

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



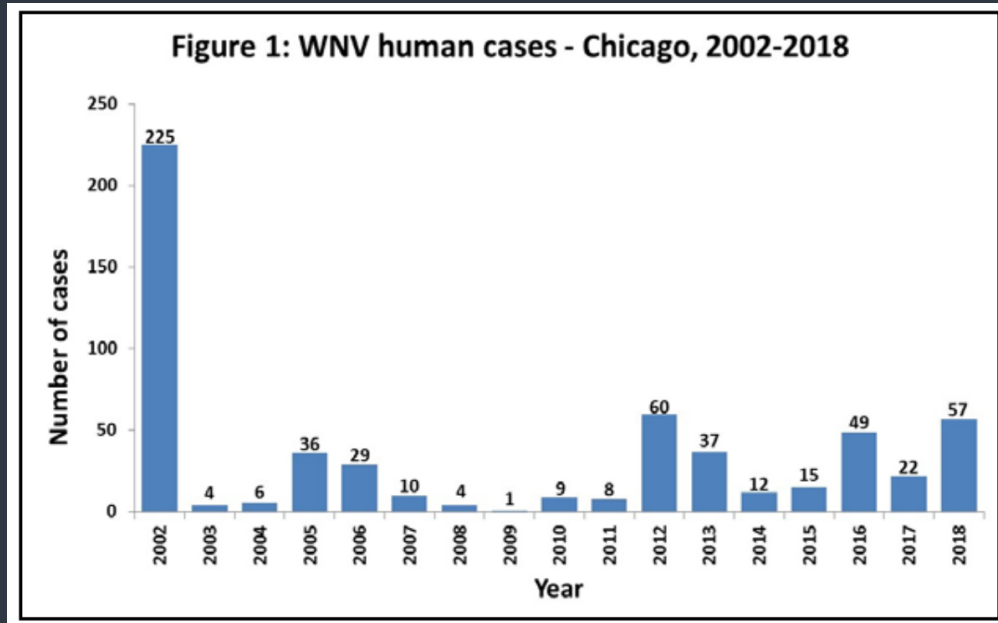
No vaccine,
No medications

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 On Weekly Basis**

&

**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

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

DATASETS



Data
Cleaning



Analysis



Data
Merging



Feature
Engineering



Modelling



Cost-Benefit
Analysis



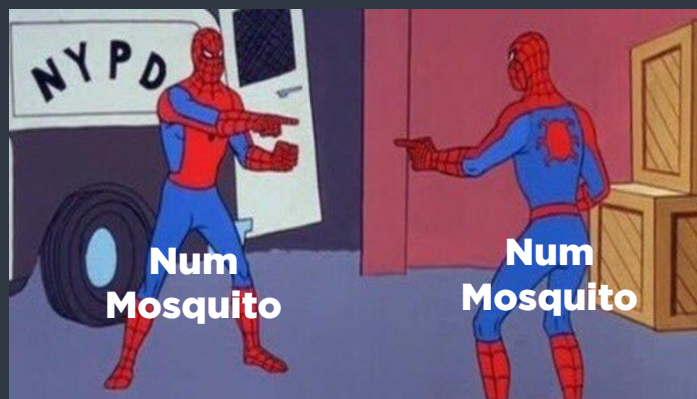
WORKFLOW

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



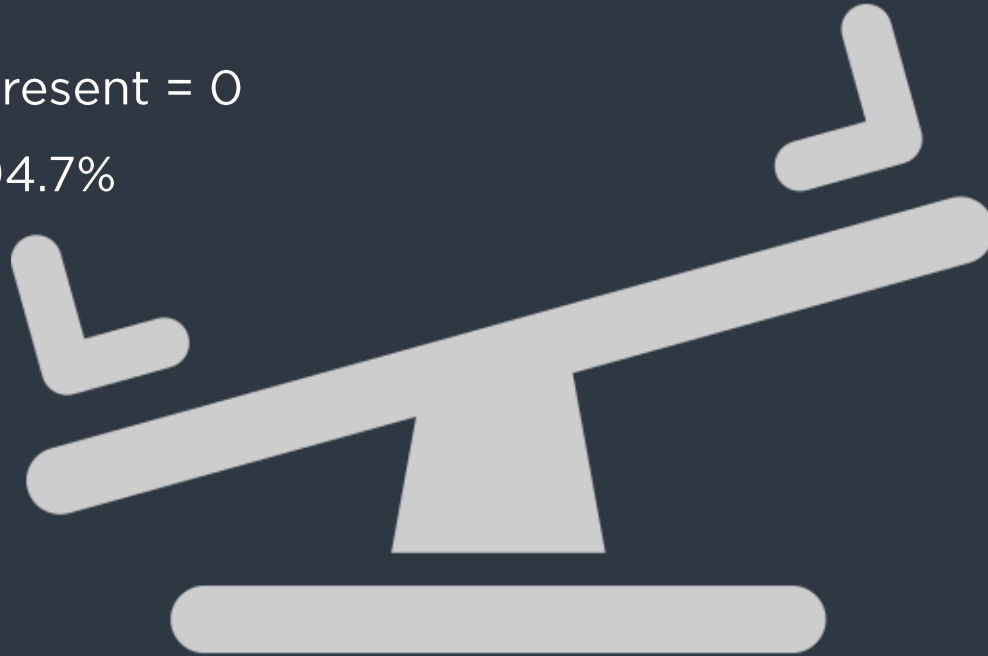
TRAIN

Wnv Present = 1

5.3%

Wnv Present = 0

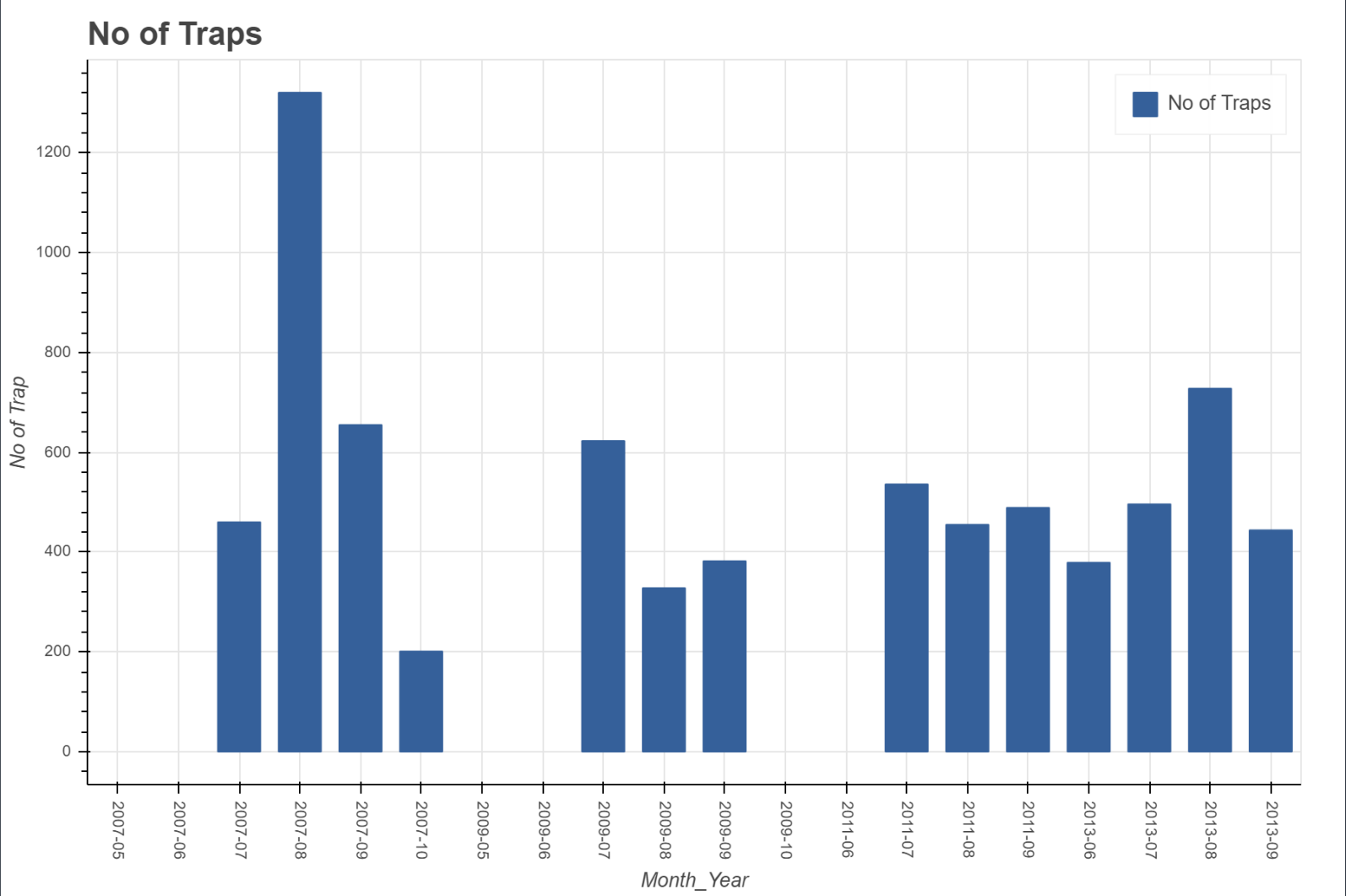
94.7%



ANALYSIS



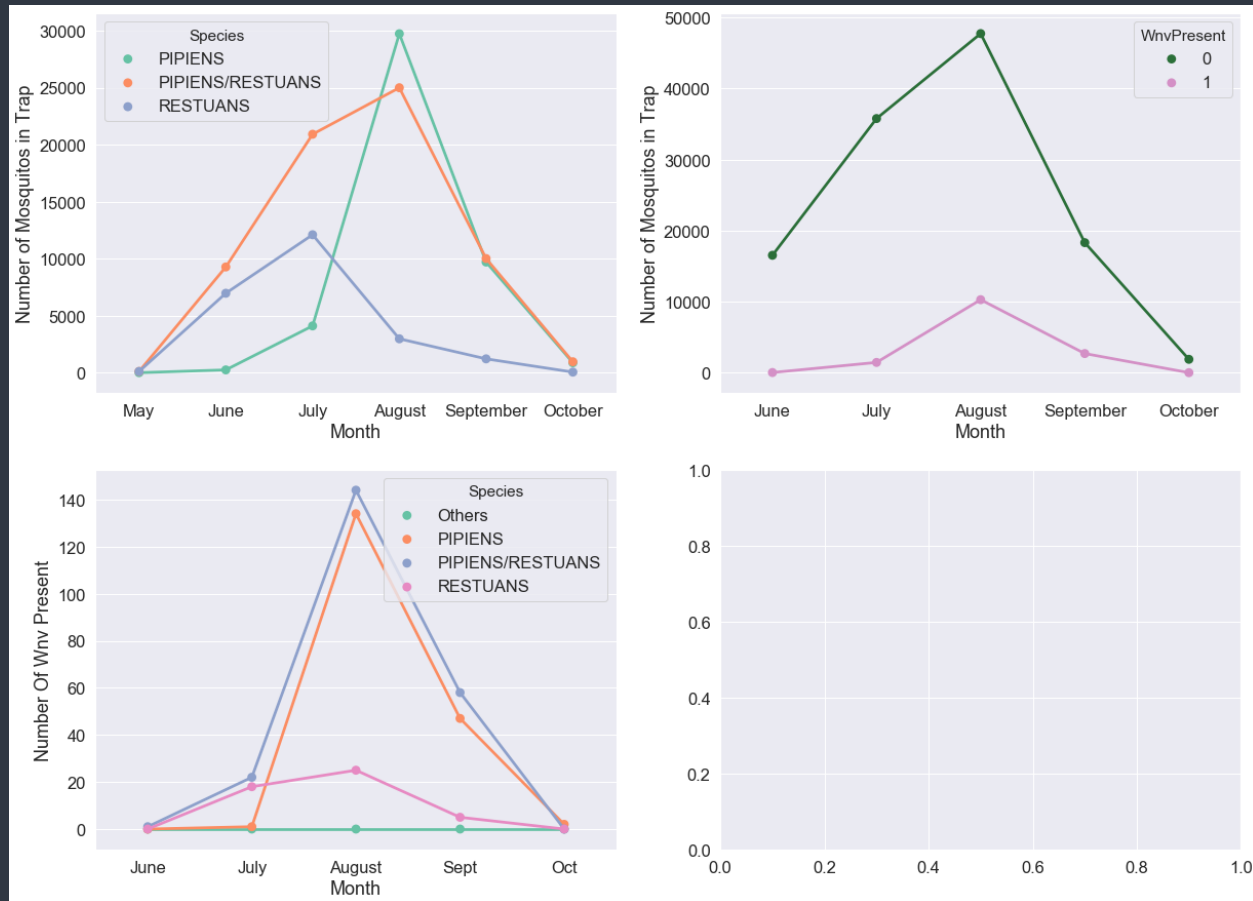
TRAIN



ANALYSIS



TRAIN

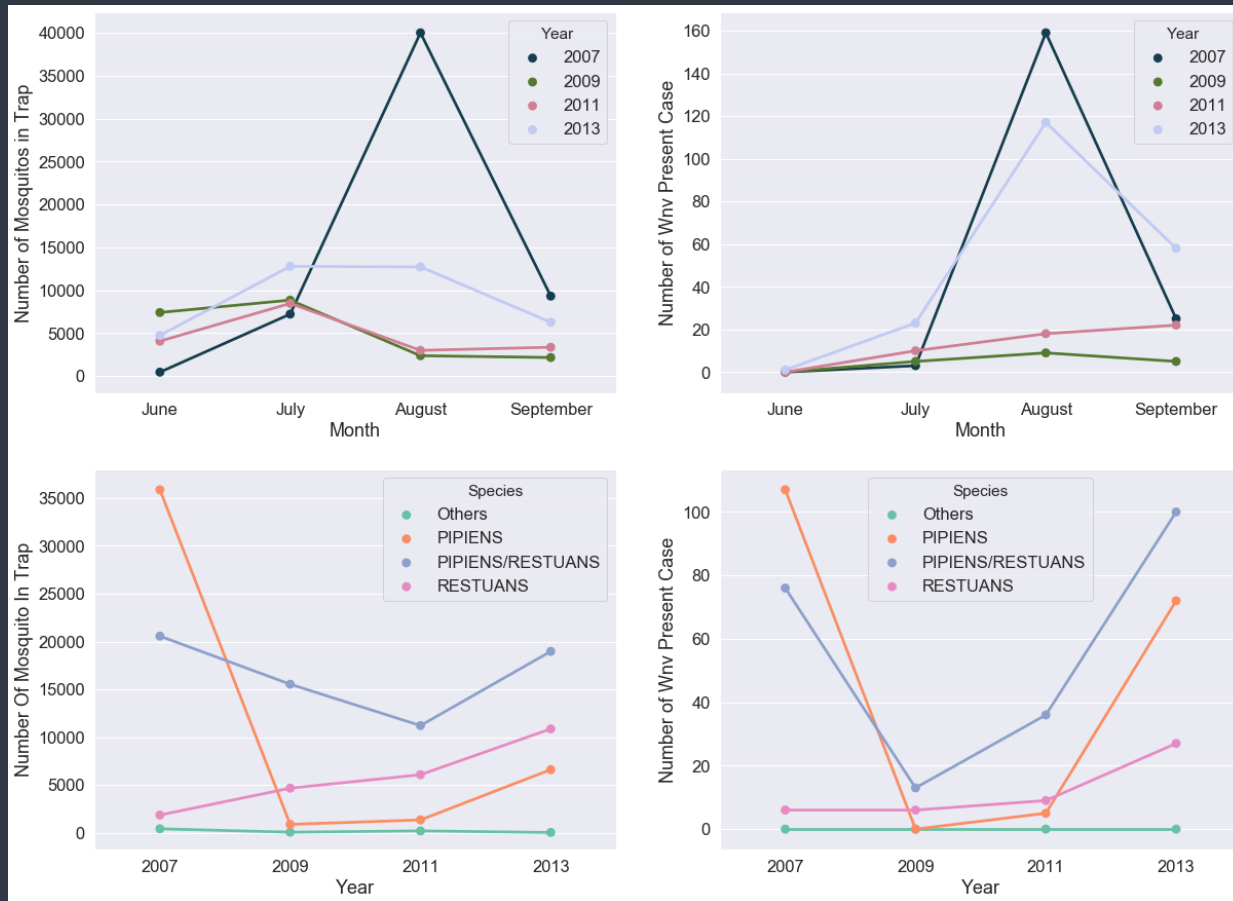


- Most number of Wnv positive mosquitos in August
- Most number of mosquitos in August for species Pipens & Pipens/Restuans
- Pipens & Pipens/Restuans seem to be the main contributors

ANALYSIS



TRAIN



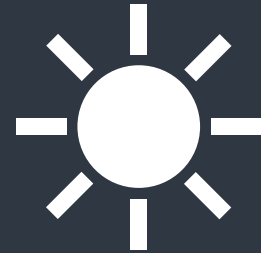
- Sharp drop in no. of Wnv Present cases between 2007 to 2009
- Sharp increase between 2011 and 2013
- Sharp drop in PIPENS mosquito from 2007 to 2009 and increase from 2011 to 2013
- PIPENS mosquito seems to be a major factor affecting whether Wnv is present

ANALYSIS



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

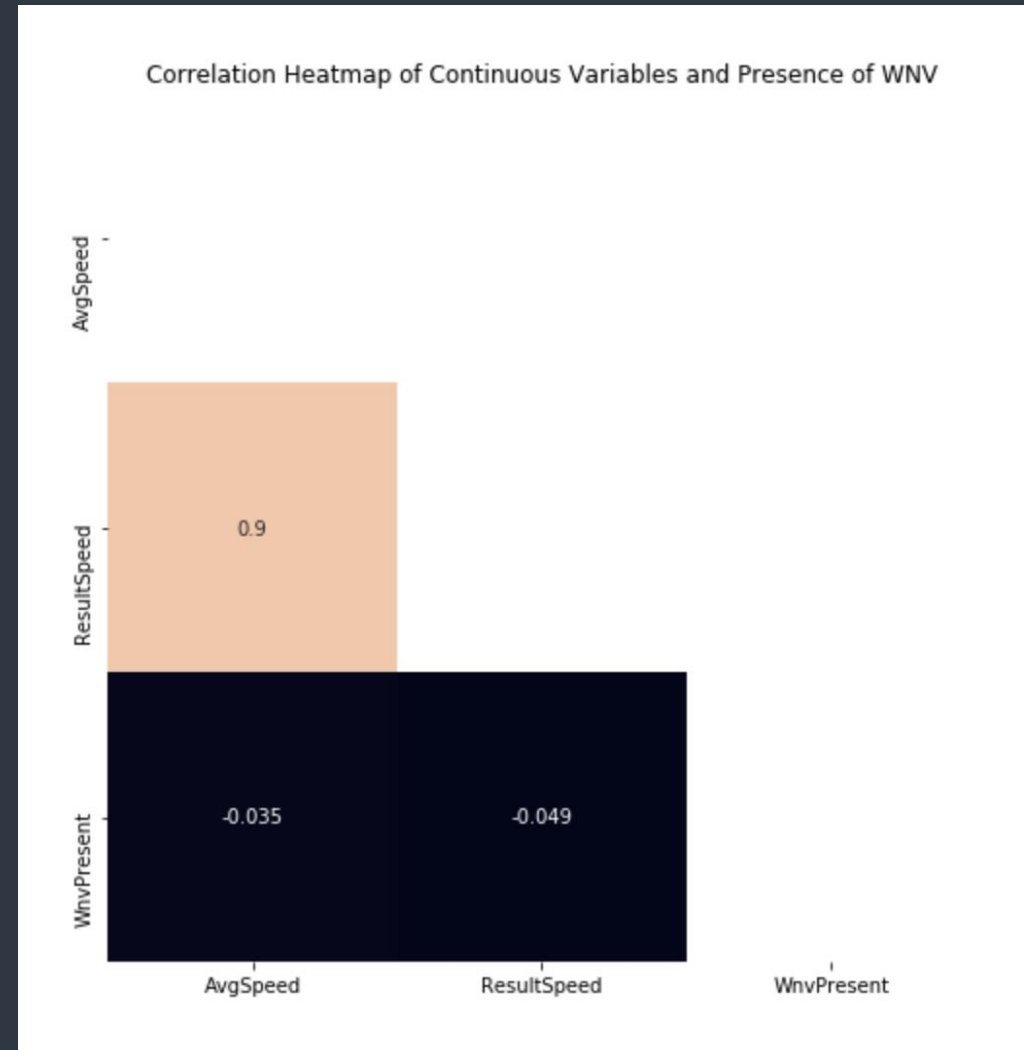


WEATHER

Removing Collinear Terms

AvgSpeed	0.034605
ResultSpeed	0.048893

ANALYSIS

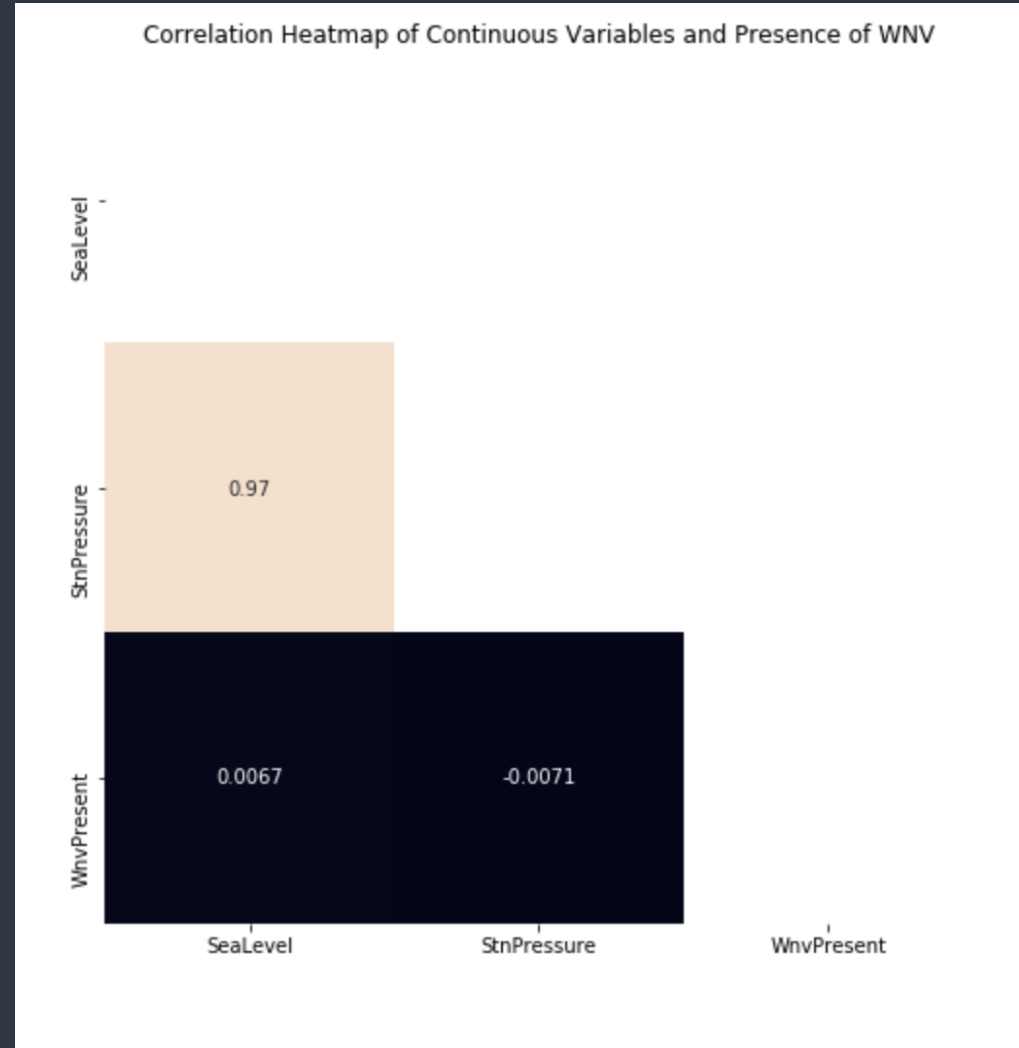


WEATHER

Removing Collinear Terms

SeaLevel	0.006738
StnPressure	0.007149

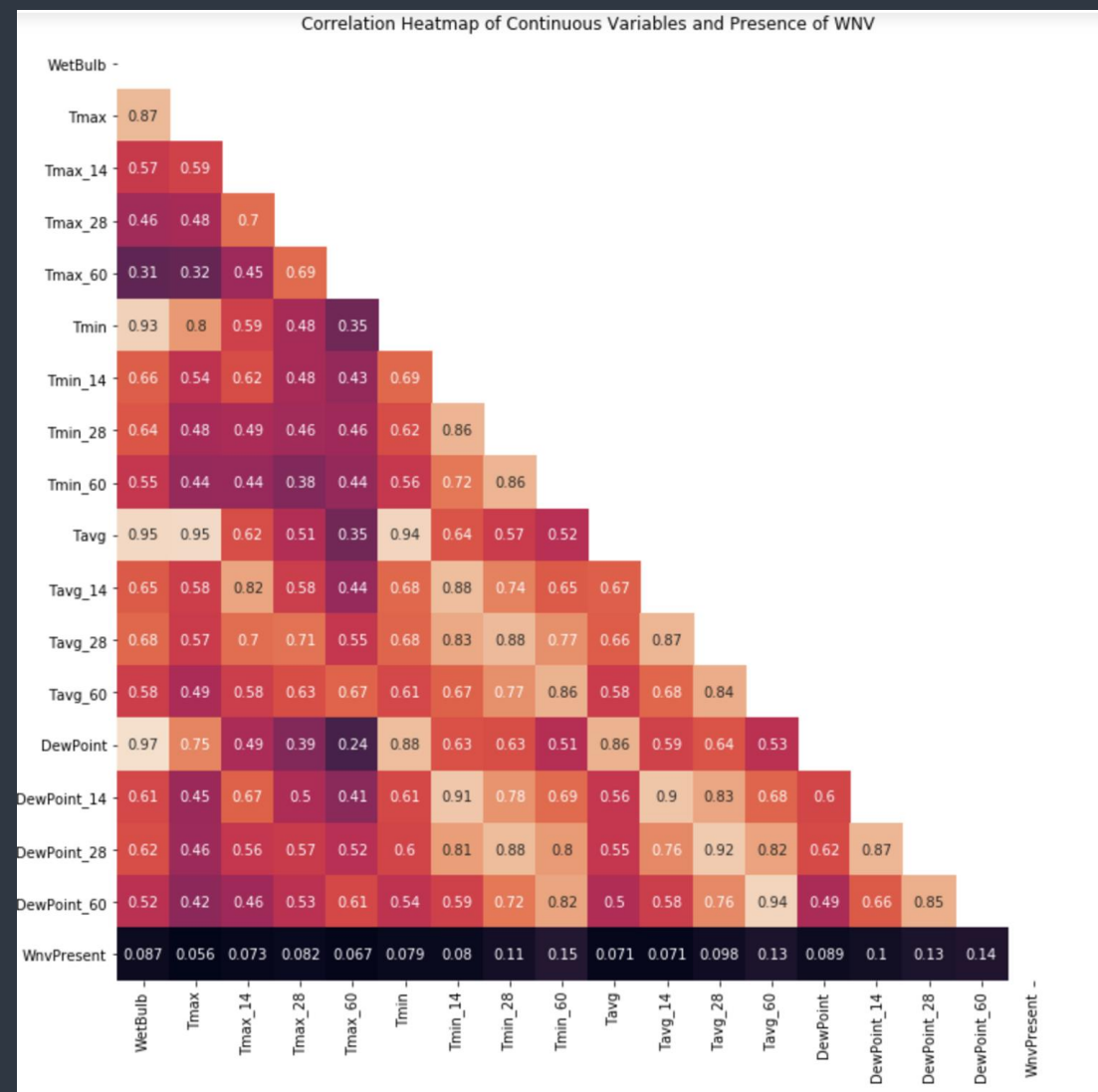
ANALYSIS



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



ANALYSIS

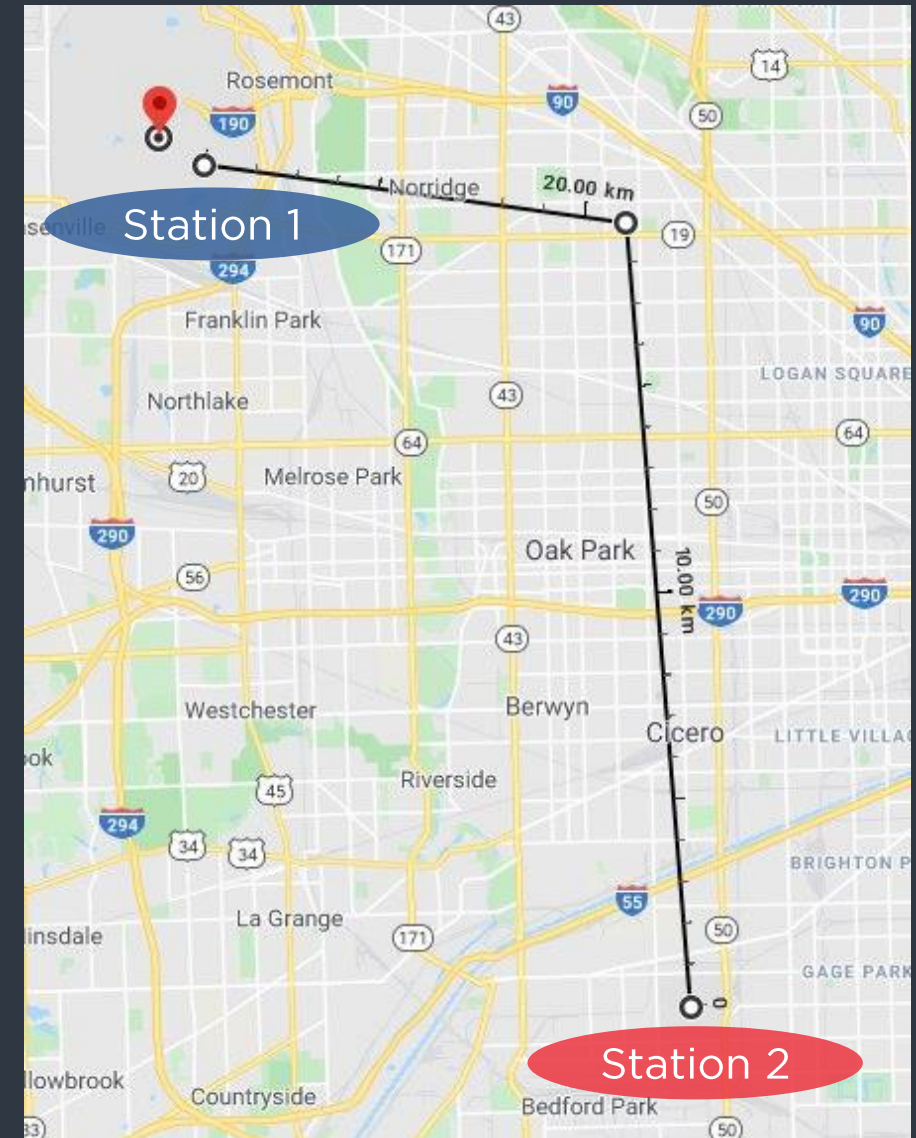


WEATHER + TRAIN/TEST

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

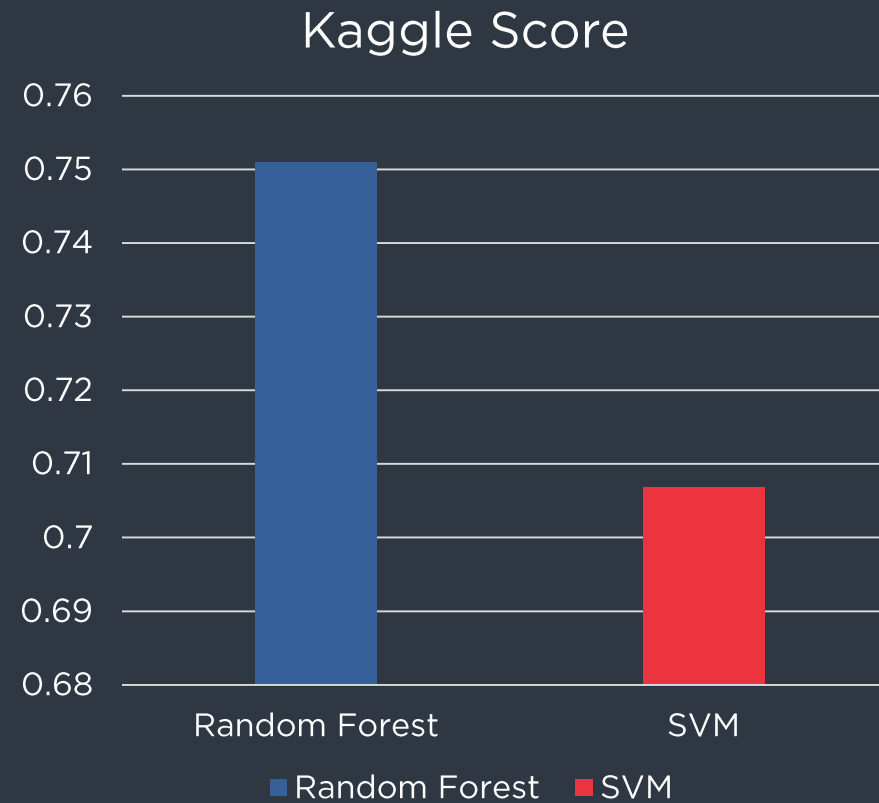


RANDOM FOREST CLASSIFIER

0.75095

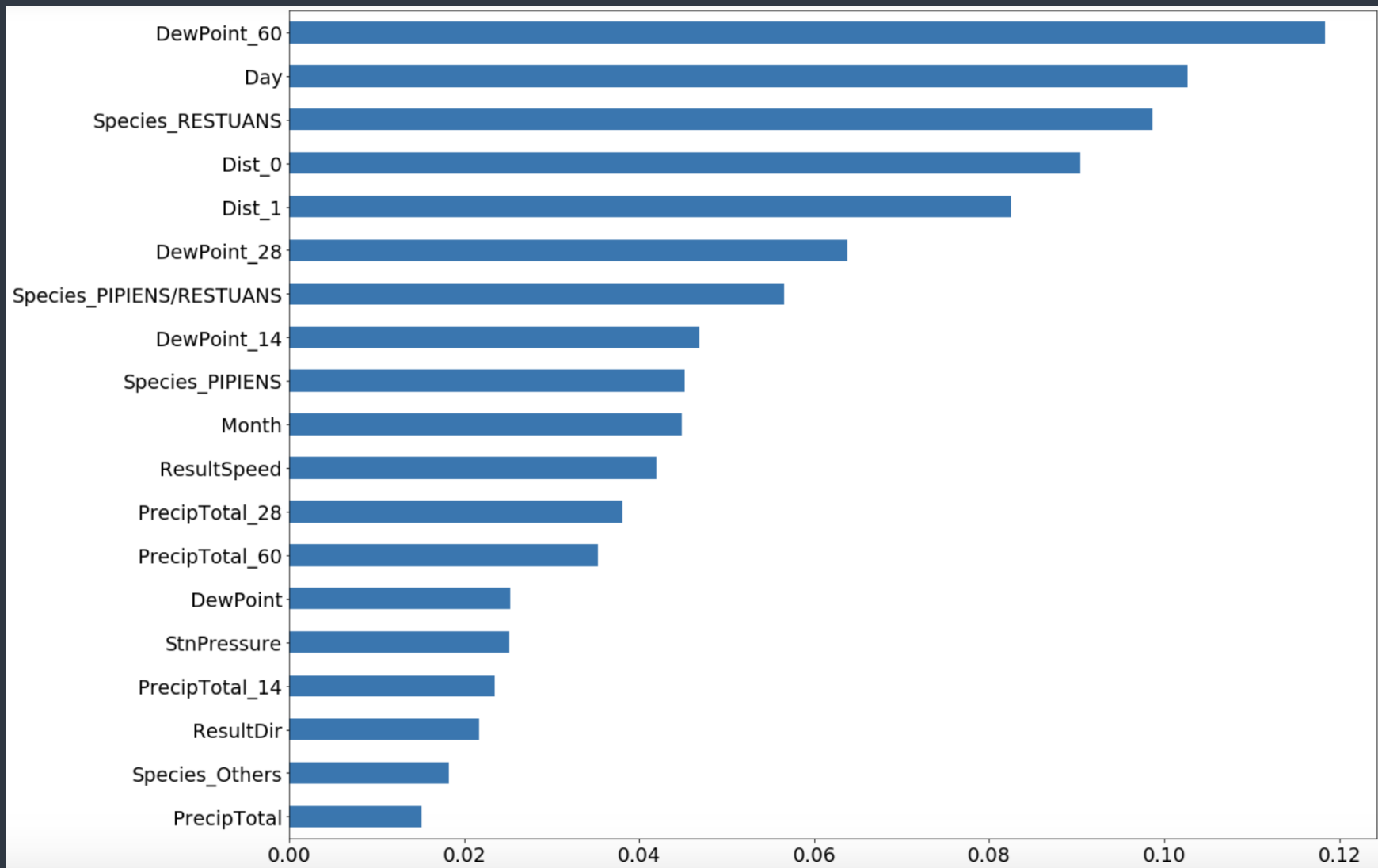
SUPPORT VECTOR CLASSIFIER

0.70679



MODELLING





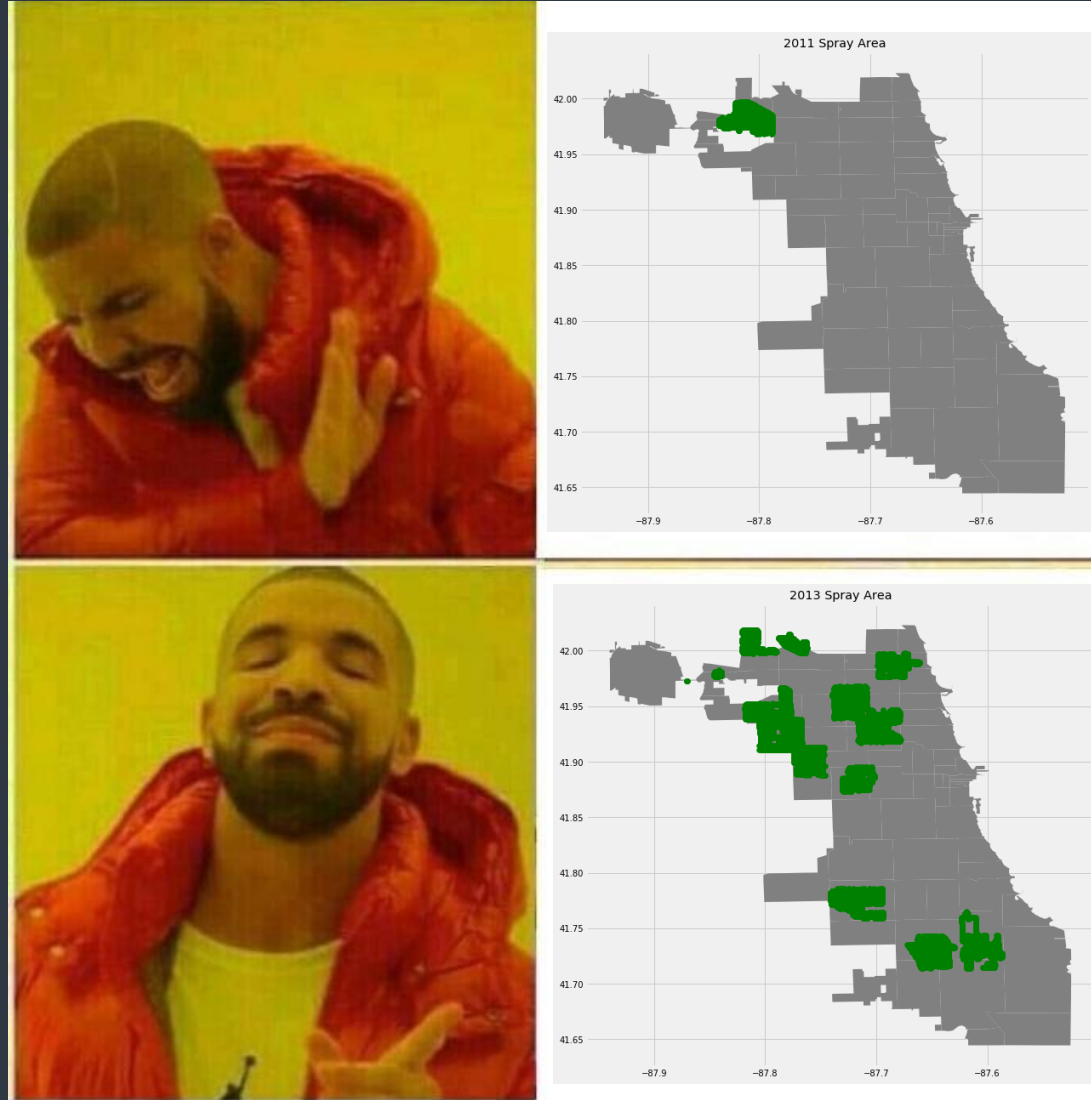
	feature	importance
11	DewPoint_60	0.120441
17	Day	0.103546
15	Species_RESTUANS	0.097625
18	Dist_0	0.091602
19	Dist_1	0.080730
10	DewPoint_28	0.064095
14	Species_PAPIENS/RESTUANS	0.054754
16	Month	0.047996
9	DewPoint_14	0.046940
13	Species_PAPIENS	0.044584
3	ResultSpeed	0.040102
7	PrecipTotal_28	0.039236
8	PrecipTotal_60	0.035143
2	StnPressure	0.025163
0	DewPoint	0.025135
6	PrecipTotal_14	0.023718
4	ResultDir	0.021070
12	Species_Others	0.018550
1	PrecipTotal	0.014365

MODELLING



SPRAY DATA

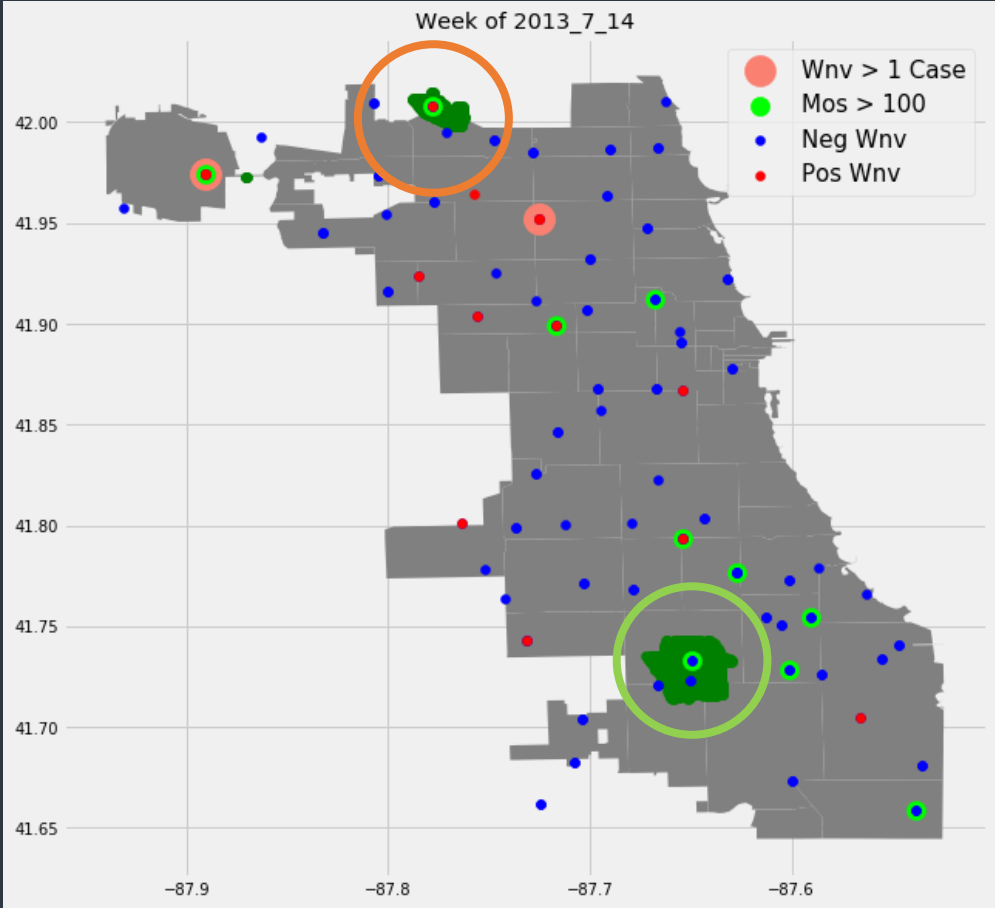
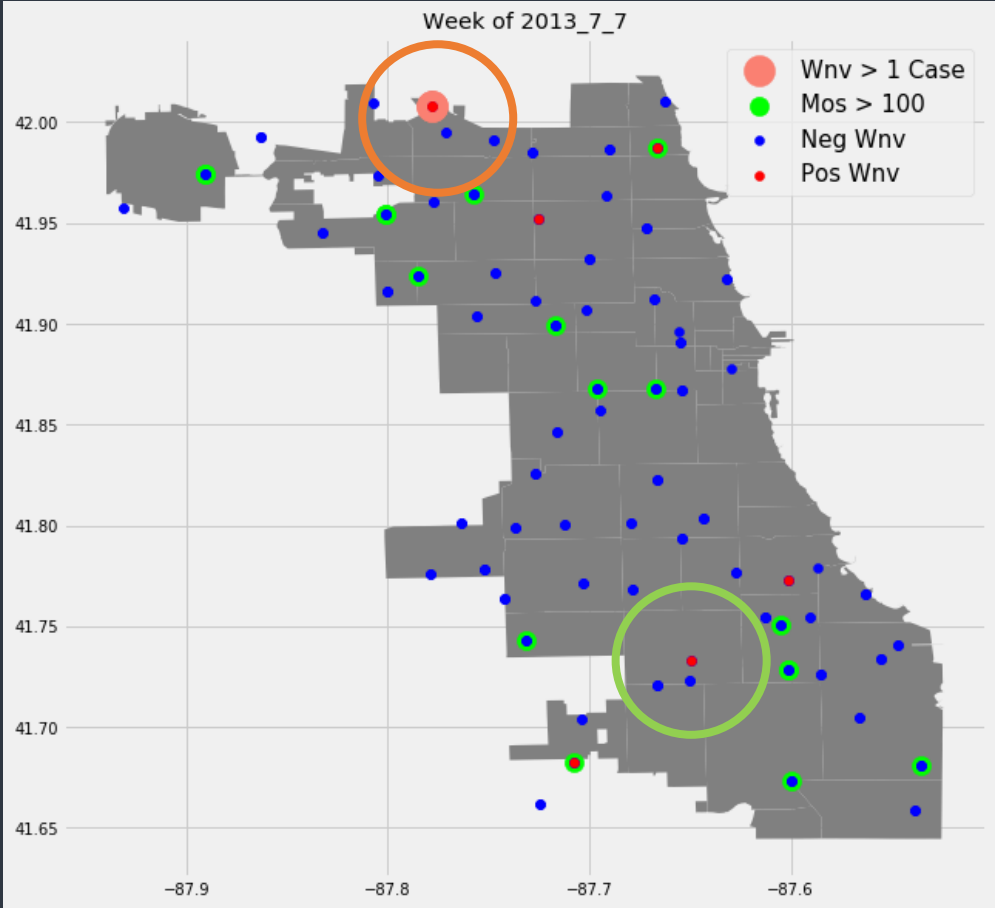
- 2011 data limited
- Analyse only on 2013



COST ANALYSIS



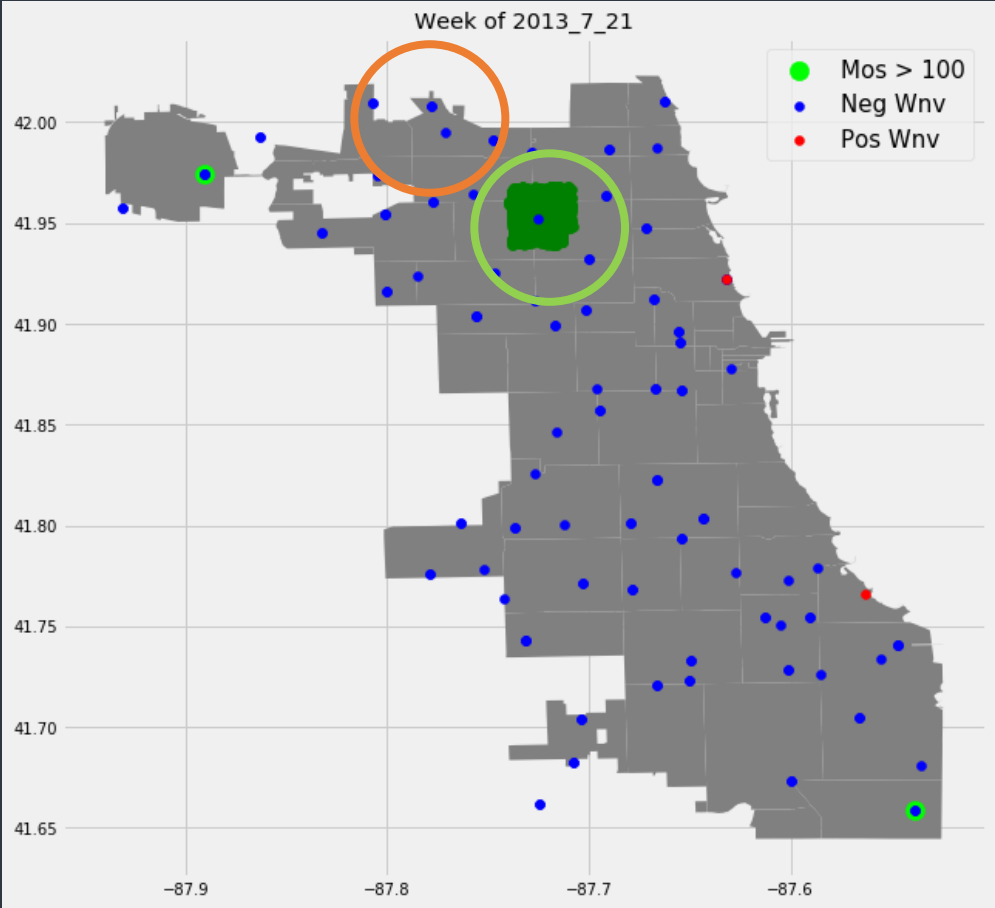
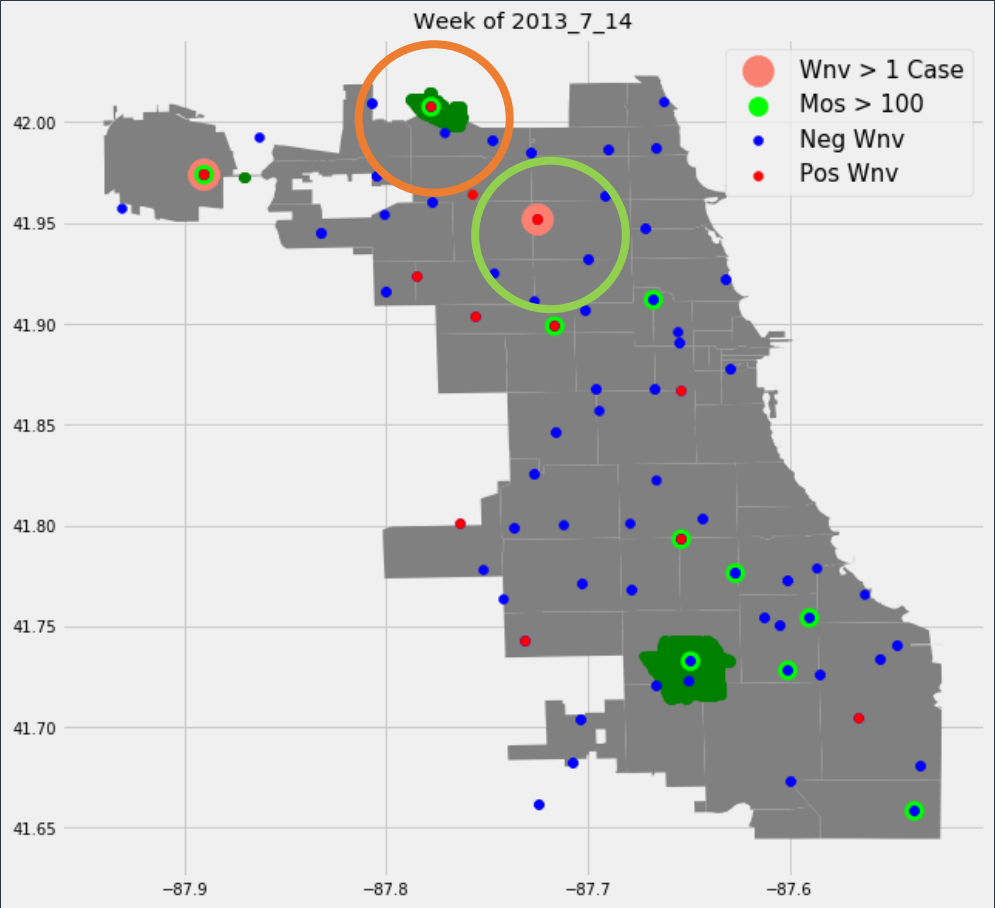
2013 SPRAY DATA



COST ANALYSIS



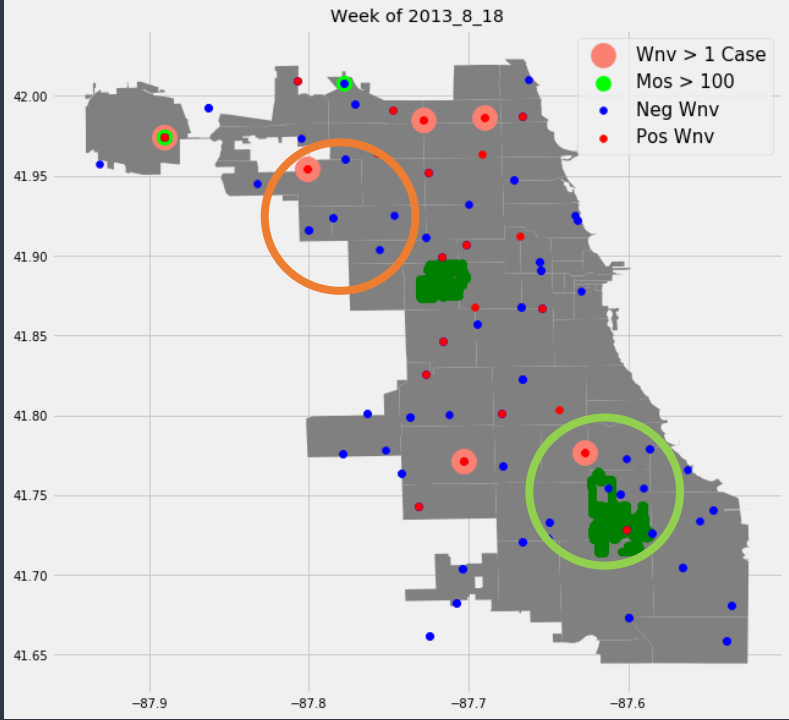
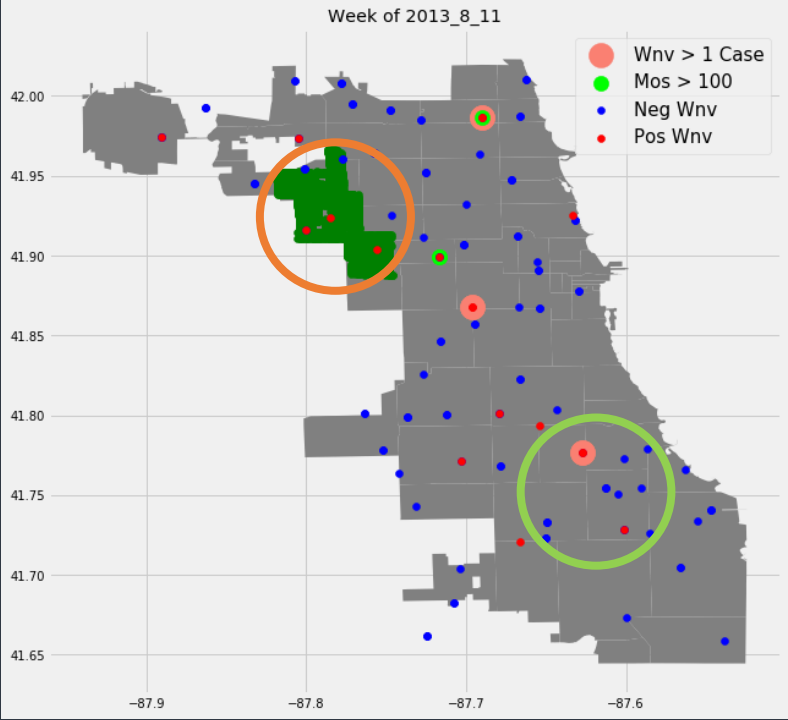
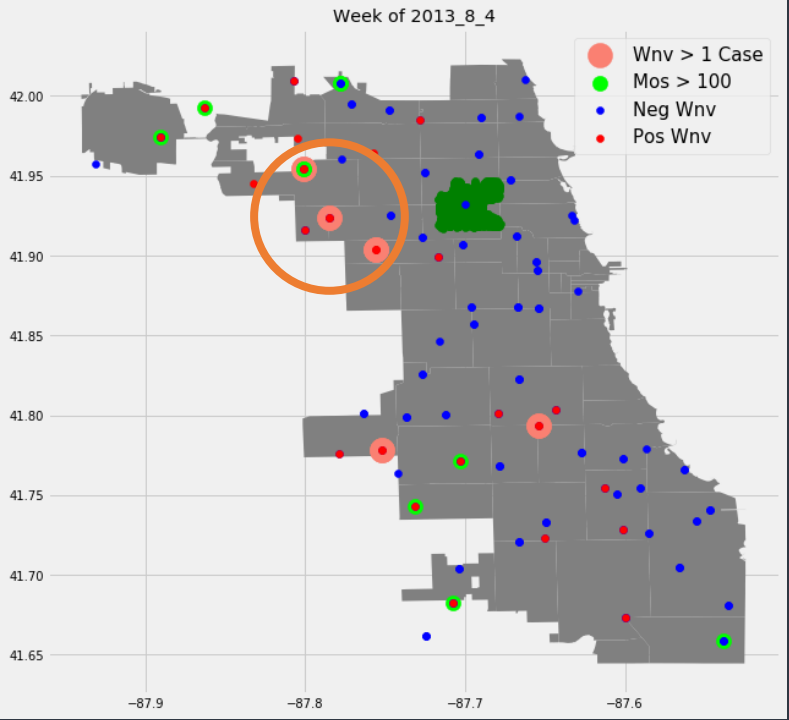
2013 SPRAY DATA



COST ANALYSIS



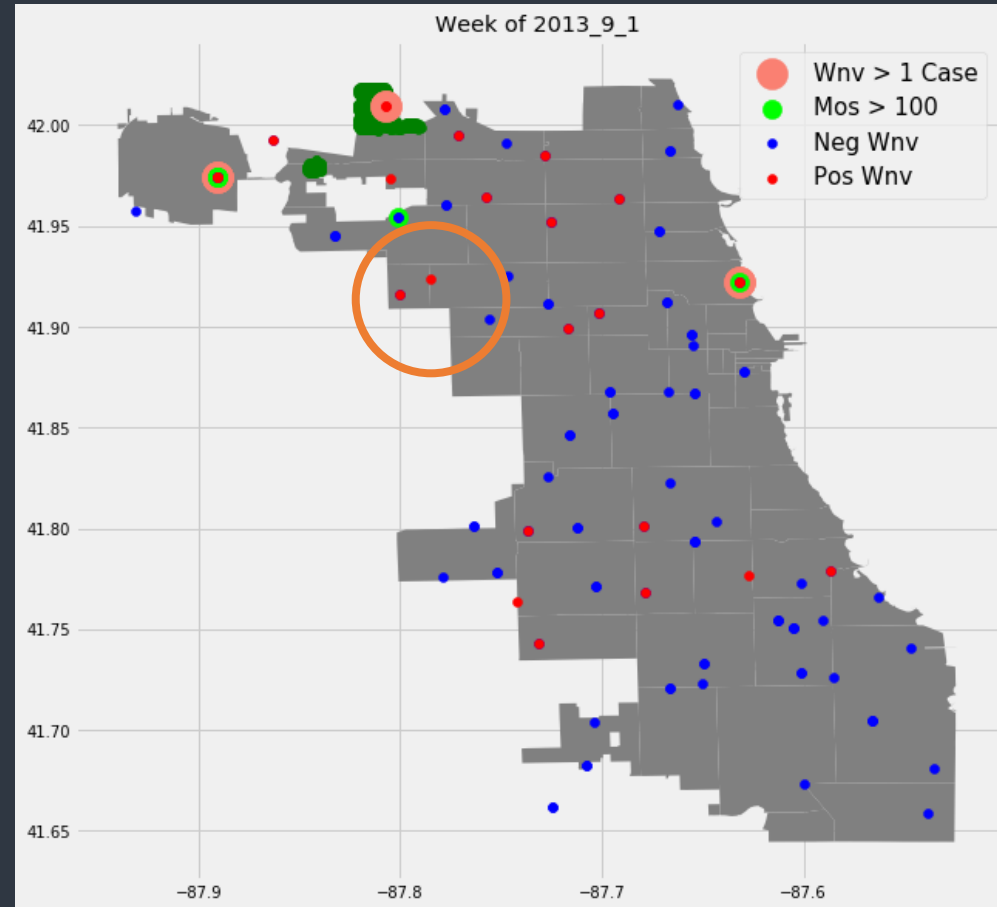
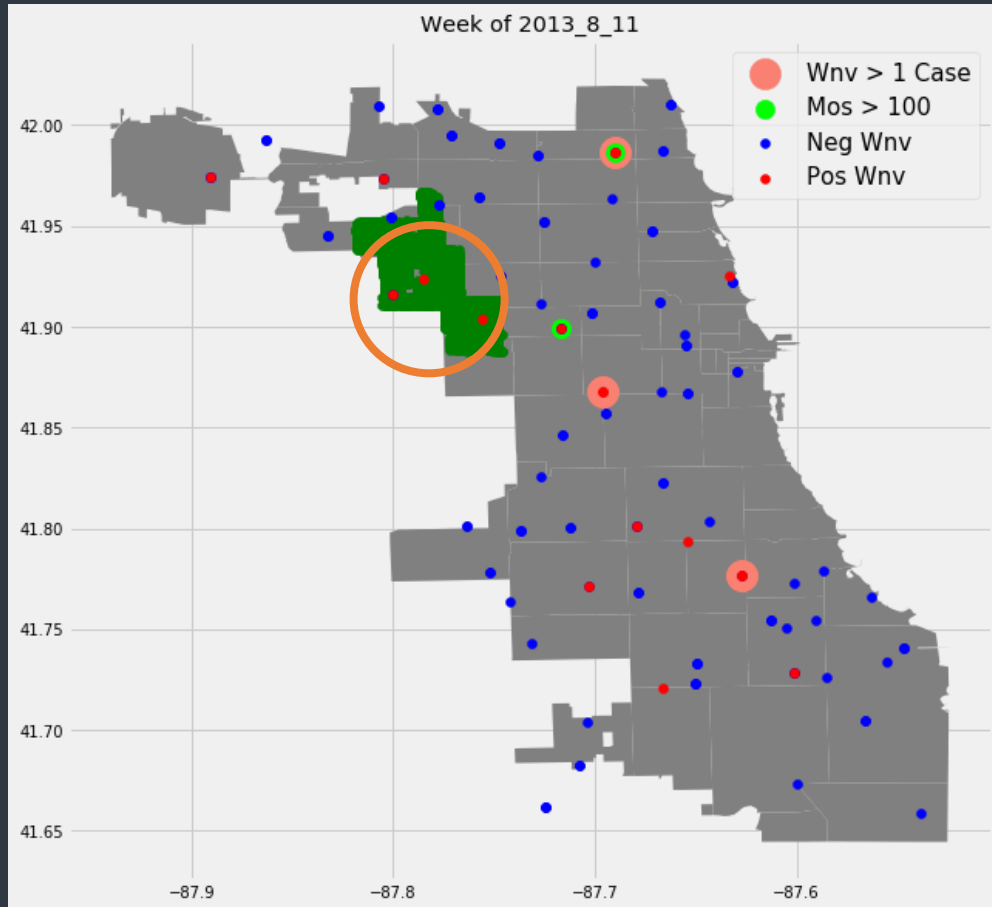
2013 SPRAY DATA



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

$$12626/14 = \mathbf{902 \text{ spray/+ve Wnv trap}}$$



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

Total: 199 Traps

OPTION 1

Total cost:

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

COST ANALYSIS



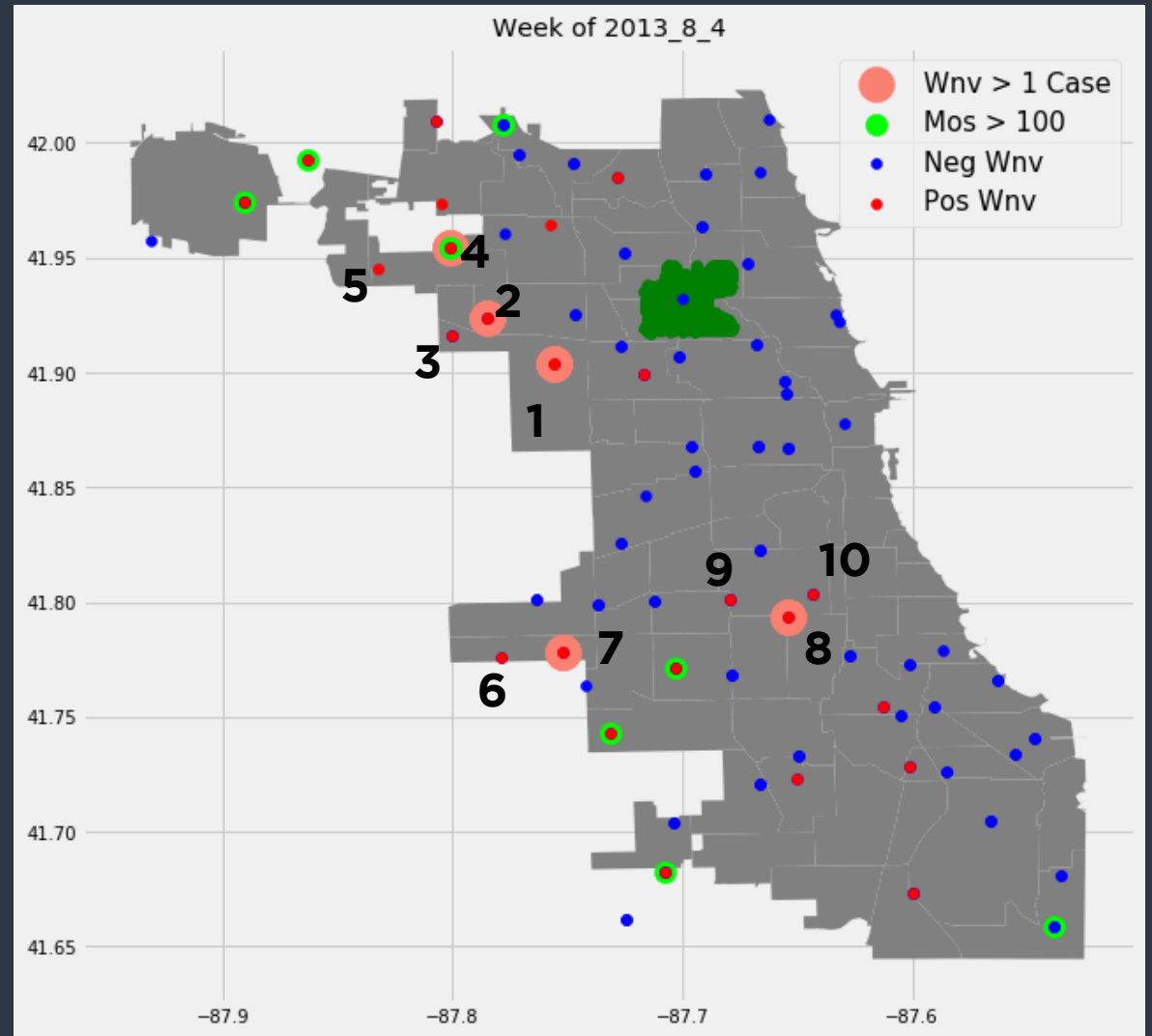
RECOMMENDATIONS

OPTION 2

Total: 41 Traps

Total cost:

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



COST ANALYSIS



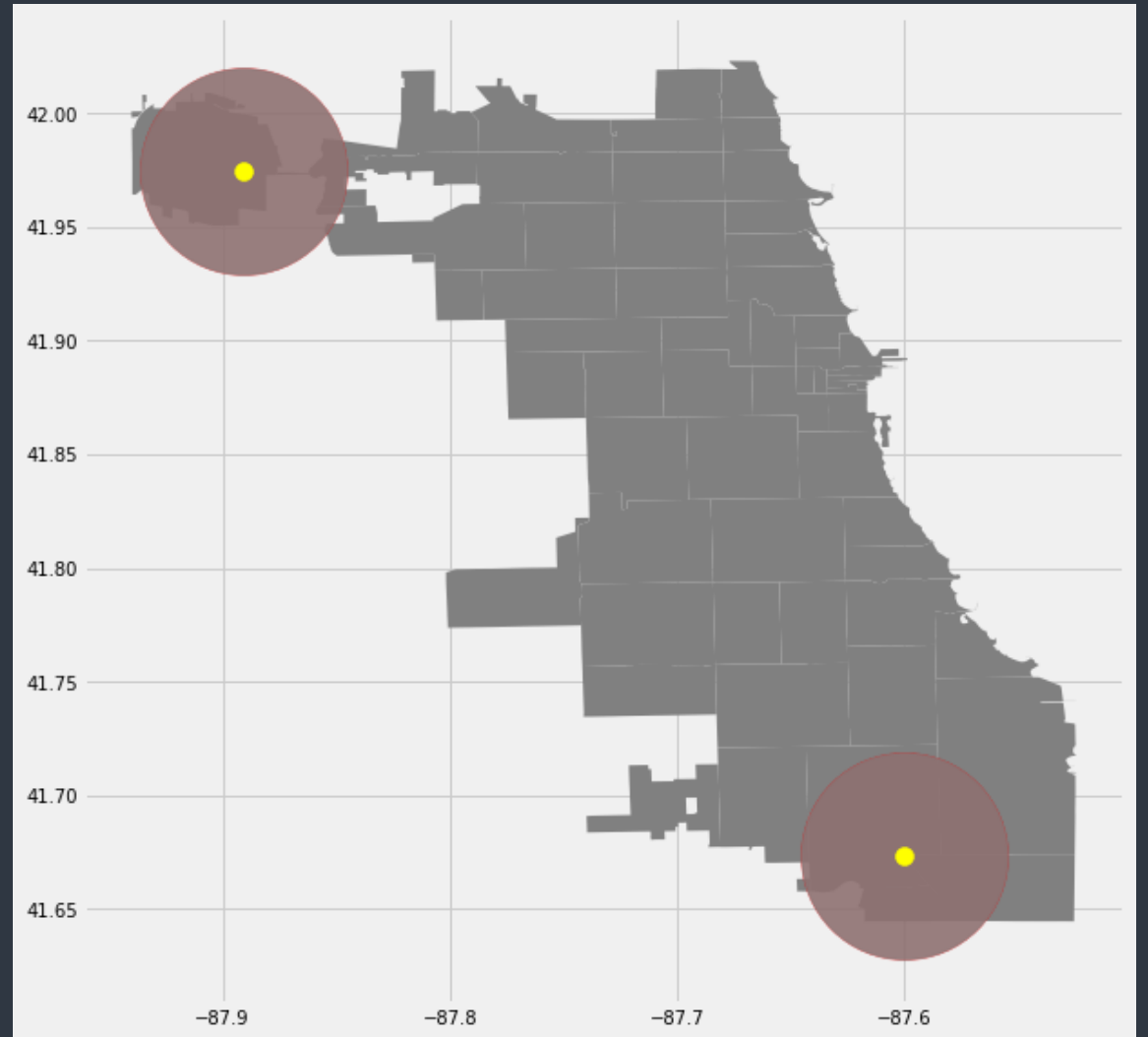
RECOMMENDATIONS

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	<ul style="list-style-type: none">Reduce Wnv +ve mosquito can be dramatically	<ul style="list-style-type: none">Reduce Wnv +ve mosquitos in high risk areaCost saving	<ul style="list-style-type: none">Focus effort in 2 specific areasSpray on lesser areas	<ul style="list-style-type: none">Long term fixed solution
Cons	<ul style="list-style-type: none">Costly	<ul style="list-style-type: none">Missing out some Wnv +ve traps	<ul style="list-style-type: none">Missing out some Wnv +ve traps	<ul style="list-style-type: none">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

