University of Denver Analytics Challenge

Team Members: Colin Eberl-Coe, Margaret Golz, Oluwaseun (Seun) Ogunmodede, Ryan Thorpe

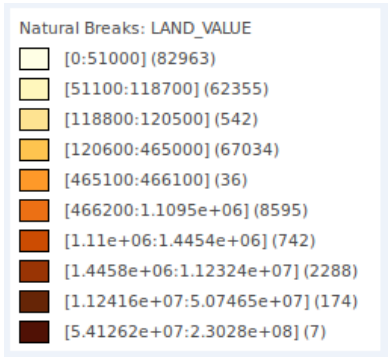
Colorado School of Mines

March 4, 2016

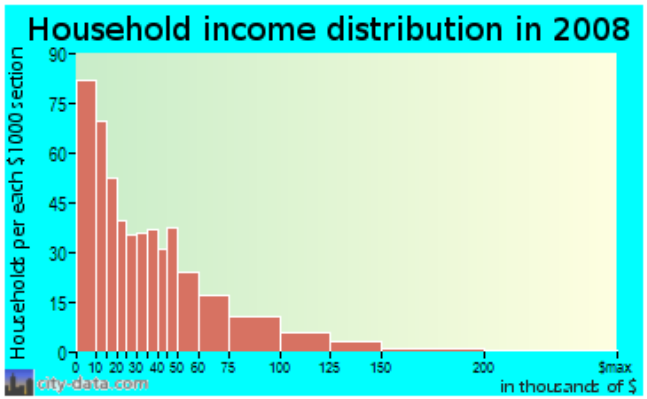
COLORADOSCHOOLOFMINES
EARTH • ENERGY • ENVIRONMENT

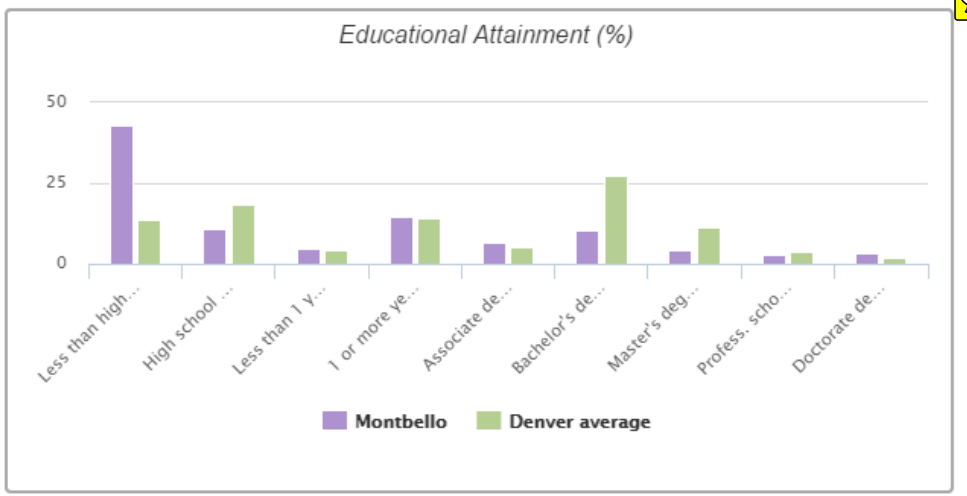
Social Control Theory: Society “Buy In”

- **Example Case: Montbello**



http://data.denvergov.org/dataset/city-and-county-of-denver-crime





Median household income in 2013:

Montbello: $46,175

Denver: $51,089

http://www.city-data.com/neighborhood/Montbello-Denver-CO.html

COLORADOSCHOOLOFMINES
EARTH • ENERGY • ENVIRONMENT

Input Data for Society "Buy In"

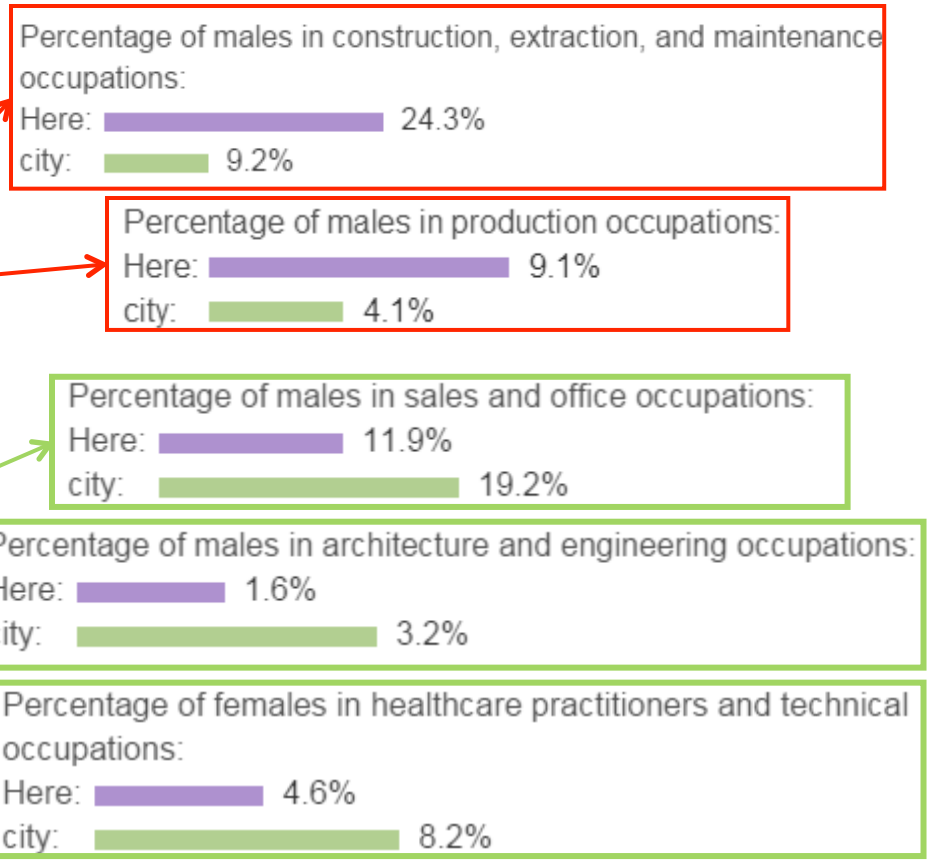
- **Montbello Economy vs. Colorado**

ESTIMATED NET JOBS CREATED IN NONAGRICULTURAL WAGE AND SALARY EMPLOYMENT SECTORS 2005–2016 (In Thousands)

Sector	2005-2015[a]
Natural Resources and Mining	13.9
Construction	-9.5
Manufacturing	-8.1
Total Goods Producing	-3.7
Trade, Transportation, and Utilities	31.0
Information	-6.8
Financial Activities	-1.2
Professional and Business Services	78.6
Education and Health Services	87.5
Leisure and Hospitality	53.9
Other Services	13.5
Government	52.1
Total Services Producing	*308.7*
Total Jobs Created[c]	305.0

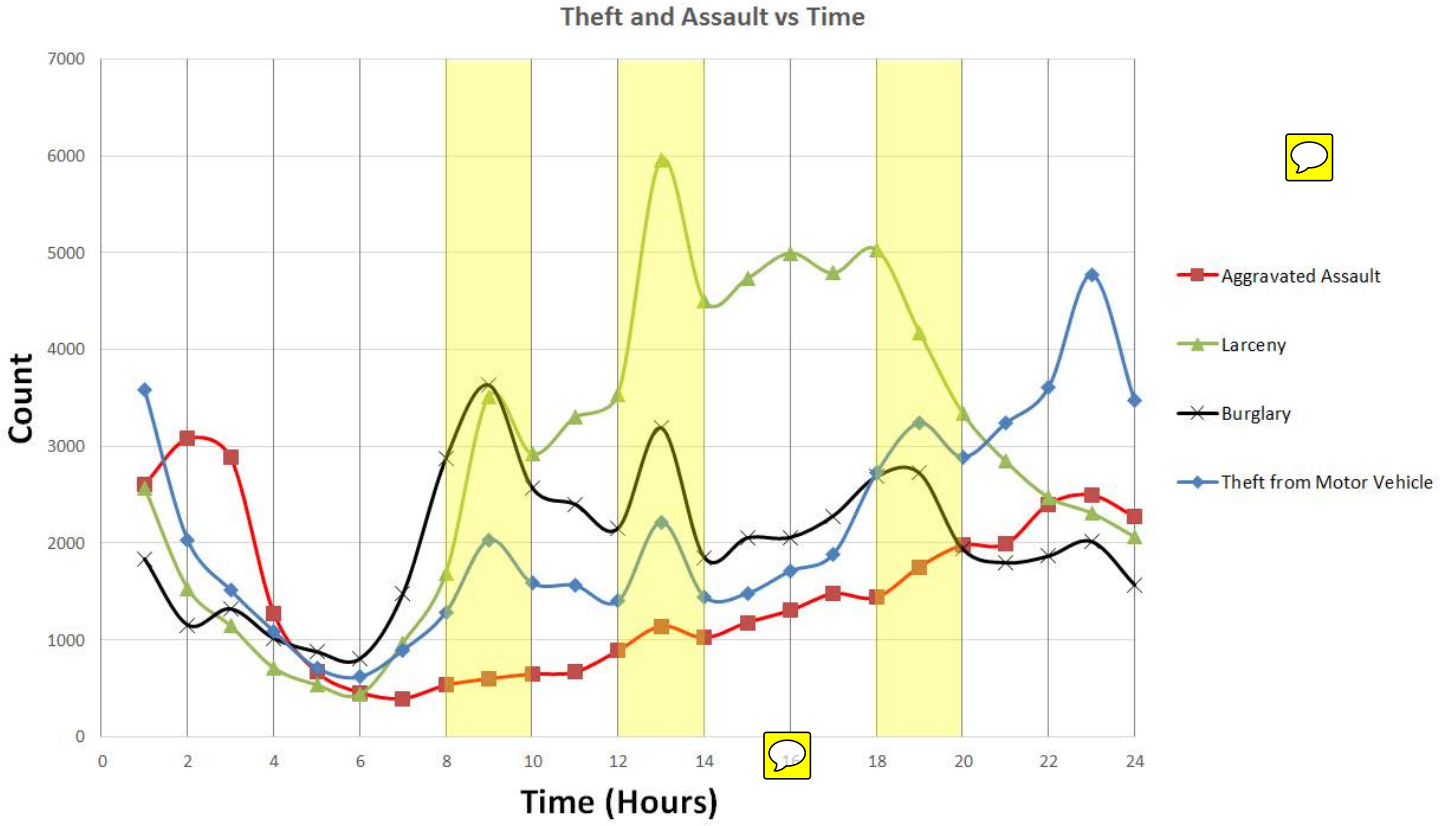
[a]Revised. [b]Estimated. [c]Forecast.

http://www.colorado.edu/business/sites/default/files/attached-files/colo_business_econ_outlook_2016.pdf



http://www.city-data.com/neighborhood/Montbello-Denver-CO.html

Theft and Assault Time Analysis



Crime Category	Total	Weekday	Weekend	Weekend (%)
Burglary	48178	36911	11267	*23.39%*
Larceny	70126	51657	18469	*26.34%*
Theft from Motor Vehicle	51016	36593	14423	*28.27%*
Simple Assault	49266	32719	16547	*33.59%*
Aggravated Assault	35192	20590	14602	*41.49%*

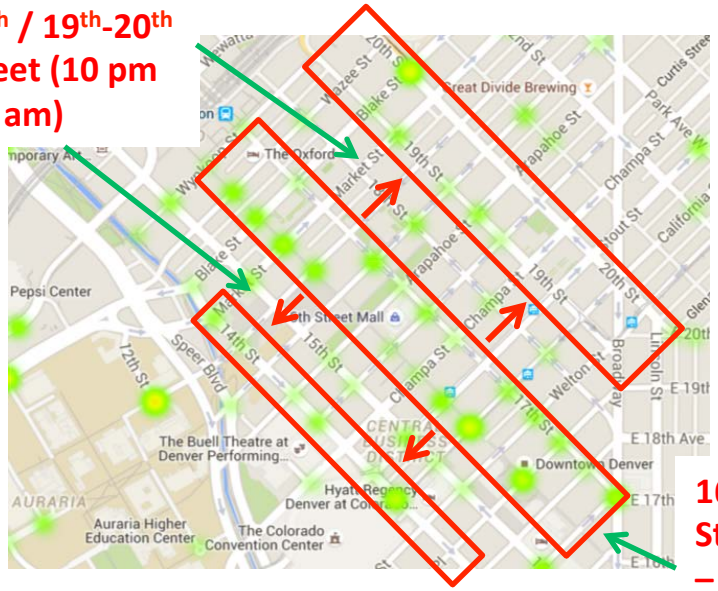
COLORADOSCHOOLOFMINES
EARTH • ENERGY • ENVIRONMENT

Hotspots Time Analysis : Larceny

Time	Patterns and Location
0 – 300	-Parking lots -Fast Food Restaurants
300-600	-Decrease in theft
600-800	- Slow Increase in larceny - Denver Airport on the radar - Parks and country clubs
800-1200	-Steady rise
1200-1400	- Sudden increase around restaurants (lunch) and near departmental stores
1400-1800	- Steady rate - Denver Airport is not a hot spot after approximately 3 pm
1800-2100	-Decline in larceny -Downtown hot spots translated *(right top figure)*
2100-2300	-Steady rate
2300-2400	-Decline in larceny

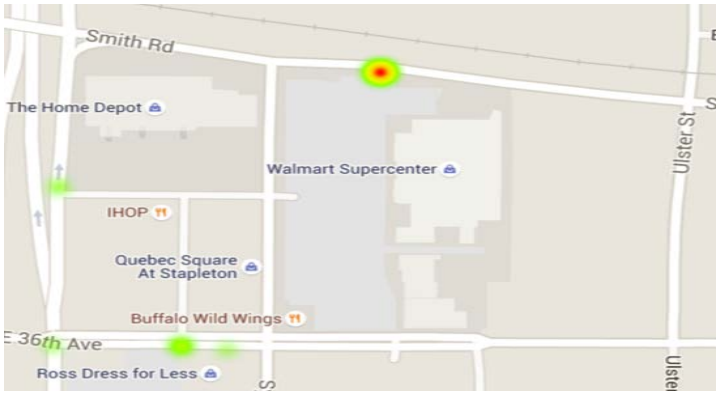
HOTSPOTS : DOWNTOWN

14th / 19th-20th street (10 pm – 6 am)



16th – 17th Street (6 am – 10 pm)

HOTSPOT : ISOLATED EVENT



7800 Smith Rd, Denver, CO 80207

COLORADOSCHOOLOFMINES
EARTH • ENERGY • ENVIRONMENT

Statistical Methodology

- Statistically, crimes are an example of events in a *spatial point process*, generated by $Pois(\lambda)$.

$$\lambda(x) = \lim_{|d\boldsymbol{s}|\to 0} \frac{\mathbb{E}[N(d\boldsymbol{s})]}{|d\boldsymbol{s}|}$$

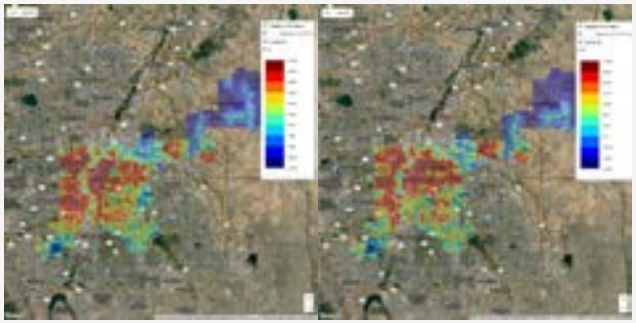
where $N(\cdot)$ is the number of points in the distance $d\boldsymbol{s}$ away from any point $\boldsymbol{s}$.

- The first assumption is *Complete Spatial Randomness*. This hypothesis was tested and the data do not display this behavior.

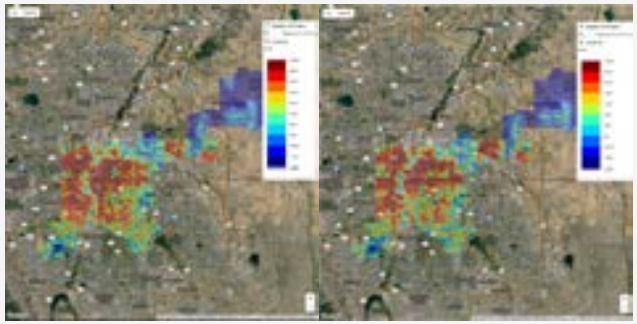
- Therefore, we modeled the crimes as spatially-varying a.k.a. an *Inhomogeneous Poisson Process* and estimated λ for each type of crime for each year with kernel-density smoothing:

$$\hat{\lambda}(\boldsymbol{s}) = \sum_{x \in N \cap D} \frac{k[(\boldsymbol{x} - \boldsymbol{s})/h]}{c(\boldsymbol{s})}$$

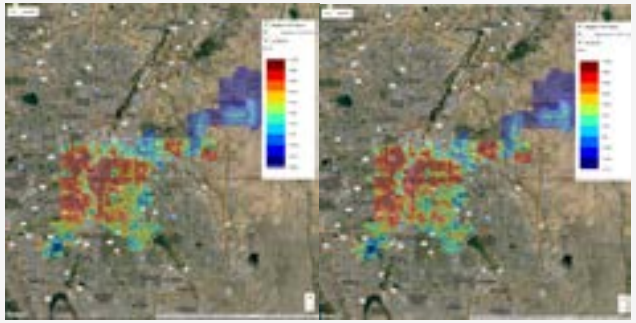
Simple and Aggravated Assault vs Street Checks



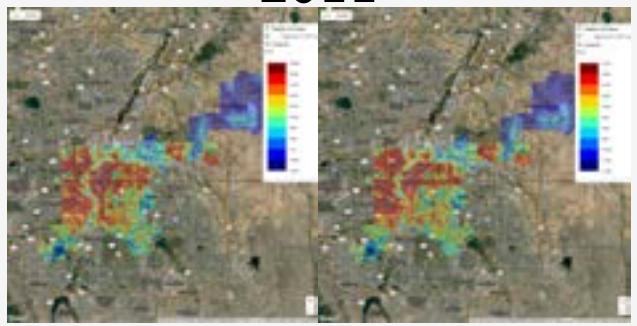
2010



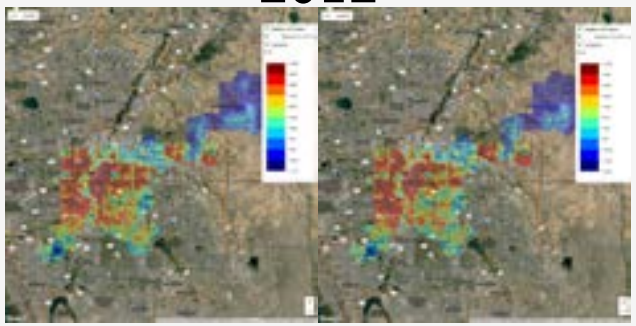
2011



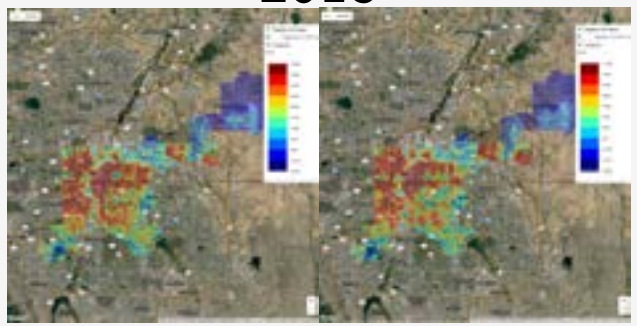
2012



2013



2014



2015

Optimization Model

Parameters:

*Weight of crimes

*Location of crimes

Variables:

*Location of each patrol

Objective:

*Minimize total distance between patrols and crimes in surrounding area

Constraints:

*At least one patrol serves each crime

*Crimes are evenly distributed between patrols

Optimization Results