the maximal change of speed, and the top-*k* users are called the top-*k* creators for maximal acceleration. The acceleration is a positive number. These top-*k* creators for maximal acceleration may receive more comments. More users want to comment on the posts after the commenting-reactions done by the top-*k* creators for maximal acceleration. On the contrary, the acceleration may be negative. It shows that some users decrease the speed of diffusion of posts through commenting-reaction. The top-*k* creators for minimal acceleration may handle comments or draw conclusions. For a post, some comments are positive and some are negative. These users handle the positive and negative comments. They may play important roles in the activity.

**Table 4. The acceleration of the commenting-reaction.**

| | Mean | Maximum | Minimum | Median | Mode | Standard derivation | Q1 | Q3 |
|---|---|---|---|---|---|---|---|---|
| Positive acceleration | 3.47 | 31 | 0.001 | 2 | 1 | 3.88 | 1 | 4 |
| Negative acceleration | -4.21 | -0.0074 | -22 | -3 | -2 | 3.52 | -5 | -2 |

We also set *k* to 100. We aggregate the top-*k* creators for maximal acceleration and the top-*k* users who comment on the maximal posts. Nobody appears in the list of the top-*k* creators for maximal acceleration and the list of the top-*k* users who comment on the maximal posts.

Then, we discuss the top-124 creators for minimal acceleration through commenting-reaction, because the value of acceleration of the top-124 creators for minimal acceleration is minimum. Three users are the top-124 creators for minimal acceleration and the top-100 users who comment on the maximal posts. Two users, U204 and U210 in Table 2(c), are the top-10 users who comment on the maximal posts. They appear in one post. The other user (U267, a top-100 user who comments on the maximal posts) appears on two posts. The three users are active and important users. It presents that the three users can draw conclusions regardless of the negative or positive comments. Facebook makes it easy to add emotions to comments. Anyone can easily add a comment to any post on the news feed. Therefore, the three users are possibly leaders. They handle comments with the positive or negative words.

Further, we aggregate the top-*k* users who like or share the maximal posts and top-*k* creators for maximal acceleration through commenting-reaction. There is only one user (U18, a top-100 user who likes the maximal posts) who is top-*k* user liking the maximal posts and the top-*k* creator for maximal acceleration. It shows that this user who likes posts and his or her comments are spread quickly. This user is an active user. Nevertheless, nobody appears to be a top-*k* creator for minimal acceleration and a top-*k* user regardless of liking and sharing on posts.

## 5.Conclusion

Recently, the Internet becomes a complicated tool enabling individuals to create content and communicate with others.

Facebook has become a way of life and the most popular social media website, especially in Taiwan. We use the data collected from fan pages on Facebook to analyze important users. The sunflower student movement was an important activity in Taiwan's history. Hundreds of college students sat during the demonstration in Taipei to protest the ruling party's push for an agreement with China. They wanted the government to resume the negotiation of CSSTA. These students applied the Internet technology and the influence of social media to spread their opinions. In this study, we use cross-analysis to mine important Facebook users from different aspects in the movement. Our key findings are as follows:

1) On average, a user likes 7 times, shares 3 times, and comments 2.5 times. For a user, the liking-reaction is easier than other reactions. Commenting on a post is harder than sharing or liking it. It shows that the cost of commenting on posts is higher than that of sharing or liking posts.

2) One user is a top user who likes and shares the maximal posts; another user is a top user who likes and comments on the maximal posts. The two users are most active users.

3) Three users share the maximal posts and they are important users for diffusion of posts through sharing-reaction. They are active and influential users.

4) Two users are the top users who share the maximal posts and also the top creators for minimal acceleration through sharing-reaction. It shows that their friends have shared the posts before the two users share the posts.

5) Three users are the top users who comment on the maximal posts and also the top creators for minimal acceleration through commenting-reaction. They are important users and handle comments and draw conclusions. They are possibly leaders in the movement.

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