CHICAGO

WEST NILE VIRUS

CONTROL PLAN

WESLEY

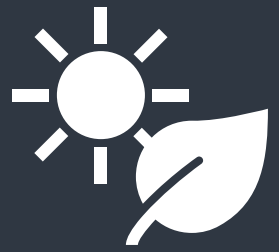
RUSSELL

SATHYA

BOON JUN

WHAT IS WEST NILE VIRUS (WNV)

Leading cause of mosquito borne disease in USA



Summer through fall

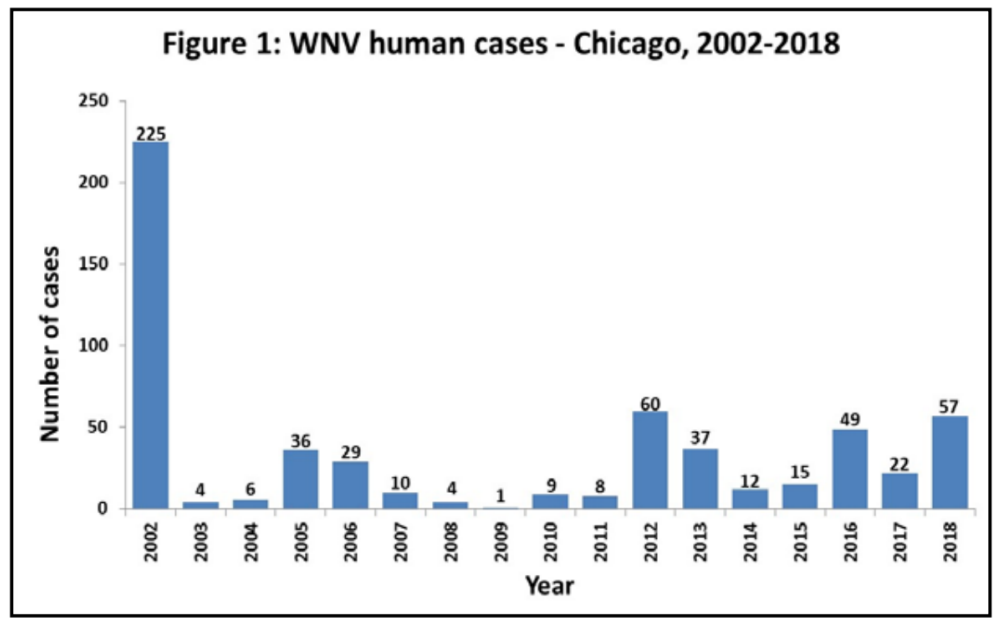
No vaccine, No medications

1 IN 5

Developed symptoms

INTRODUCTION

CHICAGO



Source: Chicago Department of Public Health (CDPH)

- First Wnv case: 225 in 2002
- Implemented city wide surveillance & mosquito control measures
- Continues to have one of the most robust mosquito control program in the US

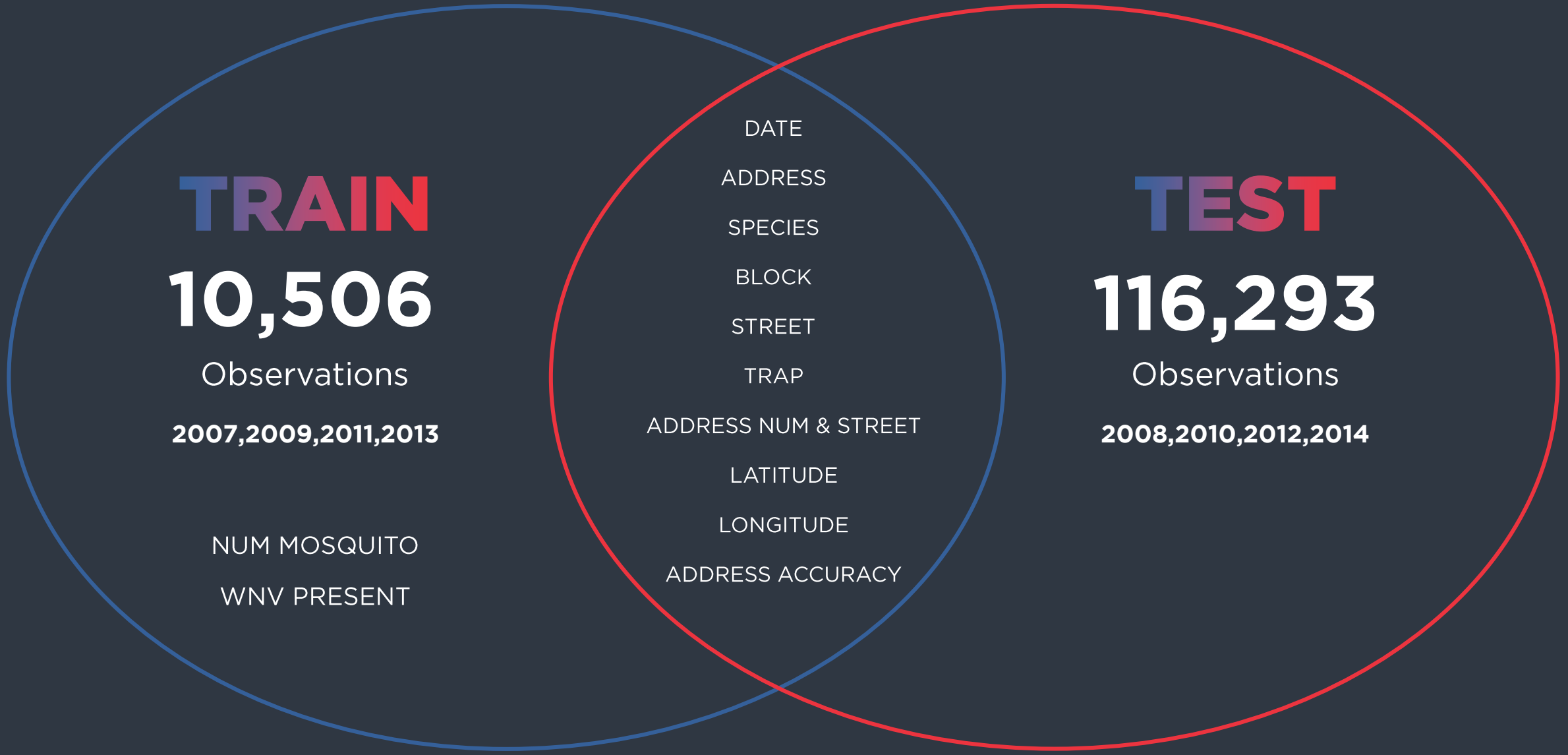
INTRODUCTION

Predicting The Presence Of Wnv For Coming Mosquito Season

&

Providing Effective Spray Strategy For City Of Chicago

PROBLEM STATEMENT


TRAIN
10,506
Observations
2007,2009,2011,2013
NUM MOSQUITO
WNV PRESENT
DATE
ADDRESS
SPECIES
BLOCK
STREET
TRAP
ADDRESS NUM & STREET
LATITUDE
LONGITUDE
ADDRESS ACCURACY
TEST
116,293
Observations
2008,2010,2012,2014

DATASETS

DATASETS

WEATHER

2007 - 2014

NOAA weather data

22 weather features

2 Stations

1) CHICAGO O'HARE INTERNATIONAL AIRPORT

2) CHICAGO MIDWAY INTL ARPT

SPRAY

14,835

Observations

2011 (2 dates)

2013 (July – Sep)

Spray effort data by Chicago government

Data Cleaning

EDA

Data Merging

Feature Engineering

Modelling

Cost-Benefit Analysis

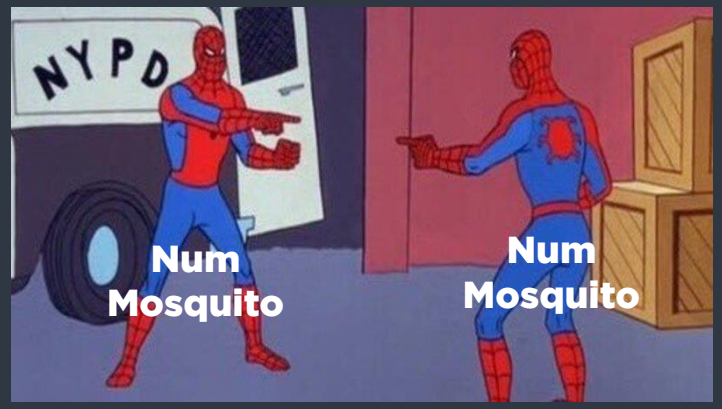
WORKFLOW

TRAIN & TEST

- Relatively clean with no null values

Train

- Mosquitos count capped at 50 for each date, trap, species and Wnv present
- Sum up all mosquitos of same date, trap, species and Wnv present, drop duplicate



CLEANING

TRAIN

Wnv Present = 1

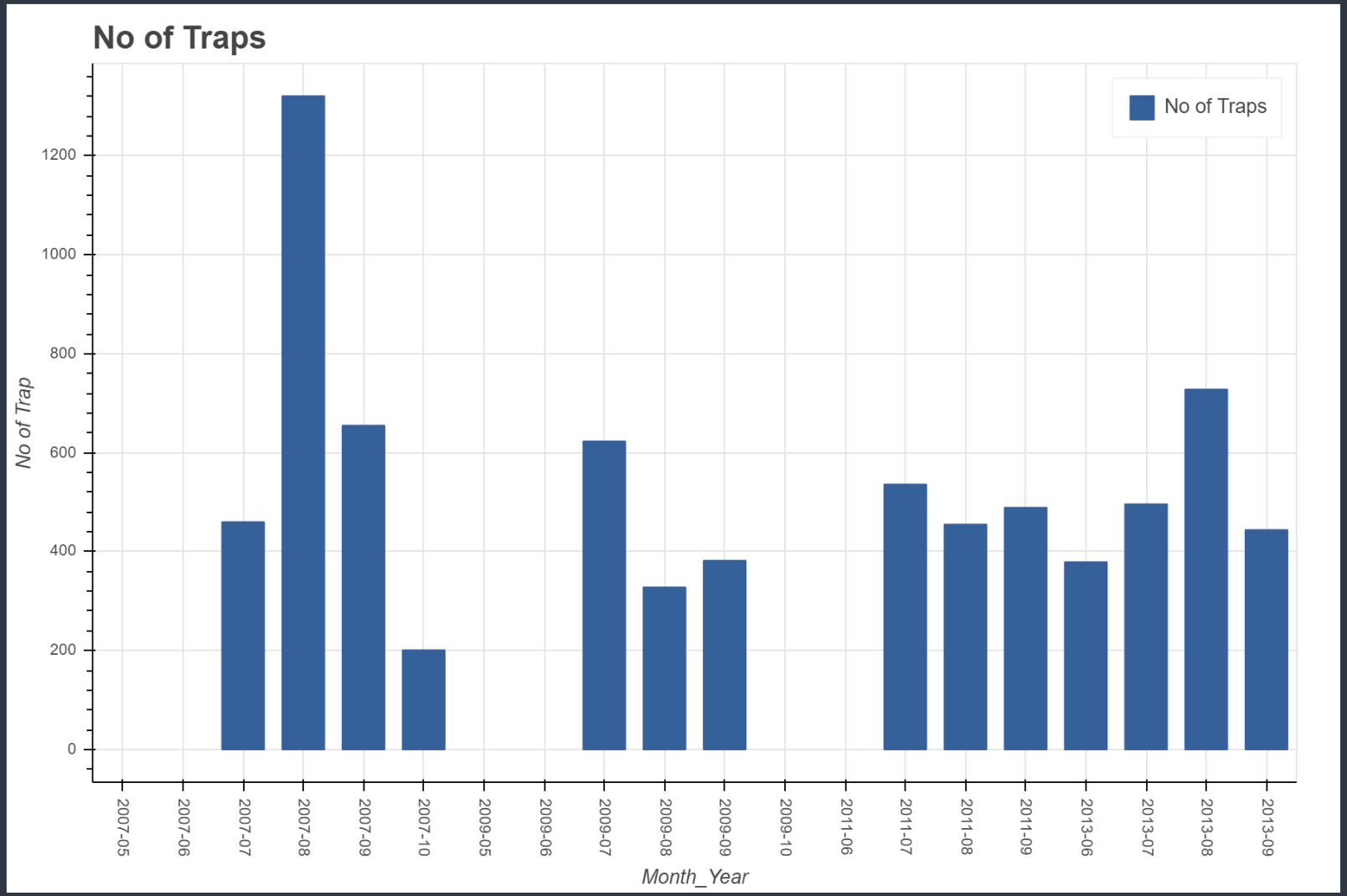
5.3%

Wnv Present = 0

94.7%

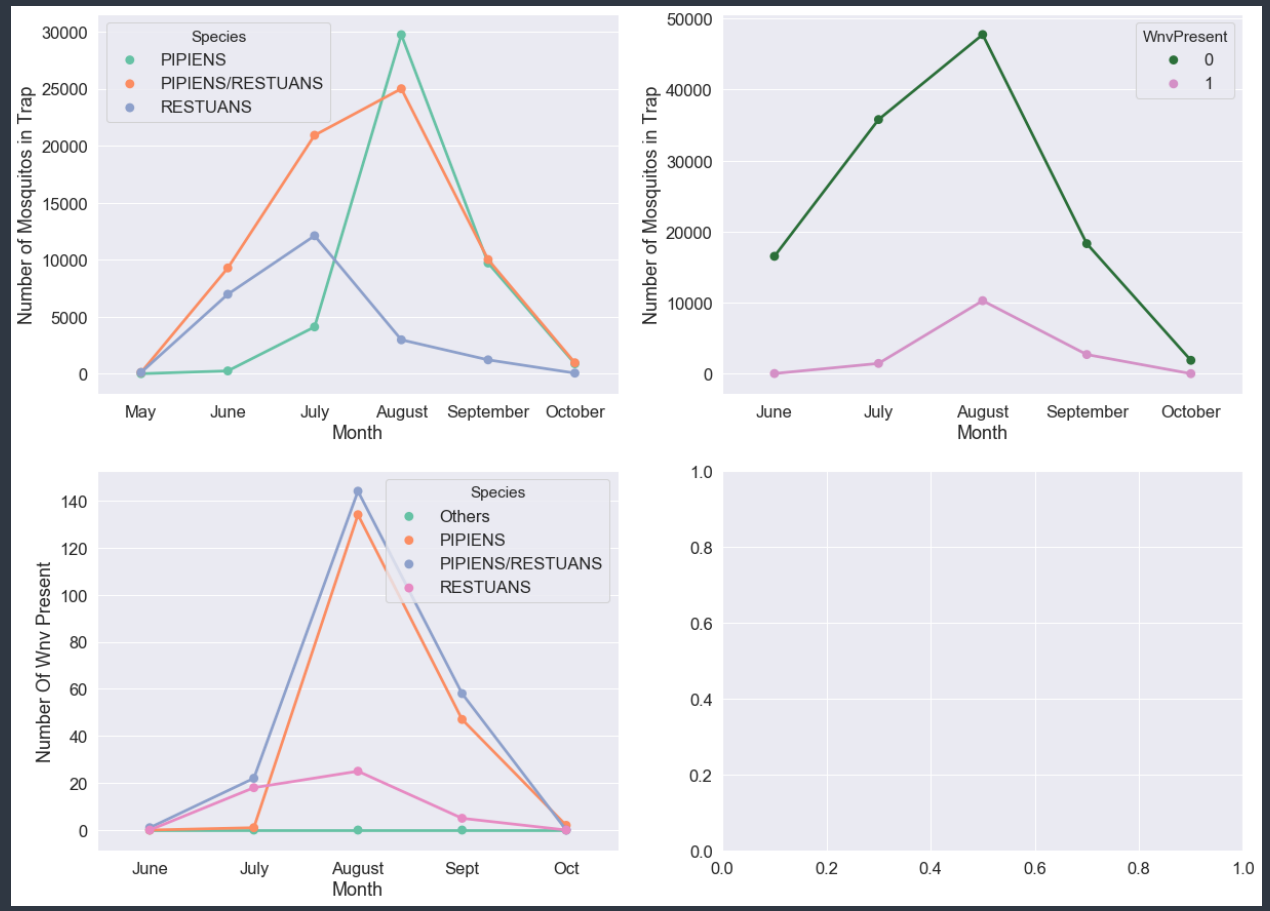
EDA

TRAIN


No of Traps
No of Traps
No of Trap
1200
1000
800
600
400
200
0
2007-05
2007-06
2007-07
2007-08
2007-09
2007-10
2009-05
2009-06
2009-07
2009-08
2009-09
2009-10
2011-06
2011-07
2011-08
2011-09
2013-06
2013-07
2013-08
2013-09
Month_Year

EDA

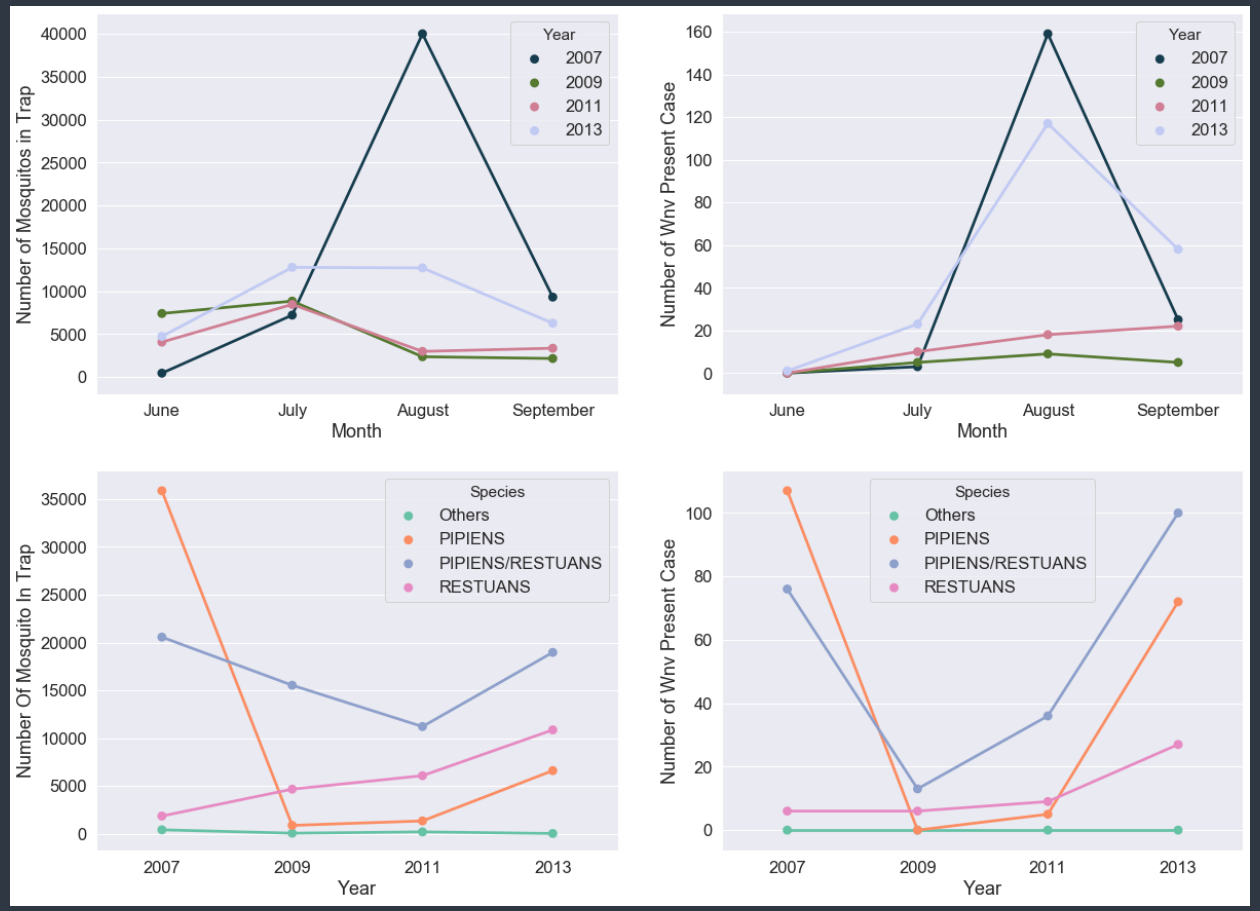
TRAIN



- Most number of Wnv positive mosquitos in August
- Most number of mosquitos in August for species Pipens & Pipens/Restuans
- Pipens & Pipens/Restuans seem to be the main contributors

EDA

TRAIN



- Sharp drop in no. of Wnv Present cases between 2007 to 2009
- Sharp increase between 2011 and 2013
- Sharp drop in PIPENS mosquito from 2007 to 2009 and increase from 2011 to 2013
- PIPENS mosquito seems to be a major factor affecting whether Wnv is present

EDA

WEATHER

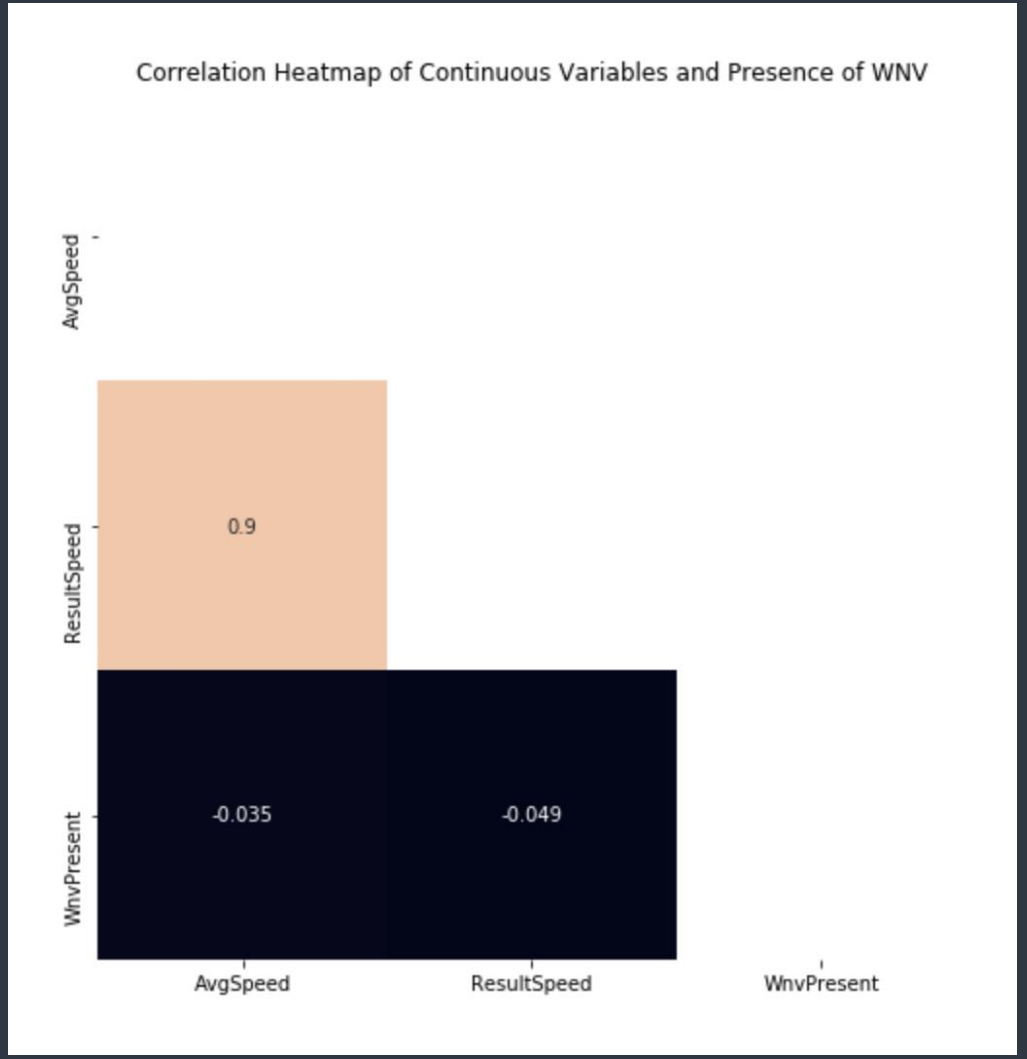
- Data had no null values there were many missing values and traces which were labelled M and T
- Making references to best fill missing data
  (e.g. WetBulb, StnPressure)
- Dropped columns with low variance or when there is no logical way to input values (e.g. SnowFall, Water1)

CLEANING

WEATHER

Removing Collinear Terms

AvgSpeed	0.034605
ResultSpeed	0.048893

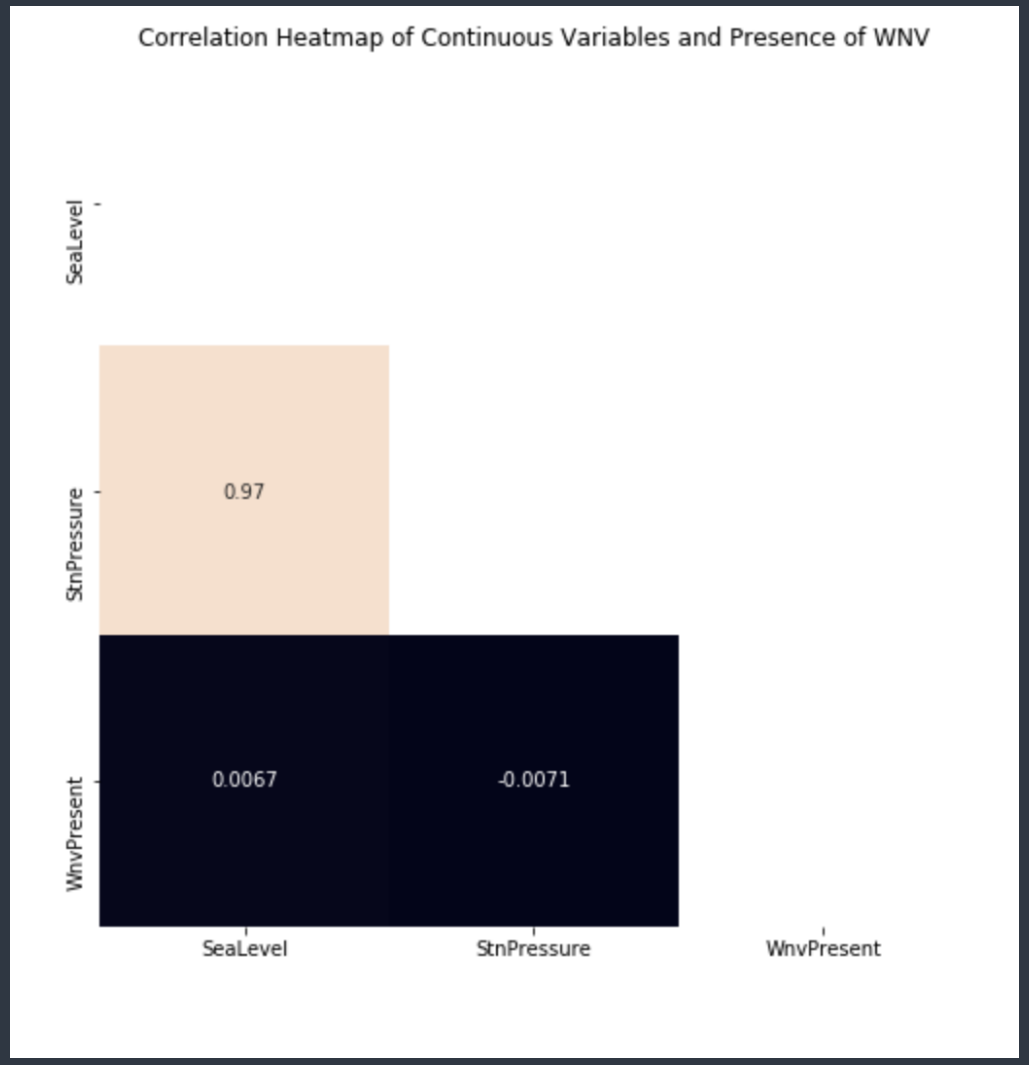


EDA

WEATHER

Removing Collinear Terms

SeaLevel	0.006738
StnPressure	0.007149

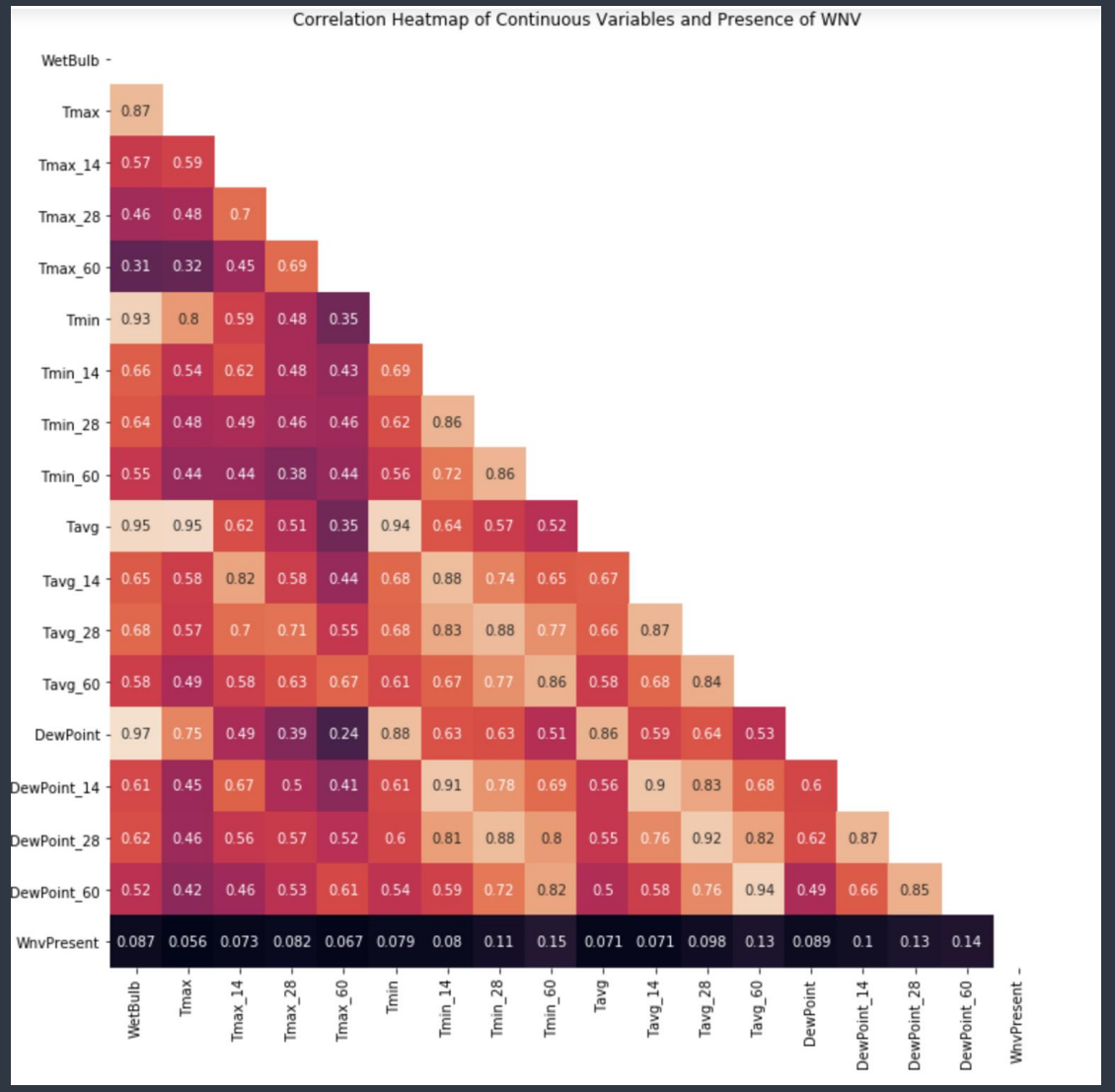


EDA

WEATHER

Removing Collinear Terms

WetBulb	0.087295
Tmax	0.056156
Tmax_14	0.073485
Tmax_28	0.082459
Tmax_60	0.067110
Tmin	0.078749
Tmin_14	0.080009
Tmin_28	0.110154
Tmin_60	0.154747
Tavg	0.070603
Tavg_14	0.070628
Tavg_28	0.097595
Tavg_60	0.130006
DewPoint	0.088737
DewPoint_14	0.103341
DewPoint_28	0.132170
DewPoint_60	0.142533



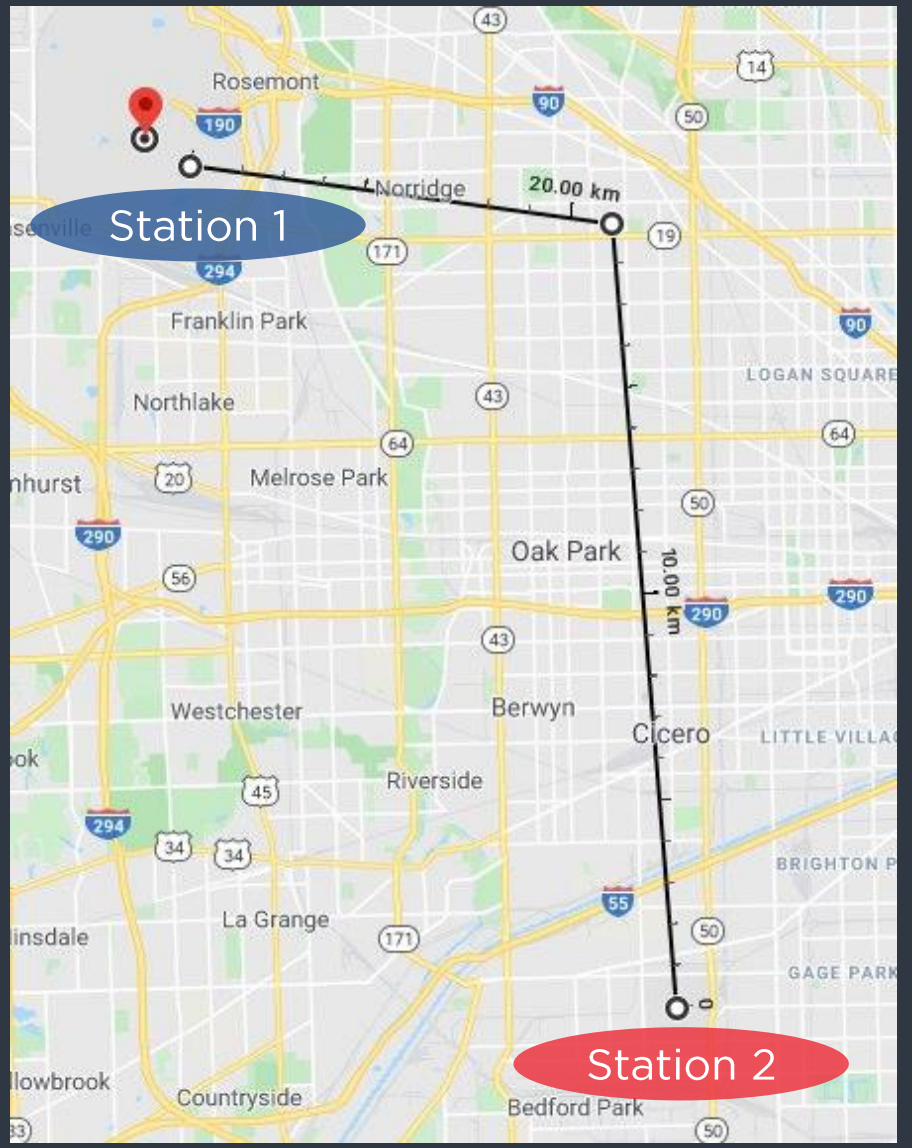
EDA

WEATHER + TRAIN/TEST

Two main weather stations:

- Station 1: Chicago O'Hare International Airport
- Station 2: Chicago Midway International Airport

Calculate displacement to the weather stations and take information from nearest station when merging to train/test data.



MERGING

Identify main locations with highest WnvPresent

Calculate the distance from these locations to the rest of the train/test data

Get rolling mean of different periods for temperature, dewpoint and precipitation

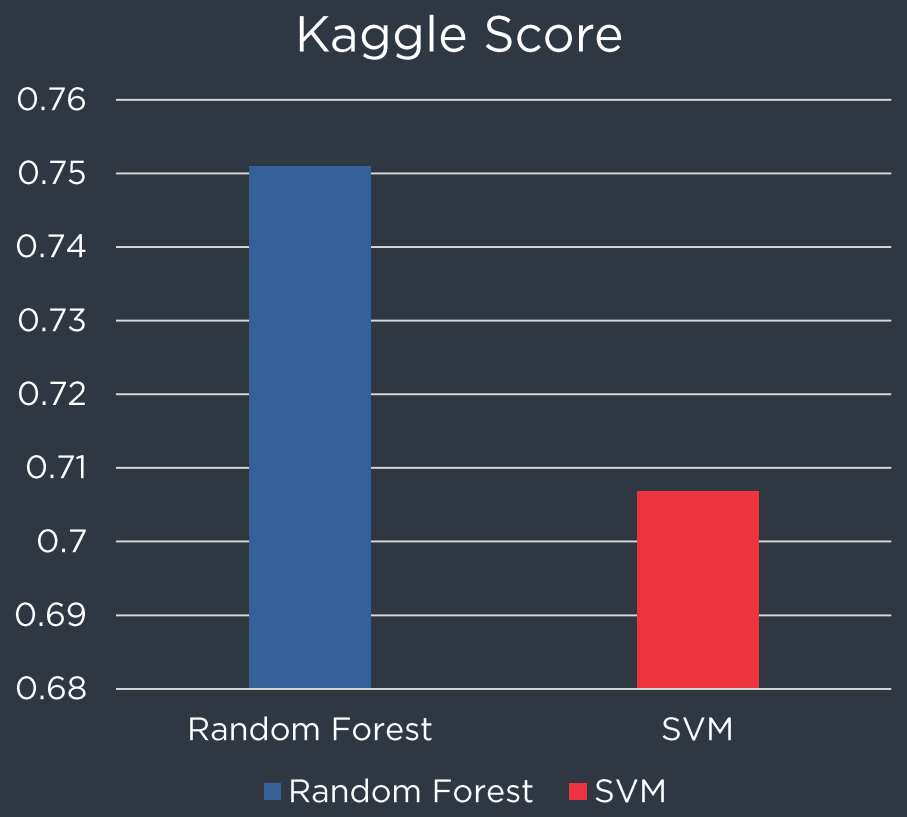
ENGINEERING

SMOTE

ENGINEERING

RANDOM FOREST CLASSIFIER

0.75095



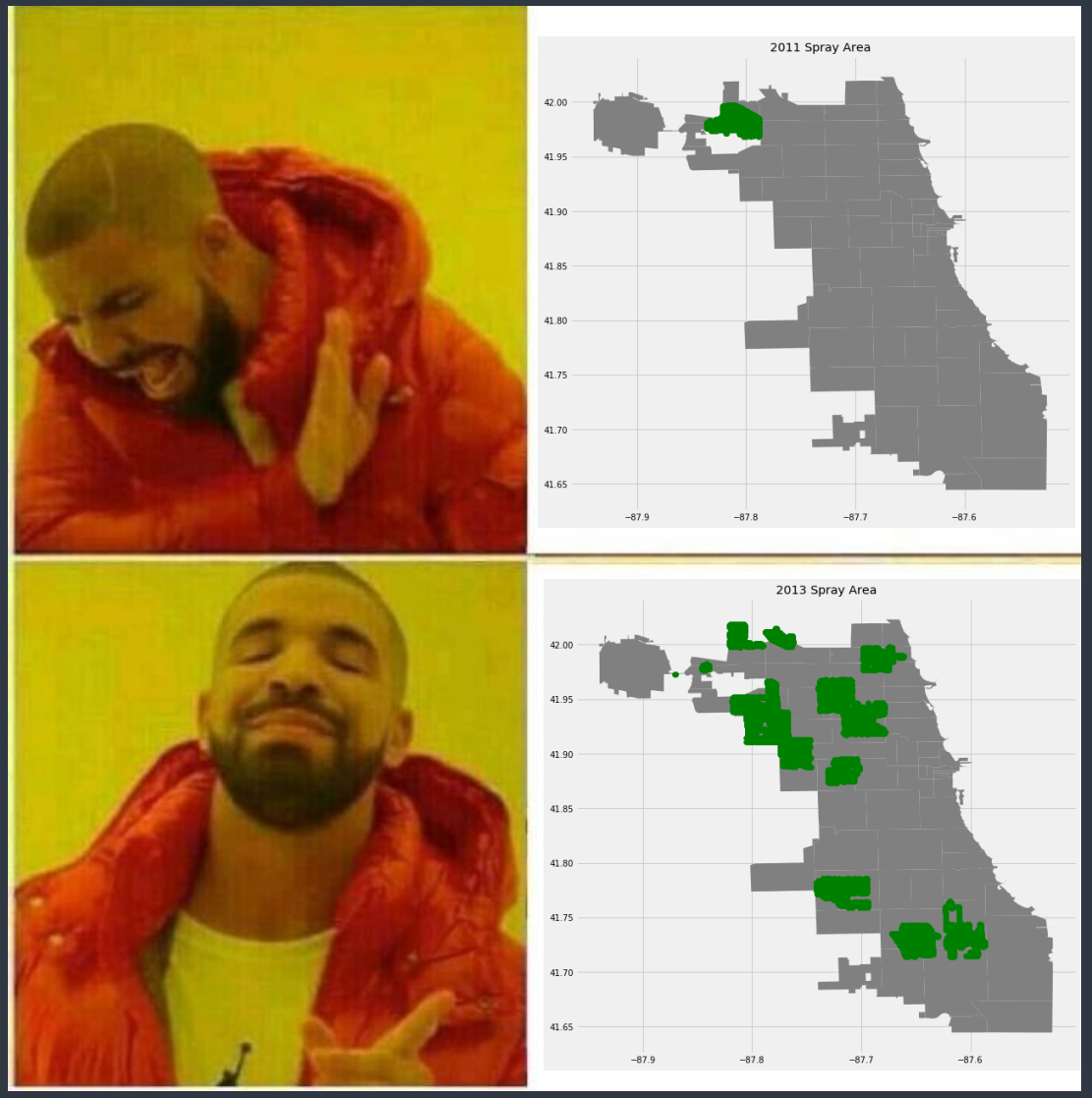
SUPPORT VECTOR CLASSIFIER

0.70679

MODELLING

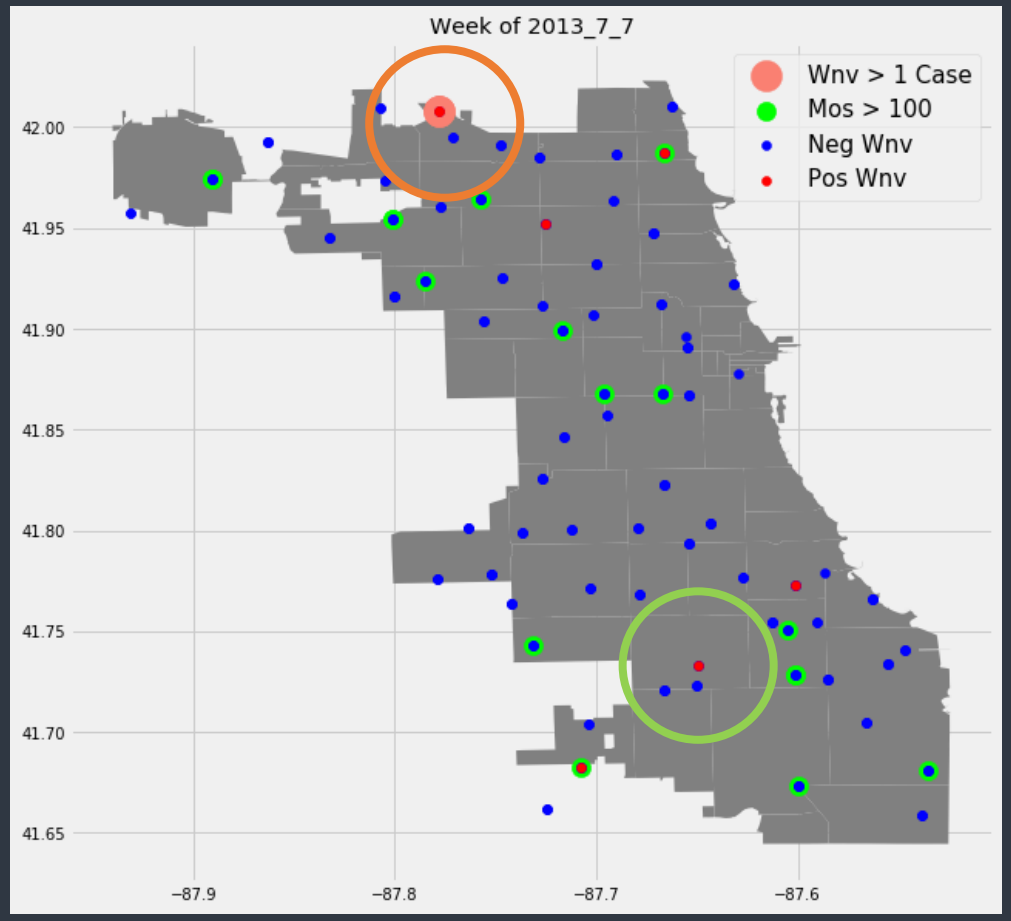
SPRAY DATA

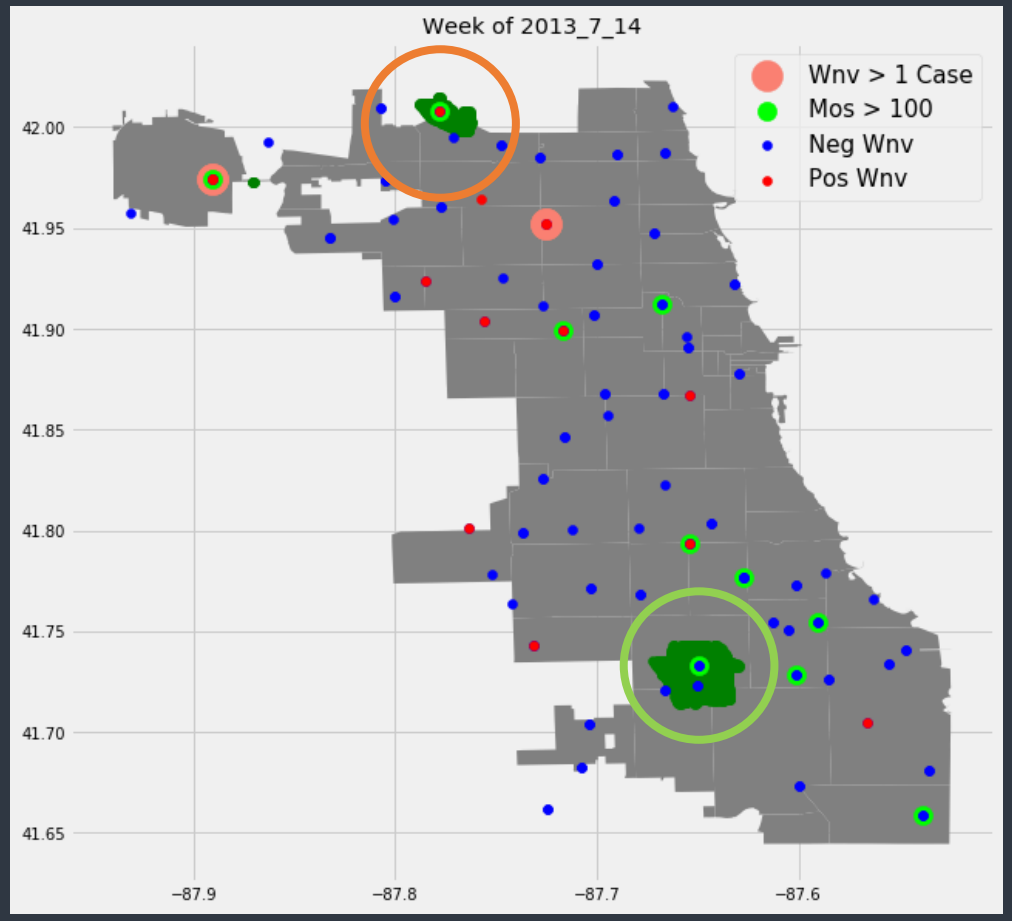
- 2011 data limited
- Analyse only on 2013



COST ANALYSIS

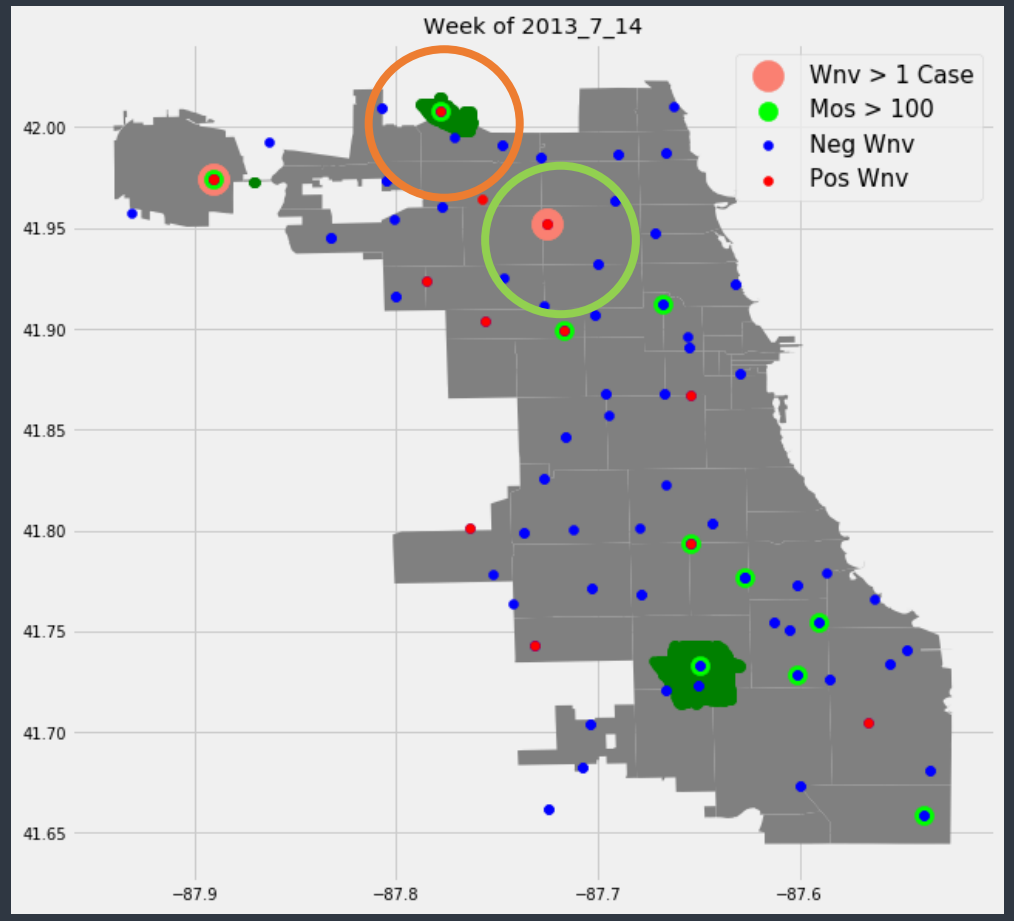
2013 SPRAY DATA

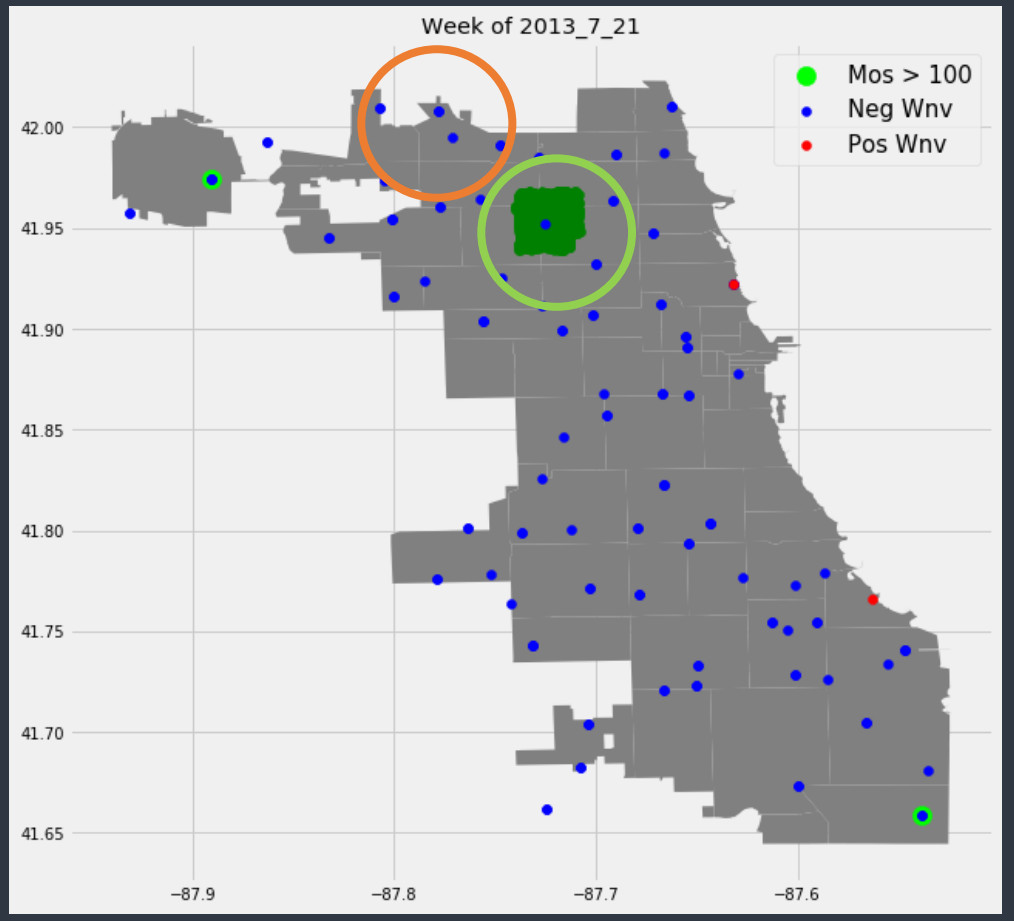




COST ANALYSIS

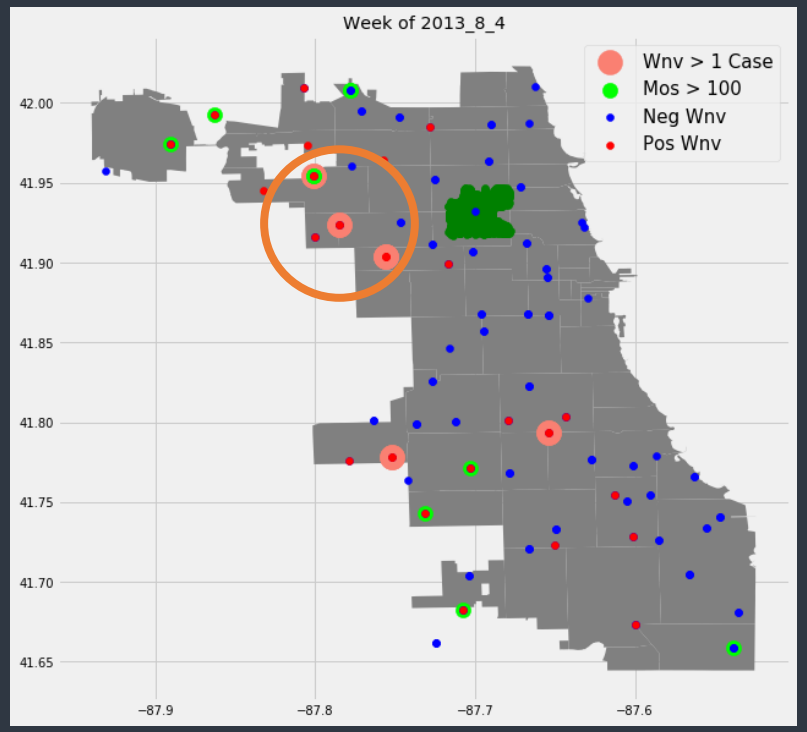
2013 SPRAY DATA

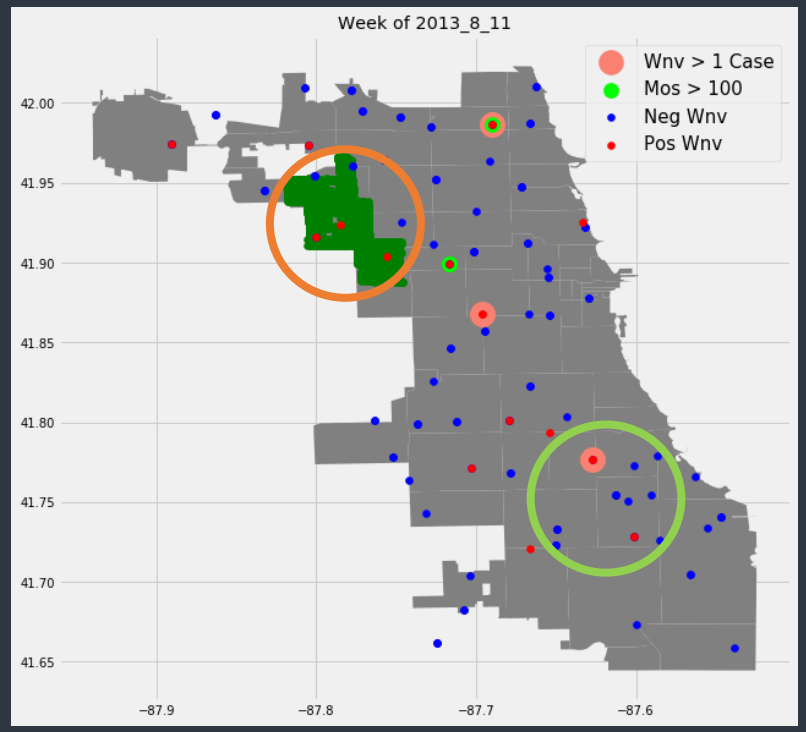


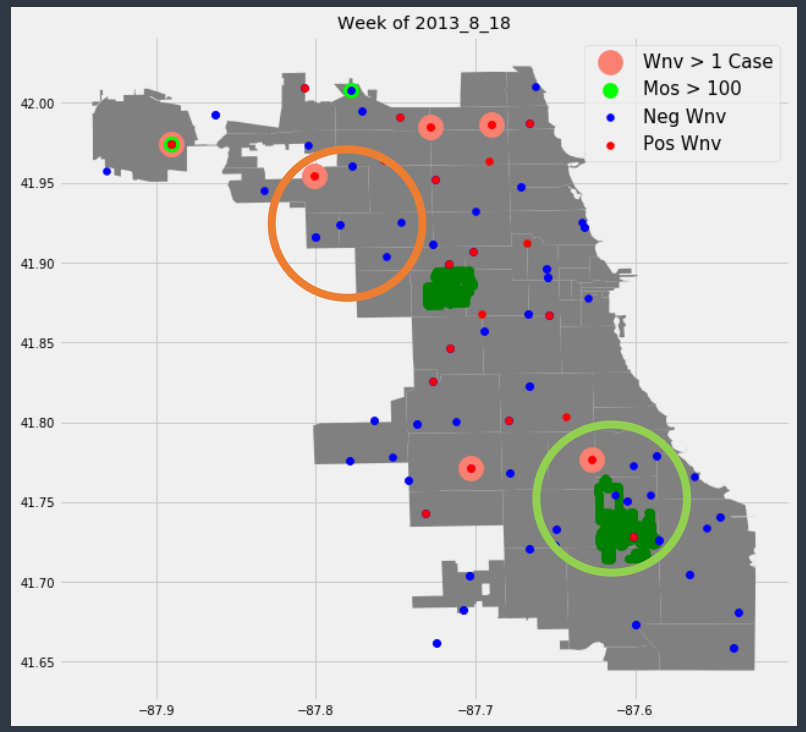


COST ANALYSIS

2013 SPRAY DATA

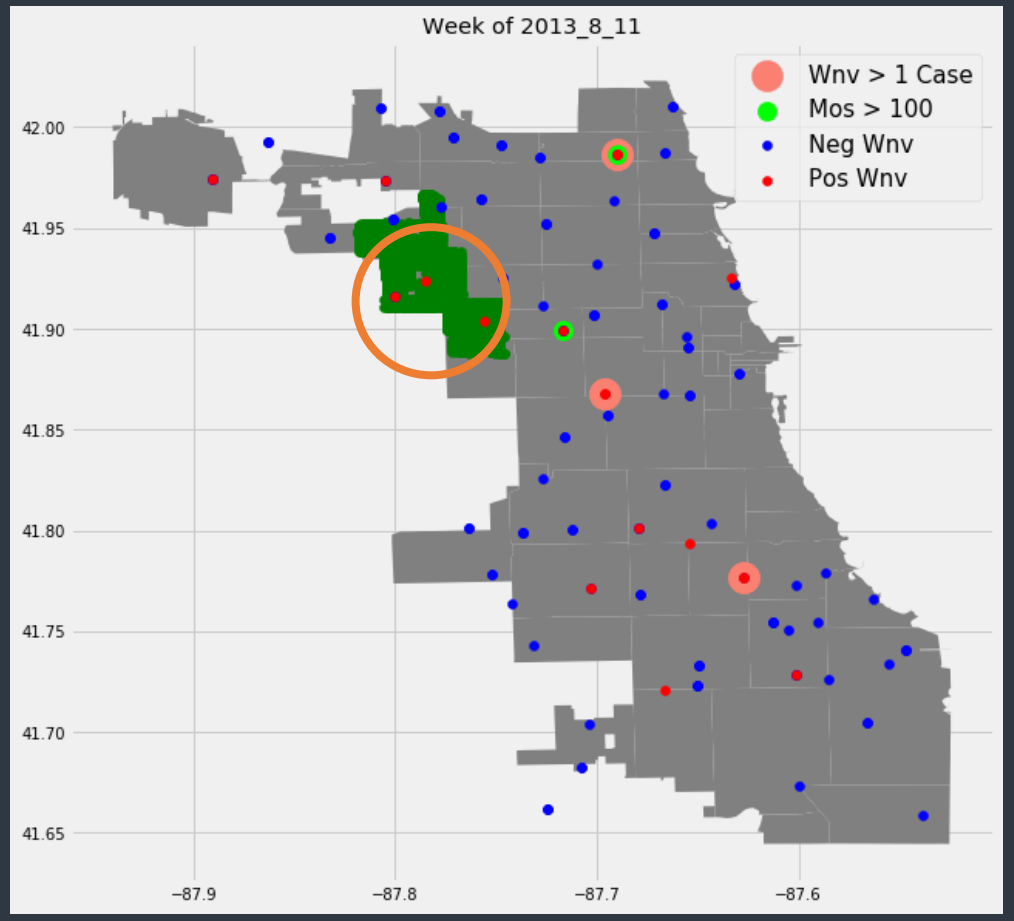


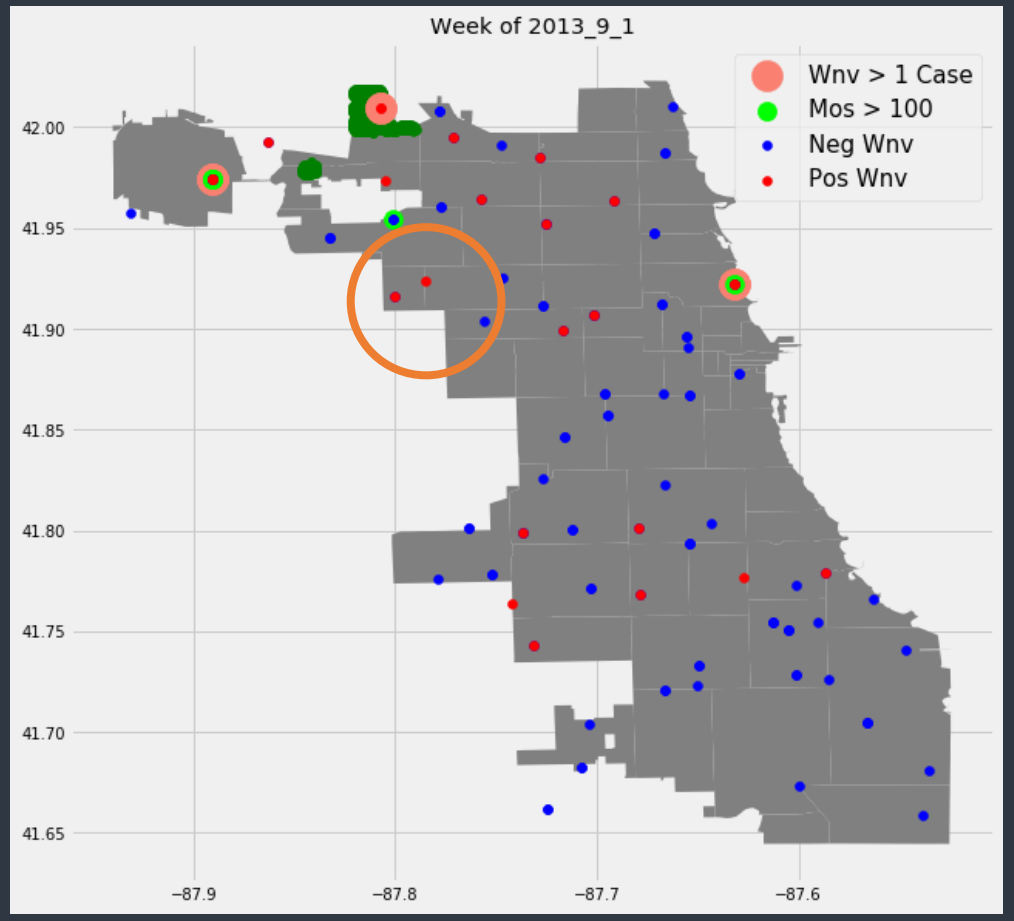




COST ANALYSIS

2013 SPRAY DATA





COST ANALYSIS

2013 SPRAY DATA

- Spraying worked but with short term effect

- Sprayed areas often lagged by at least 1 week

Year	Total Spray Count	Total Mosquitos with Wnv \+Ve	No\. of Wnv Human case*	Ratio of Wnv Mos : Human
2011	1668	50	8	6.25
2013	12626	199	37	5.38
Differences (2013/2011)	7.57	3.98	4.63	0.86

*Source: Chicago Department of Public Health (CDPH)

COST ANALYSIS

COST ESTIMATION

- 12626 spray to eliminate 14 traps with +ve Wnv

  12626/14 = **902 spray/+ve Wnv trap**

- Average price per spray: USD 100
- Visually inspect 10 weeks plot or calculate no. of trap require to spray if option is chosen in 2013

COST ANALYSIS

RECOMMENDATIONS

OPTION 1

Total: 199 Traps

Total cost:

199 * 902 * 100 = $17,946,957

COST ANALYSIS

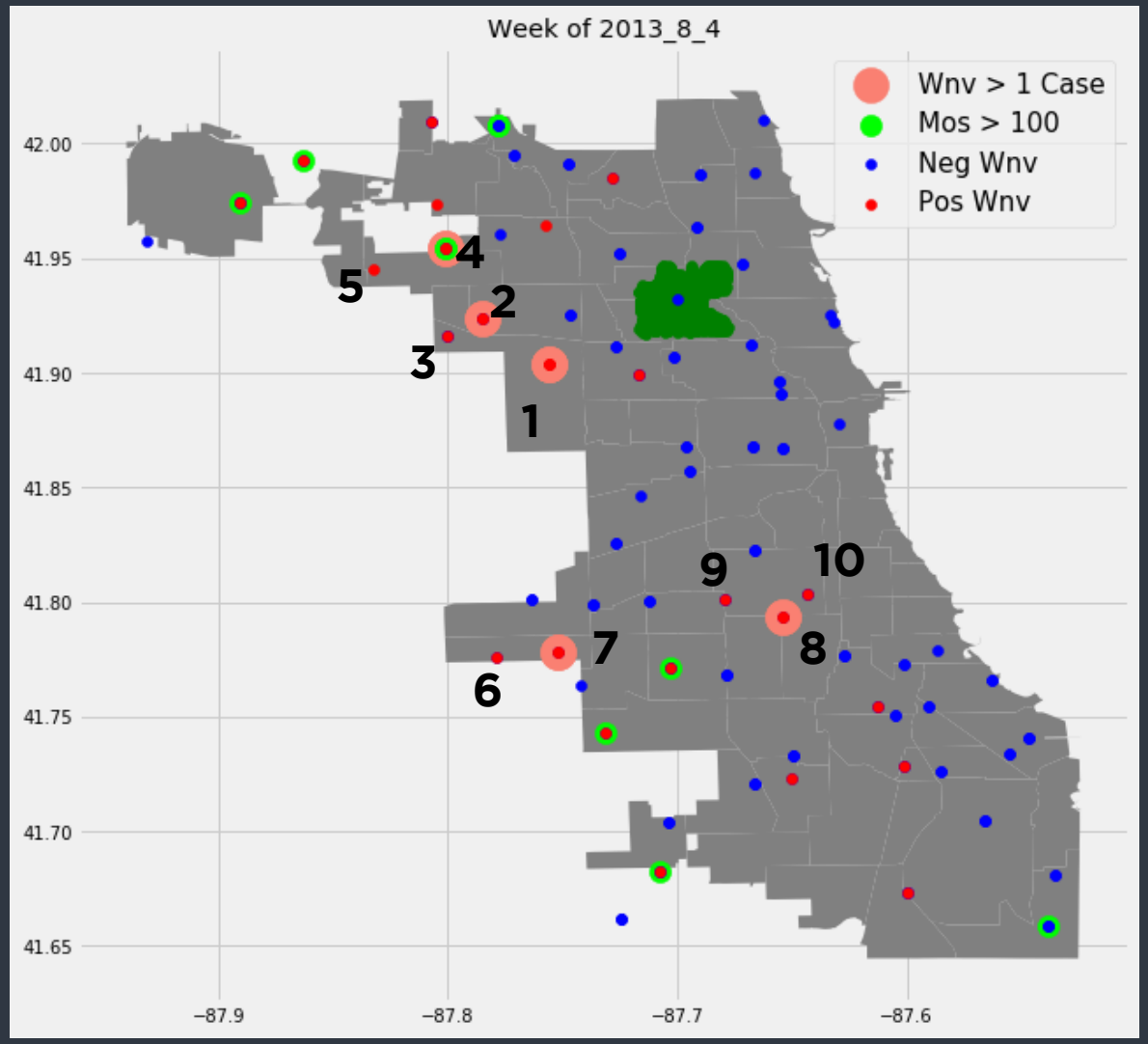
RECOMMENDATIONS

OPTION 2

Total: 41 Traps

Total cost:

41 * 902 * 100 = $3,697,614



COST ANALYSIS

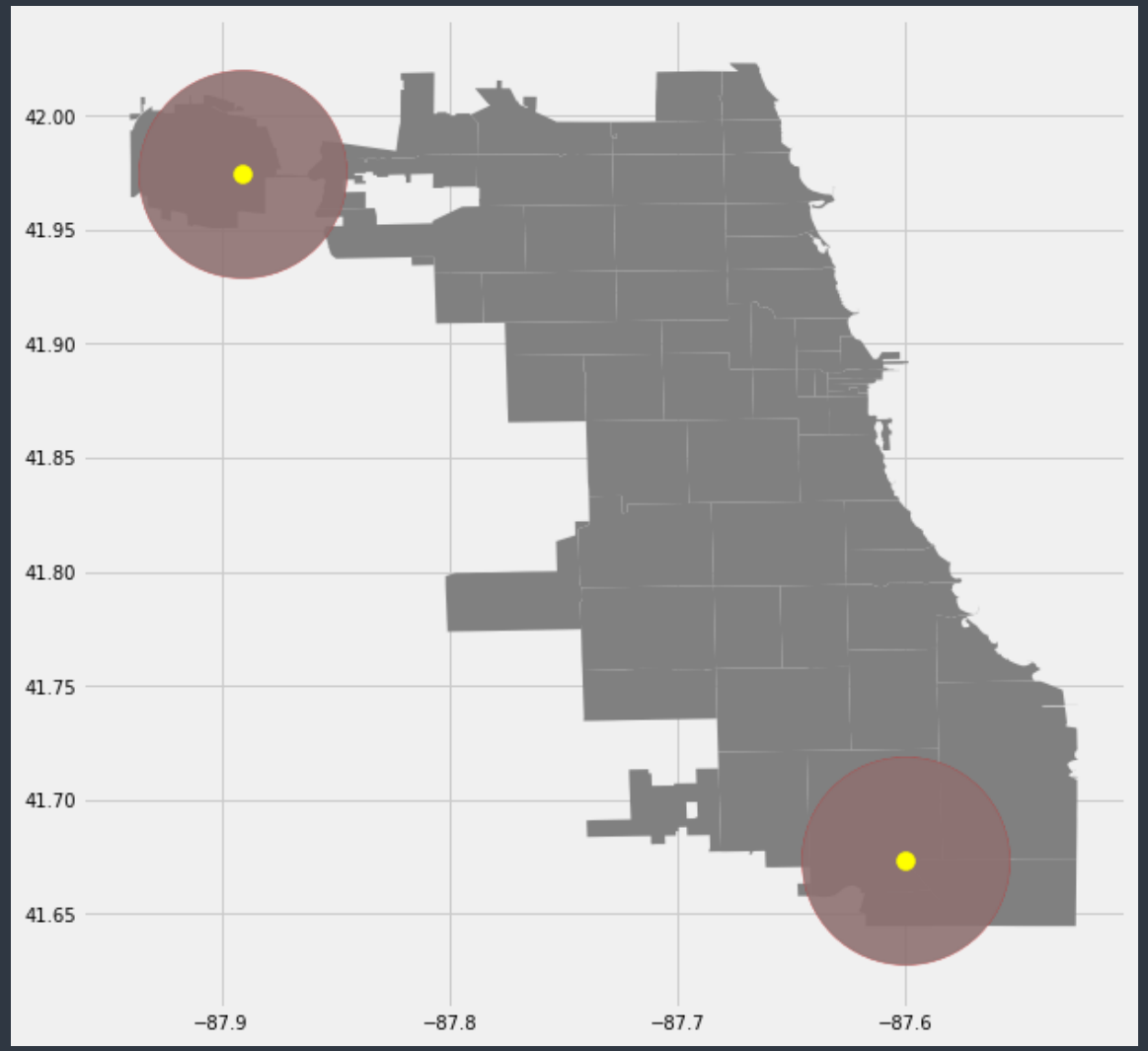
RECOMMENDATIONS

OPTION 3

Total: 23 Traps

Total cost:

23 * 902 * 100 = $2,074,271



COST ANALYSIS

RECOMMENDATIONS

Estimated actual 2013 spending: **$1,262,600**

	Option 1	Option 2	Option 3	Option 4
Method	Spray all Wnv Positive Areas	Spray based on community areas	Spray based on distance from 2 key points	Release genetically modified mosquitos
Pros	• Reduce Wnv +ve mosquito can be dramatically	• Reduce Wnv +ve mosquitos in high risk area • Cost saving	• Focus effort in 2 specific areas • Spray on lesser areas	• Long term fixed solution
Cons	• Costly	• Missing out some Wnv +ve traps	• Missing out some Wnv +ve traps	• Require significant R&D investment cost & time to implement
Cost	$17,946,957	$3,697,614	$2,074,271	$3,599,880

COST ANALYSIS

Random Forest Classifier

0.75095

Spray Recommendations

4 Options

More Info

No. Mosquito in test

No. of Wnv human case & area

More spray data

SUMMARY

THANK YOU