Modelling serial offenders' spatial behaviours: new assumptions for geographic profiling

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Abstract

The geographic profiling is a methodology of investigation which uses the crime sites of a criminal series in order to delineate prior areas for searching the offender. Its implementation is currently limited by too simplistic assumptions that are difficult to assess during an investigation or even not corroborated at an individual level of observation. This thesis studies the predictive capacities of geographic profiling in the context of Belgium, a dense country where the road network is not suitable for classical algorithm implemented with Euclidean or Manhattan distances. More precisely, the thesis has for first objective to integrate space anisotropy with two improvements: (1) the integration of the road network in the journey-to-crime and (2) the integration of the structure of opportunities for series of sexual offences. Beyond this objective, the thesis questions a hypothesis underlying this type of research methodology: the kind of spatial relationship between the offender's residence and the crime sites. An alternative to the distance decay effect is developed, minimising the variance in travelled distances between the offender anchor point and the initial contact sites of the offences (MOV hypothesis). The sensitivity of this methodology is measured and its effectiveness is compared to the one of the distance decay effect.

A major result of the thesis is that the share of behaviours than can be modelled by this new hypothesis is similar to the one of the distance decay effect. However, a large number of series did not meet the required conditions to implement an efficient methodology given the multiplicity of offender's residences or the scarcity of sites composing the series; those applicability criteria are analysed in this work. Nevertheless, the MOV hypothesis is particularly valuable for long series of offences. Then, the thesis analyses the impact of the geometry of crime series locations on the effectiveness of the chosen spatial assumption (distance decay effect or MOV) with graph theory. It highlights the superiority of the MOV hypothesis for offenders travelling in some preferred direction. The analysis also shows that both hypotheses are not mutually exclusive but can be combined to build offender geographic profiles.

Finally, this thesis focuses on the modelling of neutral areas in terms of criminal attractiveness on the Belgian territory. The work presents the originality of analysing data on a whole country, integrating both urban and non-urban areas. The objective of the modelling is the integration of the opportunity structure of sexual offences in the geographic profile and the estimation of the perturbing effect of a differentiated attractiveness. In order to assess this perturbation, we propose a two-steps process. Firstly, a regression model combining factors from the crime pattern and social disorganisation theories models the spatial distribution of crimes. The regression model identifies a centre-periphery relationship in the spatial distribution of crime locations. Still, the model underestimates the number of positive sectors, omitting some attractors. Then, the impact of attractive location (i.e. presenting the favourable factors for crime concentration)

is evaluated for the series of sexual offences.

In fine, the two spatial hypotheses do not seem affected by the attractors identified by the modelling except when the contact sites are clustered in attractive areas. In addition, the share of serial offenders committing their offences in the most attractive locations is smaller than that of single offenders. This observation strengthens the need for working on spatial distribution models instead of calibrated functions with solved cases.

Résumé

Le profilage géographique est une méthodologie d'investigation qui utilise la localisation d'une série d'agressions pour identifier des zones prioritaires de recherche de l'agresseur. Son implémentation reste toutefois conditionnée par un nombre d'hypothèses trop simplifiées, difficiles à évaluer au cours d'une investigation ou encore non vérifiées à un niveau individuel d'observation. Cette thèse apporte une réflexion sur les capacités prédictives du profilage géographique dans le contexte de la Belgique, dont le réseau routier ne se prête pas aux algorithmes classiques d'investigation. Plus particulièrement, cette thèse a pour premier objectif de mieux intégrer l'anisotropie de l'espace au travers deux améliorations : (1) la prise en compte du réseau routier dans le « journey-to-crime » et (2) l'intégration de la structure d'opportunité pour des faits sériels d'agressions sexuelles. Au-delà de cet objectif, la thèse questionne une hypothèse sous-jacente au développement de ce type de méthodologie de recherche : le type de relation spatiale existant entre la résidence de l'agresseur et ses sites de crime.

Une alternative à l'effet de décroissance avec la distance est développée, exploitant la variance des distances entre le point d'ancrage et le site de contact du crime. La sensibilité de cette méthodologie est évaluée et son efficacité est comparée à celle de l'effet de décroissance avec la distance. Un résultat majeur de cette thèse est que la proportion de comportements modélisables par l'hypothèse de minimisation de la variance est similaire à l'hypothèse de décroissance avec la distance. Toutefois, un grand nombre de séries n'entrent pas dans les conditions requises pour implémenter une méthode efficace étant donné la multiplicité des résidences de l'agresseur ou le nombre restreint de faits ; ces critères d'applicabilité sont analysés ici. L'hypothèse de minimisation de la variance apparaît cependant comme prometteuse pour les longues séries de faits.

La thèse analyse ensuite l'impact de la géométrie des lieux de crimes sur l'efficacité de l'hypothèse spatiale choisie (décroissance avec la distance ou minimisation de la variance) en utilisant la théorie des graphes. Elle met en évidence l'intérêt de la minimisation de la variance lorsque l'agresseur voyage avec une direction préférentielle. Cette analyse met également en exergue que les deux hypothèses spatiales ne sont pas exclusives mais peuvent être combinées pour établir le profil géographique de l'agresseur.

Enfin, ce travail s'intéresse à la modélisation des zones neutres en termes d'attractivité criminelle sur le territoire belge. Il présente l'originalité de modéliser la distribution spatiale des crimes pour un pays entier, intégrant des zones urbaines et non urbaines. L'objectif poursuivi par cette modélisation est d'intégrer la structure d'opportunité des agressions sexuelles dans le profil géographique et d'estimer si chacune des hypothèses spatiales est perturbée par une attractivité différentielle des sites de crime. Cette possible perturbation est évaluée en deux

temps. Premièrement, un modèle de régression combinant des facteurs issus de la théorie des patterns criminels et de la désorganisation sociale modélise la distribution spatiale des crimes. Ensuite, l'impact des zones dites « attractives » (c'est-à-dire présentant les facteurs favorables à la concentration de crimes) est évalué pour les séries d'agression sexuelles. Le modèle identifie une relation centre-périphérie dans l'organisation spatiale des concentrations de crime. Le modèle sous-estime le nombre de secteurs non nuls, n'identifiant pas certains attracteurs.

In fine, il ressort que les deux hypothèses spatiales ne semblent pas perturbées par les attracteurs identifiés par la modélisation, excepté lorsque l'ensemble des faits de la série sont regroupés dans des zones attractives. De plus, la proportion de faits appartenant à des séries commises dans les zones attractives est plus faible que pour les agresseurs non-sériels. Cette observation renforce l'intérêt de travailler sur les modèles de distribution spatiale plutôt que sur une calibration de faits résolus.

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