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

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Motivation: understanding iconic images in context

More motivation!

THE COMMON LAW IS THE WILL OF *Mankind* ISSUING FROM THE *Life* OF THE *People*

THE UNITED STATES DEPARTMENT of JUSTICE

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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

Environmental friendliness

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

Ökostrom

Regierungsberater wollen EEG absch

25.02.2014 · Das wird Angela Merkel nicht gerne hören: Wissenscha
Förderung von Ökostrom abzuschaffen. Sie helfe weder dem Klima, n
technische Innovationen.

Von ANDREAS MIHM

Artikel | Bilder (1) | Lesermeinungen (416)

Wunderland ist abgebrannt: Die Förderung erneuerbarer Energien bringt wenige

Das wird Angela Merkel (CDU) nicht gerne hören: Während i
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arbeitet, rät ihr eine vom Bundestag eingesetzte Expertenkommis
Erneuerbare-Energien-Gesetz (EEG) komplett abzuschaffen. Das
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dem der F.A.Z. vorliegenden Gutachten, das an diesem Mittwoch
Bundeskanzlerin überreicht wird.

Non-literal image usages

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Multilingual / Multicultural issues

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

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Weakly supervised acquisition of iconic images

- 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

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

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”)

Image clustering

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

Image matching

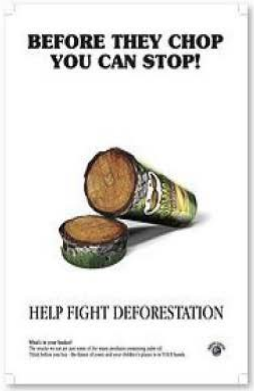
- Match images from the clusters to the original seeds
- Use features capturing *high-level content similarity* (i.e., distinct, yet similar objects such as the smokestacks of different plants, etc.) and promote diversity with respect to our initial seeds
- Unmatched images are classified as being not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

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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


An industrial area, with a power plant, south of Yangzhou's downtown, China


Industrial air pollution emissions


Air pollution from a fossil-fuel power station

- 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)



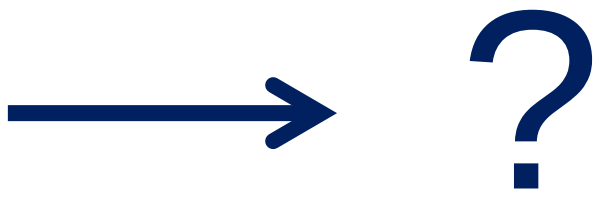
– Requires clearly recognizable image content

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

Progress?

Danger?

Thank you for your attention!