Network-based crime prediction

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Big Data and Intelligent Policing

CPC Project Closing Workshop

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Security for all in a Changing World

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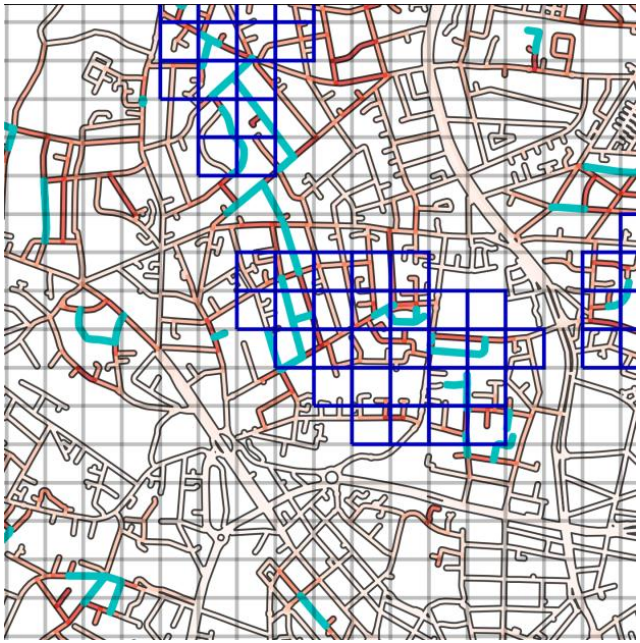
Network-based crime prediction

- Introduction to crime prediction
- Existing grid-based prediction approaches
- Motivating a network-based approach
- Network prediction method
- Accuracy results



Introduction to crime prediction

Q

How do the police decide where to patrol?

A

Optimise their potential to safeguard the public, deter criminals and increase public confidence.

Introduction to crime prediction

- Maps have been used for a long time to help guide patrols.
- This is typically retrospective:

"Spatial crime patterns tomorrow will be similar to those last week."

- More recently, digital Geographic Information systems are used to achieve the same outcome faster and with better data.
- Responses are still reactive.

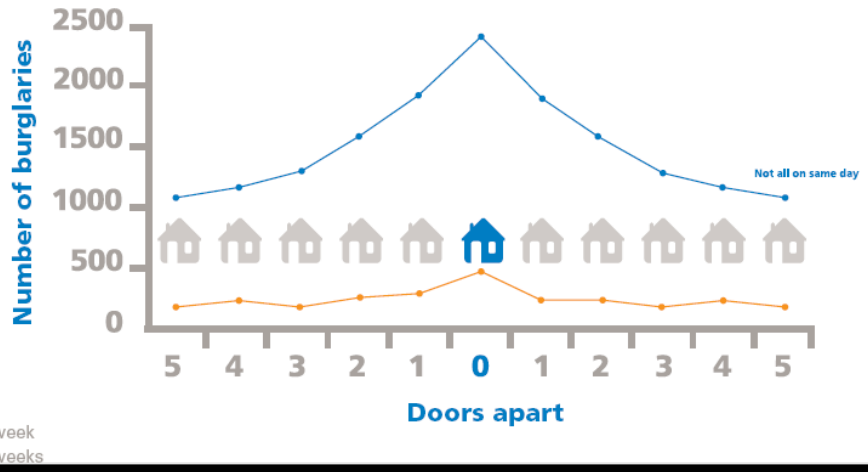
Introduction to crime prediction

- The use of maps for proactive policing is a relatively new paradigm.
- Send police to the places that *will be* at risk of crime.

Why is this possible?

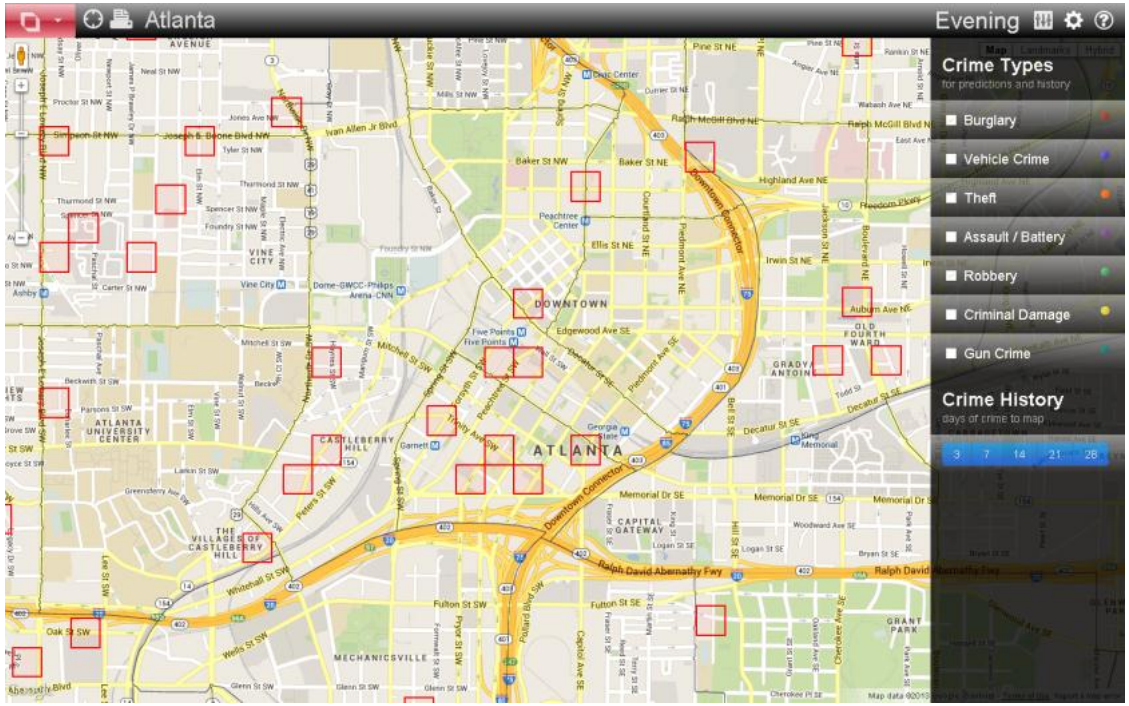
- The space-time patterns of crime events cluster in space and time.
- Modelling these effects allows us to generate forecasts that are more accurate than simply returning to the same locations.

‘Near-repeat victimisation’ phenomenon in burglaries.



Grid-based prediction approaches

- Predictions must be reported on an areal unit.
- Existing systems typically highlight the most risky grid squares.



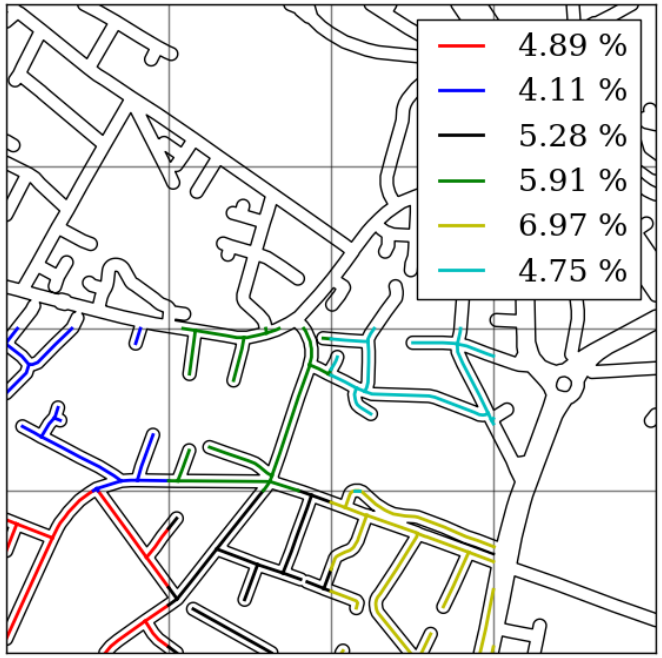
Motivating a network-based approach

Disadvantage (1)

- Police patrol streets, not grid squares.

Blue -> red: walking 100 metres.

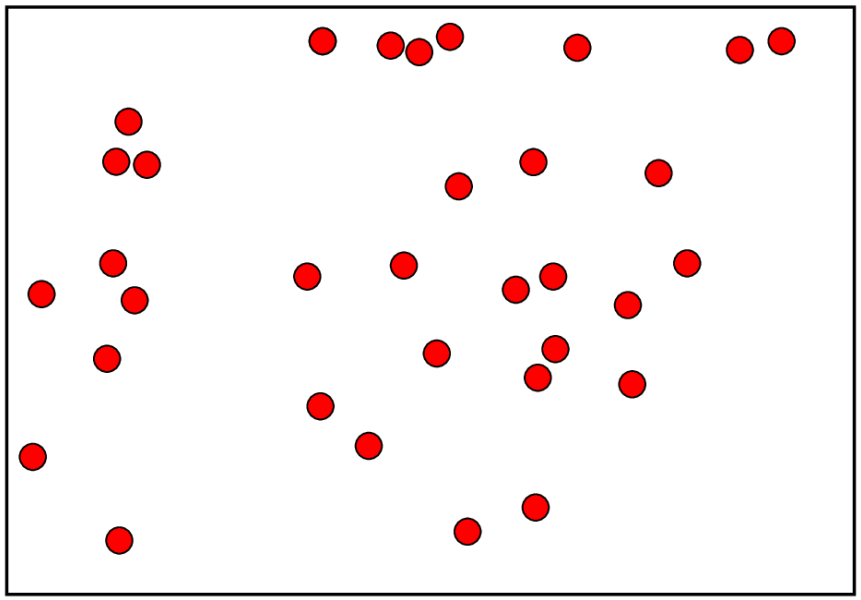
Proportion of road length in grid.



Motivating a network-based approach

Disadvantage (2)

- Many urban crimes occur along streets, so our models should take that into account.
- Typical assumption that crimes occur in planar space.



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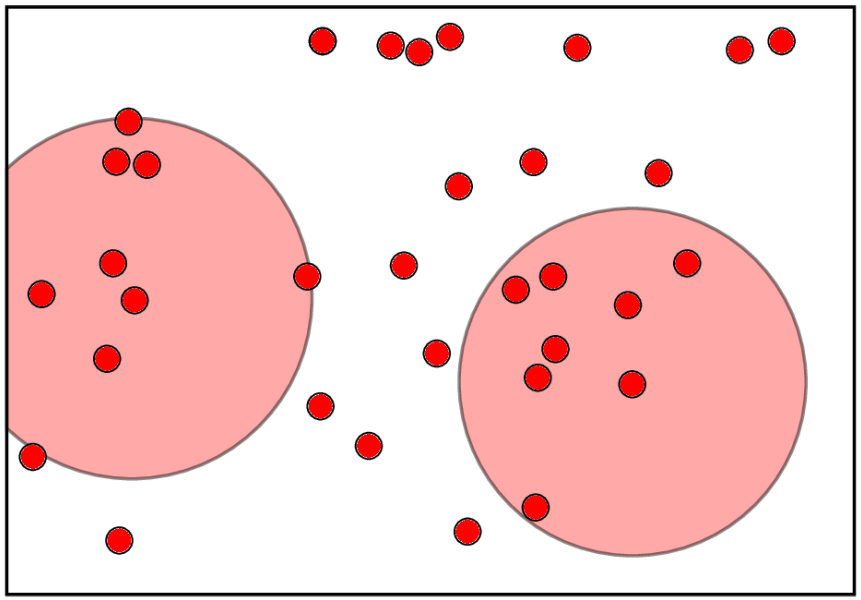

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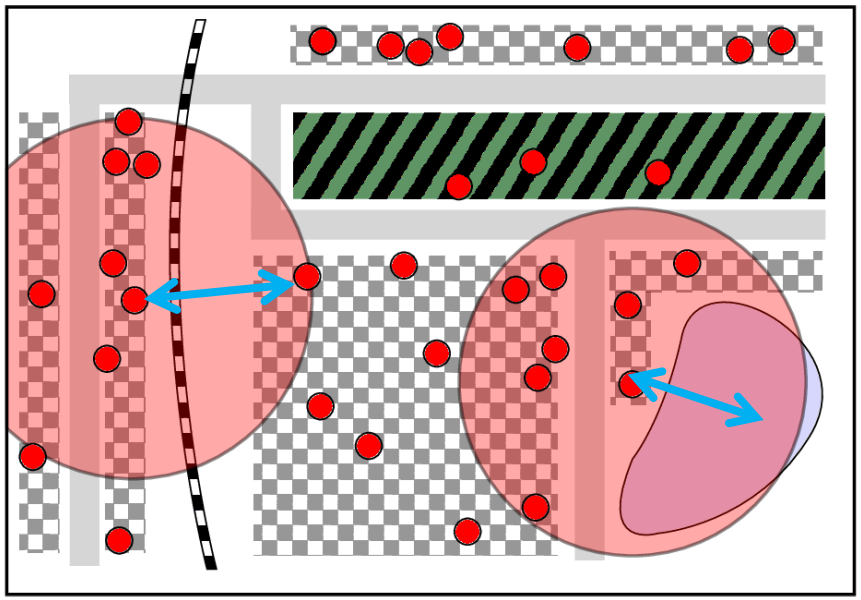
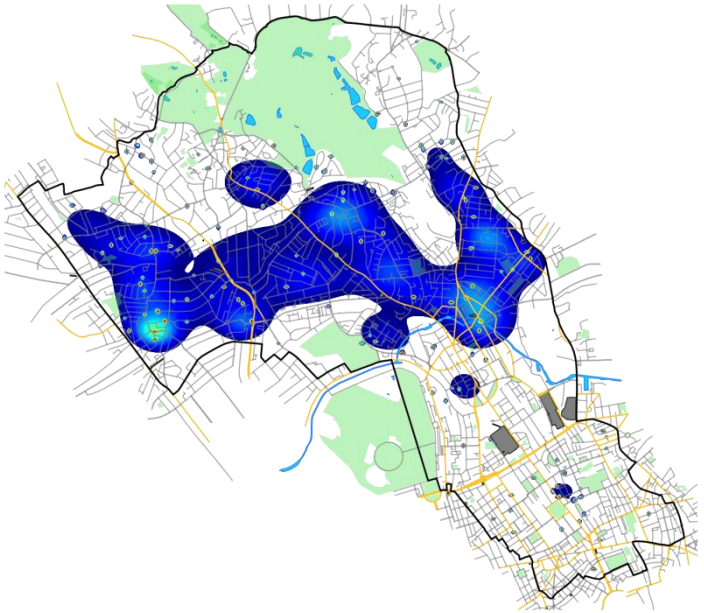
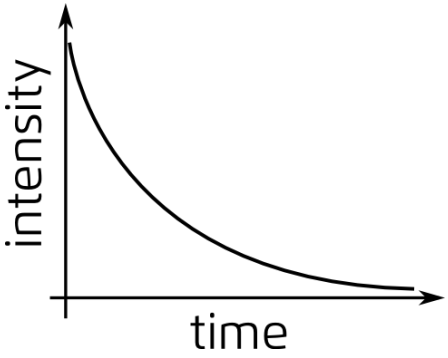
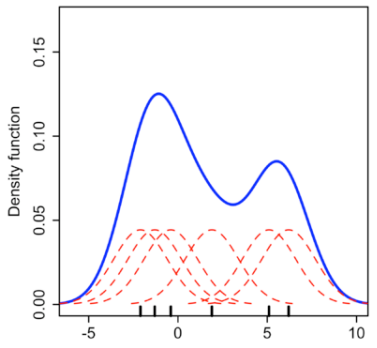


Network prediction method

- Our method is based on an extension of an existing approach used to generate heat maps called kernel density estimation (KDE).
- In planar applications, this works by dropping a 2D 'kernel' (bell curve) onto every crime to obtain a smoothed surface.
- The height of the bell curve decays over time.



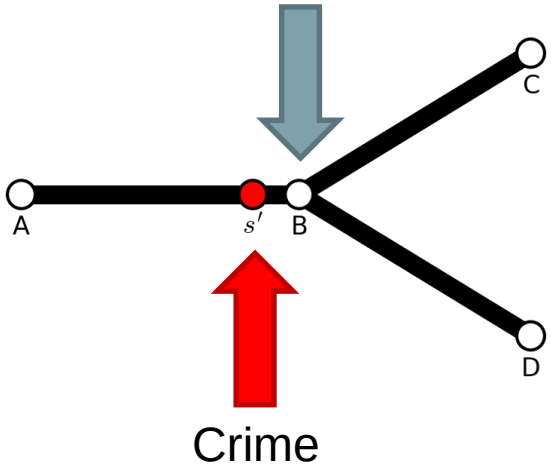


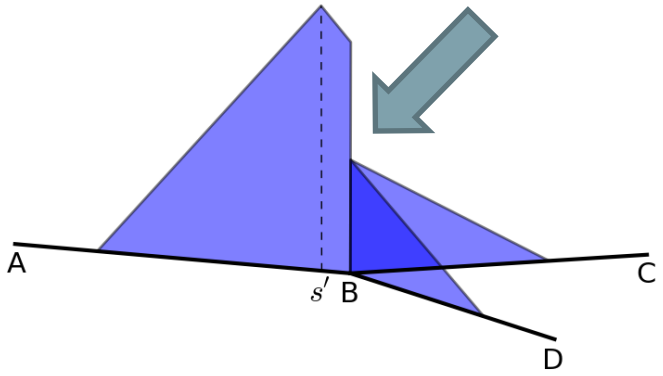


Network prediction method

In our network application, we only change the spatial part: this is now defined on the street network.

- The spatial kernel decreases linearly with distance.
- Every time the network splits, the kernel splits too.

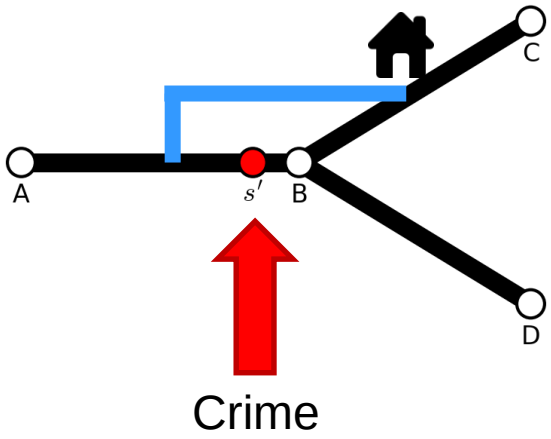


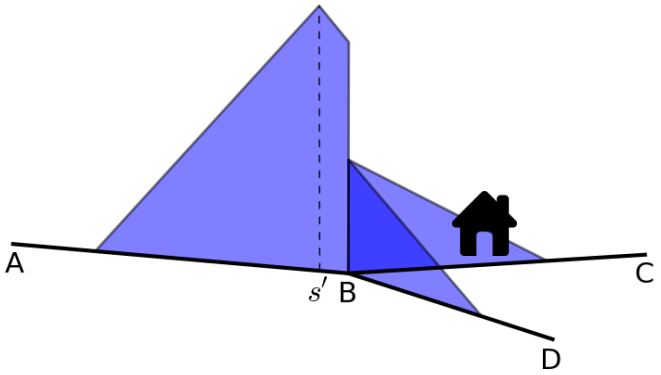


Network prediction method

In our network application, we only change the spatial part: this is now defined on the street network.

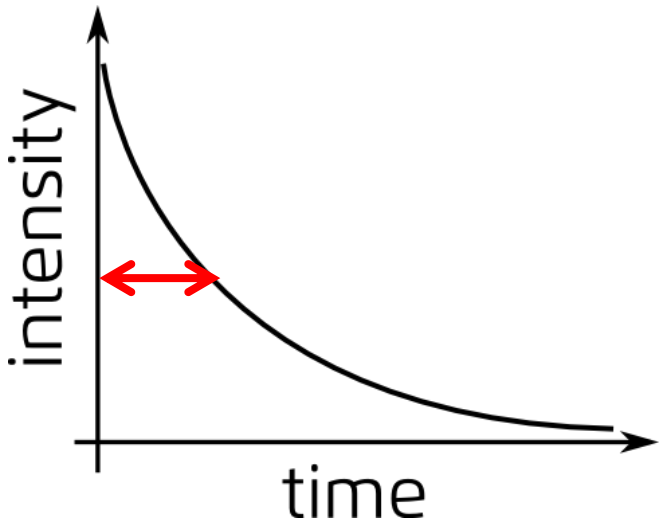
- The spatial kernel decreases linearly with distance.
- Every time the network splits, the kernel splits too.
- All routes are counted from s' -> B.

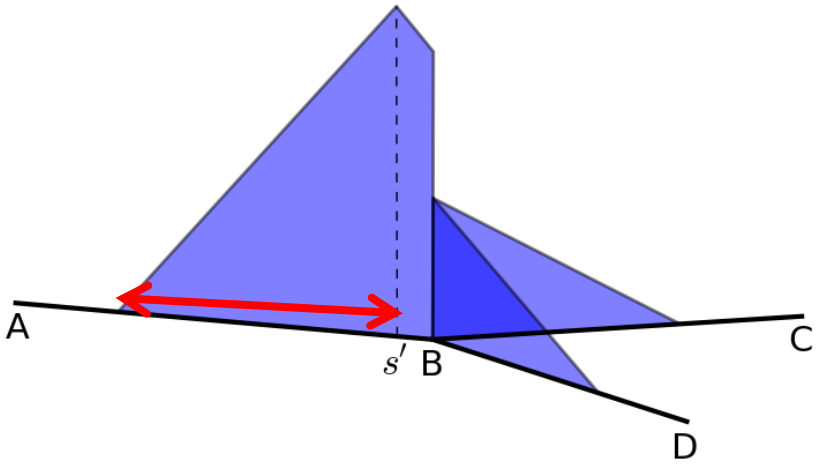




Network prediction method

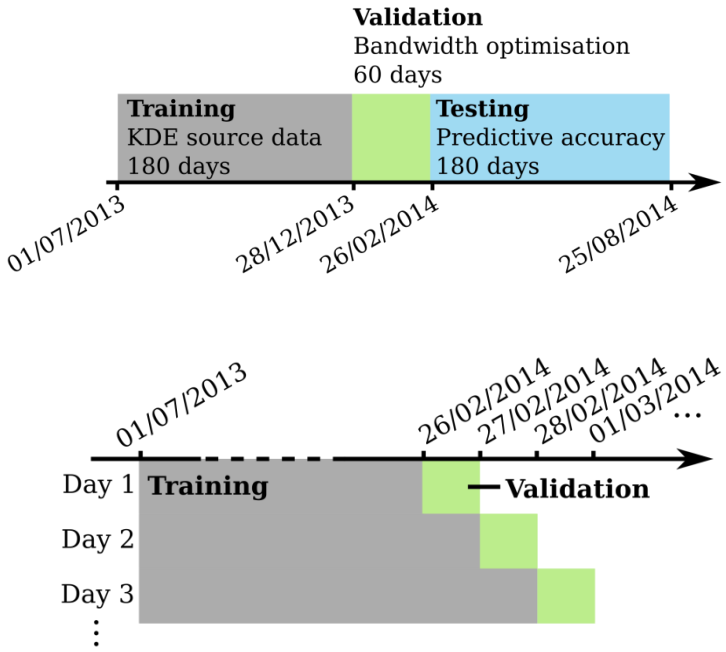
- There are two key parameters here: the bandwidths.
- These should be tailored to the crime type and study area.

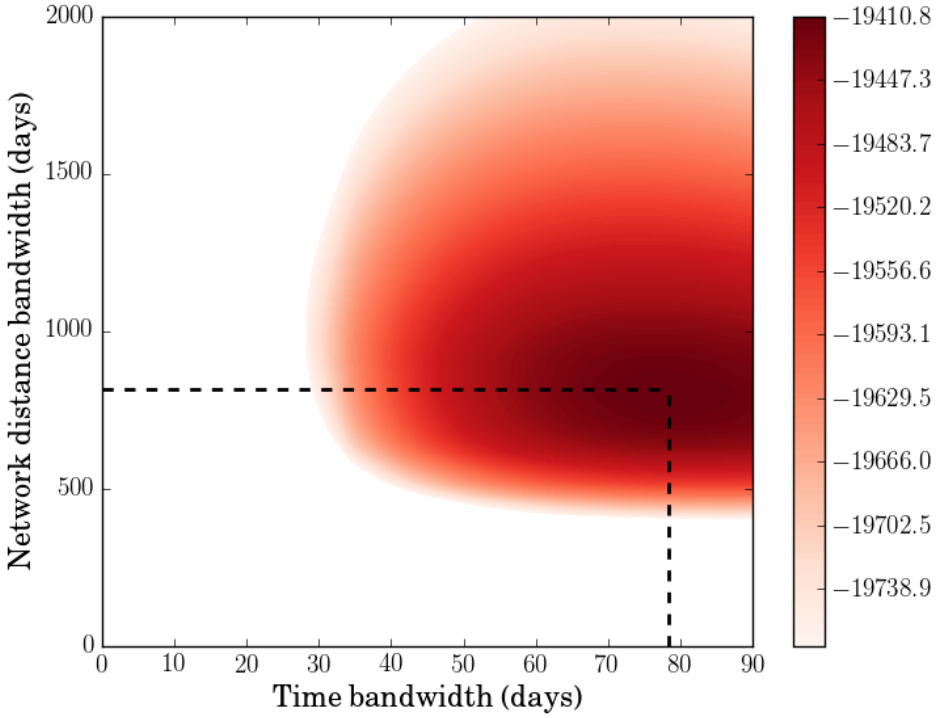




Network prediction method

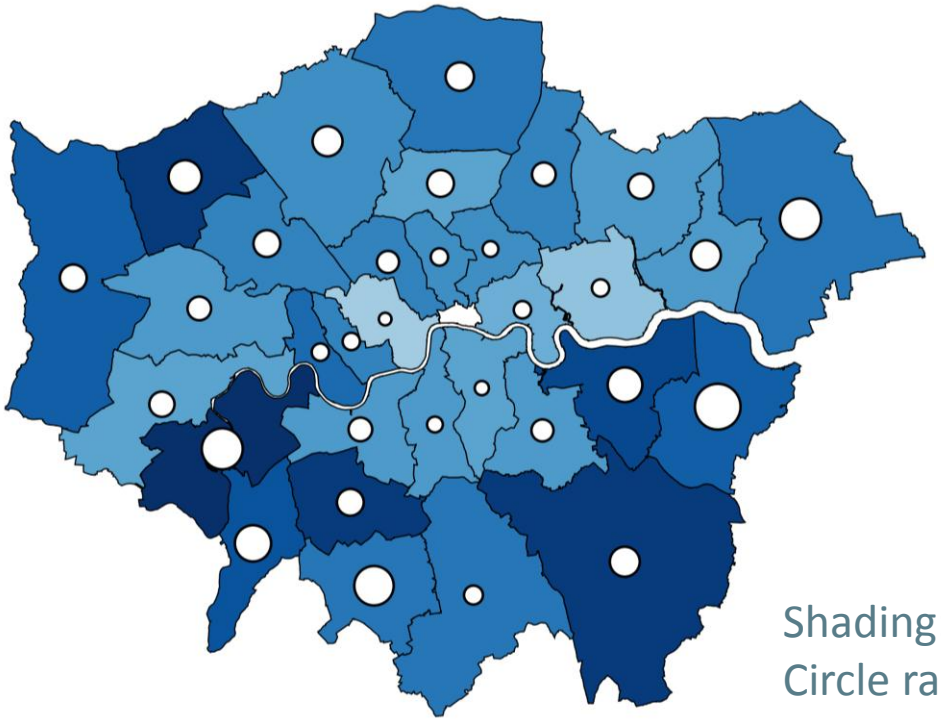
We use a maximum likelihood approach.





Network prediction method

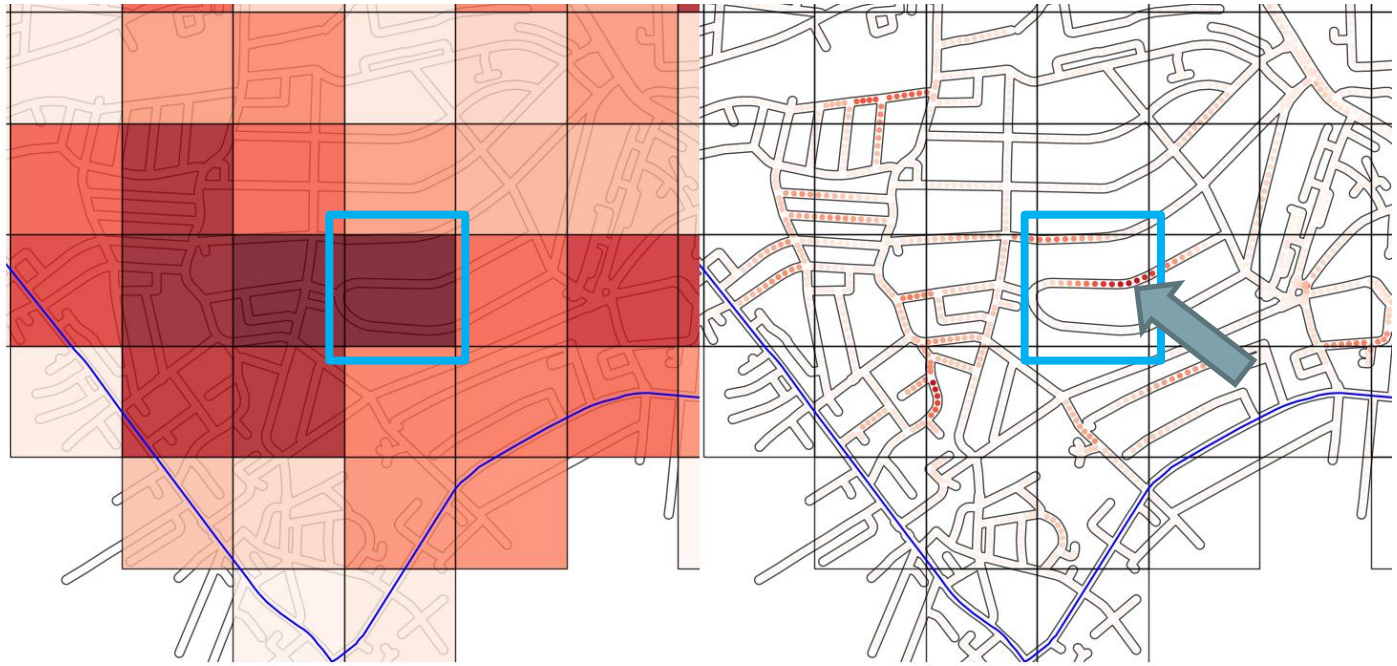
- We use a maximum likelihood approach.
- The bandwidths vary significantly by location and crime type.



Shading: temporal bandwidth
Circle radius: spatial bandwidth

Network prediction method

- Using this method, we can produce predictive crime maps with hotspots based on the road network.
- More easily interpreted than grid-based maps.

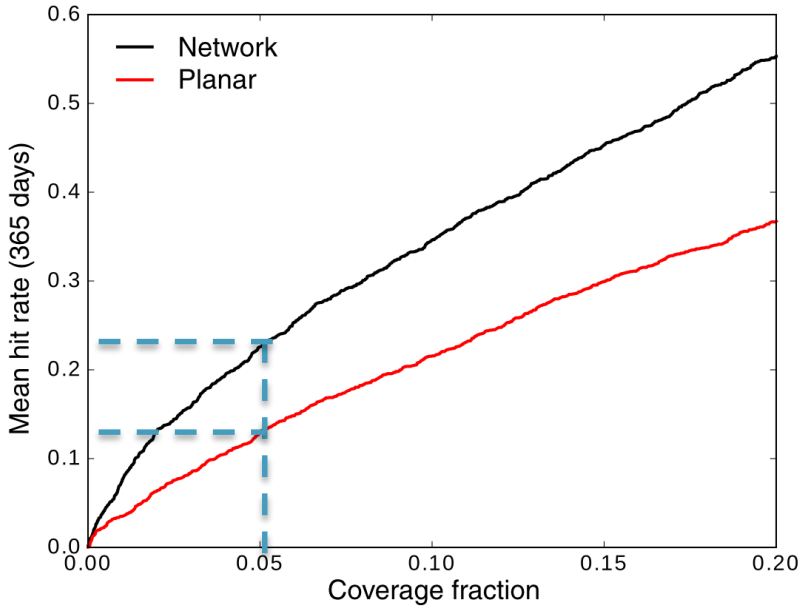


Network prediction method

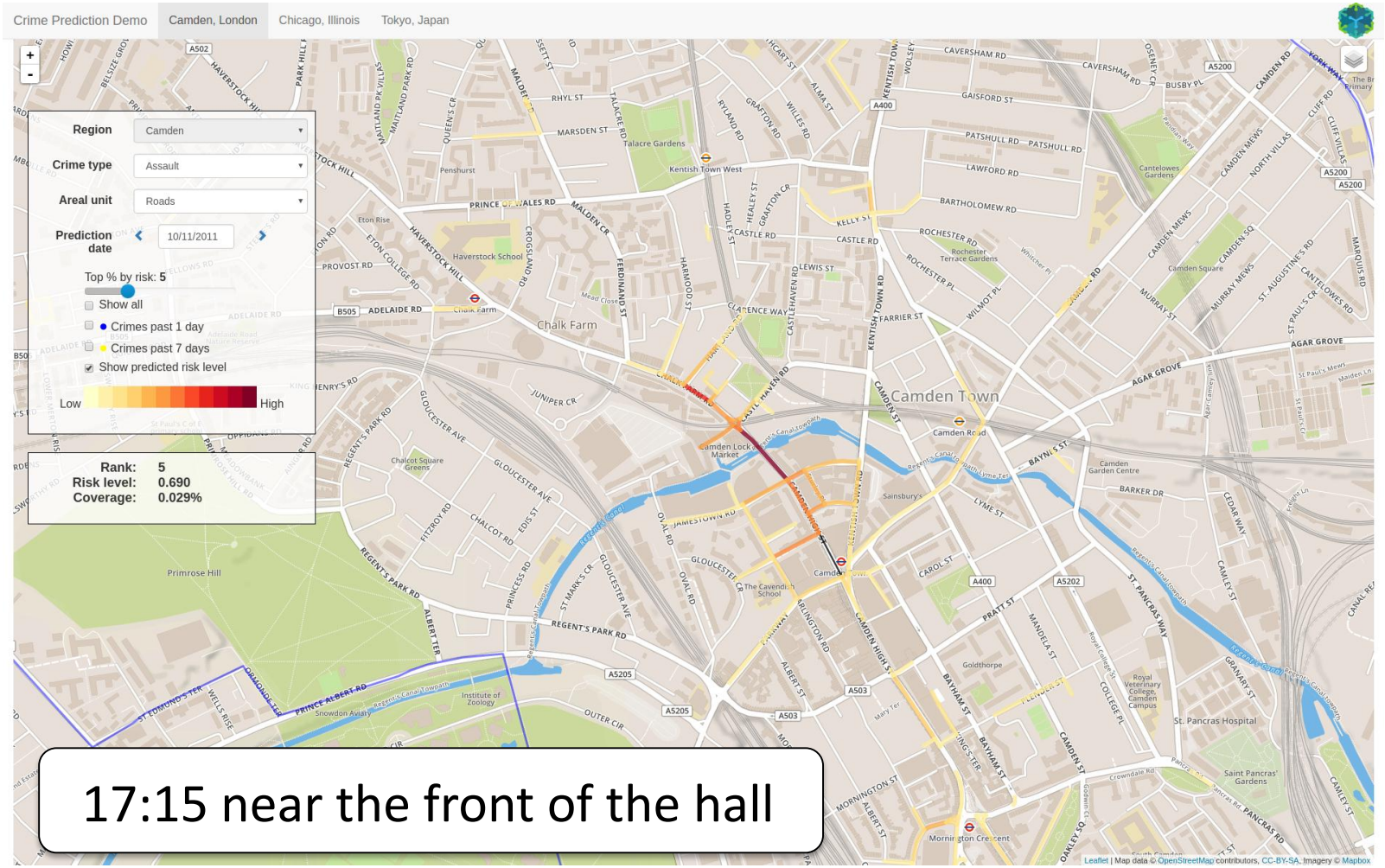
- Using this method, we can produce predictive crime maps with hotspots based on the road network.
- Less ambiguous than grid-based maps.

Accuracy results

- Monsuru will talk more about evaluation methods in the next presentation.
- We compare the network method with a grid-based prediction method using the hit rate. Results are for 1 year of burglary crimes in Camden.
- The network-based approach is almost twice as accurate at 5% coverage.



Demo application



Thank you!