The ImageCLEF 2013 Scalable Concept Image Annotation Subtask

Mauricio Villegas,[†] Roberto Paredes[†] and Bart Thomee[‡]

[†] ITI/DSIC, Universitat Politècnica de València
{mvillegas,rparedes}@iti.upv.es

[‡] Yahoo! Research
bthomee@yahoo-inc.com

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Outline

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Introduction

- **Automatic image annotation** is the process by which a computer assigns to an image, metadata that describes its content.
- In this work the metadata considered is only the presence or absence of concepts in the images, e.g.

$\rightarrow$ Dog
$\rightarrow$ Table
$\rightarrow$ Rural
$\rightarrow$ Grass
$\rightarrow$ Daytime
$\rightarrow$ Tree
$\rightarrow$ ...

Introduction – Motivation

- Image annotation research has mostly relied on manually labeled training data. Examples of available datasets are:
  - **ImageNet:** $\approx$1.2M images, 1000 concepts, but only one concept per image.
  - **NUS-WIDE:** $\approx$269k images, multiple concepts per image, but only 81 concepts.
- Even though crowdsourcing has proved to be very useful, it is expensive and difficult to scale to a large amount of concepts.

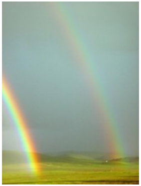
Are there alternatives that do scale concept-wise?

- Millions of images and corresponding related text can be cheaply crawled from the Internet for practically any topic.

Introduction – Motivation

How to effectively use Web data for image annotation?

- The text in websites is noisy and the degree of relationship to the images varies greatly.
- The types of images also varies. Take for example images from a search query of “rainbow”:


Outline

Subtask description

- **Objective:** To use only automatically gathered data for developing concept scalable image annotation systems.
  - Any data could be used as training, except for hand labeled images, e.g. crawled data, WordNet, dictionaries, stemmers, etc.
- **Participants were provided with:**
  - Crawled dataset (250,000 images and respective webpages).
  - Development set (1,000 images, labeled for 95 concepts).
  - Implementation of a baseline system and code for computing the performance measures.
- **Test set:** 2,000 images, the participants had to label them for 116 concepts (max. 6 runs could be submitted per group).
- **Concepts:** Were defined as WordNet synsets and for most of them, also a Wikipedia article was associated.

Subtask description – Lines of work

In contrast to traditional image annotation tasks, the proposed one involves more lines of work:

- Which representation to use for the images (visual features).
- How to use unsupervised web data as training.
    - Automatically assign concepts to the images using the textual data?
    - How to preprocess and clean the textual data?
    - Use other resources:
        - Ontologies
        - Language dictionaries
        - Automatic translation
- Which method to use for modeling the concepts.
- What strategy to use for deciding how many and which concepts are assigned to an image.

Subtask description – Web training dataset

- Web training dataset[1] composed of 250,000 images, 7 visual features types and 4 textual feature types.
- Images found by querying Google, Bing and Yahoo using the words from the English dictionary.
- Precautions taken to avoid “message images”, duplicates and near-duplicates.
- To ease data download and handling by participants, the subset of 250,000 images was selected using 158 concepts (including the concepts for the task).

[1] Dataset available at `http://risenet.iti.upv.es/webupv250k`

Subtask description – Web training dataset

Visual Features:

Feature	Dimensionality	Training data size
Thumbnails	Max. 200 pixels high	15 GB
GIST	480	810 MB
Color Hist.	576	170 MB
GETLF	256	30 MB
SIFT	5,000 BoW	770 MB
C-SIFT	5,000 BoW	660 MB
RGB-SIFT	5,000 BoW	750 MB
OPP-SIFT	5,000 BoW	720 MB

Subtask description – Web training dataset

Textual Features:

1. Words used to find the images (3MB).
2. Relative URLs of images in webpages (25MB).

Dogs can tell size of another dog by listening to its growls

Washington, Dec 21 : A new study has shown that dogs can tell the size of another dog by listening to its growls.
Peter Pongracz and his team recruited 96 dogs of various breeds ...

```
<html>
<head>
 <title> Dogs can tell size of another dog by listen-
  ing to its growls | Science / Technology </title>
</head>
<body>
 <h2> Dogs can tell size of another dog by listening
  to its growls </h2>
 <img src="img/dogs.jpg" alt="dogs in the park" />
 <p> Washington, Dec 21 : A new study has shown that
  dogs can tell the size of another dog by listening
  to its growls. </p>
 <p> Peter Pongracz and his team recruited 96 dogs of
  various breeds ... </p>
</body>
</html>
```

3. Image webpages as valid XML (2.3GB).
4. Webpage text (110M): dogs 0.09 of 0.0422 by 0.0336 growls 0.33 to 0.0326 dog 0.0321 can 0.0309 size 0.0307 ...

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Outline

Evaluation – Participation

Groups that registered	104
Total submitted runs	58
Groups that participated	13
Groups that submitted working notes paper	9

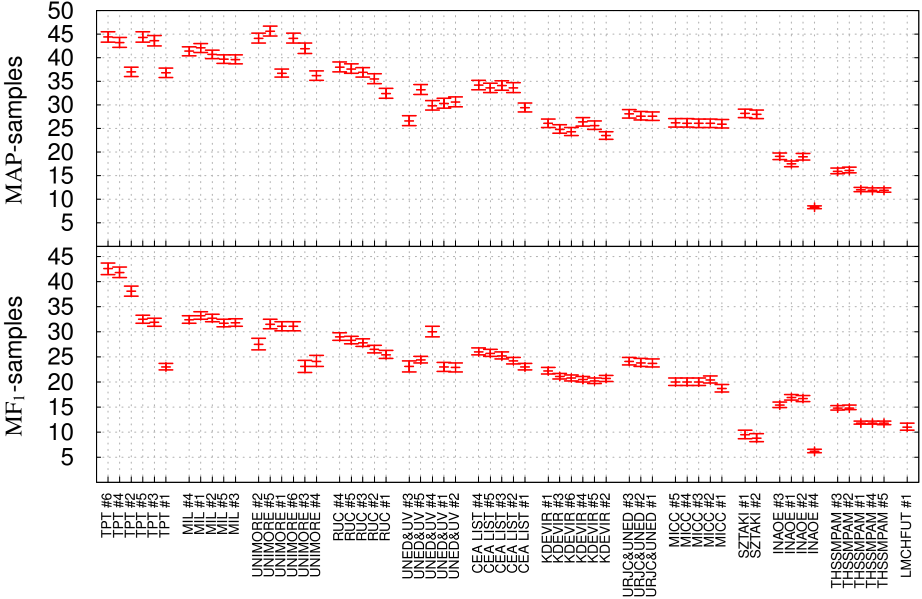
Participants:

- **CEA LIST:** Vision & Content Engineering group of CEA LIST (Gif-sur-Yvettes, France).
- **INAOE:** Instituto Nacional de Astrofísica, Óptica y Electrónica (Puebla, Mexico).
- **KDEVIR:** Computer Science and Engineering department of the Toyohashi University of Technology (Aichi, Japan).
- **LMCHFUT:** Hefei University of Technology (Hefei, China).
- **MICC:** Media Integration and Communication Center of the Università degli Studi di Firenze (Florence, Italy).
- **MIL:** Machine Intelligence Lab of the University of Tokyo (Tokyo, Japan).
- **RUC:** School of Information of the Renmin University of China (Beijing, China).
- **SZTAKI:** Datamining and Search Research Group of the Hungarian Academy of Sciences (Budapest, Hungary).
- **THSSMPAM:** Jile Zhou (Beijing, China).
- **TPT:** CNRS TELECOM ParisTech (Paris, France).
- **UNED&UV:** Universidad Nacional de Educación a Distancia and Universitat de València (Spain).
- **UNIMORE:** University of Modena and Reggio Emilia (Modena, Italy).
- **URJC&UNED:** Universidad Rey Juan Carlos and Universidad Nacional de Educación a Distancia (Spain).

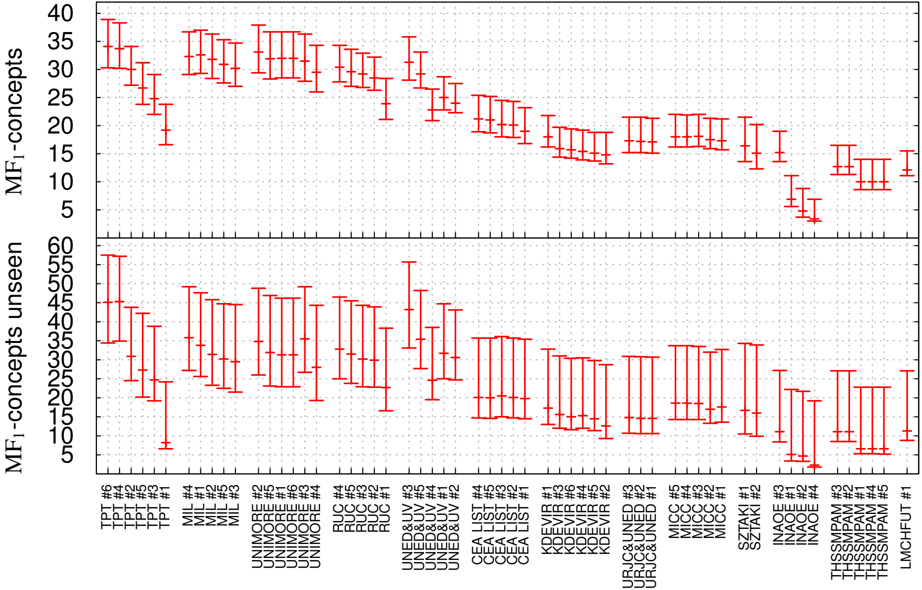
Evaluation – Some of the submitted systems

System	Visual Feat.	Training Data Processing	Annotation Technique
TPT #6	Provided by organizers	Tr. images selected/labeled by appearance of concept in webpage (+morphological expansions)	- Multiple SVMs with context dependent kernels - Annotation based on threshold
MIL #4	Fisher Vectors (SIFT, C-SIFT, LBP, GIST)	Tr. images selected/labeled by appearance of concept in webpage (+synonyms and hyponyms with a single meaning)	- Linear multilabel classifier learned by PAAPL - Annotation of the top 5 concepts
UNIMORE #2	Multiv. Gauss. Distrib. of local desc. (HSV-SIFT, OPP-SIFT, RGB-SIFT)	Tr. images selected/labeled by appearance of concept in webpage (+stopwords, stemming, synonyms, hyponyms and negative context disambiguation)	- Linear SVMs learned by stochastic gradient descent - Annotation based on threshold
RUC #6	Provided by organizers	Positive Tr. images selected by a combination of text feat. and Flicker based weighted search engine keywords. Negative examples selected by Negative Bootstrap.	- Multiple staked hikSVMs and kNNs - Annotation of the top 6 concepts

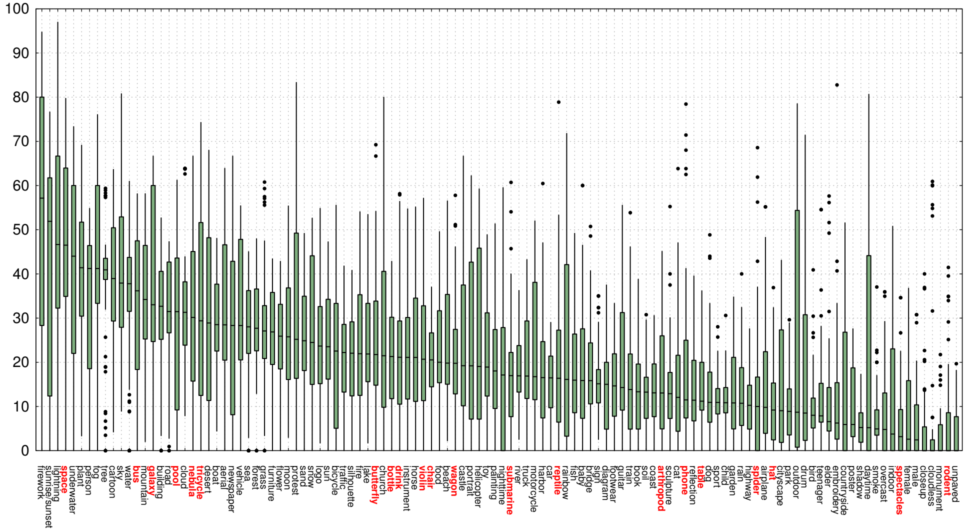
Evaluation – Results (samples)



Evaluation – Results (concepts)



Evaluation – Concept F_1 boxplots for all runs



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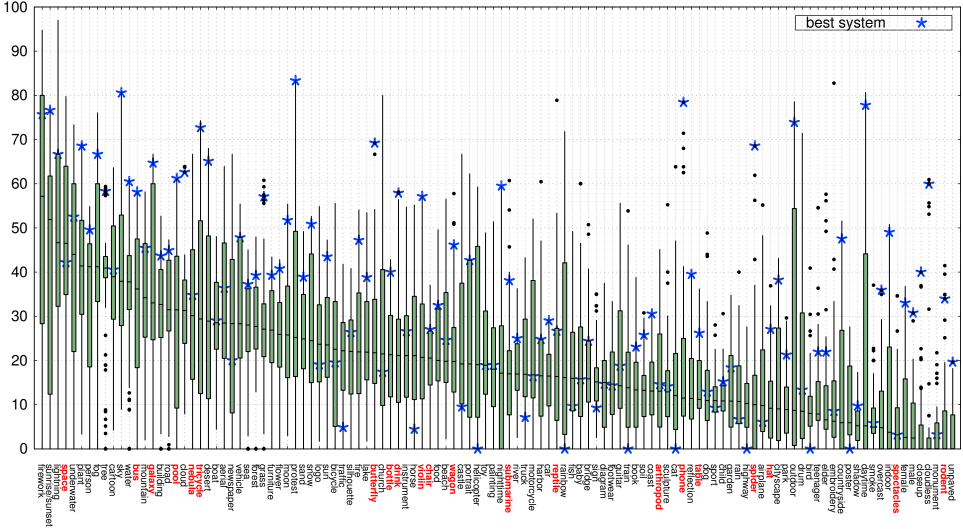

Outline

Conclusions and Future Work

- Participation was excellent, and the teams presented diverse approaches to address the proposed challenge.
- The results indicate that the web data can be effectively used for training practical and scalable annotation systems.
- The performances improved from a baseline below 10% to over 40% for both MAP and MF_1 measures.
- The performance for the concepts not seen during development demonstrates potential for scalability of the systems.
- Comparing the systems, several of the proposed ideas are complementary, thus future improvements are expected.

Conclusions and future work

- This task has attracted considerable interest, so we decided to continue it for ImageCLEF 2014.
- Ideally more testing data should be used to obtain more conclusive results related to the performance of unseen concepts.
- Modifications for the task, e.g. use both supervised and unsupervised data.
- Try the same ideas in other tasks, e.g. video.

Thank you for your attention!

Questions? Comments?