N8 POLICING RESEARCH PARTNERSHIP

Exploring Analytics for Crime Reduction Resource Allocation

Amidst a climate of increasingly diverse demands and restricted resources, predictive data analytics are often touted as a transformative technology for policing. Yet, the effectiveness of these techniques to local crime problems and resourcing realities can be difficult to ascertain without significant investment into proprietary technologies. This project aimed to develop software to allow police to assess the potential effectiveness of prospective crime mapping analytics – *software that seek to prospectively identify future locations of increased crime risk to support resource allocation decision making*.

KEY FINDINGS

- **The sharing of geospatially referenced crime data between police and a university, in the context of GDPR, is complex and time-consuming, requiring technical skill, infrastructure and appropriate governance. To better realise academe-practice knowledge exchange in policing data analytics, robust and agile protocols for data sharing between police and academic institutions need to be developed.**
- **Significant advances in the development of prospective crime mapping analytics can be made by utilising publicly available data, but evaluations of effectiveness ultimately require access to police held datasets.**
- **Prospective crime mapping analytics have the potential to provide 'time-poor' police analysts with access to cutting edge science. However, their operational utility will ultimately be contingent on close collaboration between academics and police.**
- **Current resourcing realities dictate that prospective crime mapping analytics may best be used to inform the targeted delivery of non-patrol interventions, such as situational crime prevention measures, or identifying problem areas that warrant further detailed problem-oriented analyses.**
- **To this end, software developed in the project will be trialled in two multi-agency situational crime prevention projects submitted to the Home Office Safer Streets Program by Durham Constabulary (outcome pending July 2020).**
- **Software tools developed during this project are to be made publicly available for use by other police services.**
- **Reflecting current harm-focused approaches, future research should assess the effectiveness of analytics that combine and weight forecasts of multiple offence types based on measures of harm.**

THE RESEARCH

Research was conducted by a team from the University of Leeds (UoL) working in collaboration with police and partners in Durham Constabulary. The UoL team was led by Dr Daniel Birks, Professor Graham Farrell, and Professor Nick Malleson, plus technical and legal support at UoL. The Durham team consisted of DCI Lee Gosling (Durham Constabulary), Stephanie Kilili (Office of the Durham Police and Crime Commissioner) and Durham Constabulary Intelligence Analysts Gary Pearson and Angela Lau with support from varying technical, legal and operational staff. Software development was undertaken by Dustin Foley who was employed as Research Fellow at UoL.

PROJECT BACKGROUND

Threat, risk, harm and vulnerability are not distributed evenly across jurisdictions – with some locations, at some times - experiencing more significant problems than others. In response, police demand and the subsequent allocation of resources that seek to respond to and prevent these problems is not uniform across communities. Over the last two decades rapid increases in the quantity and quality of data collected by police, and the ICT capacity to analyse them, have led to the development of a range of data analytics designed to support day-to-day service delivery in such complex environments. However, the effectiveness of this concept (and individual tools) has been subject to limited research. In response, this project sought to develop software tools to allow police services to evaluate the potential effectiveness of prospective crime mapping analytics to local problems in their jurisdiction without significant financial investment or organisational change.

RESEARCH FINDINGS

Research has consistently shown that crime is not uniformly distributed in space or time. In particular, patterns of several high-volume offences, including burglary and vehicle crime, have been shown to concentrate spatio-temporally in many westernised nations. This means that when a crime occurs the risk that a further crime will occur nearby within a relatively short time period is elevated. Drawing on repeat victimisation literatures, this spatio-temporal clustering has been labelled the 'near-repeat' phenomena. The presence of near-repeats has (at least) one direct implication for crime reduction – *that previous victimisation might be effectively used to forecast the risk of future victimisation*. And, by extension, may offer means to increase the efficiency and effectiveness of crime reduction resource deployment strategies. Such strategies may take several forms but have historically involved the allocation of police patrol or other agency resources to areas deemed at an increased risk in the immediate future - with the aim of preventing or detecting future victimisation. It is this key premise that underlies a range of prospective mapping analytics described both within the academic literature and in more recent years offered by an array of private sector software providers.

While police agencies are understandably interested in how such analytics might support operational policing there remain significant challenges regarding how they best go about evaluating them in their own jurisdiction. Software developed by academics to explore the effectiveness of such techniques is often designed for scientific and not operational purposes. Moreover, where operational solutions are provided to police they are typically specific to crime recording systems of a particular police service. At the same time, analytics provided by private sector software providers are understandably expensive and can require significant organisational investment to incorporate into day-to-day policing, often without prior independent evaluations of potential effectiveness. In addition, while often based on academic research, the algorithms that underpin private sector solutions remain 'closed source' – meaning that they cannot be readily scrutinised.

In context, these challenges are significant given that despite promising results, research has generally concluded that there is, as yet, insufficient evidence to draw robust conclusions about the efficacy of predictive policing tools or the effectiveness of operational tactics they inform. In an attempt to help address these challenges, working in collaboration with Durham Constabulary, this study developed a data analytics software suite for prospective crime mapping analytics – designed to serve four interlinked purposes:

- To analyse the degree to which particular volume crimes exhibited spatio-temporal structure – that is, how predictable particular crime patterns may be;

- To establish the degree to which this patterning is consistent over time and area;
- To assess, using historic data, the potential effectiveness (in terms of predictive accuracy) of prospective algorithms harnessing these patterns to forecast future crime risk and benchmark these results against existing retrospective methods used by police intelligence analysts.
- To – through coproduction - build prototype software that could be trialled operationally to support crime reduction resource allocation decisions – through, traditional tasking and co-ordinating, problem-oriented analyses and other potential targeted responses.

For a period of 12 months of close collaboration, the research team developed a range of software products to accomplish these goals. The project and software development process resulted in several key learnings. First, software that are to be used in operational settings need to reflect the needs, data infrastructure and workflows, and expertise of existing police analysts. This requires a sustained dialogue between academic and police partners and the ability to rapidly iterate solutions in response to feedback.

Second, due to the significant challenges associated with setting up data sharing between police and the University, all software development conducted throughout the project used publicly available recorded crime data. While this data was sufficient to develop and test software tools in terms of their functionality, further research will need to be undertaken to formally evaluate the effectiveness of prospective crime mapping analytics within Durham and other police services – the tools have been built, their application to police held datasets will allow police to begin answering the substantive question regarding the benefits (or otherwise) to be realised from prospective crime mapping analytics.

Third, reflecting on their use in modern operational settings, prospective crime mapping analytics have traditionally been applied to low-harm high-volume offences such as burglary and car crime (this approach is self-evident as these offences often demonstrate space-time clustering). However, in recent years relative reductions in police resources and increases in quantity and complexity of demand have led to harm-focused approaches to resource allocation becoming increasingly prominent – whereby resources are often targeted on the basis of potential harm rather than absolute numbers of offences. Consequently, if prospective mapping analytics are to support modern police decision making at least two options should be considered: (1) that methods forecasting the risk associated with low-harm high-volume offences are used to target non-patrol or other agency crime reduction resources (e.g. situational interventions) which have less impact on resourcing and a potentially longer preventative 'half-life'. To this end, we plan to trial the tools devised in this project to target situational crime prevention interventions as part of two projects proposed to the Home Office Safer Streets programme; (2) that models be developed to incorporate multiple high volume offences and combine forecasts to prospectively identify areas likely to experience the greatest levels of cumulative harm across multiple types of offending in the near future. Prototypes of these 'prospective harm mapping analytics' were developed during the project but further evaluation of their potential effectiveness and compatibility with resource allocation models is required.

CONCLUSION

Data science is increasingly leveraged by private and public sector agencies in a hope to positively influence the evidence base of future decision making. In collaboration with police practitioners, this project was able to build a suite of flexible software tools which will allow researchers and police intelligence analysts to estimate the potential gains to be derived from prospective crime mapping analytics over traditional methods.

Importantly, these software allow such evaluations to take place without significant investment in proprietary technology, and where underlying algorithms are open to examination, scrutiny and critique. In addition, the project developed prototype prospective crime mapping application that, where appropriate, could be deployed for testing in an operational policing environment.

METHODOLOGY

All software were developed using the Python development language and a range of relevant mathematical, statistical and geospatial libraries. Software rely on a dataset containing the type, location (expressed as a grid reference) and (from/to) date-time of offences occurring within a given region. Software using methods from spatial epidemiology was developed to allow quantification of the space-time clustering in a dataset. This approach measures the distance (in space and time) between all pairs of crime events and compares observed clustering to that expected by chance, producing measures of statistical significance and space and time bandwidths over which clustering occurs. The latter are then used to calibrate risk forecasting tools. Prior to this however, software was developed to automate this space-time structure analysis over large quantities of historic data, measuring and visualising how consistent such clustering is over both region and time period – this is necessary to assess where and when model parameters should be recalculated. Subsequently, software was developed to assess the predictive accuracy (the proportion of future crimes correctly classified in high risk areas by the prediction algorithm) of a series of prospective crime mapping analytics, comparing these to traditional retrospective crime mapping techniques. This was done by constructing a hindcasting software tool – a method of testing a mathematical model by using historic data to assess the effectiveness of the model in predicting known outcomes. Finally, to explore the operational logistics of utilising such analytics to support police decision making, a prototype decision support tool was developed which allows police analysts to generate risk forecasts from current data systems and display them on a fully interactive street map of their jurisdiction.

IMPLICATIONS FOR FURTHER RESEARCH

This project represents the first step in an ongoing collaboration between the University of Leeds and Durham Constabulary. Consequently, a range of avenues of further research are envisaged. First, given the significant challenges faced with data sharing, robust and agile data sharing agreements, and the University IT infrastructure required to support them, need to be developed to support this and other crime data analytics projects. With regards to the project at hand, prototype 'prospective harm mapping analytics' were developed, further research should assess their potential effectiveness and operational suitability. Research should also explore incorporating measures of resource availability into prospective analytics – with the hope of better reflecting the dynamic nature of police resource allocation. Finally, while this project has focused on providing police with technology to assess potential effectiveness of prospective analytics, equal efforts should be made in assessing the actual effectiveness and implications of varying crime interventions allocated to locations forecast to be at increased risk. A range of options exist – including traditional police patrol, situational prevention measures, and directing further problem-oriented analyses. This holistic approach to policing data analytics is necessary and will require close collaboration and knowledge exchange between both academics and practitioners to ensure an informed understanding of the strengths and weaknesses of analytics, the data which underpins them, and the operational behaviours they hope to inform.