Exploring the relations between misconduct and career development

The Slient Fox

Introduction

According to Citizen Police Data Project from Invisible Institute and several big news related to misconduct behaviors of police including the death of George Floyd on May 25th, 2020, we find that some involved police officers show demographic differences focusing on seniority of a police officer(eg. Salary, awards) and their kinds of misconduct are also different along with their demographic difference. Nevertheless, detailed analysis on the demographics of officers is supposed to be provided to see if our guess is true. With it, statistically significant correlations can be drawn to guide actionable policy changes and to avoid future similar misconducts.

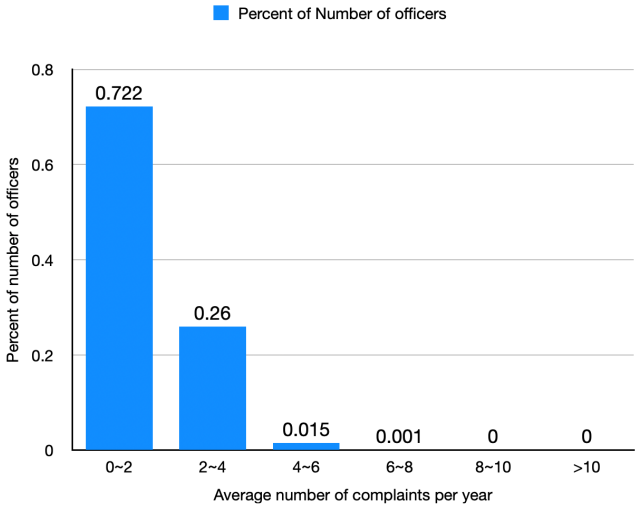
Theme

Our theme is to explore the relationship between misconduct in police officers and their career development. To be more specific, we are going to find if the misconduct in enforcement of a police officer can be reflected properly by his/her career. For example, if a group of officers have a higher average salary than others at the same rank, will their number of misconducts be higher or lower than others? How does the number or frequency of misconduct for an officer become after a change in his/her career(eg. an honor mention, award, promotion, salary change). Overall, we are going to find if the misconduct in enforcement of a police officer can be reflected properly by his/her career especially in salary, award and rank.

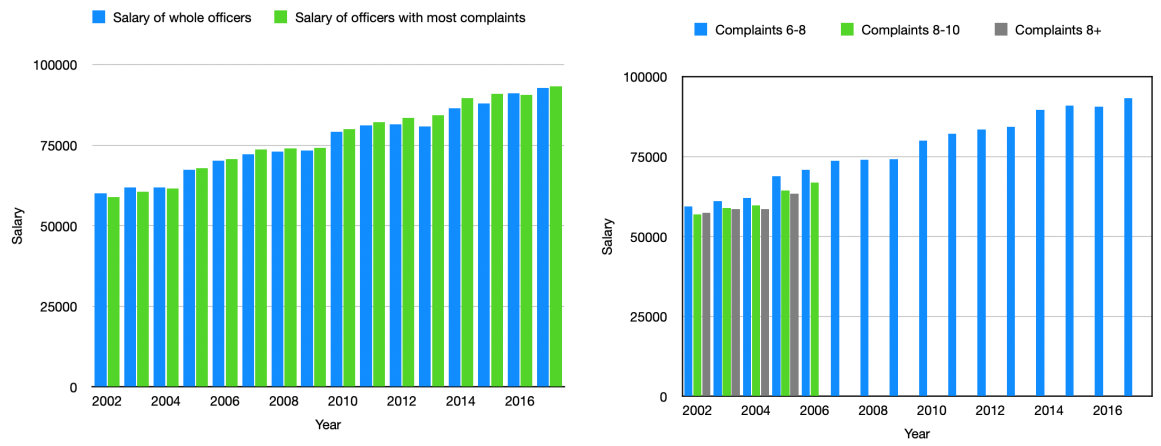
Relational Analytics

In this checkpoint, we conduct analytics by answering the following questions based on SQL query with CPDB database. You are able to find source code in the ‘checkpoint1/src’ folder.

First, we calculate the statistics of salary for the officers with the most complaints, and make graphs to show the comparison between officers with different salaries. Based on the following figures, we can see that officers with the most complaints means that these officers received at least 6 complaints. At the beginning, the average salary of officers with the most complaints is below the average of all officers, but starting from 2005, their salary is beyond the whole average(figure 2).

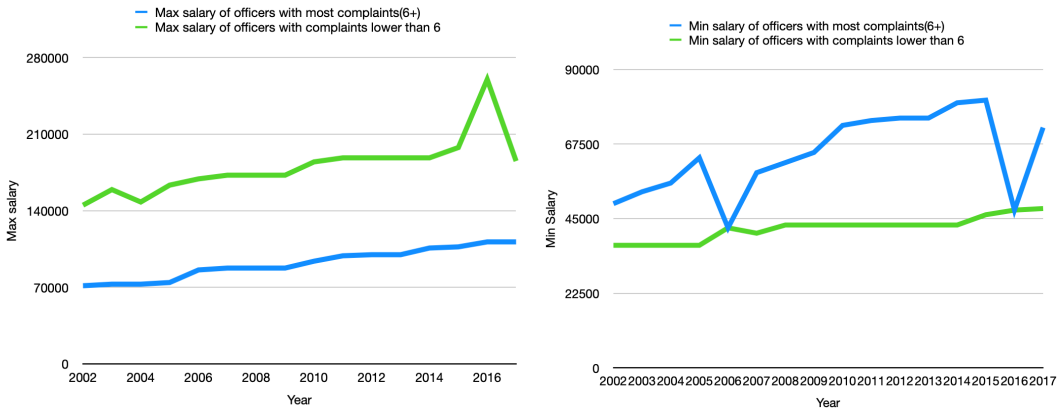


Distribution of officers with the most complaints (figure 1)



Comparison between salary of officers with most complaints (figure 2)

Officers with complaints over 10 haven't worked since 2006 and officers with complaints between 6 and 8 haven't worked since 2007. We compare the maximum and minimum salary of officers with the most complaints(6+) and that of officers with complaints below 6 in each year(figure 3). We can see though the maximum salary of officers with most complaints is lower than that of officers with complaints below 6, the minimum salary is quite higher. It means, if you get the most complaints, you will not be the one who has the lowest payment. Also, there is not much difference on median salary according to the number of complaints, but the variance differs a lot. The variance salary of officers with most complaints is much lower than that of officers with lower complaints in most years.



maximum and minimum salary of officers (figure 3)

Second, we try to figure out the percentage of total complaints these officers who have received an honor mention or award are responsible for. We have:

Total number of complaints from citizens: 235263

Total number of complaints received by officers who get awards: 225182

Total number of officers who receive complaints: 23098

Total number of officers who receive both complaints and awards: 20818

The percentage of total complaints these officers who have received an honor mention or award responsible for is 225182/235263, which is 0.9572

The percentage of officers who receive complaints get an honor mention or awards is 20818/23098, which is 0.9013

As the calculation shows, both the percentage of total complaints received by officers who get awards and the percentage of total officers who receive both complaints and awards are quite high.

We can see that receiving complaints has little influence on officers who receive an honor mention or awards. In the police department, it is common to give an award to the officer who received a complaint before.

There could be a more precise way to conduct this analysis, in which we remove the data of officers who got awards before their first complaints. Because it is not relevant to the question if receiving a complaint impacts an officer getting honor mention and awards. In addition, if an officer gets an award a long time after receiving a complaint, it may also be irrelevant to our question. However, it is too complicated to achieve, but it is worthy to conduct more research in the future.

	total_complaints	total_complaints_office...	officer_with_complaints	award_officer_with_comp...
1	235263	225182	23098	20818

Data from CPDB(figure 4)

Then, we calculate the percentage of officers who were disciplined in an allegation get an honor mention or awards. We have:

Total number of officers who were disciplined in an allegation: 9977

Total number of officers who were disciplined in an allegation get an award: 8895

The percentage of officers who were disciplined in an allegation get an award is 8895/9977, which is 0.89155

We can see the percentage is quite high, but is consistent with the percentage we have in the previous question. This also means there is no strong relationship between misconducts in police officers and their achievements in career.

For this question, we may also take timeliness as consideration in our analysis, which removes any award before the first discipline for an officer.

	disciplined_officer	disciplined_award_officer
1	9977	8895

Data from CPDB(figure 5)

Next, we find out if the total number or frequency of complaints received by the officer are reflected by his/her career advancement. To answer this question, we have the following analysis. Since the award record in the database starts at 2005, we only analyze the complaints and awards received by officers from 2005 to 2008

We divide the data into 3 sections:

Year 2005 - 2006:

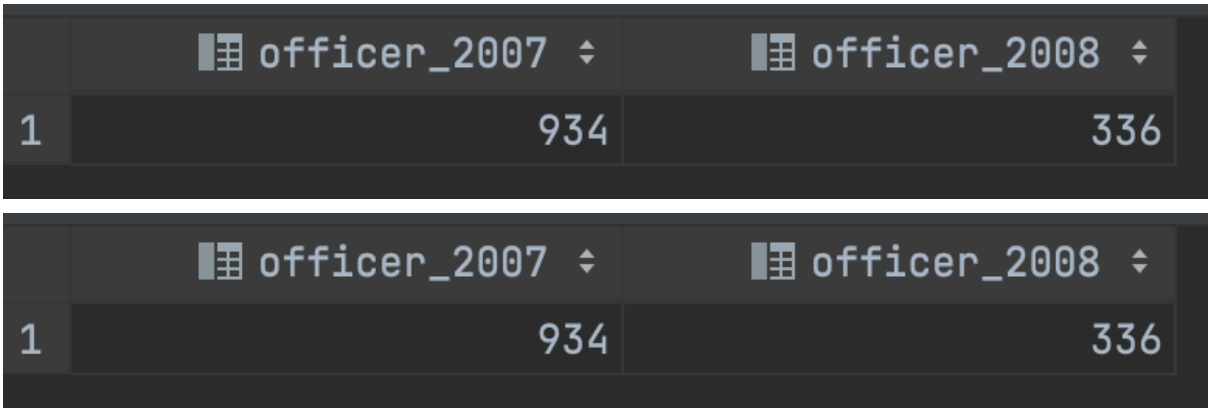
We select all officers who receive complaints but no awards in 2005, and then find all of these officers who receive both complaints awards in 2006. For these officers, we compare the number of complaints they received in 2005 and in 2006. First, we have the number of officers who received complaints but no awards in 2005, which is 1315. For these officers, we find their record in 2006 to find the number of them who received both complaints and awards, which is 324. As we can see, for these 1315 officers, only 324 officers receive complaints next year, which is a 75.36% decrease. Also, we count the number of complaints for officers in both years separately to compare if there is any clear difference in the number of complaints received by an officer who does not hold any awards in a year, and this officer who holds an award in the next year(figure 9). Then, we calculate the total number of complaints for these officers in 2005, and in 2006. Surprisingly, though the number of officers who receive complaints in 2006 is largely less than in 2005, the total number of complaints received by these officers in 2006 is much greater than in 2005.

Year 2006 - 2007

We also have the number of officers who received complaints but no awards in 2006, which is 911. For these officers, we find their record in 2007 to find the number of them who received both complaints and awards, which is 207. As we can see, for these 911 officers, only 207 officers receive complaints next year, which is a 77.28% decrease. We can see the relationship between number and frequency of officers who receive complaints and awards they hold is consistent.

Year 2007 - 2008

Result for officers who receive complaints but no awards in 2007 and officers who receive both complaints and awards as above.



	officer_2007	officer_2008
1	934	336

	officer_2007	officer_2008
1	934	336

Comparison between number of officers received complaints in 2007 &2008 (figure 6)

As a result, we believe that the number of complaints received by the officers can be reflected by their career advancement, which is specifically whether officers hold an award. We see a clear decrease in the number of officers who receive complaints in the year that they hold awards. The frequency of officers who receive complaints is also reflected by whether these officers receive awards. Conversely, the frequency of offices who receive complaints is higher in the year they hold awards than in the year they do not have any awards.

Finally, we would like to answer if there is a relationship between change of frequency of an officer who gets allegations and the change of his salary. We view this relationship by obtaining the average salary of the police officer from 2005-2008 and we collect the total allegations(reported by civilians) from 2005-2008. As shown in the above graphs, we have average salary for police and total number of allegations from 2005-2008.

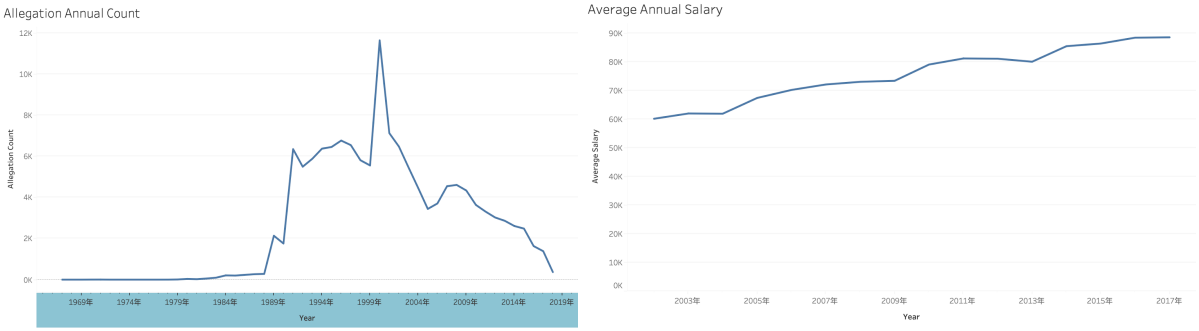
From the first table, we can see that polices' average salary has been increasing from 2005-2008. The increasing percentages are as follows: 4.14%, 2.71%, 1.29%. From the second table, we can see that the total number of allegations has been increasing from 2005 to 2008. The increasing percentages are as follows: 4.84%, 23.31%, 1.51%. From the percentages,it seems that there might be a positive correlation between policies' average salary and allegations reported by civilians. When the positive increase in the percentage of salary dropped from 4.14% to 2.71%, the number of allegations increased tremendously from 4.84% to 23.31%. However, when we look at the changing percent between 2007 and 2008, along with the salary dropped from 2.71% to 1.29%, the number of allegations only increased by 1.51% which is far from the previous 23.31%.

As a result, we would conclude that there might be a weak correlation between the change of salary and the number of allegations.

Data Exploration

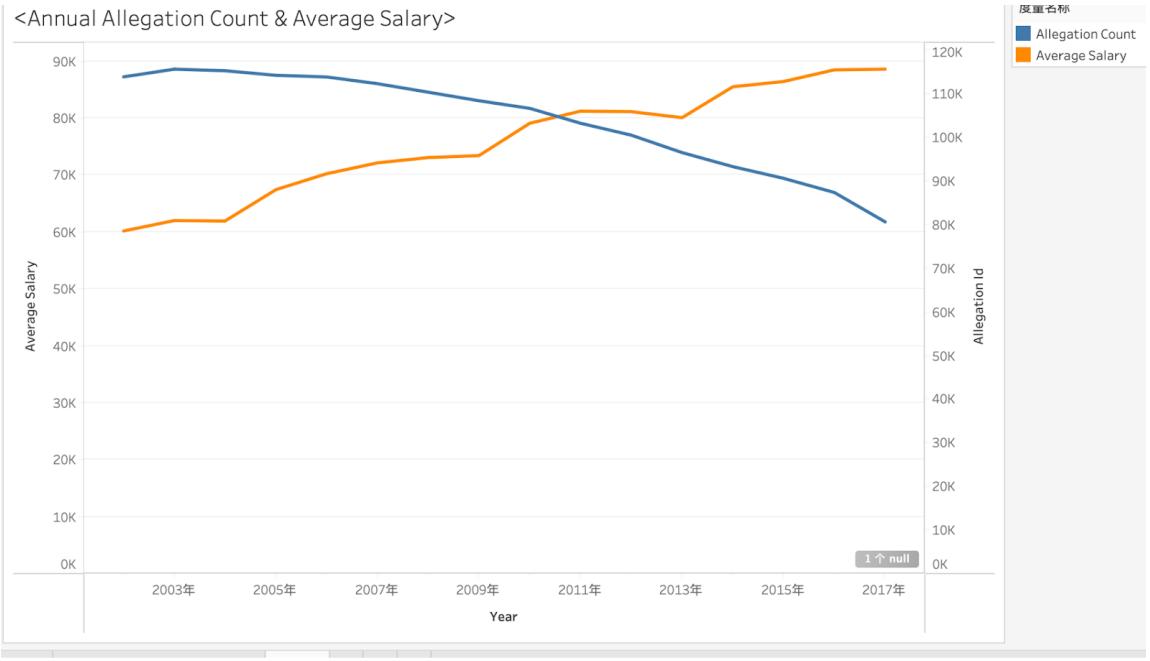
In this section, we are going to introduce the analysis we conduct to answer questions using graphical techniques.

First, we figure out if there is a correlation between the salary of the officer and the number of complaints. The trend of annual allegation count over years. We can see the number of allegations shows a trend like a quadratic function, peaking in 2002, and then gradually reflecting a downward trend. We also notice that there is a sudden rise in the number of allegations around 1990. Since there is no other evidence related to officers' careers before this year, we cannot conclude why this trend is shown. One guess is that the database may contain more data about records of allegations after 1990, and we take the annual count for allegations, instead an average number of allegations received by each officer, so the number of annual allegations after this year is much greater than the years before. The trend of annual average salary over years. It shows that the annual salary of officers is an upward trend, which may correlate with a downward trend of the number of allegations we found in the figure (figure 7 left).



Trend of annual allegation(left) and average salary(right) (figure 7)

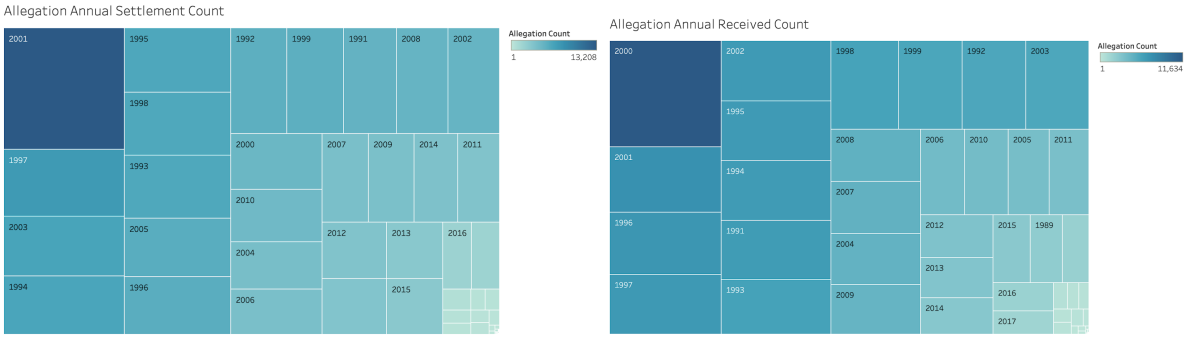
Since the records of salary in the database starts from 2002 to 2017, we also create a double-line chart to compare the trend of annual salary with the allegation count over years in a clearer way. We can say that while the average salary of officers is increasing, the number of allegations received by officers is decreasing.



Annual allegation count & average salary(figure 8)

Second, we try to answer the question that is there a correlation between the number of allegations received before an officer's first settlement. We regard the end of date of allegation as its settlement and the start date of allegation as the received time to make the heatmaps of received

allegation count over years. Compare the color of heatmap, we can find that the number of allegations received after officers' settlement cases is lower than the number of allegations received before. For example, the bubble represents the year 2000 and 2001 have an inverse size trend(before and after) between the two bubble maps. The settlement indeed influenced the number of allegations an officer received and officers cared more about how many allegations they received.

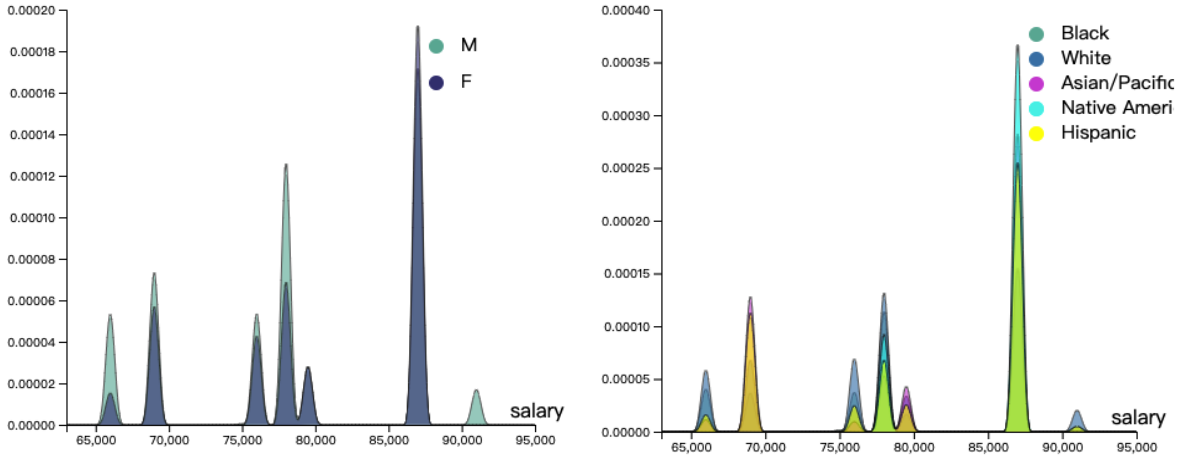


Heatmaps of annual settlement count & received count(figure 9)

Interactive visualization

In this section, we are going to answer questions using interactive visualization techniques. You can find source code and detailed analysis in 'checkpoint3/src'.

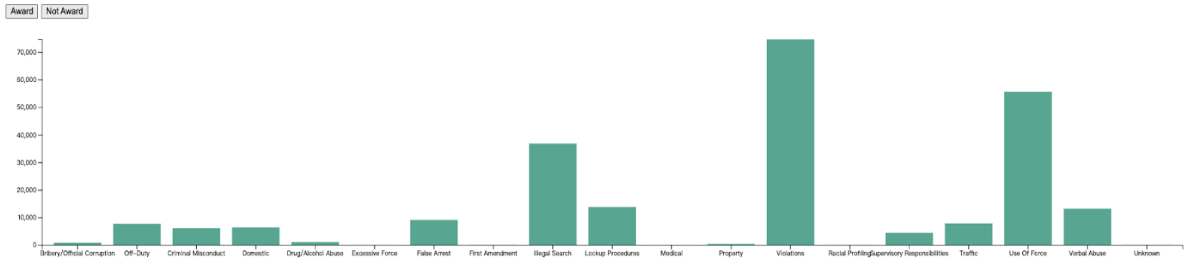
First, we have the distribution of officers' salaries across race and gender. we find that the distribution of all officers' salaries focused on three parts. There are two main gaps between these salary distributions. Comparing male and female officers' salaries, male officers get higher payment than female officers. Then, we find that officers of different races have a similar distribution of salary. Among officers who get highest payment, white officers account most, and then balck officers and hispanic officers. From these figures, we find that officers of different races have a similar distribution of salary. Among officers who get highest payment, white officers account most, and then balck officers and hispanic officers.



Distribution of officers salary across gender & race(figure 10)

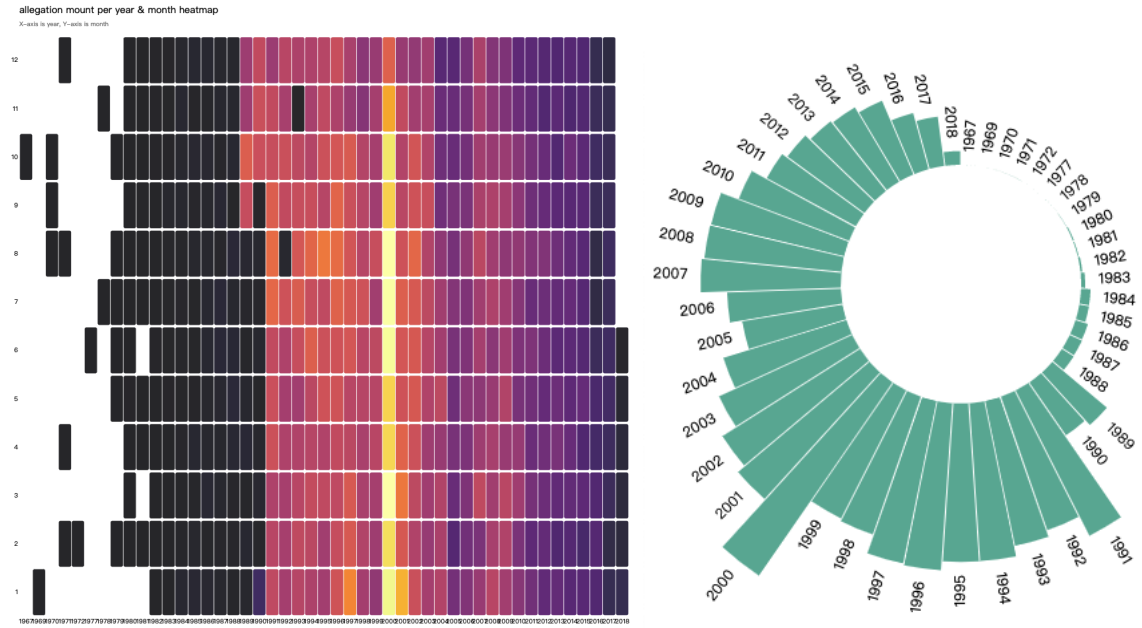
Then, we have the distribution of the categories of the misconducts (illegal search, use of force, etc.) for officers with or without awards. From the comparison of officers with and without awards from this interaction map, we see the changes of histogram and y-axis measurement. We find that officers with awards received more misconduct allegations, especially violentation, use of force and illegal search. These three kinds of misconduct behavories happened far more than others on officers with awards. Compared to officers with awards, officers without awards received less

allegations where off-duty allegations accounts more.



Distribution of the categories of the misconducts for officers with awards(figure 11)

Next, we try to figure out if we can compare misconduct maps according to different time lines. We made more than one interactive map to show the continuous change.This heat map shows the number of allegations for officers over years and months. Horizontally, We can see that the lightest area is around 2000, and gradually becomes colder over years, which means the amount of allegations in police offices has decreased since 2000. Vertically, We find the number of allegations occurring evenly over months, and if it must be said that the allegation amount in the middle of a year is higher than the beginning and end of that year, this pattern only shows in several years. Based on these, we also make a barplot showing the change of allegation amount along with time.We can see that the allegation amount received in 2000 is the highest peak. And it increases from 2005 to 2007 but decreases since 2007.



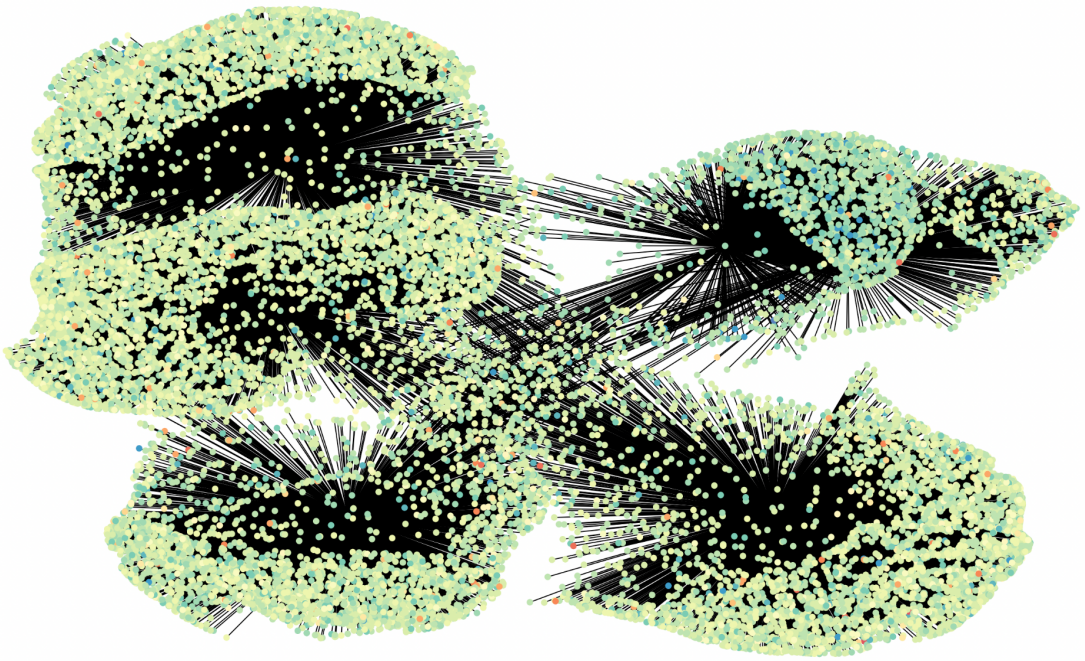
Heatmap & barchart of change of allegation amount along with time(figure 12)

Graph Analytics

In this checkpoint, we will describe questions we discover by building springout networks using networkX. You can find source code in ‘checkpoint4/src’.

First, we want to find if there is a relationship between the clusters of officers with the most complaints and their salary. We collect officers who have received complaints and their salaries. We regard each officer as a node, and connect nodes in the same range of complaint percentile. We group officers with the complaint percentile by 0, 20, 40, 60, 80, 100. For example, if two officers have 0 complaints, we connect these two nodes. If one officer has 15.7 as complaint percentile and the other officer has 11.4 as complaint percentile, we connect these two nodes. Also, the color of nodes reflects

the current salary of each officer, which a node with lighter color, such as green, means the officer has a lower current salary compared to other officers; a darker color means a higher salary. With the settings we describe above, we create this network in a spring layout with iterations = 10, and k = 0.1. In this network, we have a total of 17991 nodes, 17985 edges. As shown by the network, there are five clusters, which represents the number of complaints received by officers in different ranges we mentioned above. By looking at the color of each cluster, we can see officers' salaries in each cluster are consistent, which is basically similar in color. And the overall color of the nodes in the network is light, which means most officers who receive complaints have a lower salary compared to overall salaries. Also, we notice that the cluster of nodes at the top right corner of the network seems to be darker than other clusters, so we would like to take a closer look to find out more information. The total number of nodes in a cluster cannot be shown clearly in the graph of this spring layout network, but we can roughly compare the density of them. This cluster seems to have the least number of nodes compared with other clusters, so we calculate the total number of officers in each range of complaint percentile. We find out that the cluster at the top right corner of this network is the group of officers who receive 0 complaints, and a darker color means a higher salary. This finding is consistent with a conclusion we have in previous analysis, that officers who receive higher salary have less complaints.



Spring layout network of officers along complaints and salary(figure 13)

Natural Language Processing

In the final section, we train a transformer-based language model to identify the officier complaint from allegation narratives. Based on this model, we are going to answer the question about if the number of officer complaint records in allegation narratives consistent with existing data.

In the previous analysis, we used a field called if_officer_complaint a lot in the table data_allegation, which is an identifier if an allegation is about an officer complaint. Here we checked the table data_allegation especially summary and if is_officer_complaint. Therefore, we think it is helpful for later data exploration to build a model that can automatically fill out this field from allegation narratives. First, for choosing the dataset for training and testing, we extract 'summary' and 'is_officer_complaint' fields from table data_allegation, where the summary is not empty.

Our dataset is quite small, there are only 1147 pieces of data containing actual summary in table data_allegation. For these data, 772 allegations are not officer complaints and 375 are officer complaints. We take the first 70% data as training data and the last 30% as test data. The next step is text cleaning. Text contains several kinds of noises, which are unnecessary in training and may mislead the machine to understand the patterns in the input text. First, we normalize the text by removing special characters, like hashtags, numbers as well as short words. Stopwords, such as I, the, often use frequently in a sentence, but provide little knowledge, which is necessary to remove them. Stemming and lemmatization is used to reduce words to their root form. We use some models, like nltk and wordninja, to implement data cleaning. Then, we extract features from the cleaned text. We have two features: bag-of-words and TF-IDF. The bag-of-words works in a way that we regard each summary as a bag, and in each bag, we count the number of appearances for each work. The TF-IDF features are calculated by term frequency and inverse document frequency, how common or infrequent a word shows in the entire text. Next, we implement the gensim Word2Vec model and see how it performs. We will specify a word and the model will pull out the most similar words from the corpus. Details can be checked in the Jupyter notebook.
Finally, we tried logistic regression. We use Bag-of-Words features and split data into training and validation sets. We use F1 scores to represent the accuracy of our model, which is a common measurement for precision and recall of the test.

Feature	Bag-of-Words	TF-IDF
Accuracy	0.6956521	0.6945606

As you can see, there is no big difference between using two features, which shows the accuracy of the model is around 70%. Hence, our training model can predict if it is an officer complaint according to allegation narratives in an above average accuracy.

Using this model, we are able to answer the question if the percentage of officer complaints in total allegations in existing table data_allegation is similar to our prediction percentage from allegation narratives provided. First, we calculate the percentage of officer complaints in total allegations. There are two cases. In the table data_allegation, there are only 1147 out of 216052 data that have a summary field(which is not Null). This is what we use for the training model. Also, we calculate the percentage for the entire data_allegation, no matter if it has an empty summary field.
For prediction, we use the provided allegation narratives, in which we extract the text field, and perform text cleaning and apply TF-IDF features. Then, we predict the number of officer complaints in these allegations using our trained model. After data cleaning, we have 21303 allegation reports, and we get there are 4016 of them which are officer complaints.

Dataset	Total allegations	Is_officer complaint = True	Percentage
With summary	1147	375	0.32693
With/without summary	202608	13444	0.06635
Prediction	21303	4016	0.18851

We can see that 18 percent of allegations are officer complaints predicted from narratives. This percentage is not perfectly consistent with existing data, but we think this makes sense. Because the

amount of our training data is too small, and the entire dataset is too large compared to training and prediction data. This could influence the accuracy of our model. Moreover, our prediction lies between the small dataset and the large dataset, so we think the model works properly. If we can have more data to feed the model in the training process, the accuracy of the model would be higher.

Conclusion

Through our different methods of experimentations and data visualizations, we found that only some of the features among police officers' career development does show strong correlation to the number of allegations and others either show weak correlation or are not related. Weak correlated feature is the changing salary of the police officers and their number of allegations. Strong correlation features include: change of police' settlement place decreases the number of allegations, increasing number of awards increases specific types of allegations, lower/higher salaries tend to have higher/lower complaints. From the above correlations, it is very interesting to have two conflicting results: the changing salary of the police officers(weakly correlated) and lower/higher salary tend to have higher/lower complaints (strongly correlated). This may indicate that the determination factors of salary change need to be reevaluated. What's more, considering more awards leads to more specific types of allegations, it is possible that the award system unintentionally encourages police officers to do specific operations which reflects as certain types of allegations increase as awarding increases.

Future Research

For the Natural Language Processing part, as mentioned above, due to time limitations, the result does not match current data precisely but we believe that it makes sense. With lack of training data, the accuracy of our model has been negatively affected. We believe that the model would be correct because our forecast falls between the small and big datasets and its accuracy would improve if we had additional data to feed it throughout the training phase.

For the interesting conflicting result mentioned in the previous, there could be several potential factors involved in, for example, the award system inside the Chicago Police department may need evaluation. The future direction could be to dive deep into the award system and find unique relationships between awards received and certain types of allegation. Focusing on certain features of awards, for example, time awarded, award type, award category would also help future researchers to develop further on this track.