

AI Based Opto-Lexical Pattern Analysis for Behavior Classification

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90%

of all terrorist communication happens through social media

Background

Social media has 4 main purposes for terrorist groups:

1. Share operational and tactical information
2. Gateway to other online radical content
3. Media outlet for terrorist propaganda
4. Remote reconnaissance for targeting purposes

Twitter is the platform on which most of this occurs.

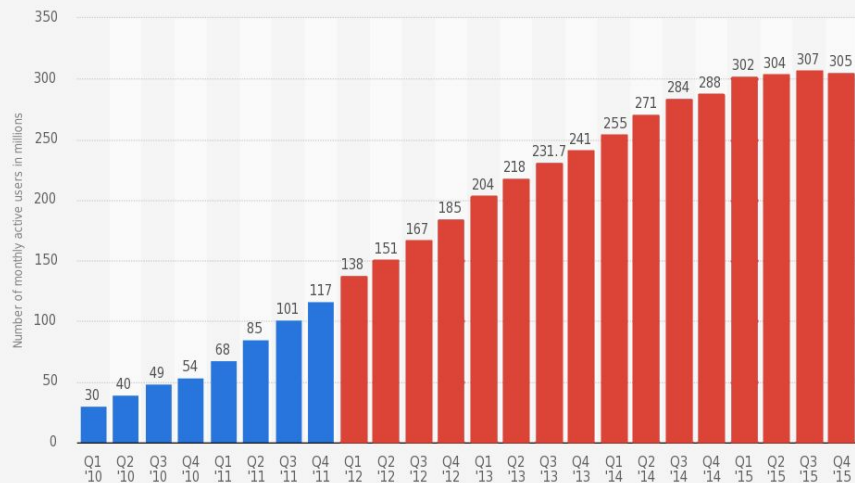
- Microblogging site
- Active user base of 300 million

There are an estimated 90,000 terrorist accounts on Twitter (0.03%).

Background

An increase in Twitter users is correlated with an increase in terrorist attacks.

Number of monthly active Twitter users worldwide from 1st quarter 2010 to 4th quarter 2015 (in millions)

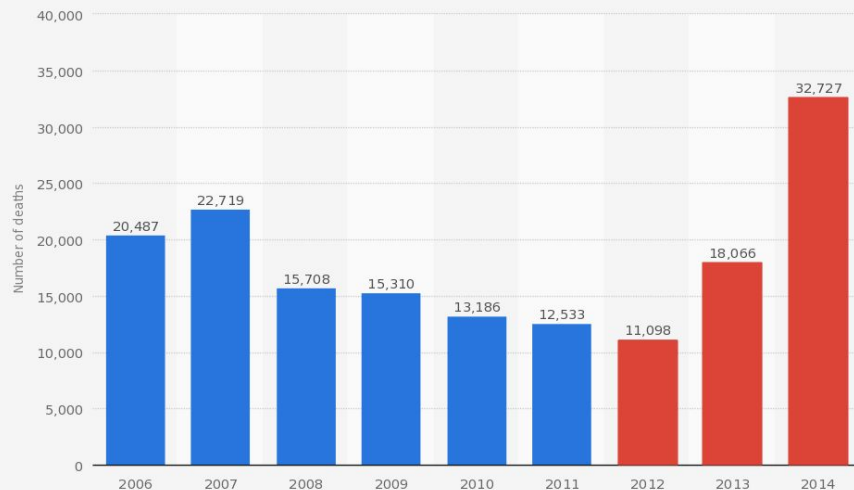


Source:
Twitter
© Statista 2016

Additional Information:
Worldwide; Twitter, 1st quarter 2010 to 4th quarter 2015; excluding SMS
fast followers

statista

Number of fatalities due to terrorist attacks worldwide between 2006 and 2014



Source:
NCTC
© Statista 2015

Additional Information
Worldwide; NCTC

statista

Analyzing social media feeds with machine learning algorithms can classify behavioral patterns

Algorithm

A simple 3 step process ensures optimal efficiency within the program.

Twitter Account Data Collection

Data Parsing

Data Analysis & Prediction

Methodology

The 27 parameters used to ensure minimal false-positives.

Diction

- Word choice/frequency
- Percent match
- Average match distribution
- Hashtags

Affiliation to Known Accounts

- Friends
- Followers
- Retweets
- Content mentions

Miscellaneous

- Date
- Time/Time Zone
- Number of tweets per day
- Location
- Language

Visual Media

- Adult Score
- Racy Score
- Autogenerated image caption
- Number of males
- Number of females
- Number of faces
- Average age
- Width
- Height
- Foreground color
- Background color
- Blaw and white status
- Clipart status
- Vector-style status

Code Sample

```
1  /*
2  Name: Akshath Jain
3  Date: 12/27/16 - 12/28/16
4  Purpose: Image Object java that stores an image, the object
5  */
6
7  /*
8  example of json output:
9  {"adult":{"isAdultContent":false,"isRacyContent":false,"adu
10 {"adult":{"isAdultContent":false,"isRacyContent":false,"adu
11
12  */
13
14  import org.apache.http.HttpEntity;
15  import org.apache.http.HttpResponse;
16  import org.apache.http.client.HttpClient;
17  import org.apache.http.client.methods.HttpPost;
18  import org.apache.http.client.utils.URIBuilder;
19  import org.apache.http.entity.StringEntity;
20  import org.apache.http.impl.client.HttpClients;
21  import org.apache.http.util.EntityUtils;
22
23  import java.net.URI;
24
25  import org.json.*;
26
27  public class ImageObject {
28      private double adultScore;
29      private double racyScore;
30      private WordList tags;
31      private int numMales;
32      private int numFemales;
33      private int numFaces;
34      private double averageAge;
35      private int width;
36      private int height;
37      private int dominantColorForeground;
38      private int dominantColorBackground;
39      private int isBlackAndWhite; //0 for false, 1 for true
40      private static final int WHITE = 1000;
41      private static final int BLACK = 1001;
42      private static final int RED = 1002;
43      private static final int ORANGE = 1003;
44      private static final int YELLOW = 1004;
45      private static final int GREEN = 1005;
46      private static final int BLUE = 1006;
47      private static final int CYAN = 1007;
48      private static final int INDIGO = 1008;
49      private static final int VIOLET = 1009;
50      private static final int BROWN = 1010;
51      private static final int GREY = 1011; //check for grey
52      private int clipArtType; //0 = nonclipart, 1 = ambiguous
53      private int lineDrawingType; //0 = non-line drawing; 1
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Code Sample

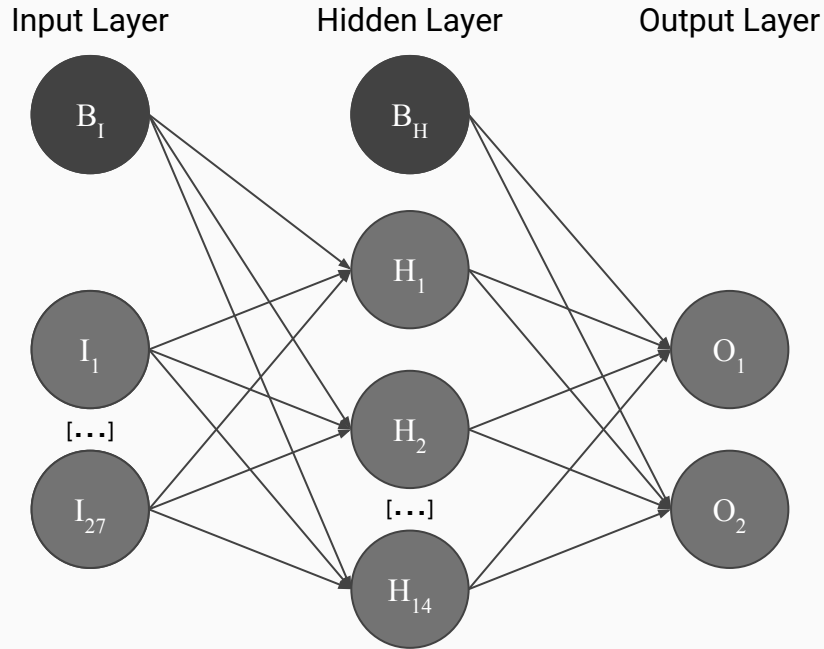
```
151 //get number of males, number of females, number of faces, and average age
152 JSONArray faces = parser.optJSONArray("faces");
153 if(faces != null){
154     objToReturn.numFaces = faces.length();
155     for(int i = 0; i < faces.length(); i++){
156         JSONObject tempObj = faces.optJSONObject(i);
157         if(tempObj != null){
158             objToReturn.averageAge += tempObj.optInt("age", 0);
159             if(tempObj.optString("gender").equals("Male"))
160                 objToReturn.numMales++;
161             else
162                 objToReturn.numFemales++;
163         }
164     }
165     if(faces.length() != 0)
166         objToReturn.averageAge = objToReturn.averageAge / faces.length();
167     else
168         objToReturn.averageAge = 0;
169 }else{
170     objToReturn.averageAge = 0;
171     objToReturn.numMales = 0;
172     objToReturn.numFemales = 0;
173     objToReturn.numFaces = 0;
174 }
175
176 //get width and height
177 JSONObject metadata = parser.optJSONObject("metadata");
178 if(metadata != null){
179     objToReturn.width = metadata.optInt("width", 0);
180     objToReturn.height = metadata.optInt("height", 0);
181 }else{
182     objToReturn.width = 0;
183     objToReturn.height = 0;
184 }
185
186 //get dominant color foreground and background
187 JSONObject color = parser.optJSONObject("color");
188 if(color != null){
189     String[] field = new String[]{"dominantColorForeground", "dominantColorBackground"};
190
191     String tempBW = color.optString("isBWImg");
192     if(tempBW.equals("true"))
193         objToReturn.isBlackAndWhite = 1;
194     else if(tempBW.equals("false"))
195         objToReturn.isBlackAndWhite = 0;
196     else
197         objToReturn.isBlackAndWhite = -1;
198
199     for(int i = 0; i < 2; i++){
200         String tempColorString = color.optString(field[i]);
201         int tempColorInt;
202         switch(tempColorString){
203             case "White":
204                 tempColorInt = WHITE;
205                 break;
206             case "Black":
207                 tempColorInt = BLACK;
208                 break;
209             case "Red":
210                 tempColorInt = RED;
211                 break;
212             case "Orange":
213                 tempColorInt = ORANGE;
214                 break;
215             case "Yellow":
216                 tempColorInt = YELLOW;
217                 break;
218             case "Green":
219                 tempColorInt = GREEN;
220                 break;
221             case "Blue":
222                 tempColorInt = BLUE;
223                 break;
224             case "Cyan":
225                 tempColorInt = CYAN;
226                 break;
227             case "Indigo":
228                 tempColorInt = INDIGO;
229                 break;
230             case "Violet":
231                 tempColorInt = VIOLET;
232                 break;
233             case "Brown":
234                 tempColorInt = BROWN;
235                 break;
236             case "Grey":
237                 tempColorInt = GREY;
238                 break;
239             case "Gray":
240                 tempColorInt = GREY;
241                 break;
242             default:
243                 tempColorInt = -1;
244                 break;
245         }
246     }
247     if(i == 0){
248         objToReturn.dominantColorForeground = tempColorInt;
249     }else{
250         objToReturn.dominantColorBackground = tempColorInt;
251     }
252 }
253
254 }else{
255     objToReturn.dominantColorBackground = -1;
256     objToReturn.dominantColorForeground = -1;
257     objToReturn.isBlackAndWhite = -1;
258 }
259
260 //get clipart type and line drawing type
261 JSONObject imageType = parser.optJSONObject("imageType");
262 if(imageType != null){
263     objToReturn.lineDrawingType = imageType.optInt("lineDrawingType", -1);
264     objToReturn.clipArtType = imageType.optInt("clipArtType", -1);
265 }else{
266     objToReturn.lineDrawingType = -1;
267     objToReturn.clipArtType = -1;
268 }
269
270 return objToReturn;
271
272 public String toString(){
273     return "adultScore: " + adultScore +
274         "\nracyScore: " + racyScore +
275         "\ntags: " + tags.toString() +
276         "\nnumMales: " + numMales +
277         "\nnumFemales: " + numFemales +
278         "\nnumFaces: " + numFaces +
279         "\naverageAge: " + averageAge +
280         "\nwidth: " + width +
281         "\nheight: " + height +
282         "\ndominantColorForeground: " + dominantColorForeground +
283         "\ndominantColorBackground: " + dominantColorBackground +
284         "\nisBlackAndWhite: " + isBlackAndWhite +
285         "\nlineDrawingType: " + lineDrawingType +
286         "\nclipArtType: " + clipArtType;
287 }
288
289 public double getAdultScore() {
290     return adultScore;
291 }
292
293 public double getRacyScore() {
294     return racyScore;
295 }
296
297 public WordList getTags() {
298     return tags;
299 }
300
301 public int getNumMales() {
302     return numMales;
303 }
```

Code Sample

```
300 public int getNumMales() {  
301     return numMales;  
302 }  
303  
304 public int getNumFemales() {  
305     return numFemales;  
306 }  
307  
308 public int getNumFaces() {  
309     return numFaces;  
310 }  
311  
312 public double getAverageAge() {  
313     return averageAge;  
314 }  
315  
316 public int getWidth() {  
317     return width;  
318 }  
319  
320 public int getHeight() {  
321     return height;  
322 }  
323  
324 public int getDominantColorForeground() {  
325     return dominantColorForeground;  
326 }  
327  
328 public int getDominantColorBackground() {  
329     return dominantColorBackground;  
330 }  
331  
332 public int getIsBlackAndWhite() {  
333     return isBlackAndWhite;  
334 }  
335  
336 public int getClipArtType() {  
337     return clipArtType;  
338 }  
339  
340 public int getLineDrawingType() {  
341     return lineDrawingType;  
342 }  
343 }
```

Prediction Algorithm

Neural Network Diagram

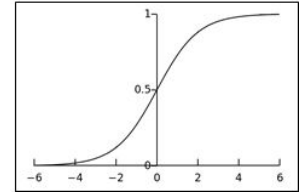


Regular Usage

$$H_j = \sigma \left(w_{B_1 H_j} + \sum_{i=1}^{14} I_n w_{I_i H_j} \right)$$

$$O_k = \sigma \left(w_{B_H O_k} + \sum_{j=1}^2 H_j w_{H_j O_k} \right)$$

$$\sigma(s) = \frac{1}{1 + e^{-s}}$$



Network Training

$$\delta O_k = O_k(E)(1 - O_k(E))(T_k(E) - O_k(E))$$

$$\delta H_j = H_j(E)(1 - H_j(E)) \sum_{k=1}^2 w_{H_j O_k} \delta O_k$$

$$\Delta w_{I_i H_j} = \eta I_i(E) \delta H_j$$

$$\Delta w_{H_j O_k} = \eta H_j(E) \delta O_k$$

Neural Network Code Sample

```
NeuralNetwork.java x
79
80 public int classify(TwitterAccount account) {
81     //initializes input layer
82     WordList textData = account.getTextData(); //contains diction data
83     ImageList imageData = account.getTextData(); //contains visual media data
84     double[] misc = account.getMisc(); //contains affiliation and misc data
85     textData.fillInputLayer(inputLayer, 1, 1 + textData.numParams());
86     imageData.fillInputLayer(inputLayer, 2 + textData.numParams(), 2 + textData.numParams() + imageData.numParams());
87     for(int i = 0; i < misc.length; i++)
88         inputLayer[i + 3 + textData.numParams() + imageData.numParams()] = misc[i];
89
90     //initializes input layer
91     double[] temp = account.getDictio();
92     for (int i = 1; i <= 3; i++)
93         inputLayer[i] = temp[i - 1];
94     inputLayer[4] = account.getAffiliation();
95
96     //set hidden layer values
97     for (int j = 1; j < numHiddenNodes; j++) {
98         double sum = 0;
99         for (int i = 0; i < numInputNodes; i++)
100             sum += inputLayer[i] * wIH[i][j];
101
102         hiddenLayer[j] = sigmoid(sum);
103     }
104
105     //set output layer values
106     for (int k = 0; k < numOutputNodes; k++) {
107         double sum = 0;
108         for (int j = 0; j < numHiddenNodes; j++)
109             sum += hiddenLayer[j] * wHO[j][k];
110
111         outputLayer[k] = sigmoid(sum);
112     }
113
114     //determine account
115     if (outputLayer[0] > outputLayer[1]) //the first node: is a match; second node: not a match
116         return 1; //account is a match
117     else
118         return 0; //account isn't a match
119 }
```

Experimentation

Methodology

A two step process to train and test the prediction algorithm.

Neural Network Training

- Supervised learning with sample data
- Computer “learns” patterns

Testing

- Sample data set used
 - Precompiled data set of known hostile accounts
 - Contains images, text, media, etc

Overview

Training

- Training set (120 total)
 - 12 positive
 - 108 negative
- Validation set used to prevent overfitting (120 total)
 - 12 positive
 - 108 negative

Testing

- Trial 1: (64 total)
 - Core accounts (1.0%)
- Trials 2 - 9: Negative accounts from different categories (6,336 total)
 - Brands and Products (2.50%)
 - Companies and Organizations (2.50%)
 - Local Businesses (0.05%)
 - Movies (0.95%)
 - Music (4.73%)
 - Sports (2.03%)
 - Television (0.23%)
 - Websites (1.57%)
 - People (85.44%)

Results/Analysis

84%

accurate in correctly classifying terrorist accounts

Visual Media Analysis Sample #1



Auto-generated caption: *"a group of birds sitting in the snow"*

Source: @NatGeoPhotos

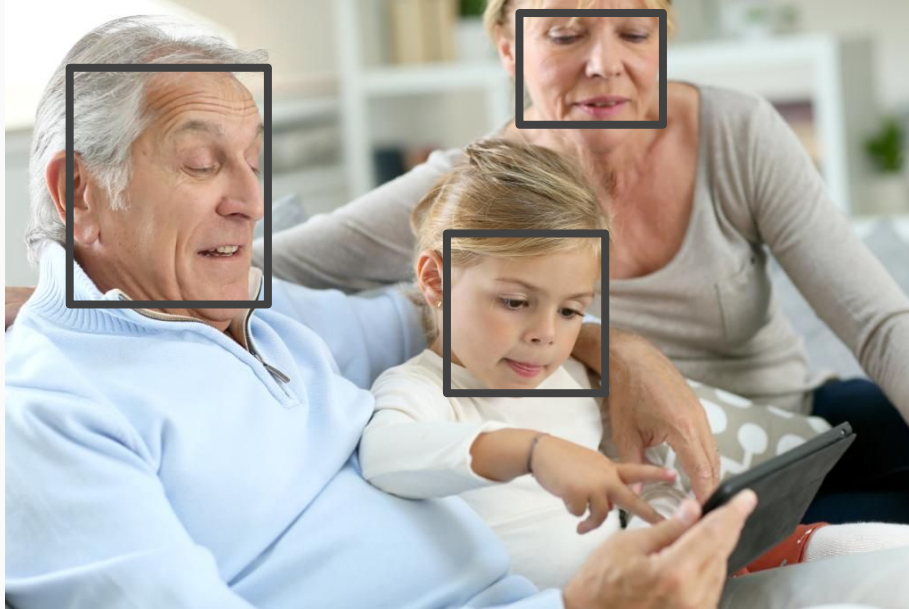
Metadata

- Height: 864
- Width: 648
- Prominent foreground color: *grey*
- Prominent background color: *grey*

Description

"fish", "animal", "water", "snow", "sitting", "table", "man", "top", "boat", "bird", "large", "standing", "blue", "parked", "air", "skiing", "ocean", "white", "laying", "group", "people", "riding", "playing", "cat", "beach"

Visual Media Analysis Sample #2



Auto-generated caption: *"a man with a computer holding a little girl"*

Source: @Forbes

Metadata

- Height: 683
- Width: 1024
- Male: 1, age 70
- Females: 2, ages 6 and 55
- Prominent foreground color: *white*
- Prominent background color: *white*

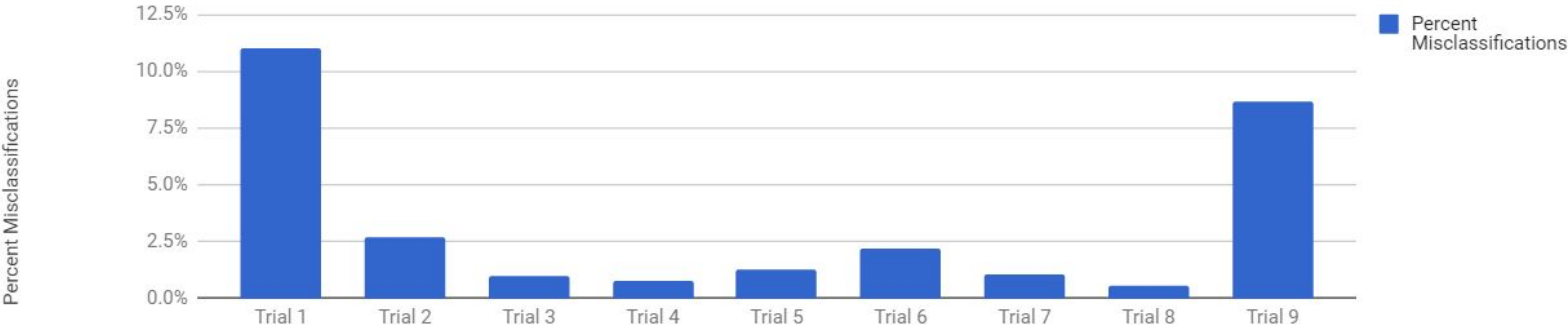
Description

"Person", "sitting", "man", "table", "looking", "holding", "laptop", "older", "people", "using", "computer", "woman", "baby", "food", "playing", "young", "white", "player", "room", "group", "phone"

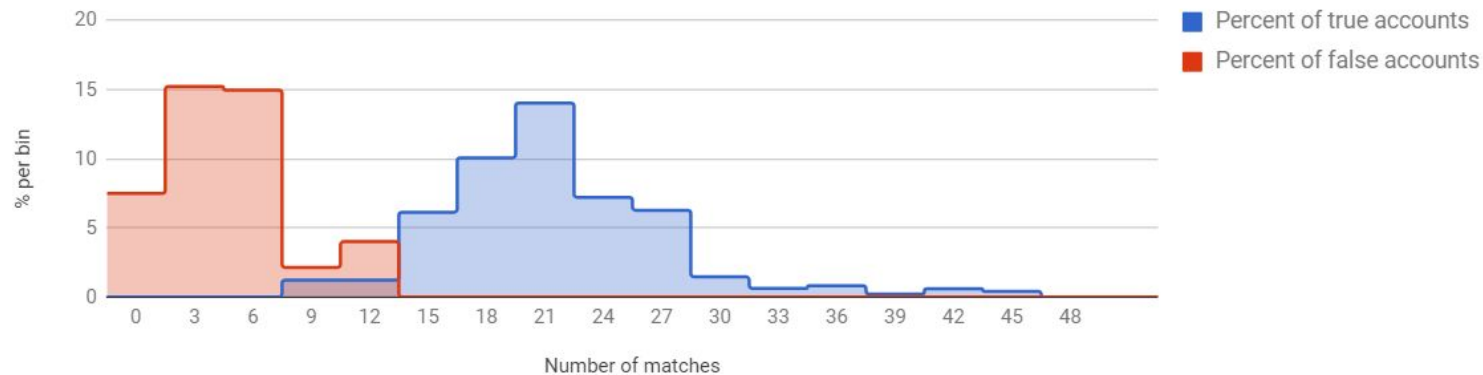
Analysis

	True Accounts	False Accounts							
	Trial 1: Hostile	Trial 2: Brands and Products	Trial 3: Companies and Organizations	Trial 4: Local Businesses	Trial 5: Movies and Television	Trial 6: Music	Trial 7: Sports	Trial 8: Websites	Trial 9: Individual
Percent Misclassifications	11.0%	2.7%	1.0%	0.8%	1.3%	2.2%	1.1%	0.6%	8.7%

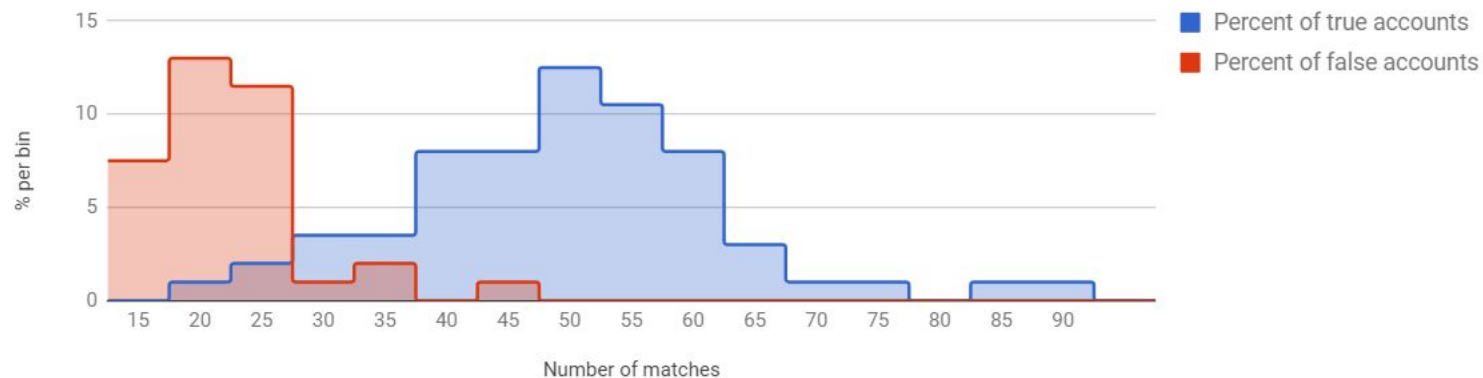
Percent Misclassifications



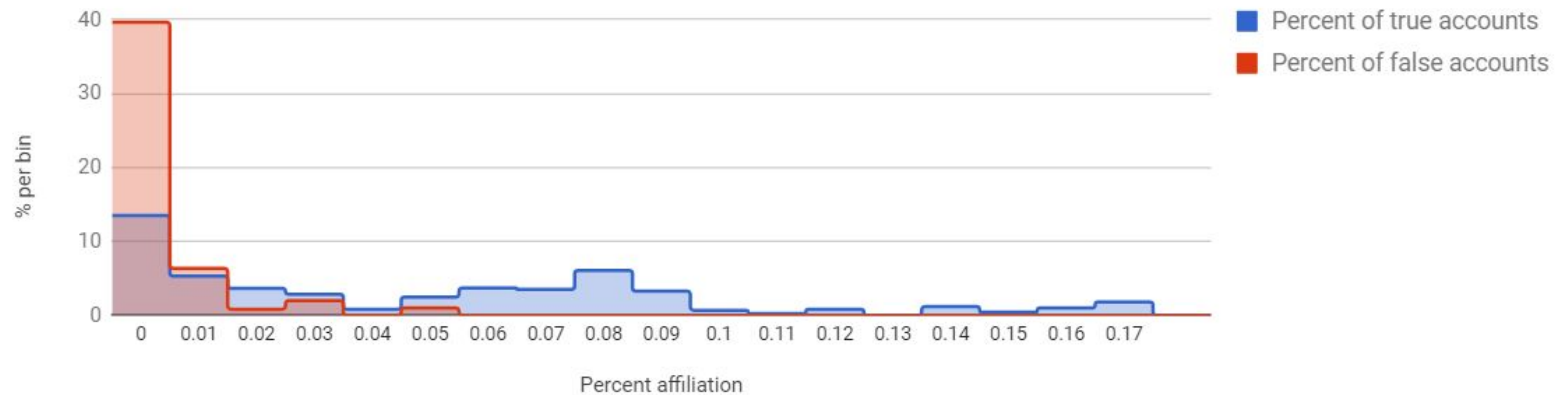
Distribution of Text-Based Common Word Matches



Distribution of Visual-Media-Based Caption Matches



Distribution of Percent Affiliation



Conclusion

Overview

Hypothesis was correct:

- Analyzing social media feeds with machine learning algorithms can classify behavioral patterns

Experiment was successful

- National Institute of Justice: “Success rates are based on the consequences of errors”
- 84% accurate in identifying accounts
- False positive rates show areas for improvement

Plans for Improvement

Ameliorations to my project for its betterment.

Expand Analysis Platforms

- Other types of social media
- More analysis parameters

Test Using a Larger Sample Size

Enhance Efficiency

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