AUTOMATIC IDENTIFICATION OF ANONYMOUS PROFILES ON SOCIAL NETWORKS

Daniel Garnacho
Alvaro Ortigosa

Casimiro Nevado
Silvia Iluminada Ramos

Institute of Forensic and Security Science
/ Computer Science Department
Universidad Autónoma de Madrid

Training and Improvement Division
Spanish National Police Force
"Technology... is a queer thing. It brings you great gifts with one hand, and it stabs you in the back with the other."

Cooperation: Police + Academic

- In the last years the cooperation between LEAs and Academic institutions has been increased.
- Dealing with crime has become a race for the use of technology.
  - New technologies enable new ways of crime and requires new ways of fighting it.
- (Lack of) Security is global. LEAs have to tackle crime.
- In this context, LEAs need the support of Academia for being updated.
- From the Academic point of view, LEAs show real needs and provide information based on real threats.
Dark Side of Technology

• ICTs are also tools for extremist groups,
  • Those sheltering / hiding behind different social movements
  • Transnational terrorist groups.

• Used for:
  • Propaganda
  • Recruitment
  • Training
  • Radicalization
The Dark Side of Social Networks

- Offenders have moved from websites (easier to identify) to Social Networks (greater anonymity).
  - These networks ensure a wider dissemination with no costs

- Radical groups can use SN for:
  - Recruitment of new followers
    - Frequently telling stories looking to arise feelings of (in)justice
  - Mobilizing some sectors of society or specific individuals
    - SNs are currently the best tool to obtain publicity and go viral
  - Giving legitimacy to radicalization
The Dark Side of Social Networks

• Once recruitment and mobilization has been performed, it follows the ideological recruitment to transform the recruited individuals into individuals trained and ready to act.

• For these reasons, it is important to “patrol” these channels.
  • It is vital for collecting information and intelligence

• There is a need for (automatic) technological tools supporting this task
  • Better understanding and identification of information
Example of Hate Crime on Twitter

Detienen a un tuitero en Palma de Mallorca por un delito de odio contra el colectivo LGTB

- El arrestado tenía una intensa actividad en la red social, con más de 4.000 mensajes publicados
A “classical” problem

• One of the largest obstacles to LEAs is how easy results to create a new profile on this SN.

• It was observed, time and time again, that short time after closing a Twitter profile, similar ones came up:
  • Similar dogma and speech
  • Very difficult to identify individuals behind a given profile or publication
  • Police work should start all over again.
The goal

- Designing and implementing a data analysis tool...
- ... Based on Semantic Analysis of written texts
- ... Intended to link an anonymous SN profile to a “public” one
  - That is, a profile with elements enabling an identification of the user: personal pictures, address, work place, previous knowledge, etc.

- The initial prototype was implemented to analyse Twitter profiles

- The proposed approach does not rely on any specific language.
  - For example, for counter terrorism activities it can be used in language as different as Spanish, English, Pashtum or Bangla.
... but more subtle

• What if the target profile wants to “hide” itself?

How to Hide Your Identity on Twitter
by Michelle Varsallona; Updated September 28, 2017

• Our hypothesis is that a given person will use similar speeches in all of them
  ➔ The real person could be identified against profiles with real data that are similar to the one investigated.

• The message resemblance is evaluated based on both the topics (words) and the perspective (grammar constructions) used.
Comparing in Twitter

• Analyzing tweet by tweet would not produce significant results.
  • Individual tweets are too short. (280 chars from Nov.7 !!).

• Our proposal is to combine all the tweets of a profile in a single document.

• So comparing Twitter profiles → comparing text documents.
Comparing documents

• Recurrent problem on the NLP field.
• It is needed a method for measuring document similarity

\[
\text{words in common between documents} \quad \frac{\text{total number of words on both documents}}{\text{Distance?}}
\]
Distance between vectors (docs)

- Frequently documents are transformed to vectors for a faster calculation.
Converting docs in vectors

- Original *Bag of Words* methods were used
  - They do not take into account the order or context of the words
### Bag of Words example

#### Document 1
The quick brown fox jumped over the lazy dog’s back.

#### Document 2
Now is the time for all good men to come to the aid of their party.

<table>
<thead>
<tr>
<th>Term</th>
<th>Document 1</th>
<th>Document 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>aid</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>all</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>back</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>brown</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>come</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>dog</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>fox</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>good</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>jump</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>lazy</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>men</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>now</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>over</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>party</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>quick</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>their</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>time</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Stopword List
- for
- is
- of
- the
- to

Either present/not present or counting number of times

Most frequent words are discarded.
Our proposal: to use Doc2Vec

- *Bag-of-words* methods have a fundamental limitation: because they do not consider word order, they ignore how sentences are constructed (semantic).
  - If the way of expressing is significant, the grammar constructions and verb tenses should be considered

- Doc2Vec is based on a **neural network** used to **maximize the probability to predict a word** based on a set of words and a given document vector.

- Depending on the goal StopWords are discarded and Steaming method used (**looking for similar topics**) or the original text is used (**looking for similar profiles**).
Based on Word2Vec

- Predicting the next word given its context (semantic)
Word2Vec at Work

Input:
one document

Model:

word vectors

vector space

kite

space

netherlands
spain
france

belgium
italy
dog

water

house

most_similar(‘france‘):

<table>
<thead>
<tr>
<th>Word</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>spain</td>
<td>0.678515</td>
</tr>
<tr>
<td>belgium</td>
<td>0.665923</td>
</tr>
<tr>
<td>netherlands</td>
<td>0.652428</td>
</tr>
<tr>
<td>italy</td>
<td>0.633130</td>
</tr>
</tbody>
</table>

highest cosine distance values in vector space of the nearest words
Results of Word2Vec
Results of Word2Vec
Doc2Vec at Work

w  w_w  
quick  
brown  
fox  +
jump  
over  +
lazy  
dog  

sentence

w_w  w'
quick  
brown  
fox  
jump  
over  
lazy  
dog  


Doc2Vec at Work

Input: many document

Model:

- wv_kite
- dv_doc1
- wv_space
- wv_netherlands
- wv_dog
- wv_italy
- wv_france
- dv_doc2
- wv_louvre
- wv_spain
- wv_belgium
- wv_paris
- wv_water
- dv_doc3
- wv_house

most_similar('france'):
- paris 0.876543
- louvre 0.765432
- normandy 0.654321
...

vector space: consists of word vectors for each word and additional document vectors

highest cosine distance values in vector space with consideration of the document vectors

training a word vector for each word and each document gets an ID/tag with a vector while training
Example of Use: twin profiles
The big data problem

• We need to search for profiles similar to one given among millions of candidates in a minimal time.
• We have used some of the latest technological development for dealing with large datasets.
• The prototype requires some time for training (learning vectors), but then it can scan through millions of profiles in a few seconds.
Use Cases

• The search of twin profiles can be done either vertically (within a given SN) or horizontally (looking for similar publications among different SN and forums).

• The method can also be used to link current profiles with profiles long inactive.

• Given a well-known and dangerous user, the method can be applied to look for similar users
  • That feature could enable to discover hidden relationships, even criminal networks.

• The method is indifferent to crime domain (radicalization, child pornography, hate speech, etc.) or language.
Context of Use

- The tool would not replace the human work in any case; on the contrary, it was designed to assist police agents on their work.
  - It can save time by searching in a few minutes through millions of SN profiles, producing a small set of candidate profiles.
  - These profiles should be afterwards analyzed by experts in order to determine if any of them could correspond to the target.
Future Work

• Algorithms for text classification can be improved, as new and more efficient versions are being continuously researched.
• Text analysis can be combined with traditional SNA analysis for measuring and looking for similarity.
• These analysis can be combined with personality profiling
  • Personality is an individual features extremely difficult to hide.
  • It can be used to risk prediction.
  • We have already made some progress on inferring personality through open source information.
Thank you very much!

Silvia Iluminada Ramos Pérez
sramos@policia.es

Alvaro Ortigosa
alvaro.ortigosa@uam.es
@a_ortigosa