Detecting Crime Patterns

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What is a crime pattern?

“A series of crimes committed by the same offender or group of offenders…

To identify true patterns, one would need to consider information beyond simply time and space, but also other features of the crimes, such as the type of premise and means of entry.”

- Wang et al 2013
Crime in the 73 Pct, Brooklyn

Robbery 11/14/18 @ 1745 HRS
XXX Grafton St

Perpetrator states:
“If you back up I’m going to stab you, if you run I’ll stab you.”

Perpetrator punches victim, then takes his cell phone. Victim is a 13 year-old boy.
P.O. records information about the crime:

Who?
What?
Where?
When?
How?
Robberies in the 73 Pct

Each precinct has a crime analysis team charged with detecting patterns.

This can be a difficult job!

For example, the 73 Pct team had to determine if the 145 Grafton St robbery was in a pattern.

However, in the previous 3 months, 107 other robberies occurred in the 73 Pct.
Between 8/14/18 and 11/14/18, 444 seven-major crimes occurred in the 73 pct.

In addition to detecting patterns, the crime analysis team has many responsibilities.
Related Robbery 10/11/18 @ 1635 HRS
Legion St and Sutter Ave
“Give me your phone or I will stab you.”

Recent Robbery 11/14/18 @ 1745 HRS
XXX Grafton St
“If you back up I’m going to stab you, if you run I’ll stab you.”

Pattern established 11/17/18.
Pattern Progresses

Robbery #1 10/11/18 @ 1635 HRS
Give me your phone or I will stab you.

Robbery #2 11/14/18 @ 1745 HRS
If you back up I’m going to stab you, if you run I’ll stab you.

Robbery #3 11/21/18 @ 1730 HRS
Show me your wallet or I will shoot you.

Robbery #4 11/25/18 @ 1935 HRS
Give me your phone or I’m going to shoot you.

Robbery #5 11/26/18 @ 1600 HRS
Give me your money and phone or I’ll shoot you.

Robbery #6 11/26/18 @ 1600 HRS
Give me your phone or I will shoot you.

Robbery #7 11/26/18 @ 1640 HRS
Give me your phone or I’ll shoot you.
Citywide Grand Larceny Pattern
What do we do when a pattern is detected?

- Adjust patrol deployments
- Add investigative resources
- Request media attention
- Hold executives accountable
In 2018, NYC recorded:

- 12,913 Robberies
- 11,687 Burglaries
- 43,588 Grand Larcenies
Organizational Challenge

Tens of thousands of complaints reported each year. When a new complaint is reported, analysts in each precinct are tasked with identifying related complaints. These patterns, after review, inform NYPD operations.
Patternizr helps us meet this challenge

- Designed for robberies, burglaries, and grand larcenies
- Built into the Domain Awareness System
- Patternizr helps the analyst make decisions, it does not make decisions for the analyst
Supervised Machine Learning

- Historical patterns (~10,000 of each crime type)
- Training patterns
- Validation patterns
- Complaint pair similarities
- Features extracted from complaint pairs
- Random forest generation
What is a Random Forest?

Derived from classification trees which rely on features.

For example:

- Round?
  - Yes
  - No

- Apple
- Yellow?
  - Yes
  - No

- Banana
- Carrot

Patternizr uses features to classify complaint pairs. The output of Patternizr is the probability that a pair of complaints are in a pattern together.
P.O. records information about the crime:
- Time of occurrence
- Place of occurrence
- Premise type
- Property taken
- Suspect description
- Perpetrator’s statements
- Narrative of what happened
- Etc.
What features does Patternizr use?

- Days apart
- Distance apart (exponential)
- Distance apart (Euclidean)
- Complaint narrative similarity: sum
- Complaint narrative similarity: mean
- Premise type (narrow)
- Time-of-day similarity
- Time-of-week similarity
- Size of occur windows (diff)
- Size of occur windows (larger)
Deployment and Production Process

Train and test algorithm
Perform historical load
Integrate into Domain Awareness System
Train analysts
Perform differential loads and monitor usage
Approximately 1/3 of test patterns perfectly rebuilt, and approximately 4/5 at least partially rebuilt.
Efficiency of Patternizr vs. a simple baseline
Safeguards ensure Patternizr is used fairly

- Sensitive attributes were hidden from the algorithm.
- Outputs of the algorithm were tested for fairness.
- Several layers of analytic and supervisory review required.