Understanding Mass Media Using Facebook Like Activities

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Abstract

With the emergence of social network services, many media organizations have established their fan pages on social platforms (e.g., Facebook and Twitter). They promote their content, disseminate breaking news, interact with the audience, and publish editorials on particular events through fan pages. For readers, these online channels not only help them to receive the latest information but also enable them to directly express their endorsement or disagreement toward specific news or articles. According to the observation, in this study, we use the online behaviors to investigate favors/controversy from users to media organizations and to quantify the ideological difference of popular channels and their audience. We collect and analyze the actions of mass media pages on Facebook in a 6-month-long observation in 2018. A total of 19 fan pages of major mass media companies in Taiwan are investigated, and we locate their positions in a two-dimensional space using singular value decomposition. The results demonstrate that online activities from users can help to distinguish and cluster media companies based on several characteristics, including media types (magazines or newspapers), political stands, and their owners. These findings also correspond to previous offline qualitative studies in communication and media disciplines.

1 Introduction

Online social networks have been essential channels for organizations to interact with their followers in recent years. For mass media companies, they establish fan pages to announce the latest news, publish opinions, and communicate with the audience. Meanwhile, users follow the media of their interests; moreover, they express their supports/rejection toward specific articles using the emotion bottoms. The endorsements and interactions not only reveal the connections between users and media organizations but also demonstrate "birds of a feather" phenomenon between online users. From the previous studies, people with similar political stands are likely to consume specific news sources. For example, Republicans endorse radio news while Democrats prefer television news (Pfau et al., 2007). The research demonstrated the ideological difference of users would reflect on their media preference and news consumption using qualitative studies. In contrast, with the widespread use of social network services, data scientists have explored a series of new approaches to realize political information cascading and polarization using online social data (Bakshy et al., 2015; Barberá et al., 2015; Flaxman et al., 2016; Garimella et al., 2018). Nonetheless, despite the abovementioned studies, how to leverage large-scale online behaviors for measuring ideologies/features of media organizations remains scant.

Thus, in this study, we make use of user endorsements on news pages on Facebook to understand and quantify the distances between media organizations. From the findings, we aim to approach two goals:

1. **Positioning media companies with a two-dimensional space:** Demonstrating a method to pinpoint mass media pages according to the page-user interactions. With appropriate visualization, we situate and present the locations of mass media.

2. **Exploring and validating derived locations of media pages:** Correlating

the previous qualitative studies, backgrounds, and other characteristics of media organizations with the analysis results. The steps not only validate the effectiveness of our method but also provide new interpretation to mass media using social data.

To achieve the research goals, we study 19 popular official pages (receiving likes from at least 25 thousand distinct users) of mass media in Taiwan, including printed media (newspapers, magazines), television news, and state-owned news stations. There are two reasons for selecting Taiwanese news sources as research targets. 1) Taiwanese politics have been polarized and divided into pro-unification and pro-independence for many decades. The differences in political stances not only appear in the two major parties (Kuomintang and Democratic Progressive Party) but also occurs in the mass media groups (Wang and Chang, 2006; Huang, 2011; Clark and Tan, 2012; Rawnsley et al., 2016). Thus, the media industry in Taiwan would be suitable for us to investigate media polarization. 2) Facebook has the highest penetration rate in Taiwan at 97% and about 15 million active users per month, according to the recent report[1]. Therefore, Taiwan would be an appropriate place for Facebook studies. We collect the user-article emotion records from the selected pages and perform a series of processing and analysis on the data collection to retrieve representative features of the pages. Based on the results, we locate the pages using a two-dimensional space and discuss the effectiveness of the method with the backgrounds of channels and the previous qualitative research results. According to the outcomes, our approach can successfully distinguish media pages by their types (journals, newspapers, TV channels), backgrounds, and political tendencies, and the results also correspond to the previous literature.

The followings describe the organization of this paper. In Section 2, we introduce the background of offline/online media bias researches. The details of our data collection,

formalized processes, and derived features of pages are presented in Section 3. In Section 4, we demonstrate validations of our obtained results based on the previous qualitative studies. We conclude our research and discuss future directions in Section 5.

2 Related works

Media bias has long been an important issue in journalism (D'Alessio and Allen, 2000; Eveland Jr and Shah, 2003; Ardèvol-Abreu and Gil de Zuniga, 2017). With the increasing concerns regarding the biased reports on mass media from the general public (Morris, 2007; Iyengar and Hahn, 2009), previous scholars have demonstrated pieces of evidence of selective media usage according to users political identities (Stroud, 2008; Ardèvol-Abreu and Gil de Zuniga, 2017). On the other hand, with the capabilities of online social networks, online information polarization has become a general phenomenon (Bakshy et al., 2015; Barberá et al., 2015; Sunstein, 2018). The mechanisms and algorithms of social networks could result in selective exposure to information (Lee et al., 2014; Schmidt et al., 2017; Fletcher and Nielsen, 2018), especially in political news consumption (Jacobson et al., 2016; Gruzd and Roy, 2014). These works demonstrate various methods, including online experiments, share activities, content analysis, and surveys.

The abovementioned researches have investigated and observed media bias and selective exposure from offline media and online experiments; however, a few works focus on employing online behaviors to empirically cluster media organizations in a single country or a region to identify and quantify media bias. In this study, we start from a perspective of mutual attitudes from users toward media companies and locate different entities on a two-dimensional space. We validate the method and derived results with offline theories and previous scholars.

3 Data and Method

Benefiting from the popularity of social media, not only broadcasting but also printed media establish fan pages to disseminate their articles and interact with users. To thoroughly include the major media companies in Tai-

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[1] https://www.forbes.com/sites/ralphjennings/2018/10/11/facebook-says-it-already-has-97-of-taiwans-internet-users-and-now-its-targeting-businesses.

wan, we manually search official pages of media companies on Facebook according to two criteria: 1) The media should concentrate on reporting Taiwan-related issues and written in Traditional Chinese. 2) As organizations may create many fan pages, only the most popular pages belonging to the same group are included.

A total of 19 pages which attract at least 25 thousand "like" activities from individual accounts during a 6-month-long observation are included in our list. Next, we refer to the ideological measurement methods proposed in the previous studies (Bond and Messing, 2015; Wang et al., 2017) and extract the interactions between unique accounts and media pages from the data collection. Next, we construct a co-emotion matrix[2] between each two fan pages. The co-emotion matrix demonstrates the ratio of mutual users who have expressed the same attitudes to media page pairs. Different from the previous two methods, we here perform centering on the matrix. Then, we apply singular value decomposition (SVD) to the co-emotion matrix and retrieve the top left singular vectors (LSV) as the extracted features for each page. Finally, we locate the pages with a two-dimensional space and discuss the effectiveness of the method using the offline backgrounds, profiles, and the previous qualitative research results. According to the results, the approach can successfully distinguish media pages by their types (journals, newspapers, TV channels), backgrounds, and political tendencies and correspond to the previous literature.

3.1 Dataset Descriptions

According to the selection, a total of 19 fan pages are included in our study list, including five television news channels, two state-owned media, six magazines, and six newspapers. We collect the user endorsements of the pages from July 1 until December 31, 2018. The language of every fan page is traditional Chinese, the official language character used in Taiwan. For every page, there are at least 25 thousand unique accounts have pressed "like" toward the article of the media. The reason

we select the "like" activity as the emotion to study is because "like" is the most commonly used emotion on Facebook. A detailed media list of our data collection is shown in Table 1.

3.2 Retrieving Left Singular Vectors from Co-emotion Matrix

Our methodology is motivated from the previous two studies (Bond and Messing, 2015; Wang et al., 2017). Before 2016, Facebook only built the "like" option for users to express their attitudes; thus, in the previous studies, "like" activity could combine various emotions, e.g., "like" and "loves." Since 2016, Facebook added five more emotions, including "loves", "laugh", "wow", "angry", and "cry", which enable users to express their feelings more precisely. According to the observation, we present a generalized method to locate media pages using different emotions on Facebook.

The followings describe the construction and analysis steps. First, the study extracts a list of unique accounts which give an emotion toward at least an article on the mass media pages. From the user list, we construct the co-emotion matrix as follows:

Definition 3.1. For each emotion i on Facebook, the co-emotion matrix $C_i, i = 1, ..., 6$, among n pages, where $n = 19$ in this study, is defined as a $n \times n$ symmetric matrix. Considering a page x of these n pages, we define the account list of page x with emotion i as $u_{x,i}$, $x = 1, ..., n$ and $i = 1, ..., 6$. The value in cell (x, y) of C_i is the number of common accounts that have expressed the same emotion to page x and y, as the following definition.

$$C_i(x, y) = |\text{intersect}(u_{x,i}, u_{y,i})|. \quad (1)$$

Note that in the co-emotion matrix C_i, the diagonal entries $C_i(x, x)$ is the number of accounts expressing emotion i of page x.

Next, according to the above equation, the values in cells affiliated with popular pages with be significantly higher than others. To concentrate on the ratio of overlapped users, following the previous method we normalize the matrix according to the number of accounts which have expressed the emotion on each page (the diagonal value). The normalized matrix is derived as follows:

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[2]In the two previous work there was only **like** emotion while currently there are 6 emotions on Facebook.

Table 1: The media organizations and the values from 1st and 2nd left singular vectors

ID	Page Name	Page Name (English)	Page ID	# like	1st LSV	2nd LSV	Type
1	東森新聞	EBC News	news.ebc	312,731	0.197	-0.018	broadcast
2	TVBS 新聞	TVBS News	tvbsfb	227,351	0.251	0.207	broadcast
3	三立新聞	SET News	setnews	167,813	0.223	-0.209	broadcast
4	民視新聞	FTV News	ftvnews53	39,378	0.168	-0.391	broadcast
5	中視新聞	CTV News	Ctfansctvnews	26,260	0.232	0.398	broadcast
6	中央社新聞粉絲團	Central News Agency	cnanewstaiwan	45,441	-0.205	-0.175	government
7	PNN 公視新聞網	PTS News Network	pnnpts	30,260	-0.215	-0.332	government
8	壹週刊	Next Magazine	nexttw	282,650	0.209	-0.029	magazine
9	遠見雜誌	Global Views Monthly	gv.monthly	165,864	-0.309	0.150	magazine
10	天下雜誌	CommonWealth Magazine	cwgroup	144,225	-0.351	0.067	magazine
11	商業周刊	Business Weekly	bwnet.fans	121,456	-0.385	0.103	magazine
12	今周刊	Business Today	BToday	111,860	-0.350	0.078	magazine
13	鏡週刊	Mirror Magazine	mirrormediamg	82,135	0.140	-0.003	magazine
14	蘋果日報台灣	Apple Daily	appledaily.tw	476,434	0.116	-0.107	newspaper
15	udn.com 聯合新聞網	United Daily News	myudn	393,632	0.152	0.245	newspaper
16	中時電子報	China Times	CTfans	196,209	0.172	0.362	newspaper
17	大紀元時報 - 台灣	The Epoch Times-Taiwan	epochtimes.taiwan	116,411	0.104	-0.130	newspaper
18	自由時報	The Liberty Times	m.ltn.tw	79,472	0.064	-0.403	newspaper
19	經濟日報	Economic Daily News	edn168	62,130	-0.213	0.187	newspaper

Definition 3.2. Given a co-emotion matrix C_i, the normalized co-emotion matrix is denoted as R_i. The value in every cell of R_i is the ratio of the accounts of page x expressing emotion i who also ever gave the same emotion to page y.

$$R_i(x, y) = C_i(x, y)/C_i(x, x). \qquad (2)$$

However, we observe the column values are still highly correlate to the popularity of pages in the normalized co-emotion matrix R_i. The sum of each column have a significant correlation with the popularity of each page. To address this issue, we alter the previous approach by centering on the columns of the matrix R_i as in Equation 3. We denote the derived matrix as R_i', $i = 1, ..., 6$.

$$R_i'(x, y) = R_i(x, y) - \frac{\sum_{k=1}^{n} R_i(k, y)}{n}. \qquad (3)$$

We then perform a singular value decomposition (SVD) on R_i'. The procedure decomposes R_i' into a factorization form:

$$R_i' = U\Sigma V^T,$$

with

$$U = [\underbrace{\mathbf{u}_1 \quad \mathbf{u}_2 \quad \ldots \quad \mathbf{u}_r}_{\text{Col } A} \quad \underbrace{\mathbf{u}_{r+1} \quad \ldots \quad \mathbf{u}_m}_{\text{Nul } A^T}]$$

$$\Sigma = \begin{bmatrix} \sigma_1 & 0 & \ldots & 0 & 0 & \ldots & 0 \\ 0 & \sigma_2 & \ldots & 0 & 0 & \ldots & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & & \vdots \\ 0 & 0 & \ldots & \sigma_r & 0 & \ldots & 0 \\ 0 & 0 & \ldots & 0 & 0 & \ldots & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & & \vdots \\ 0 & 0 & \ldots & 0 & 0 & \ldots & 0 \end{bmatrix}$$

$$V^T = \begin{bmatrix} \mathbf{v}_1^T \\ \mathbf{v}_2^T \\ \vdots \\ \mathbf{v}_r^T \\ \mathbf{v}_{r+1}^T \\ \vdots \\ \mathbf{v}_n^T \end{bmatrix} \begin{matrix} \\ \left. \right\} \text{Row } A \\ \\ \left. \right\} \text{Nul } A \end{matrix}$$

The derived LSV of R_i' is a set of orthonormal eigenvectors of $R_i' R_i'^*$, where $R_i'^*$ is the conjugate transpose of R_i'. According to the study (Bond and Messing, 2015; Wang et al., 2017), the top LSV can explain the ideology of political celebrities. We retrieve the top LSV of R_i', $\mathbf{u}_1 \mathbf{u}_2 \ldots \mathbf{u}_m$ of R_i', from U, where each $\mathbf{u}_j$, $j = 1, ..., m$, is a length-n vector corresponding to n pages. The values are used to locate each pages in a m-dimension space.

4 Analysis

This section consists of two parts, including 1) demonstration of the top two LSV, $\mathbf{u}_1$ and $\mathbf{u}_2$, of pages and investigating each page according to two one-dimension (the first and second LSV) spectrum. We use it to discuss what each dimension implies in offline context; and 2) using the values of the two LSV to position pages in a two-dimensional space. From the observation, we categorize pages into groups and correlate the offline backgrounds and theories about their publication types, covered topics, political leanings, and the owner's history, with the derived results.

4.1 The Distribution of Left Singular Vectors

We select "like" to build co-emotion matrix, as "like" is the most frequently used expressions on Facebook. After applying SVD on the matrix, we extract the values in the first and the second LSV, as the features of each page. According to the two elements, we present the location of each page in a two-dimensional space, as shown in Figure 1. In the figure, we label media organizations with different colors and shapes according to their attributes. We discuss the distribution of these pages in each dimension and present the offline explanations on them.

- **The 1st Left Singular Vector**: From the perspective of values on the x-axis in Figure 1, we observe most of the broadcasting news channels and printed newspapers are located in the first and the fourth quadrants, where the values of the first LSV are positive. We find that all of the organizations owned by the government and most of the weekly magazines are situated in the left half of the figure.
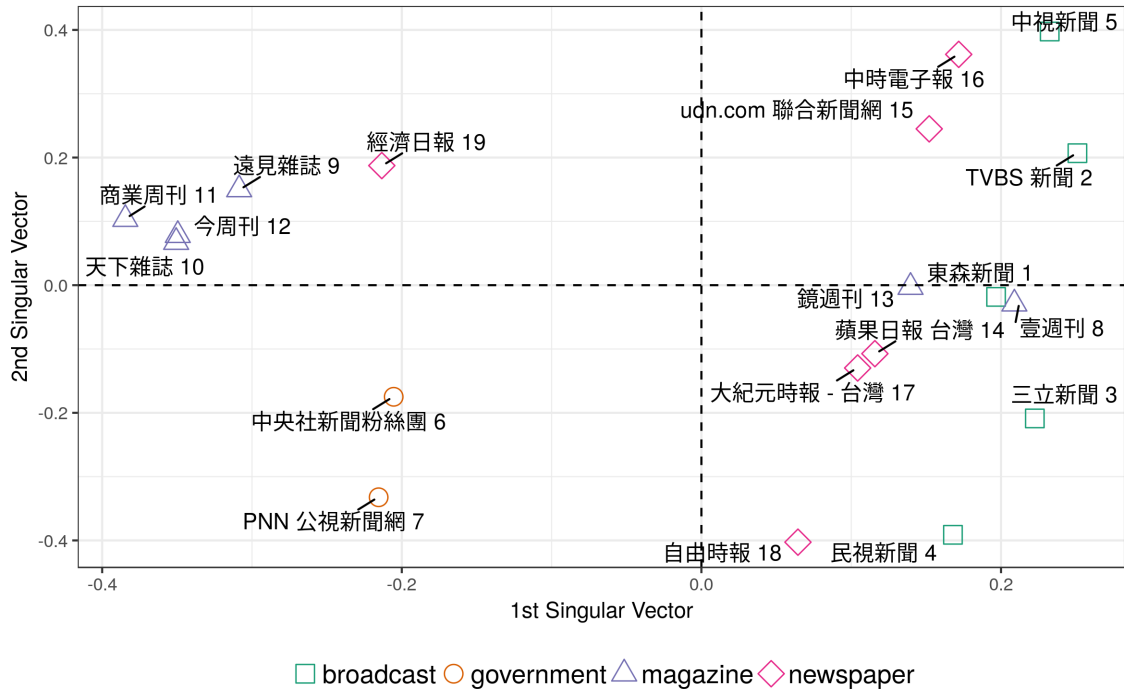
Figure 1: The location of media organizations by the 1st and 2nd LSV

However, there are two magazines with positive values and one newspaper with a negative value. To understand this, we investigate the backgrounds of these off-group institutions. From the perspective of reporting topics, we find the two off-group magazines (page 8 and 13) are gossip weekly[3] [4] whose themes are distant from the other four magazines focusing on the finance topics. Moreover, the off-group newspaper (page 19) dedicated in financial news is also close to the four financial magazines.

The above results demonstrate that the 1st LSV can cluster media pages based on their topics (general-interest vs. business-focused/ state-owned media). Even though our method roughly separates media organizations according to the 1st LSV, it is not easy to distinguish finance magazines and state-owned channels by the 1st LSV. Thus, we attempt to investigate if other singular vectors also provide different characteristics of media in the following section.

- **The 2nd Left Singular Vector**: In Taiwan, the politics have been polarized and divided into pan-green (supporting Democratic Progressive Party, DPP, tends to be pro-independence) and pan-blue (supporting Kuomingtang, KMT, tends to be pro-unification) for several decades (Hsieh and Niou, 1996; Stockton, 2010); also, the polarization happens in the stance of mass media (Huang, 2011; Clark and Tan, 2012). From the results of the 2nd LSV, we find the two media companies (page 5 and 16) owned by the pro-China Taiwanese businessman Tsai Eng-meng (Hsu, 2014a) stay at the top of the figure. On the contrary, the bottom two pages of the second LSV are page 4 and 18; these two organizations have long been considered as pan-green or pro-DPP according to the previous studies (Rampal, 2011; Rawnsley et al., 2016; Sullivan and Lee, 2018).

We also find the two state-owned media (page 6 and 7) have negative values in the 2nd LSV, as other pro-DPP channels. We consider the results could be attributed to that the DPP is the current governing party, which won the presidential elec-

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[3]Next Magazine: https://en.wikipedia.org/wiki/Next_Magazine_(Hong_Kong_and_Taiwan).
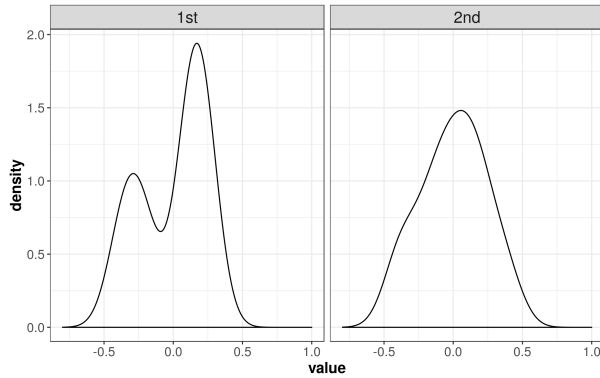
[4]Mirror Magazine: https://www.mirrormedia.mg/.

Figure 2: The density of values in the top 2 LSV

tion in 2016. According to the positions of pages, we assert the second LSV indicates the difference in political stances of media.

- **Polarization**: To figure out the polarization of media pages from our analysis, we show the density of the values in the top two LSV in Figure 2. From the figure, we observe the polarization does not occur at the second LSV (political stance), but it happens in the first LSV (general-interest vs. financial/business). One possible reason could be that not all channels concentrate on political discussion and have strong political stances; thus, there are pages stay at the center of the spectrum according to the second LSV. On the contrary, the polarization in the first LSV indicates that the users following business magazines are quite distinct from that audience of the general-interest media.

Though we acquire some implications from the distribution of media pages, we cannot conclude a suitable clustering by merely one LSV, either the first or the second LSV. Thus, we integrate the values of each page on the 1st and 2nd LSV and locate pages with a two-dimensional space to explore an appropriate clustering on different pages.

4.2 The Combined Location of Pages

We combine the values of the top two LSV and locate each page in a two-dimensional space, as shown in Figure 1. We also mark vertical and horizontal lines, representing the zero value of the top two LSV. We describe the categorization of mass media and correlate the results

with offline studies.

- **State-owned Media**: The two pages of the government channels are perfectly located at the third quadrant. Page 7 is the news department of Taiwan Public Television Service, and page 6, the Central News Agency, is the state-owned news agency of Taiwan. We also noticed that the two media organizations are at the downside of the figure. One reason could be that the DPP is the current governing party; thus, the reports of the state-owned media may be more accepted by the pan-green audience.

- **Financial magazine and newspaper**: In the second quadrant, the five pages are all focused on economics, finance, and business topics, including four periodical magazines and one daily newspaper. Page 9 (Global Views), 10 (CommonWealth Magazine), 11 (Business Weekly), and 12 (Business Today) are the four major business magazines in Taiwan[5]. Page 19, Economic Daily News, is the first newspaper in Taiwan concentrating on economics and financial issues.

- **Pan-green and pan-blue media**: In the first quadrant, we find the four pages which are all considered as pan-blue media according to many previous studies (Hsu, 2014a; Metzler, 2017; Maeshima et al., 2018). Despite the abovementioned pro-China media page 5 and 16, the other two pages close to them, page 2 (TVBS News) and 15 (United Daily News), are considered to be supporting Kuomintang.

  In contrast, we observe page 3, SET News, is also located near page 4 and 18. These channels are considered as pan-green from a number of qualitative studies (Rampal, 2011; Rawnsley and Gong, 2012; Hsu, 2014b). According to the results, we successfully use online observations to demonstrate the polarization of pan-blue and pan-green media groups.

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[5]The four magazines are all categorized in the finance group in Wikipedia. https://zh.wikipedia.org/wiki/%E5%8F%B0%E7%81%A3%E9%9B%9C%E8%AA%8C%E5%8F%8A%E6%9C%9F%E5%88%8A%E5%88%97%E8%A1%A8#%E8%B2%A1%E7%B6%93%E4%BC%81%E7%AE%A1.

- **Gossip magazines**: Page 8 (Next Magazine) is the most selling magazine reporting gossip news in Taiwan. Its content mainly focuses on digging gossip news about entertainment and political celebrities. Page 13, the Mirror magazine, is another magazine with similar topics. From the results, our method clearly demonstrates the difference between magazines of different categories. In contrast to the other 4 financial magazines, the locations of gossip magazines are close to the general-interest broadcasting media. The results correspond to the previous studies about the difference between "elite" and "popular" press (Lehman-Wilzig and Seletzky, 2010).

- **The Epoch Times**: The only one non Taiwan-based media in this list is the Epoch Times (page 17). Established by Falun Gong practitioners, the main themes of the organization are uncovering negative news about the China government and reporting the persecution of Falun Gong. The location of the Epoch Times is at the downside of the figure. As the politics in Taiwan are divided into pro-independence and pro-unification with China, the location of this anti-communism media is reasonable to be close to the pro-DPP media.

5 Discussion and Conclusion

In this study, we demonstrate a data-driven method to categorize 19 major mass media in Taiwan from Facebook "like" behaviors. We collect a 6-month-long observation data in 2018 and performed a series of formalized procedures to measure each organization. From the findings of this paper, we not only locate mass media organizations but also verify the results according to the offline theories, backgrounds, and other qualitative studies.

This paper provides a data-driven approach for understanding online media pages based on user endorsements; however, to make the study more complete and general, still many issues should be discussed and addressed in the future studies. First, currently we use the "like" behavior (the most common emotion on Facebook) in this work; applying the method to other emotions and measuring the effectiveness of our proposal are worthy of investigation. Second, we choose Taiwan and traditional Chinese as the region and language in this work. We believe the cultural, political, and media differences between Taiwan and other countries are also important factors for positioning media. In the future we aim to validate the usability of the method in the media industries of other countries or languages. Third, many Internet-based media channels have been emerging in recent years, and the audience of them could be distinct from conventional media groups. Extending the method in this study to new types of press companies and other previously unlabelled organizations is also a potential topic.

Acknowledgments

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