SEMI-SUPERVISED FEATURE EMBEDDING FOR DATA SANITIZATION IN REAL-WORLD EVENTS

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Forensics on Real-World Events

Which are the relevant and irrelevant samples to the event (X)?
What is Image Data Sanitization?

- The goal is determining of the relevant samples from irrelevant ones upon an event of interest.

Image examples are taken from Notre Dame Cathedral Fire Dataset.
## Collected Datasets

<table>
<thead>
<tr>
<th>Event</th>
<th>Location</th>
<th>Year</th>
<th>Number of images</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Notre-Dame Cathedral</strong></td>
<td><strong>Paris, France</strong></td>
<td><strong>2019</strong></td>
<td><strong>1660</strong></td>
<td><strong>22023</strong></td>
</tr>
<tr>
<td><strong>Grenfell Tower</strong></td>
<td><strong>London, UK</strong></td>
<td><strong>2017</strong></td>
<td><strong>14161</strong></td>
<td><strong>0</strong></td>
</tr>
<tr>
<td><strong>Marathon Bombing</strong></td>
<td><strong>Boston, US</strong></td>
<td><strong>2013</strong></td>
<td><strong>19092</strong></td>
<td><strong>0</strong></td>
</tr>
<tr>
<td><strong>Bangladesh Fire</strong></td>
<td><strong>Dhaka, BD</strong></td>
<td><strong>2019</strong></td>
<td><strong>125</strong></td>
<td><strong>125</strong></td>
</tr>
<tr>
<td><strong>National Museum</strong></td>
<td><strong>Rio de Janeiro, Brazil</strong></td>
<td><strong>2018</strong></td>
<td><strong>125</strong></td>
<td><strong>125</strong></td>
</tr>
</tbody>
</table>
## Instances of Events

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Image 1</th>
<th>Image 2</th>
<th>Image 3</th>
<th>Image 4</th>
<th>Image 5</th>
<th>Image 6</th>
<th>Image 7</th>
<th>Image 8</th>
<th>Image 9</th>
<th>Image 10</th>
<th>Image 11</th>
<th>Image 12</th>
<th>Image 13</th>
<th>Image 14</th>
<th>Image 15</th>
<th>Image 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notre-Dame cathedral</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
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<td><img src="image15" alt="Image" /></td>
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<tr>
<td>Marathon bombing</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
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<td><img src="image4" alt="Image" /></td>
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<td>National Museum</td>
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</table>
Image Characteristics

- **Data-Driven Features**
  - VGG16
  - InceptionV4
  - Xception

- **Complementary Features**
  - Gabor filters and Covariance (GBICOV) based descriptor
  - Histogram Oriented Gradient (HOG)

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Feature Dimensionality</th>
<th>Image input size</th>
</tr>
</thead>
<tbody>
<tr>
<td>VGG16</td>
<td>4096</td>
<td>224 × 224</td>
</tr>
<tr>
<td>InceptionV4</td>
<td>1536</td>
<td>299 × 299</td>
</tr>
<tr>
<td>Xception</td>
<td>2048</td>
<td>299 × 299</td>
</tr>
<tr>
<td>gBiCov</td>
<td>1536</td>
<td>150 × 150</td>
</tr>
<tr>
<td>HOG</td>
<td>648</td>
<td>150 × 150</td>
</tr>
</tbody>
</table>
Embedding Learning method

- Local and Global Consistency (LGC) Semi-Supervised techniq.

\[ f : f \rightarrow \mathbb{R}^2 \]

\[ f = [f_1, \ldots, f_n]^T \cdot y \]

\[ f^* = \arg\max_j f_j \]
Experimental Setup

- We selected $\beta$ randomly labeled data samples for each target dataset.
- We adopted kNN to construct our affinity matrix with $k=16$.
- The LGC algorithm was iterated up to 300.
- We applied PCA to reduce the dimension of each feature to 128 elements.
Some Results

NotreDame Data set

- VGG16
- InceptionV4
- Xception
- gbicov
- gbicov_VGG16
- HOG
- gbicov_HOG_VGG16
Some Results (Cont.)

National Museum Data set

Bangladesh Fire Data set
Conclusions

- Training a supervised learning method for image sanitization is daunting…
- Label spreading has shown to be adequate to this problem properly propagating the labels in five events.
- The best performance accuracy in a range between 65% and 95%
- Exploring semi-supervised algorithms hold promise for the applications that are highly expensive on annotating data process
Future Work

- we are currently exploring a different set of *graph-based semi-supervised techniques* that fit with complex data structure.

- Also we explore *self-supervised learning algorithms* to generate robust feature representation upon the particular structure of an event.
Acknowledgement

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