Automatic Classification of Iconic Images Based on a Multimodal Model. An Interdisciplinary Project

Motivation: understanding iconic images in context

What are climate change and global warming?

What is climate change?

Global warming – doesn’t mean we’ll all just have warmer weather in future.
More motivation!

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PREVENTION AND CLEAN UP OF POLLUTION

One of the Division’s primary responsibilities is to enforce federal civil and criminal environmental laws such as the:

- Clean Air Act to reduce air pollution;
- Clean Water Act to reduce water pollution and protect wetlands;
- Resource Conservation and Recovery Act to ensure that hazardous wastes are properly stored, transported, and disposed;
- Comprehensive Environmental Response, Compensation and Liability Act (or “Superfund”), which requires those who are responsible for hazardous waste sites to pay for their clean up; and the
- Drinking Water Act and the Lead Hazard Reduction Act, which directly protect the health of Americans.
Iconic images

An iconic image is a **visual representation of an entity** that

- is *widely used in public communication* to create an association with (aspects of) a focus topic, e.g., climate change (**media content perspective**)

- is *easily recognized as being associated* with (an aspect of) the topic by media users (**media use perspective**)

- is capable of *triggering a substantial cognitive, affective, and/or behavioral response* related to the focus topic in media users (**media effects perspective**)
Iconic images

Visual representations of entities

- which are widely used in public communication

- exhibit a clear topical associations

- and are capable of triggering a substantial, cognitive, affective, and/or behavioral response
Non-literal image usages

Overlap with other figurative usages, e.g. artistic ones
This talk

- First results of an interdisciplinary project involving media and communication researchers and computer scientists

- Main objective: a computational approach to iconic image understanding in context

- Desiderata:
  - The methodology should be well-founded theoretically
  - Outcomes should enable a variety of applications where computer and communication science can interact and benefit from each other
Outline

- **Our vision**: Computational iconic image understanding

- **A first application**: Weakly supervised construction of a repository of iconic images

- **Conclusions, lessons learned and future work**
Automatic classification of iconic images

Two main steps:

1. **Data acquisition**: semi-automatically create a dataset of iconic images by relying on existing Web resources.
   - start with manually-created examples of iconic images
   - use captions and text to automatically generate queries and send these to online resources like, e.g., Flickr, in order to retrieve similar iconic images.

2. **Classification task**: train algorithms for statistical classification to automatically classify new, unseen images into a closed number of classes namely
   (i) binary iconic vs. non-iconic image detection;
   (ii) topical classification (e.g. global warming);
   (iii) topical sub-classes labeling (e.g., icons capturing global warming impact vs. causes vs. solutions)
Our overarching vision

Develop and apply automated methods

- to identify iconic images of a target topic (e.g., climate change)
- to analyze the context in which these iconic images are embedded
  - surrounding text
  - website metadata (type of website, cultural origin of website/author, political position of website/author, etc.)

Long-term vision:

- develop models that cover all three aspects of iconicity in context:
  (i) content
  (ii) usage
  (iii) effects
Outline

- **Our vision**: Computational iconic image understanding

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- Conclusions, lessons learned and future work
A first attempt at semi-automatically harvesting a dataset of iconic images:

- Start with representative topic-evoking images from Wikipedia
- Query an online image repository (i.e., Flickr) to acquire additional examples
- Leverage a combination of visual similarity measures, image clustering and matching algorithms to acquire clusters of iconic images

We view the task of iconic image understanding as the ability to build a dataset for further research.
Semi-automatic iconic image acquisition: framework

5 main steps:

- Seed selection
- Text-based image search
- Image filtering
- Image clustering
- Image matching
Seed selection

- We start with the encyclopedic entries from National Geographic Education, an on-line resource in which human expert editors make explicit use of prototypical images to visually represent encyclopedic entries.

- We use these (proprietary) images to:
  - provide us with human-validated examples of iconic images
  - identify (freely available) similar images within Wikipedia page

- Examples:
  - “Air Pollution” and “Greenhouse Effect”: smokestacks
  - “Climate change”: polar bear on iceberg
### Text-based image search

Query Flickr to collect additional data and enlarge our dataset with additional images depicting iconic relations.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Themes of seed images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaption</td>
<td>hummingbird, king snake, koala</td>
</tr>
<tr>
<td>Agriculture</td>
<td>cattle, ploughing, rice terraces, tropical fruits</td>
</tr>
<tr>
<td>Air</td>
<td>balloon, sky view</td>
</tr>
<tr>
<td>Air Pollution</td>
<td>smokestack, Three Mile Island, wildfire</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Amazonas, blue starfish, cornflowers, fungi, Hopetoun Falls</td>
</tr>
<tr>
<td>Capital</td>
<td>Capitol Hill, Praca Dos Tres, Washington Monument</td>
</tr>
<tr>
<td>Climate</td>
<td>Mykonos (mild climate), Sonoran Desert, tea plantation (cool climate)</td>
</tr>
<tr>
<td>Climate Change</td>
<td>polar bear, volcano, dry lake</td>
</tr>
<tr>
<td>Climate Refugee</td>
<td>climate refugees from Indonesia, Haiti, Pakistan, etc.</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>bison, flooded forest, Flynn Reef, harp seal, rainforest, thorn tree</td>
</tr>
<tr>
<td>Global Warming</td>
<td>deforestation, flooding, smokestack</td>
</tr>
<tr>
<td>Greenhouse Effect</td>
<td>smokestack, steam engine train (smoke emissions)</td>
</tr>
</tbody>
</table>
Image filtering

- Apply a face and HoG-based person detection
- Remove images with people but focused around other entity types
- Example: picture of a koala (topic: “Adaption”)

![Example Image]
Image clustering

- Group together *similar images* based on *visual features*
- Example: smokestacks ("Air Pollution" and "Greenhouse Effect")
Image matching

- Match images from the clusters to the original seeds
- Use features capturing *high-level content similarity* (i.e., distinct, yet similar objects such as the smokestacks of different plants, etc.) and promote diversity with respect to our initial seeds
- Unmatched images are classified as being not iconic

Example matching: SIFT
Example “good” clusters

Air pollution

Deforestation
Example “bad” cluster

Wildfire
Evaluation

- Evaluated on ~4,000 images
  - grouped into ~1,200 and 870 soft clusters (~27 and 19 images per cluster)
  - annotated as “iconic” and “not-iconic”
- Promising performance on automatic classification (59.5% recall and 68.5% precision)
- Most errors due to state-of-the-art image understanding techniques far from being perfect…
Outline

- **Our vision**: Computational iconic image understanding

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- Conclusions, lessons learned and future work
Conclusions

- A semi-automatic, weakly-supervised approach to the acquisition of a repository of iconic images

- A method to automatically classify images as iconic or not

- Performance figures indicate that the task is feasible
Next steps: Natural Language Processing

- We barely scratched the surface of using text and images together...

- Exploit the image captions, their content, etc.
  - Entities
  - Locations
  - Events

- Explore the use of joint image and text features

- How does this problem relate to figurative language usages?
Next steps: Computer Vision

- Improve results by analyzing visual image content with image segmentation and shape classification techniques

High visual similarity of the segmented wind generators (background is set to blue)

- Requires clearly recognizable image content
Next steps: interdisciplinary research

Extend the computational approach in two ways

1. **Study change over time:** How do new iconic images emerge in media discourse? *(media content perspective)*

   - Identify sites with high concentration of known iconic images (e.g. greenpeace.com; cnn.com), record full range of pictures displayed there, track those pictures on the wider Web for possible iconic use
Next steps: interdisciplinary research

Extend the computational approach in two ways

2. **Compare across cultures:** Do iconic images function the same way in countries differentially affected by climate change? (media use perspective)

   - Use crowd-sourcing platform (e.g. Mechanical Turk), ask respondents about their associations with certain images, and conversely, about pictures they associate with climate change
Thank you for your attention!