

Re-scaled Range Analysis of a decade of crime in Baltimore. (DRAFT)

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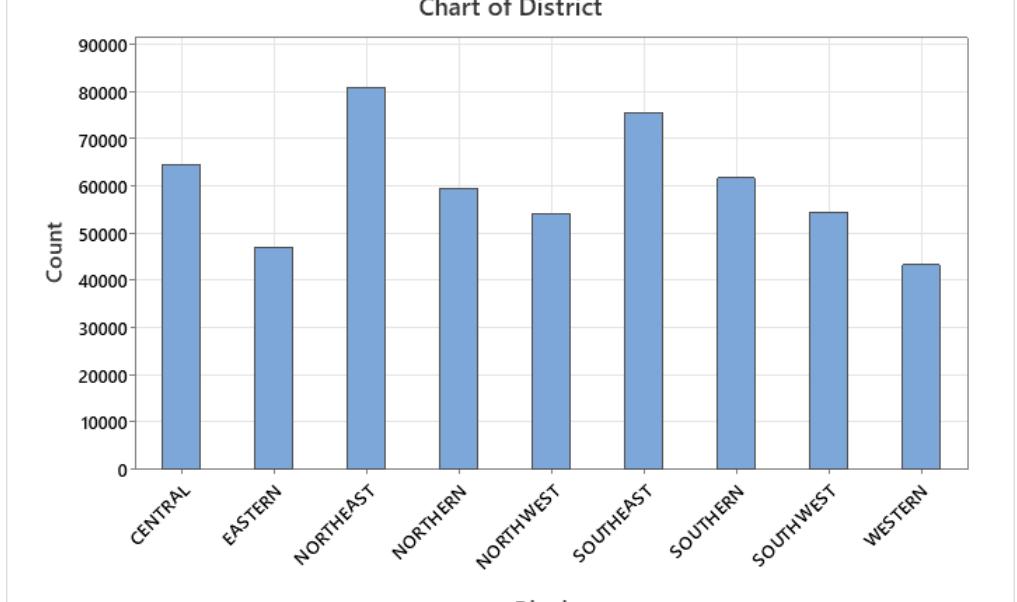
(Dated: December 5, 2022)

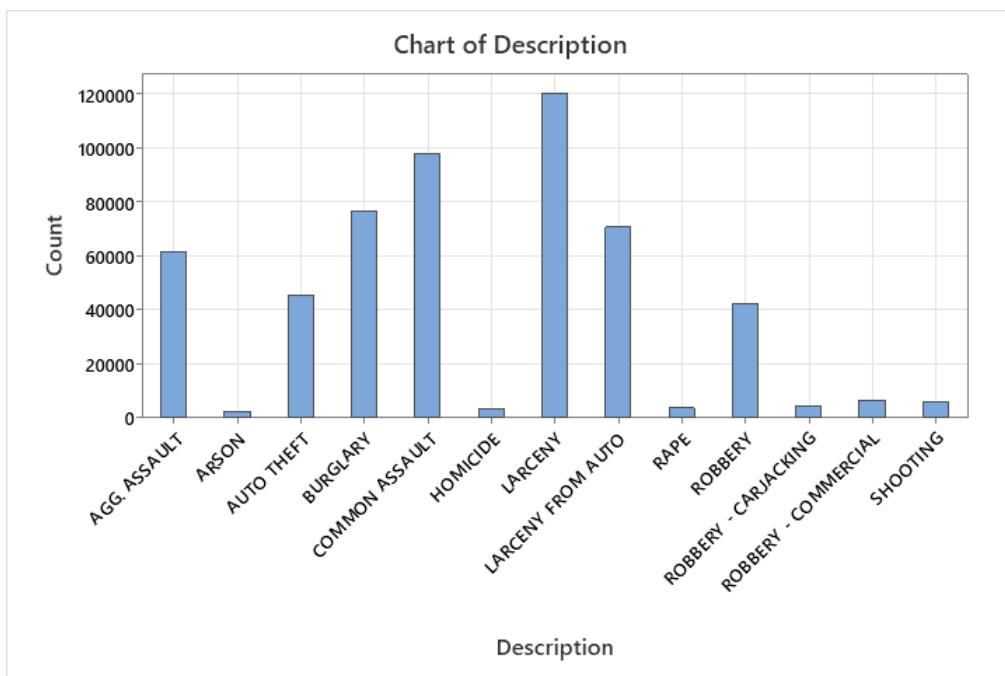
Write abstract

Complex Systems	CARLSON	Ex 13 p 1 Paper DRAFT
<u>OUTLINE</u>	RIS Range Analysis	
- INTRODUCTION	- The criminal / security problem	
	Subject → GUARDIAN → object (ATTACKER) (CONTROLS) (protected)	
<u>CRIME</u> IS A COMPLEX SEQUENCE OF EVENTS THAT OCCURS WHEN A <u>subject</u> (motivated offender) ENCOUNTERS AN <u>object</u> (CRIMINAL TARGET) IN THE ABSENCE OF A <u>FUNCTIONING PROTECTOR</u> .		
<u>PROPOSITION 1:</u> CRIME IS NOT A RANDOM EVENT IN ALMOST ALL CASES. THE SUBJECT MUST INTERACT WITH THE OBJECT IN ORDER FOR A CRIME TO HAPPEN IS NOT A FULLY <u>RANDOM</u> EVENT, BUT AN <u>UNKNOWN</u> ONE OR PROBABLY BECAUSE THE INITIAL CONDITIONS WERE NOT KNOWN IN ADVANCE.		
<u>PROPOSITION 2:</u> THE GUARDIAN FUNCTION (CONTROLS) CANNOT ECONOMICALLY SUSTAIN BEING EVERYWHERE AT ONE SO A RISK BASED CALCULUS IS ESTABLISHED TO BEST DEPLOY SCARCE RESOURCES TO PROVIDE A FUNCTIONING PROTECTIVE SERVICE TO AS MUCH OF THE LAW ENFORCEMENT JURISDICTION AS THE POLICE CAN. THE MEASUREMENT OF EFFECTIVENESS IS IMPORTANT TO NOTE, AS IT IS OVERWHELMINGLY STATISTICAL IN NATURE.		
<u>PROPOSITION 3:</u> THE NATURE OF MODERN LIFE ENSURES THAT A CRIMINAL ENCOUNTER IS FEASIBLE AND EVEN LIKELY. GEOGRAPHY, INTERNET CONNECTIVITY, TAX SYSTEMS, SOCIAL STRUCTURES, AND SOCIOECONOMIC / LEGAL CONDITIONS TIED TO LOCALITY CREATE A CONNECTIONAL ENVIRONMENT WHERE EVEN SMALL CHANGES IN ONE CONDITION OF ACTIVITY WILL HAVE OUTSIZE EFFECTS.		
IN SHORT, THE MACRO ENVIRONMENT OF CRIME CAN BE MEASURED WITH FRACTAL ANALYSIS, AS A COMPLEMENT TO THE STATISTICAL SYSTEMS THAT ARE LARGELY USED BY POLICE DEPARTMENTS TO MEASURE OFFENDER		

Complex Systems	CARLSON	NON linear
<p><u>Proposition 4:</u> Crime is a complex system that is measured by statistical (linear) methods. Deterministic methods such as modern statistical analysis are part of the solution as crime is partly deterministic and partly probabilistic with extreme sensitivity to initial conditions.</p> <p>THAT SAID, IT CAN BE SAFELY SAID THAT IN ALL BUT THE MOST SOPHISTICATED LAW ENFORCEMENT ORGANIZATIONS HAVE <u>LINEAR EXPECTATIONS IN A NON-LINEAR WORLD.</u></p> <p><u>Proposition 5:</u> IN A SITUATION where non-linear AND linear determinants coexist it is likely to be modeled assuming that we can create time series fractals that are self-similar and scale invariant. The crime issue as a dynamic system can be visualized as as non-linear systems.</p> <p><u>Example - Sierpinski's triangle</u></p> <ul style="list-style-type: none"> - consists of infinite triangles within a larger triangle - Formed by choosing a random point within any triangle and then joining it by a line to another random point. - Looping this process, it doesn't matter where one begins you get the same Sierpinski triangle. <p>The combination of local random walk and global determinism creates a stable structure (fractal) that is scale invariant.</p> <p><u>Example - Hurst Exponents and R/S analysis</u></p> <ul style="list-style-type: none"> - The Hurst Exponent is a time series analysis that is related to random motion and is useful as a baseline for the persistence of crime in each of the Baltimore Police Districts. 		

#	C1	C2	C3	C4-T	C5-T	C6-T	C7-T	C8-T	C9-T	C10	C11-T	C12	C13-T	C14-T	C15-T	C16-T
	X	RowID	CrimeDate	CrimeTime	CrimeCode	Location	Description	Inside_District	Weapon	Post	Gender	Age	Race	Efficiency	District	Neighborhood
1	-76.6637	39.3388	1/20/2021/1/05	19:45:00+00:00	4E	4300 PIMULCO RD	COMMON ASSAULT	Missing	PERSONAL WEAPONS	614 F	38	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	NORTHWEST GREENSPRING	39.3388	-76.6637 (39.3388,-76.6637)
2	-76.6796	39.3308	2/20/2021/1/05	18:40:00+00:00	3I0	3800 BARRINGTON RD	ROBBERY	Missing	PERSONAL WEAPONS	623 F	28	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	NORTHWEST CALLAWAY-GIBSON	39.3308	-76.6796 (39.3308,-76.6796)
3	-76.5981	39.2931	3/20/2021/1/05	20:15:00+00:00	6F	1400 E FAYETTE ST	LARCENY	Missing	Missing	212 F	43	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	SOUTHEAST DUNBAR-BROADWAY	39.2931	-76.5981 (39.2931,-76.5981)
4	-76.6251	39.3109	4/20/2021/1/05	11:00:00+00:00	4C	1900 Mt Royal Ter	AGG. ASSAULT	Missing	UNKNOWN	133 F	53	BLACK_OR_AFRICAN_AMERICAN	Missing	CENTRAL RESERVOIR HILL	39.3109	-76.6251 (39.3109,-76.6251)
5	-76.6266	39.2435	5/20/2021/1/05	11:20:00+00:00	4E	1000 BETHUNE RD	COMMON ASSAULT	Missing	UNKNOWN	922 M	37	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	SOUTHERN CHERRY HILL	39.2435	-76.6266 (39.2435,-76.6266)
6	-76.6075	39.3372	6/20/2021/1/05	23:25:00+00:00	3I8	600 WYANKEE AVE	ROBBERY	Missing	HANDGUN	525 M	52	BLACK_OR_AFRICAN_AMERICAN	Missing	NORTHERN PEN LUCY	39.3372	-76.6075 (39.3372,-76.6075)
7	-76.6377	39.3048	7/20/2021/1/05	00:00:00+00:00	95	1300 E FAYETTE AVE	SHOOTING	Outside	FIREARM	724 Female	29	BLACK_OR_AFRICAN_AMERICAN	Missing	WESTERN SANDTOWN-WINCHESTER	39.3048	-76.6377 (39.3048,-76.6377)
8	-76.6075	39.3372	8/20/2021/1/05	00:00:00+00:00	1A	1000 E BIDDLE ST	ROBBERY	Outside	FIREARM	332 Male	53	BLACK_OR_AFRICAN_AMERICAN	Missing	EASTERN BIDDLE STREET	39.3372	-76.6075 (39.3372,-76.6075)
9	-76.6047	39.3194	9/20/2021/1/05	02:15:00+00:00	95	4700 GARRISON BLVD	SHOOTING	Outside	FIREARM	621 Female	27	BLACK_OR_AFRICAN_AMERICAN	Missing	NORTHWEST WEST WILMINGTON	39.3194	-76.6047 (39.3194,-76.6047)
10	-76.5758	39.3012	10/20/2021/1/05	12:49:40+00:00	1A	1400 N POTOMAC ST	HOMICIDE	Outside	FIREARM	332 Male	20	BLACK_OR_AFRICAN_AMERICAN	Missing	EASTERN BEREA	39.3012	-76.5758 (39.3012,-76.5758)
11	-76.5664	39.2935	11/20/2021/1/05	06:04:28+00:00	95	3400 E FAIRMOUNT AVE	SHOOTING	Inside	FIREARM	222 Male	53	BLACK_OR_AFRICAN_AMERICAN	Missing	SOUTHEAST BALTIMORE HIGHLANDS	39.2935	-76.5664 (39.2935,-76.5664)
12	-76.5890	39.2306	12/20/2021/1/05	13:34:40+00:00	95	3800 PENNINGTON AVE	SHOOTING	Outside	FIREARM	911 Male	36	ASIAN	Missing	SOUTHERN CURTIS BAY	39.2306	-76.5890 (39.2306,-76.5890)
13	-76.6847	39.3394	13/20/2021/1/05	02:27:50+00:00	1A	4700 GARRISON BLVD	HOMICIDE	Outside	FIREARM	621 Male	31	BLACK_OR_AFRICAN_AMERICAN	Missing	NORTHWEST WEST ARLINGTON	39.3394	-76.6847 (39.3394,-76.6847)
14	-76.6351	39.3312	14/20/2021/1/05	11:20:00+00:00	4E	3600 FALLS RD	COMMON ASSAULT	Missing	PERSONAL WEAPONS	531 M	23	WHITE	Missing	NORTHERN HAMPDEN	39.3312	-76.6351 (39.3312,-76.6351)
15	-76.5803	39.2921	15/20/2021/1/05	12:30:00+00:00	6F	2600 E BALTIMORE ST	LARCENY	Inside	AUTO THEFT	222 F	45	WHITE	Missing	SOUTHERN PATTERSON PARK NEIGHBORHOOD	39.2921	-76.5803 (39.2921,-76.5803)
16	-76.6075	39.3372	16/20/2021/1/05	12:45:00+00:00	4D	1000 E BIDDLE ST	ROBBERY	Inside	BLOWN_OBJECT	913 F	27	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	SOUTHERN PATTERSON PARK NEIGHBORHOOD	39.3372	-76.6075 (39.3372,-76.6075)
17	-76.5703	39.2925	17/20/2021/1/05	22:00:00+00:00	3A0	3300 E BALTIMORE ST	ROBBERY	Inside	MISSING	222 M	35	WHITE	Missing	SOUTHEAST PATTERSON PARK NEIGHBORHOOD	39.2925	-76.5703 (39.2925,-76.5703)
18	-76.6537	39.2446	18/20/2021/1/05	20:00:00+00:00	4E	2600 CARROLL ST	COMMON ASSAULT	Missing	MISSING	831 M	25	Missing	MISSING	SOUTHWEST MORELL PARK	39.2446	-76.6537 (39.2446,-76.6537)
19	-76.6072	39.2980	19/20/2021/1/05	22:30:00+00:00	4A	600 E Lombard St	AGG. ASSAULT	Missing	HANDGUN	111 M	16	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	CENTRAL DOWNTOWN	39.2980	-76.6072 (39.2980,-76.6072)
20	-76.6077	39.2867	20/20/2021/1/03	15:26:00+00:00	5A	600 E PRATT ST	COMMON ASSAULT	Inside	PERSONAL WEAPONS	112 M	34	WHITE	UNKNOWN	CENTRAL INNER HARBOR	39.2867	-76.6077 (39.2867,-76.6077)
21	-76.5937	39.2226	21/20/2021/1/03	06:00:00+00:00	5A	1300 CHURCH ST	BURGLARY	Outside	MISSING	911 M	52	BLACK_OR_AFRICAN_AMERICAN	Missing	SOUTHERN CURTIS BAY	39.2226	-76.5937 (39.2226,-76.5937)
22	-76.6250	39.2488	22/20/2021/1/03	09:00:00+00:00	4B	2900 CHERYLAND AVE	AGG. ASSAULT	Inside	KNIFE_CUTTING_INSTRUMENT	922 M	19	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	SOUTHERN CHERRY HILL	39.2488	-76.6250 (39.2488,-76.6250)
23	-76.5959	39.2279	23/20/2021/1/03	12:00:00+00:00	4E	4200 E BIDDLE ST	COMMON ASSAULT	Inside	MISSING	913 F	29	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	SOUTHERN BROWNSTOWN	39.2279	-76.5959 (39.2279,-76.5959)
24	-76.6075	39.3372	24/20/2021/1/03	00:00:00+00:00	4E	1000 E BIDDLE ST	COMMON ASSAULT	Inside	MISSING	913 M	31	BLACK_OR_AFRICAN_AMERICAN	UNKNOWN	SOUTHERN BROWNSTOWN	39.3372	-76.6075 (39.3372,-76.6075)
25	-76.5115	39.2791	25/20/2021/1/03	02:00:00+00:00	7A	6700 DILUTH AVE	AUTO THEFT	Outside	MISSING	234 M	21	WHITE	NOT_HISPANIC_OR_LATINO	SOUTHEAST GRACELAND PARK	39.2791	-76.5115 (39.2791,-76.5115)
26	-76.6556	39.3414	26/20/2021/1/03	13:00:00+00:00	4E	2100 CARTERDALE RD	COMMON ASSAULT	Inside	PERSONAL WEAPONS	533 M	15	NATIVE_HAWAIIAN_OR_OTHER_PACIFIC_ISLANDER	NOT_HISPANIC_OR_LATINO	NORTHERN MOUNT WASHINGTON	39.3414	-76.6556 (39.3414,-76.6556)
27	-76.6996	39.2383	27/20/2021/1/02	19:00:00+00:00	4E	3200 HOWARD PARK AVE	COMMON ASSAULT	Outside	PERSONAL WEAPONS	622 F	28	WHITE	NOT_HISPANIC_OR_LATINO	NORTHWEST HOWARD PARK	39.2383	-76.6996 (39.2383,-76.6996)
28	-76.5739	39.3094	28/20/2021/1/02	20:47:00+00:00	4E	3100 E FEDERAL ST	COMMON ASSAULT	Outside	MISSING	332 F	66	BLACK_OR_AFRICAN_AMERICAN	Missing	EASTERN BEREA	39.3094	-76.5739 (39.3094,-76.5739)
29	-76.5868	39.2849	29/20/2021/1/02	18:30:00+00:00	6F	2100 FLEET ST	LARCENY	Inside	MISSING	213 M	35	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	SOUTHEAST CANTON	39.2849	-76.5868 (39.2849,-76.5868)
30	-76.5497	39.3563	30/20/2021/1/02	18:20:00+00:00	3I0	6100 GLENDAK AVE	ROBBERY	Outside	PERSONAL WEAPONS	424 F	37	BLACK_OR_AFRICAN_AMERICAN	UNKNOWN	NORTHWEST WESTFIELD	39.3563	-76.5497 (39.3563,-76.5497)
31	-76.6904	39.3333	31/20/2021/1/02	18:00:00+00:00	6J	6100 REISTERSTOWN RD	LARCENY	Missing	MISSING	631 F	Missing	Missing	Missing	NORTHWEST REISTERSTOWN STATION	39.3333	-76.6904 (39.3333,-76.6904)
32	-76.6075	39.3372	32/20/2021/1/02	18:00:00+00:00	6J	6100 REISTERSTOWN RD	LARCENY	Missing	MISSING	631 M	Missing	Missing	Missing	NORTHWEST REISTERSTOWN STATION	39.3372	-76.6075 (39.3372,-76.6075)
33	-76.6994	39.3333	33/20/2021/1/02	18:00:00+00:00	6J	6100 REISTERSTOWN RD	LARCENY	Missing	MISSING	631 F	Missing	Missing	Missing	NORTHWEST REISTERSTOWN STATION	39.3333	-76.6994 (39.3333,-76.6994)
34	-76.5601	39.3140	34/20/2021/1/02	20:15:00+00:00	4E	3800 STRAWBERRY FIELD LN	COMMON ASSAULT	Inside	PERSONAL WEAPONS	432 F	37	BLACK_OR_AFRICAN_AMERICAN	Missing	NORTHWEST ORCHARD RIDGE	39.3140	-76.5601 (39.3140,-76.5601)
35	-76.6411	39.3010	35/20/2021/1/02	20:46:00+00:00	7A	1400 RIGGS AVE	AUTO THEFT	Inside	MISSING	724 F	35	BLACK_OR_AFRICAN_AMERICAN	Missing	WESTERN SANDTOWN-WINCHESTER	39.3010	-76.6411 (39.3010,-76.6411)
36	-76.5974	39.2313	36/20/2021/1/02	22:00:00+00:00	3A0	3900 10TH ST	ROBBERY	Inside	PERSONAL WEAPONS	913 M	17	Missing	MISSING	SOUTHERN BROOKLYN	39.2313	-76.5974 (39.2313,-76.5974)
37	-76.5857	39.3089	37/20/2021/1/02	20:00:00+00:00	6D	2300 E FEDERAL ST	LARCENY FROM AUTO	Inside	MISSING	331 F	62	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	EASTERN BROADWAY EAST	39.3089	-76.5857 (39.3089,-76.5857)
38	-76.5675	39.3533	38/20/2021/1/02	18:00:00+00:00	6J	5300 HAMLET AVE	LARCENY	Missing	MISSING	423 F	77	WHITE	Missing	NORTHEAST HAMILTON HILLS	39.3533	-76.5675 (39.3533,-76.5675)
39	-76.5991	39.3162	39/20/2021/10/10	16:15:00+00:00	4E	1200 DARLEY AVE	COMMON ASSAULT	Inside	PERSONAL WEAPONS	312 F	36	BLACK_OR_AFRICAN_AMERICAN	NOT_HISPANIC_OR_LATINO	EASTERN EAST BALTIMORE MIDWAY	39.3162	-76.5991 (39.3162,-76.5991)





Complex Systems	Conlon	EX 13 P3
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What this paper seeks to do is conceptually straightforward. We wish to calculate a R/S analysis and a Hurst Value for each of the 7 districts and we wish to break that down into specific crimes. We also wish to calculate $\sqrt{4}$ which is the Fractal Dimension.

Our function will be as follows

$$X(t, N) = \sum_{z=1}^t (z_i - A_N) \quad \text{:: Peters (1991)}$$

where $X(t, N)$ = deviations over N points.

z_i = Number of calls per hour \in

A_N = Average Number of calls over N points

Range is. = $\text{MAX}[X(t, N)] - \text{MIN}[X(t, N)]$

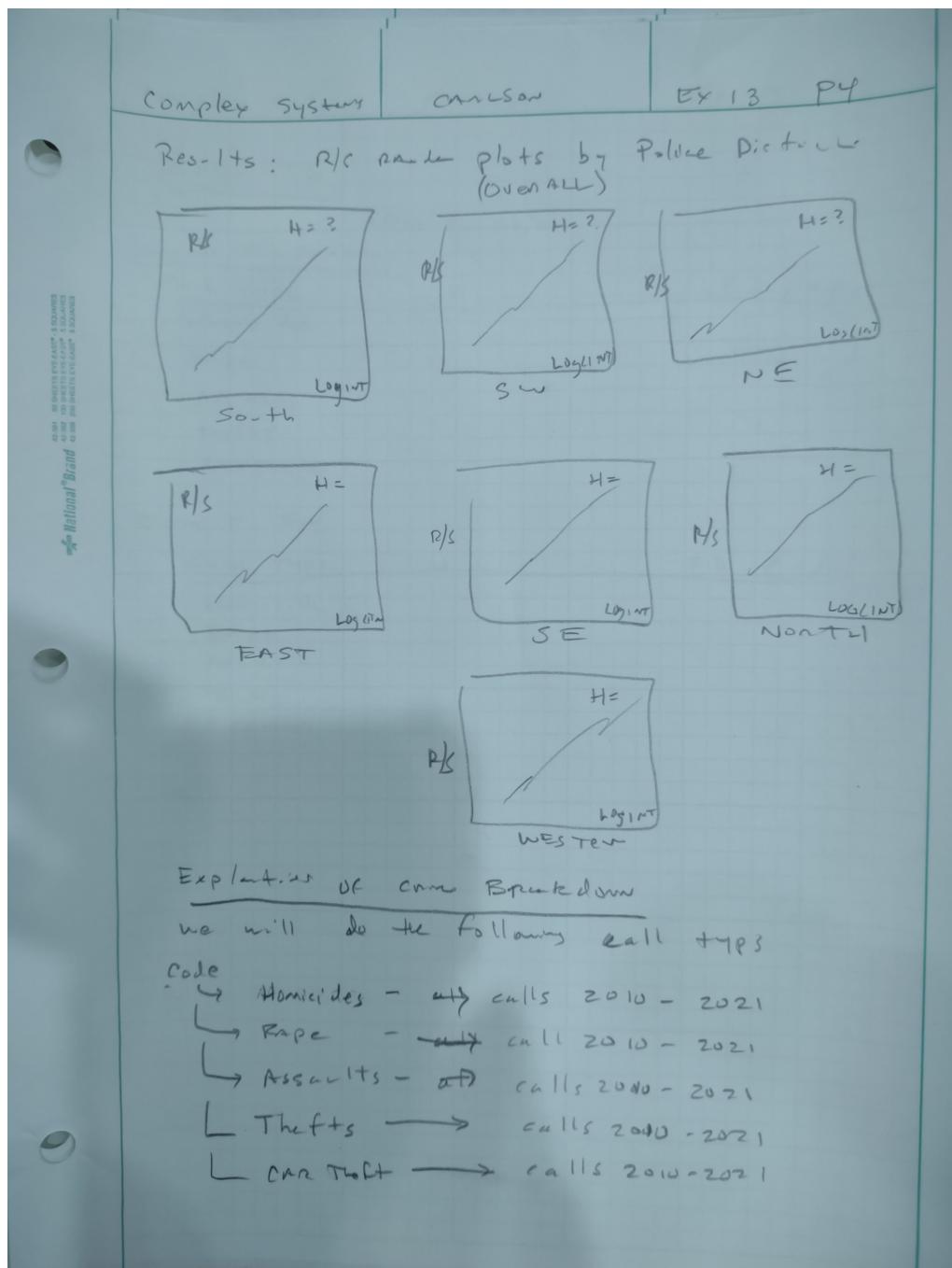
where R = range of X

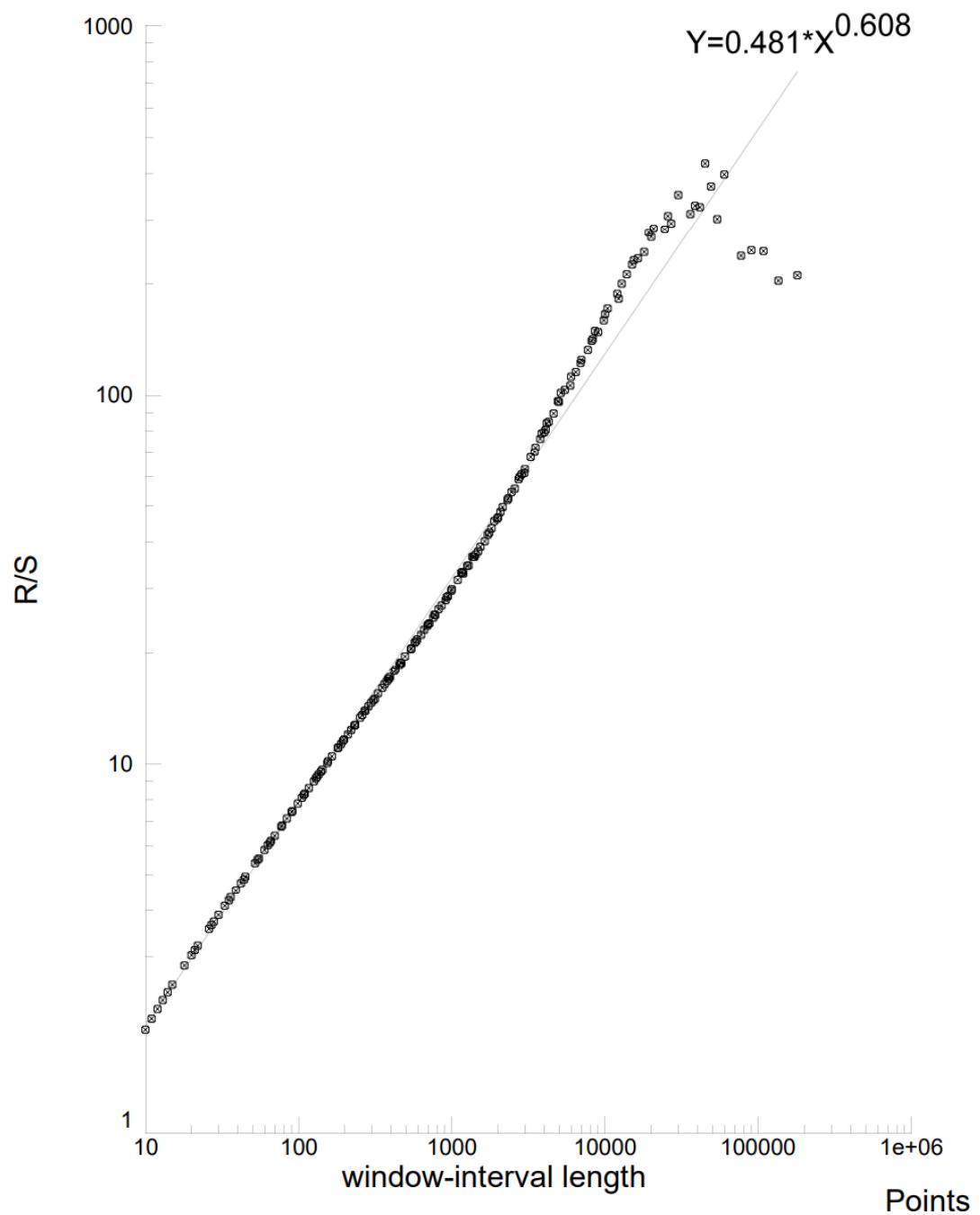
The Data for this project will come from the open Baltimore Dataset which has 10 years of crime data, timestamped, and by type and district

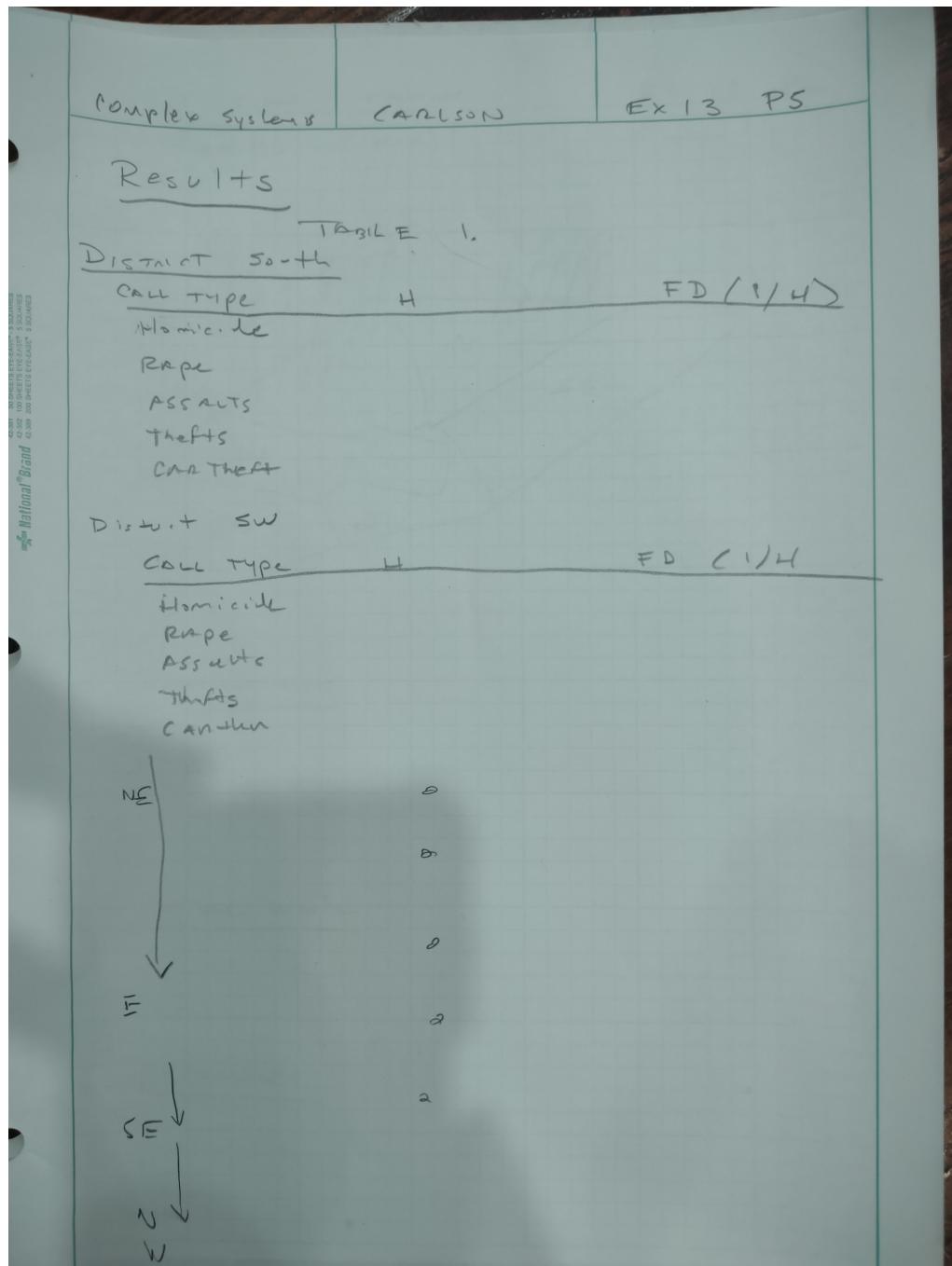
Open DATA
Baltimore Example

Figure 1 - Open Data

The analysis tool will be the Banovit program which is a simple tool to do R/S analysis (and other fractal measures) at scale. This tool will be hacked up by the MATLAB Non-linear plug in, and possibly by Excel.







Complex system	causal	Ex 13 P6
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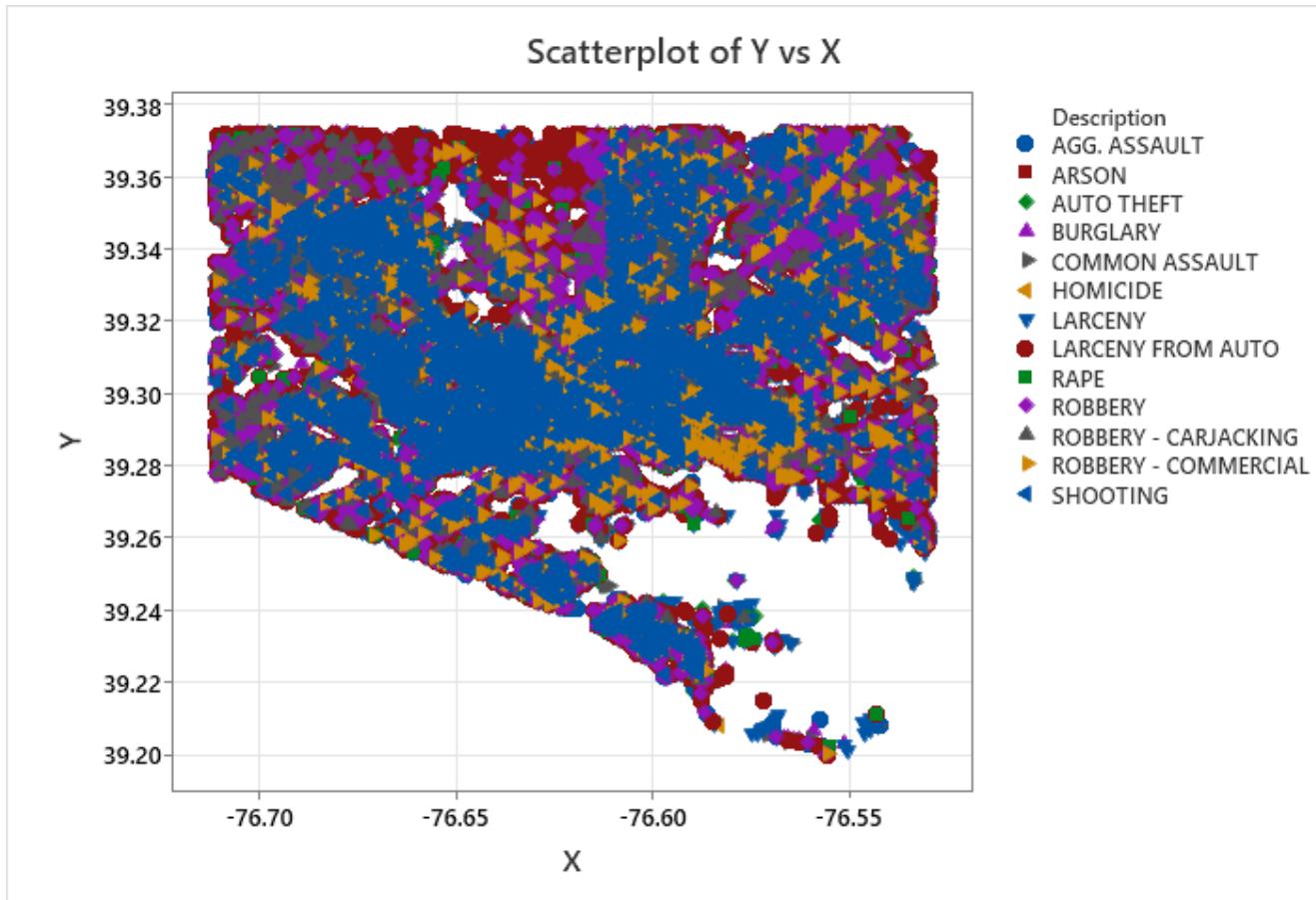
Results (MAP)

The diagram shows a large irregular shape divided into several smaller regions labeled N, NW, NE, S, SW, E, and W. Arrows point from the center towards the outer regions, with labels such as 'AH', 'R', 'T', 'CT', and 'A H A T C R' at the top right. There are also arrows pointing from the left side towards the center.

Conclusions

Future work

References



I. INTRODUCTION

III. MODEL

IV. RESULTS

Add scintillating introduction.

Explain what we found

V. CONCLUDING REMARKS

Bring it home.

VI. METHODS

Add methods.

II. DESCRIPTION OF DATA SETS

ACKNOWLEDGMENTS

Describe our incredibly interesting data set.

We are grateful for ...

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