INF 2178H: Experimental Design for Data Science

“Inherit bias affecting arrests and the probability of being stripped searched”

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Introduction

The TPS Public Safety Data Portal houses a dataset called Arrests and Strip Searches (RBDC-ARR-TBL-001) that has social, cultural, and economic attributes. This paper explores and critically evaluates the inherent bias associated with gender, type of arrest, and perceived race in regard to the probability of being strip-searched during the arrest. The structure of the analysis comprises normalizing discrete categorical variables by their frequency, exploratory data analysis (EDA), data visualization, the t-test, and the analysis of variance (ANOVA). A discussion and conclusion that covers the correlations that arise from the statistical analysis of the data is at the end of the paper.

Exploratory Data Analysis

Overview

The possible correlated and/or explanatory attributes with discrete levels we are exploring are **“Perceived Race,”** which is what ethnicity the police person perceived when looking at the arrestee. **“Sex”** refers to if an arrestee’s gender; labeled as female, male, or other. **“Occurrence Category”** speaks to the nature of why the individual was arrested or investigated. The outcome variables we are looking to explore are “**Strip Search**”; a binary attribute that indicates if the arrestee was strip-searched or not. After our initial review of the dataset, exploring the parameters, and removing duplicates, the dataset itself consists of 25 variables and 65267 unique arrests.

Cleaning

Occurrence category, race, and sex are the primary focus of our investigation. Correlations are found after analyzing the number of arrestees subjected to strip searches for each occurrence type.

One of the first steps is determining if "**Stripe Seach**" only contains ones and zeros. A value of 0 indicates that the suspect was not subjected to a strip-search, whereas a value of 1 indicates that the suspect was subjected to a strip-search. We divide the total number of arrests up into their respective groups depending on the levels of the occurrence type variable. The M stood for male, the F for female, and the U for unknown. There were only 9 instances of U out of 65267, and U was removed from the dataset since the size is too small to give any meaningful result.

Sex	F	M	U
Occurrence_Category			
Assault	1619.0	6107.0	NaN
Assault & Other crimes against persons	1494.0	5741.0	NaN
Break & Enter	130.0	785.0	1.0
Break and Enter	119.0	749.0	NaN
Crimes against Children	9.0	60.0	NaN
Drug Related	494.0	2257.0	NaN
FTA/FTC, Compliance Check & Parollee	699.0	3177.0	1.0
FTA/FTC/Compliance Check/Parollee	836.0	3408.0	2.0
Fraud	134.0	340.0	NaN
Harassment & Threatening	158.0	1110.0	NaN
Harassment/Threatening	182.0	1164.0	NaN
Homicide	8.0	65.0	NaN
Impaired	255.0	1107.0	NaN
LLA	90.0	496.0	NaN
Mental Health	83.0	156.0	NaN
Mischief	266.0	1056.0	NaN
Mischief & Fraud	377.0	1355.0	NaN
Other Offence	347.0	1625.0	NaN
Other Statute	176.0	768.0	NaN
Other Statute & Other Incident Type	373.0	1970.0	1.0
Police Category - Administrative	766.0	3122.0	NaN
Police Category - Incident	70.0	494.0	NaN
Robbery & Theft	1327.0	3252.0	1.0
Robbery/Theft	1018.0	2735.0	1.0
Sexual Related Crime	29.0	810.0	NaN
Sexual Related Crimes & Crimes Against Children	28.0	764.0	1.0
Vehicle Related	97.0	671.0	NaN
Vehicle Related (inc. Impaired)	275.0	1702.0	NaN
Warrant	837.0	3547.0	1.0
Weapons	149.0	959.0	NaN
Weapons & Homicide	139.0	966.0	NaN

Figure 1: Arrest number for each category by sex.

Basic Visualizations

Figure 3 bar chart displays the total number of people arrested under each occurrence category by sex. We can clearly see a trend in which the number of

men arrested is significantly higher than the number of women. That feature is anticipated and we expand on further experiments with the Sex attribute.

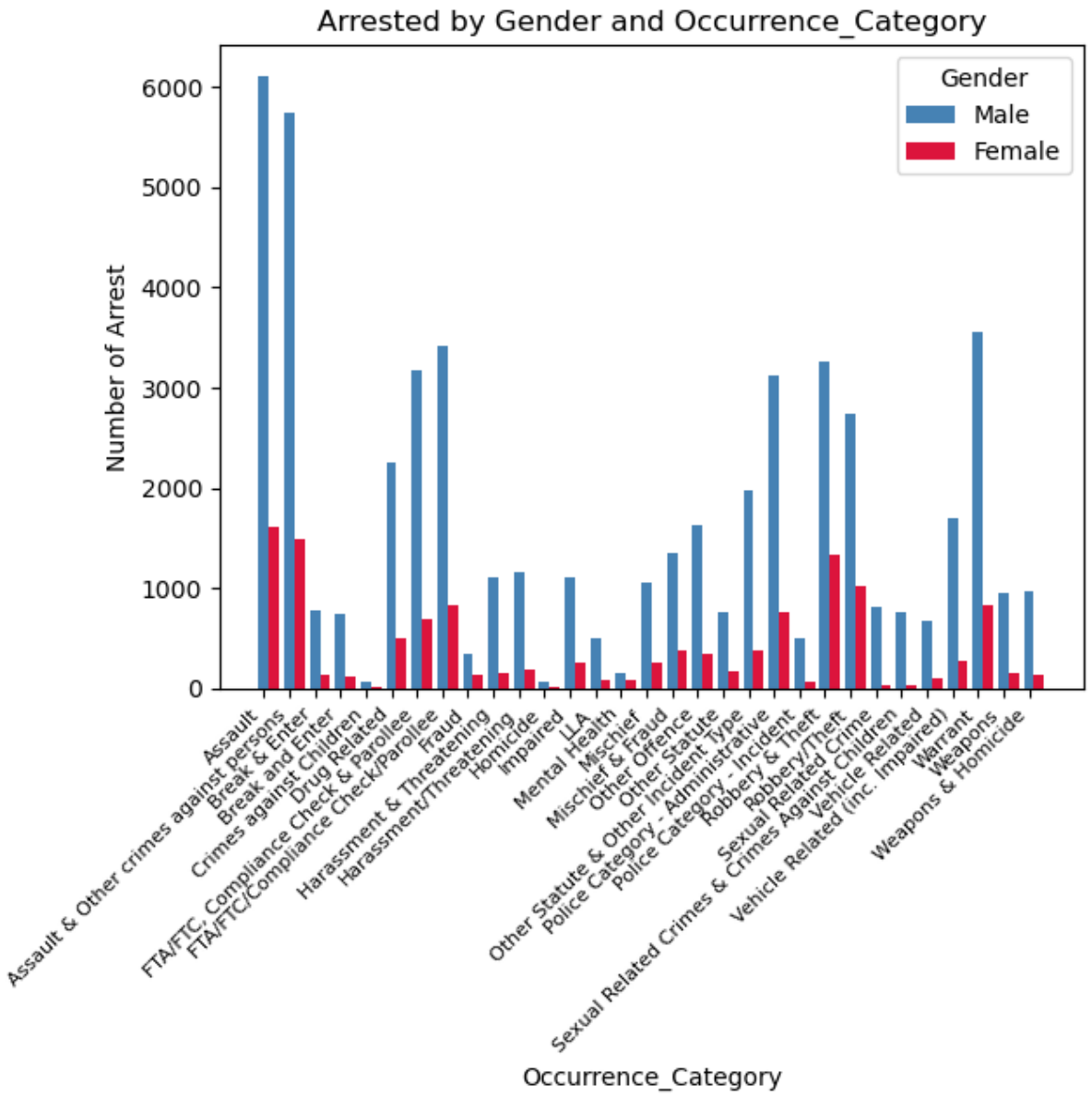

Figure 3: Bar chart of the total number of people arrested under each occurrence category.

Further exploration leads to combining Sex and Occurrence Category counts with just the population of arrests that also are strip-searched. **Figure 4** bar chart contains the number of individuals strip-searched for each Occurrence Category across Sex. Further evaluation is required to determine a correlation.

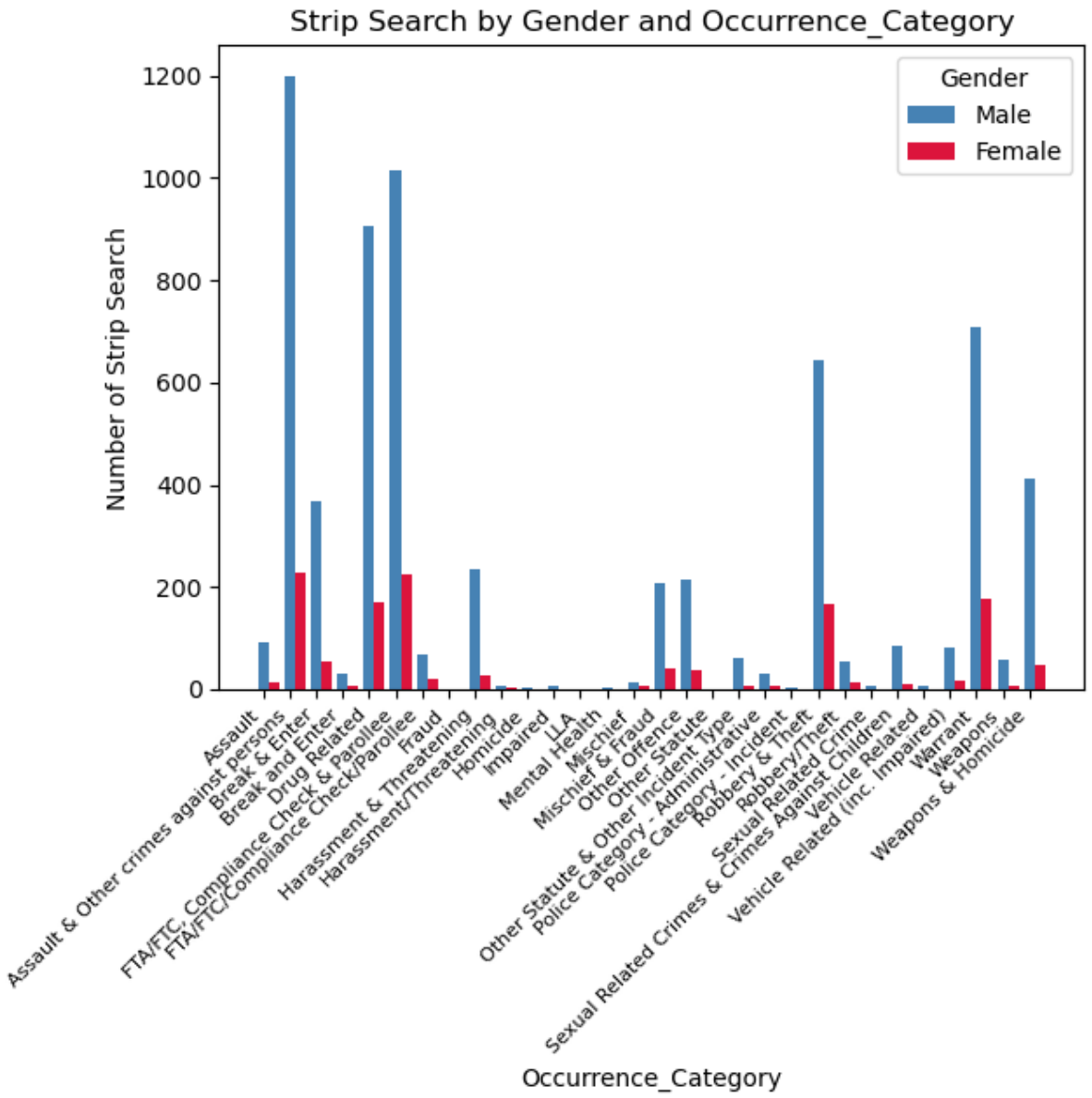

Figure 4: Bar chart of the total number of people strip-searched during an arrest under each category.

To continue to explore the type of occurrences, we added a second bar chart (**Figure 5**), which contains the proportion of being strip-searched for each occurrence category when people get arrested. The next avenue is converting nominal variables into discrete continuous variables using marginal, joint, and conditional probabilities.

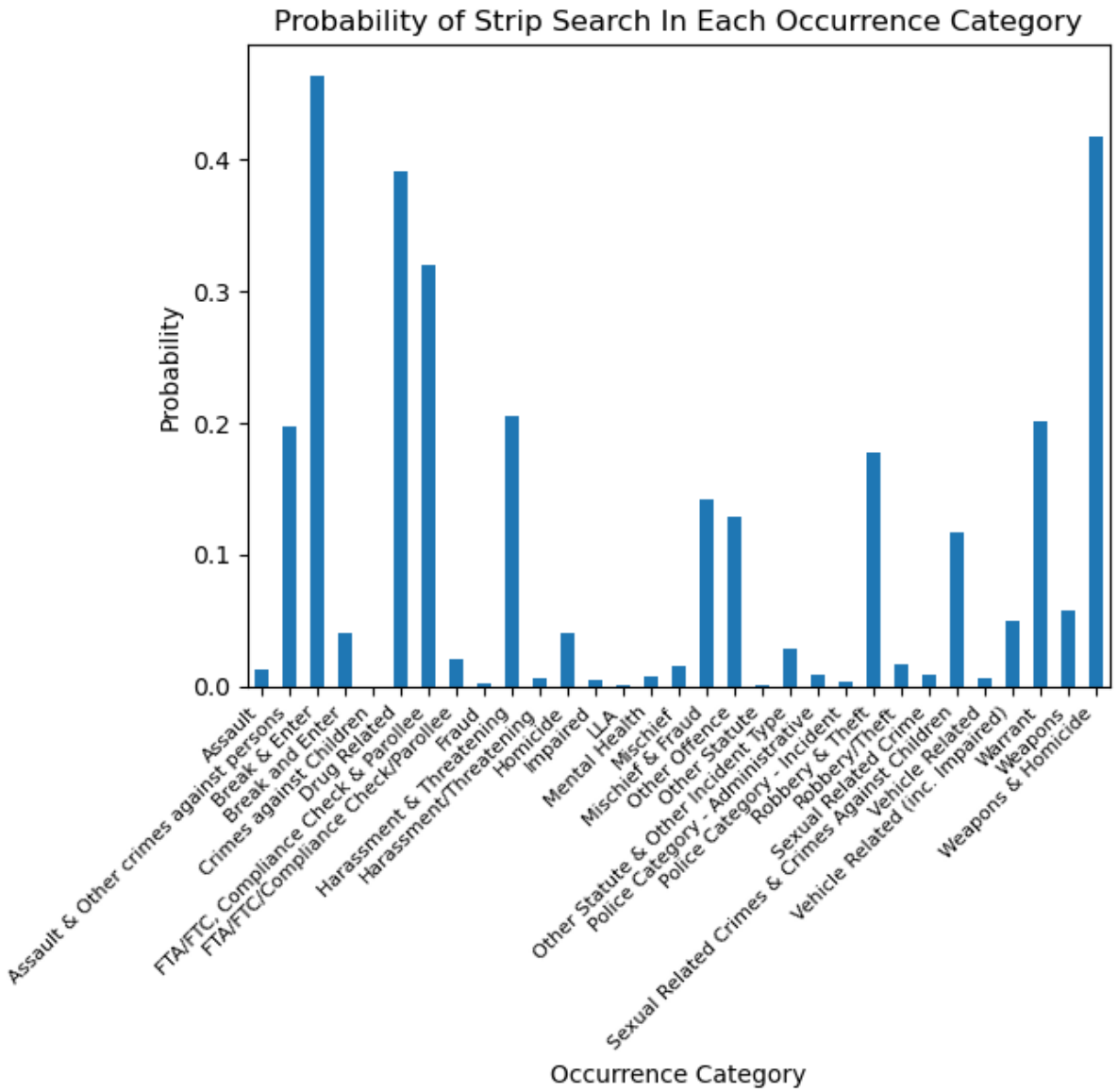

Figure 5: Bar chart of prob being strip searched under each occurrence category.

Discrete Continuous Variables

To get a sense of the basic probability distributions for each nominal variable, we generated a probability mass function (PMF) for each category along with generating the joint distribution between each explanatory variable and the outcome variable “Strip Search”. **Figure 6**, **7**, and **8** displays the joint distributions with a heatmap that demonstrates the frequency of the joint conditional probability for each category.

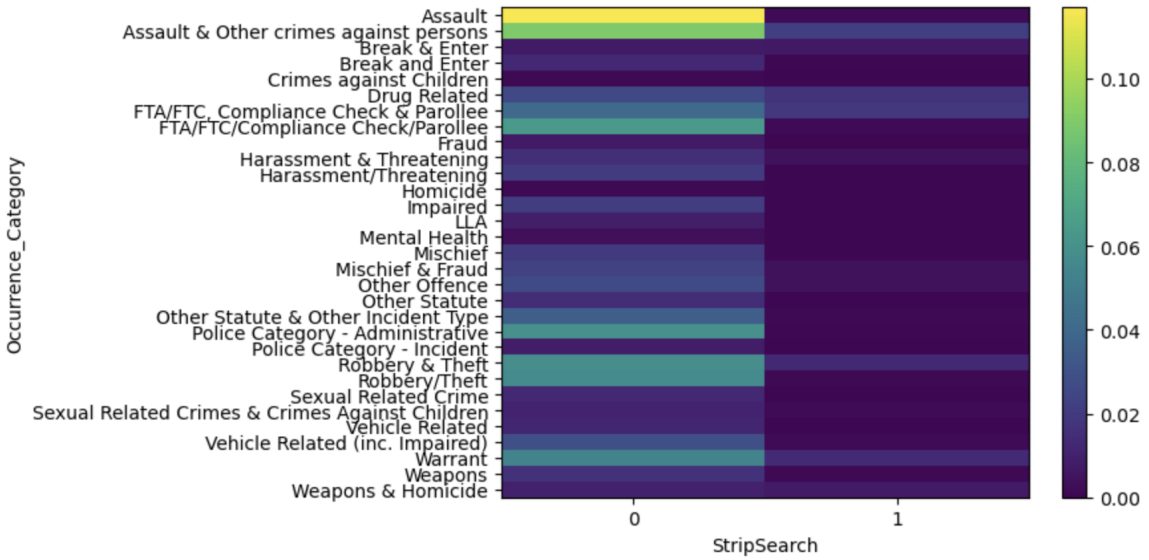

Figure 6: Heat map for frequency of joint distributions for Occurrence Category and Strip Search.

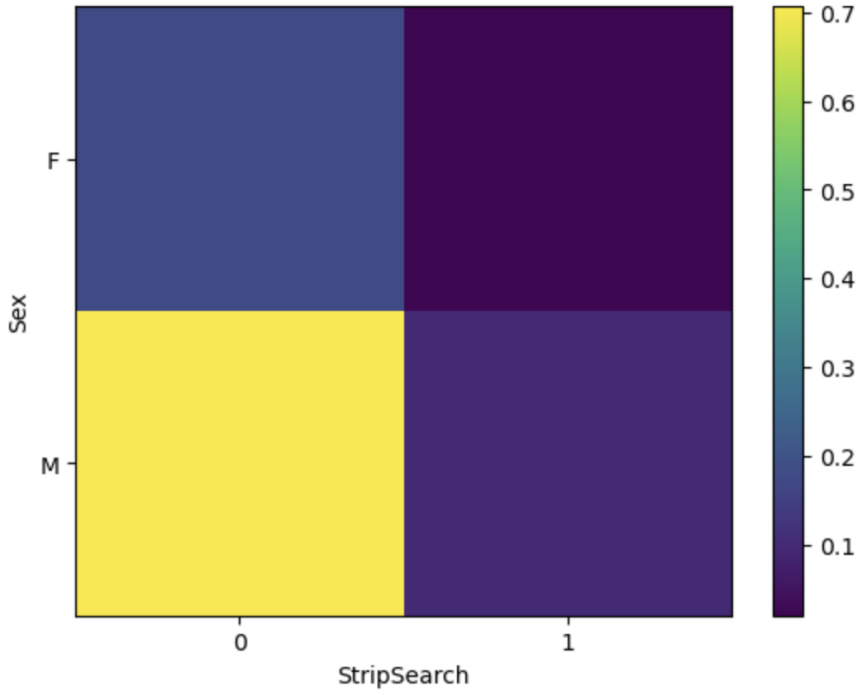

Figure 7: Heat map for frequency of joint distributions for Sex and Strip Search.

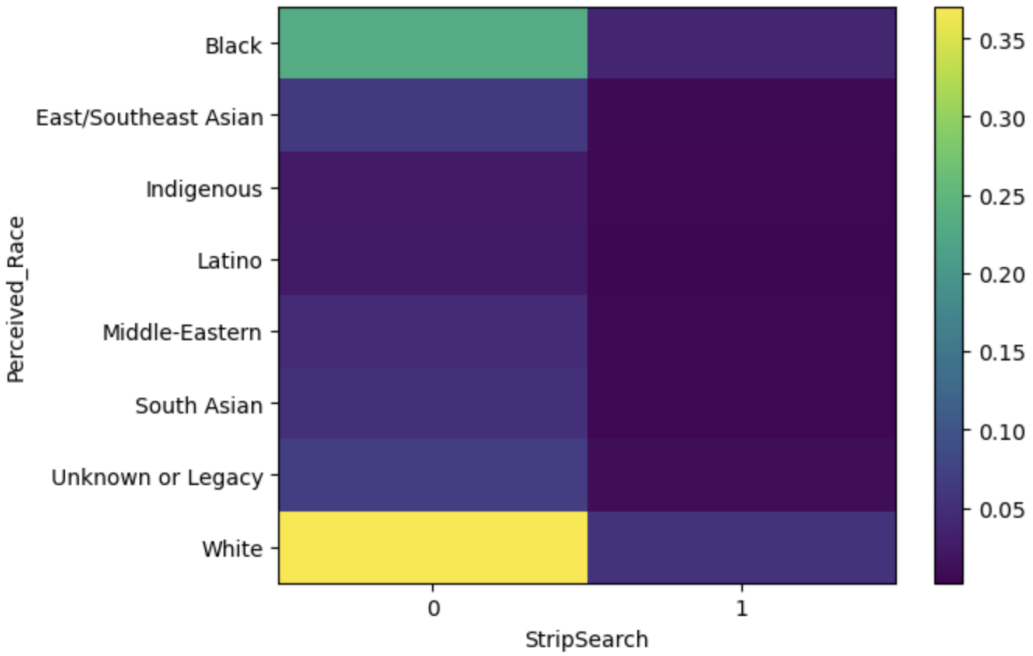

Figure 8: Heat map for frequency of joint distributions for Perceived Race and Strip Search.

Joint Marginal Frequency Distributions

"Occurrence Category" and "Perceived Race" are categorical variables with a high spread through the population of the dataset; so we calculated the joint marginal distributions for both variables with "StripSearch". After determining the frequency of each occurrence category, we sliced it by the "StripSearch" variable levels to see if there were any interesting patterns.

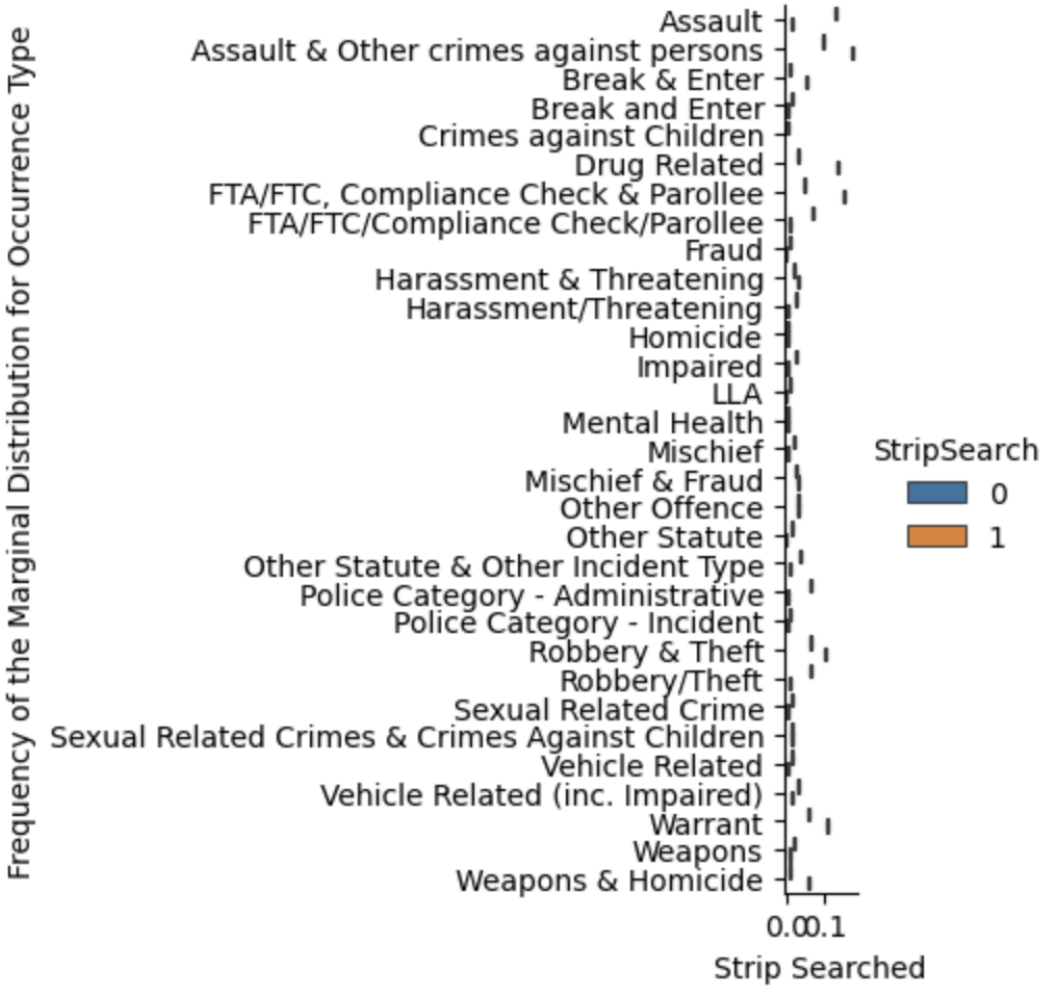

Figure 9: Frequency of joint distributions for Occurrence Type and Strip Search.

Figure 9 demonstrates the frequency of joint distribution across occurrence categories. There are several occurrence category levels that are interesting to explore further in regards to the variance between arrests involving strip-searches or not. It is clear from **Figure 9** that a few categories have a higher probability of getting strip-searched than most categories. Examples of such categories are "Break and Enter," "Weapons and Homicide," and "Drug-Related." For each of these three types of offences, is there a disparity between men and women involving the probability of being strip-searched during an arrest?

Figure 10 reveals several levels of perceived race and that some levels are more susceptible to the probability of being strip-searched during an arrest,

specifically the “Indigenous” level, which is explored further. Indigenous people have a significantly different mean value than the rest of the population that is subjected to strip searches. We are interested in determining whether or not the difference is significant. Our third line of inquiry concerns the possibility that people of indigenous ancestry have a different probability of being strip-searched while being arrested.

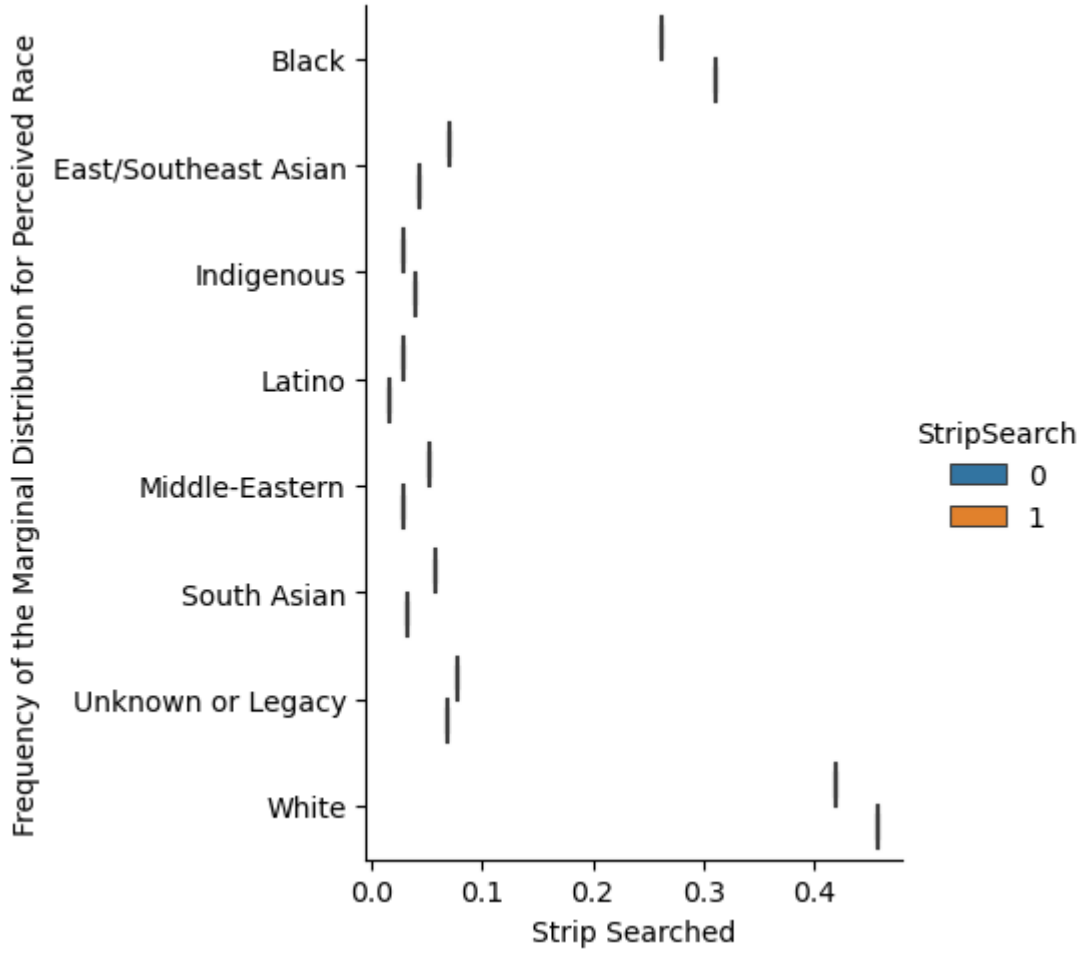

Figure 10: Frequency of joint distributions for Perceived Race and Strip Search.

Evaluation

The evaluation section aims to critically examine the inferences that are present in the EDA; starting with the features of the probability of being strip-searched based on gender.

Two Sample T-Tests: Gender <> Strip-Search

A two-sample t-test is conducted to compare whether males and females have different probabilities of being strip-searched. And the result shows there is a significant difference in the probability of males being strip-searched (M = 0.12) and the probability of females being strip-searched (M = 0.10); t = 6.87, p= < 0.05. This indicates that we have sufficient evidence to reject the null hypothesis and continue the line of inquiry to explore it further.

Question: *Is there any difference between the probability of males and females being strip-searched?*

Null hypothesis: *Males and females are equally likely to be strip-searched.*

Alternative hypothesis: *Males and females are NOT equally likely to be strip-searched.*

Male Strip Search Probability	0.123799
Female Strip Search Probability	0.101688

Table 1: The probability of being searched based on gender.

Two-Sample T-Test	P-Value	T-Stat
M and F Strip Search	6.1039305439141965e-12	6.878475003915285

Table 2: P-value and t-stat for being strip-searched across gender.

Two Sample T-Tests: Gender <> Strip-Search Levels

Once we were able to prove that foundational aspect, we isolated three different levels from Occurrence Type. Three two-sample t-tests were used to determine if there is a difference in the probability of being strip-searched in three specific occurrence categories based on gender separately.

Question: *Is there any difference between the probability of males and females being strip-searched in a specific category?*

Null hypothesis: *Males and females are equally likely to be strip-searched in a specific occurrence category.*

Alternative hypothesis: *Males and females are NOT equally likely to be strip-searched in a specific occurrence category.*

Two-Sample T-Test for M and F	P-value	T-stat
Break & Enter	0.3202160903766334	0.9945553328498329
Weapons & Homicide	0.06617687652990255	1.8390474854709176
Drug Related	0.02263760005938303	2.2807811177307027

Table 3: P-value and t-stat for male and female in three categories

After doing three two-sample t-tests, the test statistics and p-values are recorded in **Table 3**. We observe that only the “Drug Related'' category has a p-value smaller than the significance level of 0.05, this indicates sufficient evidence to reject the null hypothesis of the “Drug Related” category and conclude that there is a difference between men (mean= 0.40) and women (mean = 0.34) who are subjected to a strip search in this category. At the same time, the other two test results do not have p-values small enough to allow us to reject the null hypothesis, which means there is no evidence to show that there exists a difference between the probability of men and women being strip-searched if they arrest by reason of ”Break & Enter” and “Weapons & Homicide.”

Two-Sample T-Tests: Perceived Race Level and Indigenous Peoples

Finally, the last feature to scrutinize is discovering if the TPS may have an inherent bias towards individuals who are perceived as Indigenous compared to all other races. Using a two-sample t-test, we determined that there is a difference, and the p-value is significantly smaller than the significance level of 0.05. We may therefore reject the null hypothesis and conclude that there is a difference in how arrestees who are also Indigenous have an increased probability that they are strip-searched during an arrest.

Question: *Is there any difference between the probability of Indigenous and all other races being strip-searched?*

Null hypothesis: *Indigenous and all other races are equally likely to be strip-searched.*

Alternative hypothesis: *Indigenous and all other races are NOT equally likely to be strip-searched.*

Two-Sample T-Test for M and F	P-value	T-stat
Indigenous and rest races	2.2002889080215823e-06	4.747807831464853

Table 4: P-value and t-stat for indigenous and other race

Two-Way ANOVA

A two-way ANOVA was performed to analyze the effect of “Perceived Race” and gender on the probability of someone being strip-searched. A two-way ANOVA revealed that there is an **increase** in the statistically significant interaction between the effects of “Perceived Race” and “Sex” (F(7, 65247) = [1.470645e+06], p = < .001).

Simple main effects analysis showed that “Sex” does have a statistically significant effect on the probability of being strip-searched during an arrest (p = <.001). Finally, the simple main effects analysis showed that “Perceived_Race” does not have a statistically significant effect on the probability of being strip-searched during an arrest.

Two-Sample T-Test for M and F	Sum_Sq	df	F	PR(>F)
Perceived_Race	1563.389203	7.0	1.470645e+06	0.000000e+00
Sex	0.005562	1.0	3.662757e+01	1.437717e-09
Perceived_Race:Sex	4.351610e+00	7.0	2.100873e+01	1.815692e-28

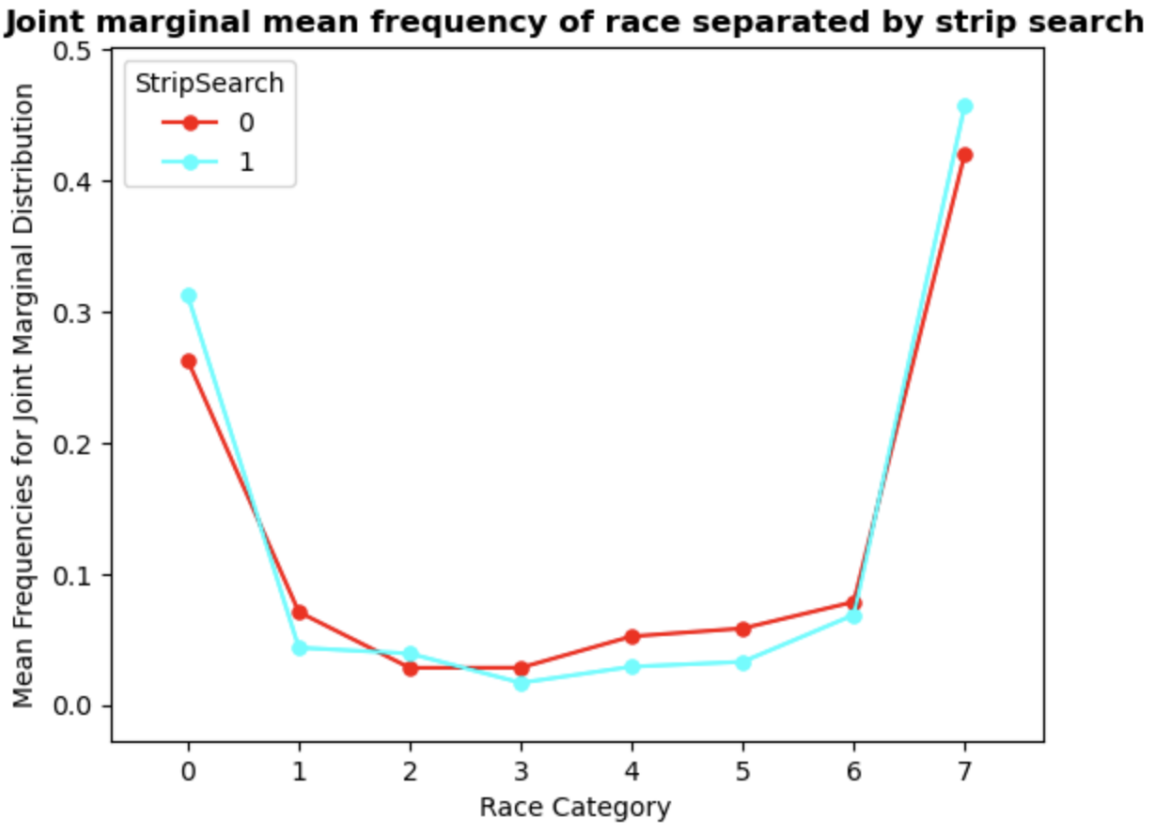

Figure 11: An interaction plot for Joint marginal mean frequency of race based on the probability of being strip-searched during an arrest.

Conclusion and Discussion

The statistical analysis draws upon several conclusions, the first of which is that the likelihood of being subjected to a strip search varies by gender. There is a considerable difference between males and females in the total rate of strip searches. But there may not be a significant difference in certain specific reasons for arrest. Second, we were surprised to see that the likelihood of being strip-searched varied by race. Indigenous persons in Toronto were more likely to be subjected to a strip search than the general population. This reveals that the Toronto Police Department may have certain prejudices.

Some limitations exist while we perform various tests, such as skipping the assumption check part before doing the tests, which may cause incorrect conclusions about the relationship between variables, and may increase the likelihood of a Type I error, and decrease the power of our conclusions.

In summary, further analysis regarding the Two-way ANOVA reveals that there is an increase in the probability of being strip-searched based on the intersection of gender and race, but not race alone. The conclusions in this paper are limited, and further research is required into which combination of levels affects that increase for which gender and which perceived race of an arrestee.