C22 Machine Learning in Data From Crime-Related Mobile Devices: Bidirectional Recurrent Neural Networks for Named-Entity Recognition (NER) in WhatsApp, Instagram™, and Facebook® Messenger Text Conversations

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Learning Overview: This presentation summarizes the initial efforts of a Brazilian Federal District Police forensic research team to use the huge amount of text data extracted from crime-related mobile devices to shed light on the general crime panorama of the Brazilian Federal District and to develop tools that can help the digital forensic investigator in his casework. Attendees will have a chance to see the nature and format of the text data extracted from mobile devices in Brazil, the path chosen by the research team to retrieve drug-related information from this data, the difficulties encountered, and the solutions developed by the team.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by discussing how recently developed Bidirectional Long Short-Term Memory (LSTM) Neural Networks can be used to extract information from text data retrieved from crime-related mobile devices. This presentation will show the strategy developed by the forensic research team to perform drug-related named-entity recognition on WhatsApp, Instagram™, and Facebook® Messenger Text Conversations.

It is notable that in recent years there was a significant increase in the volume and variety of data in the hands of corporations and institutions. Most of this data is represented in the form of unstructured text. Many are examples situations in which huge quantities of text data can be used to achieve valuable insight.

The Digital Forensics Department of the Brazilian Federal District Police works as a hub to a huge amount of data retrieved from mobile devices owned by crime perpetrators and victims. This data group represents an untapped potential. The correct interpretation of this data can bring valuable information on the general panorama of criminal offenses in the Federal District.

In order to start exploring this data group, the forensic research team considered the development of a tool to extract drug-related information from text conversations. Machine learning techniques have already been successfully employed to identify crime-related images on police databases, but content-sensitive text analyses are yet to be used in this context.[1]

NER is an information extraction technique that aims at locating and classifying named-entity mentions in unstructured text into predefined categories, such as person names, organizations, quantities, etc. Recently published research used a Recurrent Neural Network to perform NER in Brazilian legal texts, obtaining satisfactory results.[2]

A Bidirectional LSTM Neural Networks was chosen to perform drug-related NER in text conversations retrieved from mobile devices seized by police officers in the Federal District. The researchers identified a similarity between these text messages and tweets made by Brazilian users, so public tweets were used as a complementary source to the database.

After a pre-processing stage, the database was manually labeled. The entities were assigned the values B-DRUG, for terms that represent names of drugs, and B-DRUG_RELATED, for terms that represent activities related to drug abuse. The final base was made up of 102,325 words, of which 7,356 refer to drugs and 2,148 correspond to drug-related activities. After the construction of the database, a Bidirectional LSTM Neural Network was implemented and trained with the database.

The model was then tested. The base was randomly divided, using 80% of its data for training, and 20% for testing. Experiments revealed that the model was able to satisfactorily classify the test data, obtaining a precision rating of 0.99 for B-DRUG terms and 0.97 for B-DRUG_RELATED terms. The F1-Scores were 0.99 and 0.98, respectively. A validation test was performed using only data from the mobile devices, resulting in a precision rating of 0.91 for B-DRUG terms and 1.00 for B-DRUG_RELATED terms. The F1-Scores were 0.74 and 0.93, respectively. These results are promising. Content-sensitive text classification in text messages is a difficult task, so named-entity recognition can be used in machine learning applications to aid in the fight against crime.

Reference(s):

1. Mayer, Felix, and Martin Steinebach. Forensic image inspection assisted by deep learning. *Proceedings of the 12th International Conference on Availability, Reliability and Security.* ACM, 2017.
2. de Araujo, Pedro Henrique Luz et al. LeNER-Br: A Dataset for Named Entity Recognition in Brazilian Legal Text. *International Conference on Computational Processing of the Portuguese Language*. Springer, Cham, 2018.

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