Determining the importance of figures in journal articles to find representative images

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Introduction

- Images are **essential for diagnosis and treatment planning**
  - Diversity of modalities and protocols is growing
- Medical images represent **largest amount** of medical information produced
- Medical literature carries much of the medical knowledge
  - Images are essential for medical articles
  - Images can help understand content of an article quickly
    - Much quicker than reading a text to determine relevance
- Search in the literature is frequent
Motivation

- Image retrieval and classification make medical visual content accessible for search
  - Images from PACS or from the medical literature (as in the ImageCLEF image retrieval campaign)
- When searching the image needs to be put into context
  - Text and visual data to understand context
  - Often more than a single image
- Identification of important figures
  - Use of visual content to determine relevance quickly
  - Limit search to important figures
Examples for using figure importance

- **Interfaces and visualization require choices**
  - Mobile information search has small interface
- **Creation of ground truth and rules for importance ranking to select in the best way**
  - Often the first N are taken
Database used

- ImageCLEF 2012 dataset
  - ~75,000 articles of PubMed Central, ~300,000 images
- Subset was used
  - ~800 articles contained more than 8 images
- Final choice of 50 articles containing 641 diagnostic images
Types of figure importance

- Five categories – sorted by importance
  - Most important figure – 1 figure that best describes the article
  - Essential figures – 0-3 figures
  - Important figures – 0-3 figures
  - Little importance figures – 0+ figures
  - Totally unimportant figures – 0+ figures
User test

- User test participant profile:
  - 45-year-old physician, surgeon
  - Working with medical images on a daily basis

- User test scenario:
  - Searching for relevant articles on the topic of the text
  - Which figures contain the most important information about the article?

- Requires to read and understand article

- All systematic findings or rules for the ranking were written down
Results

- All 50 articles were analyzed and all 641 images manually ranked by importance
  - Usually over 1 hour per article
- Rules and findings were noted and discussed
- Statistics on figure importance and places in the text were made
- Compound figures were difficult to judge
  - Information content is high as they contain different subfigures and links between them
  - Compound figure separation new sub task in ImageCLEF
Rules for determining importance

- Diagnostic images are more important than graphs/system overviews
- **Diversity** in the results set is important
  - Not several times the same modality if others exist
- Size/resolution matters
  - Image quality is importance
- **Position** in article
  - Most importance in the conclusions, then results
- **Common** vs. rare modality
  - Common modalities are often easier to understand
More rules for the importance

- **Magnification**
  - Highest magnification most important
- **MRI for soft tissue diseases, CT for bone related ones**
  - Modality adapted to the disease, can be derived from RadLex terms
- **Compound vs. other**
  - Compound figure contains much information
- **In non-diagnostic images, statistical graphs most important**
Results

- Distribution of figure importance

![Graph showing distribution of figure importance categories]

- Number of images classified in each of the importance categories:
  - Most Important: 50
  - Essential: 150
  - Important: 150
  - Little Importance: 280
  - Unimportant: 10
Results

- **Importance vs. position** of the figure in the article based on relative position in the text
Example for figure importance

(a) Most important figure

(b) Essential figures

(c) Important but not essential figures

(d) Not important figures

(e) Totally unimportant figures
Conclusions

- **Relative importance** of visual content in scientific articles is important for many applications
  - First study to investigate this in a user test

- **Can improve IR system performance**
  - Rank images based on position or remove some images to search a smaller sub space

- **Can improve visualization**
  - For small interfaces such as mobile phones and tablets
  - To combine text and images in an optimal way
Future work

- Repeat the same test with a second person to measure *inter-rater disagreement*
  - Quantify the subjectivity of the task
- Model the rules and optimize an automatic selection strategy
  - Modality classification to filter out unwanted images
  - Clustering and use of cluster centers to increase diversity
- Find the place of figures in the text and rank based on this
Thank you for your attention!

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