How Consensus can be Involved through Innovating Voting Mechanism? Using Polis Platform as an Example

Shiaw-Shiuan Chuang, Shirui Zhou[a]

[a]DSPP'24, McCourt School of Public Policy, Georgetown University, Washington, DC 20057, USA

Horse-racing problem, information-bubble and segregation on digital space by echo chamber, and media censorship under authoritarian regimes are preventing polling to serve as public sphere for debate regarding serious concerns, discussion of social discourses and formation of large-scale consensus. Polis as open source platform propose a democratic innovation for large-scale coordination and rational decision-making. This study use Vtaiwan's open consultation regarding Uber compliance issue as case study to study the different position of participant's on value system and political spectrum, and to examine whether consensus is forming in this deliberative process.

Voting Mechanism | Umap | Kmeans | PCA

1. Introduction

Amid the era where political polarization, far-right populism ethos and suppression of freedom of speech are echoing at global level. The public sphere for citizen participation of social discourse, rational debate, large-scale coordination are being significantly compromised. The failure of coordination mechanisms in both Western and Eastern, led to the shortage of public goods, fragmented civil society to promote real social interest, and the united voice against the authoritarian regime or the government dominated by the politicians representing profit-mongering interest groups. Therefore, this paper is based on Polis (add link)platform to research on the question how consensus can be involved through the innovative voting mechanisms, which aims to present participants with the most trivial concerns from the people outside of their echo chamber. By observing the collective voting behavior of the participants, this paper attempts to provide some insights on the effectiveness of Polis platform as a fundamental democratic innovation to reach large-scale agreement.

This paper contains 6 sections. The first section would discuss the motivation of this research from the perspective of the problems existing in current polling and public opinion aggregators' role in safeguarding the public interest, and present some previous studies on Polis platform regarding the UberX issue, which this paper uses as a study case. The second section mainly reveals the data set this paper utilizes, including the data source, variable of interest, data wrangling process and data limitations and possible bias. The third section explains how this paper uses PCA and UMAP to visualize the participants' stance on a 2-dimensional map, uses Kmeans to cluster and classify group A and B, and uses centroid coords calculation to get the distance between two groups. The fourth section explains the result of the group informed consent, comments bring disputes and the result of UMAP and calculation, including tables and visualizations. The fifth section concludes the research result and discusses the limitations, future work and potential applications.

1.1. Motivation

As a public opinion aggregator, pre-election polling should be a process of understanding the concern of the opposite group who disagrees with the subject on certain issues, which may be helpful to search for the common ground and develop the consensus among different opinion groups. However, polling and public opinion surveys are not guarding the interest of the public due to some issues in both western and eastern countries.

1.1.1. Horsing-racing problem.
With a growing interest in using quantitative methods to obtain an prediction of accurate election result, pre-election polling is often used as input of probabilistic modeling. Political journalists would overemphasize

---

Significance Statement

We need a platform for large-scale decision making and development of regulation, considering the pluralism and appealing of different opinion groups, as a fundamental democratic innovation (Colin et al, 2022), a proxy of consensus among the public sphere and a true voice of people under authoritarian state.

---

the importance of mathematical models and stretch for the accuracy of the prediction result Toff, 2019. This reliance on the quantitative model and overconfidence in the prediction may have a negative impact on public space as more attention is being focused on to "win" the election as a "horse race", rather than concentrating on addressing the agenda proposed by the opposite side.

1.1.2.Misinformation and Echo chamber. As a proxy of the public sphere in the digital sphere, social media can influence the spreading of information and formation of consensus to a large extent.Cinelli et al (2021) performed comparative analysis on more than 100 billion controversial topics, proving that homophilic users are clustered in their echo chambers. The information bubble and online segregation can have a consequential impact on reality, since citizens are blocked from the voice of other opinion groups and the whole picture of truth. The rising of populism and increasing gap of polarization are the byproducts of the bias in information diffusion towards like-minded peers.

1.1.3.Lacking of Alternative Voice in Authoritarian Regime. In some authoritarian regimes, freedom of speech is severely restricted, and there is no space for political communication and public discussion on digital media. According to Xu (2014), the Xi administration exerted further pressure on independent journalists, silenced the dissidents and erased numerous posts accusing the government on Wechat. The latest movement is "A4 revolution", in which students and citizens are holding a piece of white paper and standing on the street to protest against the zero covid policy, media censorship and control on freedom of speech.

Facing these problems regarding the political communication and public sphere, to reconstruct a healthy environment for rational and reasonable conversation among citizens which encourages the formation of consensus in the process of meaningful debate, technologies for coordinating and reaching large-scale agreements are urgently needed to be developed.

1.2.Previous Studies

Polis is a platform, where everyone can draft a statement about how a matter should be solved and respond to other participant's suggestions by either agreeing or disagreeing with them. According to the individual response, Polis churned through the many axes of agreements and disagreements to draw a map (UMAP), then it will reduce the high dimension to the four dimension space and try to show people different opinions from different groups.

Launched in 2014, Vtaiwan aims to advocate an open consultation process to gather the citizens and government together in online and offline space to reach a large-scale agreement and consensus on national issues, whose process typically includes four stages: proposal stage, opinion stage, reflection stage and legislation stage.

UberX as a sub branch of Uber services, registered as a technology company, are regarded as a transport company by the Ministry of Transportation and Communications and are required to abide by the taxi laws. Refusing to do so, Uber would face significant penalties under the Highway Act. To seek the consensus among public, Vtaiwan experimented with Polis platform to open the consultation process regarding UberX's entry into Taiwan.

2. Data

2.1.Data Source. As polis is an open source platform and provides open data for analysis, this paper obtains the raw data directly from the comp democracy github. The main dataset are comments dataframe and participants vote dataframe. The former includes: comment-id, author-id, indicator for comments being moderated out, comment body and the datetime for the initial posting of comments. The latter is an interactive matrix containing participants' vote on each comment, whose x axis is the participants and y axis is the comments. Using comment-id and comments as columns, two dataset can be merged and the metadata of comments can be obtained.

2.2.Data Filtering. For the data cleaning, this paper follows the spirit of Polis, deems only the participants vote for equal or more than 7 comments as valid voters, and removes the participants less than 7 times from the observation. Also, this paper only selects comments not being moderated out in the analysis framework. Comments can be moderated out for following scenarios: detected spam, duplicative, statement includes more than one idea, etc. In this analysis, this paper only analyzes the comments that are not moderated out by moderators.

Table 1. Examples of comments not qualified

index	comment-id	comment-en
156	131	I think Uber than Xiao Huangyou!
64	49	The number of taxis of Greater Taipei has enough taxis, the streets are full of taxis, and the convenient mass transportation (such as: MRT/ bus/ ubike ..., etc.) has given people a variety of choices, plus a large number Personal transportation (such as: locomotive/ car ..., etc.), the air rate of the taxi has continued to rise, and now it is not the other way to put a private car into the loading passenger ... please think twice !!
42	26	I think that Uber has been suspended in the country in China, how can it be still unimpeded in the streets and alleys, and the illegal business behavior allows it to exist, which means that the government's incompetence is broken.The actor wants the people to express their opinions.
61	178	Uber credit card deduction does not need to get zero.
87	74	I think Uber does not have a complete standard like a taxi to take the self -use car of unknown people. It is very terrible.

Table 2. Examples of qualified comments

index	comment-id	comment-en
108	96	I think all business vehicles should adopt the passenger scoring mechanism, rather than relying on the government to issue business permits.
107	94	I think it is necessary to consider the situation of computer autonomous driving in advance, including whether the modern mass system is necessary, and what should I do if the employment of the taxi driver in the future.
98	97	I think that although bonus billing makes people less want to take Uber, it is reasonable to change the bonus billing in accordance with the rules of supply and demand.
124	106	I think to find an exit for Uber, it is time to set regulations that are different from professional passenger cars and taxis, so that non -business cars are only necessary to take or subsidize oil money, part -time self -use cars, and there is a rules of game rules that follow the rules of the game.
77	64	Uber is an overseas company. I think Uber has the responsibility to put forward the response method of persuasion in Taiwan society.

2.3.Data Set and Variable of Interest. After filtering the data, 1269 observations are viewed as valid participants, 99 comments are left, the data time of comments being added is ranging from 30th August to next year 30th January. This paper is interested in both the participant and the comment as a unit of interest. Monitoring participants voting behavior in a time-series trend would allow this paper to identify a general pattern of the consensus involvement. Grouping participants into opinion groups would enable this paper to deduce the group informed consensus and the main disputes between groups.

2.4.Data Limitation. The data limitation is largely associated with the missing data, since the participants are volunteers to vote, but not compulsory to consistently participate in the whole process. Thus, some early voters may leave the conversation, and not come back to vote. To grasp a general picture, this paper uses heat map to visualize the entering and quitting behavior of voters. Another limitation lies in the seed comments and topic control, since multiple studies have recorded different responses of participants and the heterogeneity of conversation when the same problem is framed and discussed in various scenarios. Topic modeling and approximation towards equal distribution of seed comments on the spectrum may alleviate the bias and discrimination rooted in the initialization process. Lastly, as the moderator is also human-being with its own moral standard and value preference, the bias in the moderation process is avoidable. One solution to this is to design a system of open and transparent rule in a community call, which allows for amendment and voting, and the rule would be transformed into an algorithm implemented by AI.
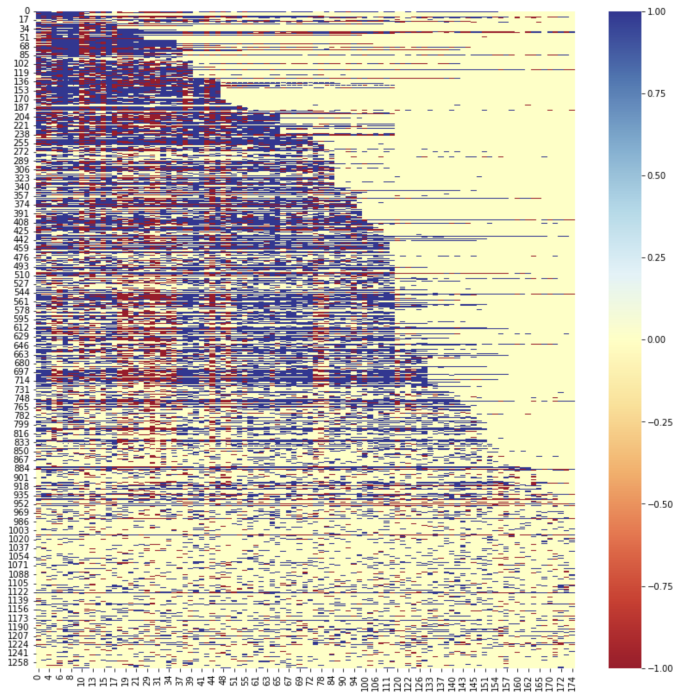
Fig. 1. Some things to notice about the matrix: comments are submitted over time, so participants who do not return will only have voted on the statements which were avialable when they arrived.

3.Methods

To check how public opinions change, our project consists of three successive stages: data cleaning, dimension reduction, and cluster. In this project, we tried multiple dimensionality reduction methods to optimize our result in visualization and to show the distribution better.

3.1.Data Cleaning. Our two main datasets are comments data and participants-based votes data. There are 1921 participants and 196 comments before cleaning. We dealt with participants-based votes data first. The shape of raw votes data is 1921 x 203, 1921 participants with 203 columns. In these 203 columns, we have metadata that includes participants' IDs, the number of their total votes, the number of agree and disagree votes, and the number of comments.

3.1.2.Votes Data:. Our first step is to remove the participants with too few votes. The threshold is seven votes. If the participant voted less than seven-time, they will be disqualified as they may not read enough comments to try our hypothesis. After filtering out people with low participation rates, we have 1296 participants left.

In the next step, we add another filter on the participants-based votes data. This time is a column-based filter. We delete columns that record the data of moderated out comments. Then we split the whole votes data into two parts: metadata dataframe and value dataframe. Now, the shape of value data records 1296 participants' voting on 99 comments.

3.1.2.Comments Data:. So far most preprocess steps on votes data have been done. We can dig more about the comments data.

The first step is to translate all comments into English. The raw comments are traditional Chinese because we use Taiwan's datasets. And clearly present our research result, we use the googletrans package to auto-translate all comments. This python library implemented Google Translate API. Before translating comments, we need to eliminate comments containing URLs. The translation function of googletrans raises an error if the text is a URL. We add a column named "comments-en" to record our translation.

The next step is to delete comments been moderated as not qualified. We will only use votes on qualified comments for later's analysis. See Table 1 for the non-qualified comments and Table 2 for the qualified comments. Fig 2 and Fig 3 can see the difference in filtered data after doing dimension reduction.
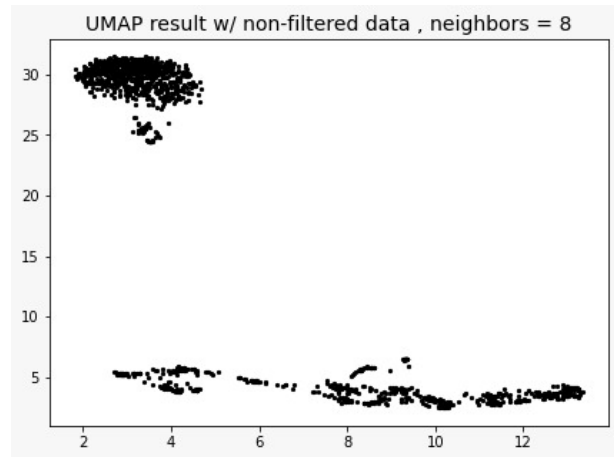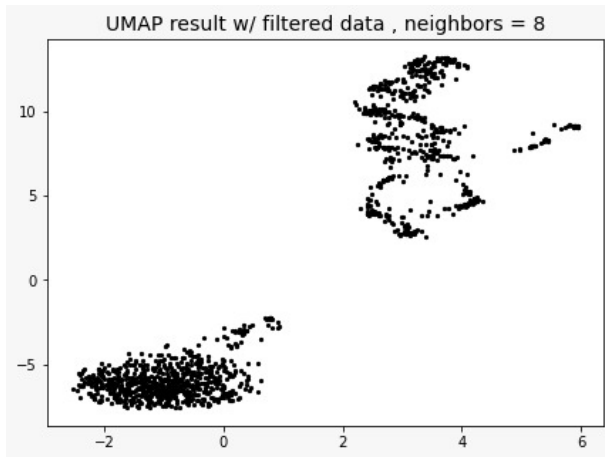
3.2. Dimensionality reduction. Dimensionality reduction is a technique that involves reducing the number of features (variables, dimensions) in a dataset. This is often done to remove redundant or irrelevant features, which can improve the performance of a model, reduce the time and computational resources required to train the model, and make the model more interpretable. In this project, the dataset isn't really huge but the shape of the data is hard to make visualization. The core of our goal, however, is to see the connection between participants' opinions. There are multiple algorithms that can reduce the dimension. We choose PCA, the most popular dimension reduction algorithm, and UMAP which is very effective for visualization.

Approaches of dimension reduction can be divided into feature selection and feature extraction also known as data projection. Both methods we choose belong to feature extraction. The major difference between feature selection and feature extraction is: Feature Extraction converts from a high dimension to a lower dimension through many operations (often including matrix operations). Assuming that data visualization is the goal, it is often desired that the destination dimension be two or three dimensions. In contrast, feature selection is about selecting a subset of features out of the original features.

3.2.2. PCA. Principal component analysis (PCA) is a method used to simplify data by reducing the number of dimensions or variables that describe it. It does this by finding the directions (called "principal components") in the data that explain the most variation, and then it projects the data onto these directions. This results in a new set of dimensions that are more informative and easier to understand than the original ones.

We implement PCA with sklearn package and wrote a **polis_pca** function. The function contains 2 variables: **dataframe** and **component**. The former one can input the dataset needed to reduce dimension and the latter can set the target dimension. The function will return both the result data **coords** and the calculated variance **explained_variance**.

In the previous paragraphs, we discussed the basic ideas of feature extraction. The main logic behind PCA is that the data can find a projection axis (vector) in the feature space to obtain the maximum variation of the set of data after projection. The variance plays a quite critical role in our dataset today. But one thing worth noticing is that PCA with 2 principle components only explains approximately 30% of the variance. See Fig2, the PCA has performed not that well compared to the result of UMAP.

3.2.2. UMAP. We employ Uniform Manifold Approximation and Projection (UMAP), a stochastic and nonlinear dimensionality reduction approach that retains the local and global structure of the data. Through the full name of UMAP: **Uniform Manifold Approximation and Projection**, we can have a basic image of the algorithm.

- **Uniform**, the uniformity assumption tells us that our data samples are uniformly (evenly) distributed over the manifold. However, in the real world, this rarely happens. Therefore this assumption leads to the notion that distances are varying on the manifold. That is, the space itself is distorted: the space stretches or contracts depending on where the data appear to be more sparse or dense.

- **Manifold**, a manifold is a topological space that locally resembles Euclidean space near each point. One-dimensional manifolds include lines and circles, but do not include shapes like the number eight. Two-dimensional manifolds (aka surfaces) include planes, spheres, etc.

- **Approximation**, the algorithm assumes that we have only a finite set of data samples (points), rather than the entire set that makes up the manifold. Therefore, we need to approximate the manifold based on the available data.

- **Projection**, the process or technique of reproducing a spatial object on a plane, surface, or line by projecting points. It can also be considered as a mapping of objects from a higher to a lower dimensional space.

In summary, we can describe UMAP as A dimensionality reduction technique that assumes that the available data samples are uniformly distributed in a topological space (Manifold) and can be approximated and projected from these finite data samples to a lower dimensional space.

148   We use the **umap-learn** python library to implement our map. Some key variables in this model: **n_neighbors**: UMAP
149 uses the Nearest-Neighbor-Descent algorithm to find the nearest neighbors. We can specify how many nearest neighbors we
150 want to use by adjusting UMAP's n_neighbors hyper-parameter. In Fig 2 and Fig 3 can see the results of set n_neighbor 5
151 and 10. And another variable **local_connectivity** can see as the lower bound of the number of connections. For UMAP we
152 also wrote a function called **polis_umap**. This function also has the **dataframe** input variable to customize the input data.
153 The other variable for this UMAP function is **neighbor** which can set n_neighbor manually.

154 ***3.2.2. UMAP v.s. PCA.*** From the above two sections can see that both PCA and UMAP have their benefit and constraints. After
155 experiments, we end up decide to use UMAP because UMAP shows better on the shows different groups' differences. From
156 Fig.4, the PCA doesn't have a good performance on how data be grouped.
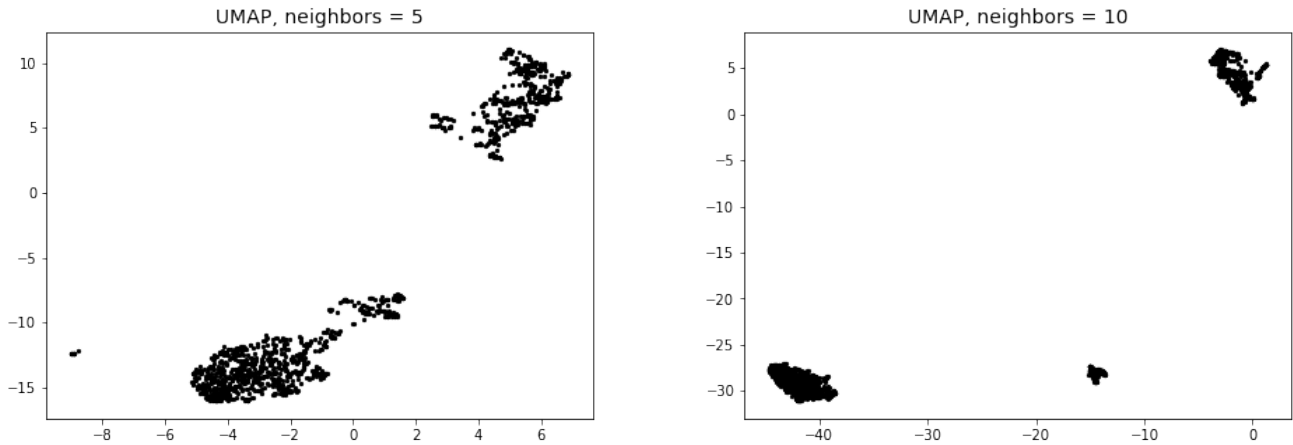
157 **3.3. Cluster.** A clustering algorithm is a type of algorithm that is used to divide a dataset into groups (clusters) of similar
158 data points. Clustering algorithms are often used for unsupervised learning, where the group assignments are the output of
159 the algorithm and no labeled data is available. There are many different types of clustering algorithms, including k-means
160 clustering, hierarchical clustering, etc. These algorithms work by using different techniques to identify groups of similar data
161 points and assign them to the same cluster. In this project, we use the simple Kmeans to cluster the result produced by UMAP.

162 ***3.3.1. Kmeans.*** K-means clustering is a common cluster model to identify groups (clusters) of similar data points in a dataset.
163 The algorithm works by first dividing the data points into K groups, where K is a user-specified parameter. Through observing
164 the visualization of UMAP, we set k equals to two in this project. Then, the algorithm iteratively updates the group assignments
165 for each data point and the group centers, until it converges on a final set of groups that best represents the underlying
166 structure of the data. To implement Kmeans we use sklearn package. Then we will get which participants belong to which
167 groups by the labels data of Kmean's result.

168 **3.4 Other functions.**

169 ***3.4.1 Show_embedding.*** In the **show_embedding** function, we set all of the scatterplot functions, so that the user can simply
170 input the data (usually the result of dimension reduction in this project), color, and title.

171 ***3.4.2 Time series analysis.*** To confirm whether our assumptions are valid, we wrote a set of functions that can help us auto-generate
172 UMAP graphs by setting start time and period. First, to analyze data according to time frames, we need data for a specified
173 time period. The participant votes data didn't record when a participant voted but the comments data have the record of
174 when a comment is created. First, we need the time of when the first comment is created. The data type of **datetime** column
175 has been converted into a timestamp in the data preprocessing step. We sort the whole comments_df by the datetime column.
176 Then, get the first and last values in order to have the whole time frame. To filter paricipants' vote data within a specified
177 time period. We wrote **get_time_limited_cmt_vals** function. It contains two input values: **begin_time** and **period**,
178 the former one needs timestamp type data to indicate the start time of this time frame and the latter one is about how long's
179 data we want. With these data, we first count the end time, use the start and end time data to filter all the **comment-id** in
180 **comments_df** (use list comprehension), use the comment-ids to filter the columns we need in df. Finally, we filter one more
181 to drop participants with never vote for any of the comments. Then, we got the specific time frame's data.
182   Because our ultimate goal is the specific period's data, we wrote another function **first_Ndays_umap_graph**. This
183 function generate the UMAP results and graph(optional) by inputting how many days of data you need and n_neighbor.
184 Inside the function, we first get data through the **get_time_limited_cmt_vals** function. Then, out our subset data into
185 **polis_umap** function to generate the dimension reduction embedding. At the end of this fuction, user can decide whether to
186 use the **show_embedding** function to show the UMAP result.

4.Results
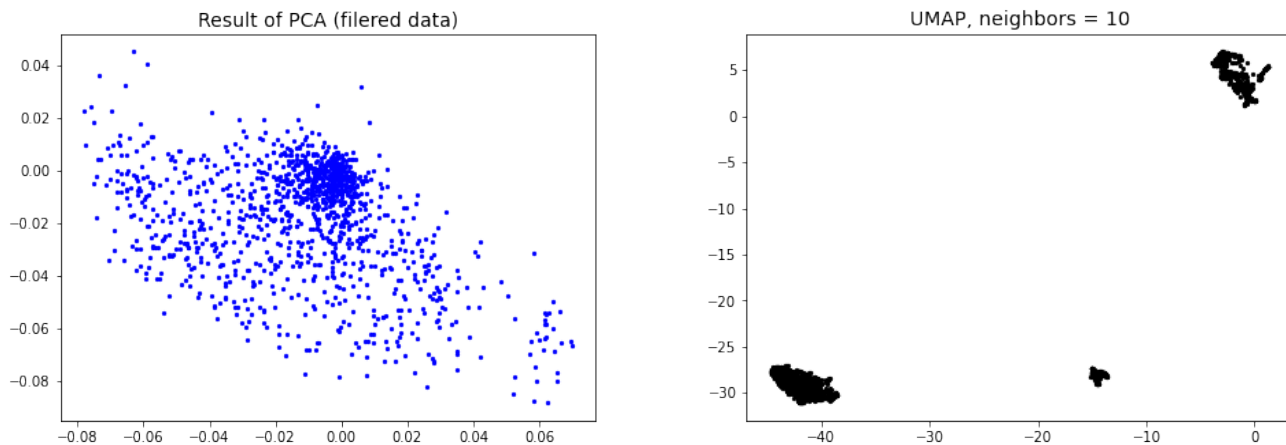
4.1.PCA. This paper uses PCA to visualize the position of the participants as a proxy to their stance regarding the Uber issue. Although its relatively computationally cheap, and can save the embedding model to then project new data points into the reduced space. It linear reduction limits information that can be captured not as discriminable clusters as other algorithms. PCA with 2 principle components only explains approximately 30 percent of the variance, while explaiuser-defined percent of the variance when including 20 principle components. Also, the graph shows that the separation is not very boundary-clear.

4.2.UMAP. UMAP processes non-linear reduction that is computationally faster than t-SNE, and it's user defined parameters enables the preserving of both local and global structure. However, it requires the setting of hyper-parameters that influence quality of the embedding, and the non-deterministic nature of algorithm may contribute to the randomness in the produced result. From the result, it's clear that the data is generally clustered into two groups. While one cluster's boundary is clear, the other is more dispersed.

4.3.K-means: Constructing Opinion Group A and B . Using PCA to map the multi-dimensional data into a 2-D graph, and Umap to examine the global structure of the clustering, this paper can observe the overall dynamics of the voting behavior. Generally speaking, using innovative voting mechanisms such as Polis, the general stance of participants on a particular social discourse can be obtained, and participants can be partitioned into opinion groups. The standards of constructing opinion groups are following the spirit of Polis, which states the members in a group tend to have the same opinions with members within the group and hold different opinions with members outside the group for most of the comments. Regarding the Uber issue, opinion group A tends to be more friendly towards Uber and believe the market as the correction mechanism, while group B supports more strict regulation and government intervention.

Table 3. comments causing dispute

| index	comment-id	a_support	b_support	comment-en
13	16	240	392	I think that when Uberx self -use passenger is carried, it should insure car passenger liability insurance.
7	9	143	255	I think the record of the Uber platform's dispute resolution should be reported to the Ministry of Communications.
11	14	161	269	I have a small car driving license.
29	40	237	343	I think traditional taxis now have to join the team to survive. This is not the government's regulations. Uberx has subverted this unwritten rule, and it feels great!
5	7	393	368	I think the driver of the passenger should protect accident insurance.

Table 4. consensus

index	comment-id	$a_s support$	$b_s support$	comment-en
89	161	20	20	Compared with the self -use, the professional driver's license is compared with the self -use. The written test has more locations and attractions. The narrow S is more than the driving line, and the traffic safety rules are the same.
86	157	27	27	I think Uber should pay the tax paid to the government. The government does not need to intervene too much to allow Uber to compete freely with Xiaohuang; consumers have the right to choose from. If this is the general idea of the public, then Uber will naturally be eliminated by the market mechanism. Why should the government intervene too much?
96	172	32	31	I think the biggest difference between Uber and the taxi team is: Uber's scoring system is open and transparent and implemented. Driving with a score of less than 4.5 will definitely be shut down, and therefore ensure the quality of the vehicle. On the contrary, the scoring system of the taxi team is a completely black box. The input method is not only good for passengers to use, but the scoring system is not available at all. Even after pressing, passengers cannot know whether the team has received a score.
88	160	7	8	As for management, unless Uber admits that he is a virtual car company, the management is weak.
68	122	40	38	Personally, I think that it should be compared with Xiao Huang's standard. The driving of Uber must pass the driving certification or examination organized by the supervisory unit of the Ministry of Communications.On the other hand, it can protect the basic rights of all driving.

4.4.Comments Causing Dispute and Consensus. Labeling participants with opinion groups may enable us to identify the comments with high support constructed by the number of participants who agree minus who disagrees in both opinion groups. Ranking comments in a descending order by the difference of support, this paper obtains a data frame containing comments that are consensus between opinion group A and B. Similarly, ranking the difference of support in an ascending order would render a data frame of comments that causes disputes between opinion group A and B.

From the table comprising consensus, it's clear that both group A and B have approximately the same support for the comments including: "the thriving or fading of Uber should be a result of market competition, rather than the government intervention"; " the transparency of Uber scoring system is much higher than the traditional taxi, whose credit system is completely a black-box"; "Uber should admit itself as an virtual car company rather than an technology company" ; "Uber's should compliant the standard of XiaoHuang, and require the drive to obtain certification before operation, which can not only protect the safety of passenger but also guarantee the legal rights of driver."

From the table largely containing disputed comments, it is clear while group B largely supports: "UberX should be responsible for passenger's liability insurance"; "Safety comes first", "Drivers should have accident insurance"; "the dispute resolution on Uber platform should be reported to the Ministry of Transportation".

4.5.Time-series Analysis.

223

224

225
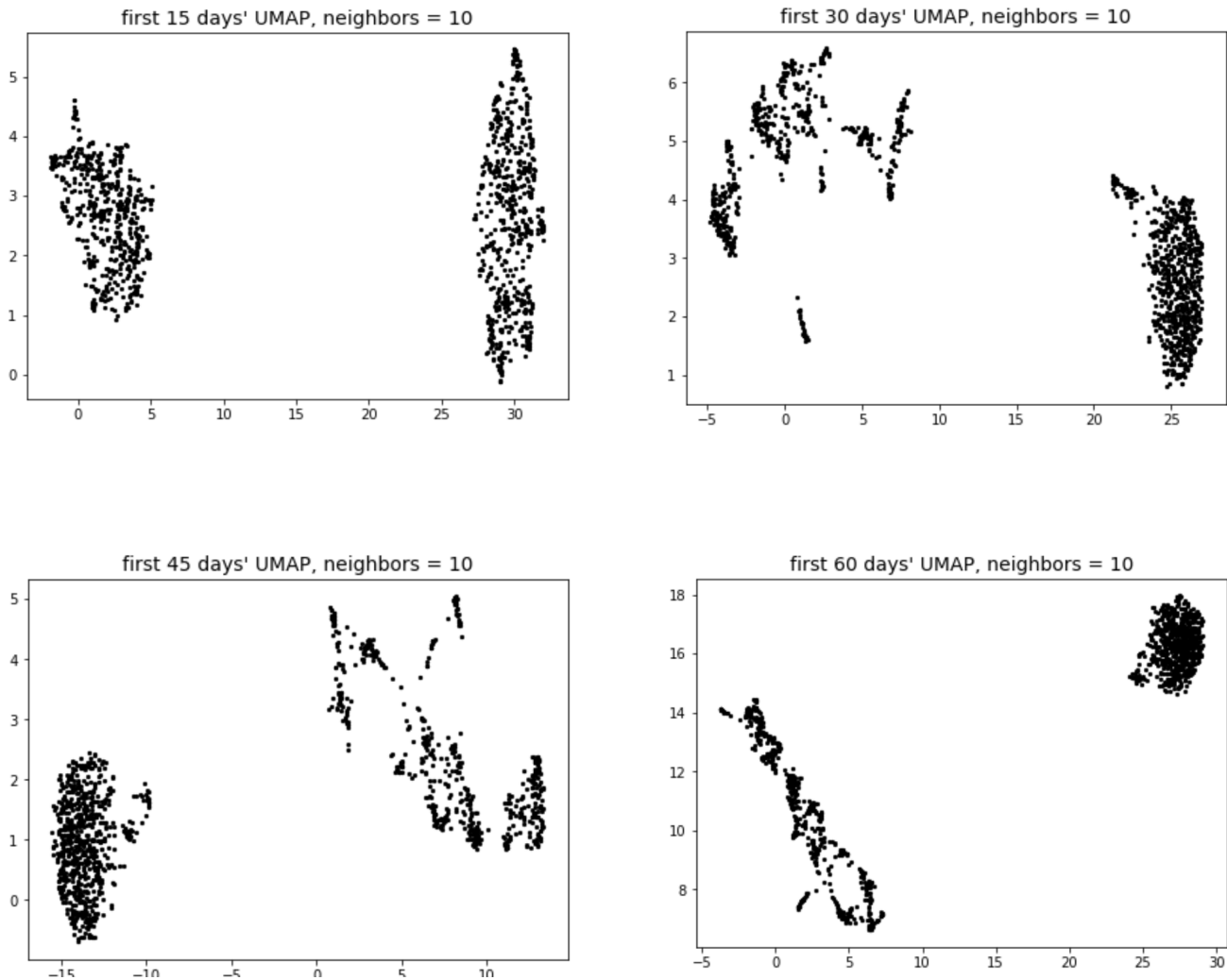
After filtering comments, the data time of initialization of the comments is an interval with 60 days. To study the dynamic of voting behavior, and the changing in relative position of 2 clusters, this study cuts the data frame into 4 sub-periods each containing 15 days, and generates four graphs of UMAP of the first 15, 30, 45 and 60 days. The first 15 days accumulate 1165 participants and 15 comments, and from the graph, two clusters with clear boundaries are aggregated. From the UMAP of the first 30 days, with the participants increasing to 1238 and comments rising to76, this paper witnesses an increase of density and sparse rate, particularly in the cluster on the left. The UMAP of the first 45 days records a slight change of dimension to 1239 comments and 80 comments, with the sparse rate largely remaining the same. The data frame producing UMAP of the whole 60 days period has 1242 participants and 97 comments, with a trend of concentrating among one cluster.

Theoretically speaking, the increase of sparse ratio from 15 days to 30 days may be a consequence of fragmentation in one opinion group, which can be explained as the breaking of the echo chamber after receiving the external information and having more understanding of concerns from other opinion groups, rendering more diverse stance surrounding the issue. The subsequent graph shows relatively stable of both global and local distance among subjects, with a slight concentration among one clustering from 45 days to days. This stability can partially be explained by the fact that only a few comments have been added.

Fact that communication between different opinion groups is most effective in a relatively concentrated and short period of time can be another source of explanation. The sense of participation and real-time interaction with other participants may stimulate participation to formulate stronger arguments, and vote more actively on the comments left by other participants. Another way to construct the sub data frame would be to cut the date time into smaller intervals, for example using days or hours as units, which would provide a more accurate result of the dynamic of collective voting behavior.

Regarding the distance between two clusters and the relative position of the observation amid global structure, this paper witnesses there is no significant decrease of distance on the UMAP from 60 days periods, as the distance between the centroid of the cluster is floating around 25. This result may be due to the stochastic algorithm embedded in the UMAP, the limited

number of observations relative to the components. In an ideal situation where the hypothesis that there is consensus involved in the voting can be validify, the distance between two clusters would gradually decrease along with the time. However, due to the data limitation, this paper can not either accept or reject the hypothesis that consensus is involved through the innovative voting mechanism on Polis platform using the distance measurement.

5. Discussion

Although it's inconclusive whether the Polis can effectively facilitate the formation of consensus among different opinion groups, since no significant decrease of distance between two clusters on Umap due to the limited observations and stochastic process embedded in Umap. Using Umap and K-means, this paper easily constructs the opinion groups, and identifies consensus and disputes between groups. This can have significant implications on the policy design, large-scale decision-making and negotiation among multiple interest parties. The consensus among n opinion groups can serve as the main appeal of the individual participants, proxy to the true voice of the people. Therefore, in the Uber case it can be forward in the negotiation as the statement from taiwan citizens' opinions both as consumers and as potential registered drivers.

In other cases, such as the protests in Hong Kong, the sixth demand in addition to the five demands as the consensus are controversial among different opinion groups. One application of the platform would be to identify the common demand of protesters in a social movement. The innovative public opinion aggregator may facilitate the movement to have a more profound impact, since the collective voice is more easily amplified and has more power than the individual voice. Echoing the unprecedented large-scale protests recently took place in China, one future work would be to invite more protesters to participate in a real time online debate through Polis platform, as real consensus can only be involved through fierce debates and gaming among the agents.

Another application would be bridging-based ranking algorithm, which would promote the comments from people that are far from the user's position measured by social distance proxied by both demographic features and ideology on multi-dimensional discourse. Platform may incentives users to understand the concern from other opinion groups by designing a scheme allowing "bridging-to-earn".