Modeling Crime Routines

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Mathematical Modeling of Criminality
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The challenge: Crime modeling not as easy as you might guess

- Difficult to predict which **individuals** will commit crime
- Predicting backwards works better
- Prediction of individuals has not improved in 60 years
- Many tricks to make prediction of individuals look better than it is

To arrive at the solution . . .

Model CRIME,

not CRIMINALS

"Transform a problem into one you can solve." --Richard P. Feynman

Also ask yourselves

- Can math knowledge help at all to model crime?
  - Data problems –learn more about systematic errors than random errors
  - Thinking clearly about crime is hard
  - Advanced math or technical skills no guarantee
  - Mathematical intellect and experience might be more important!

Goals of this talk

- To present five fallacies about crime
- To offer lessons to help modelers
- To state some crime foraging principles
- To offer some rudimentary modeling ideas

A. Five fallacies about crime

1. Dramatic Fallacy
2. Cops-and-Robbers Fallacy
3. Not-Me Fallacy
4. Ingenuity Fallacy
5. Agenda Fallacy

1.The Dramatic Fallacy

- Emphasizing crimes that are most *publicized*, on television
- While neglecting ordinary crimes
  - Ordinary thefts
  - Getting drunk
  - Making noise, Minor fights
  - Major fights come from minor quarrels

CRIME IS ORDINARY

2. The Cops-and-Robbers Fallacy

- Overstating the justice system's power over crime
  - Police discover few crimes in the act
  - Most discovered crimes not processed
  - If it goes to court, few bench trials, like on television

CRIME IS ORDINARY

3. The Not-Me Fallacy

- I'm too good to become a criminal
  - Offenders are from a different population than I am
  - Cowboy movies, bad guys wear black hats, ride black horses
- Offenders and victims from diff. populations?

CRIME IS ORDINARY

4. The Ingenuity Fallacy

Overrating the skill required to do a crime

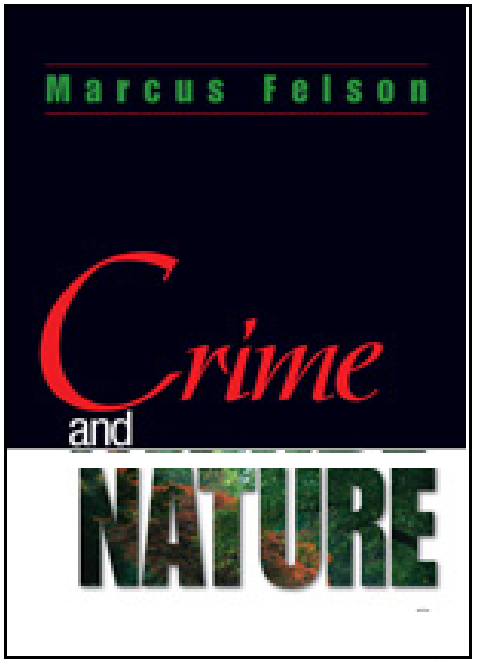
- He must have been a professional burglar. We hid the money in the cookie jar.
- You were tricked by two 15-year-olds who aren't that smart
- But offenders aren't stupid, either

CRIME IS ORDINARY

5. The Agenda Fallacy

- Linking to your favorite religion or political agenda
- “Send us money. Crime will go down”
- Hard to rehabilitate OR punish efficiently
- Labor is expensive

Tangible features of crime assist modeling



Sage Publications
2006

SNEAKY

Crime often predictable

- Dramatic difference in crime probability from hour to hour
- Crimes are highly predictable from the routine activities of everyday life
  - Where people are
  - What they are doing
  - Their noncrime activities

Divide activities into three groups

- Crime feeds off legal activities
- Crime feeds off marginal activities
- Crime feeds off other crime

- Residential burglary while people at work
- Prostitutes working with robbers and thieves
- Robbing drug dealers, street prostitutes

Disaggregate before modeling crime

- Avoid lumping all crime, all auto theft
- Several types of auto theft, with different modus operandi, time patterns, offender patterns, etc.
  - Joyriding
  - For transportation
  - Stealing contents
  - For another felony
  - Parts chopping
  - One or two parts
  - For export

Exception – certain crime settings

- Some settings invite many different types of crime
- But don’t get stuck with large neighborhoods or urban areas
- Major differences from address to address, half block to half block

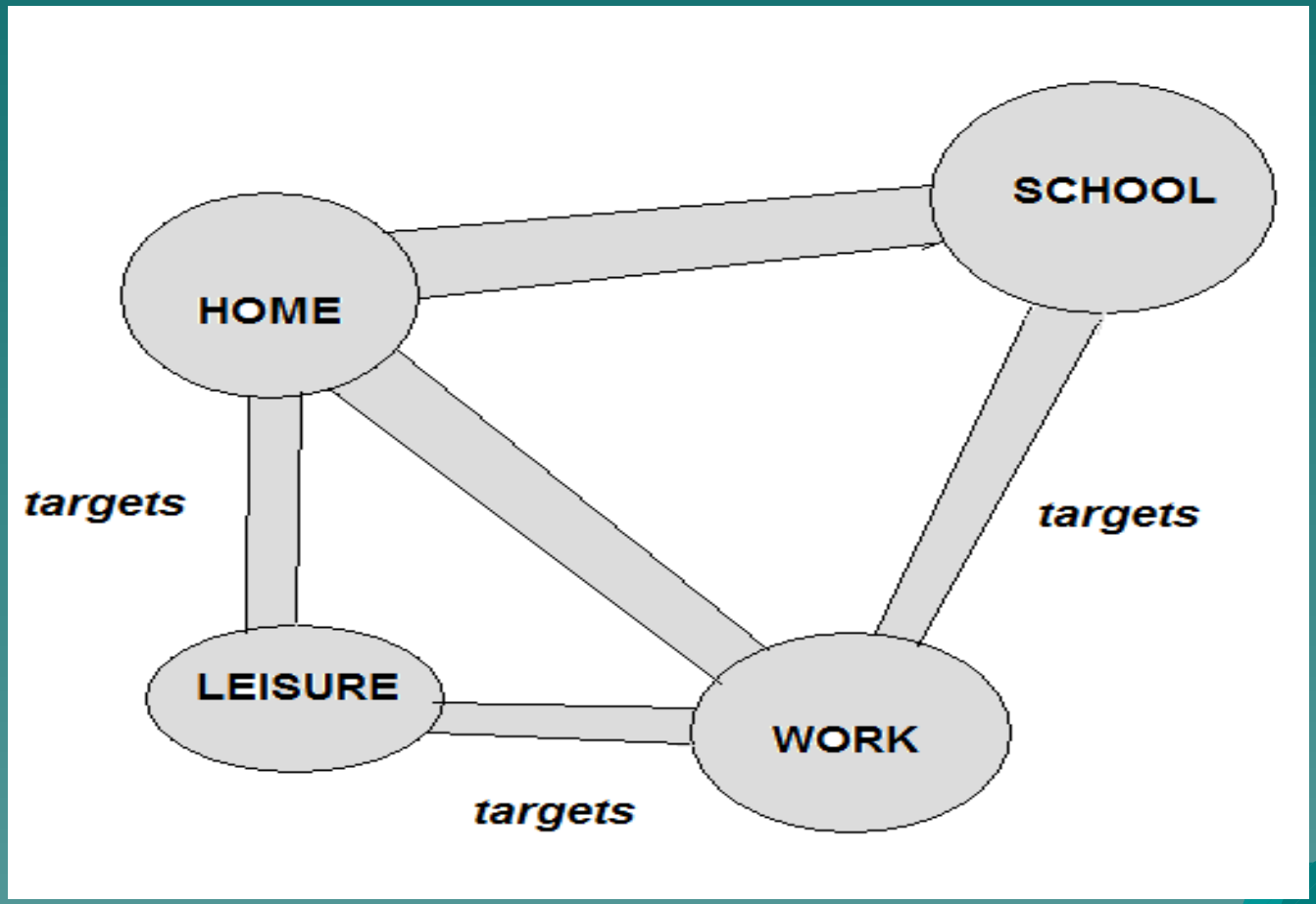
Consider

- Who, what, when, where how
- Specific modus operandi
- Map the offender's journey to crime
- Map the journey after crime
- Map victim journey
- Look at larger set of routine activities

- Examples
- *Burglars on foot*
- *Burglars in cars*
- *Robbers on motos*
- *Serial killers*
- *Drunk offenders*
- *Drunk victims*

The Crime Triangle

Offender's awareness space (Brantinghams)



Some rules of crime foraging

Optimal Foraging Theory works remarkably well for crime

$$\text{Foraging Ratio} = \frac{\textbf{Illicit Gains}}{\textbf{Search Time + Handling Time}}$$

Most offenders are relative generalists

- Don't do every time of crime
- But still do a fair variety of rather different offenses
- Irony – offenders are generalists; but crimes are specific

Foraging is complicated by other activities

- Offenders are themselves stalked by other offenders
- Offenders have to fit crime into school, work, and social obligations
- Avoid guardians, as well as police
- So you can start with simpler models, then complicate

Foraging takes advantage of other activities

- Many offenders take advantage of sex and social activities of others
- People out drinking, then mugged
- Girl meets boy, but not always safe; Homosexuals vulnerable to attacks
- A lot of crime related to sex and drinking by victim
- BUT overlap of offending and victim populations

Overcoming foraging limitations

- Basic rule – never steal something you can't carry
- Never hit anybody stronger than you
- But you might have some buddies to help carry, or a car
- Or friends to help you attack somebody bigger than you.

Some primitive math models

I like arithmetic

Model 1 – One crime leads to another

- Divide crime into its prelude, incident, and aftermath
- The aftermath of one crime is the prelude to thenext
- The aftermath of burglary is the prelude to selling stolen goods
- Problem: What is the crime multiplier for a single burglary?

Model 1 sequence

1. A burglary occurs, property taken
2. A burglar sells some of the loot
3. To someone who knowingly buys stolen goods
4. Who re-sells these stolen goods to somebody who does not know they are stolen

Model 1 assumptions

- The probability that a burglar will take non-cash goods is 0.58 (see Ronald V. Clarke, Hot Products)
- The probability that stolen non-cash goods are fenced is about 0.7 (See Mike Sutton's work)
- Probability that fenced goods are resold = 0.9 (source: My brother in law)

The Accounting

Initial burglaries	1,000	
Subtract cash burglaries		-580
Non-cash burglaries		420
First sale of stolen goods	406	
First purchase of stolen goods	406	
Resale of stolen goods	365	
Total crimes generated	2,177	

CRIME MULTIPLIER =**2.177**

Model 2 – Property crime & drug abuse

Some of us think that property crime drives drug abuse more than the other way around.

Model 2 Divide up drug abusers

- Group A totally compulsive with a daily habit
- Group B half compulsive users, every other day habit
- Group C discretionary users

- 0.30
- 0.40
- 0.30

1,000 abusers =

300 compulsive + 400 half-compulsive + 300 discretionary users

Model 2 Assumptions

Figure out probable daily property-crime take, e.g. $50 each. Figure out average cost of habit, e.g. $100 a day. Figure out difficulty for c property crime

2 - When crimes are ***easy*** to do:

Group A: 300 abusers X 2 thefts per day = **600** daily prop. crimes

Group B: 400 abusers X 1 theft per day = **400** daily prop. crimes

Group C: 300 abusers X 0.7 thefts per day =**210** daily prop. crimes

TOTAL DAILY THEFTS: **1,210**

2 - When crimes are ***more difficult*** to do

Group A: 300 X 2 thefts per day = **600** daily property crimes

Group B: 400 X 0.7 thefts per day= **280** daily property crimes

Group C: 300 X 0.3 thefts per day = **90** daily property crimes

TOTAL DAILY CRIMES: **970**

CRIMES REDUCED: 240; REDUCTION: 20%

Model 3 Street prostitution multipliers

- Prostitution illegal in US
- But often de-facto legal
- Prostitution more illegal in Europe than you realize
- Street prostitution
- Ancillary crimes and multipliers
- Emprical question – convergence of nations

Model 3 – Street Prostitution and Robbery

Assume

1,000 street solicitations by prostitutes – definition?

1,000 street solicitations by johns

(*note double counting*)

300 acts of prostitution by prostitutes **

300 acts of prostitution by johns**

12 robberies of prostitutes by johns

5 robberies of johns by prostitutes (direct)

7 robbery setups (indirect prostitute involvement)

8 unlinked robberies taking advantage of nightlife

** Depends on nation, enforcement

MULTIPLIER OF 1,000 SOLICITATIONS

US	2.632	? Def
Netherlands	2.032	?

Model 4. Consequences of an Easy-Needle Policy

- Vancouver's easy-needle policy includes:
- Needle exchange.
- Nurse-administered illicit drugs on skid-row
- Cheap needles purchased in pharmacies easily, cheaply, and legally.

Model 4: Explained

In other words, this year's drug abuse population is augmented by three components and depleted by three other components.

Augmenting the drug-abuse population:

Last year's surviving local drug abuse population,

New local abusers, and

In-migration of abusers to the local area from elsewhere.

Depleting the drug-abuse population:

Deaths of local drug abusers,

Desistence of local drug abusers, and

Model 4 – cheap needles?

- Cheap needles make it easy to become a *new* intravenous drug abuser.
- An easy-needle policy makes it easy to *remain* a drug abuser, and attracts drug abusers from elsewhere.
- Even if an easy-needle program *reduces* the case infection *rate* for AIDS, that benefit can be offset if it *increases the size* of the drug-abuse population.
- Hence the program can be self-defeating, making drug abuse safer in any given instance but more extensive in the local population.

Model 4 - Disaggregate

Disaggregate the local drug abuse population:

- continuing abusers,
- new abusers,
- desisters,
- deaths,
- in-migrating abusers, and
- out-migrating abusers.

Model 4 Equation

T_t = Total drug abuse population in year t
N_t = New local drug abuse population in year t
M_t = Deaths of local drug abuse population in year t
D_t = Desisting local drug abuse population in year t
I_t = In-migration of drug abusers to local area in year t
O_t = Out-migration of drug abusers from local area,year t

$$T_t = T_{t-1} + N_t - M_t - D_t + I_t - O_t$$

Rearranging,

$$T\,t = (T_{t-1} + N_t + I_t) - (M_t + D_t + O_t)$$

this year's drug abuse population is augmented

- by three components and depleted by three other components.
- Augmenting the drug-abuse population:
  - Last year's surviving local drug abuse population,
  - New local abusers, and
  - In-migration of abusers to the local area from elsewhere.
- Depleting the drug-abuse population:
  - Deaths of local drug abusers,
  - Desistence of local drug abusers, and
  - Out-migration of local drug abusers.

  Of course, a negative sign on the depletion components turns them into augmenting variables.

Basic Equation

(a) $T_t = T_{t-1} + N_t - M_t - D_t + I_t - O_t$

Rearranging,

(b) $T_t = (T_{t-1} + N_t + I_{t)} - (M_t + D_t + O_t)$

Even if an easy-needle policy does short-term good

for current local drug abusers,
other components of drug abuse can worsen

- Local non-abusers become abusers (N t)
- In-migration of drug abusers (I t)
- Less desistance of local drug abuse (D t)
- Reduced out-migration of abusers (O t)

Model 5. The Social Spread of Drug Abuse

Illicit drugs are locally procured via five routes:

3. Drugs offered free by friends;
4. Drugs procured by friends, sharing the cost but not the procurement;
5. Drugs bought from familiar people in familiar settings;
6. Drugs bought from relative strangers in public places; and
7. Buy from relative strangers in unfamiliar private settings.

Model 5 Illicit drugs trickle

Assume that all drugs procured via route #1,#2, and #3 were originally procured via either route #4 or #5.

That is, even those drugs procured *directly* from familiar persons and settings were *originally* obtained from relative strangers, before transfer to final users. Thus

(D1 + D2 + D3) = K (D4 + D5), where 0 < K < 1

Model 5 Assume

D1 /Dtotal = 0.35 (of all drug sales

D2 /Dtotal = 0.35

D3 /Dtotal = 0.15

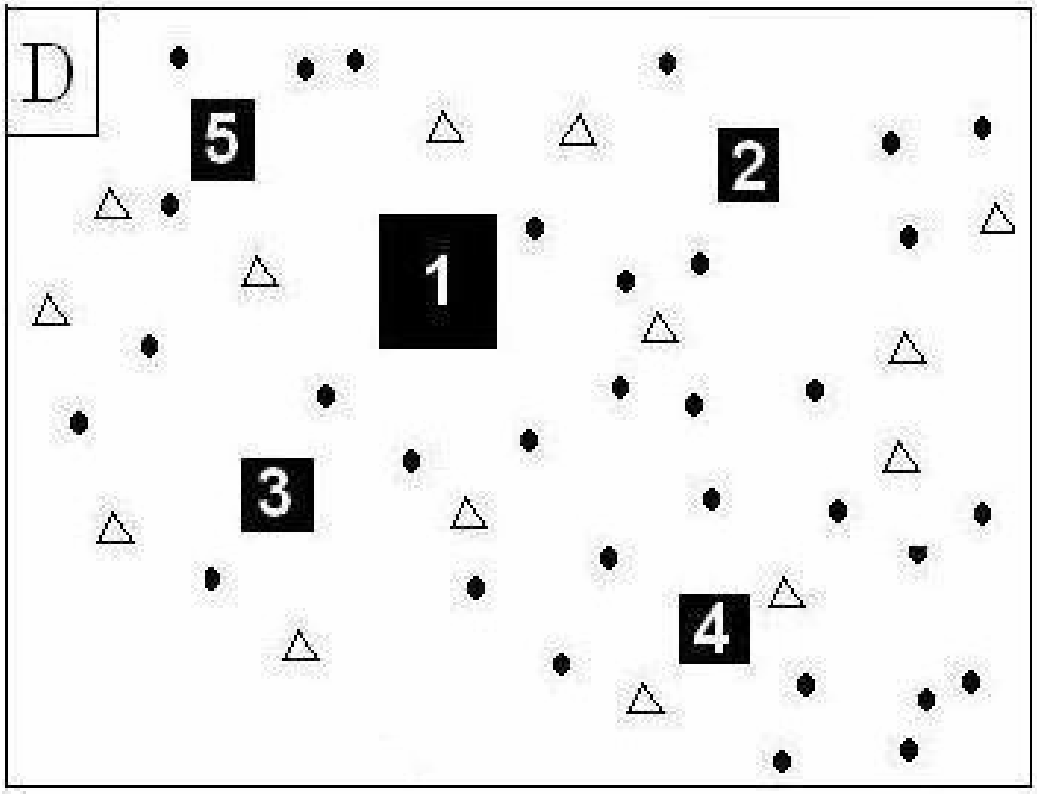
D4 /Dtotal = 0.10

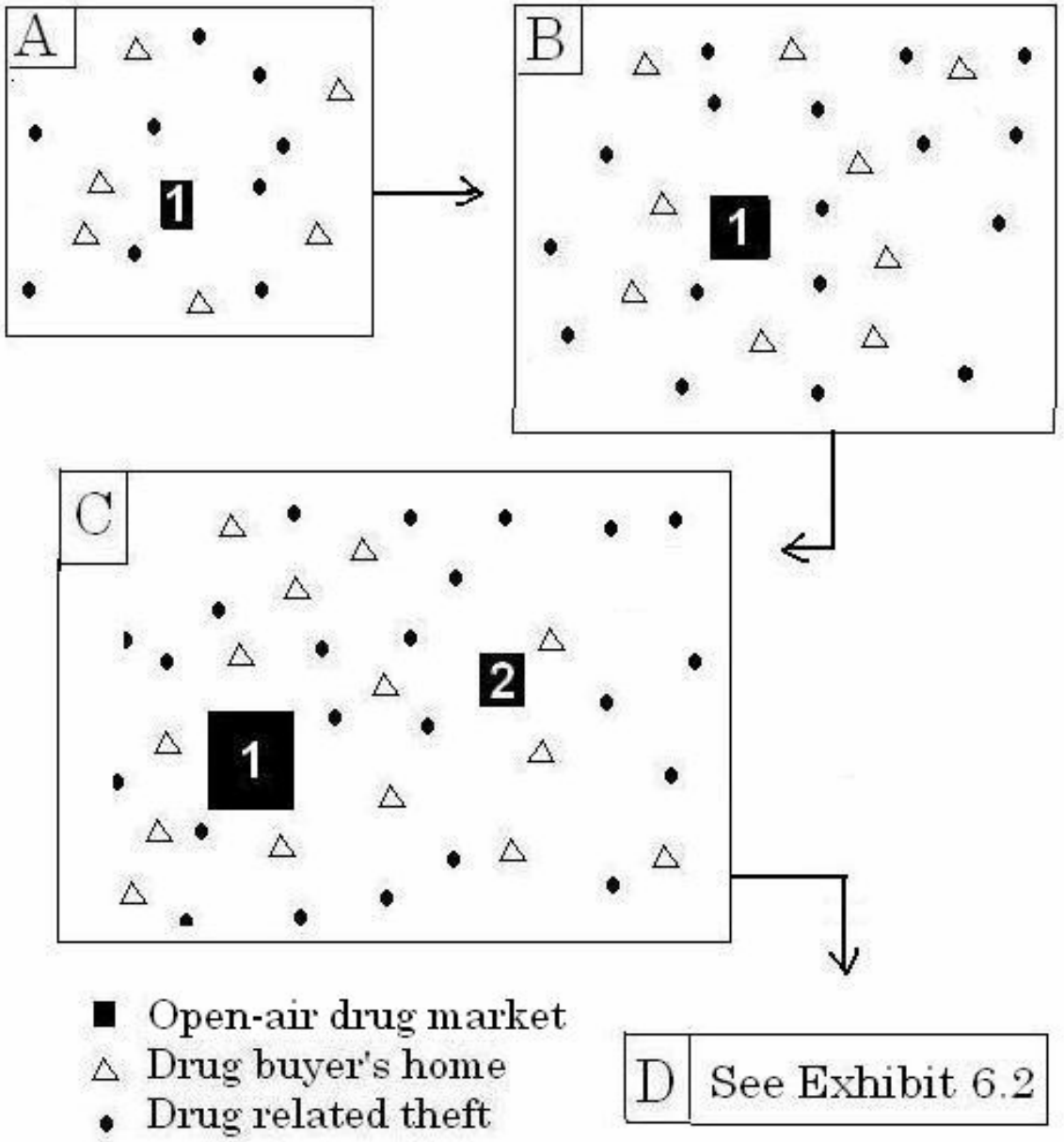
D5 /Dtotal = 0.05 Total 1.00

6 Problem: How did this happen?

Note five open-air drug markets of varying sizes

They grew outwards, producing a thick crime habitat





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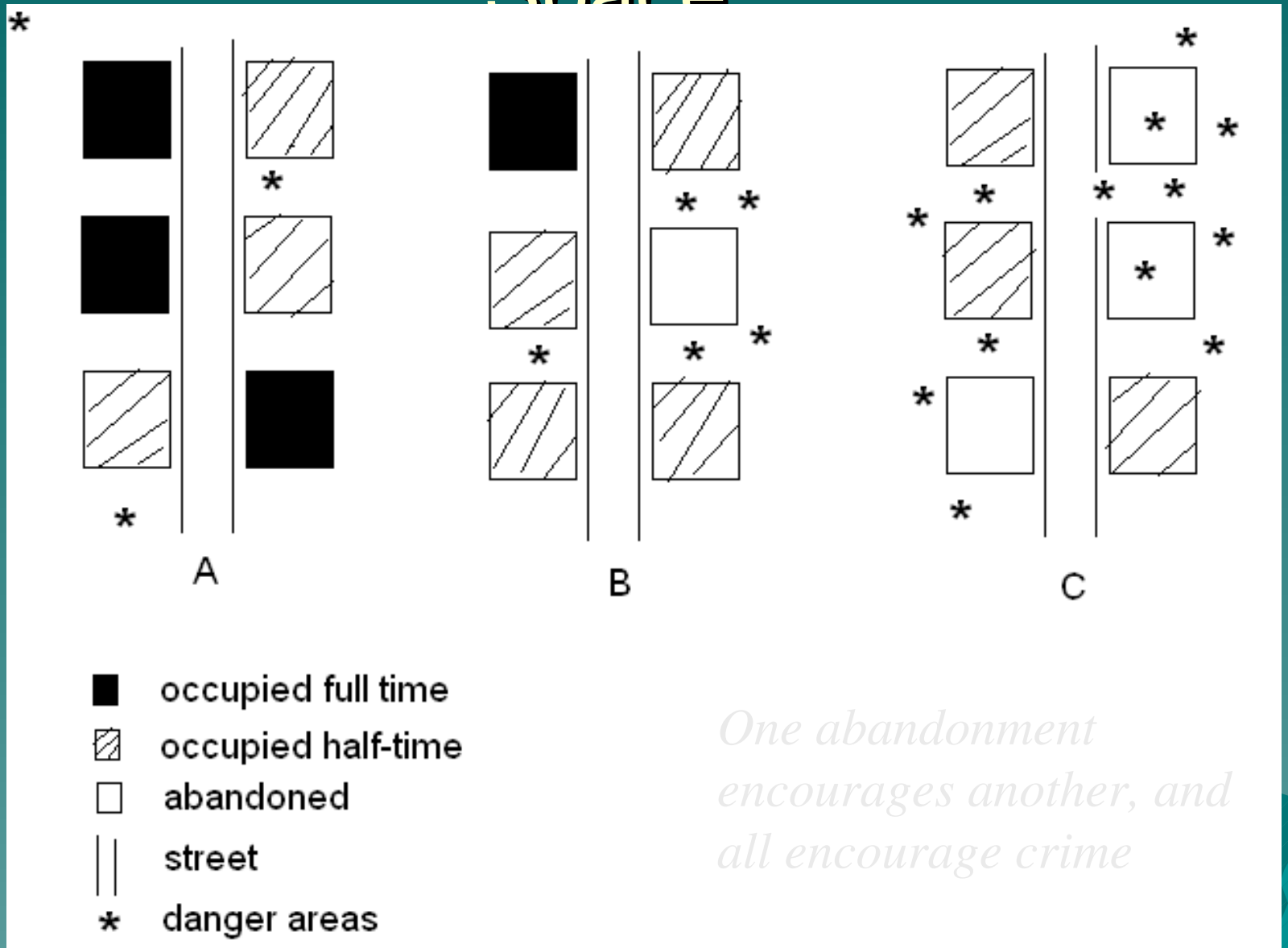
Fractal-like spread of drug markets

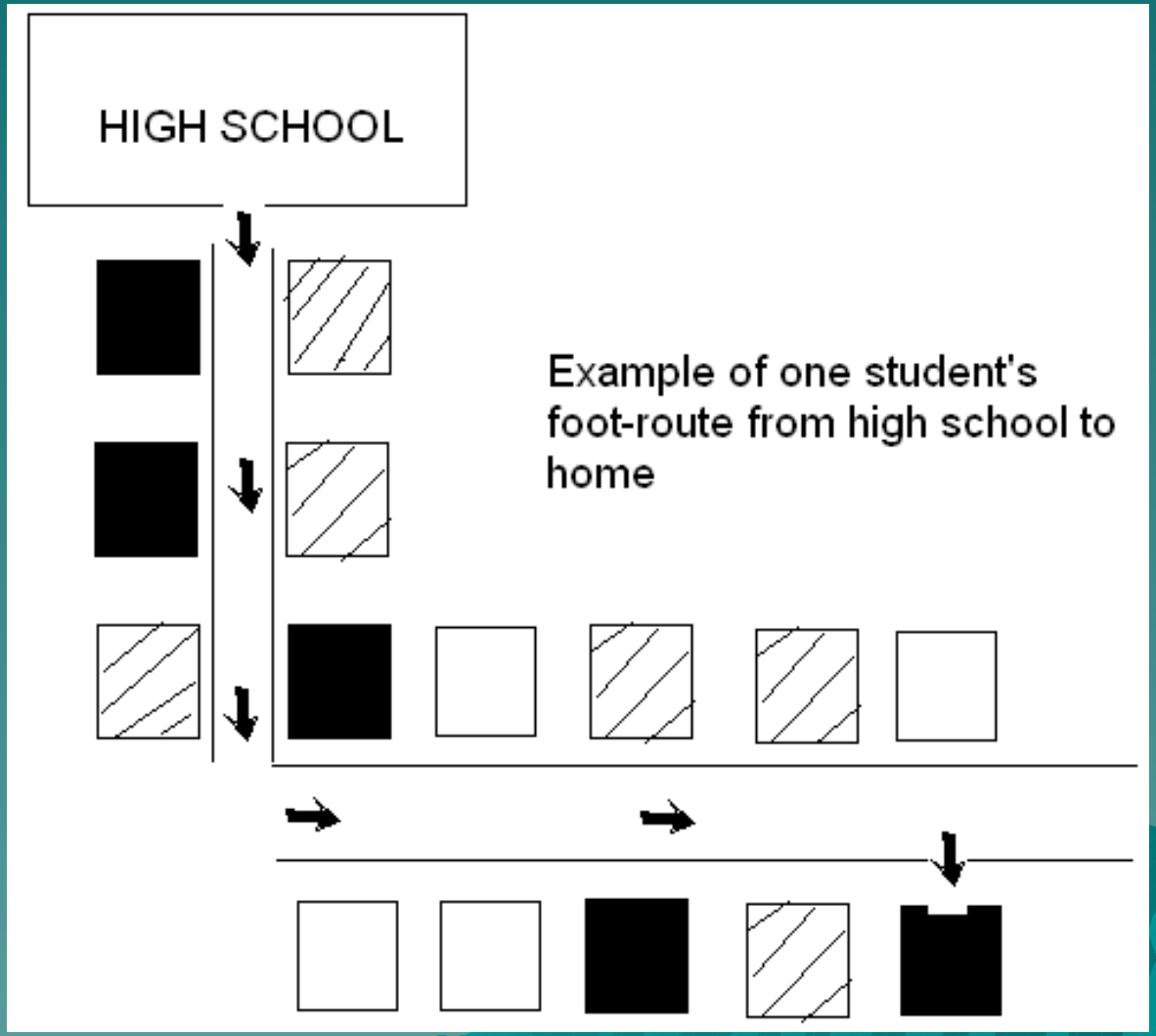
George Rengert's ideas, my version

Model 7: Abandoning & Supervising Space



One abandonment encourages another, and all encourage crime

7 Apply to trip home from school



7 Occupancy, supervision assumptions

- State rules by which these three types of occupancy produce supervision of space.
  - Derive from C.Ray Jeffery and the Brantinghams' work,
  - Use isovists.
- Apply those rules to six houses in a row, three on each side of a street segment.
- Calculate increment in unsupervised space resulting from degrees of abandonment.

7 Abandonment and supervision

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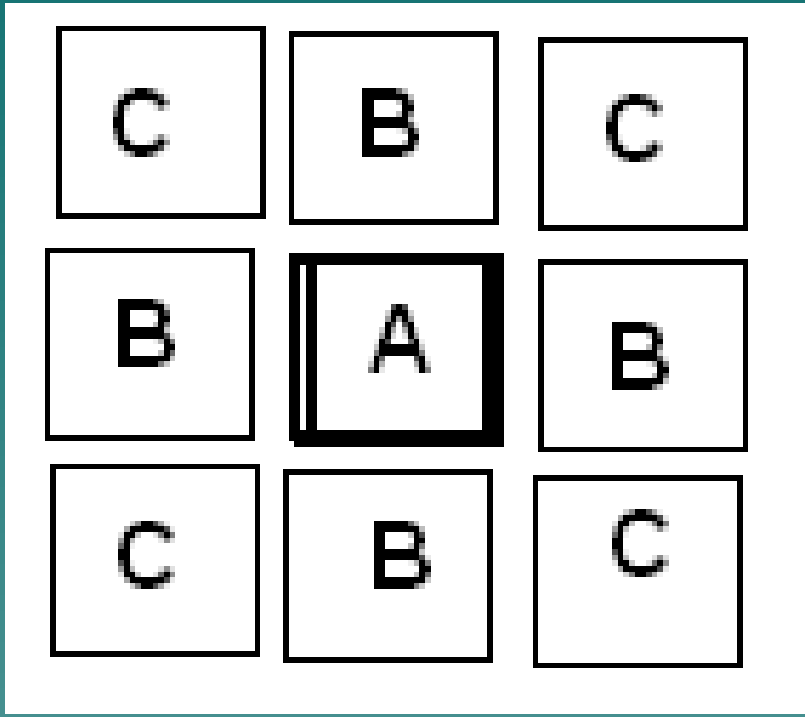
- Calculate increment in unsupervised space resulting from degrees of abandonment.

Model 8 **How Gangs Spread over a City, Month to Month**

- Rule 1. If a gang is present in an area in any given month, there's a 0.5 probability ***another*** gang will form in adjacent areas the next month, and 0.25 another gang will form in semi-adjacent areas, also the next month.

- Rule 2. Each month, a gang has a 10 percent chance of disappearing.

8 Gang spread



- A = first urban area where gang is formed
- B = areas adjacent to A, where another gang might form
- C = areas semi-adjacent to A, where another gang might form

8 Probable adjacent spread of new gangs,

neglecting chain reactions that go several steps			
	Urban Areas		
Month	**A**	**B**	**C**
1	1.0	0	0
2	0.9	0.45	0.225
3	0.8	0.4	0.2
4	0.7	0.35	0.175
5	0.6	0.3	0.15

continued

I multiplied the probable initiation of a new gang in adjacent and semi-adjacent areas by the probable continuance of a gang in area A. But what about extensive chain reactions?

(2) Gang formation in C areas should affect gang formation in B and A areas.

(3) Gang formation in areas B and C should feed back upon gang continuance in area A

Gang activity should spread to adjacent areas ***in a chain reactiion***

- This should reflect ***multiple interactions*** among areas;
- The original Area A gang should ***rebound*** as new gangs form near it;
- Two forces should ***compete***:

  The natural deterioration of gangs over time, and

  "extended chain-reaction gang growth" responding to proximity of other gangs
- Gangs ***seem to be present forever*** because the waves keep spreading in one place when fading in another.
- Gang ***hangouts*** are an extra force that helps them persist.

Thanks to those who lasted

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MANY sources of information

- http://popcenter.org
- http://crimeprevention.rutgers.edu
- Search “Jill Dando Institute”
- Search “Home Office toolkits”
- Search “Opportunity Makes the Thief”