JDiBrief - Analysis

Hot Routes: SUMMARY (1 of 5)

Author: Henry Partridge, UCL Department of Security and Crime Science

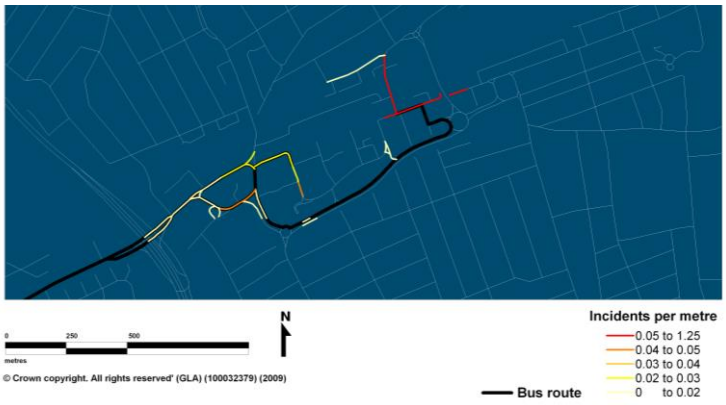
PURPOSE: Hot Routes is a spatial analysis technique that visualises crime patterns on a network. It allows an analyst to map crime concentrations along different segments of that network and uses colour and line-width to display the results (known as thematic mapping).

THEORY: According to crime pattern theory, the distribution of crime largely depends on how victims and offenders converge in space. In an urban environment an individual's 'activity space' is defined by streets and transport networks called 'paths' along which they travel to 'nodes' where they live, work, or engage in leisure activities. Crime tends to concentrate at the nodes and along the paths that connect them. Since streets and transport networks constrain the routine movements of victims and offenders, they strongly influence the spatial distribution of crime.

METHOD: Two data files are needed for the analysis: a) point-level crime data which are geocoded to a high level of spatial resolution, and b) a network layer. The following steps summarise the analytical process that needs to be followed to produce a Hot Routes map (more detailed information is provided in the Method brief on this topic along with GIS tools suitable for each step).

1. *Preparing the network layer*: network layers typically contain streets of unequal length. It is advisable in this analysis to use equal length street segments, where possible. Street segments that are unusually long or short need to be split or combined with neighbouring segments.
2. *Linking crime events to street segments*:. In this step, each crime event needs to be linked to the nearest street segment and the attribute table of the network layer updated with the corresponding count of crime.
3. *Calculating a rate:* the length of each street segment needs to be calculated (if this is not automatically done by the GIS). Next, a new column needs to be created in the network layer to record a crime per metre score. This is calculated by dividing the number of crimes linked to a street segment by its length..
4. *Visualising the results:* The final step is to thematically shade each street segment with a colour (and line thickness if desired) that corresponds to the range of the rate of crime per metre.

APPLICATION: To date, the Hot Routes method has been applied to study crimes and incidents on the transport network in London, to examine street traffic collisions involving cyclists, and in analysis on theft from motor vehicle offences.



We would like to thank Transport for London (TfL) for their time and support in the creation of this method.

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Hot Routes: PURPOSE & THEORY (2 of 5)

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PURPOSE: Identifying where crime concentrates is one of the the principle aims of crime analysis. However, the spatial analysis techniques commonly used to identify 'hot spots' of crime typically assume that crime can occur anywhere in a study area and ignore the effect that the built environment has on the spatial distribution of crime. As some crimes are particularly constrained by networks (e.g. street robbery by the street network, bus crime by the transport network) it is important that there are appropriate analytical methods available to capture such linear concentrations.

Hot Routes was devised to be a straightforward spatial technique that analyses crime patterns that are associated with a linear network (e.g. streets and other transportation networks). It allows an analyst to map crime concentrations along different segments of the network and visualise this through colour. It is deliberately simple, meaning that an analyst just needs access to a regular GIS package and suitable data sets. More sophisticated tools are available[1], but access to them is usually limited by police IT systems protocols on installing software.

THEORY: According to crime pattern theory, the distribution of crime largely depends on how victims and offenders converge in space. In an urban environment an individual's 'activity space' is defined by streets and transport networks called 'paths' along which they travel to 'nodes' where they live, work, or engage in leisure activities. Crime tends to concentrate at the nodes and along the paths that connect them when the routine activities of individuals provide a regular supply of suitable targets for offenders. Certain shopping malls, transport hubs and streets become 'crime generators' because they attract large numbers of people, and therefore multiple opportunities to commit crime. Since streets and transport networks constrain the routine movements of individuals and their encounters with offenders, they strongly influence the spatial distribution of crime.

Crime pattern theory, and the crime concentration patterns predicted by it, is supported by an impressive body of research. A universal finding has been that a large proportion of crime occurs at a very small number of places. For example, one recent study reported that half of all crime in Seattle each year occurs on just 5-6% of the city's street segments. The same Seattle study found that crime was also relatively stable over space and time (over the sixteen year data period). There was also considerable street-to-street variability in levels of crime around Seattle. Some street segments with high crime were surrounded by streets that recorded little or no crime.

The knowledge that crime concentrates along certain street segments, remains stable over time, and occurs in discrete areas has had a profound effect on policing practice. 'Hotspots policing', which increases police presence at identified hotspot area, has the potential to significantly reduce crime in the short- to medium-term. Robust trials of such policing tactics have returned favourable results. For example in Philadelphia during the summer of 2009 it was found that violent crime in the targeted areas reduced by 23% (relative to control areas) when directed police patrolling was done for three months. Similar policing practices have been trialled on London Underground's 'hot' platforms with a 21% overall reduction in crime and calls-for-service compared with the control platforms.

[1] In free software packages such as SANET (Spatial Analysis on a NETwork) and GeoDaNet

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Hot Routes: METHOD (3 of 5)

Author: Henry Partridge, UCL Department of Security and Crime Science

Hot Routes is a spatial technique that analyses crime patterns that are associated with a network. It allows an analyst to map crime concentrations along different segments of that network and uses colour and line-width to visualise the results (known as thematic mapping).

Two data files are needed for the analysis: a) point-level crime data which are geocoded to a high level of spatial resolution, and b) a network layer (e.g. in the UK this might be Ordnance Survey's Mastermap Integrated Transport Network (ITN), elsewhere it could be a street network file).

ANALYTICAL PROCESS: The following steps outline the analytical process that needs to be followed to produce a Hot Routes map. Useful tools from two of the most prominent GIS packages (in the UK) are included below each step. Other GIS's can be used but may require different tools.

1. *Preparing the network layer*: network layers (such as Ordnance Survey's ITN) typically contain streets of unequal length. Long street segments are statistically more likely to record more crime events because of their length, than shorter ones. The Hot Routes method adopts a crime per metre measure (see step 4) which controls for this. However a large denominator - in this case length in metres - may dilute the incidence of crime recorded on long street segments. Similarly, a short street segment will be at higher risk of crime, despite recording a low count, because of the small denominator (street length) used.

   It is advisable to use equal length street segments, where possible, or a histogram to identify street segments that are significantly different from the mean street length (e.g. 2 standard deviations). Street segments that are unusually long or short can be split or combined with neighbouring segments.

   MapInfo: MapCAD tools **ArcGIS: Network Analyst tools**

2. *Linking crime events to street segments:* crime events like street robbery will normally be geocoded to the nearest property address rather than the actual location where it occurred, namely the street. In this step, each crime event needs to be linked to the nearest street segment and the attribute table of the network layer updated with the corresponding count of crime.

   MapInfo: nearest statement in MapBasic **ArcGIS: Analysis tools > Proximity > Near**

3. *Calculating a rate:* the length of each street segment will typically be included in the attribute table of a network layer. However, if you have split or combined street segments that were identified as outliers the revised lengths will need to be calculated. Next, a new column needs to be created in the network layer to record a crime per metre score. This is calculated by dividing the number of crimes linked to a street segment by its length. For example, if an event occurred on a 10 metre long street segment, then the crime rate per metre would be calculated as 0.1.

   MapInfo: use objectlen(obj,"m") **ArcGIS: Calculate Geometry tool**

4. *Visualising the results:* The final step is to thematically shade each street segment with a colour (and line thickness if desired) that corresponds to the range of the rate of crime per metre.

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Hot Routes: CASE STUDY (4 of 5)

Author: Henry Partridge, UCL Department of Security and Crime Science

APPLICATION: To date, the Hot Routes method has been applied to study crimes and incidents on the transport network in London, to examine road traffic collisions involving cyclists, and in analysis on theft from motor vehicle offences. Here we illustrate the technique using two examples.

STREET CRIME: Figure 1 shows the distribution of street crime in an urban area using simulated crime data. The street segments are of varying length so an intensity measure has been used which divides the count of crime on each street segment by its length (metres).

It is clear from this map that crime concentrates along certain street segments which tend to cluster in the south western corner of the study area. The ability to identify such concentrations of crime allows limited police resources to be efficiently targeted in areas that need it most.

Figure 1: The distribution of street crime in an urban area

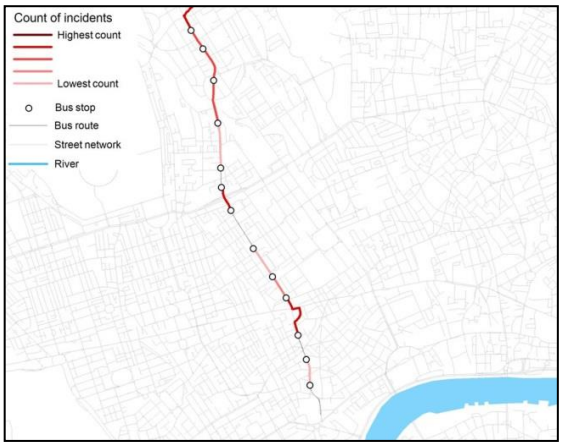

Figure 2: The distribution of driver reports of disturbance along a section of bus route

ANTI-SOCIAL BEHAVIOUR ON A BUS: Figure 2 shows the distribution of driver reports of disturbance along a section of bus route. The bus route has been divided into segments that correspond to the spacing between bus stops but it could be split by administrative boundaries, like census output areas or administrative geography, to facilitate comparison with surrounding crime levels or socio-demographic characteristics. This map shows particular sections of the route at greater risk of disturbances, allowing transport police to target their activities to these precise segments of the bus route.

DEVELOPMENTS: Accounting for the population at risk allows the risk of victimisation to be assessed more precisely. For this reason, the original Hot Routes method has been developed to use an alternative denominator to control for passenger numbers. Other denominators (for example the frequency of buses) can also be used *in addition of* the length of the network segment to estimate the risk more precisely.

It is anticipated that Hot Routes will be integrated with other network-related spatial analysis techniques in the future. In the meantime, complementary analysis is often done alongside Hot Routes. Investigating changes by time of day and day of week on the routes in question are very important before police resources can be directed to the right times and places.

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Hot Routes: RESOURCES (5 of 5)

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GENERAL RESOURCES

- Network spatial analysis software:

  SANET: http://sanet.csis.u-tokyo.ac.jp

  GeoDaNet: https://geodacenter.asu.edu/software

A SELECTION OF ACADEMIC PAPERS AND BOOK CHAPTERS

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