Visual Social signals for shoplifting prediction

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Authors Background

- Shane Reid is a Machine learning Engineer for Allstate Northern Ireland, and a PhD candidate in Ulster University School of Computing, Engineering and Intelligent Systems. His primary research interests are in the area of affective computing, specifically in field of social signal processing.
- Professor Sonya Coleman is Cognitive Robotics team leader within the Intelligent Systems Research Centre. Sonya has publications primarily in image processing, robotics, computational intelligence and financial engineering. Her research has been supported by funding from various sources such as EPSRC, The Nuffield Foundation, The Leverhulme Trust and the European Commission. In 2009 she was awarded the Distinguished Research Fellowship by the Ulster University in recognition of her contribution research and she is currently secretary of the Irish Pattern Recognition and Classification Society.
- Dr Dermott Kerr is a member of the Cognitive Robotics research group within the Intelligent Systems Research Centre. Dermot's research and teaching interests are in the areas of visual neuroscience, biologically inspired image processing, mathematical image processing, feature detection, omni-directional vision and robotics.

Authors Background

- Dr Philip Vance is a member of the Cognitive Robotics research group within the Intelligent Systems Research Centre. His research and teaching interests are in the areas of assisted living, biologically inspired computer vision and robotics.
- Professor Siobhan O'Neill is a Professor of Mental Health Sciences at Ulster University, and Interim Mental Health Champion for Northern Ireland. Her research programs focus on trauma mental illness and suicidal behavior in Northern Ireland, and the transgenerational transmission of trauma.

Background

- Retail shoplifting cost UK retailers over £1 billion in 2018
- According to the British Retail Consortium, retailers in the UK spent over £1 billion on crime prevention in 2018, almost four times as much as was spent in 2014.
- Despite this, customer theft is on the rise

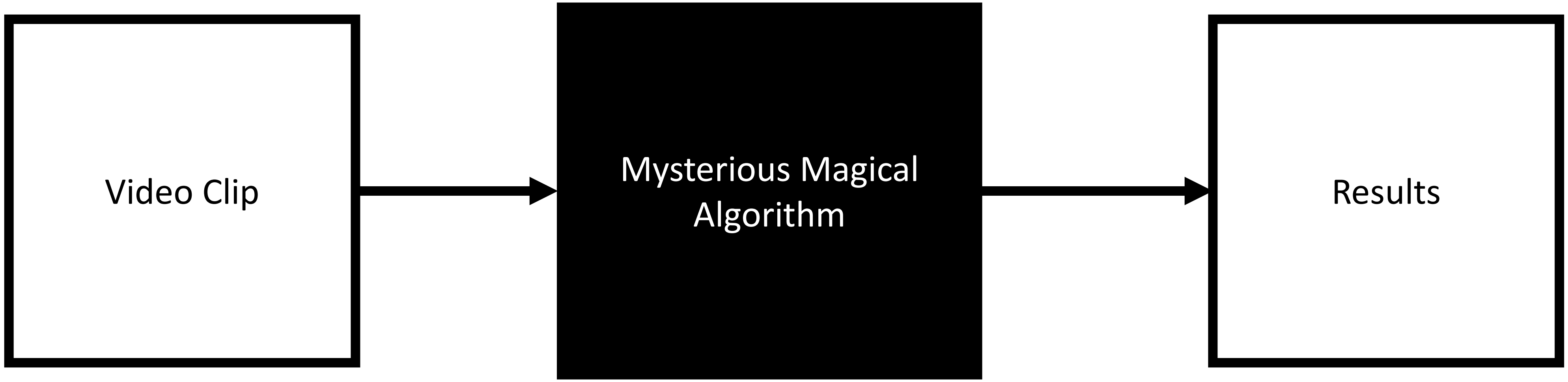
Surveillance Cameras

- The installation of CCTV cameras is one commonly used security method which is often employed by retailers to deter criminals.
- However, research has shown that unless footage is actively monitored, surveillance cameras will prove ineffective at preventing crime.
- Furthermore, research has show that thieves use several techniques in order to avoid detection.
- This makes it difficult for those who are monitoring the footage to detect potential shoplifters unless they are properly trained.
- This is compounded by the fact that those monitoring the footage will quickly become fatigued

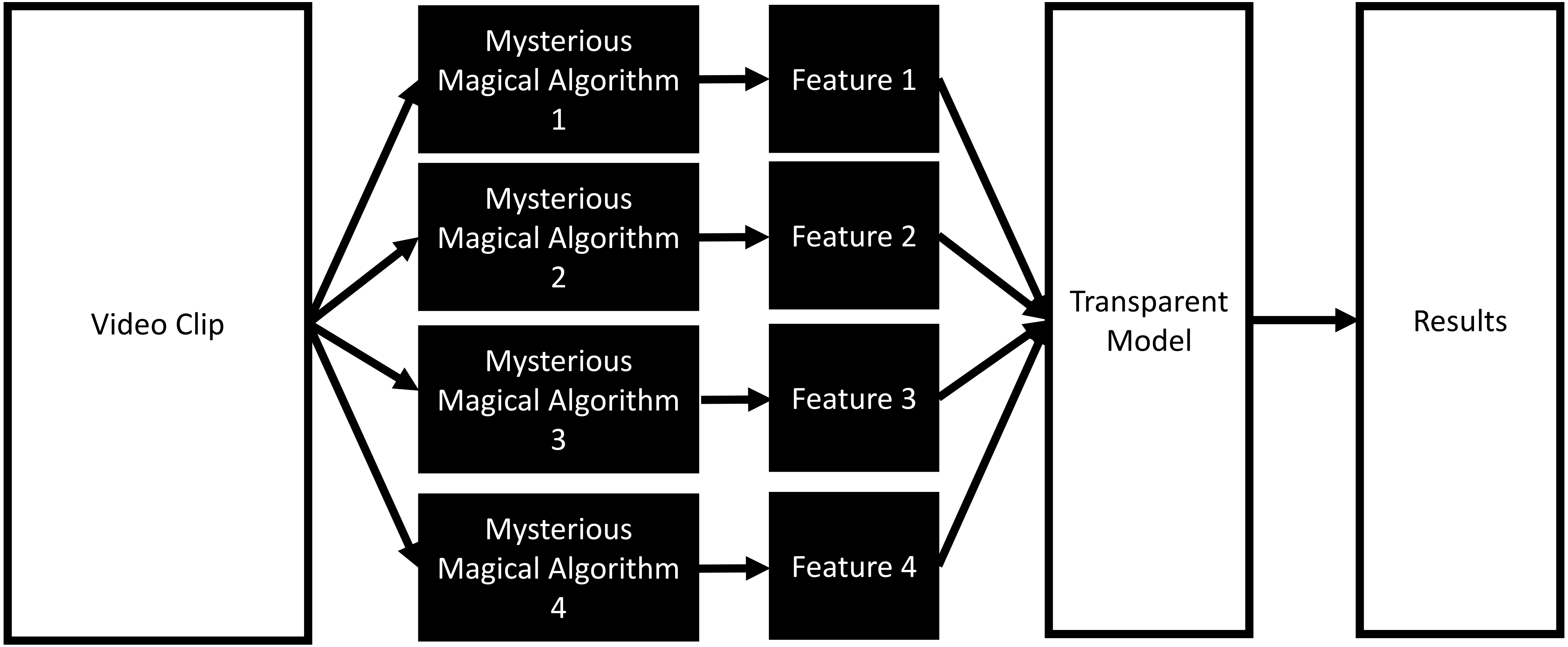
Automated Surveillance

- Previous work has aimed at the automated detection of suspicious individuals using black box methods trained using footage of an individual's behavior before they commit a crime.
- However, this type of approach throws up several ethical and humans rights concerns about bias, which may mean that this sort of evidence is inadmissible in a court of law.
- One possible solution is to use a social signals processing-based approach, where black box methods are used to detect specific features and attributes, which are then used to train a transparent model for automated detection.

Traditional Black box models



Social Signals Model



Social signals for automated shoplifting detection

- To this end we present a set of fifteen social signal attributes for the task of shoplifting prediction.
- These attributes based on the current literature, and verified through the use of a manually annotated dataset of social signal attributes taken from real shoplifting videos.

Shoplifting social signals

A. How many individuals are with them?
B. Are there staff members visible within the video?
C. What gender is the individual?
D. What gender is their accomplice?
E. Duration of time spent in the video?
F. Are they watching staff or other customers?
G. Do they exhibit avoidance behaviors ?
H. Is the shopkeeper distracted while they pick up an item?
I. Do they appear to hide what they are doing?

Shoplifting social signals

J. Do they place an item out of view either into their bag or into their pocket or else do they give an item to their accomplice?
K. Potential difficulty to steal item (Scale from 1-3)
L. Are they wearing a hood, baseball cap or some other clothing to hide their appearance?
M. Are they wearing baggy clothing or carrying a bag that could potentially conceal an item?
N. Do they pick up an item and appear to be interested in it?
O. Does the video show them interacting with staff before leaving the store?

Evaluation of attributes

- In order to evaluate the effectiveness of these social signal attributes for the problem of shoplifting prediction, it was necessary to develop a novel dataset.
- This was done by using videos from the UCF Crimes dataset.
- For each video, a human observer manually annotated whether or not they observed a particular attribute as listed above.
- For the control group we used the videos from the UCF dataset which were based in a retail setting and where the individual being observed made a legitimate purchase.

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Accuracy of all attributes

Table 2 Results

Method	Accuracy	Precision	Recall
SVM	92.40%	93.05%	92.44%
KNN	80.64%	82.09%	81.00%
Decision Tree	83.92%	84.36%	86.78%
Random forest	94.50%	93.75%	91.33%
MLP	92.40%	91.85%	92.44%

Sensitivity Analysis

- The results here, indicate that the most significant attribute was “Do they exhibit avoidance behaviors”, followed by “Do they interact with staff before leaving”, “potential difficulty to steal the item”, “Do they place the item out of view” and “Do they appear to hide what they are doing”.
- These attributes almost all relate to the individual performing (or not performing) a given action, which may indicate that an individual’s behavior gives a more reliable indicator of their intention than environmental factors such as their clothing.
- Conversely the least important features were “Gender”, “Gender of accomplice”, “Are they wearing clothing items that could hide their appearance” and “are their staff members visible withing the shot”.

Table 4 Results from sensitivity analysis

Attribute	Accuracy	Precision	Recall
A	-1.05%	-1.00%	-1.00%
B	-2.11%	-1.91%	-2.11%
C	-2.05%	-1.31%	-2.33%
D	0.06%	0.03%	0.11%
E	-1.11%	-0.82%	-1.11%
F	-3.22%	-3.02%	-3.22%
G	-4.27%	-3.93%	-4.33%
H	-2.11%	-1.91%	-2.11%
I	-3.16%	-1.96%	-3.33%
J	-2.11%	-1.91%	-2.11%
K	-1.05%	-1.00%	-1.00%
L	-2.05%	-1.59%	-2.11%
M	-2.16%	-1.82%	-2.11%
N	1.11%	1.00%	1.11%
O	-5.26%	-5.13%	-5.33%

Recommended Future work

- Currently the UCF Crimes dataset is the largest open-source dataset for this problem. However, this data set only contains 50 videos of shoplifting, a number of which are cut short. We recommend validating these results on a larger dataset
- Furthermore, the videos in this dataset come from a number of different retail environments. A single dataset of retail shoplifting from a single store with multiple cameras would enable us to determine more definitively which social signals are suspicious and the frequency at which they occur.
- We also suggest that there may be other social signals which we may have missed that also indicate shoplifting
- Finally we recommend examining methods to automatically extract these features in order to develop a SSP approach to automated surveillance.

Thanks for listening

Any questions?