Paper 1. Urban Crime Risk Prediction Using Point of Interest Data

The paper being reviewed is Cichosz (2020)

Purpose, problem, objective

The objective is clear; to create and assess machine learning (ML) models to predict urban crime using Point Of Interest (POI) data mapped to 300 x 300 metre geographic areas. This appears to be a new study and so would contribute to the collective body of knowledge in the field of crime prediction, although there are similar studies that the author mentions.

Research methodology

The research methodology is broadly sound, but with some issues.

The author has performed a literature review to check for similar published work and reported on related works which are similar but not identical. It appears that some are VERY similar though, with key differences being:

1. This study covers four geographic areas and the other studies typically covered one. On it's own this might be a weak argument for novelty, except that one test in the paper is to see how a model trained in one area could be used to predict in another, which is indeed novel.
2. This paper used a broader range of POI categories than previous papers, which might be helpful for practical implementation e.g. informing policing activities.
3. Other "differences" mainly pertained to the machine learning training methods used such as how class imbalances were handled and the effects of dimensionality reduction, which I feel isn't enough of a distinction to be considered "new work".

Data collection and analysis

The data used was robust and thorough. Crime data was collected from data.police,uk, geographic boundary data was taken from ordancesurvey.co.uk and POI data was sourced from geofabril.de, all publicly available with no obvious ethical concerns about their use. The data was combined and grids of 300x300 metre boxes were mapped to each of the four areas. Feature selection was also performed to optimise the models.

In building the ML models, the author chose to take sample data and build a selection of models that are compared to see which has the best results. The models are well described and they all performed well. However, there is a concern about how they are compared:

- When comparing the models the p-value for the (AUC) of one model performing better than another was calculated and tabulated to show which models performance better than others at the 99% confidence level. That gave some largely expected results such as Support Vector Machine (SVM) performing better than Decision Tree (DT). But the scale the difference was not adequately discussed (it was presented in the charts). For example, SVM performs better than DT, but the computational cost of SVM is significantly higher than DT, and the explainability is significantly lower, so if SVM was only marginally better it might still be preferable to use DT due to the other benefits.

Strength of conclusions

The paper concludes that POI attributes are highly relevant for crime prediction, and this does appear to be strongly supported by the evidence in the paper. It is also claimed that such predictions might become necessary with policing under ever more resource constraints. However, this later point is not backed with evidence, and the models have no time proximity element, so having a list of criminal hotspots might be useful, but without any indication about when criminal activity might occur it is debatable how useful it would be in optimising policing activities.

Suggested enhancements

Future enhancement could include addressing some of the missing elements already identified, such as:

1. Including a compute overhead metric to get the best performance at the best compute cost.
2. Adding a time feature to predict when as well as where criminal activity might occur (this is noted as a future enhancement by the author themself).
3. Not previously mentioned: it would also be useful to experiment with different sized grid boxes other than 300 x 300 metres. Bigger boxes would likely produce more accurate results (taking it to the extreme, a box covering an entire city would predict with 100% certainty that a crime would be committed, but it would be useless as far as being as actionable insight). Smaller boxes would become less accurate, but potentially more useful to police. Finding the sweet spot would be useful.

References

Cichosz, P. (2020) Urban crime risk prediction using point of interest data. *ISPRS International Journal of Geo-Information*, 9(7): 459. DOI: https://doi.org/10.3390/ijgi9070459.

Paper 2. Empirical Analysis for Crime Prediction and Forecasting Using Machine Learning and Deep Learning Techniques

The paper being reviewed is Safat et al (2021).

Purpose, problem, objective

The objective of the paper is to improve upon the current crime prediction capabilities in Chicago and Los Angeles by implementing improved machine learning models.

Research methodology

The research methodology consists of a literature review to assess the current accuracy of various machine learning models to predict crime in Chicago and Los Angeles, including some high level methods used such as the inclusion in some studies of POI data, and notably the use of Autoregressive Integrated Moving Average (ARIMA) to include a time proximity element. It was all good background knowledge, but it failed to really describe why this paper was providing anything new and unique.

Data collection and analysis

The data collection and model development was very robust. The data preprocessing was described in detail, including removal of incomplete records. Different machine learning algorithms were described in a good amount of detail, as were their results, allowing conclusions to be drawn. As with paper 1, however, there was no consideration to the computational overhead alongside the actual results.

Strength of conclusions

The conclusions were questionable in a real-world sense. The models presented achieved the objective of being better than those that came before when using standard metrics such as F1-score, precision, recall and accuracy. However, the prediction was based upon district, and so is of questionable value to help with policing when compared to more localised models that was the subject of other papers in the literature review. So it is not clear if the models really are better when compared like-for-like with other models. Unlike in paper 1, however, the predictions did include a time element so there was an additional benefit there.

Suggested enhancements

An obvious next step would be to compare the models like-for-like, as already mentioned, to see if they really are better when predicting over similar geographical areas to previous models.

References

Safat, W., Asghar, S. & Gillani, S.A. (2021) Empirical analysis for crime prediction and forecasting using machine learning and deep learning techniques. *IEEE access, 9*: 70080-70094. DOI: https://doi.org/10.1109/ACCESS.2021.3078117.