

# Interpretation of Dimensionally-Reduced Crime Data

## A Study with Untrained Domain Experts



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# Introduction to Domain Experts

## Data analysts of a Law Enforcement Agency (LEA)

- Work with tabular data on a daily basis
- Identification of patterns & suspects
- **Comparative case analysis**  
(consider similarities & correlations)

#	A	B	C	D	E	F	G	H	I	J	K	L
16	156132923	LARCENY/THEFT	GRAND THEFT FROM UNLOCKED AUTO	Monday	06.01.2015	01:00	INGLESIDE	NONE	500 Block of DAY ST	##	##	(37.7424089927314, -122.433756740526)
17	156129821	LARCENY/THEFT	GRAND THEFT OF PROPERTY	Monday	06.01.2015	20:00	INGLESIDE	NONE	1100 Block of MISSION ST	##	##	(37.7464837868984, -122.419251897751)
18	150479177	SUSPICIOUS OCC	SUSPICIOUS OCCURRENCE	Monday	06.01.2015	20:15	INGLESIDE	NONE	0 Block of NAPLES ST	##	##	(37.7279052131552, -122.425960162171)
19	150479278	NON-CRIMINAL	AIDED CASE, MENTAL DISTURBED	Monday	06.01.2015	14:23	SOUTHERN	NONE	900 Block of HOWARD ST	##	##	(37.7803113209065, -122.406508487003)
20	150479278	SUICIDE	ATTEMPTED SUICIDE	Monday	06.01.2015	14:23	SOUTHERN	NONE	900 Block of HOWARD ST	##	##	(37.7803113209065, -122.406508487003)
21	150479171	LARCENY/THEFT	PETTY THEFT FROM A BUILDING	Monday	06.01.2015	15:15	RICHMOND	EXCEPTIONAL CLEARANCE	700 Block of 7TH AV	##	##	(37.774384171507, -122.464944716156)
22	150479171	LARCENY/THEFT	PETTY THEFT FROM A BUILDING	Monday	06.01.2015	15:15	RICHMOND	EXCEPTIONAL CLEARANCE	700 Block of 7TH AV	##	##	(37.774384171507, -122.464944716156)
23	150478258	SUSPICIOUS OCC	UNUSUAL OCCURRENCE	Monday	06.01.2015	09:30	BAYVIEW	NONE	1200 Block of 3RD ST	##	##	(37.77448248240064, -122.38951748036)
24	150478220	MISSING PERSON	FOUND PERSON	Monday	06.01.2015	14:21	SOUTHERN	NONE	700 Block of MARKET ST	##	##	(37.7863072236365, -122.405294845215)
25	150478220	NON-CRIMINAL	AIDED CASE, MENTAL DISTURBED	Monday	06.01.2015	14:21	SOUTHERN	NONE	700 Block of MARKET ST	##	##	(37.7863072236365, -122.405294845215)
26	150477921	EMBEZZLEMENT	EMBEZZLEMENT, GRAND THEFT BY EMPLOYEE	Monday	06.01.2015	12:30	SOUTHERN	ARREST, BOOKED	700 Block of MISSION ST	##	##	(37.7852686309087, -122.40307000847)
27	150477244	LARCENY/THEFT	GRAND THEFT FROM LOCKED AUTO	Monday	06.01.2015	01:30	MISSION	NONE	400 Block of DOLORES ST	##	##	(37.7618086789362, -122.425956929318)
28	150476973	NON-CRIMINAL	FOUND PROPERTY	Monday	06.01.2015	06:07	TENDERLOIN	NONE	400 Block of ELLIS ST	##	##	(37.7848053746211, -122.413631253258)
29	150477426	VEHICLE THEFT	STOLEN AUTOMOBILE	Monday	06.01.2015	01:00	TARAVAL	NONE	100 Block of FONT BL	##	##	(37.755536666976, -122.473640755331)
30	150495903	NON-CRIMINAL	AIDED CASE	Monday	06.01.2015	14:30	CENTRAL	NONE	700 Block of PACIFIC AV	##	##	(37.796699717573, -122.408014703843)
31	150478327	WARRANTS	WARRANT ARREST	Monday	06.01.2015	14:15	MISSION	ARREST, BOOKED	900 Block of POTRERO AV	##	##	(37.75715180431915, -122.406604919508)
32	150478327	OTHER OFFENSES	RESISTING ARREST	Monday	06.01.2015	14:15	MISSION	ARREST, BOOKED	900 Block of POTRERO AV	##	##	(37.75715180431915, -122.406604919508)
33	150477705	BURGLARY	BURGLARY, HOT PROWL, FORCIBLE ENTRY	Monday	06.01.2015	11:00	INGLESIDE	NONE	600 Block of EXCELSIOR AV	##	##	(37.7237222548515, -122.428483538451)
34	150491866	FRAUD	CREDIT CARD, THEFT BY USE OF	Monday	06.01.2015	00:01	NORTHERN	NONE	2000 Block of BUSH ST	##	##	(37.7872796118788, -122.430995577182)
35	150500229	OTHER OFFENSES	LOST/STOLEN LICENSE PLATE	Monday	06.01.2015	18:00	CENTRAL	NONE	500 Block of COLUMBUS AV	##	##	(37.798691959585, -122.40967412997)
36	150494038	LARCENY/THEFT	PETTY THEFT FROM UNLOCKED AUTO	Monday	06.01.2015	16:00	MISSION	NONE	1700 Block of 15TH ST	##	##	(37.7665569549171, -122.422667886722)
37	150492284	LARCENY/THEFT	PETTY THEFT OF PROPERTY	Monday	06.01.2015	12:05	RICHMOND	NONE	2800 Block of TURK ST	##	##	(37.7780501202623, -122.451399828803)
38	150489170	NON-CRIMINAL	LOST PROPERTY	Monday	06.01.2015	15:30	BAYVIEW	NONE	3800 Block of 3RD ST	##	##	(37.742260519555, -122.38799452192)
39	150479911	LARCENY/THEFT	GRAND THEFT FROM UNLOCKED AUTO	Monday	06.01.2015	22:30	CENTRAL	ARREST, BOOKED	300 Block of THE EMBARCADERO NC	##	##	(37.7980532528058, -122.396374439116)
40	150496313	NON-CRIMINAL	LOST PROPERTY	Monday	06.01.2015	08:00	NORTHERN	NONE	0 Block of MARINA BL	##	##	(37.8050520228881, -122.432951589917)
41	150484389	OTHER OFFENSES	LOST/STOLEN LICENSE PLATE	Monday	06.01.2015	12:00	BAYVIEW	NONE	1000 Block of 23RD ST	##	##	(37.751186717447, -122.39045894333)
42	150485695	LARCENY/THEFT	LOST PROPERTY, PETTY THEFT	Monday	06.01.2015	17:00	TENDERLOIN	NONE	200 Block of OFARRELL ST	##	##	(37.7864044708209, -122.408519707946)
43	150485695	FRAUD	FRAUDULENT USE OF AUTOMATED TELLER CARD	Monday	06.01.2015	17:00	TENDERLOIN	NONE	200 Block of OFARRELL ST	##	##	(37.7864044708209, -122.408519707946)
44	150484170	SUSPICIOUS OCC	SUSPICIOUS OCCURRENCE	Monday	06.01.2015	22:00	RICHMOND	NONE	100 Block of 18TH AV	##	##	(37.7851364834235, -122.477506314798)
45	150481091	VANDALISM	MALICIOUS MISCHIEF, GRAFFITI	Monday	06.01.2015	19:00	TARAVAL	NONE	4600 Block of LINCOLN WY	##	##	(37.7640080580561, -122.507801507736)
46	150479561	MISSING PERSON	MISSING ADULT	Monday	06.01.2015	18:30	SOUTHERN	NONE	900 Block of MISSION ST	##	##	(37.7815063666429, -122.407912868203)
47	150478026	FORGERY/COUNTERFEITING	MONEY, CHANGING FACE AMOUNT	Monday	06.01.2015	10:01	CENTRAL	NONE	2800 Block of LEAVENWORTH ST	##	##	(37.8073139305952, -122.41906724179)
48	150480386	OTHER OFFENSES	PROBATION VIOLATION	Monday	06.01.2015	22:30	BAYVIEW	ARREST, BOOKED	1000 Block of LEONTE AV	##	##	(37.7190311787318, -122.39800417794)
49	150480386	VEHICLE THEFT	STOLEN AUTOMOBILE	Monday	06.01.2015	22:30	BAYVIEW	ARREST, BOOKED	1000 Block of LEONTE AV	##	##	(37.7190311787318, -122.39800417794)
50	150486637	BURGLARY	BURGLARY OF APARTMENT HOUSE, UNLAWFUL ENTRY	Monday	06.01.2015	14:30	MISSION	NONE	3500 Block of 19TH ST	##	##	(37.7600451698328, -122.423265598657)
51	150485297	LARCENY/THEFT	ATTEMPTED THEFT OF A BICYCLE	Monday	06.01.2015	16:30	CENTRAL	NONE	300 Block of PINE ST	##	##	(37.7920063142639, -122.40129641674)
52	150484346	BURGLARY	BURGLARY, FORCIBLE ENTRY	Monday	06.01.2015	19:00	SOUTHERN	NONE	0 Block of OTTIS ST	##	##	(37.7720755990905, -122.42005698993)
53	150482237	FRAUD	CREDIT CARD, THEFT BY USE OF	Monday	06.01.2015	00:01	CENTRAL	NONE	1000 Block of LEAVENWORTH ST	##	##	(37.79078087866738, -122.415588123596)
54	150482986	BURGLARY	BURGLARY, STORE UNDER CONSTRUCTION, UNLAWFUL ENTRY	Monday	06.01.2015	17:30	INGLESIDE	NONE	4500 Block of MISSION ST	##	##	(37.7249007364614, -122.43455277287)
55	150481609	MISSING PERSON	MISSING ADULT	Monday	06.01.2015	12:00	MISSION	NONE	800 Block of CAPP ST	##	##	(37.753084671409, -122.417499429971)
56	150481334	BURGLARY	BURGLARY, HOT PROWL, UNLAWFUL ENTRY	Monday	06.01.2015	22:00	RICHMOND	NONE	2100 Block of POST ST	##	##	(37.7846857938094, -122.43720557775)
57	150481154	LARCENY/THEFT	PETTY THEFT FROM UNLOCKED AUTO	Monday	06.01.2015	23:00	BAYVIEW	NONE	300 Block of SALINAS AV	##	##	(37.7214646496502, -122.399455248514)

# Introduction to Domain Experts

## Data analysts of a Law Enforcement Agency (LEA)

- Work with tabular data on a daily basis
- Identification of patterns & suspects
- **Comparative case analysis**  
(consider similarities & correlations)

➔ **Challenge:**  
consider multiple attributes simultaneously

	A	B	C	D	E	F	G	H	I	J	K	L
16	156132923	LARCENY/THEFT	GRAND THEFT FROM UNLOCKED AUTO	Monday	06.01.2015	01:00	INGLESIDE	NONE	500 Block of DAY ST	##	##	(37.7424089927314, -122.433756740526)
17	15612982	LARCENY/THEFT	GRAND THEFT OF PROPERTY	Monday	06.01.2015	20:00	INGLESIDE	NONE	1100 Block of MISSION ST	##	##	(37.746483786894, -122.419251897751)
18	15047917	SUSPICIOUS OCC	SUSPICIOUS OCCURRENCE	Monday	06.01.2015	20:15	INGLESIDE	NONE	0 Block of NAPLES ST	##	##	(37.7279052131552, -122.42596016271)
19	150479278	NON-CRIMINAL	AIDED CASE, MENTAL DISTURBED	Monday	06.01.2015	14:23	SOUTHERN	NONE	900 Block of HOWARD ST	##	##	(37.7803113209065, -122.406508487003)
20	150479278	SUICIDE	ATTEMPTED SUICIDE	Monday	06.01.2015	14:23	SOUTHERN	NONE	900 Block of HOWARD ST	##	##	(37.7803113209065, -122.406508487003)
21	150479171	LARCENY/THEFT	PETTY THEFT FROM A BUILDING	Monday	06.01.2015	15:15	RICHMOND	EXCEPTIONAL CLEARANCE	700 Block of 7TH AV	##	##	(37.774384171507, -122.464944716156)
22	150479171	LARCENY/THEFT	PETTY THEFT FROM A BUILDING	Monday	06.01.2015	15:15	RICHMOND	EXCEPTIONAL CLEARANCE	700 Block of 7TH AV	##	##	(37.774384171507, -122.464944716156)
23	15047828	SUSPICIOUS OCC	UNUSUAL OCCURRENCE	Monday	06.01.2015	09:30	BAYVIEW	NONE	1200 Block of 3RD ST	##	##	(37.774482480064, -122.38951748036)
24	150478220	MISSING PERSON	FOUND PERSON	Monday	06.01.2015	14:21	SOUTHERN	NONE	700 Block of MARKET ST	##	##	(37.7863072236365, -122.405294845215)
25	150478220	NON-CRIMINAL	AIDED CASE, MENTAL DISTURBED	Monday	06.01.2015	14:21	SOUTHERN	NONE	700 Block of MARKET ST	##	##	(37.7863072236365, -122.405294845215)
26	150477921	EMBEZZLEMENT	EMBEZZLEMENT, GRAND THEFT BY EMPLOYEE	Monday	06.01.2015	12:30	SOUTHERN	ARREST, BOOKED	700 Block of MISSION ST	##	##	(37.7852686309087, -122.40307000847)
27	150477244	LARCENY/THEFT	GRAND THEFT FROM LOCKED AUTO	Monday	06.01.2015	01:30	MISSION	NONE	400 Block of DOLORES ST	##	##	(37.7618086789362, -122.425956929318)
28	150476973	NON-CRIMINAL	FOUND PROPERTY	Monday	06.01.2015	06:07	TENDERLOIN	NONE	400 Block of ELLIS ST	##	##	(37.7848053746211, -122.413631253258)
29	15047748	VEHICLE THEFT	STOLEN AUTOMOBILE	Monday	06.01.2015	01:00	TARAVAL	NONE	100 Block of FONT BL	##	##	(37.755536666976, -122.47344075531)
30	150499903	NON-CRIMINAL	AIDED CASE	Monday	06.01.2015	14:30	CENTRAL	NONE	700 Block of PACIFIC AV	##	##	(37.796699717573, -122.408014703843)
31	150478327	WARRANTS	WARRANT ARREST	Monday	06.01.2015	14:15	MISSION	ARREST, BOOKED	900 Block of POTRERO AV	##	##	(37.75715180431915, -122.406604919508)
32	150478327	OTHER OFFENSES	RESISTING ARREST	Monday	06.01.2015	14:15	MISSION	ARREST, BOOKED	900 Block of POTRERO AV	##	##	(37.75715180431915, -122.406604919508)
33	150477705	BURGLARY	BURGLARY, HOT PROWL, FORCIBLE ENTRY	Monday	06.01.2015	11:00	INGLESIDE	NONE	600 Block of EXCELSIOR AV	##	##	(37.7237222548515, -122.428483538451)
34	150491886	FRAUD	CREDIT CARD, THEFT BY USE OF	Monday	06.01.2015	00:01	NORTHERN	NONE	2000 Block of BUSH ST	##	##	(37.7872796118788, -122.430995577182)
35	150500229	OTHER OFFENSES	LOST/STOLEN LICENSE PLATE	Monday	06.01.2015	18:00	CENTRAL	NONE	500 Block of COLUMBUS AV	##	##	(37.798891959585, -122.40967412997)
36	150494038	LARCENY/THEFT	PETTY THEFT FROM UNLOCKED AUTO	Monday	06.01.2015	16:00	MISSION	NONE	1700 Block of 15TH ST	##	##	(37.7665656949171, -122.422667886722)
37	150492284	LARCENY/THEFT	PETTY THEFT OF PROPERTY	Monday	06.01.2015	12:05	RICHMOND	NONE	2800 Block of TURK ST	##	##	(37.7780501202623, -122.4513998028803)
38	150491970	NON-CRIMINAL	LOST PROPERTY	Monday	06.01.2015	15:30	BAYVIEW	NONE	1800 Block of 3RD ST	##	##	(37.742260519555, -122.38799452192)
39	150479911	LARCENY/THEFT	GRAND THEFT FROM UNLOCKED AUTO	Monday	06.01.2015	22:30	CENTRAL	ARREST, BOOKED	300 Block of THE EMBARCADERO NC	##	##	(37.7980532528058, -122.3963174439116)
40	150496313	NON-CRIMINAL	LOST PROPERTY	Monday	06.01.2015	08:00	NORTHERN	NONE	0 Block of MARINA BL	##	##	(37.8050520228881, -122.432951589917)
41	150484389	OTHER OFFENSES	LOST/STOLEN LICENSE PLATE	Monday	06.01.2015	12:00	BAYVIEW	NONE	1000 Block of 23RD ST	##	##	(37.751186717447, -122.39043694333)
42	150485695	LARCENY/THEFT	LOST PROPERTY, PETTY THEFT	Monday	06.01.2015	17:00	TENDERLOIN	NONE	200 Block of OFARRELL ST	##	##	(37.7864044708209, -122.408519707946)
43	150485695	FRAUD	FRAUDULENT USE OF AUTOMATED TELLER CARD	Monday	06.01.2015	17:00	TENDERLOIN	NONE	200 Block of OFARRELL ST	##	##	(37.7864044708209, -122.408519707946)
44	150484170	SUSPICIOUS OCC	SUSPICIOUS OCCURRENCE	Monday	06.01.2015	22:00	RICHMOND	NONE	100 Block of 18TH AV	##	##	(37.7851364834235, -122.477506314798)
45	150481091	VANDALISM	MALICIOUS MISCHIEF, GRAFFITI	Monday	06.01.2015	19:00	TARAVAL	NONE	4600 Block of LINCOLN WY	##	##	(37.764068058561, -122.507801507736)
46	150479561	MISSING PERSON	MISSING ADULT	Monday	06.01.2015	18:30	SOUTHERN	NONE	900 Block of MISSION ST	##	##	(37.7815063666429, -122.407912868203)
47	150478028	FORGERY/COUNTERFEITING	MONEY, CHANGING FACE AMOUNT	Monday	06.01.2015	10:01	CENTRAL	NONE	2800 Block of LEAVENWORTH ST	##	##	(37.8073139305952, -122.419072724179)
48	150480386	OTHER OFFENSES	PROBATION VIOLATION	Monday	06.01.2015	22:30	BAYVIEW	ARREST, BOOKED	1000 Block of LEONTE AV	##	##	(37.71903131787318, -122.39800417794)
49	150480386	VEHICLE THEFT	STOLEN AUTOMOBILE	Monday	06.01.2015	22:30	BAYVIEW	ARREST, BOOKED	1000 Block of LEONTE AV	##	##	(37.71903131787318, -122.39800417794)
50	150486637	BURGLARY	BURGLARY OF APARTMENT HOUSE, UNLAWFUL ENTRY	Monday	06.01.2015	14:30	MISSION	NONE	3500 Block of 19TH ST	##	##	(37.7600451698328, -122.423265598657)
51	150485297	LARCENY/THEFT	ATTEMPTED THEFT OF A BICYCLE	Monday	06.01.2015	16:30	CENTRAL	NONE	300 Block of PINE ST	##	##	(37.7920063142639, -122.40129641674)
52	150484346	BURGLARY	BURGLARY, FORCIBLE ENTRY	Monday	06.01.2015	19:00	SOUTHERN	NONE	0 Block of OTIS ST	##	##	(37.7720755990605, -122.42005698993)
53	150482237	FRAUD	CREDIT CARD, THEFT BY USE OF	Monday	06.01.2015	00:01	CENTRAL	NONE	1000 Block of LEAVENWORTH ST	##	##	(37.79078087866738, -122.415588123596)
54	150482986	BURGLARY	BURGLARY, STORE UNDER CONSTRUCTION, UNLAWFUL ENTRY	Monday	06.01.2015	17:30	INGLESIDE	NONE	4500 Block of MISSION ST	##	##	(37.7249070364814, -122.43455277287)
55	150481609	MISSING PERSON	MISSING ADULT	Monday	06.01.2015	12:00	MISSION	NONE	800 Block of CAPP ST	##	##	(37.753084671409, -122.417499429971)
56	150481334	BURGLARY	BURGLARY, HOT PROWL, UNLAWFUL ENTRY	Monday	06.01.2015	22:00	RICHMOND	NONE	2100 Block of POST ST	##	##	(37.7846857938094, -122.43720557775)
57	150481154	LARCENY/THEFT	PETTY THEFT FROM UNLOCKED AUTO	Monday	06.01.2015	23:00	BAYVIEW	NONE	300 Block of SALINAS AV	##	##	(37.72144646496502, -122.399455248514)

# Planar Data Projections

Multidimensional Scaling (MDS) = Distance-Preserving Projection

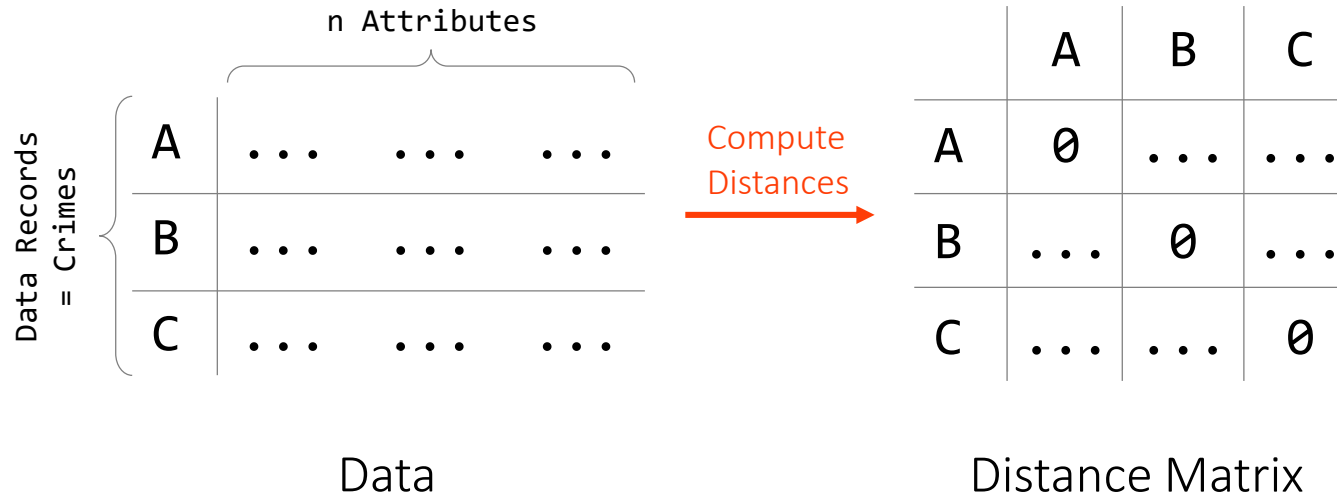
**Overall goal:**  $\mathbb{R}^n \rightarrow \mathbb{R}^m ; m < n$

Data Records = Crimes		n Attributes		
		A	...	...
		B	...	...
		C	...	...
		Data		

# Planar Data Projections

Multidimensional Scaling (MDS) = Distance-Preserving Projection

**Overall goal:**  $\mathbb{R}^n \rightarrow \mathbb{R}^m ; m < n$



# Planar Data Projections

Multidimensional Scaling (MDS) = Distance-Preserving Projection

**Overall goal:**  $\mathbb{R}^n \rightarrow \mathbb{R}^m ; m < n$

Data Records = Crimes		n Attributes								
	A	...	...	...	...	...	...	...	...	...
	B	...	...	...	...	...	...	...	...	...
	C	...	...	...	...	...	...	...	...	...

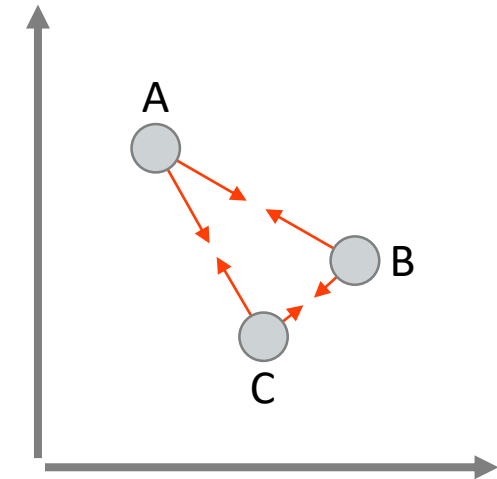
Data

Compute  
Distances

	A	B	C
A	0	...	...
B	...	0	...
C	...	...	0

Distance Matrix

Projection

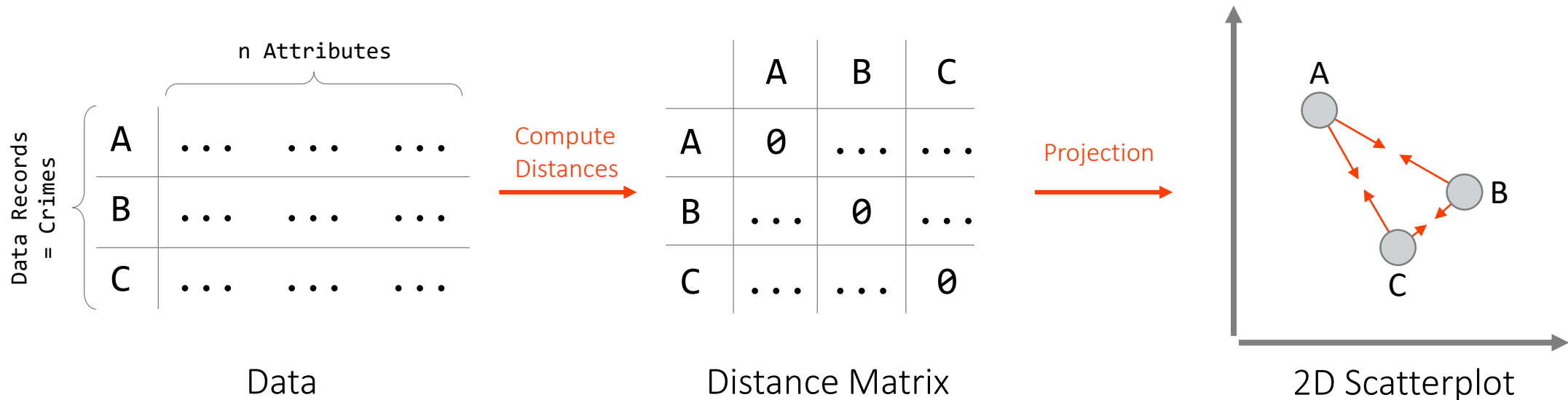


2D Scatterplot

# Planar Data Projections

Multidimensional Scaling (MDS) = Distance-Preserving Projection

Overall goal:  $\mathbb{R}^n \rightarrow \mathbb{R}^m ; m < n$



**Main Problem** interpretation of the visual depiction

# Previous Work

**Includes Domain Experts**

**No Study (any)**





# Previous Work

Includes Domain Experts

No Study (any)

Ward & Martin (1995)  
Buja (1996)



# Previous Work

Includes Domain Experts

No Study (any)

## Case Studies

Jeong et al. (2009)

Johansson & Johansson (2009)

Ingram et al. (2010)

Turkay et al. (2011)

Turkay et al. (2012)

Fernstad et al. (2013)

Yuan et al. (2013)

Liu et al. (2014)

## Application Examples

Seo & Shneiderman (2005)

Nam & Mueller (2013)

Krause et al. (2016)

Ward & Martin (1995)

Buja (1996)

# Previous Work

Includes Domain Experts

No Study (any)

## User Studies

without Domain Experts

Yi et al. (2005)

Brown et al. (2012)

Sedlmair et al. (2013)

Stahnke et al. (2016)

## Case Studies

Jeong et al. (2009)

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**Our Study**

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## Application Examples

Seo & Shneiderman (2005)

Nam & Mueller (2013)

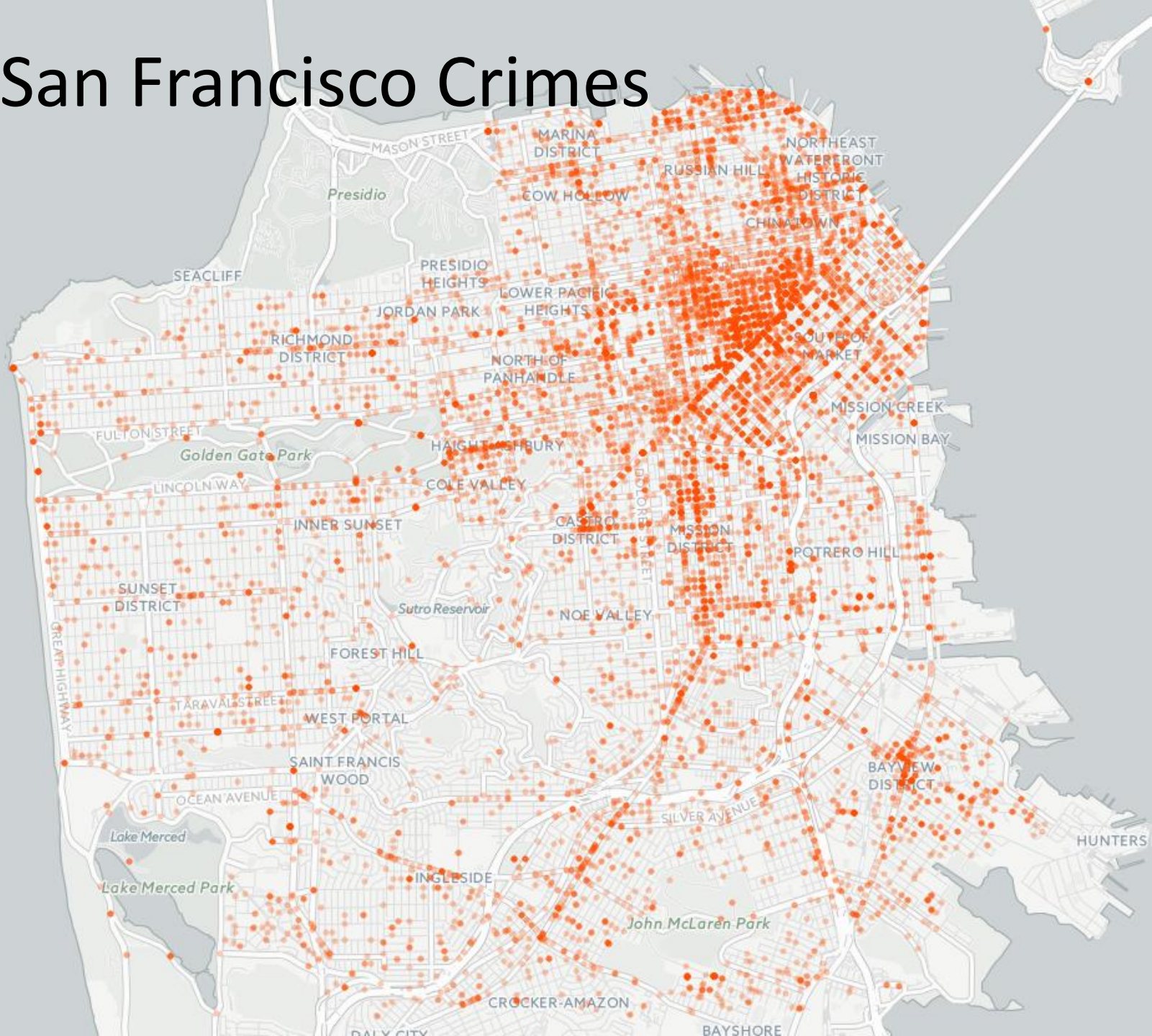
Krause et al. (2016)

Ward & Martin (1995)

Buja (1996)

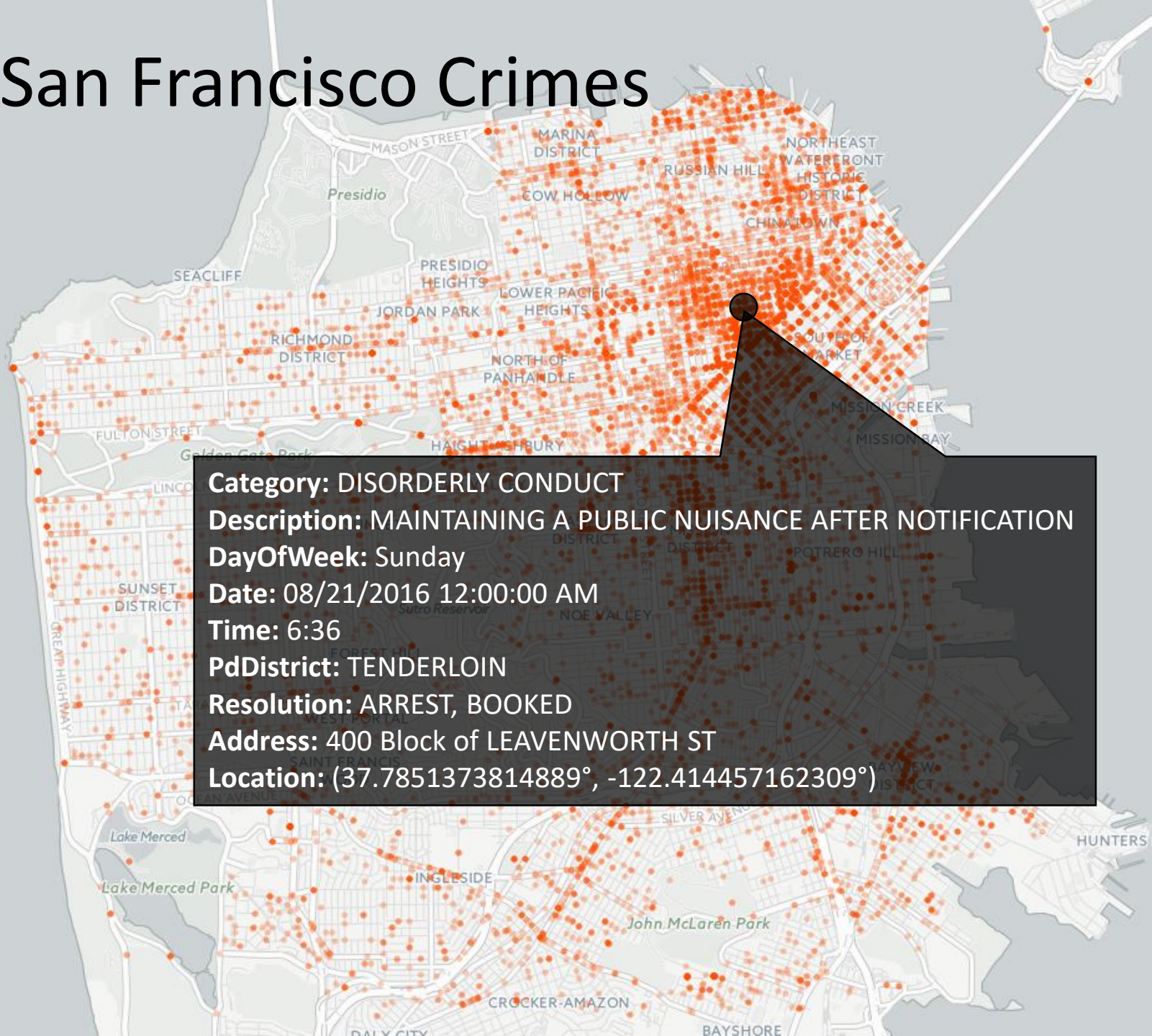
Can domain experts **not trained in advanced statistics**  
**interpret the depiction of a data projection?**

# Data: San Francisco Crimes





# Data: San Francisco Crimes



# Data Types

08/21/2016 00:06:36 AM

numerical

MAINTAINING A PUBLIC NUISANCE AFTER NOTIFICATION

textual

DISORDERLY CONDUCT

categorical



# Data Types

08/21/2016 00:06:36 AM

numerical

MAINTAINING A PUBLIC NUISANCE AFTER NOTIFICATION

textual

DISORDERLY CONDUCT

categorical

## Similarity between ...

numerical values

$$\text{sim}(V_1, V_2) = |V_1 - V_2|$$

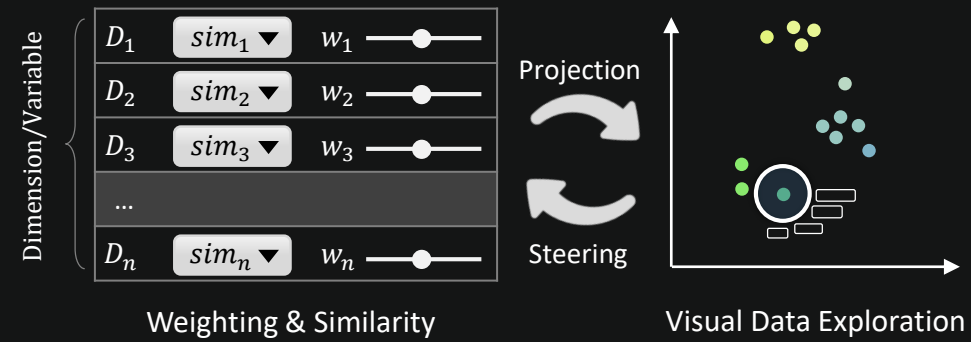
textual attrib.

$$\text{sim}(v_1, v_2) = \frac{v_1 \cdot v_2}{\|v_1\| \cdot \|v_2\|}$$

categorical values

$$\text{sim}(V_1, V_2) = [V_1 \neq V_2]$$

How to combine different data types?



# Interactive Visualization

# Weighting and Similarity

**Interactive weighting** = impact of an attribute

**Integration of diverse data types**

Gower Metric:  $dist(A, B) = \frac{\sum_{i=1}^{|dim|} sim_i(A_i, B_i) \cdot w_i}{|dim|}$

# Weighting and Similarity

The screenshot shows a web application titled "Out of Sight, out of Mind" running on the address 127.0.0.1:4000. The interface is divided into two main sections: "Weighting" on the left and a data preview on the right.

**Weighting Section:**

- Weighting Suggestions:** No suggestions are available for this dataset.
- Per Dimension Weight:** Two buttons are present: "all to 0" and "all to 1".
- Dimension Weighting Table:** A table with 13 rows, each representing a dimension. Each row has a slider, a weight value (all set to 1), and a data type dropdown.

Dimension	Weight	Data Type
IncidentNum	1	Numerical
Category	1	Categorical
Descript	1	Categorical
DayOfWeek	1	Categorical
Date	1	Categorical
Time	1	Categorical
PdDistrict	1	Categorical
Resolution	1	Categorical
Address	1	Categorical
X	1	Numerical
Y	1	Numerical
Location	1	Text Similarity
TimeOfDay	1	Numerical

**Data Preview Section:**

Navigation: < PREVIOUS 1 / 600 NEXT >

IncidentNum	160597650
Category	OTHER OFFENSES
Descript	RESISTING ARREST
DayOfWeek	Monday
Date	07/25/2016 12:00:00 AM
Time	00:28
PdDistrict	SOUTHERN
Resolution	ARREST, BOOKED
Address	100 Block of 10TH ST
X	-122.415077154938
Y	37.7746870888435
Location	(37.7746870888435, -122.415077154938)
TimeOfDay	0

# Visual Data Exploration

**Overview**

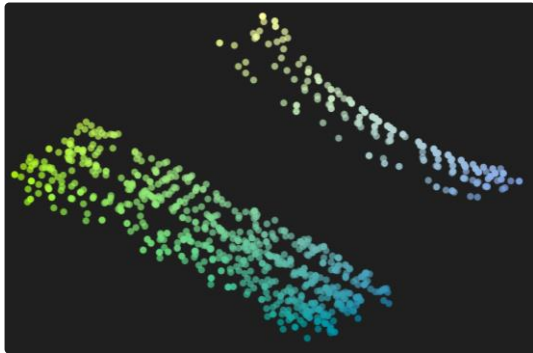
**Detail**



# Visual Data Exploration

Overview

Detail

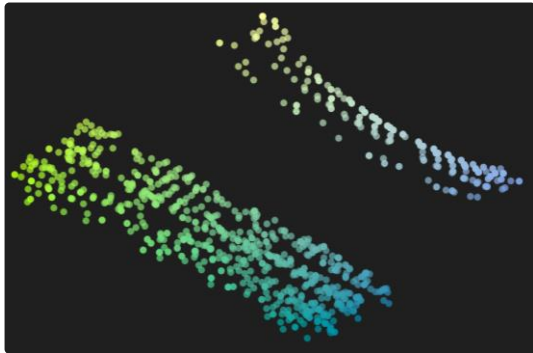


Projection

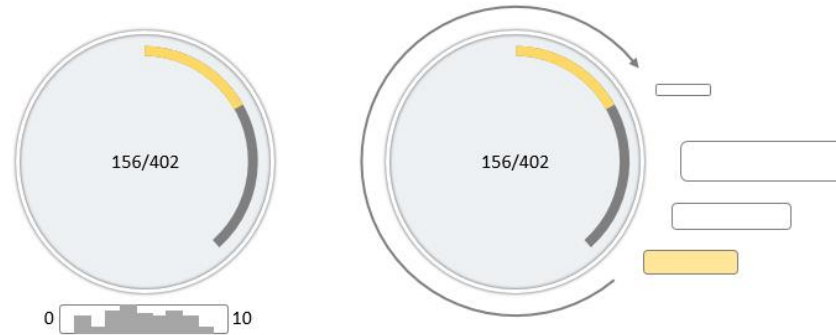
# Visual Data Exploration

Overview

Detail



Projection

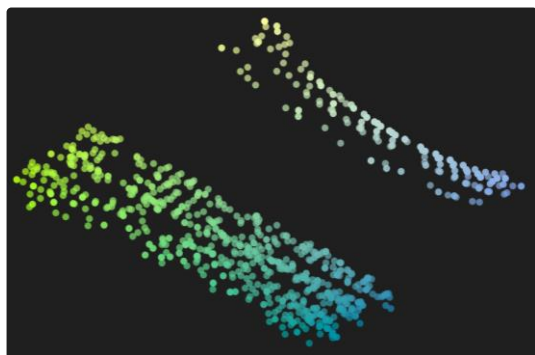


Content Lens

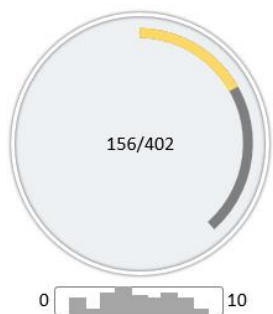
# Visual Data Exploration

Overview

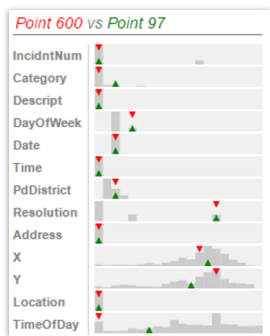
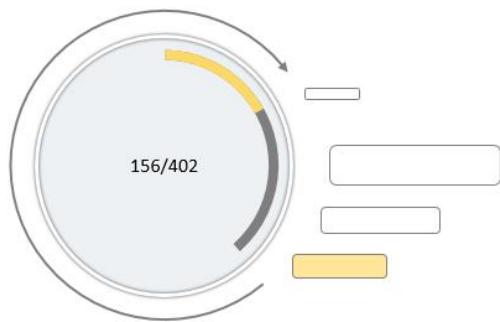
Detail



Projection



Content Lens



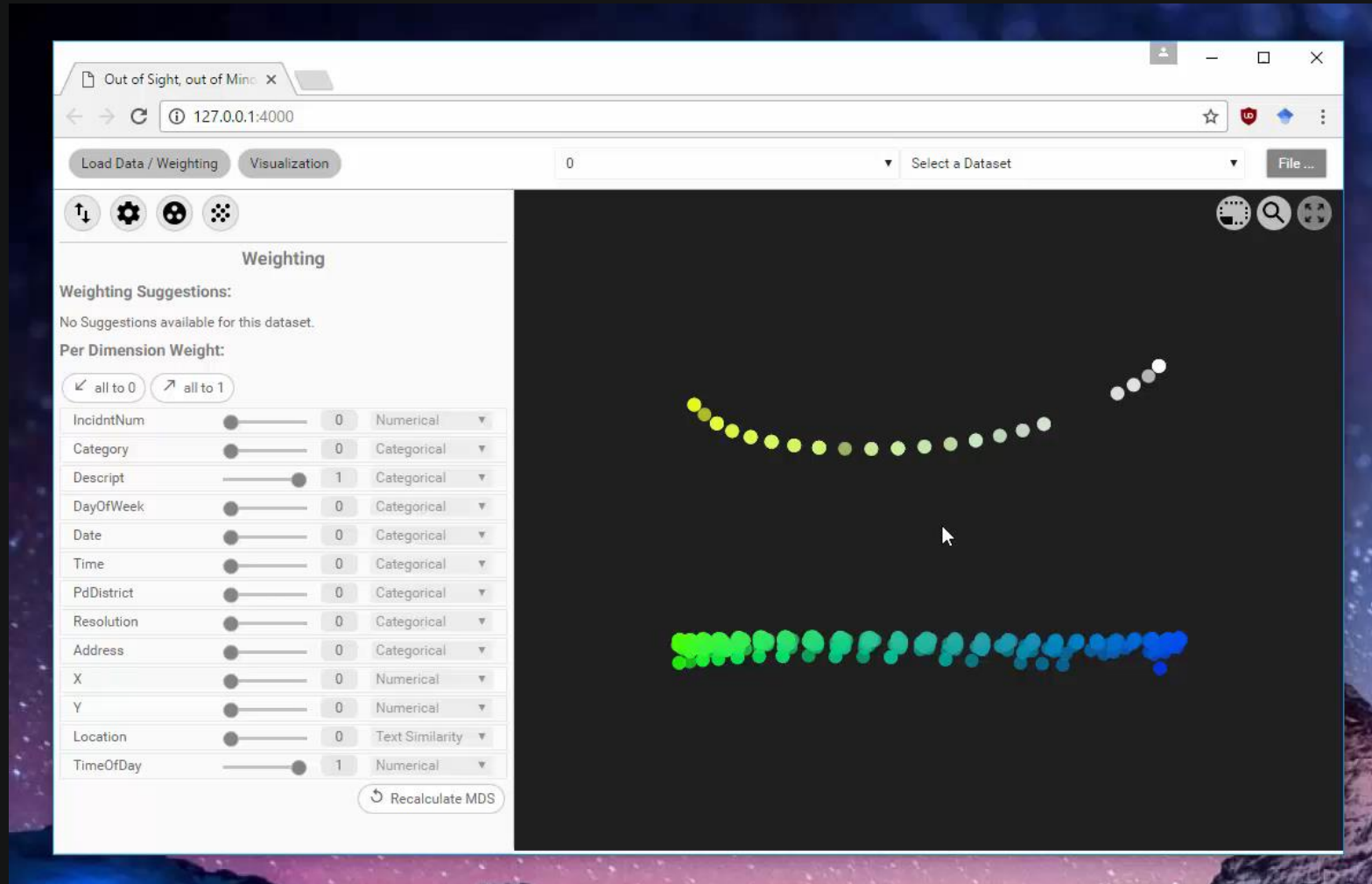
Tooltip

	A	B	C
109	150479052 NON-CRIMINAL	ASSAULT	AIDED CASE, MENTAL DISTURBED
110	150479052 ASSAULT	BATTERY	
111	150479030 BURGLARY	BURGLARY OF APARTMENT HOUSE, UNLAWFUL ENTRY	
112	150478991 LARCENY/THEFT	GRAND THEFT FROM LOCKED AUTO	
113	150478963 ASSAULT	BATTERY	
114	150478684 WARRANTS	ENROUTE TO OUTSIDE JURISDICTION	
115	150478634 OTHER OFFENSES	DRIVERS LICENSE, SUSPENDED OR REVOKED	
116	150478612 SUSPICIOUS OCC	SUSPICIOUS OCCURRENCE	
117	150478612 LARCENY/THEFT	PETTY THEFT FROM UNLOCKED AUTO	
118	150478606 NON-CRIMINAL	FOUND PROPERTY	
119	150478559 SUSPICIOUS OCC	SUSPICIOUS OCCURRENCE	
120	150478543 OTHER OFFENSES	DRIVERS LICENSE, SUSPENDED OR REVOKED	
121	150478496 MISSING PERSON	FOUND PERSON	
122	150477498 NON-CRIMINAL	LOST PROPERTY	
123	150477288 NON-CRIMINAL	AIDED CASE, MENTAL DISTURBED	
124	150477131 OTHER OFFENSES	DRIVERS LICENSE, SUSPENDED OR REVOKED	
125	150477078 OTHER OFFENSES	TRAFFIC VIOLATION ARREST	
126	150476898 SUSPICIOUS OCC	SUSPICIOUS OCCURRENCE, POSSIBLE SHOTS FIRED	
127	150476854 OTHER OFFENSES	DRIVERS LICENSE, SUSPENDED OR REVOKED	
128	150482453 VEHICLE THEFT	STOLEN TRUCK	
129	150481643 VEHICLE THEFT	STOLEN TRUCK	
130	150479999 VEHICLE THEFT	STOLEN TRUCK	
131	156133103 LARCENY/THEFT	GRAND THEFT FROM LOCKED AUTO	
132	156132757 LARCENY/THEFT	GRAND THEFT FROM LOCKED AUTO	
133	156132008 LARCENY/THEFT	GRAND THEFT FROM LOCKED AUTO	
134	156131709 LARCENY/THEFT	GRAND THEFT FROM UNLOCKED AUTO	
135	156131639 LARCENY/THEFT	GRAND THEFT FROM UNLOCKED AUTO	

Data View



# Visual Data Exploration



# Interpretation Study

# Study Design

## **3 LEA data analysts (1 female)**

- worked with data tables on a daily basis
- not used to work with abstract data representations

## **4 consecutive tasks**

- Each analyst was confronted with the same task order
- Each task was introduced as a new, subsequent analysis question

# Study Design

## San Francisco Crime Data

- Week from *Monday, July 25, 2016* to *Monday, August 1, 2016*
- 13 dimensions
- 36 different crime categories

## After the study, we let analysts fill out a questionnaire regarding:

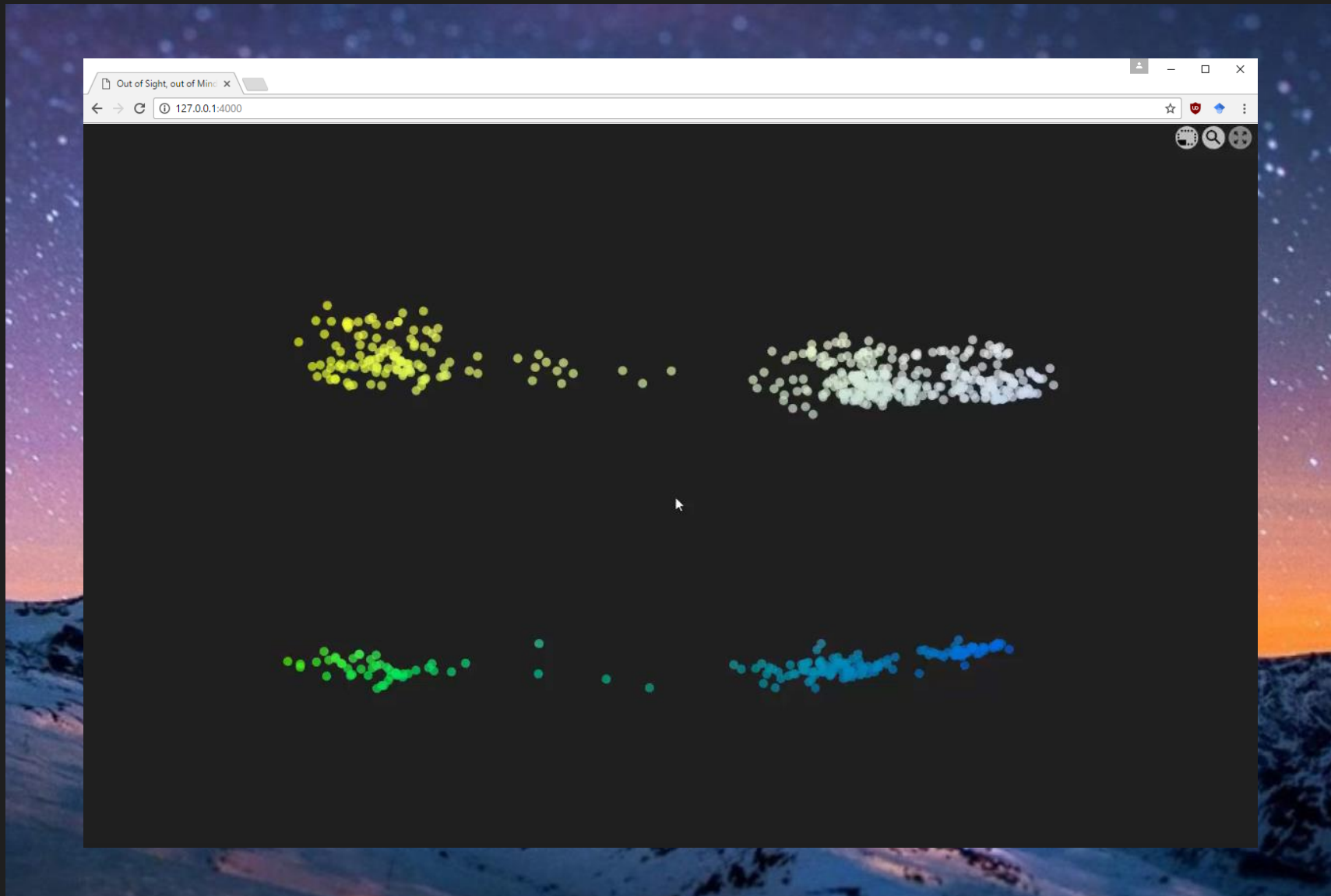
- basic understanding
- interaction concepts
- extraction of knowledge

# Tasks

## **Task 1**

Is there a pattern among dimensions between days?

# Task 1: Model Solution

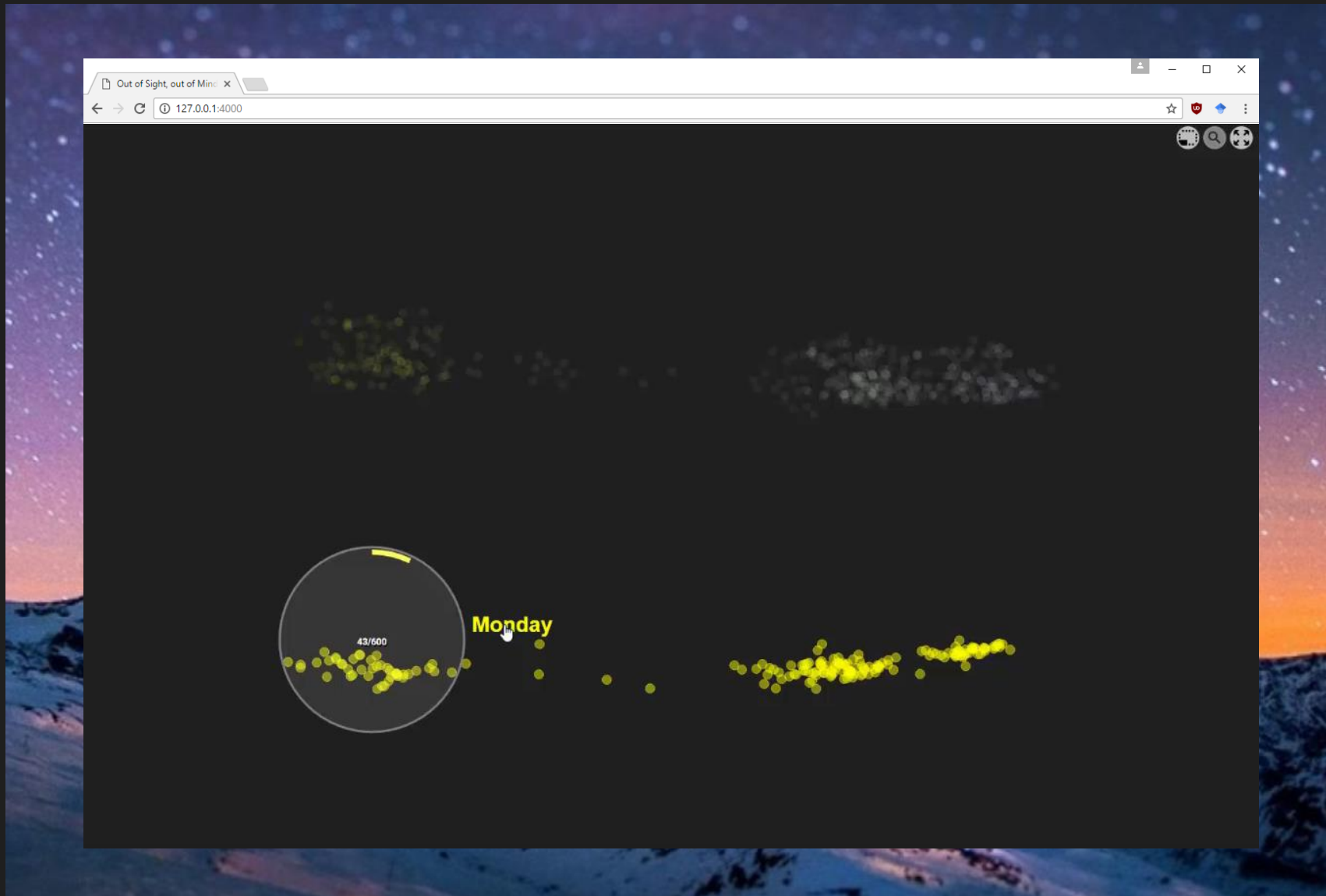


## Task 2

Why is the *Monday* separated from all other days of the week? What is special about the *Date* distribution?



# Task 2: Model Solution

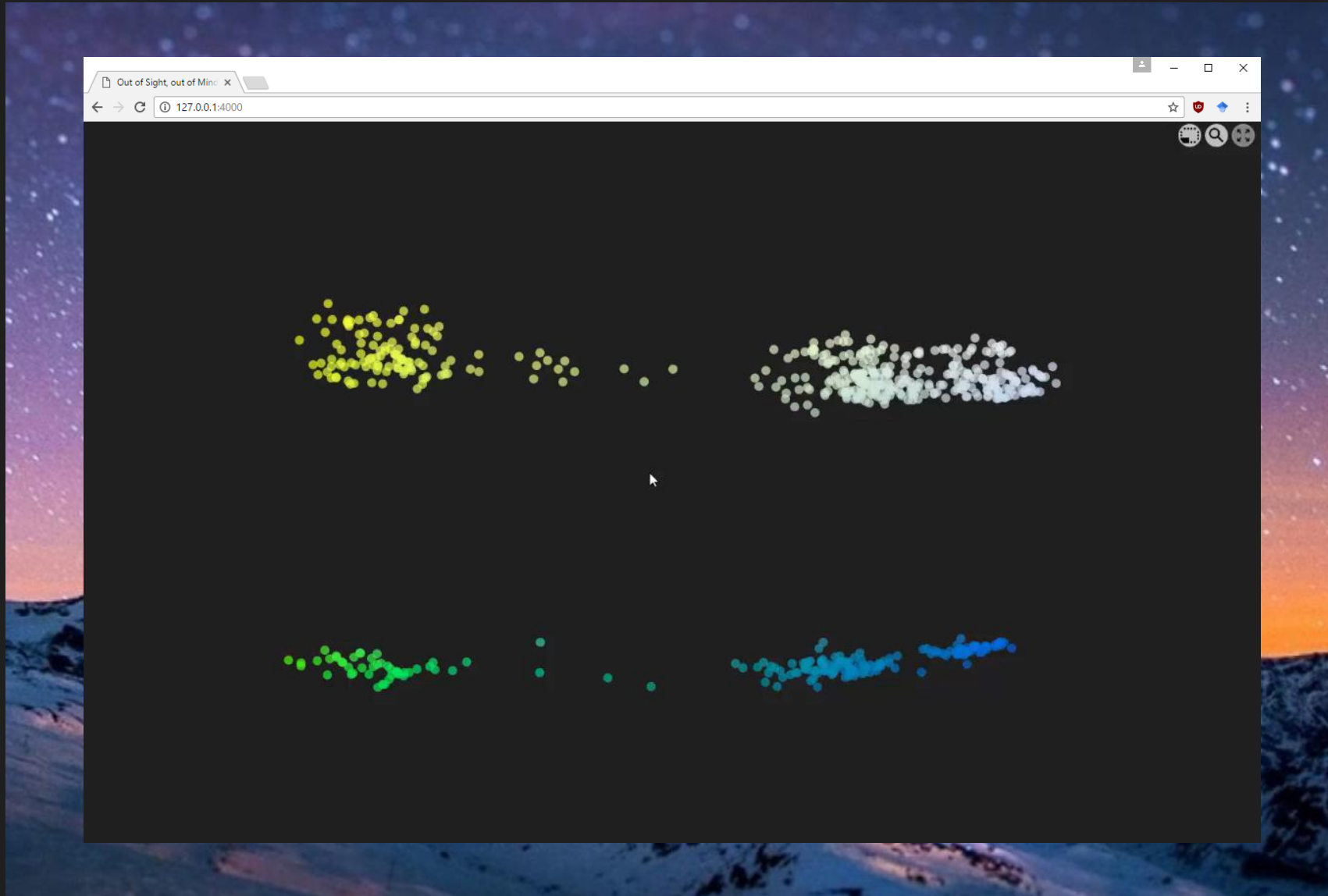


## **Task 3**

Which distribution of dimension values can you find for the rest of the week?

# Task 3: Model Solution

IncidentNum	<input type="range"/>	0
Category	<input type="range"/>	1
Descript	<input type="range"/>	1
DayOfWeek	<input type="range"/>	1
Date	<input type="range"/>	0
Time	<input type="range"/>	0
PdDistrict	<input type="range"/>	0
Resolution	<input type="range"/>	0
Address	<input type="range"/>	0
X	<input type="range"/>	0
Y	<input type="range"/>	0
Location	<input type="range"/>	0
TimeOfDay	<input type="range"/>	1

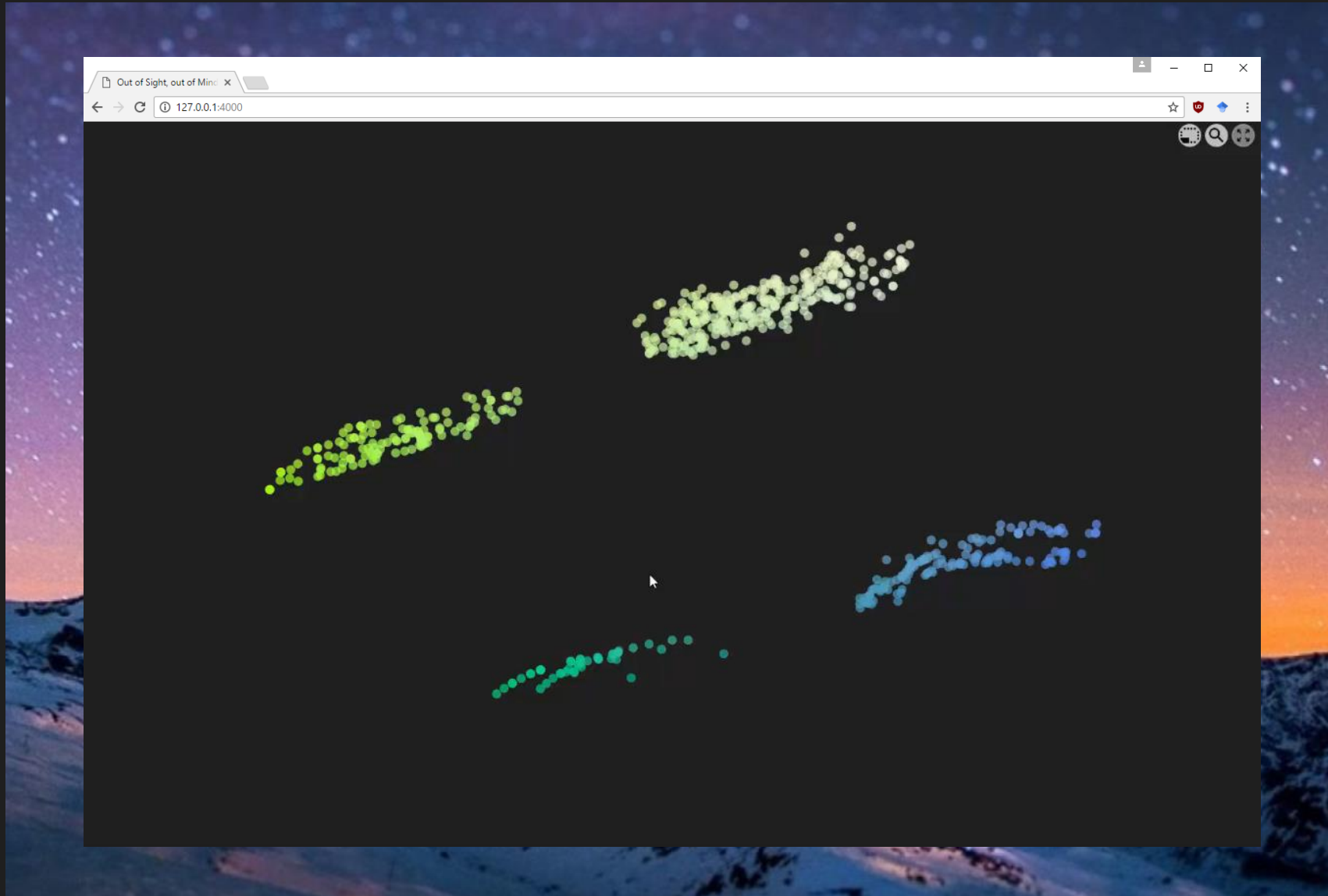


## **Task 4**

Leaving the temporal aspect behind, is there a pattern based on places or crime types?

# Task 4: Model Solution

IncidentNum	<input type="range"/>	0
Category	<input type="range"/>	1
Descript	<input type="range"/>	1
DayOfWeek	<input type="range"/>	0
Date	<input type="range"/>	0
Time	<input type="range"/>	0
PdDistrict	<input type="range"/>	1
Resolution	<input type="range"/>	0
Address	<input type="range"/>	0
X	<input type="range"/>	0
Y	<input type="range"/>	0
Location	<input type="range"/>	0
TimeOfDay	<input type="range"/>	0

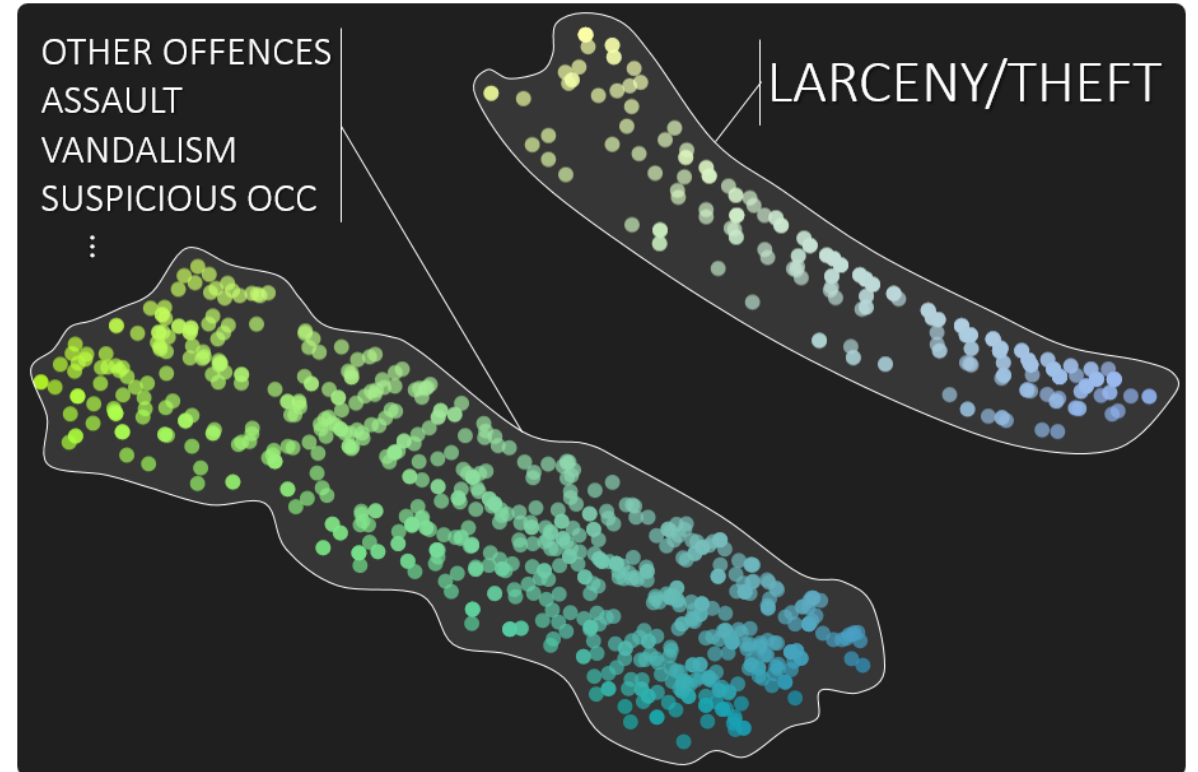


# Findings

**F1:** The analysis starts with an already known hypothesis.

# Crime Routine Activity (L. E. Cohen, 1979)

<b>Place</b>	District / Street / GPS
<b>Time</b>	Date / Time / Weekday
<b>Occasion</b>	Crime Opportunity





**F1:** The analysis starts with an already known hypothesis.

**F2:** Analysts always consider to add/remove dimensions to the depiction to explain a cluster separation.

- F1:** The analysis starts with an already known hypothesis.
- F2:** Analysts always consider to add/remove dimensions to the depiction to explain a cluster separation.
- F3:** Analysts do not add/remove dimensions to explain an anomaly they are insecure about.

- F1:** The analysis starts with an already known hypothesis.
- F2:** Analysts always consider to add/remove dimensions to the depiction to explain a cluster separation.
- F3:** Analysts do not add/remove dimensions to explain an anomaly they are insecure about.
- F4:** Analysts untrained in DR have a great understanding of a multivariate depiction given a use case relating to their domain.

# Conclusion

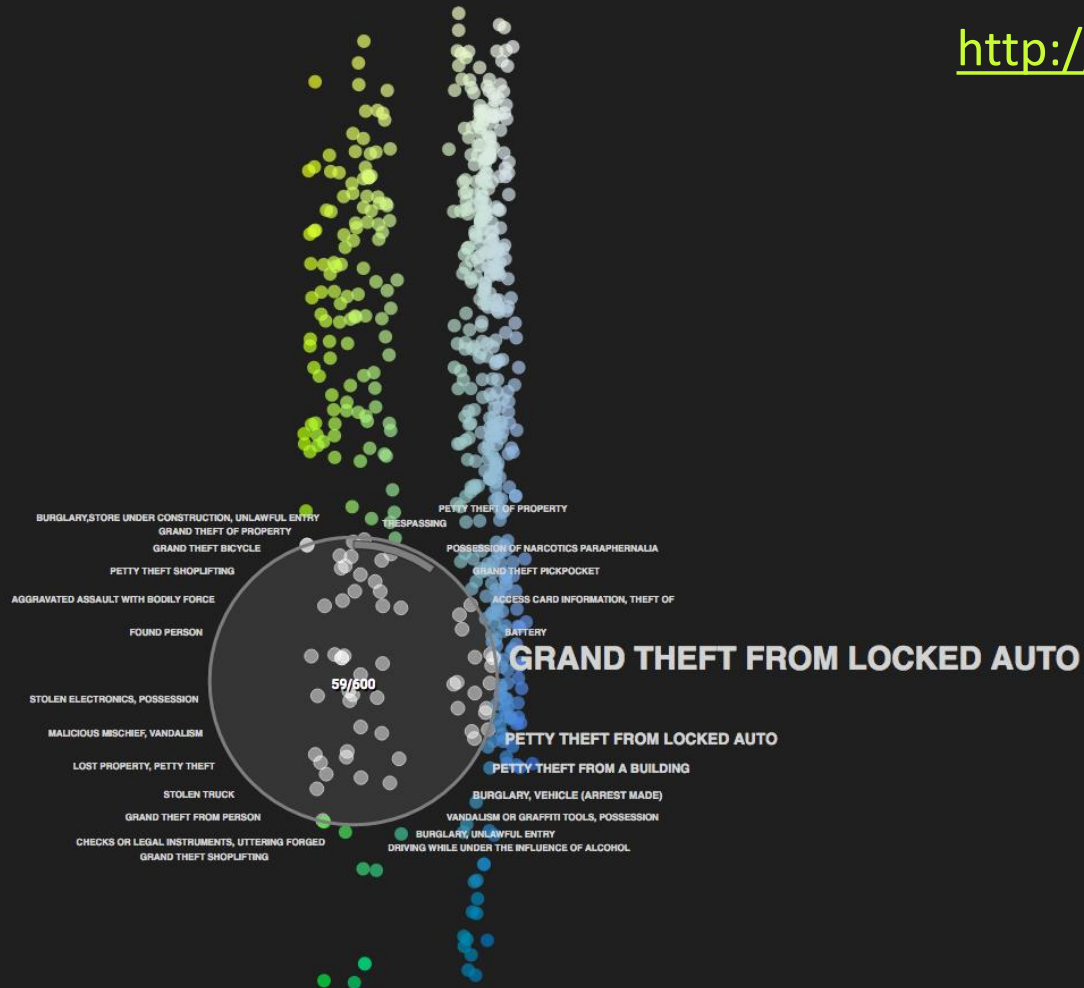
Interactive **visualization system** to explore the data using the **Gower Metric**

**Qualitative study** of subjective experiences of domain experts



# THANK YOU!

[http://www.dominikjaeckle.com/projects/2017/crime\\_interpret](http://www.dominikjaeckle.com/projects/2017/crime_interpret)



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Konstanz

