UM–SJTU Joint Institute

Probabilistic Methods in Engineering (Ve401)

Term Project 2

Police Shootings in the U.S.

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Group 39

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Abstract

In this project, the analysis of fatal police shooting is performed. The goodness-of-fit test is performed to find that the data follows a poisson distribution in 2015-2018. Moreover, using the chi-squared test for independence, we find that the average number of fatal police shootings depends on weekdays. Next, a confidence interval for parameter k of the poisson distribution is derived and calculated using the data from 2015 to 2018. We also use the data from Jan. 1, 2019 to Feb. 14, 2019 to investigate whether it follows a poisson distribution. Since we cannot reject the hypothesis that it follows a poisson distribution, we say that it follows distribution. Finally, a prediction interval for the number of mass shootings is obtained using the Nelson's formula and a plot for the estimated data and prediction interval is given.

Key words: Statistics · Hypothesis Test · fatal police shooting in the US

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1 Source of Data

The data of fatal police shooting in the United States are collected by The Washington Post since Jan.1, 2015. Julie Tate, along with her collegues, explained in an article published in 2016, ”How The Washington Post is examining police shootings in the United States”, that in 2015, The Post gathered various details about killing by ”culling local news reports, law enforcement websites and social media” (Tate). They also utilized ”independent databases such as Killed by Police and Fatal Encounters” and ”conducted additional reporting in many cases” (Tate). In 2016, the Post improved their collection by adding more information, such as the officers’ names, and requiring more open-records from the departments for each fatal shooting. In the article, it can be seen that The Post has been seeking assistence from the public as well. The database is recognized as a more complete database, compared with the one FBI has established.

It is also worth noticing that the term ”fatal police shooting” here only refers to ”those shootings in which a police officer, in the line of duty, shoots and kills a civilian” (Tate). The database excludes the situations such as deaths when being held in custody by police and ”fatal shootings by off-duty officers or non-shooting deaths” (Tate).

2 Police Homicides in the US Each Day

Figure (2.1) shows the number of homicides each day between January 1^{st} 2015 and December 31^{st} 2018 in the US. There have been 3943 homicides in total during these 1461 days. There are only 108 days having no homicide at all. And surprisingly, there is one day with 10 homicides and three days with 9 homicides.

It is noteworthy that 2016 is a leap year, which means there are 29 days in February 2016. We include the extra day to make our data more complete and also pay attention when we are assigning weekdays to those three years.

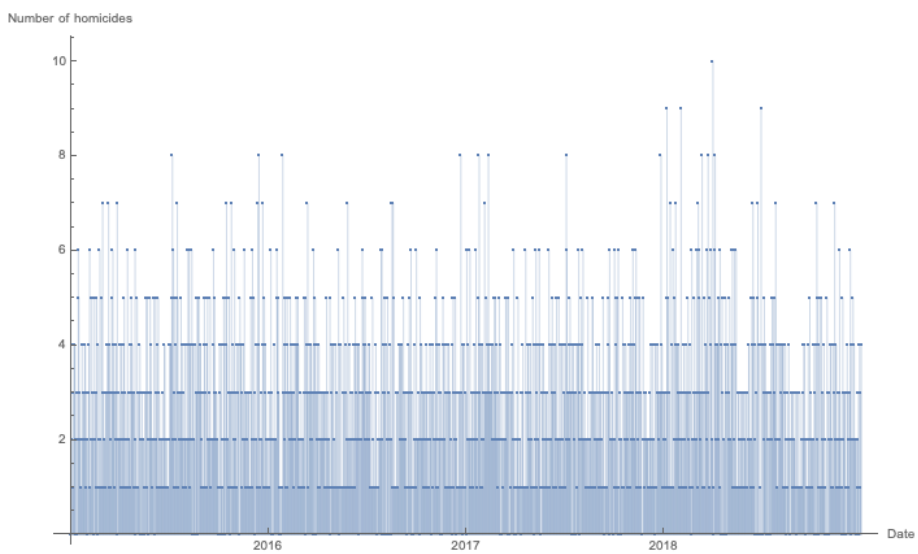

Figure 2.1: Number of homicides recorded each day in US between January 1^{st} 2015 and December 31^{st} 2018

3 Goodness of Fit Test for the Poisson Distribution

In order to investigate whether the data follows a Poisson distribution over the three years, we use the goodness of fit test for the poisson distribution. For the sample, the following number of deaths are observed:

Number of deaths	Observed days
0	108
1	287
2	324
3	310
4	227
5	116
6	53
7	21
8	11
9	3
10	1

The parameter k for the Poisson distribution is estimated using the sample

$$\hat{k} = \bar{X} = \frac{1}{1461}(1 \times 287 + 2 \times 324 + 3 \times 310 + 4 \times 227 + 5 \times 116 \\ + 6 \times 53 + 7 \times 21 + 8 \times 11 + 9 \times 3 + 10 \times 1). \tag{3.1}$$

Then we have

$$\hat{k} = 2.69884 \,. \tag{3.2}$$

Next, We calculate

$$\begin{aligned}
P[X=0] &= \frac{e^{-\hat{k}}\hat{k}^0}{0!} = 0.0673; \\
P[X=1] &= \frac{e^{-\hat{k}}\hat{k}^1}{1!} = 0.1816; \\
P[X=2] &= \frac{e^{-\hat{k}}\hat{k}^2}{2!} = 0.2450; \\
P[X=3] &= \frac{e^{-\hat{k}}\hat{k}^3}{3!} = 0.2204; \\
P[X=4] &= \frac{e^{-\hat{k}}\hat{k}^4}{4!} = 0.1487; \\
P[X=5] &= \frac{e^{-\hat{k}}\hat{k}^5}{5!} = 0.0803; \\
P[X=6] &= \frac{e^{-\hat{k}}\hat{k}^6}{6!} = 0.0361; \\
P[X=7] &= \frac{e^{-\hat{k}}\hat{k}^7}{7!} = 0.0139; \\
P[X=8] &= \frac{e^{-\hat{k}}\hat{k}^8}{8!} = 0.0047; \\
P[X=9] &= \frac{e^{-\hat{k}}\hat{k}^9}{9!} = 0.0014; \\
P[X=10] &= \frac{e^{-\hat{k}}\hat{k}^{10}}{10!} = 0.0004 \,.
\end{aligned} \tag{3.3}$$

Thus we have

Number of deaths	Observed days	Expected days
0	108	98.3
1	287	265.3
2	324	358.0
3	310	322.0
4	227	217.3
5	116	117.3
6	53	52.8
7	21	20.3
8	11	6.9
9	3	2.1
10	1	0.7

However, we see that $E_9, E_{10} < 5$. Althought this meets the requirement of the Pearson's test: $Ei \geq 5$ for 80% of the data, but we would like to make the result more accurate. We thus combine the last two categories:

Number of deaths	Observed days	Expected days
0	108	98.3
1	287	265.3
2	324	358.0
3	310	322.0
4	227	217.3
5	116	117.3
6	53	52.8
7	21	20.3
8	11	6.9
9 or more	4	2.8

We plot the obtained data in Figure (3.1) and (3.2).

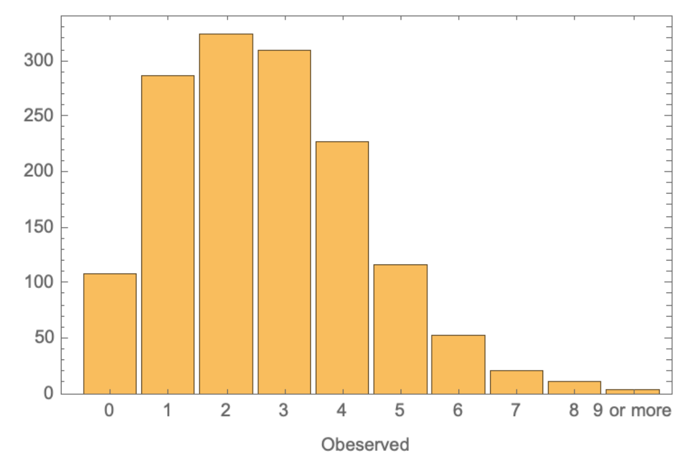

Figure 3.1: Frequency of occurrence of days in the US(observed)

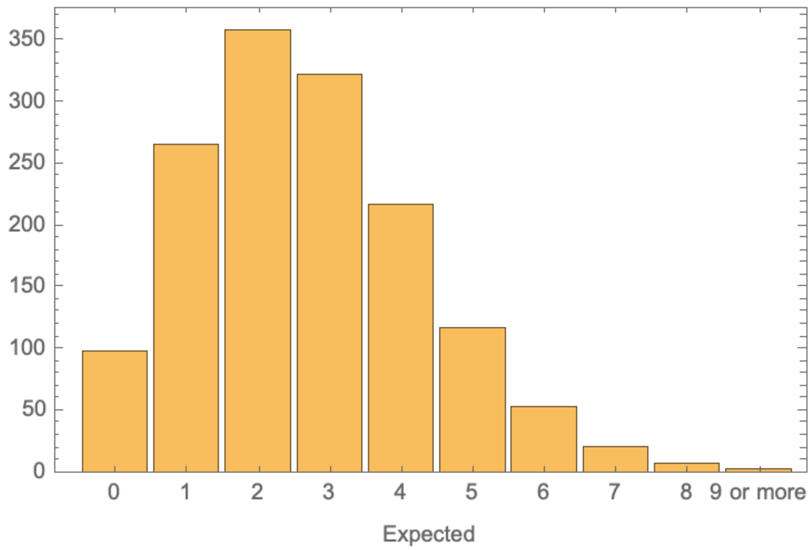

Figure 3.2: Frequency of occurrence of days in the US(expected)

We test in the three years 2015-2018,

$$H_0 : \text{The occurrence of police shootings in the US follows a Poisson distribution,} \tag{3.4}$$

which is equivalent to the test whether the number of police shootings follows a categorical distribution with parameters (98.3, 265.3, 358, 322, 217.3, 117.3, 52.8, 20.3, 6.9, 2.8). We have the following category:

Category	Number of deaths	Observed days	Expected days
1	0	108	98.3
2	1	287	265.3
3	2	324	358.0
4	3	310	322.0
5	4	227	217.3
6	5	116	117.3
7	6	53	52.8
8	7	21	20.3
9	8	11	6.9
10	9 or more	4	2.8

Since we know

$$X^2 = \sum_{i=1}^{10} \frac{(O_i - E_i)^2}{E_i} = 9.83 \tag{3.5}$$

follows a chi-squared distribution with $N - 1 - m = 10 - 1 - 1 = 8$ degrees of freedom. Assume $\alpha = 0.05$, we have

$$\chi^2_{0.05,8} = 15.5\ . \tag{3.6}$$

Therefore we are unable to reject H_0 at 5% level of significance.

From the table we have

$$\chi^2_{0.25,8} = 10.2, \qquad \chi^2_{0.1,8} = 13.4. \tag{3.7}$$

Thus, the P-value of is approximately 0.2 . In this case, we have reason to believe that the occurrence of police shootings in the US follows a poisson distribution in year 2015-2018.

4 Relationship Between Police Homicides & Weekday and Month

Figure (4.1) and (4.2) show the distribution of homicides by weekday and month.

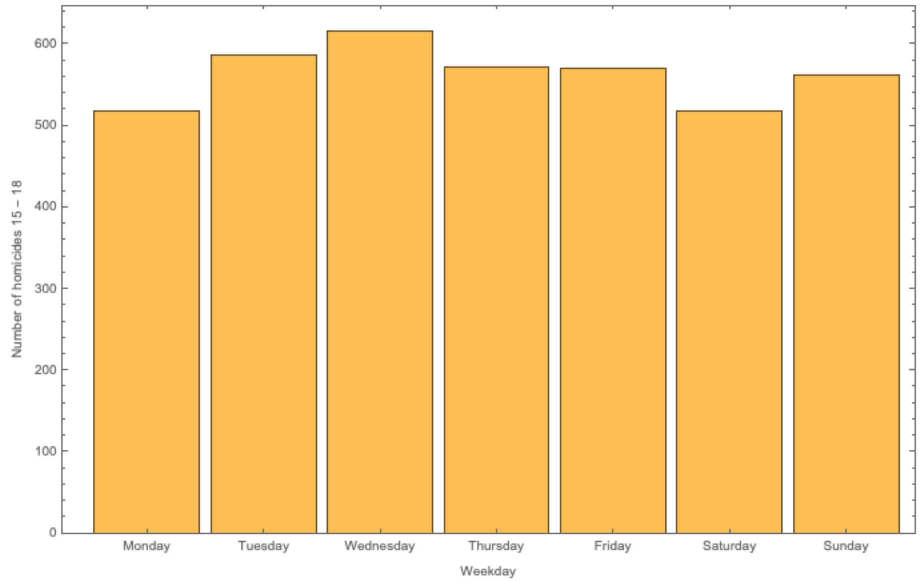

Figure 4.1: Number of occurrence of homicides on different weekdays in the US between January 1^{st} 2015 and December 31^{st} 2018

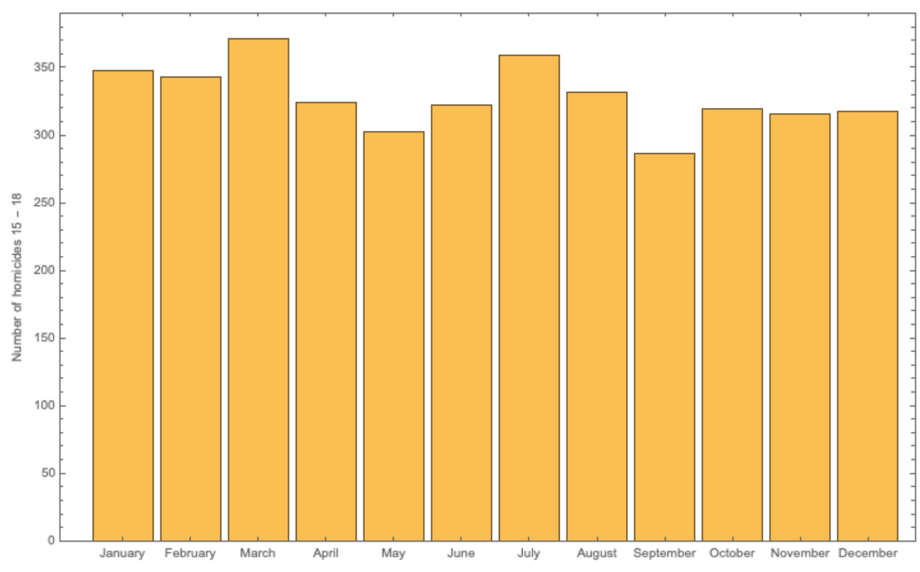

Figure 4.2: Number of occurrence of homicides on different months in the US between January 1^{st} 2015 and December 31^{st} 2018

It is intuitive to give a hypothesis that the occurrence of negative behaviors is related to the weekday. For example, it is seemingly reasonable to state that the cars produced on Monday will have higher probability to have failure because workers may not be in the mood for working after a weekend. In the case of police homicides, we first give an intuitive guess and then test it using scientific way.

We are interested in whether the average numbers of police shootings depend on weekdays. So we perform an Pearson's Chi-squared Goodness-of-fit test to see whether these data conform to a discrete nearly uniform distribution on Ω=(Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday).

Let $(X_1, X_2, X_3, X_4, X_5, X_6, X_7)$ denotes the number of police shootings on Monday to Sunday and $X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 = 3943$. We would like to analyze the distribution of this random vector. Denote the probability of a police shooting occurring on the given day by p_i, $i = 1, ..., 7$ and $p_1 + ... + p_7 = 1$. Since the total number of Mondays in those three years may be different from that of Tuesdays (and analogously for other weekdays), the distribution is nearly but not uniform exactly. The total numbers of Mondays to Sundays between 2015 and 2018 are listed as follows.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
Total number of days	209	208	208	209	209	209	209	1461

Therefore, we set the null hypothesis to be

$$H_0: \text{ the data follow a multinomial distribution}$$
$$\text{with parameters } (p_1, .., p_7) = (\frac{209}{1461}, \frac{208}{1461}, \frac{208}{1461}, \frac{209}{1461}, \frac{209}{1461}, \frac{209}{1461}, \frac{209}{1461}).$$

The observed occurrence, observed frequency, expected frequency is listed as follow.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Observed occurrence(O_i)	517	586	616	573	572	518	561
Expected occurrence(E_i)	564.1	561.4	561.4	564.1	564.1	564.1	564.1

Table 4.1: Observed and expected frequency of police homicides in 2015-2018.

We see that $E[X_i] \geq 5$ for all $i = 1, ..., 7$, which means that the sample size is large enough to ensure the observed test statistic

$$X^2_{7-1} = \sum_{i=1}^{7} \frac{(O_i - E_i)^2}{E_i} = \frac{(517 - 564.1)^2}{564.1} + \frac{(586 - 561.4)^2}{561.4} + ... + \frac{(561 - 564.1)^2}{564.1} = 14.357$$

follow a chi-squared distribution with 6 degree of freedom.

Since $\chi^2_{0.05,6} = 12.59$, the P-value is less than 5%. Therefore, we can reject H_0 at the 5% level of significance. There is reason to believe that the average number of police homicides depends on weekdays.

5 Confidence Interval for Parameter k of a Poisson Distribution

Let $X_1, \cdot, X_n$ be a random sample of size n from a Poisson distribution of parameter k, that is to say with mean $\mu = k$ and variance $\sigma^2 = k$. Since the sample size n is large enough, we assume $\overline{X}$ is normally distributed, with mean k and variance k/n. Therefore,

$$Z = \frac{\overline{X} - k}{\sqrt{k/n}}. \tag{5.1}$$

So the $100(1 - \alpha)\%$ confidence interval for $\overline{X}$(which is the estimator of k, denoted by $\hat{k}$ form now on) is given by

$$\hat{k} \pm z_{\alpha/2}\sqrt{k/n}. \tag{5.2}$$

We can see that the interval depends on an unknown parameter k here. If we simple replace k by $\hat{k}$, the number $z_{\alpha/2}$ is no longer accurate. However, since the sample size n is large enough to allow the central limit theorem to hold, then the difference between $z_{\alpha/2}$ and the true value is negligible. Finally we obtain our $100(1-\alpha)\%$ confidence interval for k, given by

$$\hat{k} \pm z_{\alpha/2}\sqrt{\hat{k}/n}. \tag{5.3}$$

Now we calculate the interval using the data of the years 2015 to 2018. From Equation (3.2) gives $k = 2.69884$ and $n = 1461$. So a 95% confidence interval is given by

$$2.69884 \pm 1.96\sqrt{2.69884/1461}, \qquad \text{or} \qquad 2.699 \pm 0.084. \tag{5.4}$$

We estimate the data from Jan 1, 2019 to Feb 14, 2019, totally 45 days to test whether it follows a Poisson distribution. For the sample, the following number of deaths are observed:

Number of deaths	Observed days
0	3
1	14
2	9
3	7
4	6
5	5
6	0
7	0
8	0
9	1

The parameter k for the Poisson distribution is estimated using the sample

$$\hat{k} = \bar{X} = \frac{1}{45}(1 \times 14 + 2 \times 9 + 3 \times 7 + 4 \times 6 + 5 \times 5 + 9 \times 1) = 2.46667 \tag{5.5}$$

We combine the categories with 4 or more observed shootings.

$$\begin{aligned}
P[X=0] &= \frac{e^{-\hat{k}}\hat{k}^0}{0!} = 0.0849 \\
P[X=1] &= \frac{e^{-\hat{k}}\hat{k}^1}{1!} = 0.2093 \\
P[X=2] &= \frac{e^{-\hat{k}}\hat{k}^2}{2!} = 0.2582 \\
P[X=3] &= \frac{e^{-\hat{k}}\hat{k}^3}{3!} = 0.2123 \\
P[X \geq 4] &= \sum_{i=5}^{\infty} \frac{e^{-\hat{k}}\hat{k}^i}{i!} = 0.2353
\end{aligned} \tag{5.6}$$

Therefore we have the expected values.

Number of deaths	Observed days	Expected days
0	3	3.82
1	14	9.42
2	9	11.62
3	7	9.55
4 or more	12	10.59

Then we have

$$X^2 = \sum_{i=1}^{6} \frac{(O_i - E_i)^2}{E_i} = 3.862 \tag{5.7}$$

follows a chi-squared distribution with $N - 1 - m = 5 - 1 - 1 = 3$ degrees pf freedom. Assume $\alpha = 0.05$, we have $\chi^2_{0.05,3} = 7.82$. Since $3.862 < 7.82$, we are unable to reject H_0 at 5% level of significance. Then we may say that it follows a Poisson distribution.

6 Nelson's Formula and Prediction Intervals

Let X be the total count in a sample of size n from a Poisson distribution with mean λ. We note that $X \sim$ Poisson $(n\lambda)$. Let Y denote the future total counts that can be observed in a sample size m from the same Poisson distribution so that $Y \sim$ Poisson $(m\lambda)$. We first define the estimator of λ, $\widehat{\lambda}$ as

$$\widehat{\lambda} = \frac{X}{n} \tag{6.1}$$

which can be proved to be an unbiased estimator as

$$\mathrm{E}[\widehat{\lambda}] = \frac{n\lambda}{n} = \lambda\,. \tag{6.2}$$

Also, we have the estimator of Y as

$$\widehat{Y} = \frac{mX}{n} \tag{6.3}$$

which can also be proved to be an unbiased estimator as

$$Y - \mathrm{E}[\widehat{Y}] = m\lambda - \frac{m}{n}\mathrm{E}[X] = m\lambda - \frac{m}{n} \cdot n\lambda = 0\,. \tag{6.4}$$

From the basic properties of Poisson distribution, we have

$$\begin{aligned} \mathrm{E}[X] = n\lambda \quad &\& \quad \mathrm{E}(Y) = m\lambda\,, \\ \mathrm{Var}(X) = n\lambda \quad &\& \quad \mathrm{Var}(Y) = m\lambda\,. \end{aligned} \tag{6.5}$$

Hence we can deduce that

$$\mathrm{E}(m\widehat{\lambda} - Y) = \frac{m}{n}n\lambda - m\lambda = 0 \tag{6.6}$$

and since X and Y are independent, *i.e.*, $\mathrm{Cov}(X,Y) = 0$, we have

$$\begin{aligned} \mathrm{Var}(m\widehat{\lambda} - Y) &= \mathrm{Var}(\frac{m}{n}X - Y) \\ &= \frac{m^2}{n^2}\mathrm{Var}(X) + \mathrm{Var}(Y) \\ &= \frac{m^2}{n^2} \cdot n\lambda + m\lambda \\ &= m^2\lambda(\frac{1}{n} + \frac{1}{m})\,, \end{aligned} \tag{6.7}$$

and immediately we have $\widehat{\mathrm{Var}}(m\widehat{\lambda}) = m^2\widehat{\lambda}(1/n + 1/m)$. From Central Limit Theorem, we have

$$\frac{m\widehat{\lambda} - Y}{\sqrt{\widehat{\mathrm{Var}}(m\widehat{\lambda} - Y)}} \tag{6.8}$$

follows a standard normal distribution. Thus a $100(1-\alpha)\%$ prediction interval is given by

$$\widehat{Y} \pm z_{\alpha/2}\sqrt{m\widehat{Y}\left(\frac{1}{m} + \frac{1}{n}\right)}\,, \tag{6.9}$$

which is valid under the assumption of large sample sizes. This prediction interval is called Nelson's prediction interval. Note that the prediction interval given above is not defined when $X = 0$. A commonly used adjustment to handle this extreme case is to set $\widehat{Y} = 0.5m/n$ when $X = 0$.

Then, we can use the data from 2015 to 2018 to predict the number of police shooting in 2019. Using the method of maximum likelihood, we know that the estimator $\widehat{k}$ for a Poisson distribution is the mean $\bar{x}$. Therefore, given the data from 2015 to 2018, we can calculate the value of n and the estimate for k as

$$\begin{aligned} n &= 365 \times 3 + 366 = 1461 \\ \widehat{k} &= \frac{X}{n} = \frac{3943}{1461} = 2.69884, \end{aligned} \tag{6.10}$$

where k is just λ in Nelson's prediction interval. Also, we can express the estimator for Y by equation

$$\widehat{Y} = \widehat{\lambda}\, m\,. \tag{6.11}$$

We first plot the estimated data for the number of police shootings in 2019 as well as its 95% prediction interval. Note that since we are predicting a discrete random variable, the prediction interval is formed by the set of integer values and is given by

$$[\lceil L \rceil\,,\, \lfloor U \rfloor] \tag{6.12}$$

where L denotes the lower bound of Equation 6.9, U the upper bound of Equation 6.9, $\lceil x \rceil$ is the smallest integer greater than or equal to x, $\lfloor x \rfloor$ is the largest integer less than or equal to x. Also, the estimated data is formed by the set of integer values, which are rounded to the nearest integer after being calculated by Equation 6.11. The graph is shown in Figure 6.1.

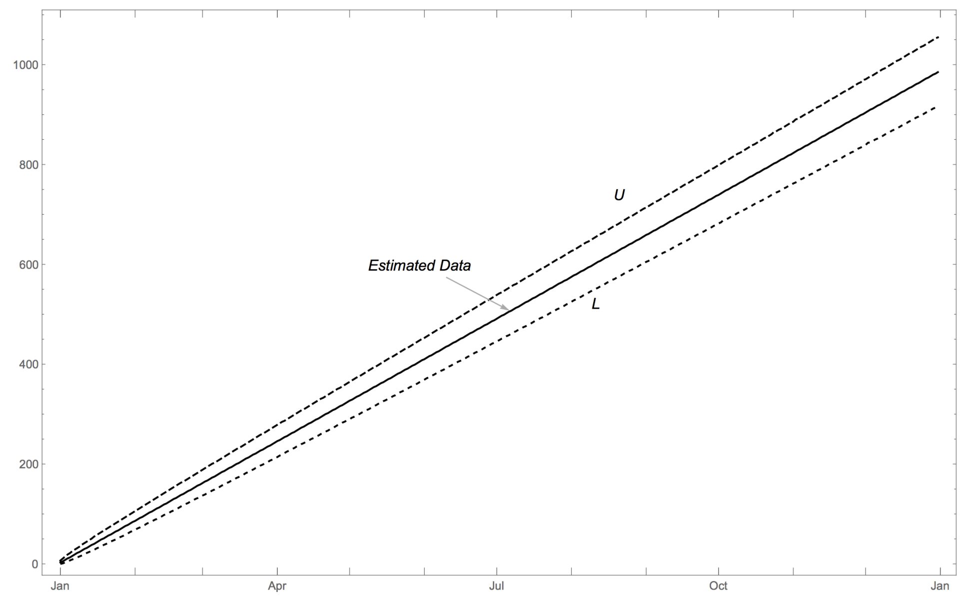

Figure 6.1: Estimated data for the number of police shootings in 2019 as well as its 95% prediction interval

The result shows that we are 95% sure that the true results will be within this interval. We can see from the graph that the estimated data, upper and lower bounds are all approximately straight lines, which is due to the fact that we have to round the number for murders of each day, since that number must be an integer. Moreover, as we have the real data from January 1st, 2019 to February 14th, 2019, we can compare them with our estimated data and the prediction interval, to see that whether our estimation and prediction correspond to the reality. We plot the real data, our estimated data and the prediction interval together in Figure 6.2.

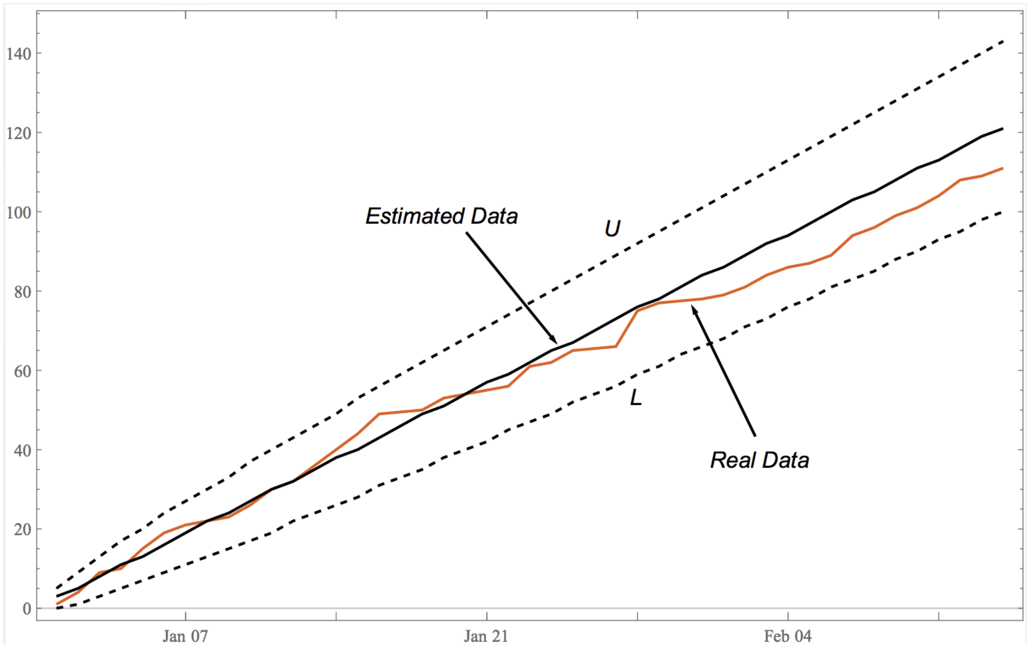

Figure 6.2: Real data, estimated data and the prediction interval from 1/1/2019 to 2/14/2019

The result shows that the real data roughly corresponds to our estimated data we obtain from Equation (6.11), although they have a trend to differ more greatly as time passes by. Besides, they are always within the prediction interval given by Equation (6.9). From the caluculation from Equation (5.5), we get k =2.46667, which is smaller than the value we used here. Therefore, the estimated data is sightly larger than the real data. Hence, we can conclude that our estimation and prediction are appropriate so far. Further conclusion can be drawn if we have more real data in 2019.

7 Conclusion

Through this project, we practice the knowledge we learned in class. In the first six questions, we use the methodology learned from multiple sources to analyze the distribution of police homicides in US and we get the results that it follows a Poisson Distribution. In the last problem, we make a prediction of number of police homicides in 2019 in US and give a 95% prediction interval. During this whole project, we deepened our understanding of statistical methods in research and we made use of tools such as Mathematica to help us analyze data, which is a precious experience for us engineers.

What's more, from this project, we know that there are actually plenty of murders around the world. For example, in US, there are almost 3 people died a day just because of police homicide. This project definitely reminds us to cherish the priceless safety we have in China.

8 Reference

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9 Appendix

Python codes for data processing

```
import qrcode
import xlrd
from PIL import Image,ImageDraw,ImageFont
data = xlrd.open_workbook('fatal-police-shootings-data.xlsx')
table = data.sheets()[1]
dates = table.col_values(0, start_rowx=0, end_rowx=None)
date_num = {}
for date in dates:
    if (date not in date_num.keys()):
        date_num.update({date: dates.count(date)})
print(date_num)
numbers = list(date_num.values())
total = 0
for i in range(15):
    total += i * numbers.count(i)
print(total)
```

Mathematica codes for plotting

Plotting Fig 2.1

```
In[1]:= ListPlot[Data, Filling -> Axis, PlotStyle -> PointSize[Small],
         Ticks -> {{{365, "2016"}, {731, "2017"}, {1096, "2018"}}, Automatic},
          AxesLabel -> {"Date", "Number of homicides"}]
```

Plotting Fig 4.1

```
In[2]:= BarChart[{517, 586, 616, 573, 572, 518, 561},
         ChartLabels -> {Monday, Tuesday, Wednesday, Thursday, Friday,
           Saturday, Sunday}, Frame -> True,
         FrameLabel -> {"Weekday", "Number of homicides 15 - 18"}]
```

Plotting Fig 4.2

```
In[3]:=  BarChart[{348, 343, 371, 324, 302, 322, 359, 332, 286, 319, 316, 317},
          ChartLabels -> {January, February, March, April, May, June, July,
```

```
    August, September, October, November, December}, Frame -> True,
  FrameLabel -> {"Month", "Number of homicides 15 - 18"}]
```

Plotting Fig 6.1 and 6.2

```
In[4]:= DateListPlot[{estimated, lowerbound, upperbound}]
        DateListPlot[{rawdata, estimated, lowerbound, upperbound}]
```

Data for plotting Figure(6.1) and (6.2)

Date	Real	Estimated	Lowerbound	Upperbound
2019/1/1	1	3	0	5
2019/1/2	4	5	1	9
2019/1/3	9	8	3	13
2019/1/4	10	11	5	17
2019/1/5	15	13	7	20
2019/1/6	19	16	9	24
2019/1/7	21	19	11	27
2019/1/8	22	22	13	30
2019/1/9	23	24	15	33
2019/1/10	26	27	17	37
2019/1/11	30	30	19	40
2019/1/12	32	32	22	43
2019/1/13	36	35	24	46
2019/1/14	40	38	26	49
2019/1/15	44	40	28	53
2019/1/16	49	43	31	56
2019/1/17	49	46	33	59
2019/1/18	50	49	35	62
2019/1/19	53	51	38	65
2019/1/20	54	54	40	68
2019/1/21	55	57	42	71
2019/1/22	56	59	45	74
2019/1/23	61	62	47	77
2019/1/24	62	65	49	80
2019/1/25	65	67	52	83
2019/1/26	65	70	54	86
2019/1/27	66	73	56	89
2019/1/28	75	76	59	92
2019/1/29	77	78	61	95
2019/1/30	77	81	64	98
2019/1/31	78	84	66	101
2019/2/1	79	86	68	104
2019/2/2	81	89	71	107
2019/2/3	84	92	73	110
2019/2/4	86	94	76	113
2019/2/5	87	97	78	116
2019/2/6	89	100	81	119
2019/2/7	94	103	83	122
2019/2/8	96	105	85	125
2019/2/9	99	108	88	128
2019/2/10	101	111	90	131

2019/2/11	104	113	93	134
2019/2/12	108	116	95	137
2019/2/13	109	119	98	140
2019/2/14	111	121	100	143
2019/2/15		124	102	146
2019/2/16		127	105	149
2019/2/17		130	107	152
2019/2/18		132	110	155
2019/2/19		135	112	158
2019/2/20		138	115	161
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2019/2/24		148	125	172
2019/2/25		151	127	175
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2019/3/3		167	142	193
2019/3/4		170	144	196
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2019/3/6		175	149	201
2019/3/7		178	152	204
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2019/3/9		184	157	210
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2019/3/12		192	164	219
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2019/3/15		200	172	228
2019/3/16		202	174	231
2019/3/17		205	177	233
2019/3/18		208	179	236
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2019/3/20		213	184	242
2019/3/21		216	187	245
2019/3/22		219	189	248
2019/3/23		221	192	251
2019/3/24		224	194	254
2019/3/25		227	197	257
2019/3/26		229	199	259
2019/3/27		232	202	262
2019/3/28		235	204	265
2019/3/29		237	207	268
2019/3/30		240	209	271
2019/3/31		243	212	274
2019/4/1		246	214	277
2019/4/2		248	217	280
2019/4/3		251	219	283
2019/4/4		254	222	285

2019/4/5		256	225	288
2019/4/6		259	227	291
2019/4/7		262	230	294
2019/4/8		264	232	297
2019/4/9		267	235	300
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2019/4/11		273	240	306
2019/4/12		275	242	308
2019/4/13		278	245	311
2019/4/14		281	247	314
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2019/4/16		286	252	320
2019/4/17		289	255	323
2019/4/18		291	257	326
2019/4/19		294	260	329
2019/4/20		297	262	331
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2019/4/22		302	267	337
2019/4/23		305	270	340
2019/4/24		308	272	343
2019/4/25		310	275	346
2019/4/26		313	278	349
2019/4/27		316	280	351
2019/4/28		318	283	354
2019/4/29		321	285	357
2019/4/30		324	288	360
2019/5/1		327	290	363
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2019/5/3		332	295	369
2019/5/4		335	298	372
2019/5/5		337	300	374
2019/5/6		340	303	377
2019/5/7		343	305	380
2019/5/8		345	308	383
2019/5/9		348	310	386
2019/5/10		351	313	389
2019/5/11		354	316	392
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2019/5/13		359	321	397
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2019/5/21		381	341	420
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2019/5/23		386	346	426
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2019/5/25		391	351	431
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2019/5/27		397	356	437

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2019/5/31	408	366	449
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2019/6/3	416	374	457
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2019/6/6	424	382	466
2019/6/7	426	384	469
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2019/6/12	440	397	483
2019/6/13	443	400	486
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2019/6/15	448	405	491
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2019/6/22	467	423	511
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2019/6/27	480	435	525
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2019/7/16	532	484	579
2019/7/17	534	487	582
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2019/7/27		561	512	610
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2019/7/29		567	517	616
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2019/8/3		580	530	630
2019/8/4		583	533	633
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2019/8/13		607	556	659
2019/8/14		610	558	661
2019/8/15		613	561	664
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2019/8/18		621	569	673
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2019/8/20		626	574	678
2019/8/21		629	576	681
2019/8/22		632	579	684
2019/8/23		634	582	687
2019/8/24		637	584	690
2019/8/25		640	587	693
2019/8/26		642	589	695
2019/8/27		645	592	698
2019/8/28		648	594	701
2019/8/29		650	597	704
2019/8/30		653	600	707
2019/8/31		656	602	710
2019/9/1		659	605	712
2019/9/2		661	607	715
2019/9/3		664	610	718
2019/9/4		667	612	721
2019/9/5		669	615	724
2019/9/6		672	618	726
2019/9/7		675	620	729
2019/9/8		677	623	732
2019/9/9		680	625	735
2019/9/10		683	628	738

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2019/9/12		688	633	743
2019/9/13		691	636	746
2019/9/14		694	638	749
2019/9/15		696	641	752
2019/9/16		699	643	755
2019/9/17		702	646	758
2019/9/18		704	648	760
2019/9/19		707	651	763
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2019/9/21		712	656	769
2019/9/22		715	659	772
2019/9/23		718	661	774
2019/9/24		721	664	777
2019/9/25		723	666	780
2019/9/26		726	669	783
2019/9/27		729	672	786
2019/9/28		731	674	789
2019/9/29		734	677	791
2019/9/30		737	679	794
2019/10/1		739	682	797
2019/10/2		742	684	800
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2019/10/4		748	690	806
2019/10/5		750	692	808
2019/10/6		753	695	811
2019/10/7		756	697	814
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2019/10/13		772	713	831
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2019/10/15		777	718	837
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2019/10/17		783	723	842
2019/10/18		785	726	845
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2019/10/20		791	731	851
2019/10/21		793	733	853
2019/10/22		796	736	856
2019/10/23		799	739	859
2019/10/24		802	741	862
2019/10/25		804	744	865
2019/10/26		807	746	868
2019/10/27		810	749	870
2019/10/28		812	752	873
2019/10/29		815	754	876
2019/10/30		818	757	879
2019/10/31		820	759	882
2019/11/1		823	762	884
2019/11/2		826	764	887

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2019/11/4		831	770	893
2019/11/5		834	772	896
2019/11/6		837	775	899
2019/11/7		839	777	901
2019/11/8		842	780	904
2019/11/9		845	782	907
2019/11/10		847	785	910
2019/11/11		850	788	913
2019/11/12		853	790	915
2019/11/13		856	793	918
2019/11/14		858	795	921
2019/11/15		861	798	924
2019/11/16		864	801	927
2019/11/17		866	803	930
2019/11/18		869	806	932
2019/11/19		872	808	935
2019/11/20		874	811	938
2019/11/21		877	813	941
2019/11/22		880	816	944
2019/11/23		883	819	946
2019/11/24		885	821	949
2019/11/25		888	824	952
2019/11/26		891	826	955
2019/11/27		893	829	958
2019/11/28		896	832	961
2019/11/29		899	834	963
2019/11/30		901	837	966
2019/12/1		904	839	969
2019/12/2		907	842	972
2019/12/3		910	844	975
2019/12/4		912	847	977
2019/12/5		915	850	980
2019/12/6		918	852	983
2019/12/7		920	855	986
2019/12/8		923	857	989
2019/12/9		926	860	991
2019/12/10		928	863	994
2019/12/11		931	865	997
2019/12/12		934	868	1000
2019/12/13		936	870	1003
2019/12/14		939	873	1006
2019/12/15		942	875	1008
2019/12/16		945	878	1011
2019/12/17		947	881	1014
2019/12/18		950	883	1017
2019/12/19		953	886	1020
2019/12/20		955	888	1022
2019/12/21		958	891	1025
2019/12/22		961	894	1028
2019/12/23		963	896	1031
2019/12/24		966	899	1034
2019/12/25		969	901	1036

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2019/12/27		974	906	1042
2019/12/28		977	909	1045
2019/12/29		980	912	1048
2019/12/30		982	914	1051
2019/12/31		985	917	1053