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Predictive Policing in Germany

The subject of predictive policing has been very virulent in Germany since 2014. Currently different approaches are running in six federal states. Despite the many approaches, there is still no scientific report that grants a corresponding overview. The reason for the lack of such an overview lies in the fact that less official reports of the different approaches have been published.¹ In this article, we introduce the German idea of predictive policing and make a brief reference to the problem of the comparability of different solutions. After that we survey the existing solutions chosen by the federal states and their police authorities.²

Defining Predictive Policing in Germany

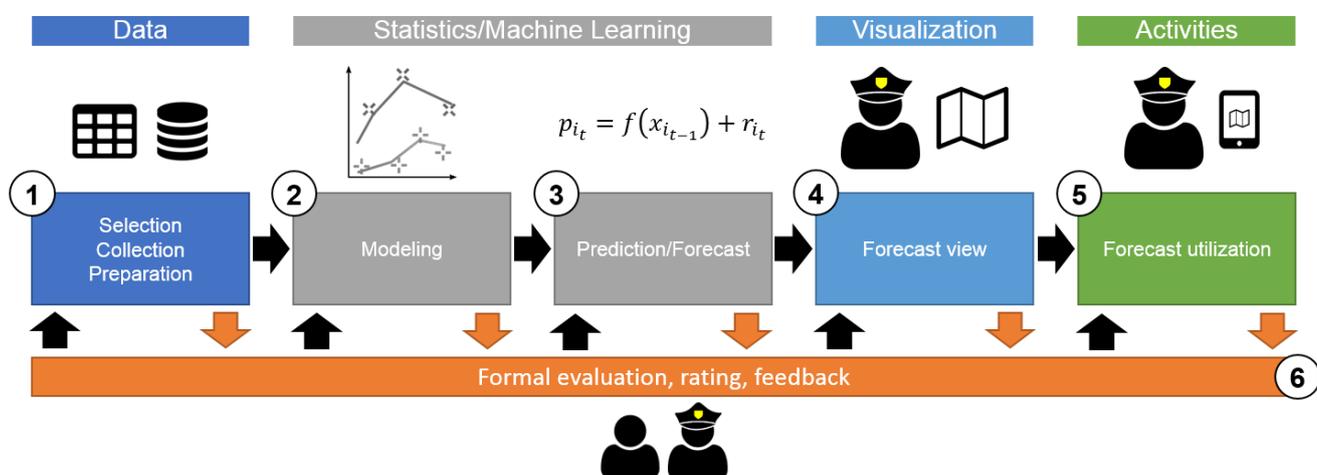
In science and practice, predictive policing is an ill-defined subject. Available definitions range from calculating the probability of future offenses to specific methods to investigate crimes already committed (e.g. Perry et al. 2013: 1f.). In Germany, police authorities agreed to use a common understanding and language regarding predictive

policing.³ Predictive policing is defined as a computer-assisted method for spatially based probability calculations of crime. The aim is to identify areas of risk in which suitable measurements are to be used to deal with future police actions. There is no focus on perpetrator or victim data and no personal data should be used.

Predictive policing as defined is composed of different, consecutive steps or components. A possible process is visualized in Figure 1.

All components of the process depend on the data to be processed, their collection and preparation for further processing. In evaluating predictive policing, data quality is crucial concerning data uncertainty. Data uncertainty refers to the problem that it is usually unknown to what extent errors are contained in the collected and utilized data. In this context data collection problems, e.g. measurement uncertainties, are conceivable, e. g. when recording the suspected time of a burglary. For data collection in the context of police forces, a

Figure 1: A depiction of a predictive policing process.



(Based on and translated from Bode et al. 2017: 2)

¹ In this context it is pointed out, that press releases and police reports are also used to illustrate the respective approach.

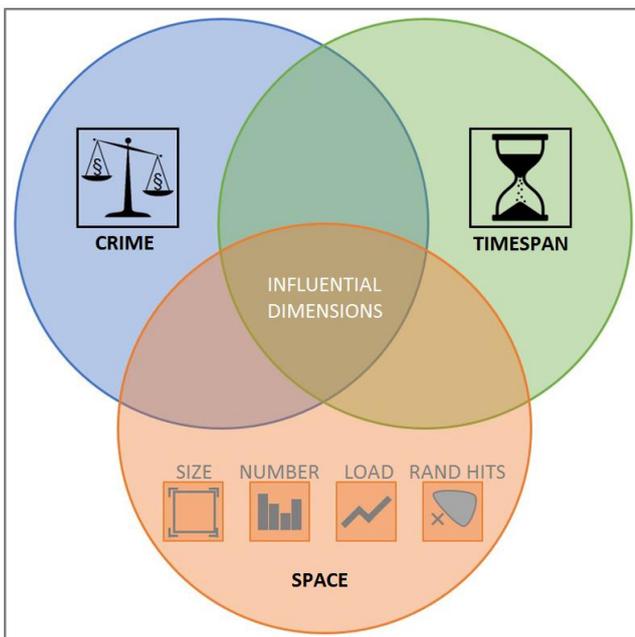
² We would like to thank Jana Becker for her contribution to the article.

³ The authors regularly participate in specialized predictive policing conferences and workshops with representatives of the federal states.

source of uncertainty is the fact that criminal offenses are either legally misjudged, or are reported late by the victims, which is not uncommon for the criminal charges of burglaries.

A general problem of predictive policing using automatic data analysis methods also affects their fundamental assumption that the offense is described sufficiently with the available data, e.g. space, time and local conditions. However, an objective description of a crime phenomenon is not entirely possible, especially if unobservable or unquantifiable effects, e.g. the non-public environment of a potential offender, are of importance. With the creation of crime predictions, the question arises whether the expected event has occurred, regardless of the criminological and mathematical models used. This article does not intend to compare the different models based on quality metrics like hit rates (HR), predictive accuracy indices (PAI), standardized accuracy efficiency indices (SAEI) or confusion matrices as such a comparison must be considered critically. There are three essential dimensions which influence the quality of the measurement: first, the offense (crime), second, the spatial dimension (space) and third, the temporal dimension (timespan), see Figure 2.

Figure 2: Fundamental influence dimensions.



(Based on and translated from Bode et al. 2017: 9)

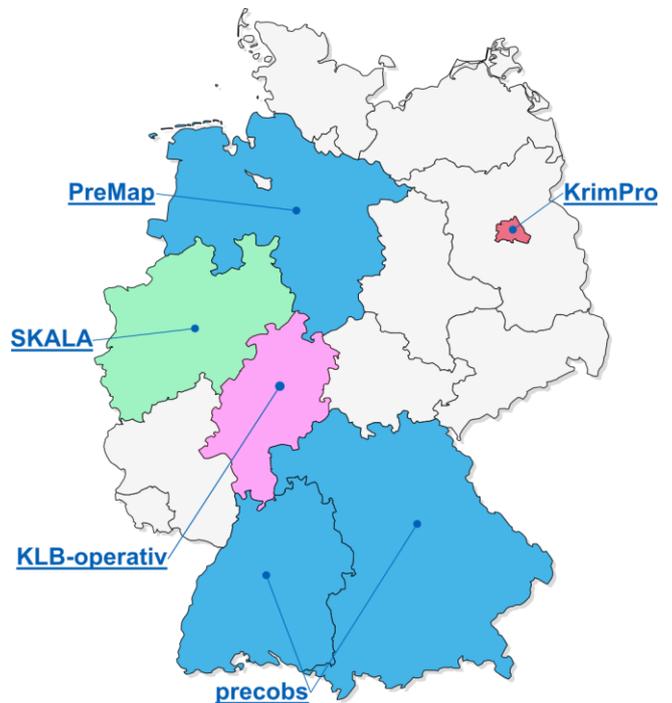
By including these dimensions into the quality metrics for predictive policing models it can be shown that corresponding results can be calculated very differently and thus a variability in these metrics is manifested inherently. This variability, in turn, affects the validity of the applied metrics

when trying to compare different models. Based on this finding, no valid statement can be made that one model is better than the other, or which model produces a “better” prediction (Bode et al. 2017).

Activities of the Federal States

Due to different jurisdictions caused by the German Federalism, there are various individual solutions in realizing predictive policing in Germany, which are based on the definition introduced above. The following map gives an overview of the different activities of the federal states:

Figure 3: Predictive policing activities of the federal states (August 2018).



precobs (Bavaria / Baden-Württemberg)

The Bavarian police has been dealing with the possibilities and methods of predictive policing for several years and has been the first police authority, which implemented a predictive policing solution in Germany. According to Egger (2015: 1) two questions were focused on:

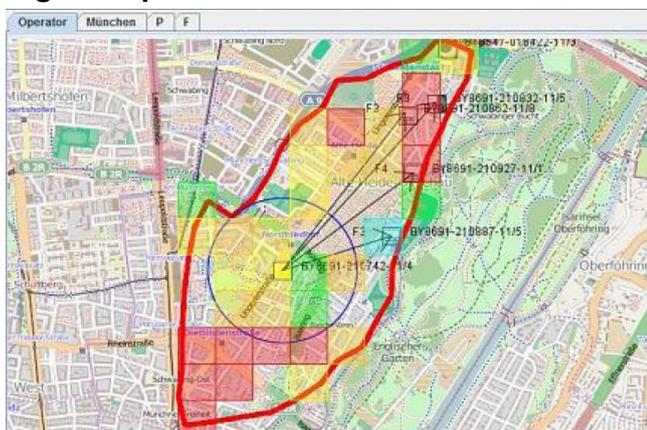
1. Is it possible to make forecasts of approaching offences?
2. Is it possible to use them to derive police measures to prevent or clarify criminal offenses?

Since 2014 the precobs software (Pre Crime Observation System) by IfmPt⁴ was tested and is regularly used in the Bavarian police headquarters in Munich, Middle Franconia and Nuremberg (Bayerisches Staatsministerium des Inneren, für Bau und Verkehr 2015). As a result, the Bavarian solution follows the near repeat approach. Through automated pattern-based detection of near repeats, an early-warning system has been established that provides daily information for the police about potentially occurring offenses, in particular domestic burglary. The computations are based on crime data only. Professional crime perpetrators are focused on due to their suspected increased pattern of offender behaviour. Local trained police analysts are able to appraise predictions to initiate and review the corresponding implementations in police measures. Preventive work of the police is focused on the most (Egger 2015: 2ff.).

Predictive policing with precobs is basically implemented with the following process:

At first, the criteria for the detection of repetitive offenses must be defined (so-called trigger criteria), e.g. based on the modus operandi, the locality or the acquired property. The second step consists of the calculation of areas in which the occurrence of near repeat data has been detected in retrograde analysis. Those areas, the so-called "observation areas", are the spatial foundation for the created predictions. Criteria and calculated areas are tested by retrograde simulation to see if the chosen assumptions are valid. After that predictions (alerts) are being created when a renewed trigger offense is recorded in these areas (Balogh 2016: 336 f.). The prediction is visualized in squares with 250x250m size and different colours symbolize the importance of the prediction (Troschka 2014: 4).

Figure 4: precobs illustration.



(RP Online 2016)

In Bavaria, the so-called "far repeat approach" is used in addition to analyse and visualize perpetrator movements across different regional areas (IfmPt 2017: 2). This approach is used to facilitate forecasts for rural areas. The reason for modeling far repeats lies in the fact that the near repeat phenomenon is not directly transferable to rural areas.

The federal state of Baden-Württemberg also implemented the precobs software by IfmPt since October 2015 in the cities of Stuttgart and Karlsruhe. Operative circles with 500m radius are used for the visualization of the predictions. The Max Planck Institute for Foreign and International Criminal Law (MPI) in Freiburg conducted an evaluation of precobs in the period of October 2015 to April 2016. The evaluation report has been published online (Gerstner 2017) and a second project phase is about to end in April 2019.

KrimPro (Berlin)

In January 2016 a project group was set up in the State Office of Criminal Investigations in Berlin which pursued the development of a predictive policing solution for domestic burglary (KrimPro) based on existing data and software. After half a year of development, which was occasionally supported or accompanied by Microsoft, a test run was performed in two bigger police precincts of Berlin (Der Polizeipräsident in Berlin 2016). Since October 2016, the prediction area was extended to the whole city of Berlin. The final test run ended in June 2017. Crime data is used for modeling and the computation of the predictions. In addition, socio-economic data, such as infrastructure data, is used. The predictions are calculated by dividing the city into squares with a size of 400x400m. The timespan of the prediction is set to three days (Graupner 2017).

Figure 5: KrimPro illustration.



(Polizei Berlin on twitter: 20.08.2016)

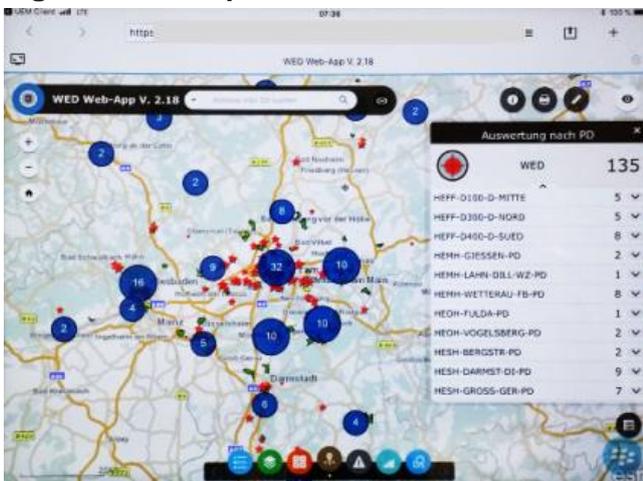
⁴ IfmPt: Institute for pattern-based Predictions (Institut für musterbasierte Prognosetechnik).

As a result of an internal evaluation, there was a noticeable decline in the number of domestic burglaries. The frequency of domestic burglaries in areas that have been predicted before was noticeably higher than the expected ratio without prediction (Heitmüller 2017). Due to promising first results, it was decided to continue the program with the aim to further improve individual facets.

KLB-operativ (Hessen)

The State Office of Criminal Investigations in Hessen tested the use of an in-house developed prediction technology to prevent domestic burglary. This solution is called KLB-operativ (Crime Situation Report - Operative). The aim of KLB-operativ is to provide optimized and more efficient strategic power for the police (Polizei Hessen 2017a). The first trial runs took place in the police authorities Wiesbaden, Main-Taunus, Hochtaunus, Main-Kinzig and Darmstadt-Dieburg (Heitmüller 2017). Since 2017, the prediction technology is executable via an app on smartphones and is available to every police officer in the state of Hessen. The app is updated each morning, mapping the recycled and valued domestic burglaries of the past ten days and highlighting daily hot spot areas. Structure and functions are similar to Google Maps or Bing Maps (Polizei Hessen 2017a). The method is based on the near repeat approach, using crime data for modeling and creating predictions (Polizei Hessen 2017b: 18). Furthermore, socio-economic census-data is used (Anbau 2016: 45). In addition, KLB-operativ enables the user to apply different filter and search functions, collect statistics and display suspicious perceptions on an interactive map (see Figure 6).

Figure 6: KLB-operativ illustration.



(Polizei Hessen 2017a)

PreMap (Lower Saxony)

After finishing a project for testing the method predictive policing in 2014, which was carried out together with the company IBM and the Karlsruhe Service Research Institute (Pistorius 2014), the police of Lower Saxony started the project PreMAP (Predictive Mobile Analytics for Police) in November 2016. Tests took place in Salzgitter, Peine, Wolfenbuettel, Wolfsburg, Hannover and Osnabruck (Hellerling 2017). It is focusing on to prevent crime and not to solve crimes or arrest suspects. In this context, studies suggest that police presence can be an appropriate way of responding to spatial risks (Pett/Gluba 2017: 329). Currently, PreMAP is focused on the prediction of domestic burglary. The prediction of further offenses is intended. The main theoretical basis is the near repeat victimization (Niedersächsisches Ministerium für Inneres und Sport 2017: 4). Mobility is one of the core areas of the project PreMAP. Predictions displayed on interactive maps are available on mobile terminals for the patrolling police services. It is possible to access background information regarding the domestic burglaries as well as location information about the area. The application can run on workstations as well. PreMAP is to be used successively throughout the whole state of Lower Saxony (Morchner 2018).

Figure 7: PreMap illustration.



(Niedersächsisches Ministerium für Inneres und Sport 2017: 6)

SKALA (North Rhine Westphalia)⁵

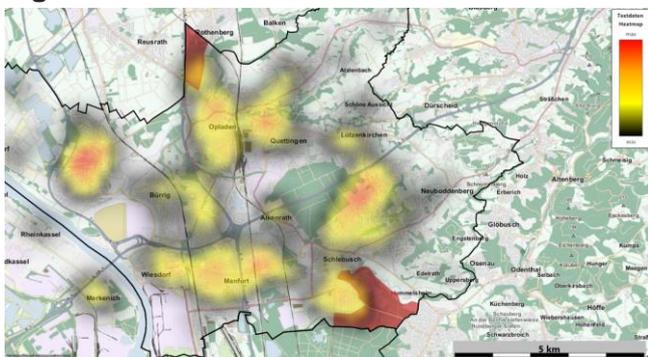
The State Office of Criminal Investigations in North Rhine Westphalia carried out the project SKALA (System for Crime Analysis and Anticipation) with six major police authorities (Bonn, Cologne, Dusseldorf, Duisburg, Essen, and Gelsenkirchen) in 2015. The project aimed to examine the possibilities and limitations of the prediction of crime and survey the efficiency and effectiveness

⁵ The final report of the project SKALA was mainly done with the cooperation of the authors of this article. For better readability, reference to the final report is only made in important places.

of corresponding police interventions. SKALA focuses on the prediction of crime risks using spatial data for each residential district in the police precincts. This approach ensures that crime predictions are made for the entire city and not just for a part of it.

SKALA uses a hypothesis-based approach that draws on criminological and socio-scientific theories, which have the potential to explain the spatial and temporal distribution of domestic burglary. According to the relevant indicators for each of the hypotheses, the corresponding data was obtained. The near repeat phenomenon is one influencing variable of many for the prediction modeling. North Rhine Westphalia uses crime data for modeling and computing the predictions. Additionally, socio-economic data is used, e. g. information on the residential location, construction or infrastructural connection. The IBM SPSS Modeler is used to do the modeling. With this data mining software, it is possible to relate different data sources to each other. Central to this is space and time-related integration and analysis. Many experiences in the field of scientific monitoring, analysis and evaluation were gained in the course of the project. Prediction models were adjusted constantly and tested in coordination with the pilot authorities.

Figure 8: SKALA illustration.⁶



(Landeskriminalamt NRW 2018a: 49)

As mentioned before, in North Rhine Westphalia the modeling is done for residential areas when predicting domestic burglary. These areas are based on the distribution of the official electoral districts and summarize on average 400 households with the highest possible homogeneity, where the size may vary. The residential districts, therefore, offer a level of analysis that is fine-grained, highly segmented, statistically stable and easy to visualize in maps (see Figure 8). The pre-

dition validity is set to one week for domestic burglary and two weeks for commercial burglary and vehicle theft. The prediction models and visualization options were developed in cooperation with the University of Konstanz and were constantly adapted during the course of the project.

An evaluation with external scientific advice by the Society for Innovative Social Research and Social Planning e.V. (GISS) helped to survey the project. The evaluation report has been published online (Landeskriminalamt NRW 2018b).

The project ended in February 2018. The final report has been published online (Landeskriminalamt NRW 2018a). Since then SKALA has been implemented in 16 major police departments and is currently the biggest predictive policing solution in Germany.

Summary and Conclusion

In this article, we surveyed the landscape of predictive policing implementations in Germany. We introduced the German idea of predictive policing that is the common ground for all the presented solutions. A number of in-house, commercial and commercially-assisted solutions exists that have all in common to support the police in their work to prevent crimes. We found that most of the solutions are predicated on the prediction of domestic burglary, although some prediction models already exist for other offenses or are due to be tested in the future. The theoretical basis of the modeling is mostly the near repeat phenomenon, which is well researched and also used in predictive policing solutions worldwide (Mohler et al. 2015), e.g. PredPol. The dynamics of the application field of predictive policing and the contributing techniques from the domain of data mining and visualization may lead to further contributions in the future.

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⁶ Maps © OpenStreetMap-Contributors, licensed under CC BY-

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