# Butterflies, Bees & Burglars

## The foraging behavior of contemporary criminal offenders

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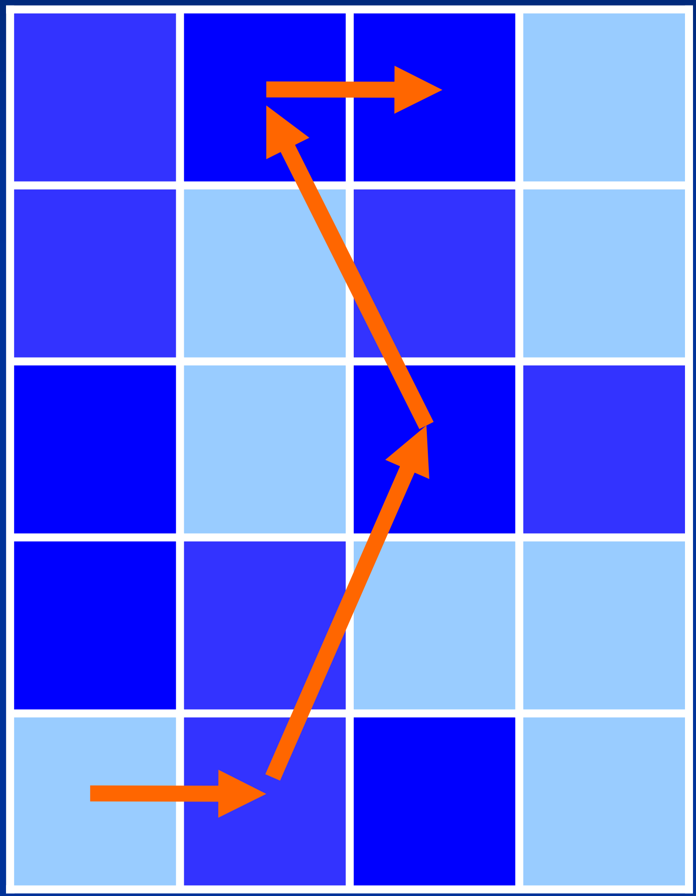
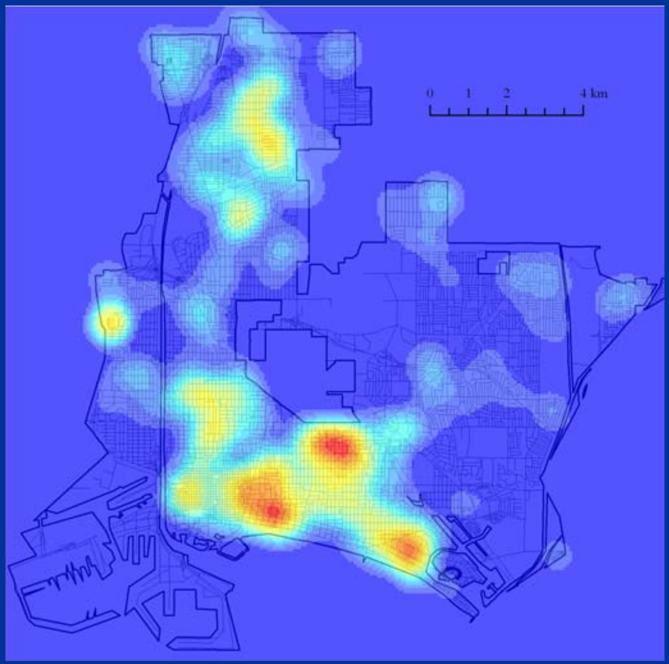
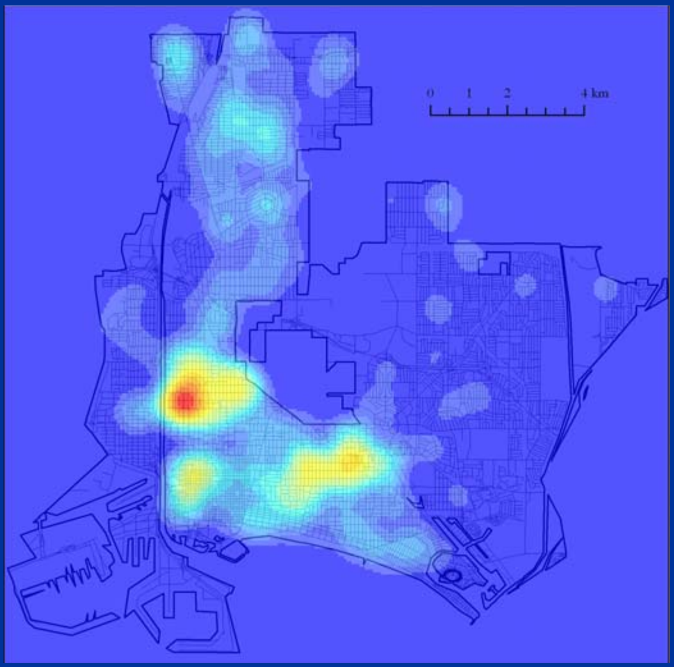
# experiments in insect foraging

- **environment:** arrangement of patches
- **manipulation:** alter spacing and/or quality of patches
- **questions:** search for patches of different quality; residence time in patch; travel time between hosts
- **observations:** insects are able to quickly adjust foraging strategies to changed patch conditions



- crime opportunities & motivated offenders → unevenly distributed
- foraging strategies are what bring motivated offenders together with criminal opportunities




Residential burglary hotspots in Long Beach, CA in two sequential three month periods December 2001- February 2002 and March – June 2002.

# two low-level questions

- given a serial burglar…
  - how far away in space or time is a second burglary (or second series of burglaries) likely to be from a first burglary (or series)?
  - how long do we have to wait between repeat burglaries at the same residential location?

# road map for this talk

1. crime as a foraging problem
2. Long Beach, CA residential burglary data
3. models of patch residence and return times
4. implications and future directions

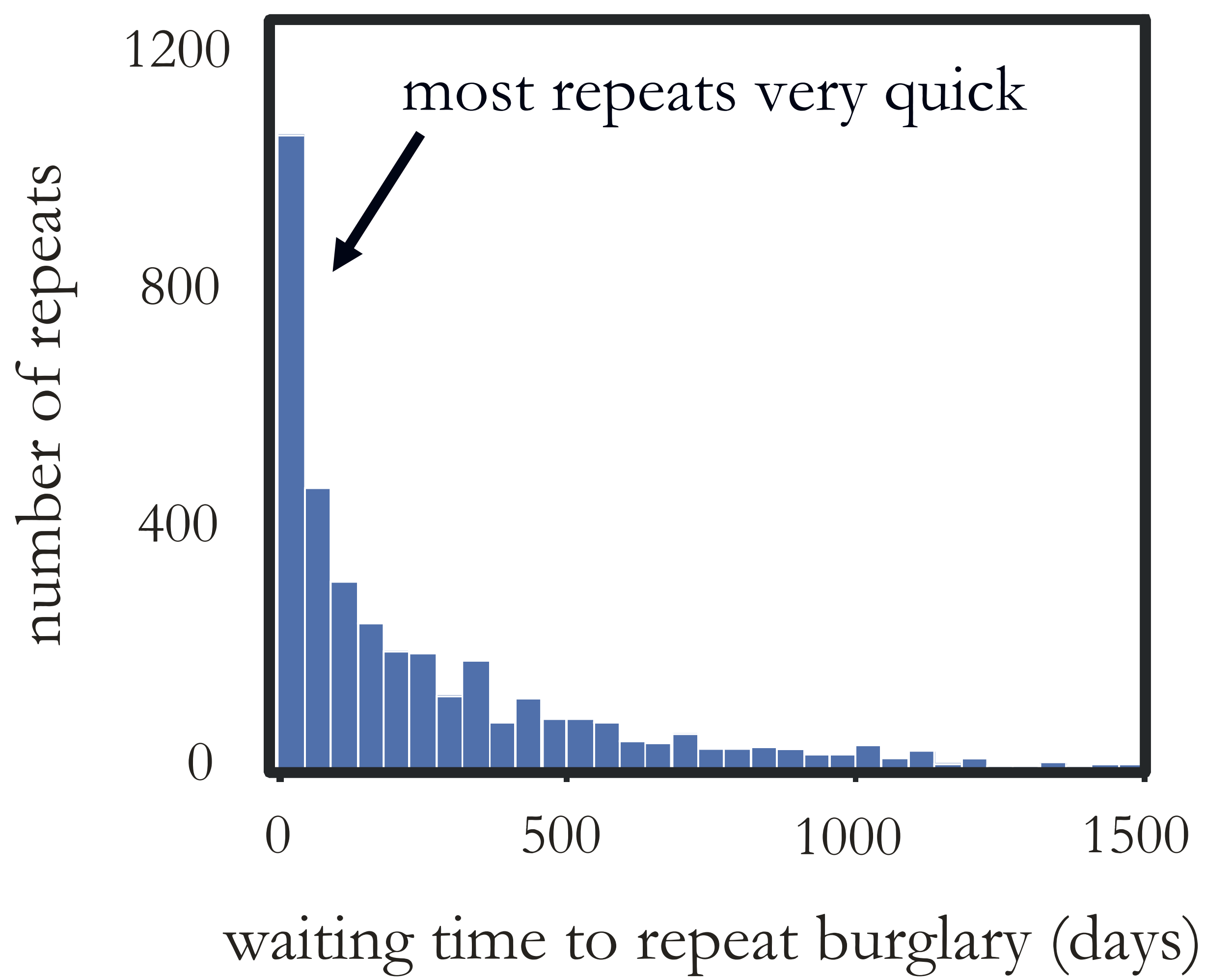
# optimal foraging theory and crime

- obligate resource acquisition
  - crime is a "boundedly rational" behavior
- behavioral options
  - strategies to find targets, victimize, and avoid detection
- selection
  - biased social or trial-and-error learning leads offenders to arrive at an optimal foraging pattern

# Long Beach residential burglary

- CPC 459R & G
  - unlawful entry into a residence with the intent to commit larceny or any felony
  - 12,690 burglaries between Jan 2000 – Dec 2005
  - geocoded address locations and reporting date
  - 3,951 repeat burglaries at the same addresses

# Repeat Victimization

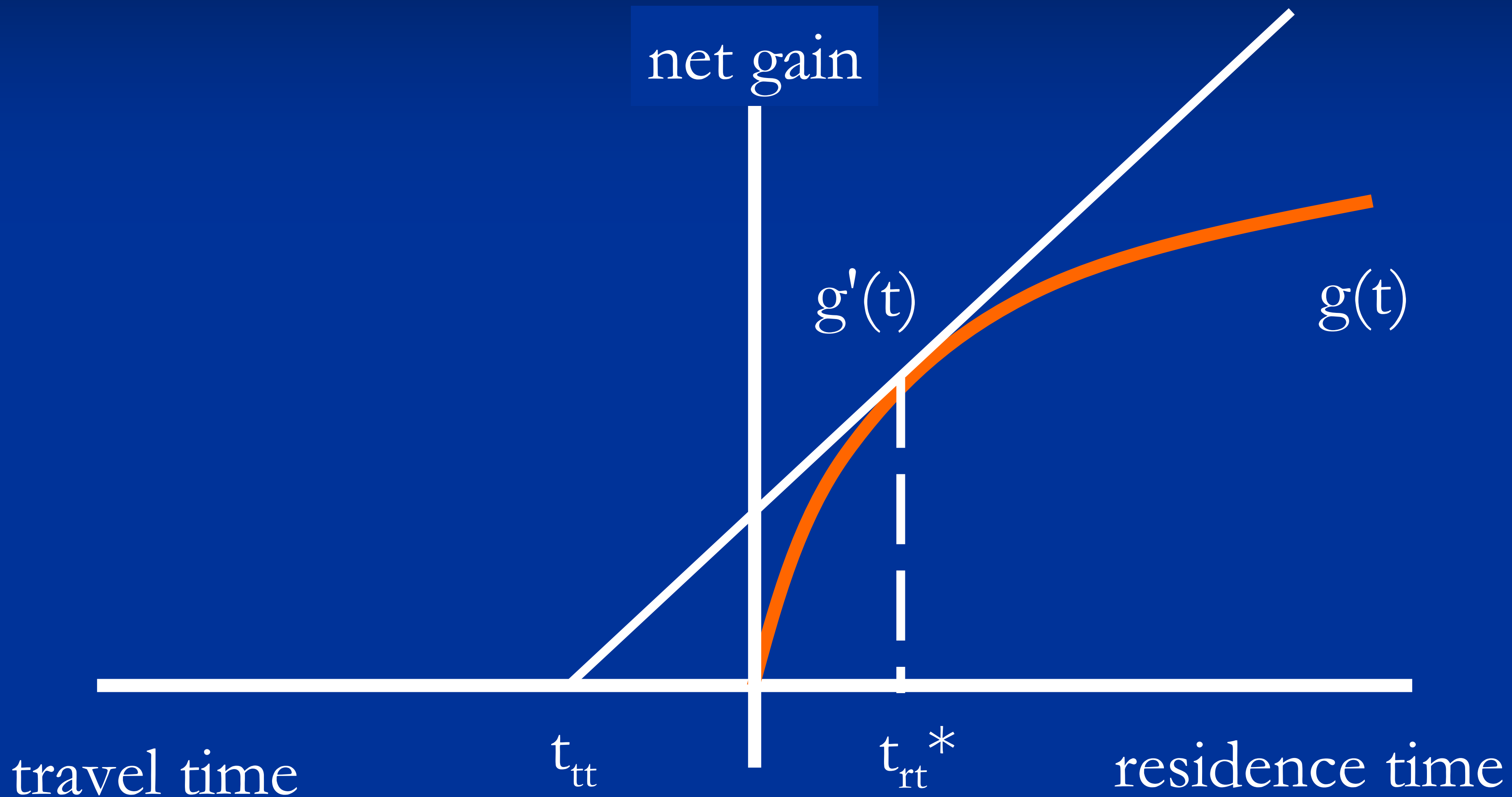



Long Beach residential burglaries 2000-2005

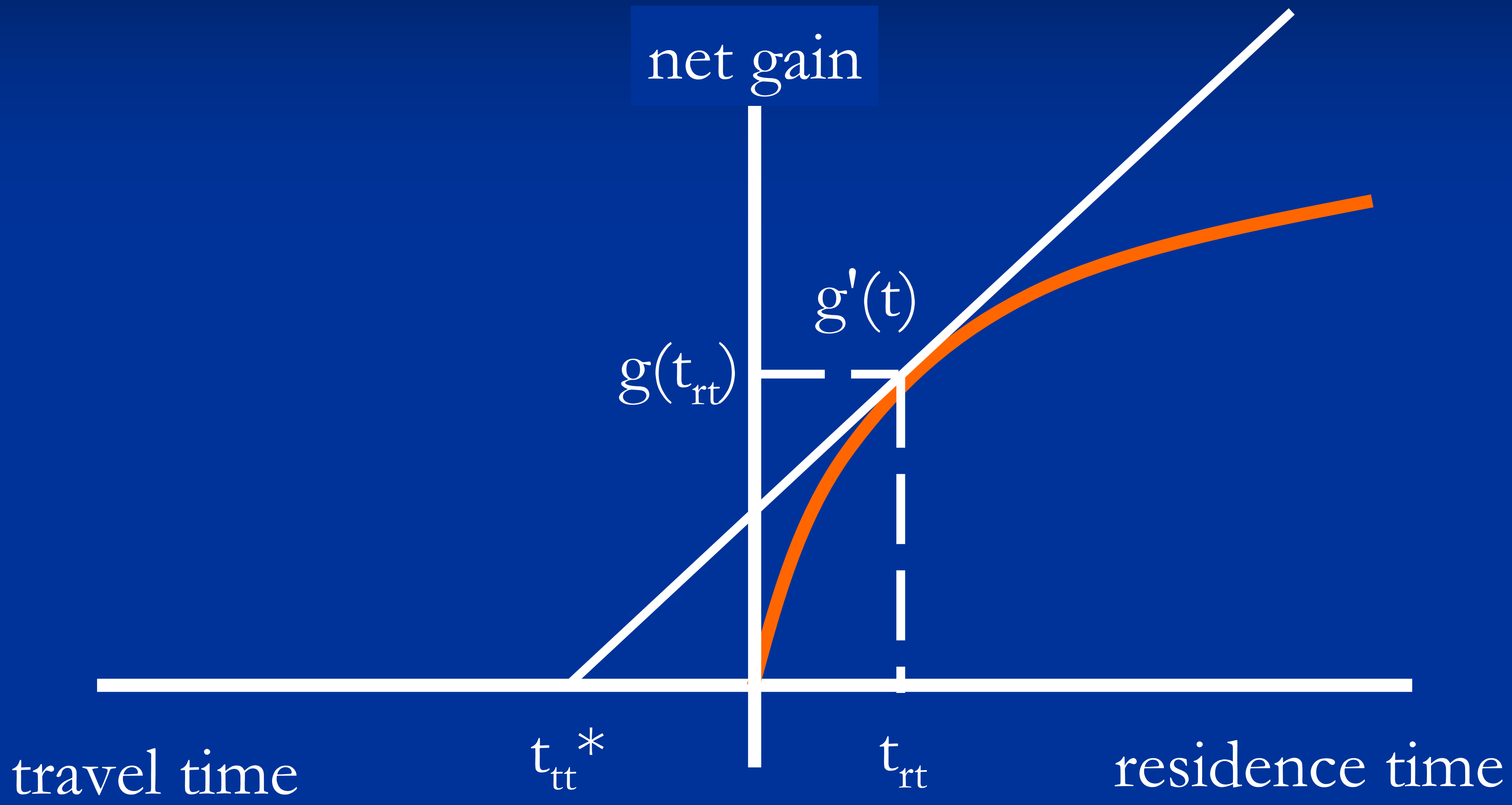
# patch foraging models

- currency
  - assume offender wants to maximize return or payoff per unit time spent in a patch OR minimize the travel times between patches
- decision variables
  - how long to remain in a patch
  - how much time to dedicate to travel between patches
- constraints
  - size and/or quality of patches
  - spatial distribution of patches
  - quality of information about the environment

# marginal value theorem (MVT)

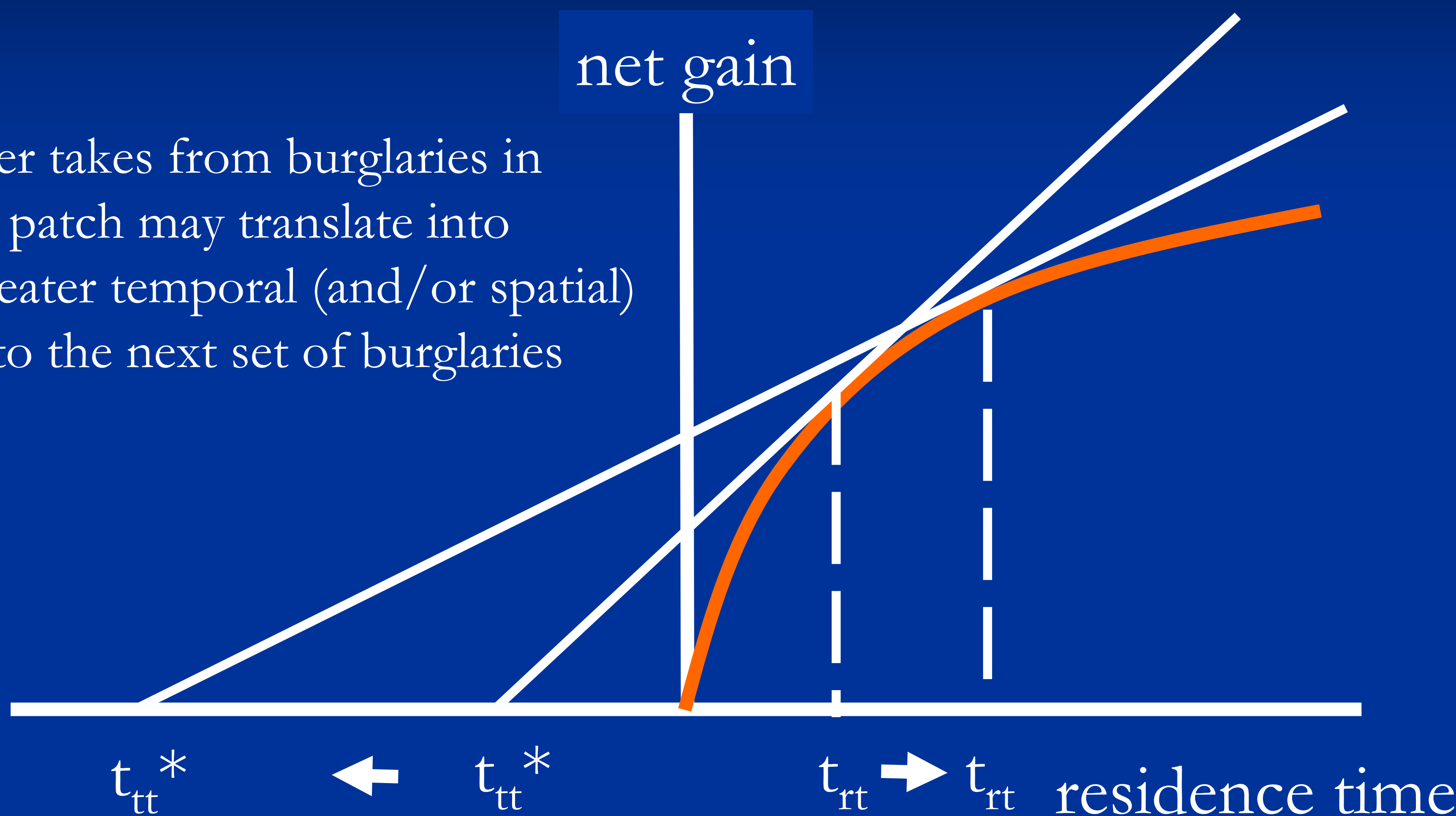


# optimal travel time



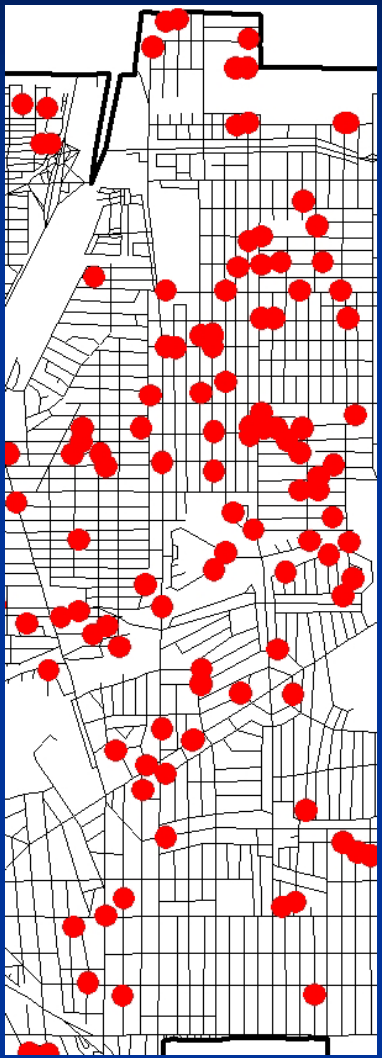
# general burglary predictions

larger takes from burglaries in one patch may translate into a greater temporal (and/or spatial) lag to the next set of burglaries



# anecdotal evidence

- most burglaries produce only small economic gains/losses, but happen very often
- major gains/losses are very rare events
- burglars that travel further (between patches) tend to net greater returns



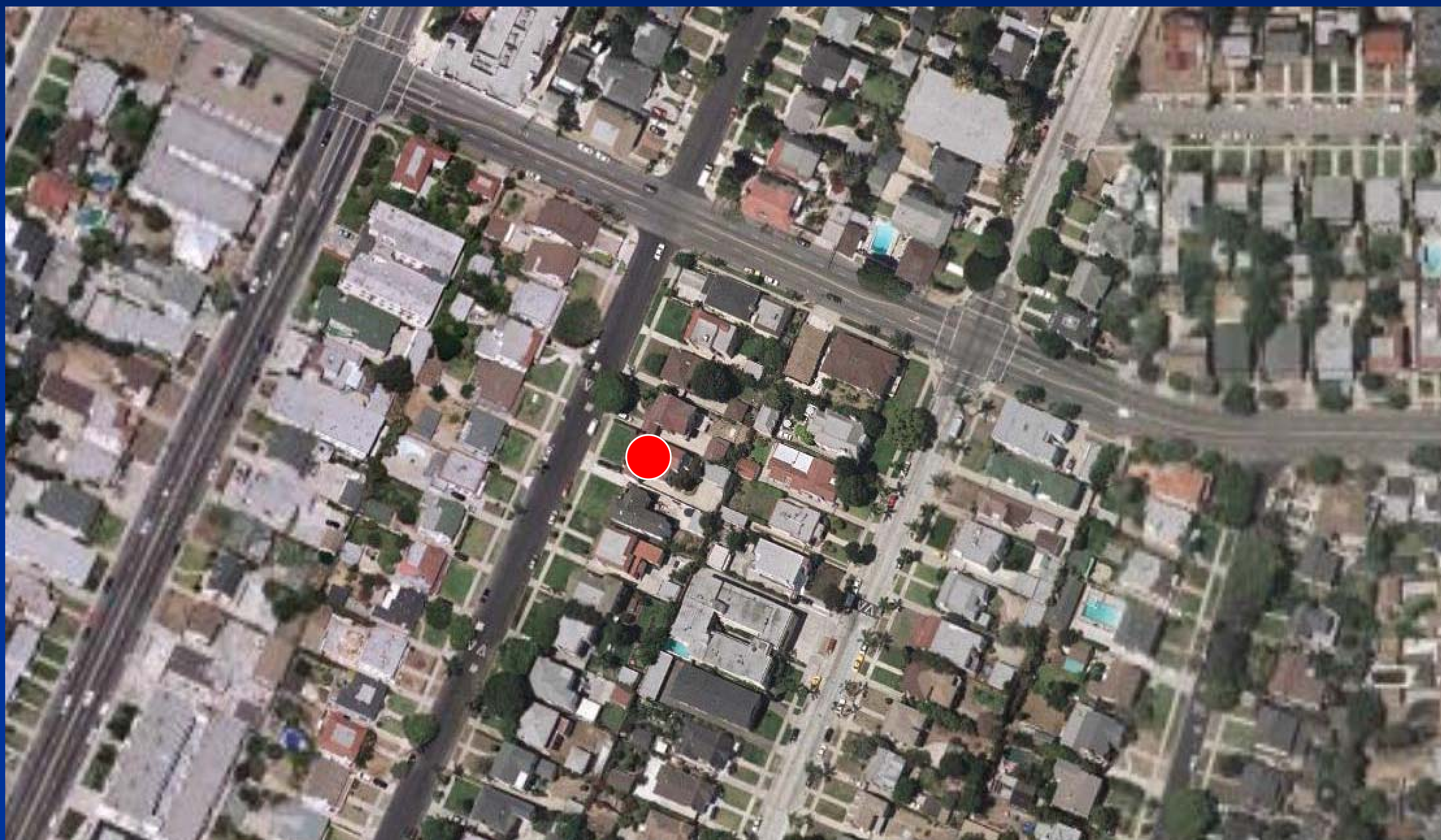
# 33% fewer burglaries, but median take 1.8 times larger

| | burglaries per month | |
|---|---|---|
| | Median | Inter-quartile range |
| Commercial | 8.7 | 2-30.3 |
| Residential | 12.8 | 3-30 |

| | burglary income per month (USD) | |
|---|---|---|
| | Median | Inter-quartile range |
| Commercial | 6,522 | 3,261-13,044 |
| Residential | 3,586 | 1,467-13,044 |

Stevenson, R. J., and L. M. V. Forsythe. 1998. *The Stolen Goods Market in New South Wales*. Sydney: NSW Bureau of Crime Statistics and Research.

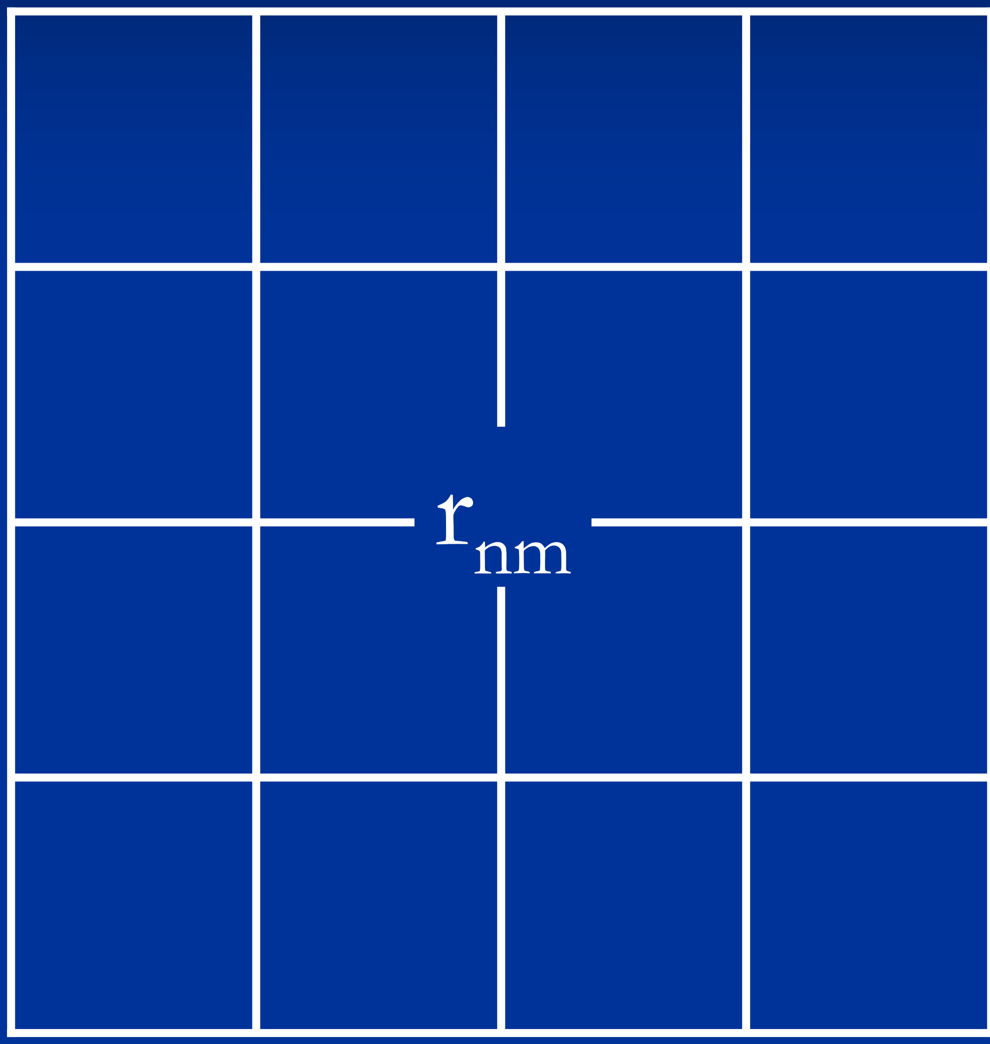
# individual house as a patch



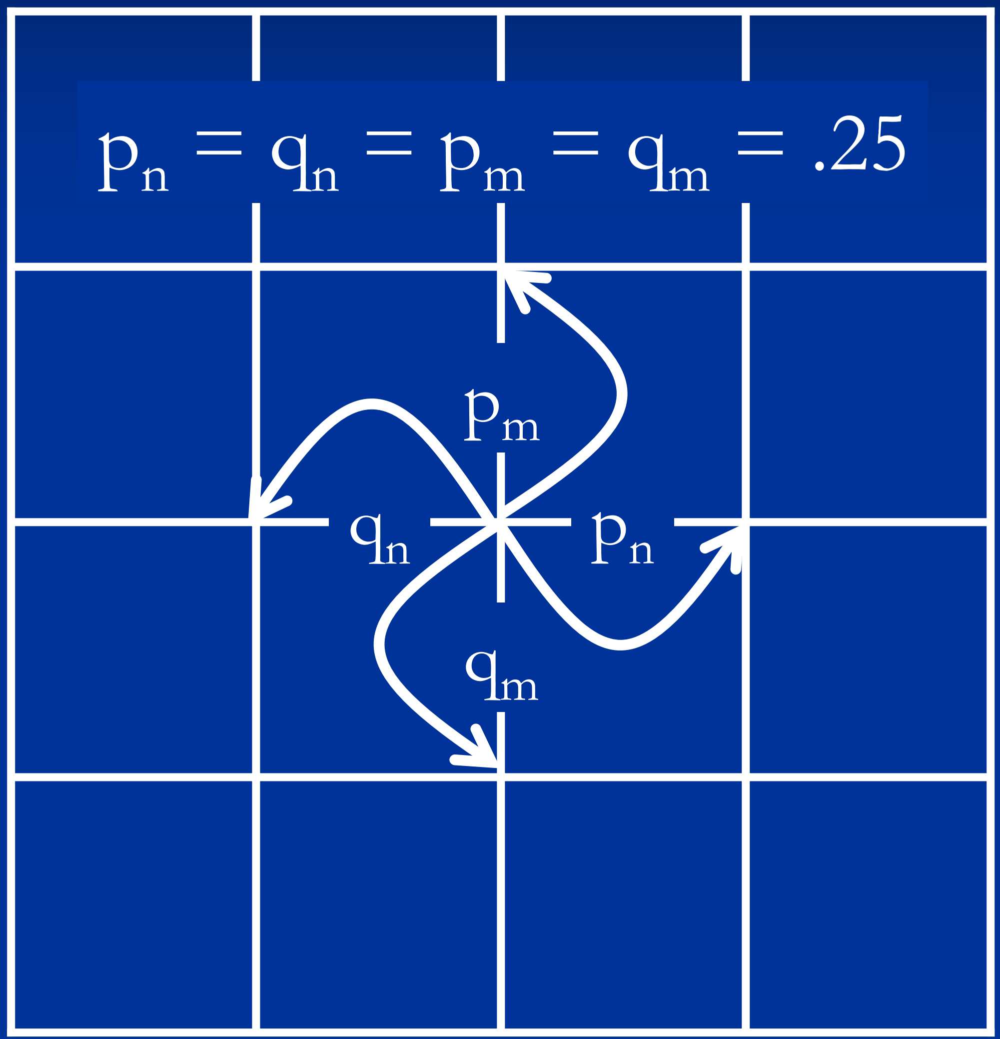
# quantitative expectations?

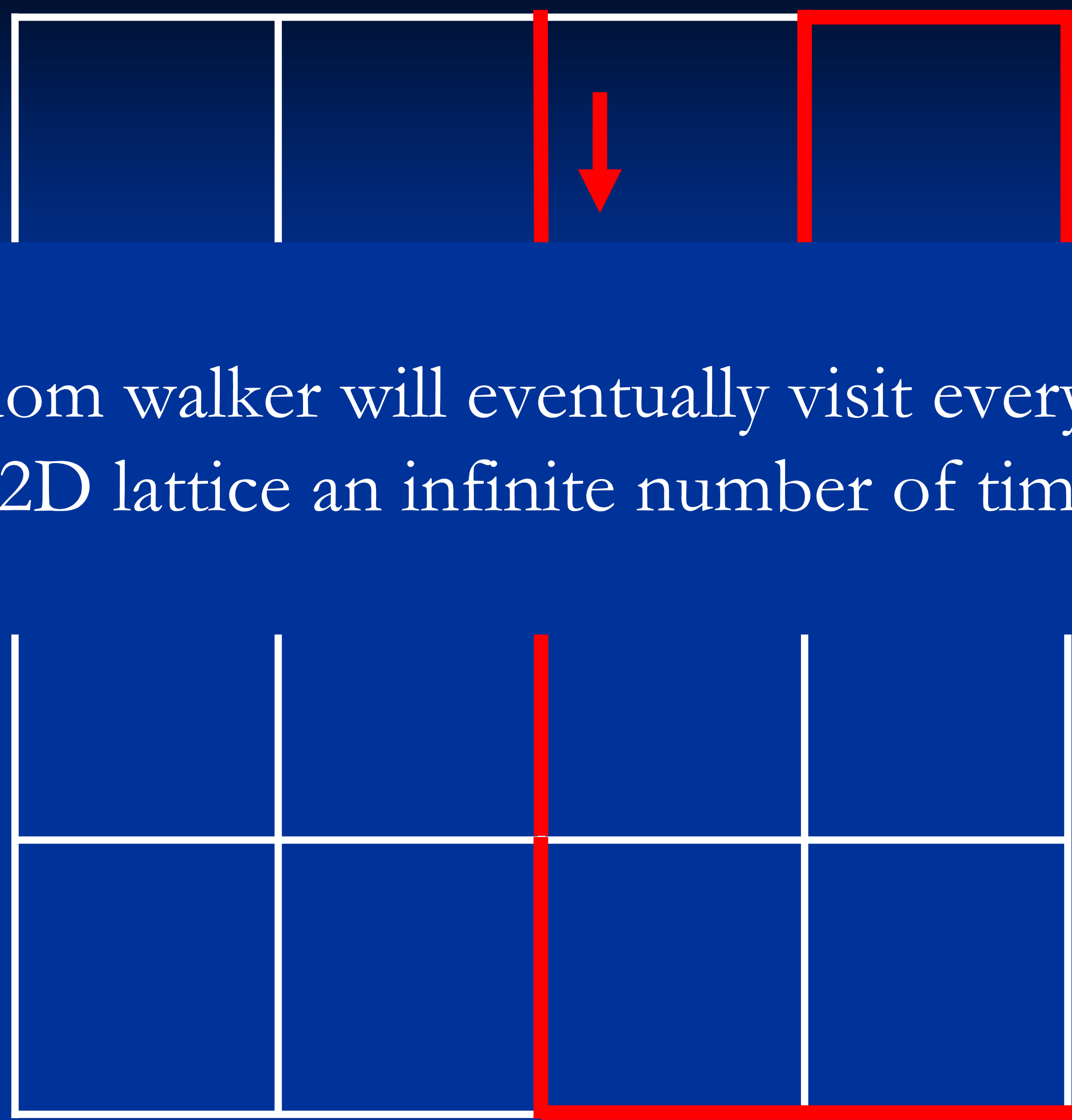
waiting time to a burglary at an individual house = the sum of all the time spent traveling between other patches (houses) and time spent burglarizing those other patches.

# 2D lattice model – sites $r_{nm}$



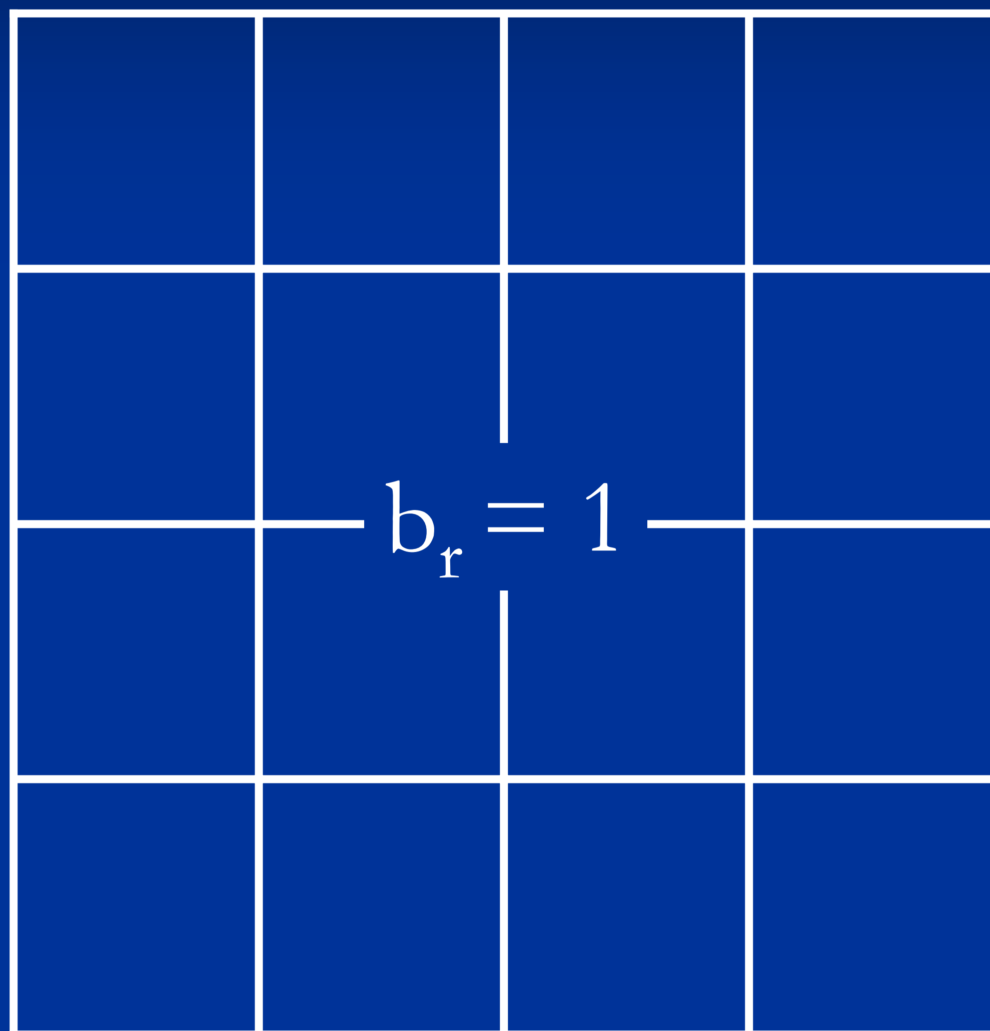
# simple random walk

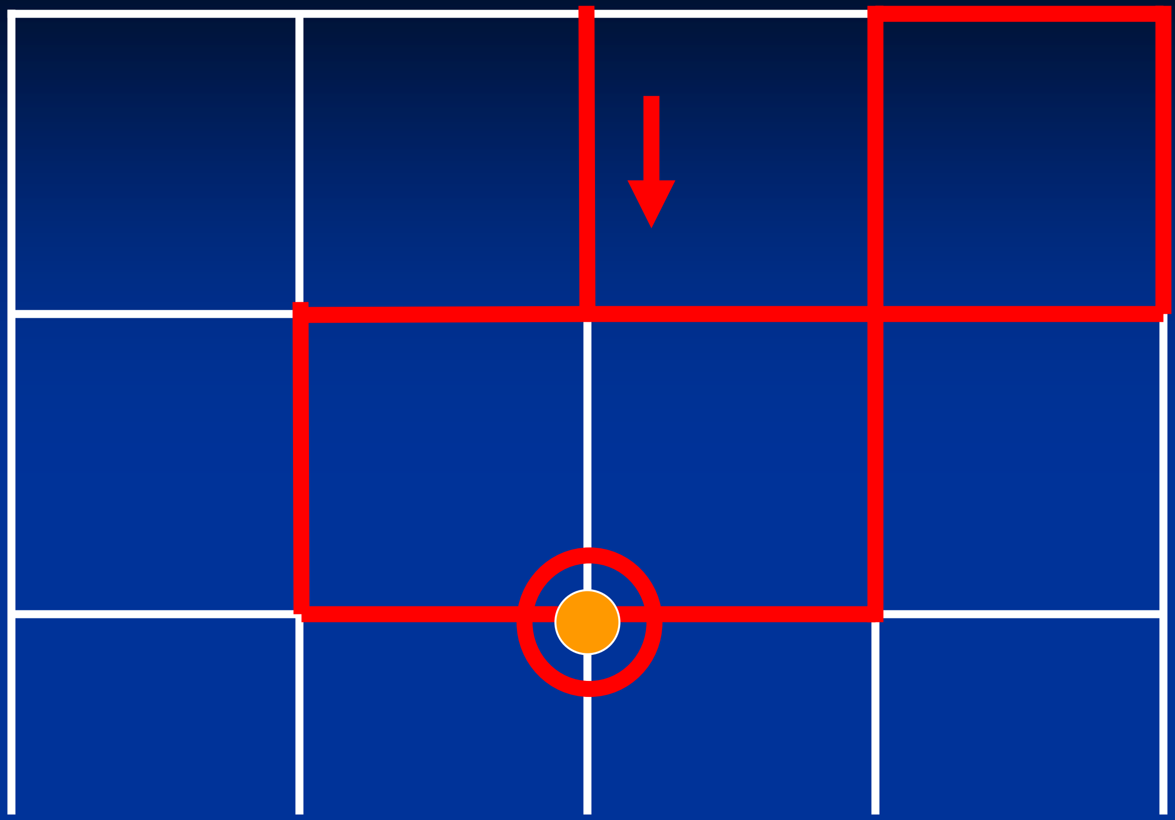




random walker will eventually visit every site in a 2D lattice an infinite number of times

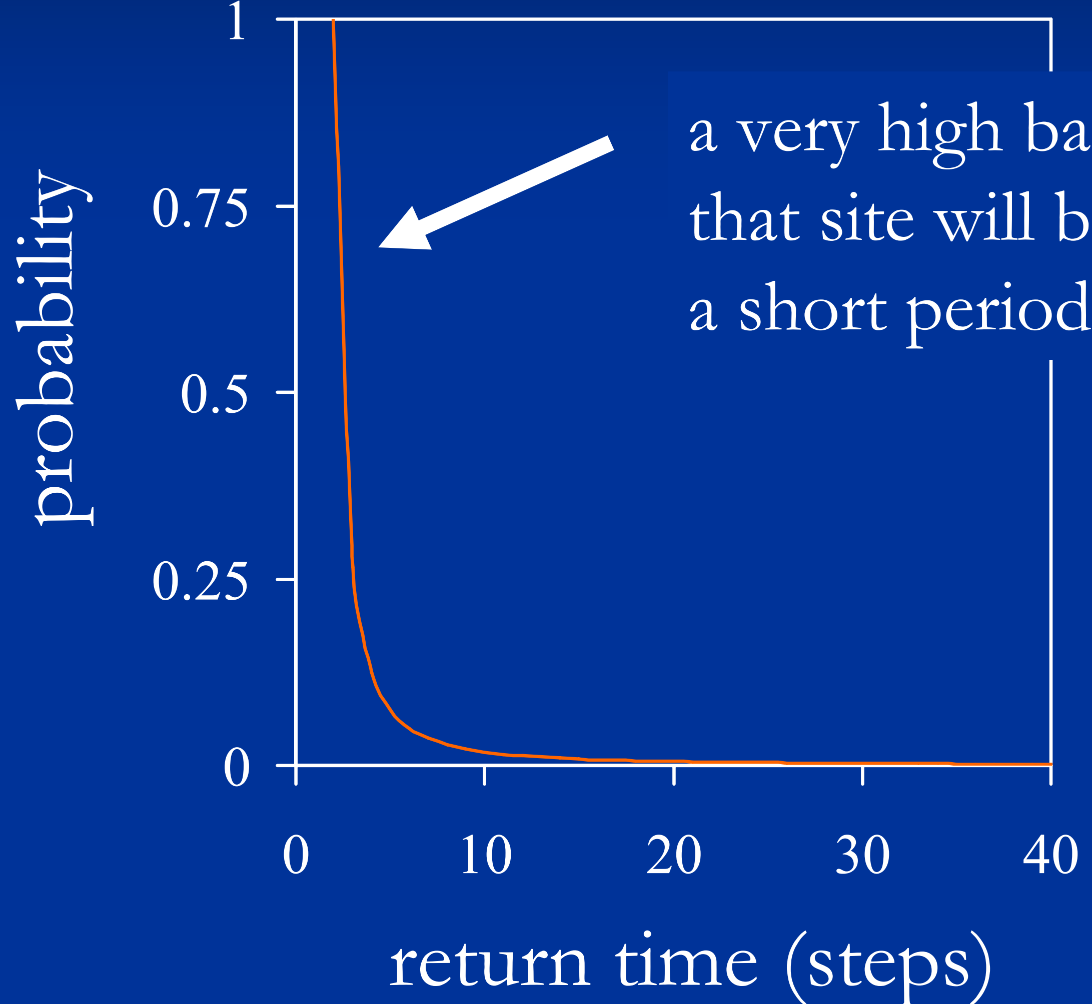
# burglary probabilities $b_r$





waiting time between burglaries
12 steps

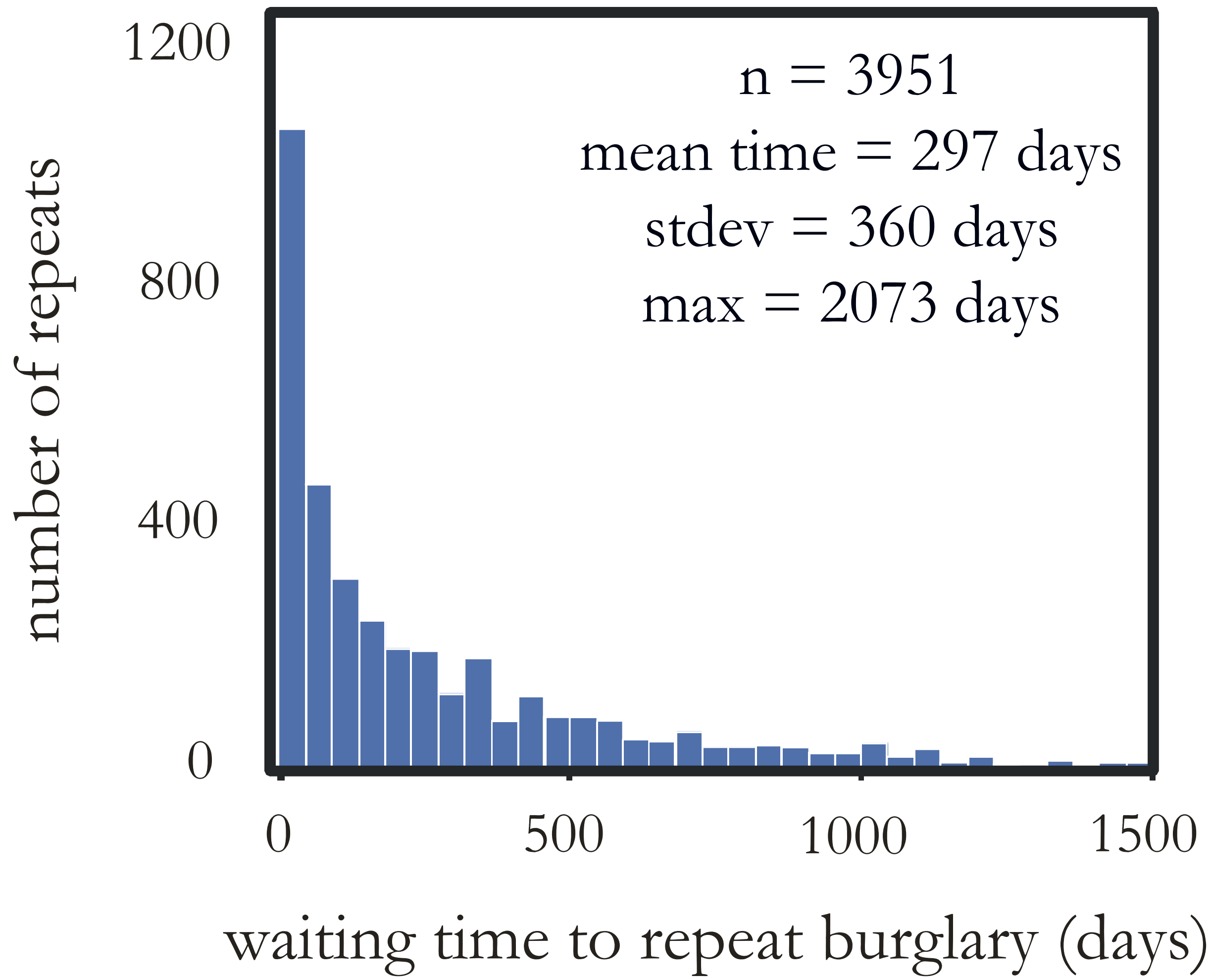
# probability distribution of first passage



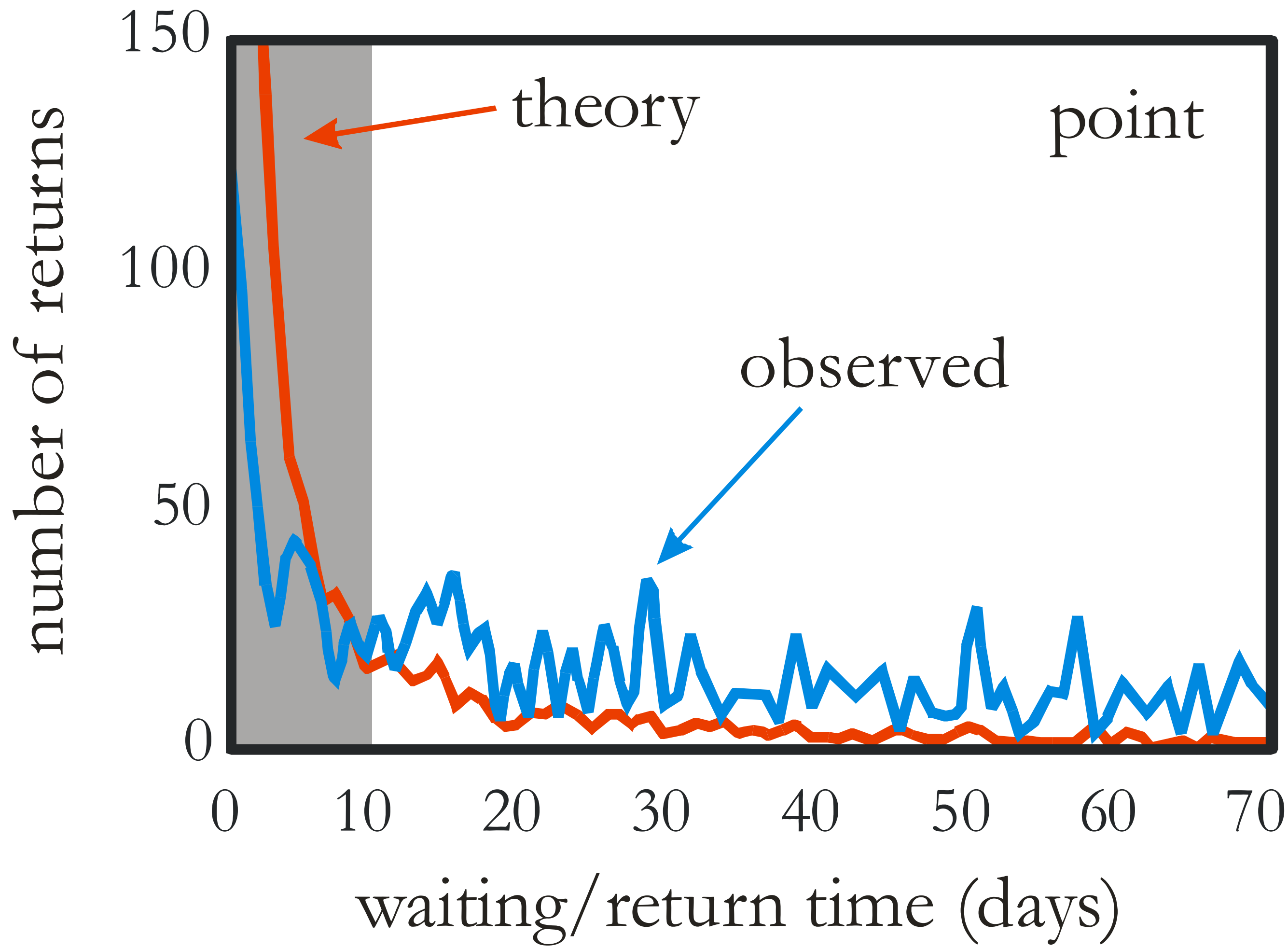

a very high baseline probability that that site will be re-victimized within a short period of time

$$F(r,t) = \frac{1}{A_1 t \ln^2 t}$$

# Long Beach 459R&G 2000-2005

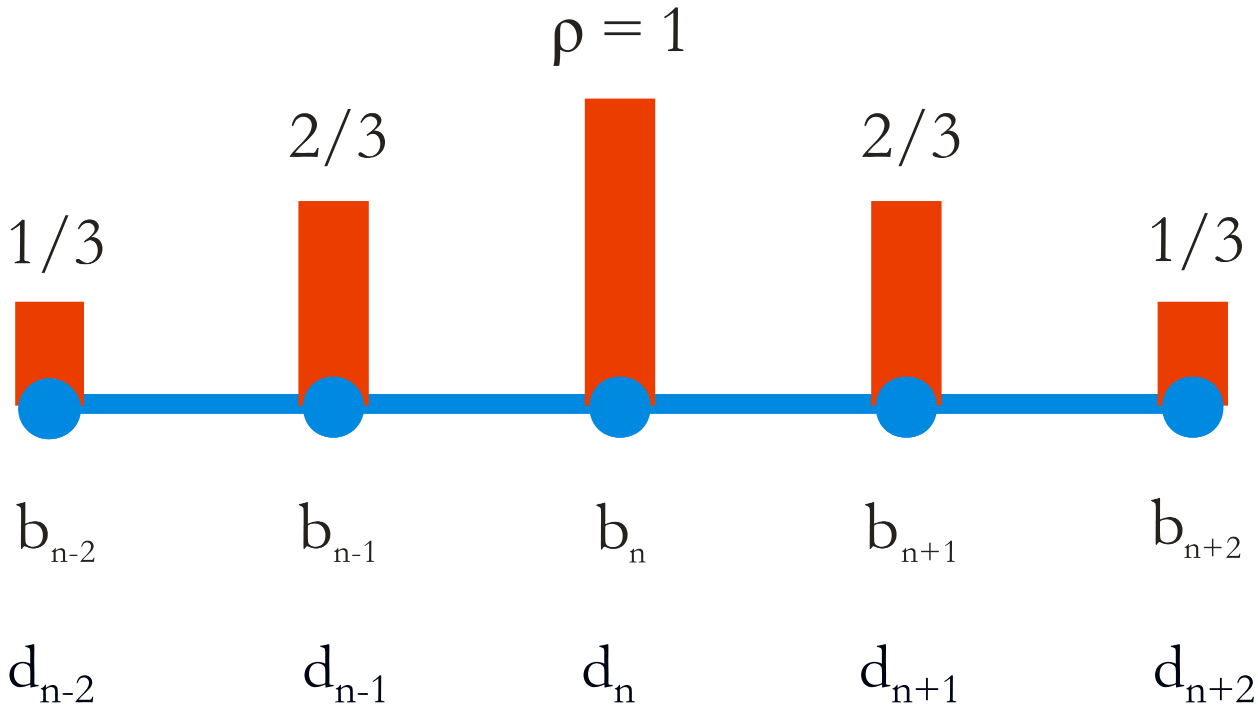


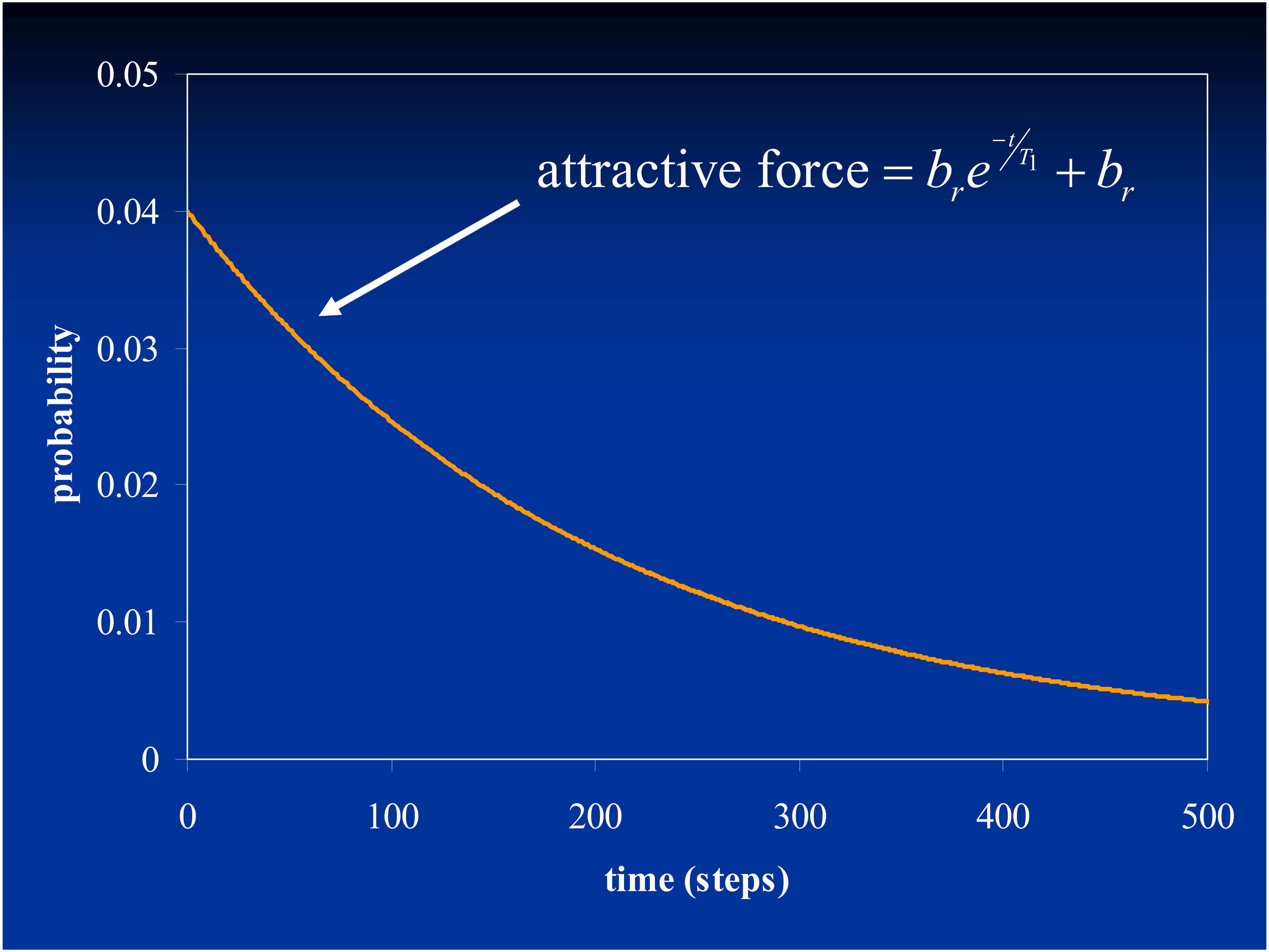
# how does the model do?

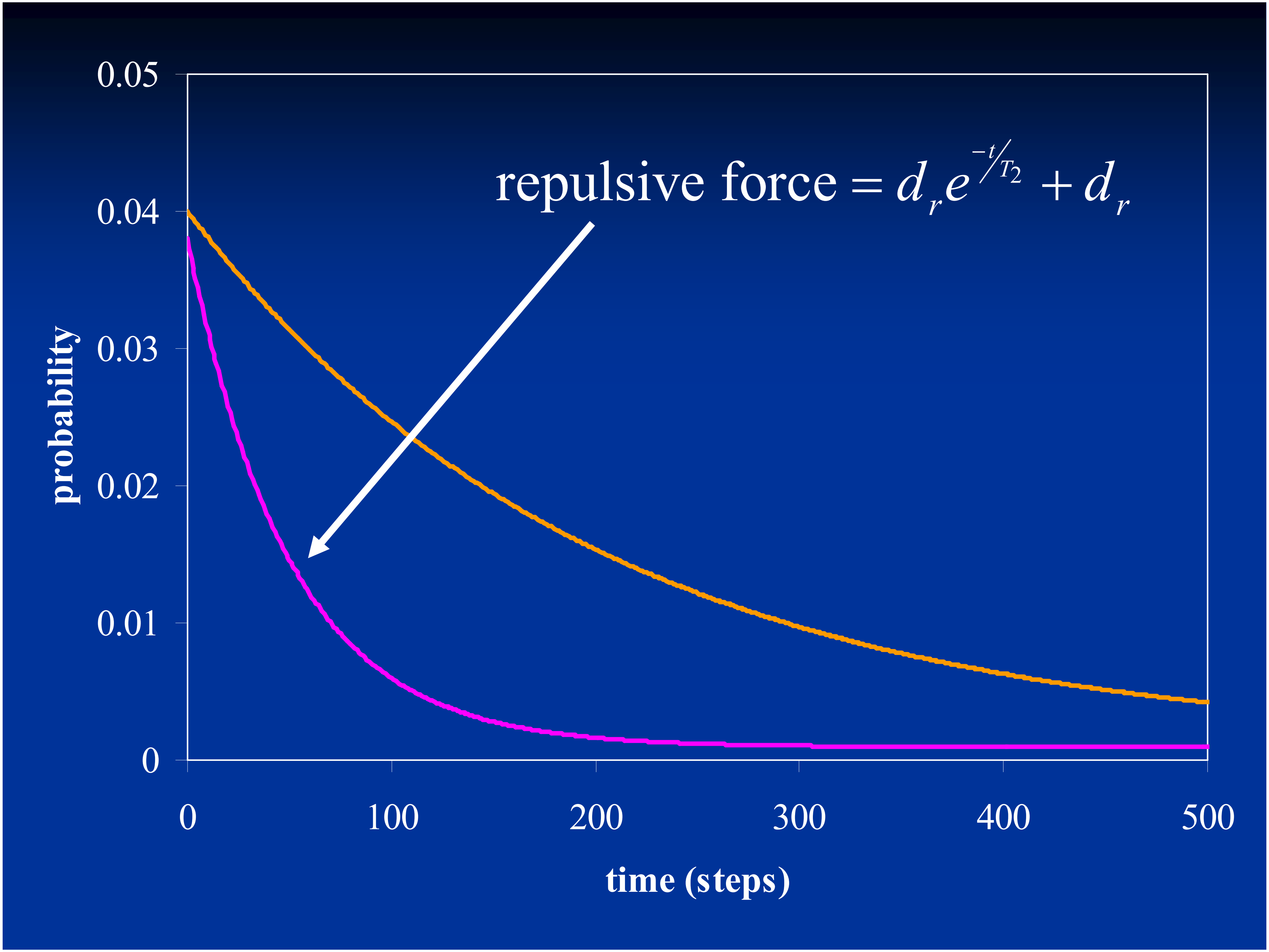


# biased random walk based on attractive & repulsive forces

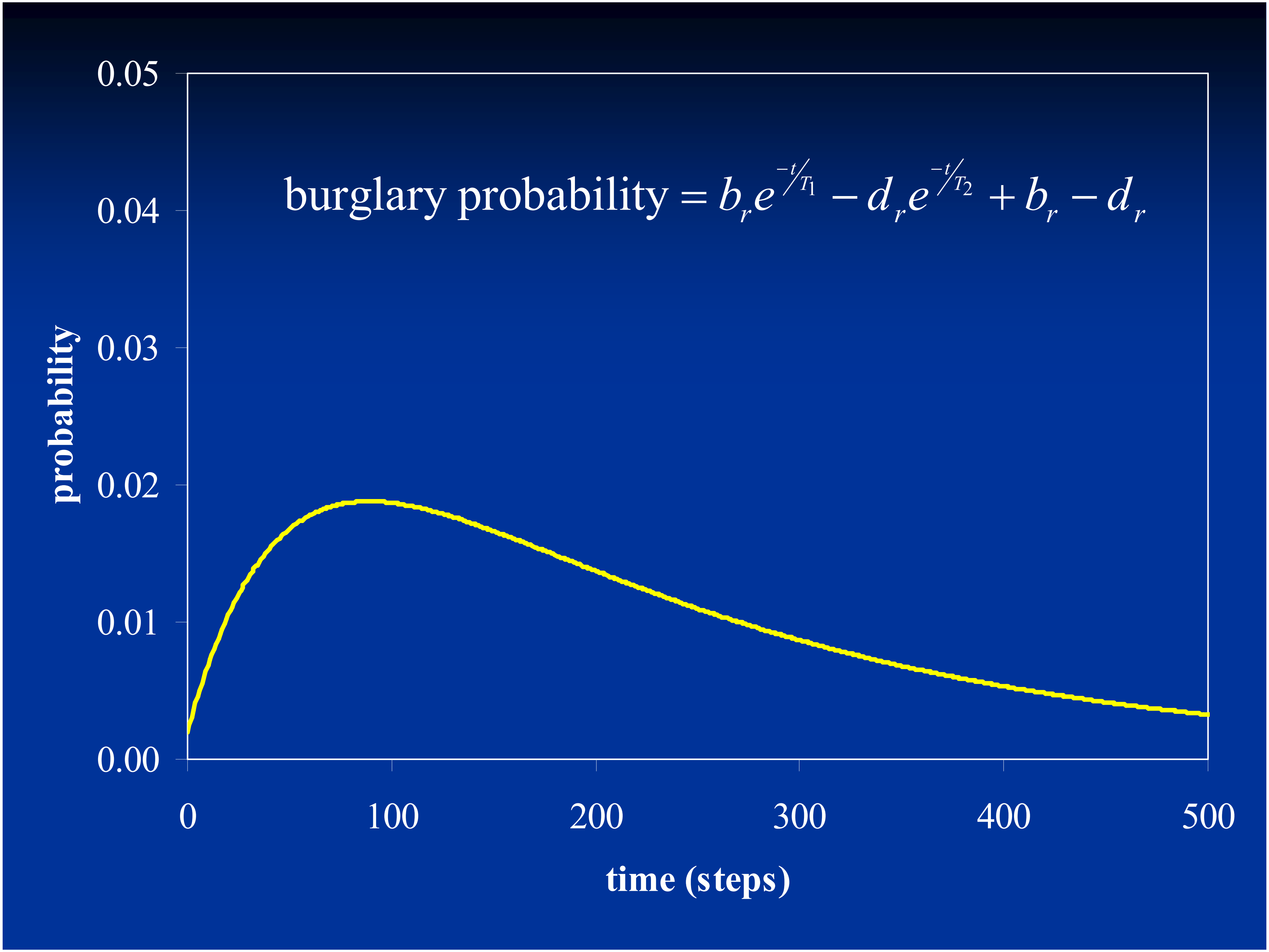
## Neighborhood Risk Levels ρ




attractive force = $b_r e^{-t/T_1} + b_r$
probability
0.05
0.04
0.03
0.02
0.01
0
0
100
200
300
400
500
time (steps)

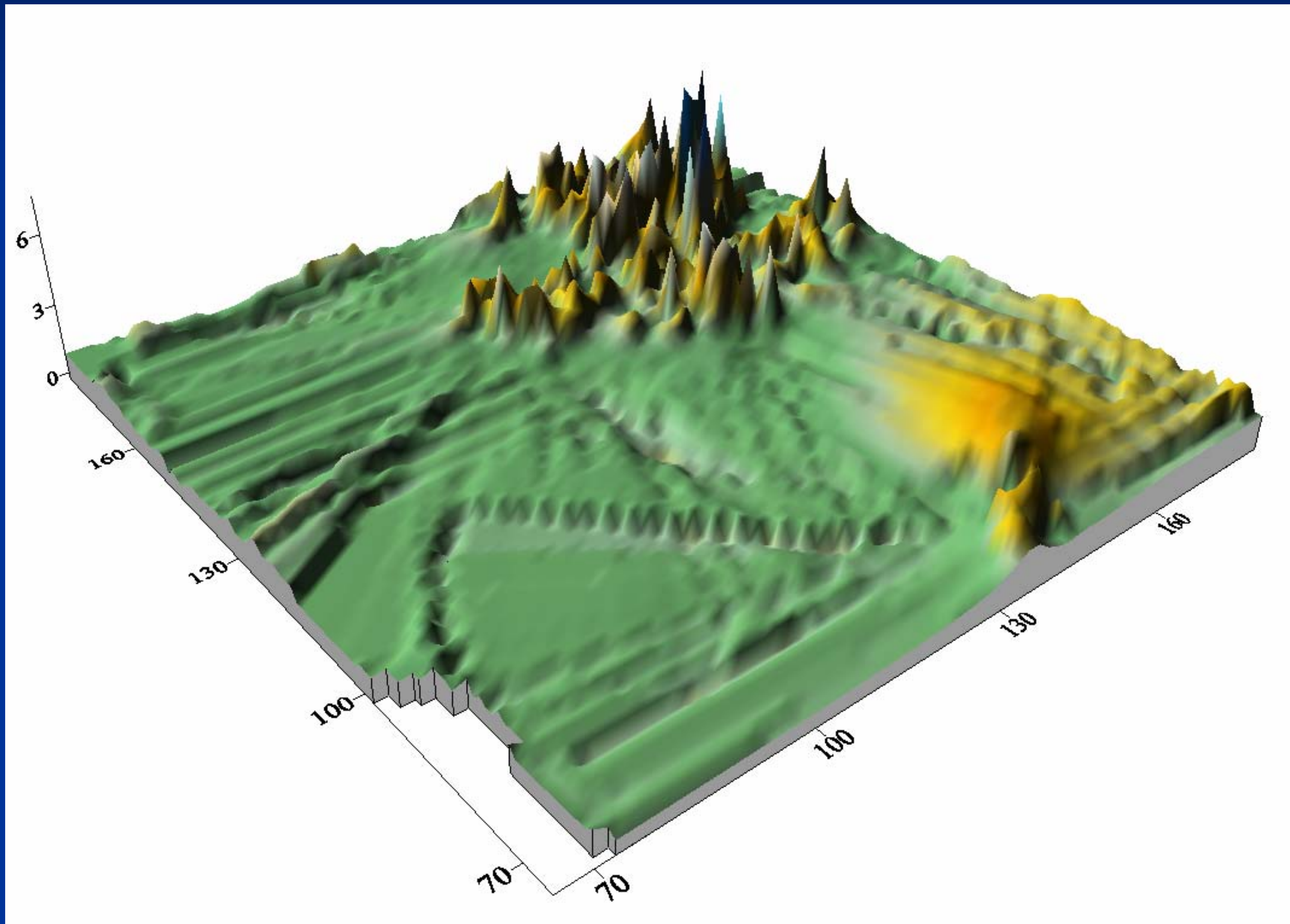


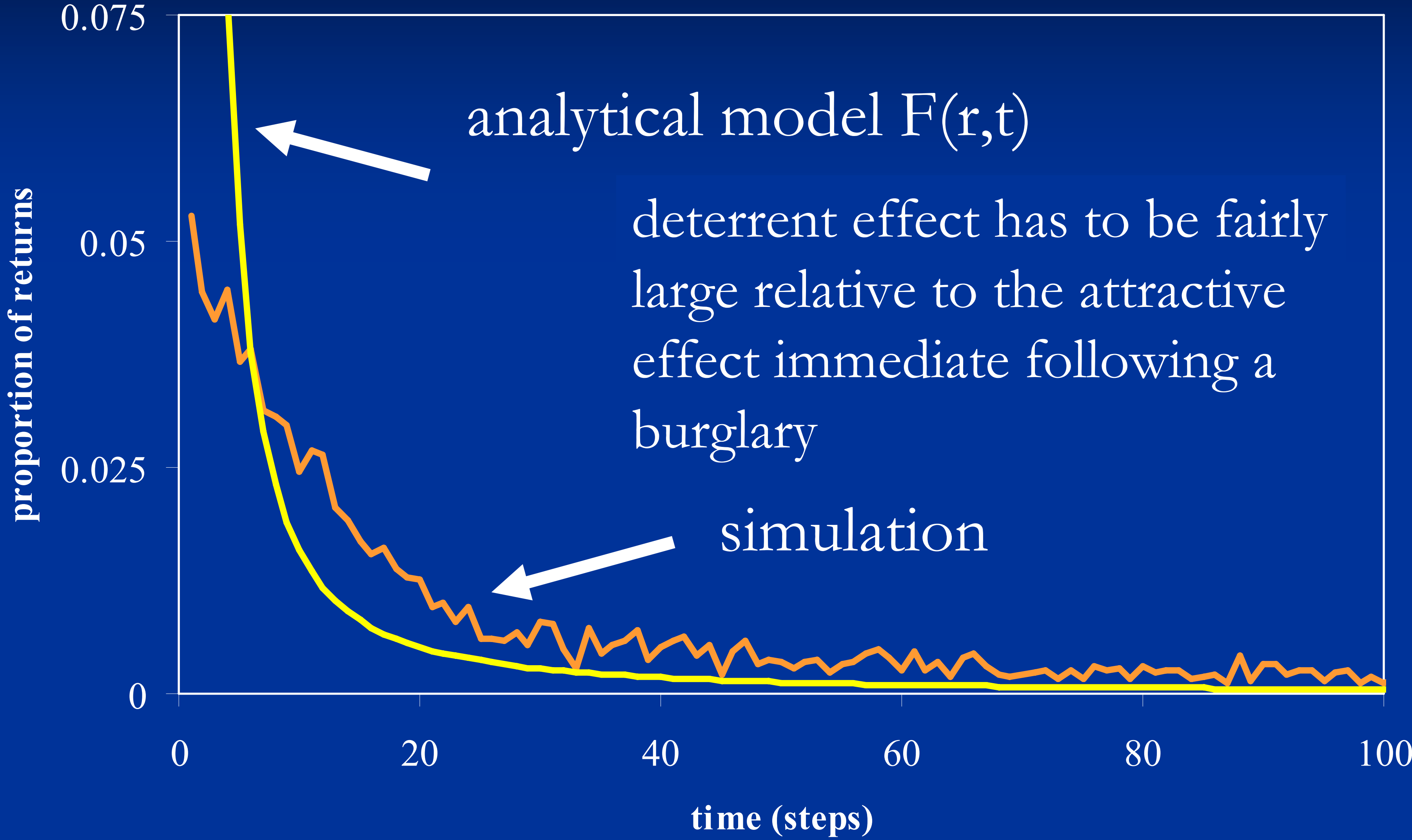
0.05
0.04
0.03
0.02
0.01
0
probability
0
100
200
300
400
500
time (steps)
repulsive force = $d_r e^{-t/T_2} + d_r$



$\text{burglary probability} = b_r e^{-t/T_1} - d_r e^{-t/T_2} + b_r - d_r$
0.05
0.04
0.03
0.02
0.01
0.00
probability
0
100
200
300
400
500
time (steps)

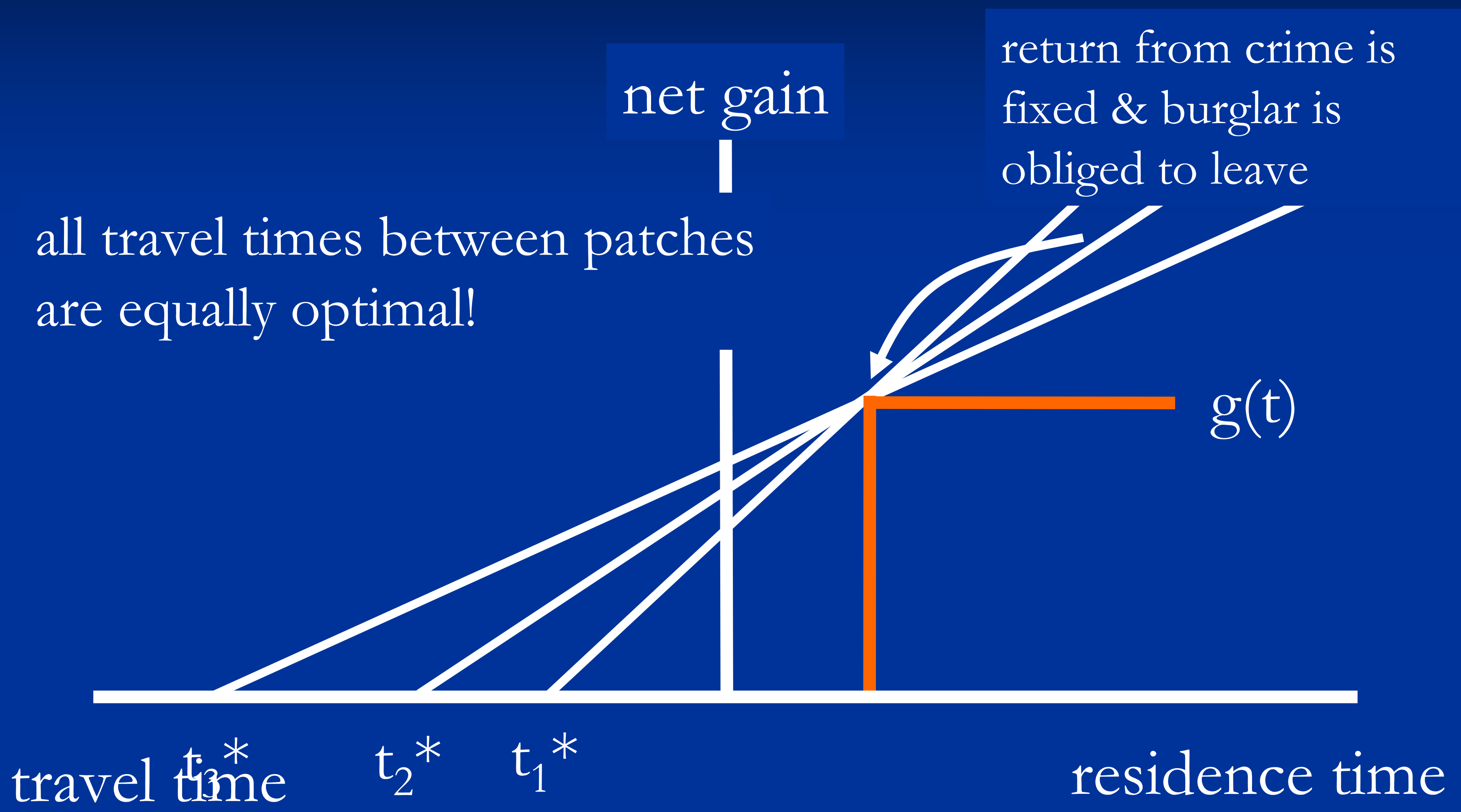
# emergent crime patterns



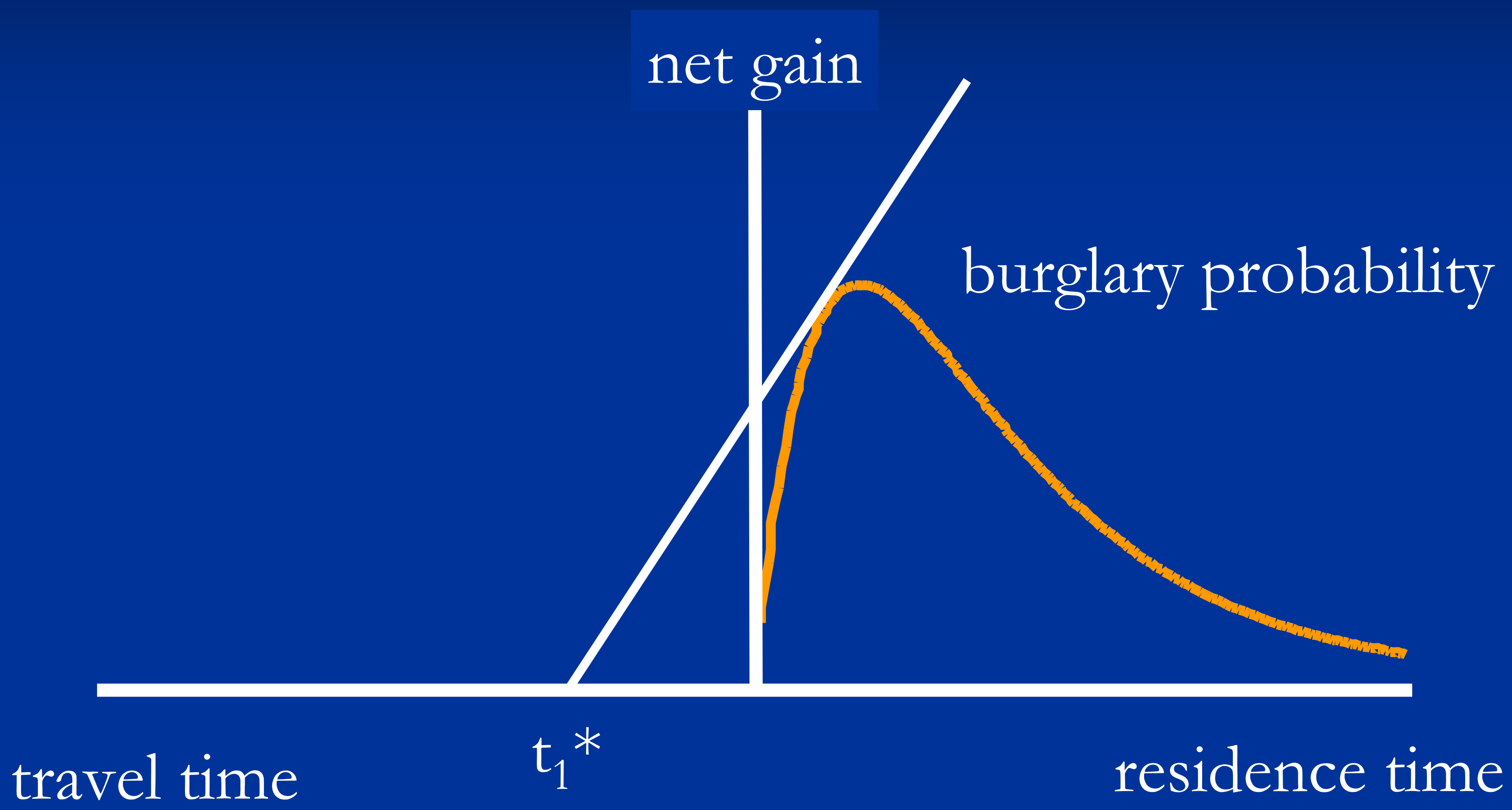



deterrent effect has to be fairly large relative to the attractive effect immediate following a burglary

# random walk model & the MVT



# biased walk model & the MVT



# crime prevention implications

- close attention to the spatial and temporal nature of repeat burglaries has been used successfully to apprehend serial burglars
- the same ideas are also central to the operation of hotspot policing—targeting areas previously victimized for stepped-up police activity is premised on the fact that offenders will likely repeat (in the same places) what has worked for them in the past

- the causes of repeat victimization may be many, but foraging theory suggests that
  - small gains or returns from burglaries or other crimes will tend to lead to repeat offenses that occur close in space and time
  - the "decay-like" character of the distribution of burglary waiting times may reflect simple constraints on movement around in a 2D world with some contributions from deterrent & attractive effects