

A complex network diagram with various sized nodes in black, blue, and grey, connected by thin grey lines. Some nodes are highlighted with larger circles. The background is light grey with faint circular patterns.

# SPATIAL ANALYSIS AND FORECASTING

August 2024

# ABOUT ME...

## **Angela Backer-Hines**

*Analyst since 2005; have worked at task forces, state fusion center, city and county law enforcement agencies*

*Master's Degree in Criminal Behavior from Tiffin University*

*CLEA since 2012*

*CICA since 2017, Lifetime CICA in 2022*

*Currently work for the Eagan Police Department in MN*

*On the training and certification committees, and an instructor for the IACA and Arizona State University's Crime Analysis Masters Program.*

[abhines@cityofeagan.com](mailto:abhines@cityofeagan.com)



# SPATIAL ANALYSIS AND PREDICTION



## Cluster Methods

- Geographic Profiling
- Mean Distance
- Repeat/  
Near-Repeat



## Moving Trends

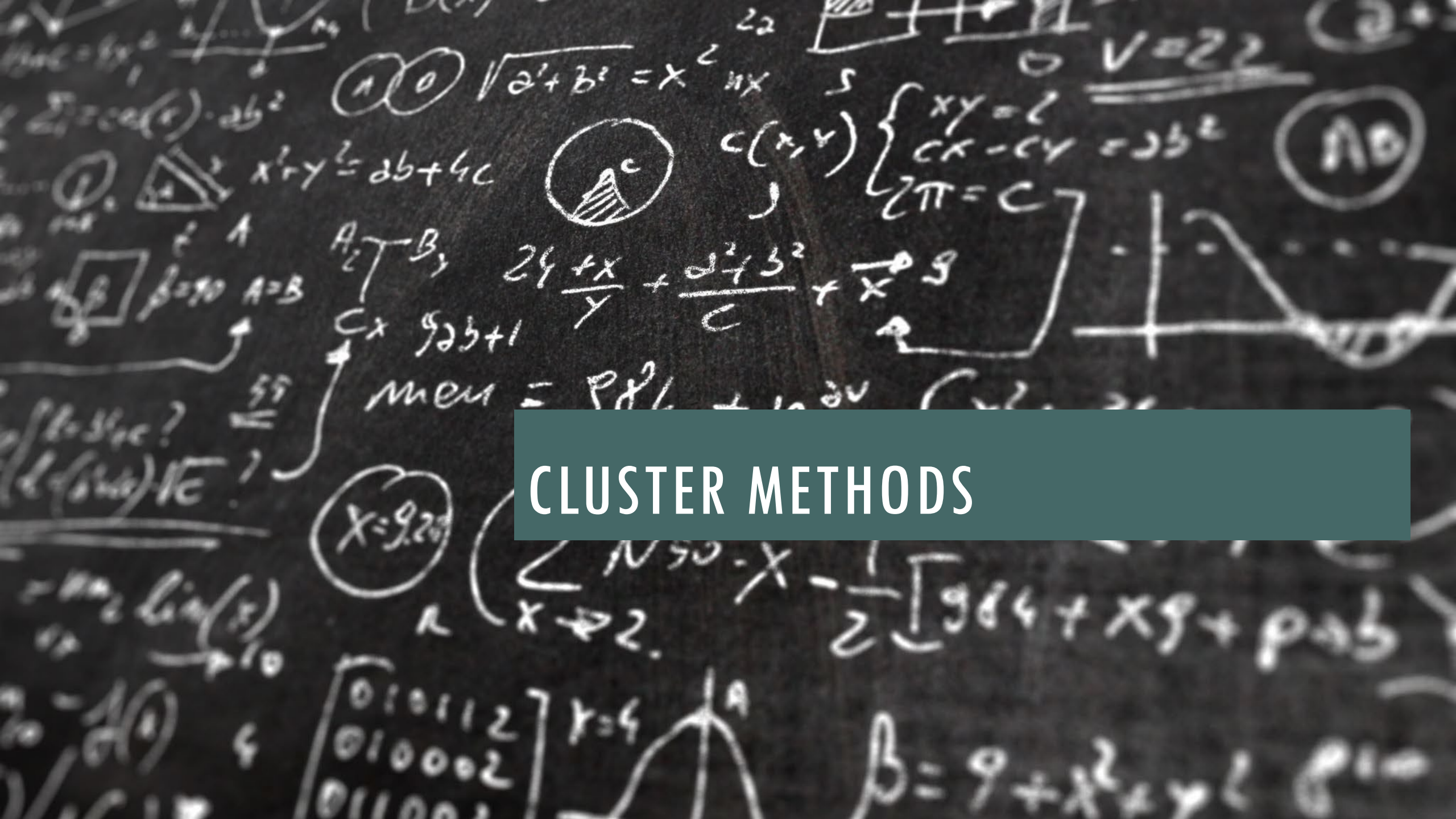
- Geographic Progression
- Space/Time Patterns

# REMINDERS

- These specific techniques are best applied to series predictions.
- Calculations for overall patterns and trends utilize different spatial analysis techniques (hotspot tools: 80/20, density-based clustering, emerging hotspot, and other techniques like RTM, etc.)



# CLUSTER METHODS



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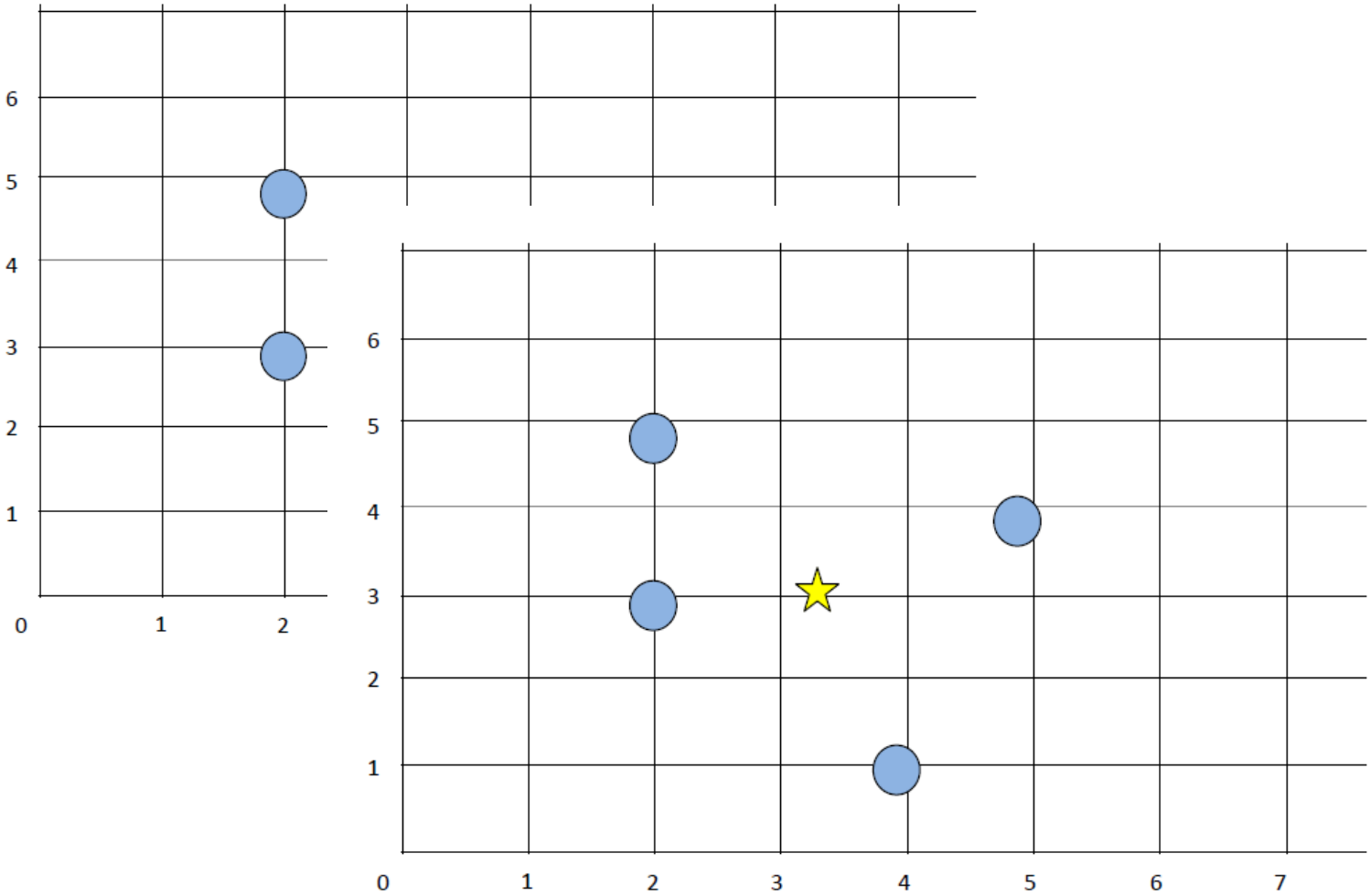
# GEOGRAPHIC PROFILING



# GEOGRAPHIC PROFILING

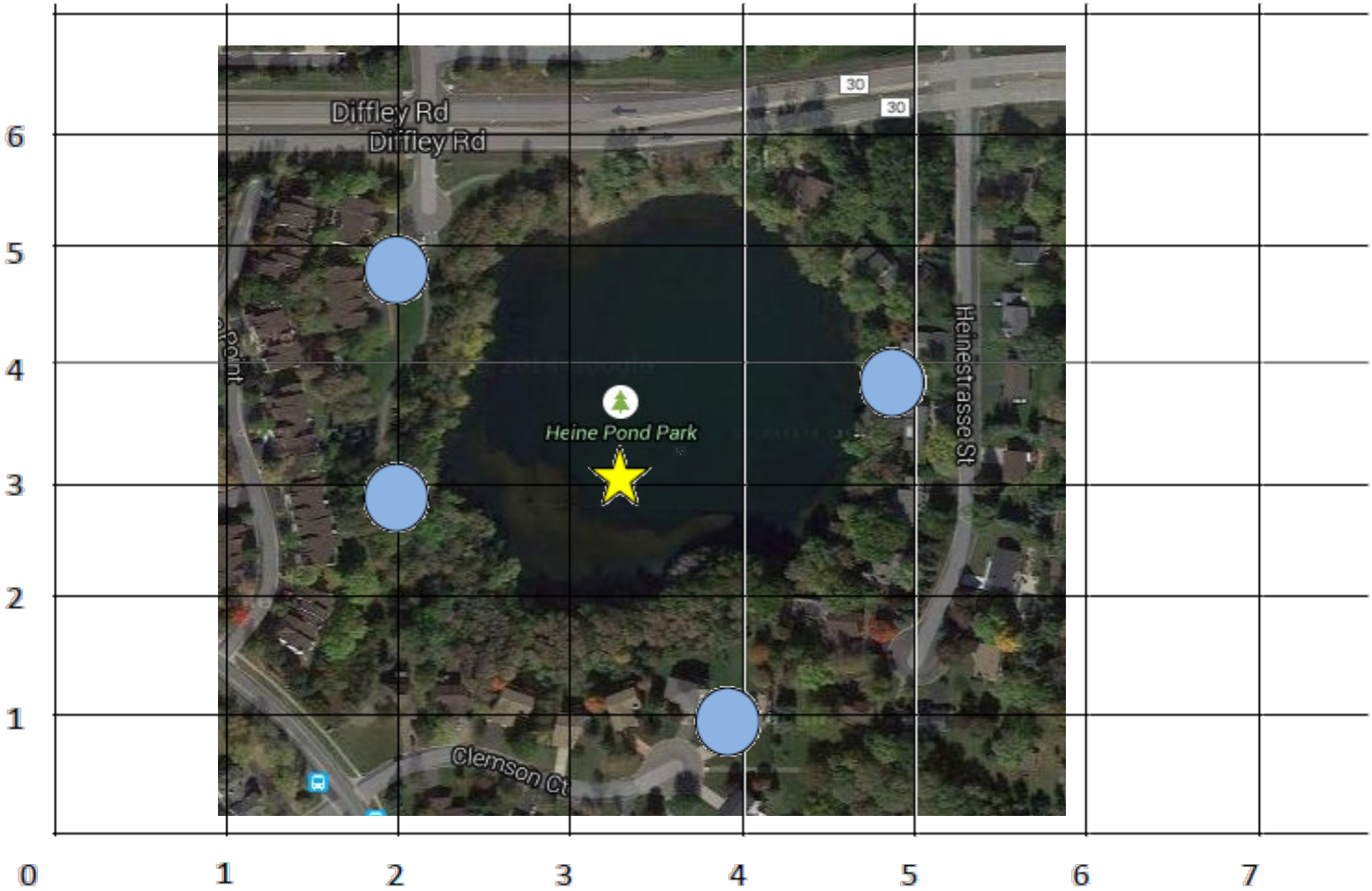
- Predicting where your serial offender lives.
- Using mapping and calculations.
  - Using the spatial mean of the crime locations, you can predict where the offender lives within 2 blocks with 90% accuracy (*if they live in the city – otherwise could indicate another node of frequent activity*)

# GEOGRAPHIC PROFILING





# GEOGRAPHIC PROFILING

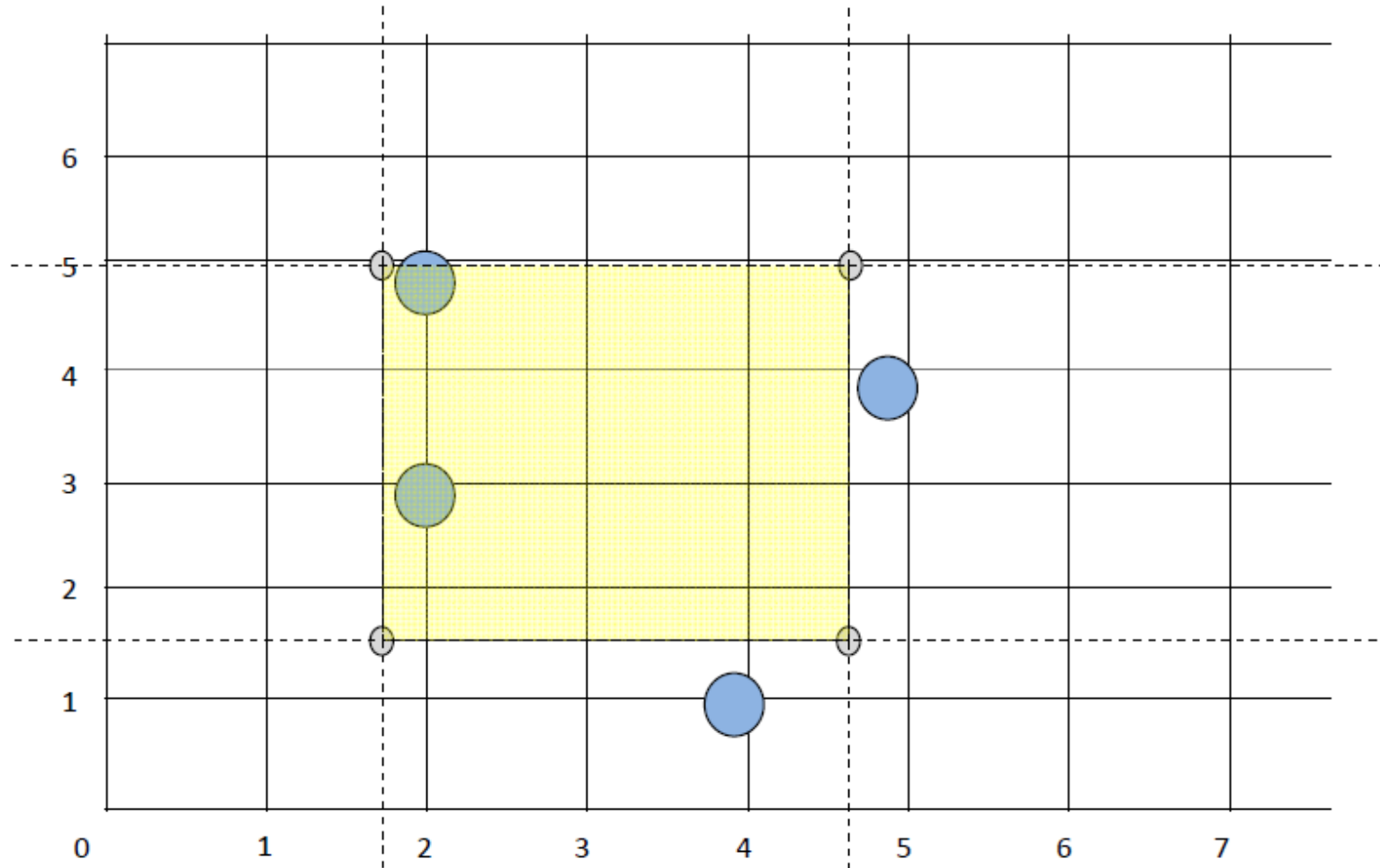


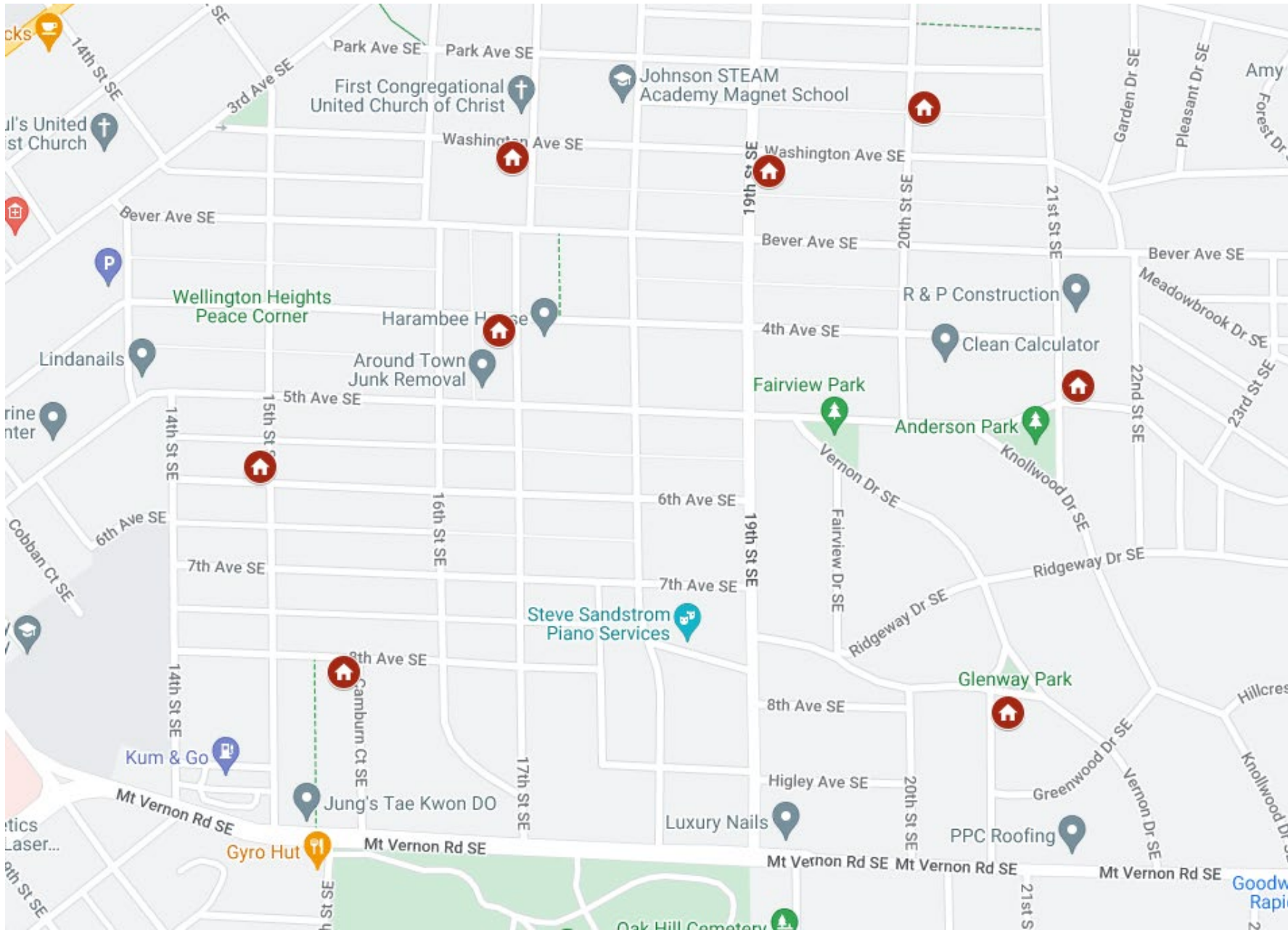
# NEXT LOCATION

- Predicting the next incident in a series
- Using mapping and calculations –
  - Use the same map/graph and calculate the standard deviation of the points to identify the target area.



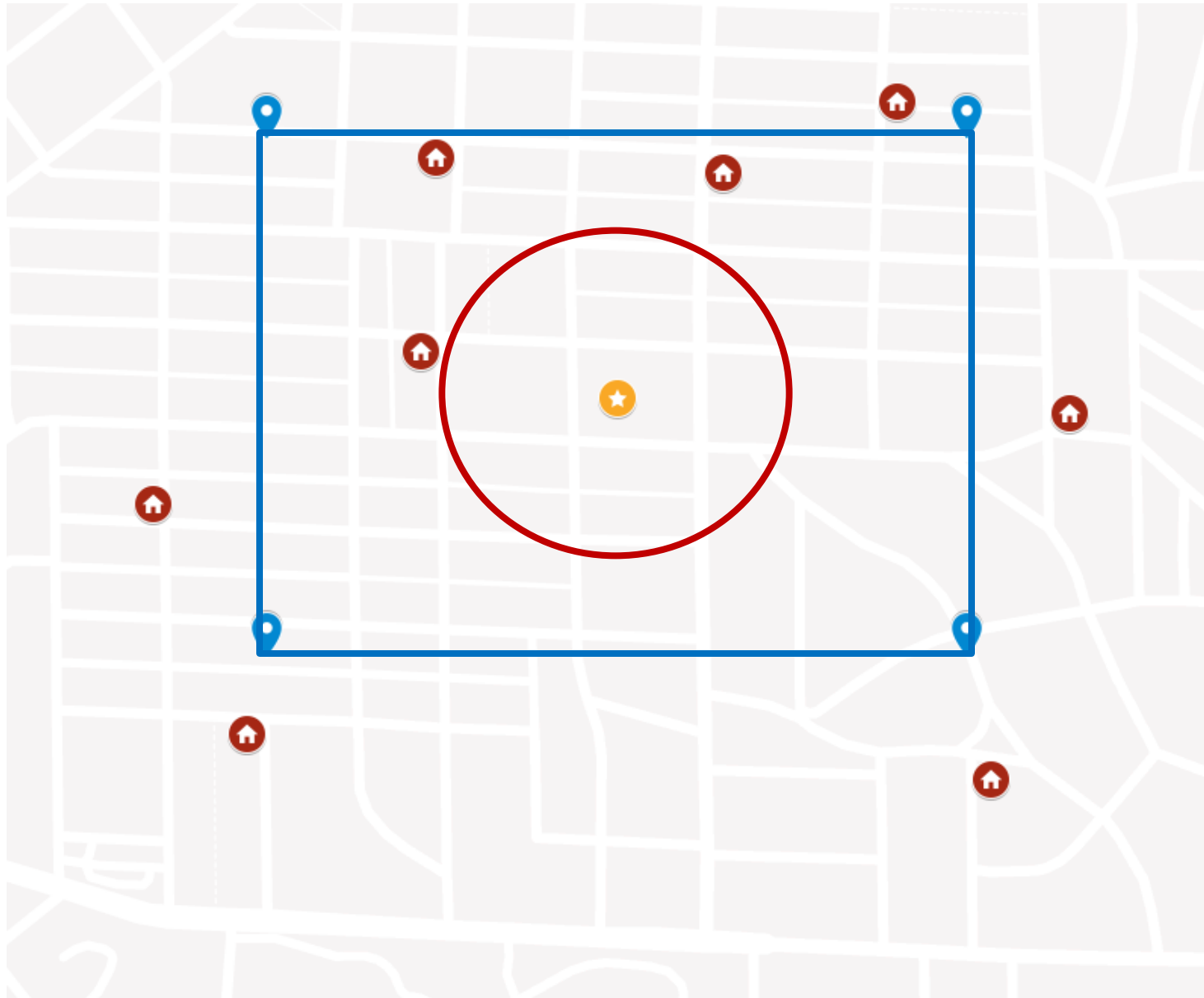
# NEXT LOCATION





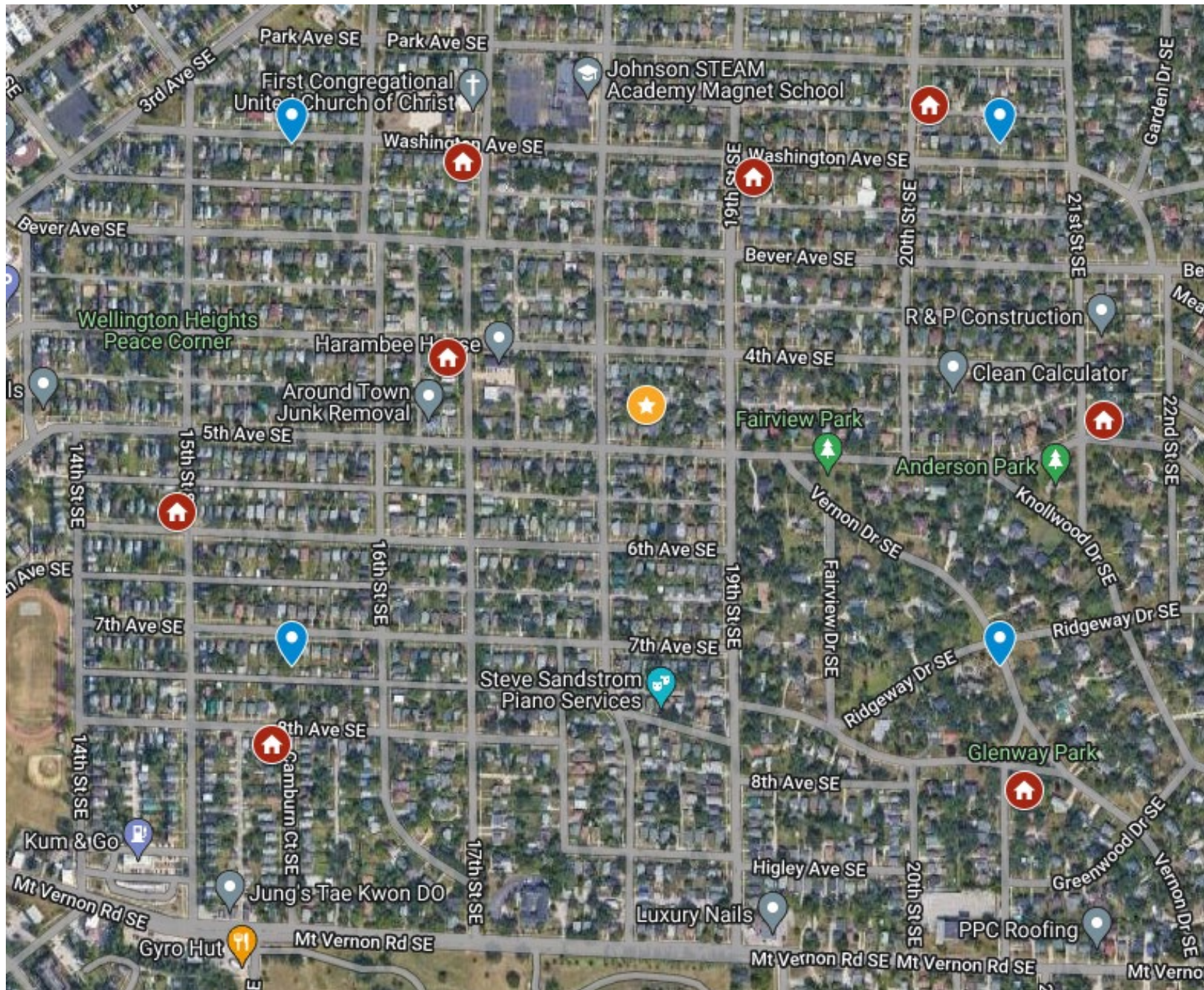
Lat(Y)	Long(X)
41.98533	-91.6426
41.98343	-91.6469
41.983	-91.6377
41.97938	-91.6493
41.97892	-91.6388
41.98606	-91.6401
41.98546	-91.6466
41.98181	-91.6507



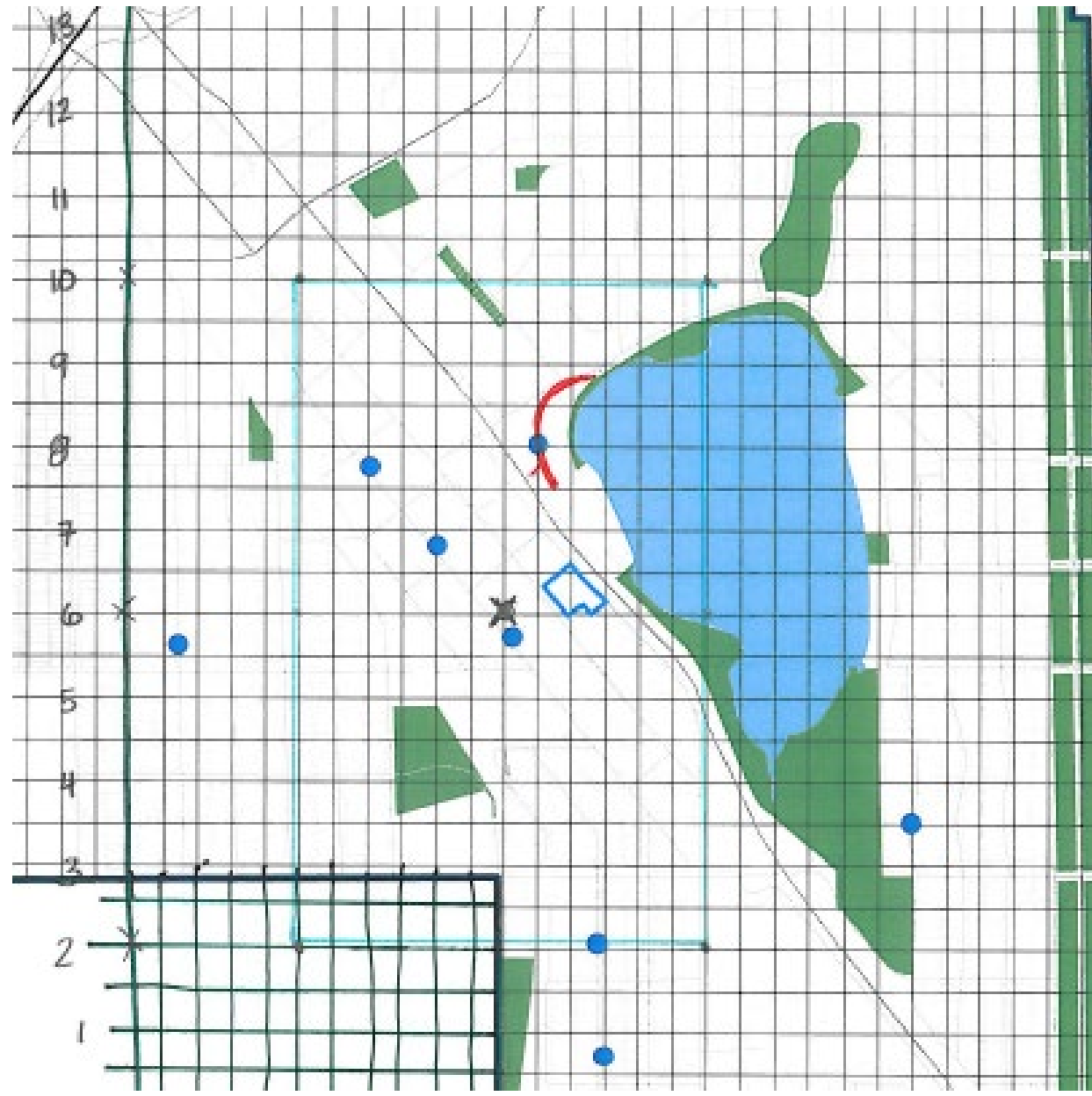


	Lat(Y)	Long(X)
	41.98533	-91.6426
	41.98343	-91.6469
	41.983	-91.6377
	41.97938	-91.6493
	41.97892	-91.6388
	41.98606	-91.6401
	41.98546	-91.6466
	41.98181	-91.6507
<b>Average</b>	<b>41.98292</b>	<b>-91.6441</b>
<b>Std Dev</b>	<b>0.002728</b>	<b>0.004969</b>

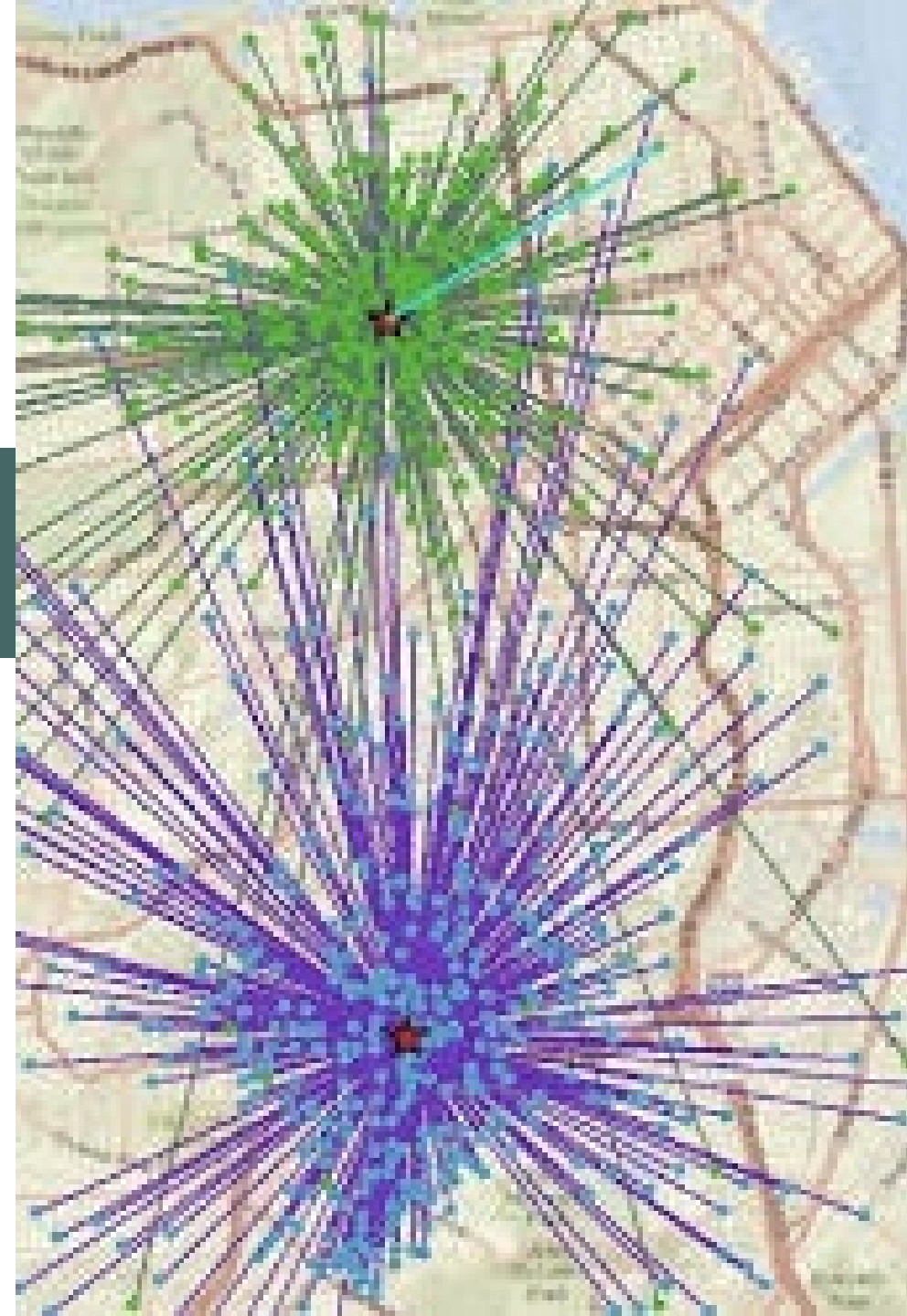
<b>Prediction Point 1</b>	41.98565	-91.6391
<b>Prediction Point 2</b>	41.98565	-91.6491
<b>Prediction Point 3</b>	41.9802	-91.6391
<b>Prediction Point 4</b>	41.9802	-91.6491







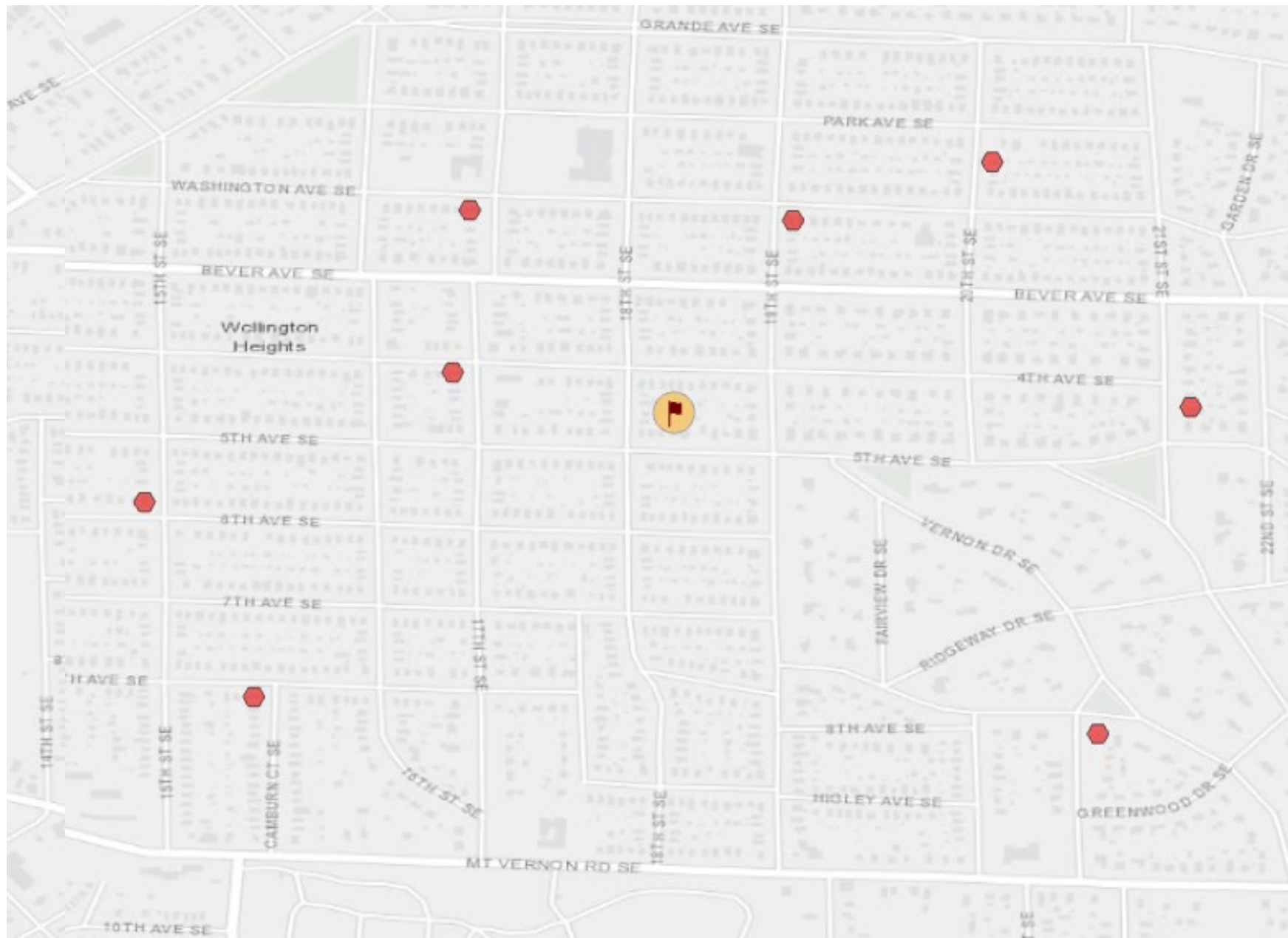
# MEAN DISTANCES



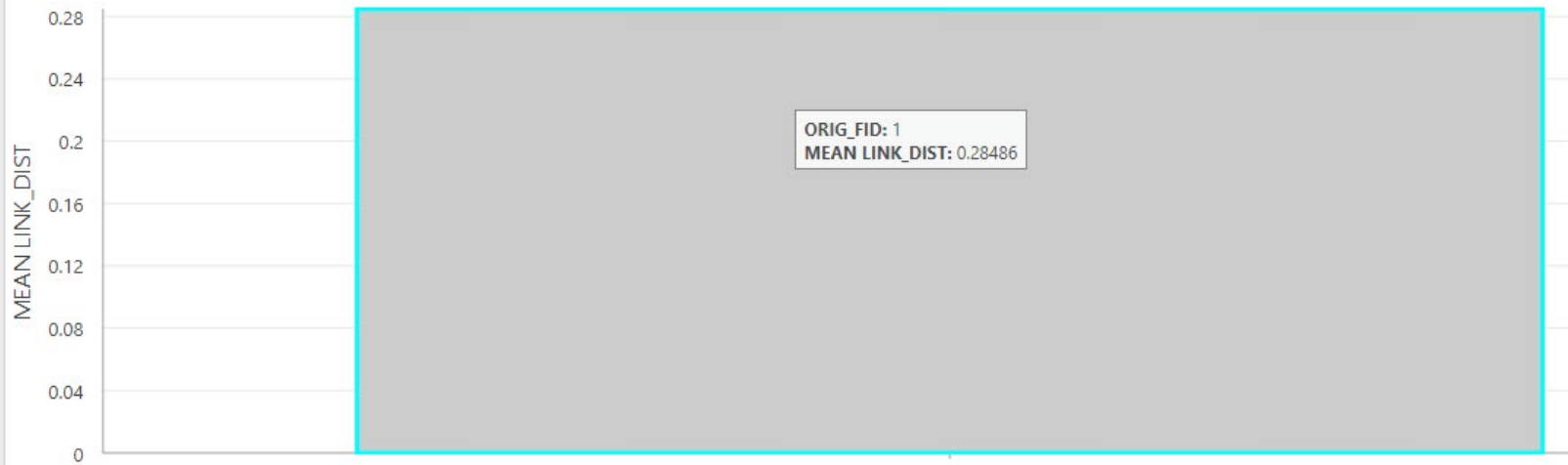
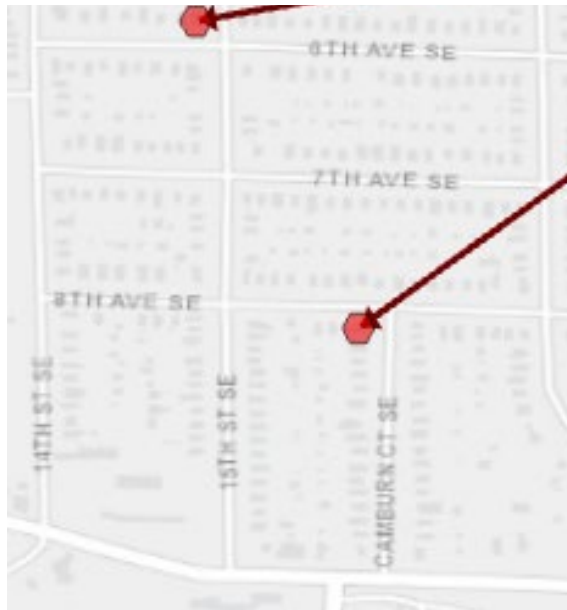
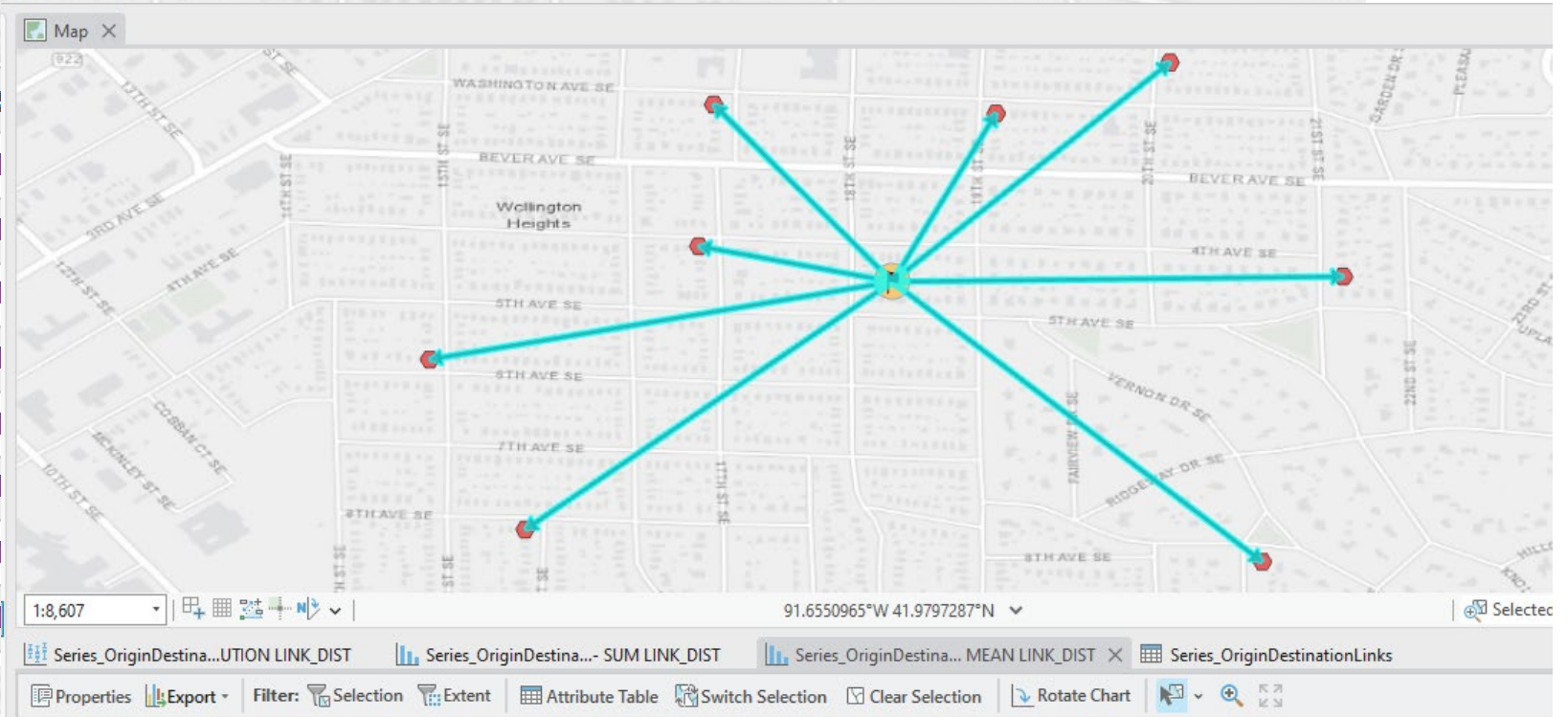


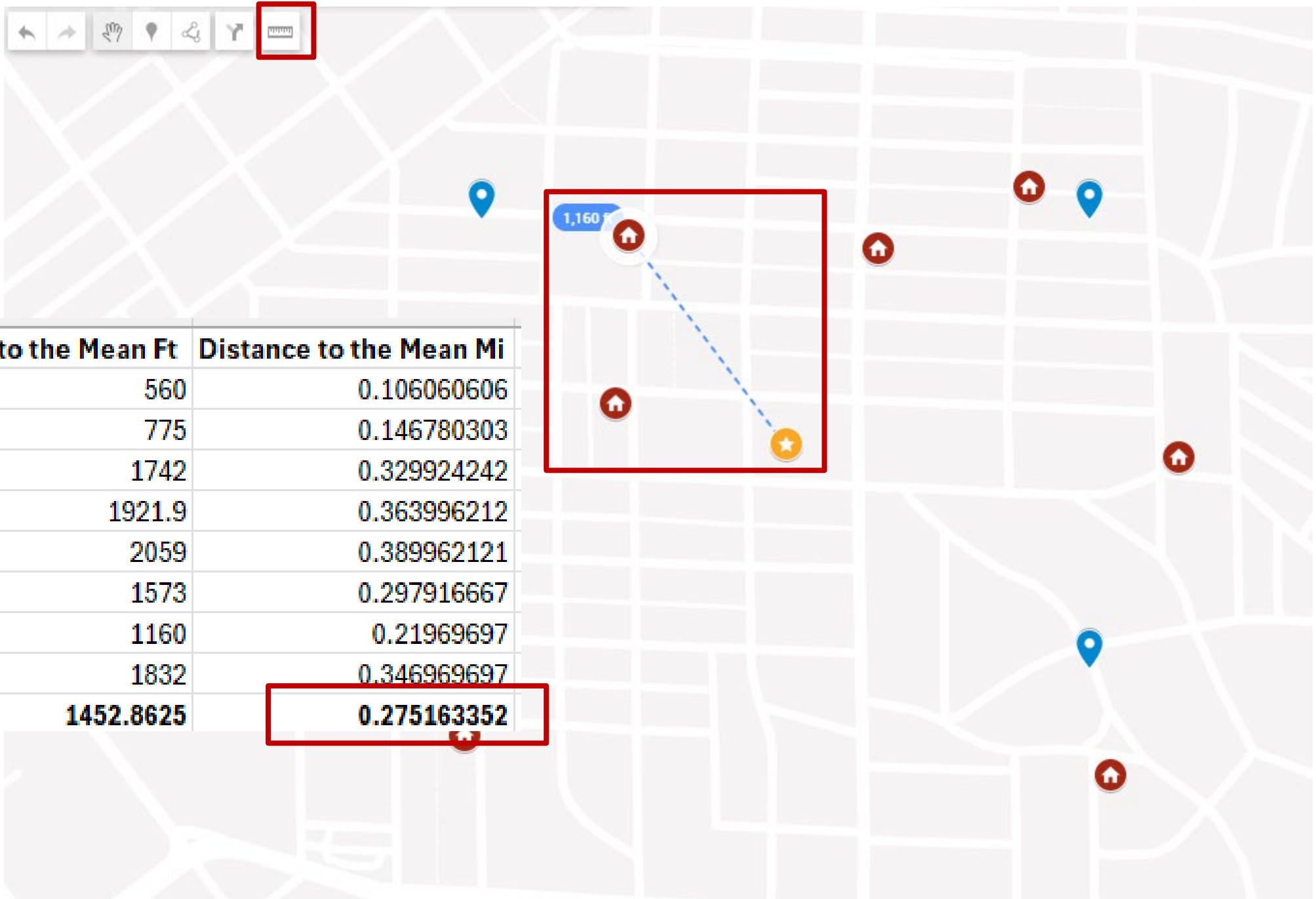
# MEAN SPIDER DISTANCE

- The distance of each crime from the arithmetic center of the series (basically the mean).
- Calculate the standard deviation of the mean and that is your spatial prediction for your next event.



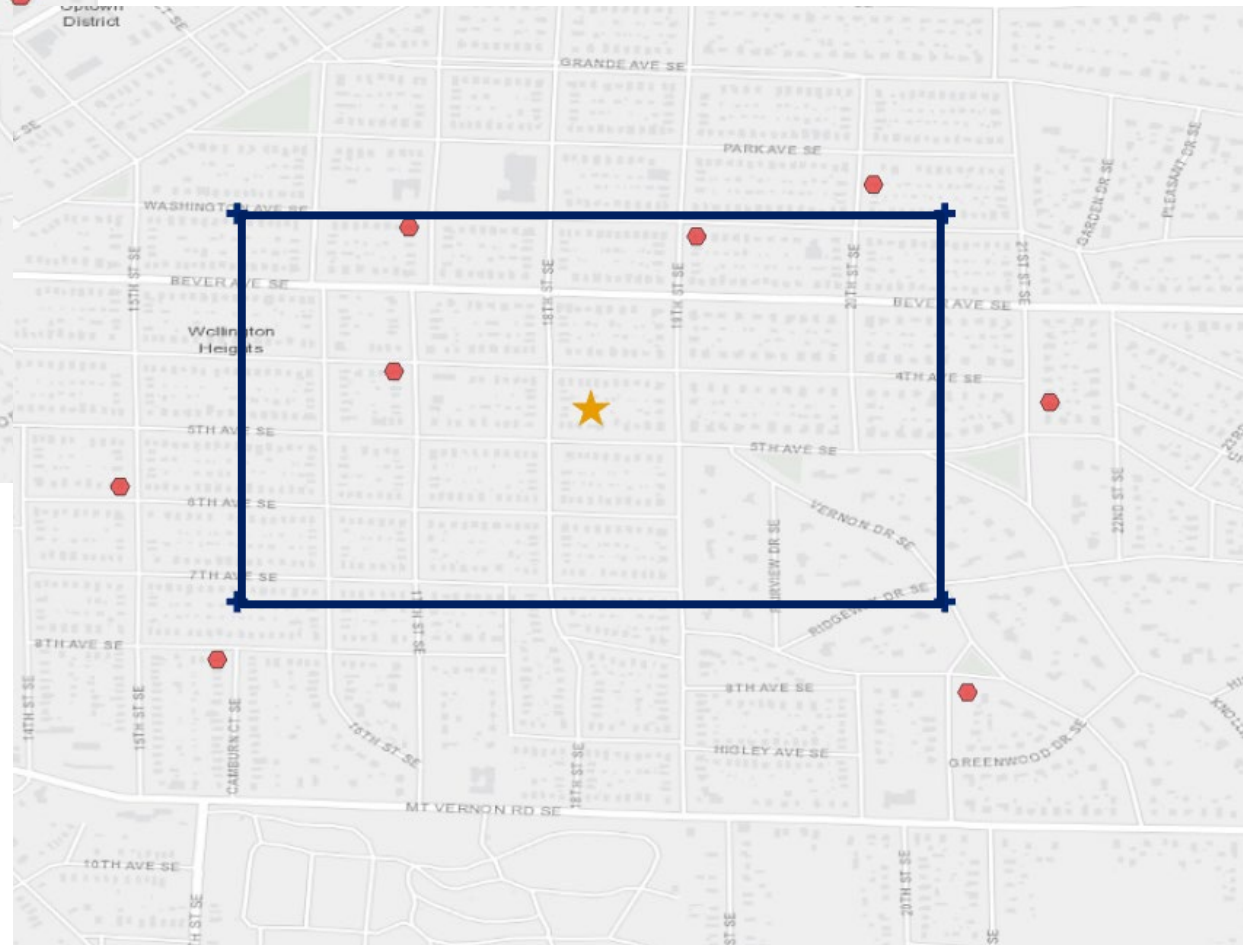
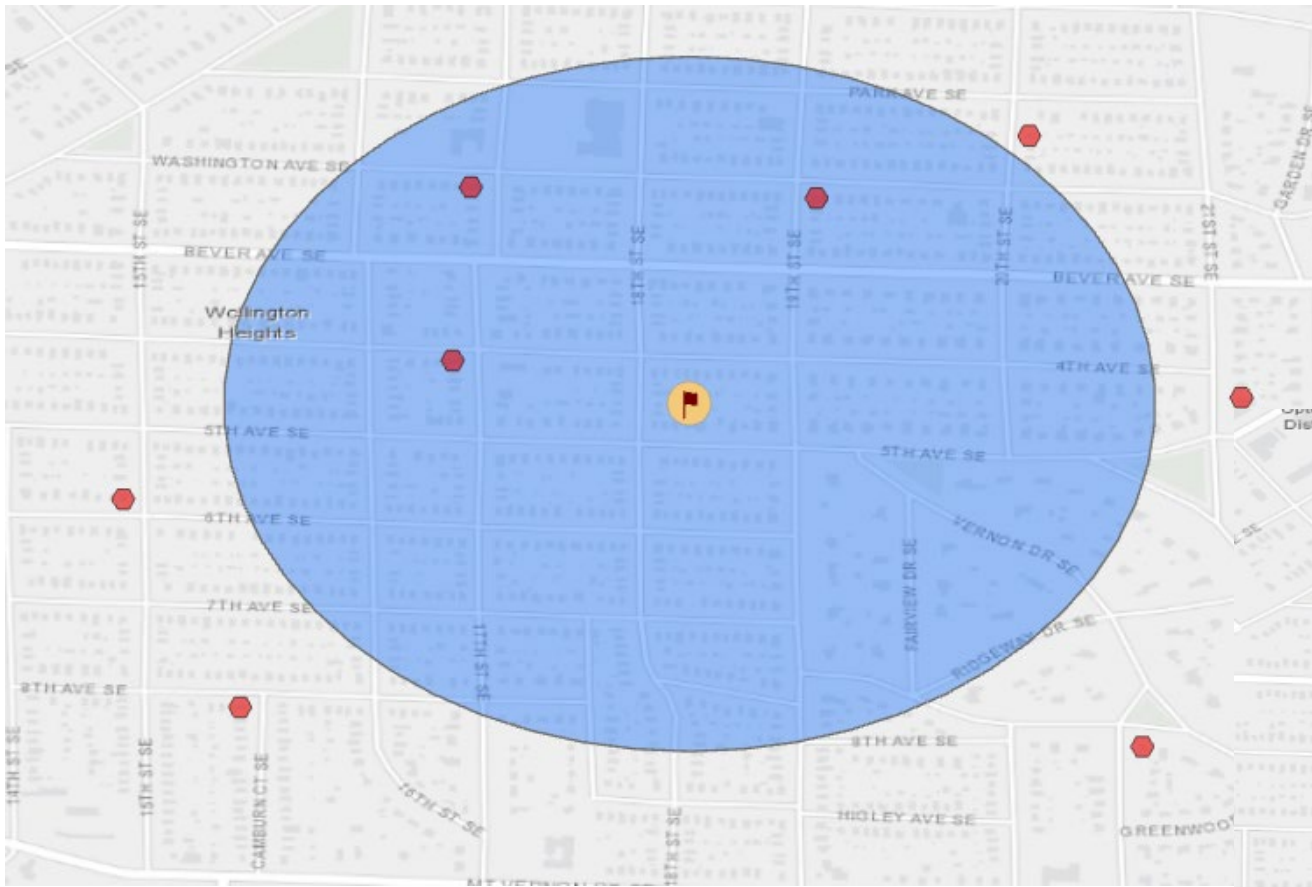
OBJECTID *	Shape *	Shape_Length	ORIG_FID	OR
1	Polyline	0.002825	1	-91
2	Polyline	0.002813	1	-91
3	Polyline	0.006445	1	-91
4	Polyline	0.006331	1	-91
5	Polyline	0.006631	1	-91
6	Polyline	0.005055	1	-91
7	Polyline	0.003597	1	-91
8	Polyline	0.006705	1	-91





Distance to the Mean Ft	Distance to the Mean Mi
560	0.106060606
775	0.146780303
1742	0.329924242
1921.9	0.363996212
2059	0.389962121
1573	0.297916667
1160	0.21969697
1832	0.346969697
<b>1452.8625</b>	<b>0.275163352</b>





# MEAN SEQUENCE DISTANCE

- Measures the distance from each crime to the next crime.
- Plots the mean and standard deviation to determine the next likely distance to the predicted event *from the last event*.



	I	J
	Distance from Last Ft	Distance from Last Mi
03		
03	1346.31	0.254982784
403	2509.63	0.47530921
IA 52403	3441.52	0.651802246
IA 52403	2869.72	0.543507186
03	2625.00	0.497159107
ids, IA 52403	1786.21	0.33829723
403	1726.74	0.327034504
<b>MEAN</b>	<b>2329.30388</b>	<b>0.441156038</b>
<b>STD DEV</b>	<b>738.6167844</b>	<b>0.139889543</b>



IN_distance_m	MAX_distance_m	STD_distance_m
410.355489	1048.974728	225.130984

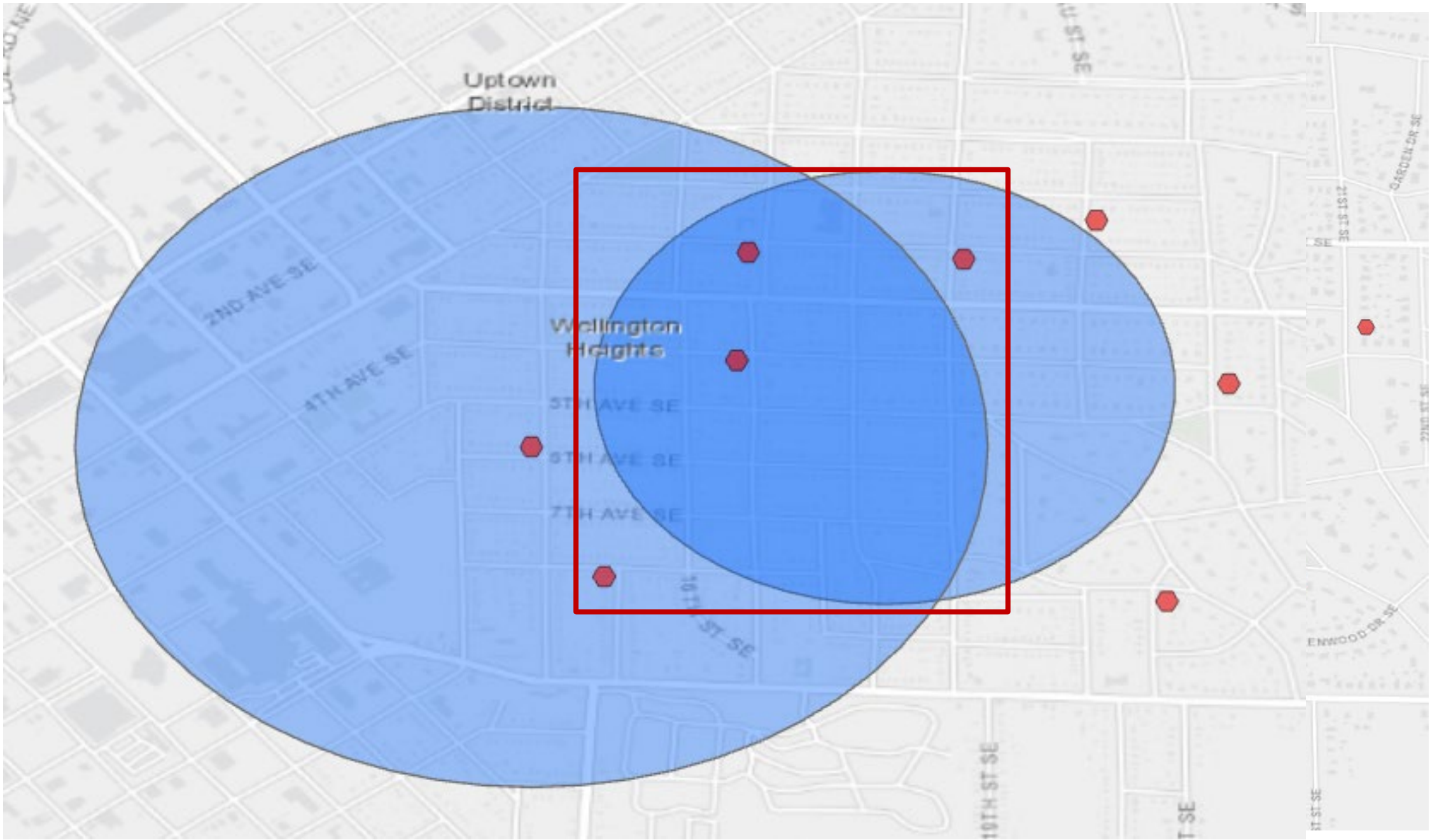


91.6560172°W 41.9817950°N

DIST Series\_OriginDestina...- SUM LINK\_DIST Series\_OriginDestina... MEAN LINK\_DIST Series\_OriginDestinationLi

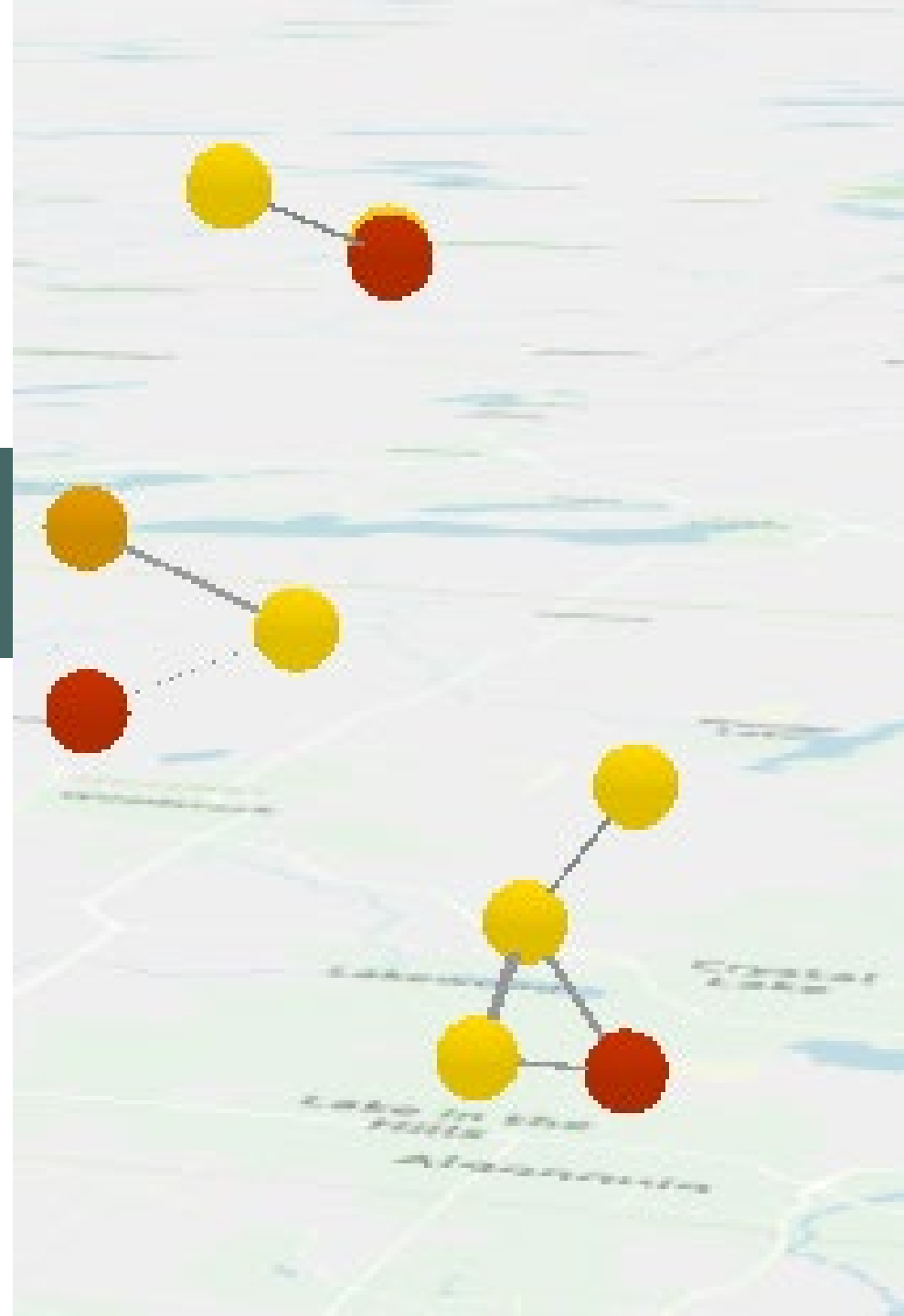
tion: Select By Attributes Zoom To Switch Clear Delete Copy

Start Date	Start Date (string)	End Date	End Date (string)	Time Delta (seconds)	Time Delta (minutes)	Distance (meters)
3/5/2024	2024-03-05 12:00:00 AM	3/7/2024	2024-03-07 12:00:00 AM	172800	2880	410.355489
3/7/2024	2024-03-07 12:00:00 AM	3/8/2024	2024-03-08 12:00:00 AM	86400	1440	764.936162
3/8/2024	2024-03-08 12:00:00 AM	3/10/2024	2024-03-10 12:00:00 AM	172800	2880	1048.974728
3/10/2024	2024-03-10 12:00:00 AM	3/14/2024	2024-03-14 12:00:00 AM	345600	5760	874.6906
3/14/2024	2024-03-14 12:00:00 AM	3/16/2024	2024-03-16 12:00:00 AM	172800	2880	800.106986
3/16/2024	2024-03-16 12:00:00 AM	3/17/2024	2024-03-17 12:00:00 AM	86400	1440	544.436686
3/17/2024	2024-03-17 12:00:00 AM	3/19/2024	2024-03-19 12:00:00 AM	172800	2880	526.311102





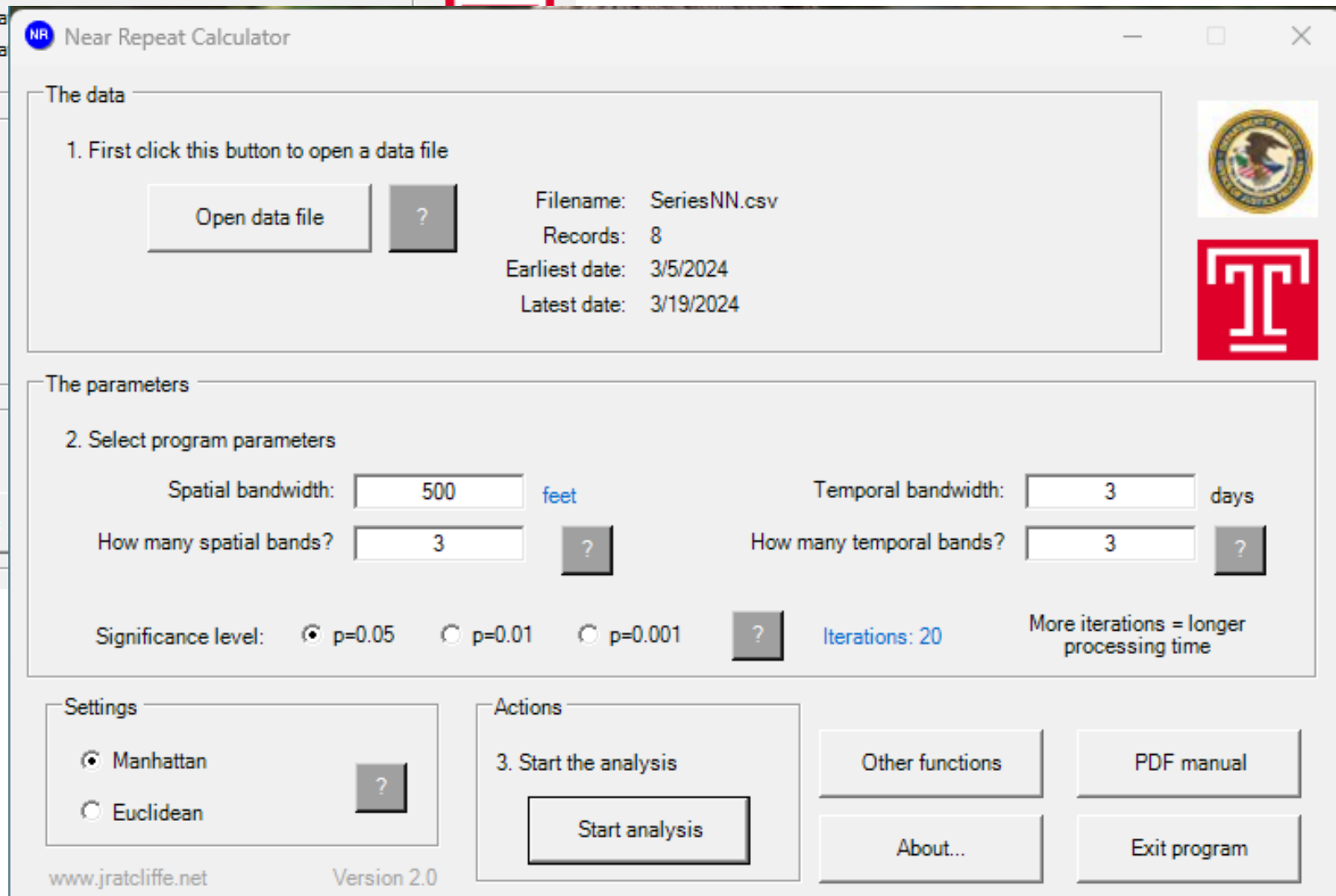
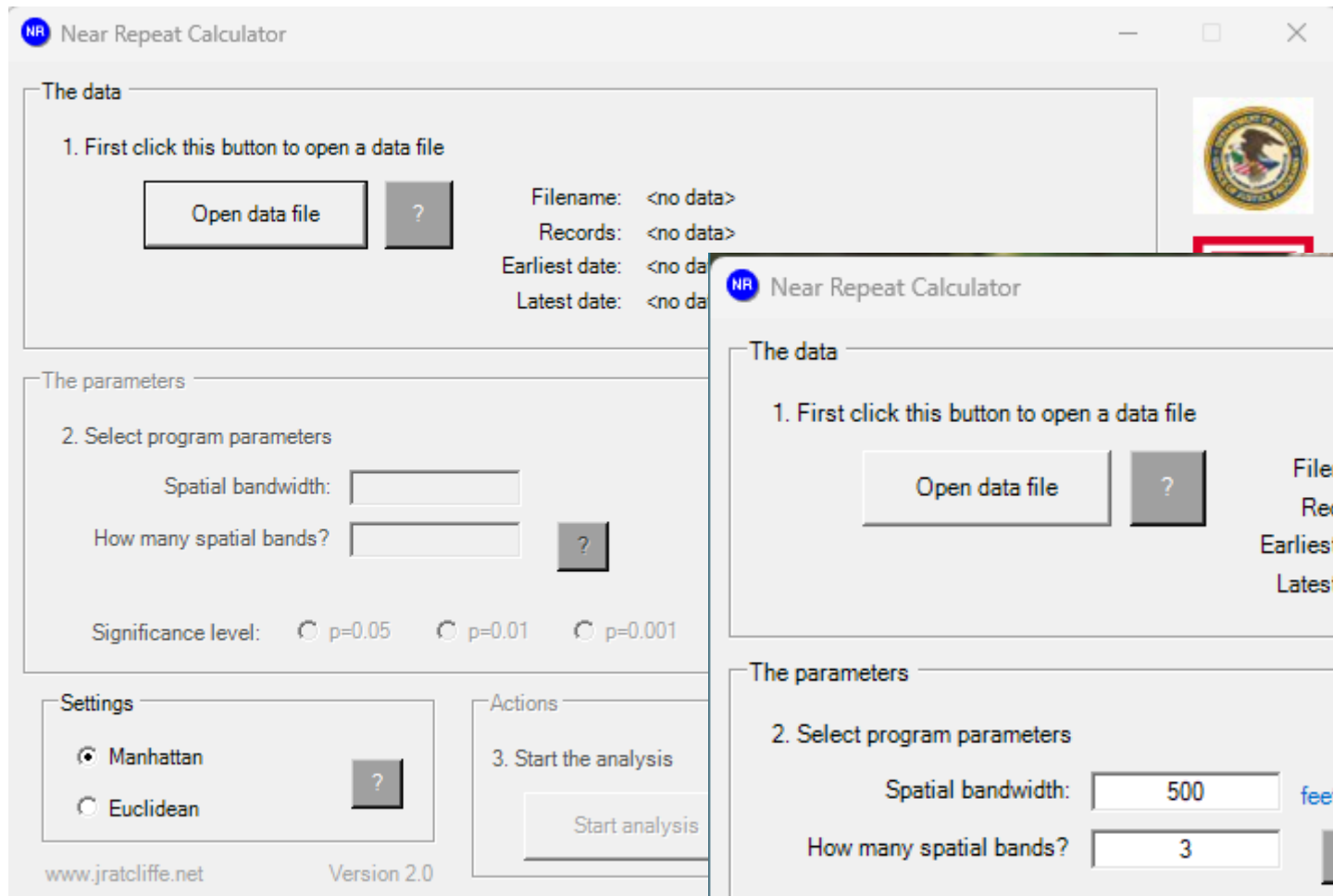
# REPEAT/NEAR-REPEAT



# NEAR-REPEAT ANALYSIS AND AVERAGE NEAREST NEIGHBOR

- A way to identify ‘clustering’ in a crime series or offender pattern of behavior.
- Looking at a pattern of repeat or near-repeat incidents within the series to predict the next hit within a certain timeframe within a certain distance of another recent incident (originator).

Repeat and Near Repeat Classification	A Repeat and Near Repeat tool that uses a series of distance and time values to classify incidents as originators, repeats, or near repeats, and to identify potential spatial and temporal relationships between incidents.
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## Summary

No indication of near repeat victimization over-representation found.

This means that near repeats do not appear to cluster in a statistical and meaningful way after a prior event.

No indication of repeat victimization over-representation found.

This means that repeat victimization does not appear to cluster in a statistical and influential way immediately after a prior event.

## Statistics

The following tables provide detailed findings.

**This color** indicates that the statistical probability is at the best possible level for your chosen number of iterations.

As you chose 20 iterations, it indicates that the statistical probability is at  $p=0.05$ .

### Observed over mean expected frequencies table

	Same day	>0 to 3 days	>3 to 6 days	>6 to 9 days	>9 days
Same location	0	0	0	0	0
>0 to 500 feet	0	10	5	7	6
>500 to 1000 feet	0	0	0	0	0
>1000 to 1500 feet	0	0	0	0	0
More than 1500 feet	0	0	0	0	0

	Same day	>0 to 3 days	>3 to 6 days	>6 to 9 days	>9 days
Same location	NaN	NaN	NaN	NaN	NaN
>0 to 500 feet	NaN	1.00	1.00	1.00	1.00
>500 to 1000 feet	NaN	NaN	NaN	NaN	NaN
>1000 to 1500 feet	NaN	NaN	NaN	NaN	NaN
More than 1500 feet	NaN	NaN	NaN	NaN	NaN

### Statistical significance table

	Same day	>0 to 3 days	>3 to 6 days	>6 to 9 days	>9 days
Same location	1.00	1.00	1.00	1.00	1.00
>0 to 500 feet	1.00	1.00	1.00	1.00	1.00
>500 to 1000 feet	1.00	1.00	1.00	1.00	1.00
>1000 to 1500 feet	1.00	1.00	1.00	1.00	1.00
More than 1500 feet	1.00	1.00	1.00	1.00	1.00

### Parameters used

Iterations requested: 19

Spatial bandwidth: 500

Number of spatial bands: 3

Temporal bandwidth: 3

Number of temporal bands: 3

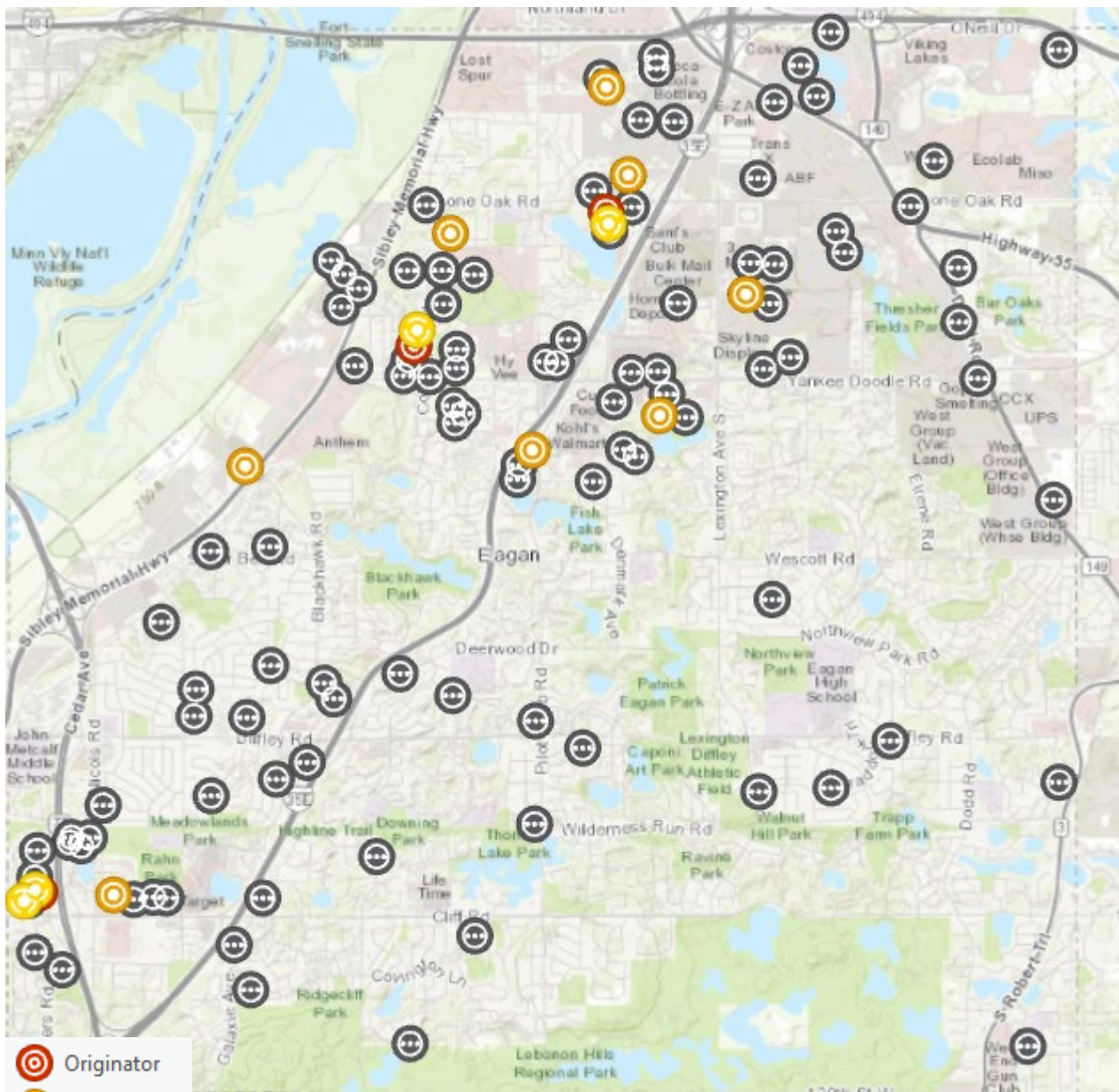
## Average Nearest Neighbor Summary





Observed Mean Distance	292.331605
Expected Mean Distance	162.569805
Nearest Neighbor Ratio	1.798191
z-score	4.318997
p-value	0.000016

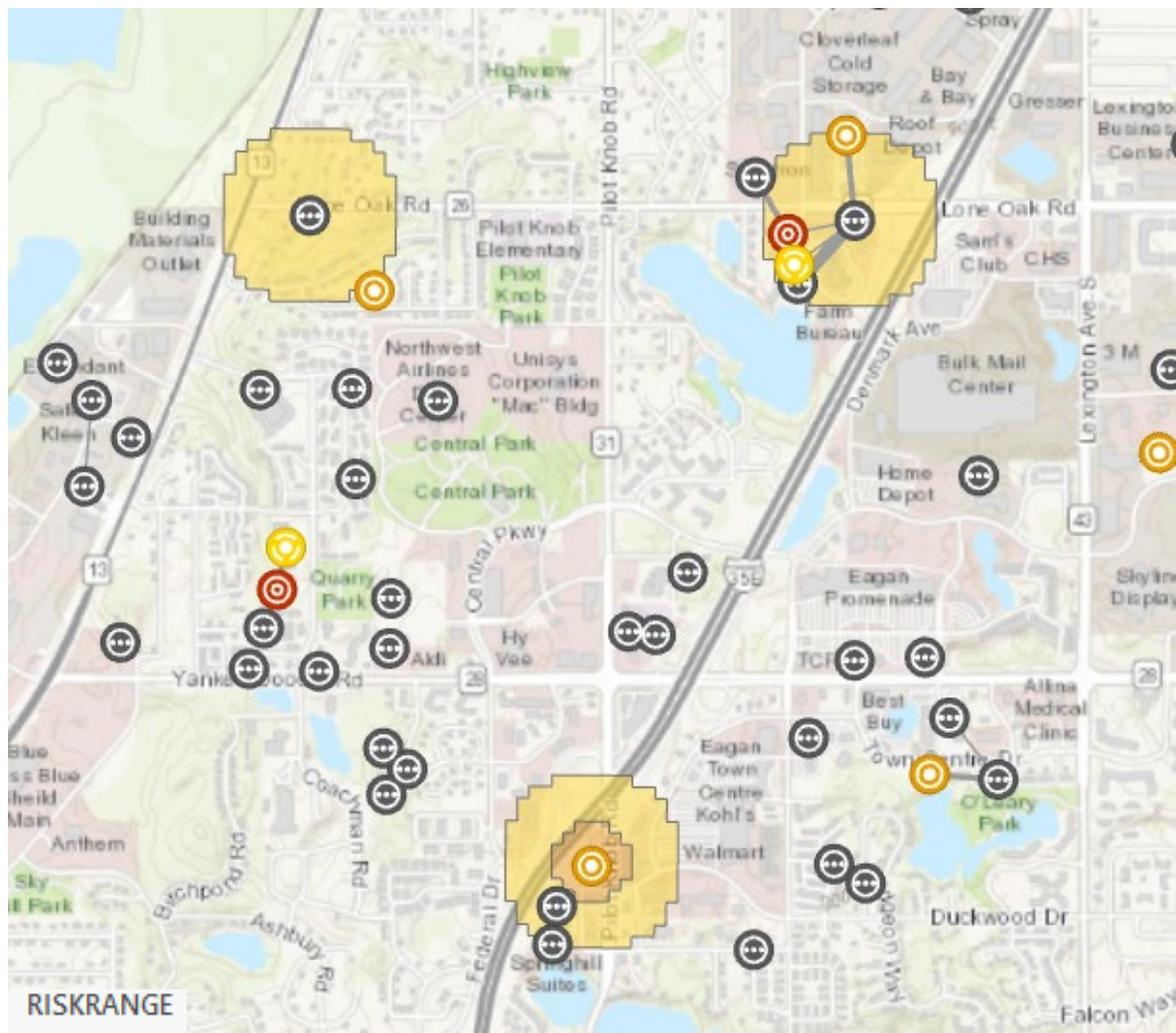
Distance measured in meters

Mean Spider Distance: 1453 ft  
Mean Sequence Distance: 2329 ft  
Nearest Neighbor Mean: 959 ft







-  Originator
-  Repeat
-  Near Repeat
-  Other



**RISK RANGE**

-  1
-  2



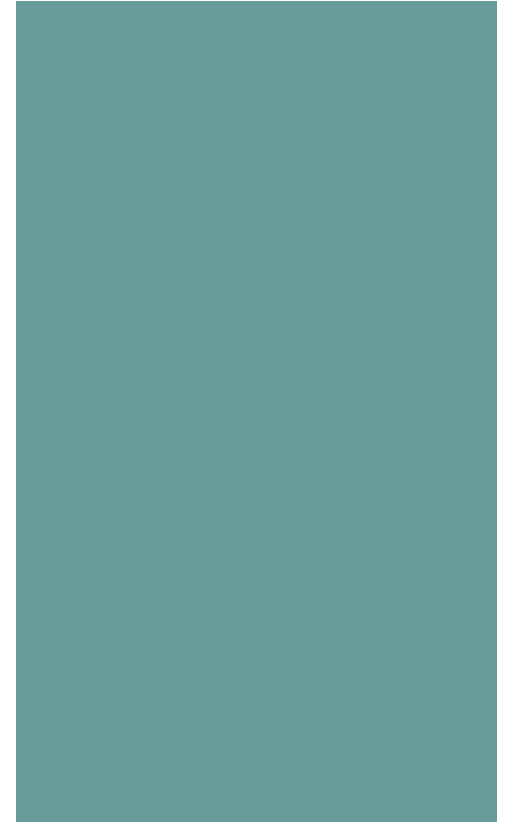


The background image shows a complex financial data visualization. At the top, there is a list of numerical values in parentheses, such as 18573 (2), 18567 (2), 18567 (9), 18390 (1), 18514 (1), 18514 (1), 18550 (1), 18390 (1), and 18589 (4). Below this, a candlestick chart displays price movements with green and red bars. Several colored lines (purple, blue, orange) represent moving averages. A semi-transparent dark green box is centered over the chart, containing the text 'MOVING TRENDS'. In the bottom right corner, there is a table with columns for 'Bid (Qty)' and 'Bid (Qty)', with values like 18590 (2) and 18591 (1).

# MOVING TRENDS

# GEOGRAPHIC PROGRESSION

- Relationship between geography and time.
- As time increases how does distance change?
  - Is the offender moving further away from their central node over time? Closer?



Series	CN	Date	Time	Start time	DOW	Lat(Y)	Long(X)	Distance to the Mean Ft	Distance to the Mean Mi
1	24-1234	3/5/2024	0000 - 0330	0	Tue	41.98532817	-91.64261246	560	0.106060606
2	24-1235	3/7/2024	0000 - 0345	0	Thu	41.98343175	-91.64686205	775	0.146780303
3	24-1236	3/8/2024	0110 - 0330	1	Fri	41.98545649	-91.64664878	1160	0.21969697
4	24-1237	3/10/2024	0230 - 0400	2.5	Sun	41.98605771	-91.64012856	1573	0.297916667
5	24-1238	3/14/2024	0230 - 0400	2.5	Thu	41.98299695	-91.63765019	1742	0.329924242
6	24-1239	3/16/2024	0300 - 0500	3	Sat	41.98181186	-91.65070732	1832	0.346969697
7	24-1240	3/17/2024	0330 - 0500	3.5	Sun	41.97938207	-91.64934355	1921.9	0.363996212
8	24-1241	3/19/2024	0400 - 0530	4	Tue	41.97892201	-91.63880759	2059	0.389962121
9					<b>Average</b>	<b>41.98292338</b>	<b>-91.64409506</b>	<b>1452.8625</b>	<b>0.275163352</b>
					<b>Std Dev</b>	<b>0.002727501</b>	<b>0.004969497</b>	<b>556.9876965</b>	<b>0.105490094</b>

<b>Correlation Coefficient</b>	<b>0.984793269</b>
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<b>Forecast of next distance</b>	<b>2439.246429</b>	<b>Ft</b>
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<b>Forecast of next distance</b>	<b>0.46197849</b>	<b>Mi</b>
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Next incident 0.46 +/- 0.11 miles from the spatial mean.  
Or between 0.36 and 0.58 miles from the spatial mean.



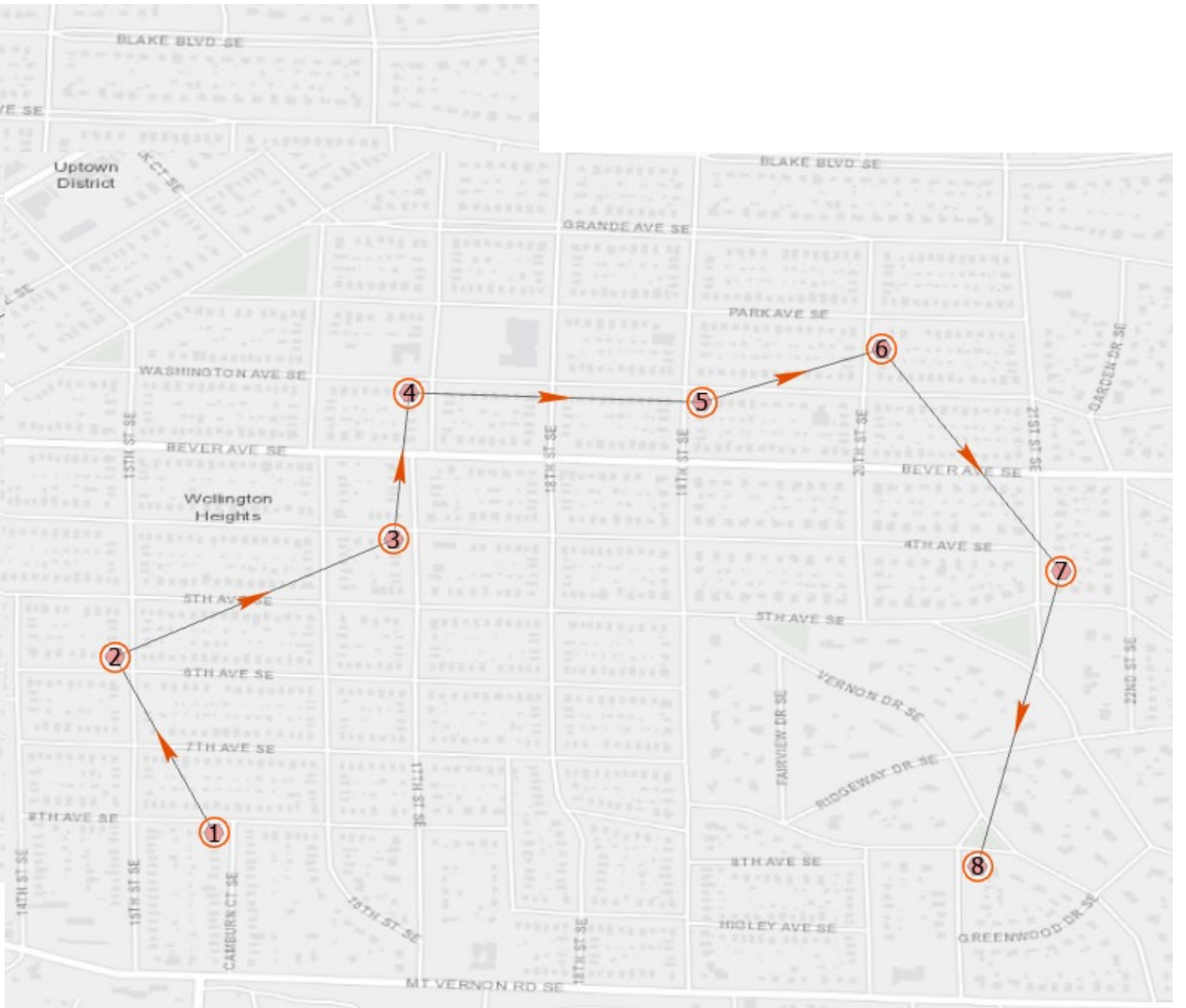
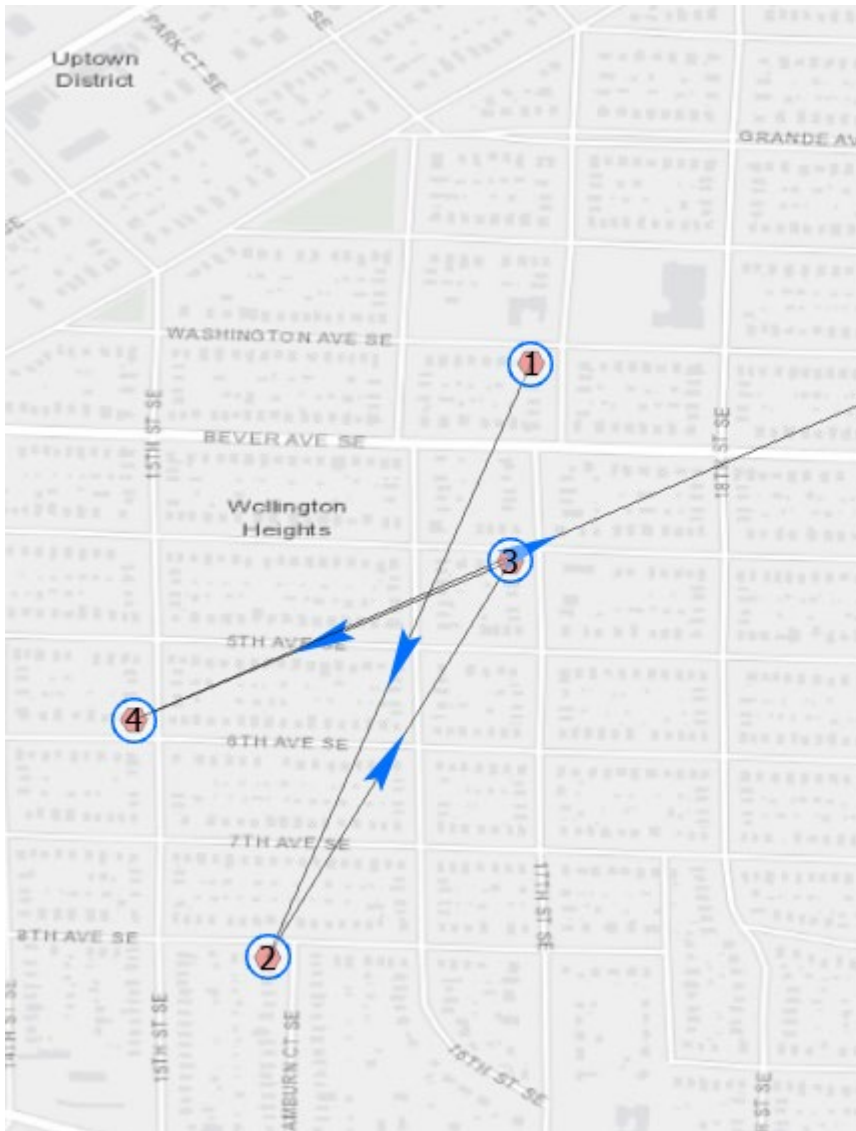




# SPACE/TIME PATTERNS

- If none of the other calculations make sense...
- Is there another pattern at play?
  - Moving North to South?
  - East to West?
  - Traveling along a major highway?
  - Going in a loop?
  - Hitting North side of the city on certain days then South side on other days?





# REFERENCES

## **Geographic Profiling –**

<https://geographicprofiling.com/GPAtraining/Geographic%20Profiling%20for%20Crime%20Analysts.pdf>

<https://www.ojp.gov/ncjrs/virtual-library/abstracts/geographic-profiling-new-tool-crime-analysts>

## **Near Repeat Analysis –**

<https://www.jratcliffe.net/near-repeat-analysis>

[https://www.policinginstitute.org/wp-content/uploads/2018/07/REVISED-FINAL-Strategy-Brief\\_12.6.pdf](https://www.policinginstitute.org/wp-content/uploads/2018/07/REVISED-FINAL-Strategy-Brief_12.6.pdf)

## **Near Repeat Calculator –**

[https://www.jratcliffe.net/\\_files/archives/f5df24\\_bdc7db27272445d6b6c6dc2b7ce54849.zip?dn=NRCv2setup.zip](https://www.jratcliffe.net/_files/archives/f5df24_bdc7db27272445d6b6c6dc2b7ce54849.zip?dn=NRCv2setup.zip)

**IACA (2017).** Exploring Crime Analysis: Readings on Essential Skills (3rd ed.). International Association of Crime Analysts.

# FUTURE CLASSES IN THE TACTICAL SERIES



CRIMINAL BEHAVIOR  
AND TACTICAL  
PROFILING



PRODUCTS AND  
DISSEMINATION



EFFECTIVE RESPONSE



AFTER THE ARREST



Angela Backer-Hines  
Eagan Police Department  
[abhines@cityofeagan.com](mailto:abhines@cityofeagan.com)

QUESTIONS?