America's Warzone: Modeling Armed Robberies in Chicago

Reuben K. McCreanor[*]
reuben.mccreanor@duke.edu

Anna K. Yanchenko[*]
anna.yanchenko@duke.edu

Lei Qian[*]
lei.qian@duke.edu

Megan S. Robertson[*]
megan.robertson@duke.edu

1 Introduction

The city of Chicago is frequently listed as one of the most dangerous and crime-ridden cities in the US. President Donald Trump frequently discusses the high-rate of crime in Chicago. According to the Chicago Tribune, there were 4,367 shooting victims in Chicago in 2016. In the same year there were also 785 homicides.[2] However, other reports conclude that Chicago should not be called the crime capital?? of America, as Chicago's violence rate is lower than cities like St. Louis and Detroit. [1] The goal of this project was to examine crime in Chicago, specifically armed robberies, from 2012-2016.

2 Data

The crime data used for this project came from the City of Chicago's website. [1] The data contained every reported crime in Chicago from 2001 to the present (Table 1). In addition to the type of crime reported (battery, assault, etc.), there was information on the location and time of the crime. The data set was reduced to only consider armed robberies.

Case Number	Date	Block	Description	Beat	District	Ward	Community Area	Location
HN180091	02/16/2007 03:20:00 PM	012XX W 103RD ST	OTHER WEAPONS VIOLATION	2232	22	21	73	(41.706819022, -87.654048084)
HN184333	02/15/2007 07:00:00 PM	093XX S WOODLAWN AVE	TELEPHONE THREAT	413	4	8	47	(41.725252492, -87.594860893)
HN182527	02/17/2007 09:00:00 PM	042XX S COTTAGE GROVE AVE	OTHER VIOLATION	213	2	4	38	(41.81741558, -87.606719823)
HN183814	02/18/2007 10:06:37 PM	063XX N SHERIDAN RD	TO PROPERTY	2433	24	49	77	(41.996866019, -87.655592844)
HN182579	02/18/2007 12:20:00 AM	033XX W HURON ST	DOMESTIC BATTERY SIMPLE	1121	11	27	23	(41.893682761, -87.710701702)
HN182986	02/18/2007 10:20:00 AM	042XX N CENTRAL AVE	OVER $500	1624	16	38	15	(41.957385814, -87.767141739)
HN183716	02/18/2007 08:40:00 PM	037XX S MICHIGAN AVE	DOMESTIC BATTERY SIMPLE	211	2	3	35	(41.827167256, -87.623160687)
HN184010	02/19/2007 02:40:00 AM	010XX N LAWNDALE AVE	DOMESTIC BATTERY SIMPLE	1112	11	27	23	(41.89998654, -87.71890157)
HN181071	02/17/2007 02:21:00 AM	051XX S CALUMET AVE	POSS FIREARM/AMMO:NO FOID CARD	232	2	3	40	(41.801609105, -87.617736187)
HN182079	02/17/2007 04:00:00 PM	034XX W FLOURNOY ST	DOMESTIC BATTERY SIMPLE	1133	11	24	27	(41.872709648, -87.711929688)
HN184350	02/19/2007 12:00:00 AM	013XX N WOLCOTT AVE	FROM BUILDING	1424	14	1	24	(41.905889056, -87.674299261)
HN184306	02/15/2007 12:01:00 AM	001XX N PARKSIDE AVE	ILLEGAL USE CASH CARD	1512	15	29	25	(41.88301997, -87.766605275)
HN183370	02/09/2007 10:00:00 AM	024XX W DEVON AVE	SIMPLE	2413	24	50	2	(41.99771689, -87.690448237)
HN183500	02/18/2007 05:10:00 PM	070XX S THROOP ST	DOMESTIC BATTERY SIMPLE	734	7	17	67	(41.7658997, -87.65656296)
HN184055	02/19/2007 05:30:00 AM	005XX W ROSCOE ST	TO RESIDENCE	2331	19	44	6	(41.943338611, -87.64332075)
HN184352	02/19/2007 10:45:00 AM	003XX N MICHIGAN AVE	FROM BUILDING	122	1	42	32	(41.887845852, -87.624560336)
HN181018	02/17/2007 01:31:00 AM	056XX S WABASH AVE	TO LAND	233	2	20	40	(41.792323044, -87.624025834)
HN182857	02/18/2007 07:39:41 AM	014XX W LUNT AVE	FORCIBLE ENTRY	2431	24	49	1	(42.009107852, -87.666843608)
HN177373	02/15/2007 08:44:00 AM	054XX S CORNELL AVE	TO VEHICLE	2132	2	5	41	(41.796263314, -87.585435453)
HN183280	01/14/2007 12:00:00 PM	021XX W BIRCHWOOD AVE	DOMESTIC BATTERY SIMPLE	2424	24	49	1	(42.017948603, -87.683418074)

Table 1: The city of Chicago website provides a data set containing information on crimes committed in the city from 2001 to present day.

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[*]Department of Statistical Science, Duke University
[1]Crimes 2001 to present, https://data.cityofchicago.org/Public-Safety/Crimes-2001-to-present/ijzp-q8t2/data

3   Time Series Analysis

The city of Chicago is divided into regions known as sides (Figure 1), where each side is comprised of several neighborhoods. There is a lot of variation in the population (Figure 2) and the number of armed robberies per capita (Figure 3) for these sides. Additionally, some sides are more residential, while others are more commercial.
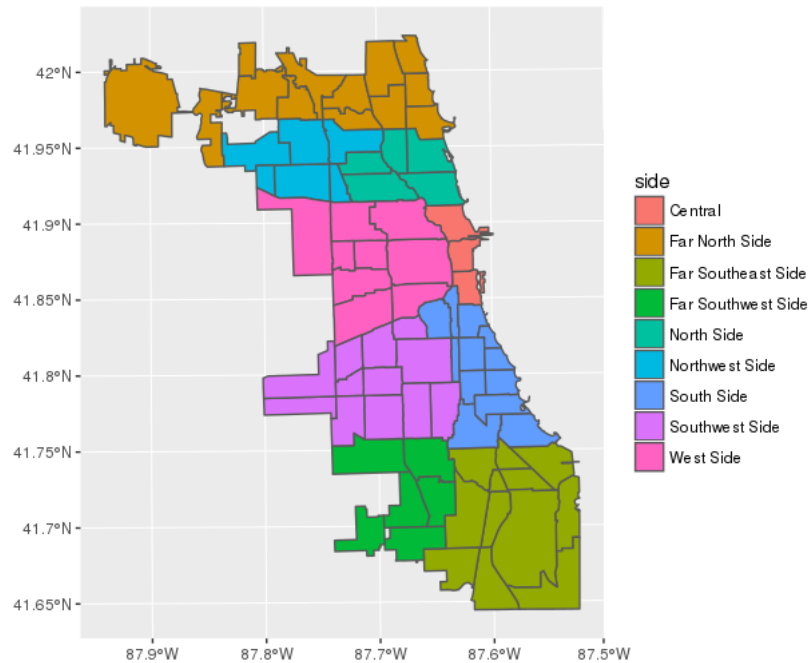

Figure 1: The "sides" of Chicago. The borders correspond to the boundaries of the community areas colored by the side.

ARIMA models were fit to predict the counts of monthly armed robberies in each side of the city between 2003 and 2016. In order to determine the type of model, the ACF and PACF plots were examined for the data for each of the sides. For example, if there was structure in the PACF plot beyond one lag, moving average terms were added. The model residuals were also examined to ensure that there was no remaining structure in the residuals. The PACF and ACF plots for the data from the South Side are displayed below. The ACF plot showed evidence of seasonality at lag 12 (i.e. yearly trends). After lag 1, there was no large values for the PACF, so no moving average terms were included in the model.
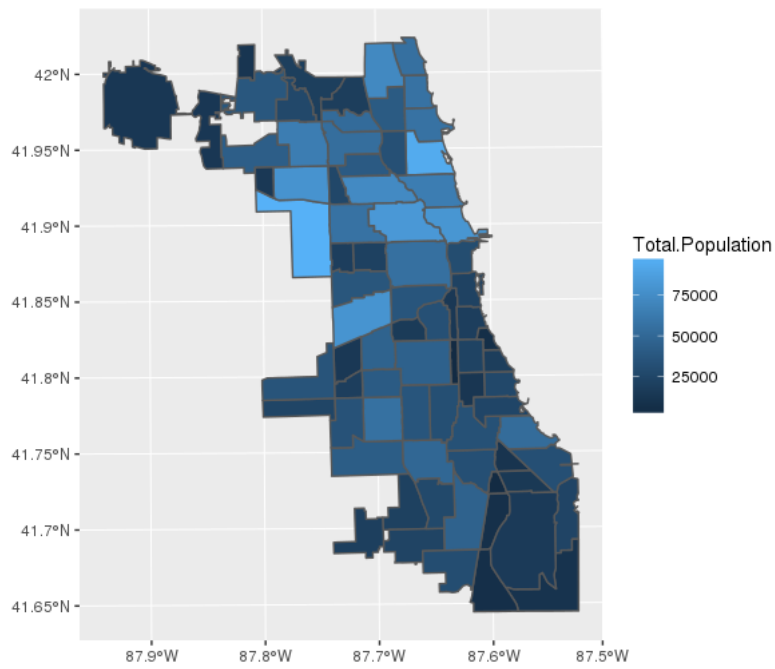
Figure 2: The population distribution of the "sides" of Chicago. The borders correspond to the boundaries of the community areas colored by the side.
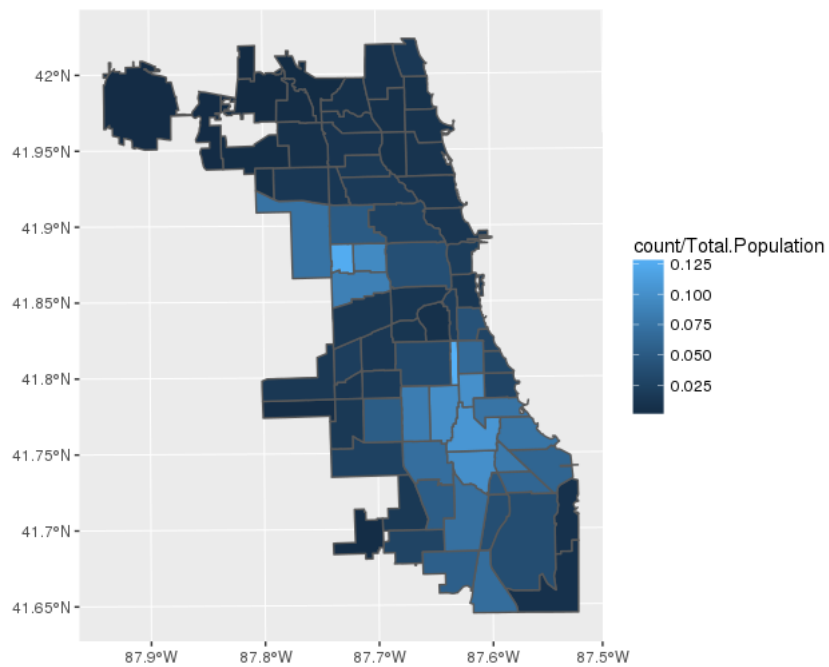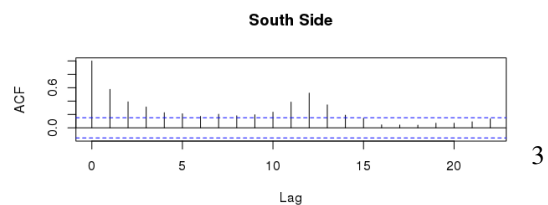

Figure 3: The number of armed robberies per capita for the "sides" of Chicago between 2003 and 2016. The borders correspond to the boundaries of the community areas colored by the side.

	ar1	ar2	ar3	ar4	sar1
Coefficient	0.3850	0.1328	0.0825	0.0167	0.4784
Standard Error	0.0793	0.0832	0.0824	0.0771	0.0708

Table 2: Summary of model fit for the AR(4) with period 12 seasonal component fit to the monthly count of armed robberies for the South Side.
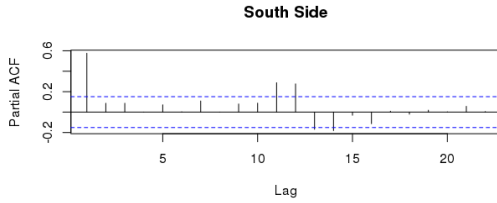
Figure 5: PACF plot for the number of monthly armed robberies in the South Side of Chicago between 2003 and 2016.

Based on the ACF Figure 6 and PACF Figure 3 plots, an AR(4) model was fit with a seasonal component with period twelve. The residuals plot for this model did not display any remaining structure in the data and the coefficients are in **??**.
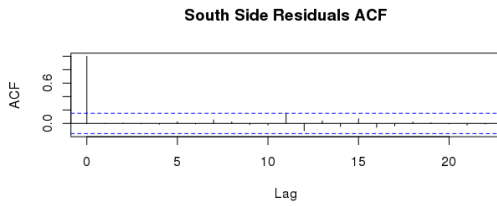
Figure 6: ACF plot of the residuals of an AR(4) model with a period twelve seasonal component fit to the monthly count of armed robberies for the South Side.
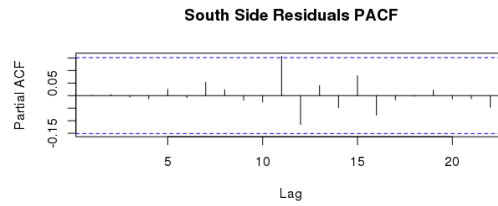
Figure 7: PACF plot of the residuals of an AR(4) model with a period twelve seasonal component fit to the monthly count of armed robberies for the South Side.

The coefficient estimates for all of the different sides were very similar. While some sides displayed evidence of higher order autoregressive structure or the addition of moving average terms, as compared to the South Side, all sides had a clear period 12 seasonal component, indicating strong yearly trends for all sides of the city. The coefficient estimates were positive for the autoregressive terms, indicating that there was a positive correlation between the amount of monthly armed robberies over time. Plots of the various model fits can be found in subsection 5.1. It is interesting that although the sides of Chicago are quite diverse in terms of population and demographics, as well as the number of monthly armed robberies, the temporal trends for all of the sides are very similar. Although the count of the monthly armed robberies differs by side of the city, the overall temporal trend is the same across Chicago and has a strong yearly, autoregressive trend.

4 Spatial Models

Intro To Data Spatially - Different Community Areas - Added Variables (100) - What We Want to Predict - Why Spatial: Moran's I - How Many Data Points - Why Armed Robbery

LASSO Model

Bayesian Spatial Model

Results + Conclusions - Talk about Austin - Cancer - Residuals Difference - Demographics - Top Ten Coeffs

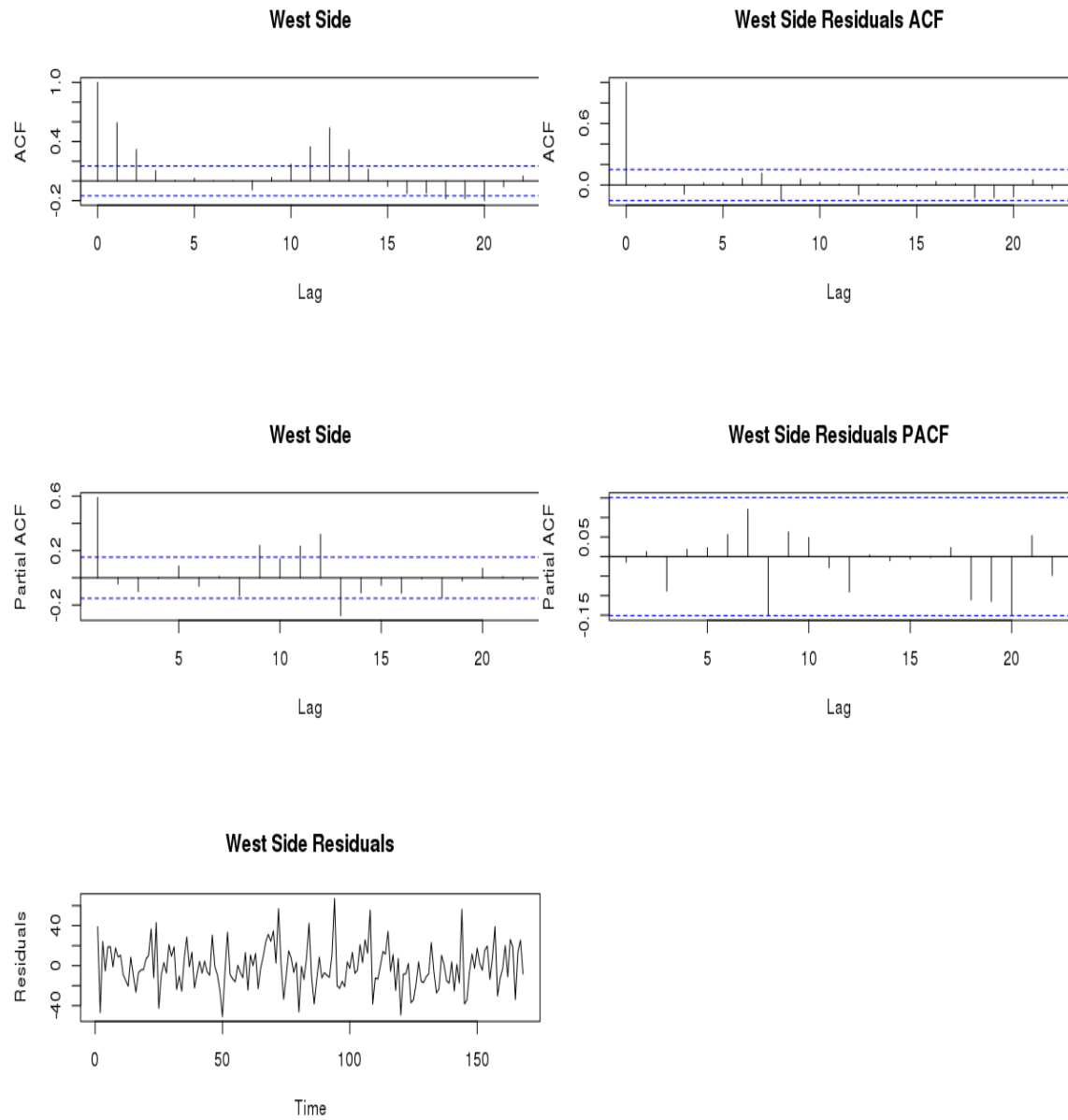- Add Betas in Appendix - Add Reference for Data Sources

References

[1] Papachristos, Andrew V., "48 Years of Crime in Chicago: An Analysis of of Serious Crime Trends from 1965-2013,http://isps.yale.edu/sites/default/files/publication/2013/12/48yearsofcrime_final_ispsworkingpaper023.pdf, December 2013.

[2] Pearson, Rick, "Trump Again Assails Chicago gun violence in speech to Congress", *Chicago Tribune*, http://www.chicagotribune.com/news/local/politics/ct-donald-trump-congress-speech-chicago-met-20170228-story.html, March 2017.

5   Appendix

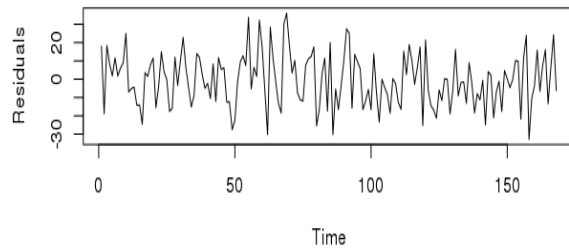## 5.1   Time Series Modeling Plots

5.1.1   West Side

West Side

West Side Residuals ACF

West Side

West Side Residuals PACF

West Side Residuals

5.1.2   Southwest Side

Southwest Side

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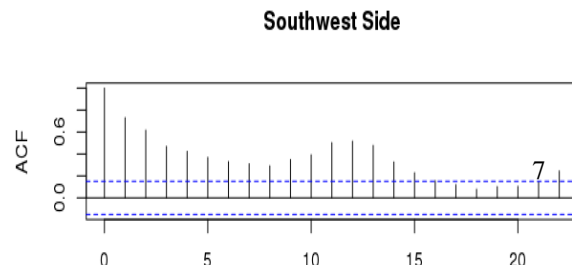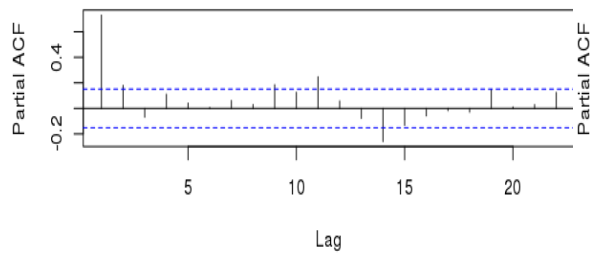
Southwest Side

Southwest Residuals PACF
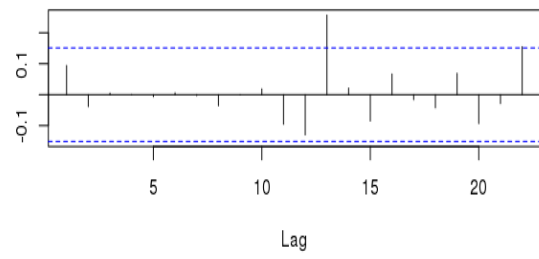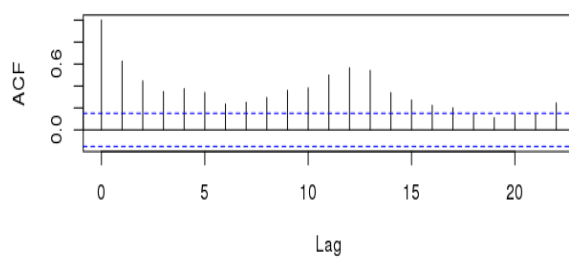

Southwest Residuals ACF
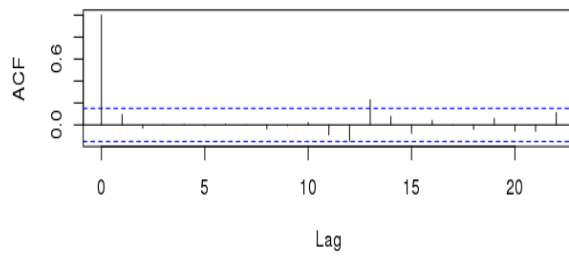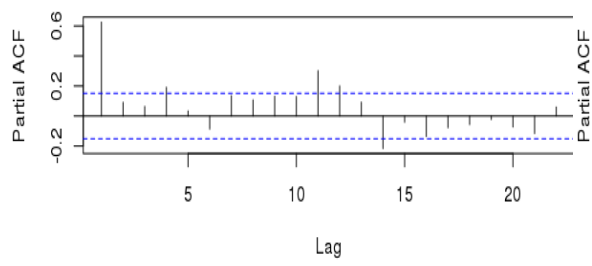

Southwest Residuals

5.1.3 Southeast Side

Southeast Side

Southeast Side

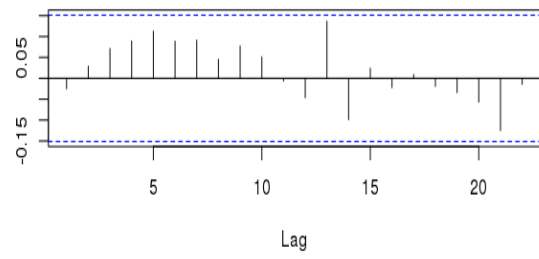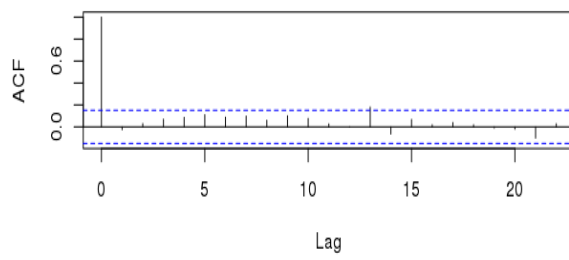**Southeast Residuals PACF**

Southeast Residuals ACF

Southeast Residuals