

[Position paper]

Multi-expert estimations of burglars' risk exposure and level of pre-crime preparation based on crime scene data

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Introduction

- This position paper describes the continuation of a previous study
 - M. Boldt, A. Borg, M. Svensson, J. Hildeby, “Predicting burglars' risk exposure and level of pre-crime preparation using crime scene data”, to appear in *Journal of Intelligent Data Analysis*, 22 (1), 2018.
- The work is carried out together with the Swedish police
 - More specifically the National offender profiler group in Stockholm
- This position paper describes the design of a study that is planned for 2017/18

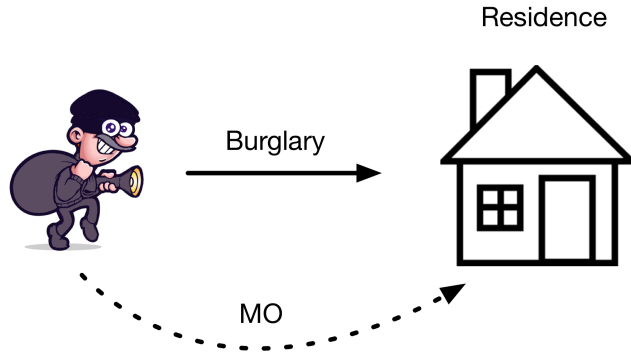
Background (i)

- Law enforcement agencies strive to combine crimes committed by the same offender(s) into crime series
 - Allows a more complete picture based on all information and evidence available from different crime scenes
 - More resource efficient
- Linking crimes into series could be done based on physical evidence, e.g. DNA or fingerprints
- However, such evidence is only present in a fraction of all crime scenes

Background (ii)

- With no physical evidence available linkage of crimes into series could rely on “soft” evidence in the form of the offender’s modus operandi (MO) instead
- MO is the offender’s habits, techniques and peculiarities of behavior when committing an offence
- Details recorded at crime scenes describe an offenders’ MO

Problem description (i)



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Problem description (ii)



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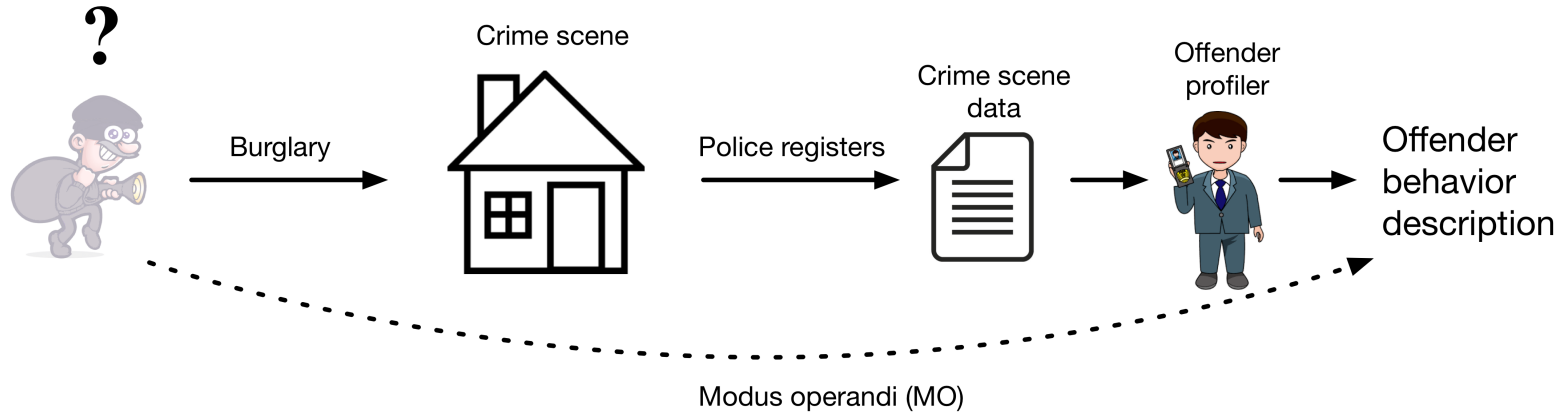
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Problem description (iii)



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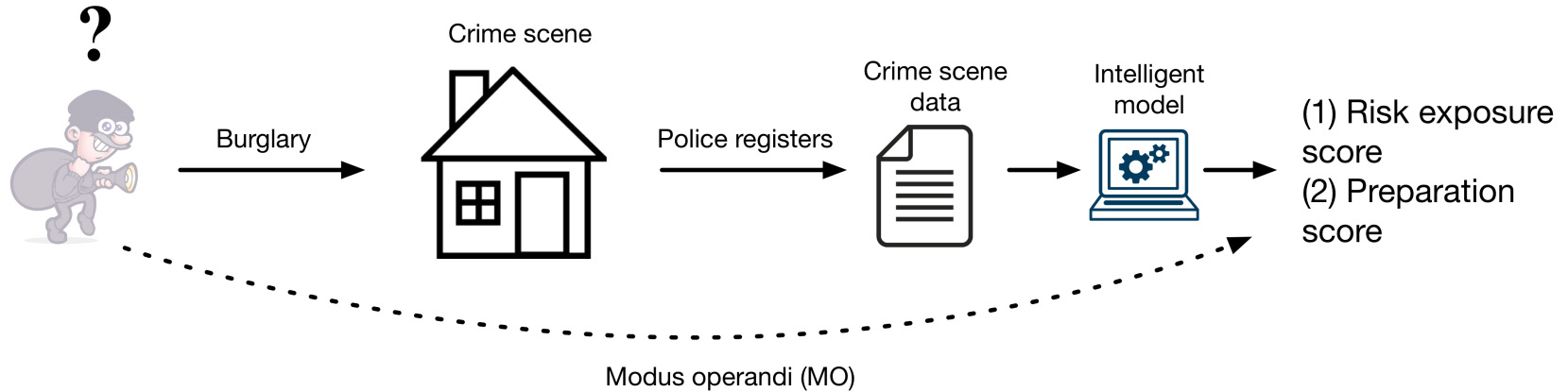
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Problem description (iv)

- Since volume crimes (e.g. various property thefts) occur in such great numbers it is not possible for profilers to manually analyze the crime scene data
 - Profilers are scarce resources that are needed for more serious crimes
- However, behavioral analyzes are very useful for volume crimes as well
 - E.g. to use as input when linking crimes into series
 - Crimes where the offender(s) has the same behavior could be considered for linking

Use of intelligent models



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Goal of the planned study

- Our goal is to investigate to what extent intelligent models can estimate offenders' behaviors w.r.t.:
 - Degree of risk exposure
 - Level of pre-crime preparation
- As crime profilers have different education, experience and domain knowledge it is interesting to investigate methods that generalize ratings from several profilers
- We will therefore investigate the use of a multi-expert decision making approach in order to mimic the decisions of several criminal profilers

Datasets to use

- Unlabeled crime scene data from ~20k residential burglaries in Sweden
 - Unlabeled as no ratings for the offenders' behaviors exists
- Labeled crime scene data for 150 residential burglaries
 - 4-6 profilers manually rate both offenders' risk exposure and preparation scores for each
- ~100 known series (including some ~400 burglaries) that are linked by a shared offender using physical evidence

Method (i)

- Labeled training data from the criminal profilers manual ratings of both offenders' risk exposure and preparation scores for 150 randomly sampled burglaries
- The profilers also rate the expertise they think the other profilers have, by assigning a weight to each one ($0 < W < 1$)
- Next, the multi-expert decision making method described by Tsiporkova and Boeva (2006) is used to produce consensus scores

Method (ii)

- Once the consensus scores are calculated a learning algorithm is used to train models
- The Naïve Bayes Multinomial algorithm showed best classification performance in the previous study so we will use that algorithm for learning the models
- 10-times 10-fold cross-validation will be used for evaluation purposes on the labelled data
- Evaluation metrics consists of: accuracy, precision, recall, F_1 -score, false positive-rate, and AUC

Method (iii)

- We will investigate the performance of models trained on consensus scores, i.e. from all 4-6 profilers, against individual models for each profiler
- Inter-rater agreement between profilers will be analyzed using Fleiss' *kappa* on the labeled data
- We will also analyze the approach on the unlabeled data by comparing score-consistency within the known linked series compared to randomly assigned series

Method (iv)

- An initial “workshop” together with the profilers will be carried out
 - Describe the task for the profilers
 - Discuss how to interpret crime scene data and how to rate the risk exposure and preparation scores
 - Allow the profilers start rating scores in order to get started
 - Have profilers grade the level of expertise for all profilers by assigning weights
- After the workshop the profilers rate the rest of the 150 burglaries on their own when they have time
- Once all 150 burglaries have been rated we can start calculating the consensus scores and evaluating the models performance

Method (v)

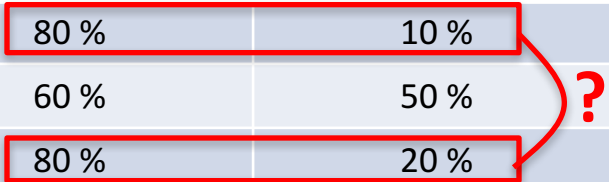
- If the results are positive and there is consistency in the scores within crime series, then the models would be highly interesting for the police
- For instance to use in the crime linkage process

	Offender's risk exposure score	Offender's pre-crime preparation score
Burglary 1	80 %	10 %
Burglary 2	60 %	50 %
Burglary 3	80 %	20 %
Burglary 4	20 %	70 %
...		

Method (v)

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Conclusions

- Evaluate whether models trained on either several profilers scores or individual profiler's scores shows best performance in estimating offender's MO behaviour
- Automated models could assist law enforcement agencies in the process of linking crimes using soft evidence

Thank you for listening

Questions?

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