CS 506 Data Science Tools and Applications

Police Overtime Project

Final Report - Team F

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Introduction:

With the Boston Police Department having a budget of over $400 million dollars, we have focused on analyzing how this money is spent. Namely, we have looked at Police Overtime and the relationship between total time worked and overtime hours. However, Overtime pay is just one category of BPD spending. We have analyzed the earnings, overtime, operating budget, field activity, and crime datasets to determine how money is used within the Boston Police Department. Additionally, to further analyze these trends we looked at datasets for race and demographics, police watchlists, complaints, and discipline. All of these datasets can be found under the data folder in the repository.

We focused on answering three main questions: Identifying financial excess in BPD Spending, Characterizing Wasteful Overtime Practices, and Filling in Narratives around waste and Misconduct by Individual Police Officers. Through our analysis of these questions we decided on an extension question which focuses on the relationship between the Boston Police Departments spending and Community safety.

Data Collection and Processing:

Crime Incident:

The Crime Incident data was not provided to us and was found on The City of Boston's website. We found this dataset useful when answering our Extension Question. In order to use this we had to convert the location (latitude, longitude) to a zip code format.

Demographic:

This dataset was provided to us, however, it contains limited information about the demographics of the BPD, split by rank into the intersections of race and gender. While there are entries for several years spanning back, until 2022, the sets provided are only screenshots that we can’t make models of, so we are limited to using 2022 and 2023 demographic data. Despite this, we used this data to help give us insights as we analyzed trends in other datasets while answering the key questions.

Earnings:

This data was provided to us and contained information about the Boston City Employees' Earnings which was used to help answer our first question. The datasets ranged from 2011-2022, and we analyzed trends in different periods of time: all of the data (2011-2022), the last decade (2012-2022), and recent years (2021-2022).

The datasets contain pay information for each employee, broken up into injury, overtime, regular, retro, Quinn, and detail pay. Additionally, the total pay for each employee is provided as well as their job title and department. To focus on the pay of the Boston Police Department we had to filter this data to only contain their employees. Additionally, we had to process the columns relating to pay to be floating point numbers so we could perform computations on the data.

Field Activity:

This dataset was provided to us and contains detailed information about specific cases of arrests/scenes, both for the suspect in question and the officer who responded. Along with the location of the arrest and supervising officer. We used this data to help answer our extension question. To preprocess the data set we had to account for the ways that the format of the tables changed. Between the first data from 2012 and now there have been 4 different schemas that had a variety of table names along with data. We also had to clean the data of any NaN values as well as incorrect data types.

Operating Budget:

This dataset was not provided to us and was found on the Boston.gov website. It provides information about the proposed budget for 2024 and the budgets for 2021-2023. This dataset can help us analyze how the budget has changed over time. We first had to replace any missing values with NaN. Additionally, the expense columns had to be formatted to floating point numbers so we could perform computations. Lastly, to look at the budget for the Boston Police Department, we filtered out other departments and only looked at the data relating to the BPD.

Overtime:

Within the Overtime folder you will find both court overtime data as well as Overtime pay data. The Court Overtime data has annual records of officers requesting overtime pay when they appear in court. We have analyzed the number of records for each year to get a better understanding of overtime court appearance for the last decade. This data has STARTTIME and ENDTIME which could be used to calculate hours worked by officers.

The overtime pay dataset ranges from 2014 to 2021. It provides records of officers requesting overtime pay and the address where the overtime took place. We have analyzed the number of records for each year to get a better understanding of overtime for the last decade and the discrepancy between ‘Hours Worked’ and ‘Hours Paid’.

Watchlists and Complaints:

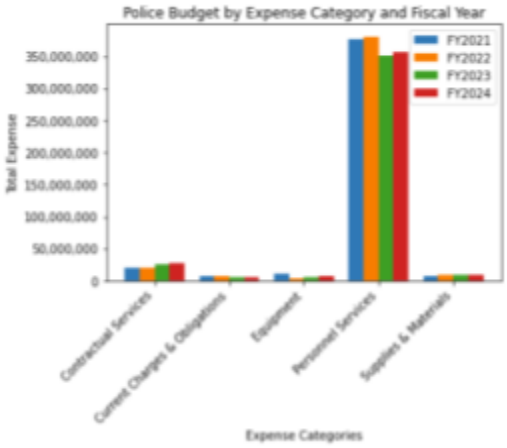
These datasets were not provided to us but required to answer the third question. They provided information about officers who are on the Suffolk County Watchlist, been disciplined for overtime abuse or misconduct, or have complaint records. To use these datasets we had to convert the format of the officer name in each dataset into the same format and remove duplicate values for complaints and salaries. Also calculating the number of years which an officer collected overtime during.

Base Analysis:

Identifying instances of financial excess in BPD spending

David, Ahmad, and Emily

Our first key question was to identify financial excess in BPD Spending. We began answering this by looking at **how the BPD Operating Budget has changed since 2021**. We found that the overall budget had increased since 2014 but recent years saw a 4.24% decrease. Additionally, the budget is broken up between five categories: Contractual Services, Current Charges & Obligation, Equipment, Personnel Services, and Supplies and Materials. Personnel Services has remained the top category for budget in all four years. This category deals with employee pay including overtime and regular pay.



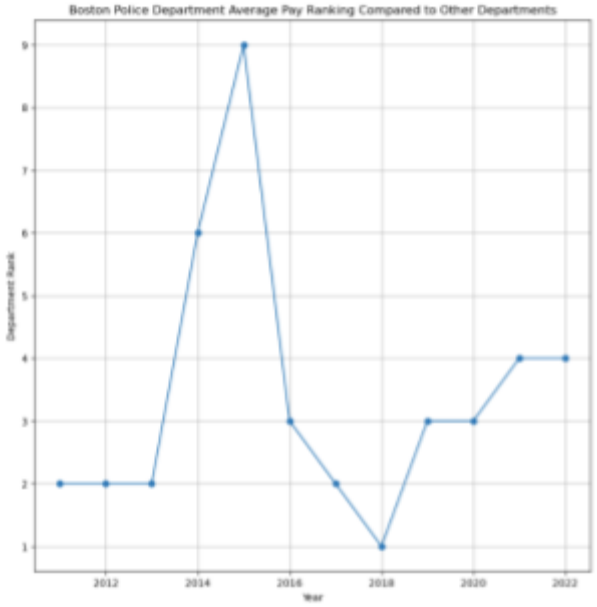
Personnel Services makes up a majority of the BPD Operating Budget and has remained the top category as it includes employee pay.

Overall the BPD Operating budget has increased. However, recent years saw a 4.24% decrease

Police Officers consistently had the highest percentage of combined pay for BPD Employees. Looking at their total earnings by year, there was a large increase in 2018 and has been decreasing since 2020.

We then looked at the Earnings Data to further analyze how this budgeting money was being spent. From this we could look at **how funds have changed intra-departmentally**. We found that Officers are consistently the highest percentage of the combined pay for BPD employees, this makes sense given that there are more police officers than other roles. Surprisingly of the top 10 highest combined pay roles almost all had an uptick in combined pay in 2018 while many had a downtick in 2021.

Police Detective is somewhat of an exception among the top 10 highest combined pay roles as it reached a peak in 2016 and after falling in 2017 has remained consistent. To compare to other departments, we looked at the average pay of BPD employees versus other department employees and determined the top 10 earning departments. From that we could determine how frequent departments appeared. The BPD was frequently ranked one, meaning they had the highest average pay for many years. BPD on the other hand, frequently ranked 2,3,4 and in 2018 ranked first.



The BPD has remained one of the top 10 departments since 2011 when ranking by average pay. In 2018 they were the top department and since 2016 have remained in the top 5.

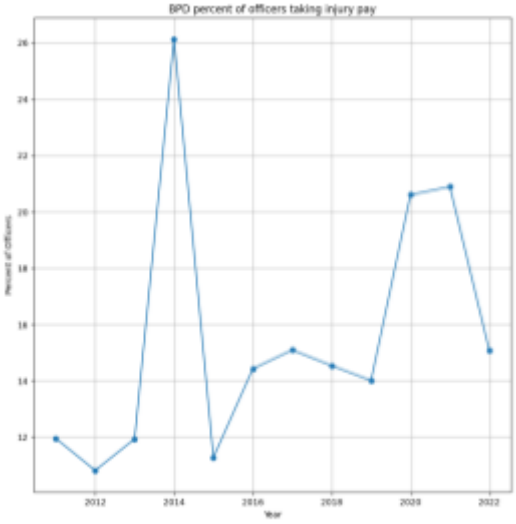
Additionally we analyzed how **BPD paychecks have changed throughout the years**. We found that the average pay, however, has gone up from a little over 60,000 in 2011 to upwards of 80,000 in the past 3 years. Regular pay has gone up slightly in the past 10 years, while overtime pay has gone up significantly – it doubled from 15k in 2011 to 30k last year.

The Average amount of overtime pay has doubled from 15k in 2011 to 30k last year.

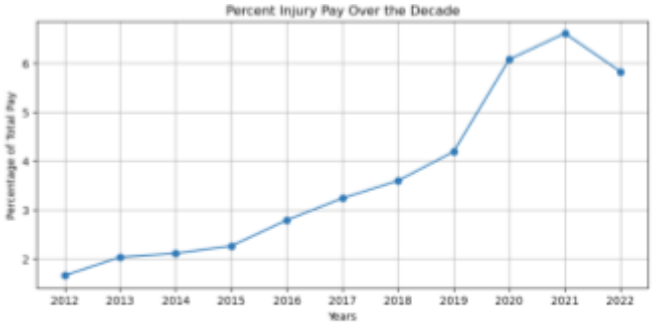
Additionally we looked at the breakdown of this pay by looking at changes in overtime, quinn, retro, injury, detail, other, and regular pay have changed from 2012-2022. To do this, we looked at what percent each category made up of the total pay for each year. From this data we found that quinn, other, and injury pay had increased whereas detail and retro have decreased. Overtime and regular pay have remained consistent.

The percentage that Overtime and Regular Pay make up of the total pay have remained consistent

Lastly for this question, we looked at **how much BPD Officer pay came from injury pay and how many officers claimed injury pay**. Looking at BPD earnings from 2012-2022 we found that Injury pay has increased overall, with a slight decrease in 2022. Additionally we found that on average across the decade 15.9% of BPD employees claimed Injury pay.



On average about 15.% percent of BPD Employees took injury pay. The percentage of officers who took injury pay peaked in 2014 with 26%.



The percentage that injury pay makes up of the total pay has increased overall, however there was a slight decrease in 2022.

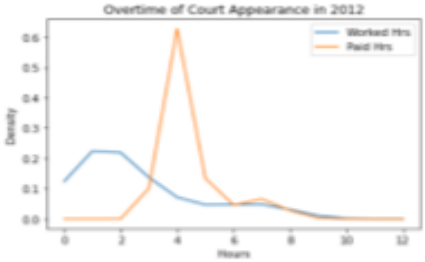
Characterizing wasteful BPD overtime practices

Jason and Ashton

The next question we had to answer was to characterize wasteful BPD Overtime practices. To find **wasteful overtime practices**, we focused on the discrepancy between overtime hours paid compared to overtime hours worked by analyzing overtime data from 2014 to 2021. Comparing the overtime hours paid and worked, the annual difference ranges from 180k hours to 260k hours but no clear pattern was found. The year of 2017 displayed maximum value and year of 2020 had minimum value.

There was no clear pattern for the discrepancy of hours worked and overtime hours

To add **narratives to misconduct in overtime pay**, the distribution for worked hours and paid hours are very different for hours less than 6. We found that when hours worked are less than 4, most officers were paid for 4 hours. This trend was visible throughout all years.



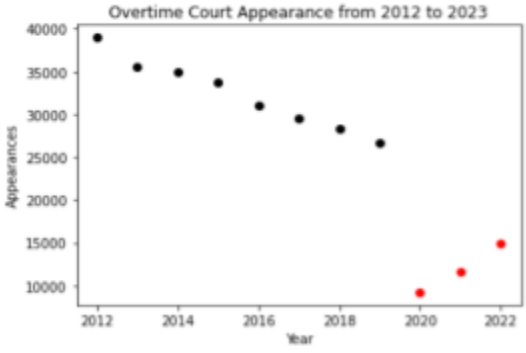
when the hours worked are less than 4, officers tend to request for 4 hours of overtime and this is where the discrepancy was the greatest.

BPD's overtime data did not have hourly pay for each officer and having the same rank can't guarantee equal pay, so we **could not calculate the financial discrepancy** due to lack of data.

Distribution of ratios of overtime worked vs. overtime paid is skewing to the right as time goes by. As the data gets skewed, the number of outliers is increasing. For 2012, the greatest outlier was 16. This is because most discrepancy happens when the hours worked is less than 4. So an outlier with a value of 16 is an officer who worked 15 minutes billing 4 hours.

the distribution for worked hours and paid hours are very different for hours less than 6

Overtime for court appearances have declined from 2012 to 2019 by 4,000 each year from 40,000 to 26,000. However, after COVID-19, appearances are increasing by 3,000 each year.

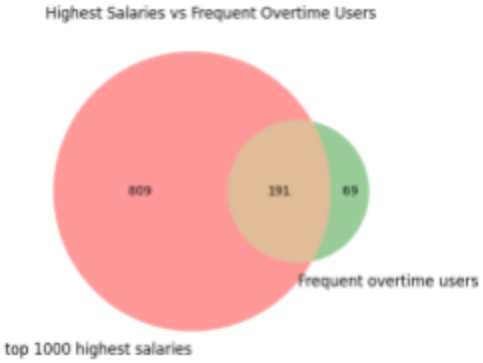


Overall, overtime for court appearances have declined from 2012 to 2019

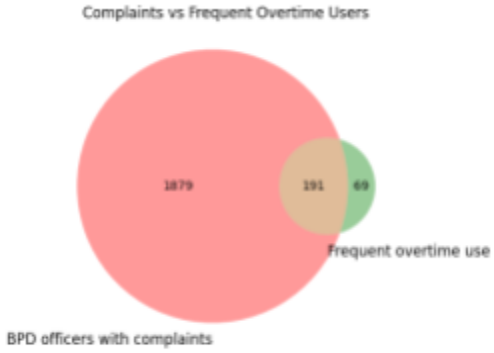
Using data to fill in narratives around waste & misconduct by individual BPD officers

David and Ashton

Our final question was to look at the **overlap between frequent overtime users and officers who have the highest salaries, are listed in Suffolk County police watch list, have been previously decided for overtime abuse, or have internal affairs complaints.** To do this we looked at the top 10% of officers who frequently claimed overtime (260 officers). We found that there was not a large overlap between frequent overtime users and the Suffolk County police watch list or officers who have a record of previous disciplinary action. We found that the vast majority of officers who were on the list had some form of internal complaints record, with 191 of the 260 checked. We found that 73% of the officers who were frequently using overtime had a salary in the top 1000 salaries in the Boston police. Most notably among the 5 datasets we checked there was one officer who appeared on all of the lists. This officer has previously been disciplined for submitting false timesheets, and is currently under investigation for corruption. Overall there does appear to be some connection between the officers who took the largest amount of overtime per year and the officers with the highest pay, and with a record of internal and external complaints.



A Venn Diagram of the overlap between highest paid BPD officers and the most Frequent Overtime Users Showing that 75% of the BPD's highest paid officers frequently use overtime.



A Venn diagram of the overlap between BPD officers with complaints and the most frequent Overtime users showing that roughly 70% of the most frequent overtime users have complaints against them.

Extension Analysis:

The Impact of Boston Police Department spending on Community Safety

Jason, David, Ashton, and Emily

Background

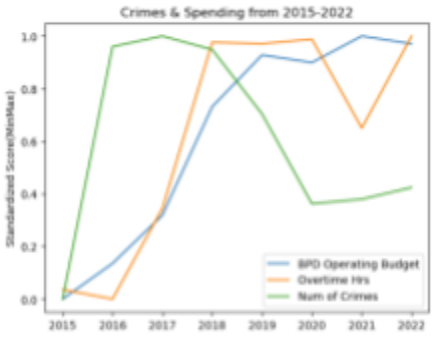
For the Extension project we focused on analyzing the impact of the Boston Police Department spending on Community Safety. As we were looking at the different datasets surrounding BPD spending, we wanted to explore how these numbers were impacting community safety. Given the significant budget allocation to the BPD, it's important to understand how police presence and activities can correlate with crime rates, community safety, and ultimately public trust in Boston. This analysis can reveal insights into the effectiveness of police spending and strategies, and whether they align with community needs.

In order to answer this, we created a few questions to guide our analysis. We focused on seeking out any correlations between overtime pay and crime rates as well as the BPD budget and crime rates. Additionally, we aimed to answer if the areas with higher amounts of field reports had higher or lower crime rates to determine if the number of on field police officers impacted crime rates.

To answer these questions we used crime datasets from the City of Boston, which are located in our GitHub repository data folder under Crime Incident. Additionally, to analyze the relationship between budget and crime, we needed more budget data from Boston as the csv file had data from 2021-2024. To accomplish this, we manually entered the budget data from 2014-2022. This information can be found on the City of Boston website, which has documents containing the operating budgets for current and past fiscal years.

Analysis

To check the relationship between overtime hours, BPD budget and number of crimes, we plotted each data's value from 2015 to 2022. Data was standardized using min-max normalization to scale the values from 0 to 1 to make relationships more visual.



We graphed the standardized values of Budget and Overtime to compare this to the standardized Number of Crimes

We predicted the **relationship between the number of crimes and overtime hours** to be positive. Contrary to our belief, our analysis using linear regression model gave us a R-squared of 0.000 and ‘overtime’ was not a significant variable to predict the ‘number of crimes’ as high p-value(0.972) demonstrates we fail to reject the null hypothesis. We did discover that the number of crimes could be a leading indicator for overtime hours by 2,3 years.

	coef	std err	t	P>|t|	[0.025	0.975]
const	7.964e+04	6.75e+04	1.181	0.282	-8.54e+04	2.45e+05
overtime	3.443e-05	0.001	0.037	0.972	-0.002	0.002

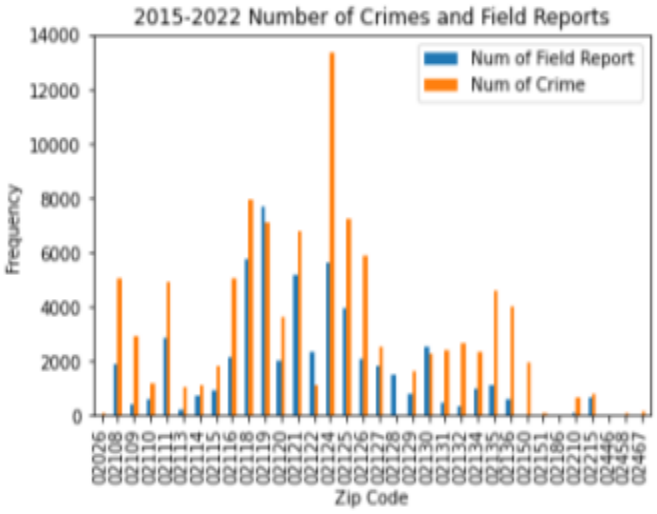
Using Linear Regression we found no relationship between the number of crimes and hours of overtime

Relationship between the number of crimes and BPD budgets was also analyzed using a linear regression model. R-squared was 0.000 and ‘budgets’ was not a significant variable to predict the ‘number of crimes’ with high p-value(0.884).

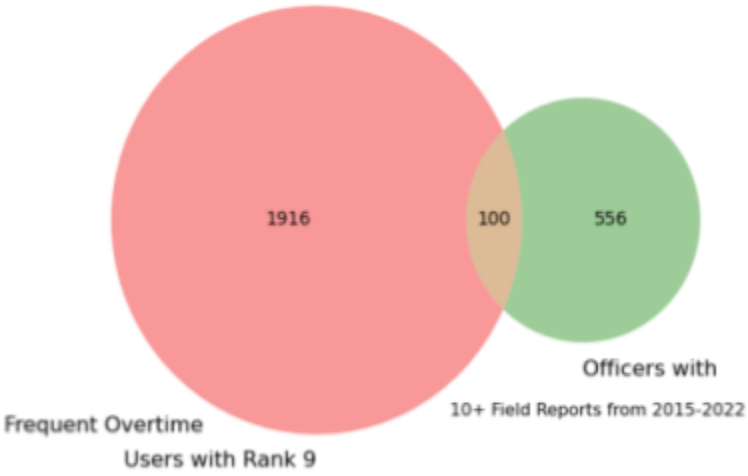
	coef	std err	t	P>|t|	[0.025	0.975]
const	9.411e+04	7.91e+04	1.189	0.279	-9.95e+04	2.88e+05
budgets	-3.071e-05	0.000	-0.152	0.884	-0.001	0.000

Using Linear Regression we found no relationship between the number of crimes and BPD Budget

We also analyzed how the number of on field police officers and how they impact the crime rates for different parts of Boston using the zip code. The number of police reports made per zip code was often considerably less than the amount of reported crime for that area between 2015-2022. We do not have an explanation for zip codes where there were more field reports than actual reported crime. From this we can conclude that police presence did not impact crime rates.



To see the relationship between crime and police activity we graped the number of field reports and crime reports from 2015-2022 by zip code.



There is not a large overlap between frequent overtime BPD Employees with rank 9 and officers with more than 10 field reports from 2015-2022

We looked into if officers with more overtime were in places with higher or lower crime rates to determine if these extra hours worked had an impact on community safety. We found that there is not a large overlap between frequent overtime BPD Employees with rank 9 and officers with more than 10 field reports from 2015-2022.