

NLM's Methods for Image Modality Classification

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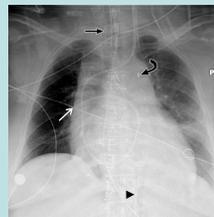
Lister Hill National Center for Biomedical Communications, U.S. National Library of
Medicine, NIH, Bethesda, MD, USA



Image Modality Classification

- **Imaging modality or “type”**
 - Captures information about its source, appearance, and use
 - Examples: X-ray, MRI, Histopathology, Ultrasound, etc.
 - Task determines imaging modality using visual and/or textual features
 - Useful in indexing images for retrieval

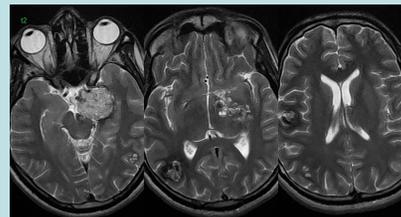
Image Modality Examples



X-ray



CT



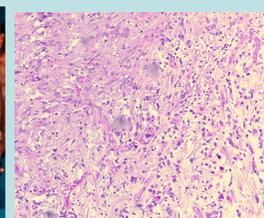
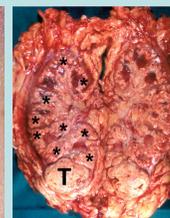
MRI



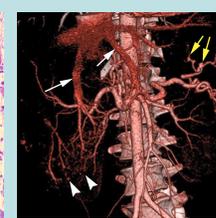
Ultrasound



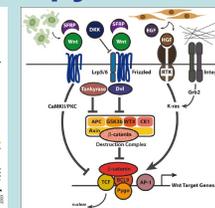
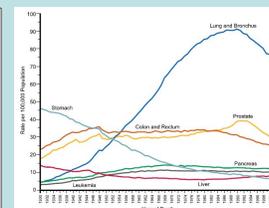
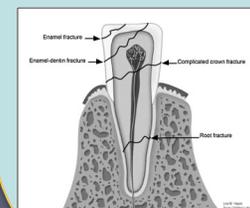
Photos



Microscopy

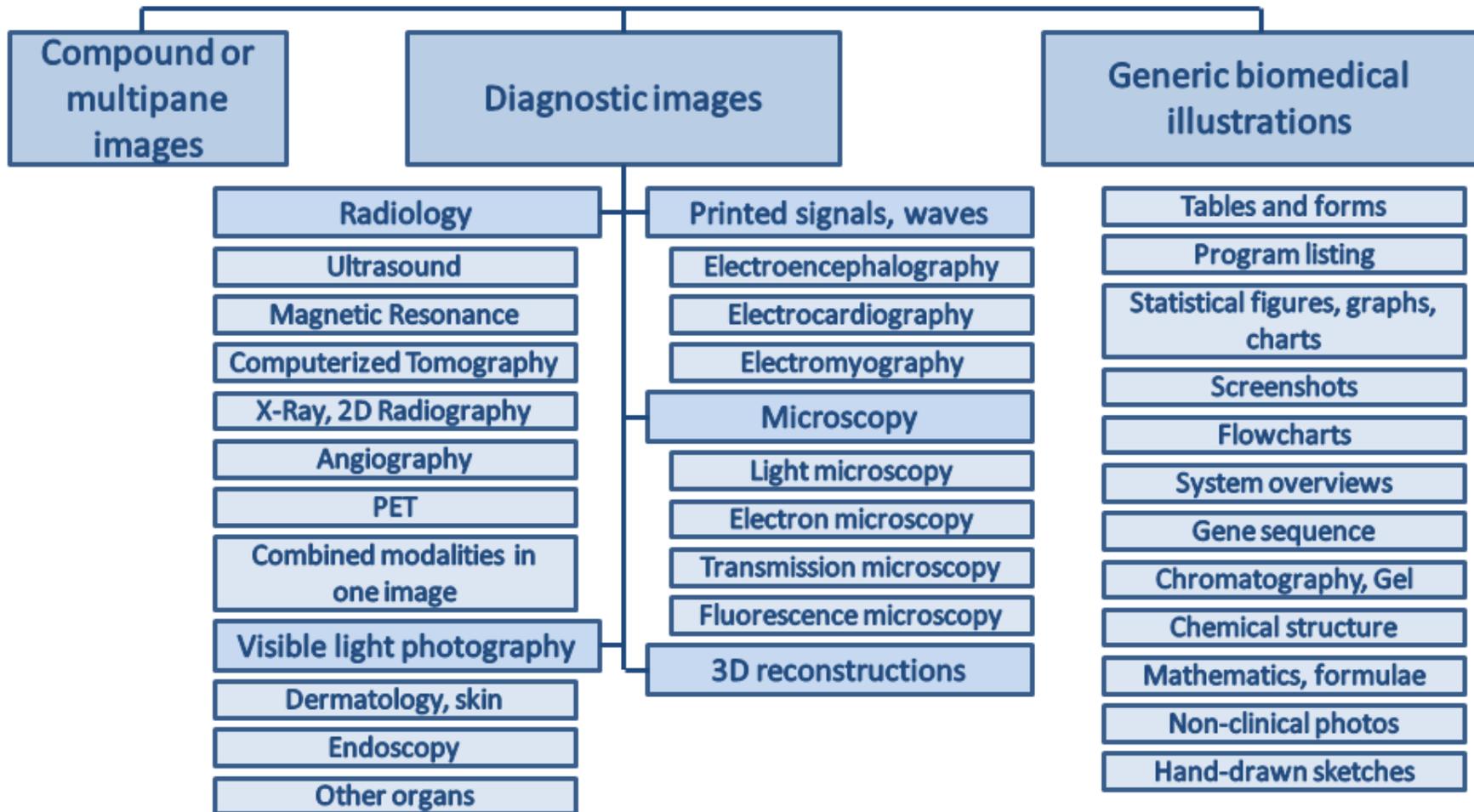


3D Rendering

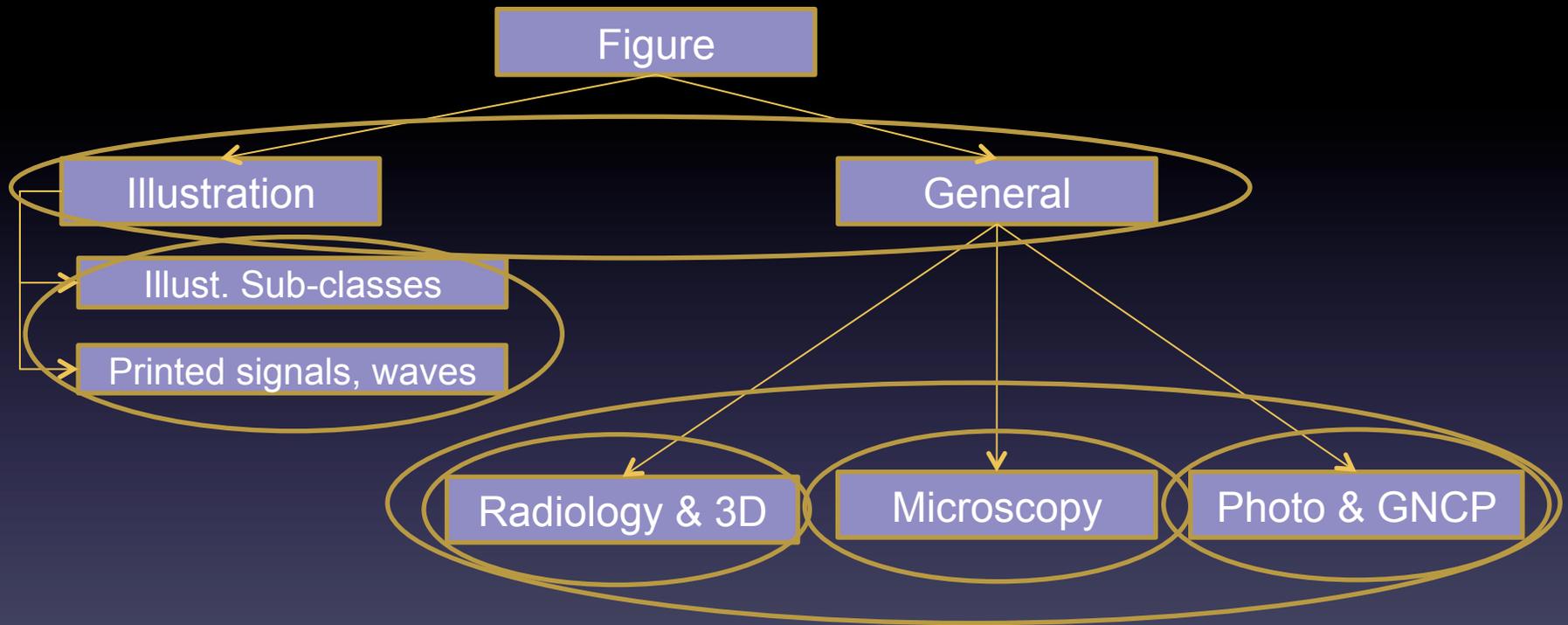


Illustration

Modality Classification



NLM Hierarchical Classification



Visual (content-based) feature extraction

- 16 features extracted from images
 - Individual features: **Color** (CLD of MPEG-7), moments (shape, color, texture), **texture** (Tamura, Gabor, etc.), edge (EHD), histogram (color, edge), etc.
 - Combined features: CEDD (color edge direction descriptor), FCTH (fuzzy color texture histogram), etc.
 - Meta-feature: Local Concept Feature (SConcept)
- Combined visual feature vector: 1391 elements

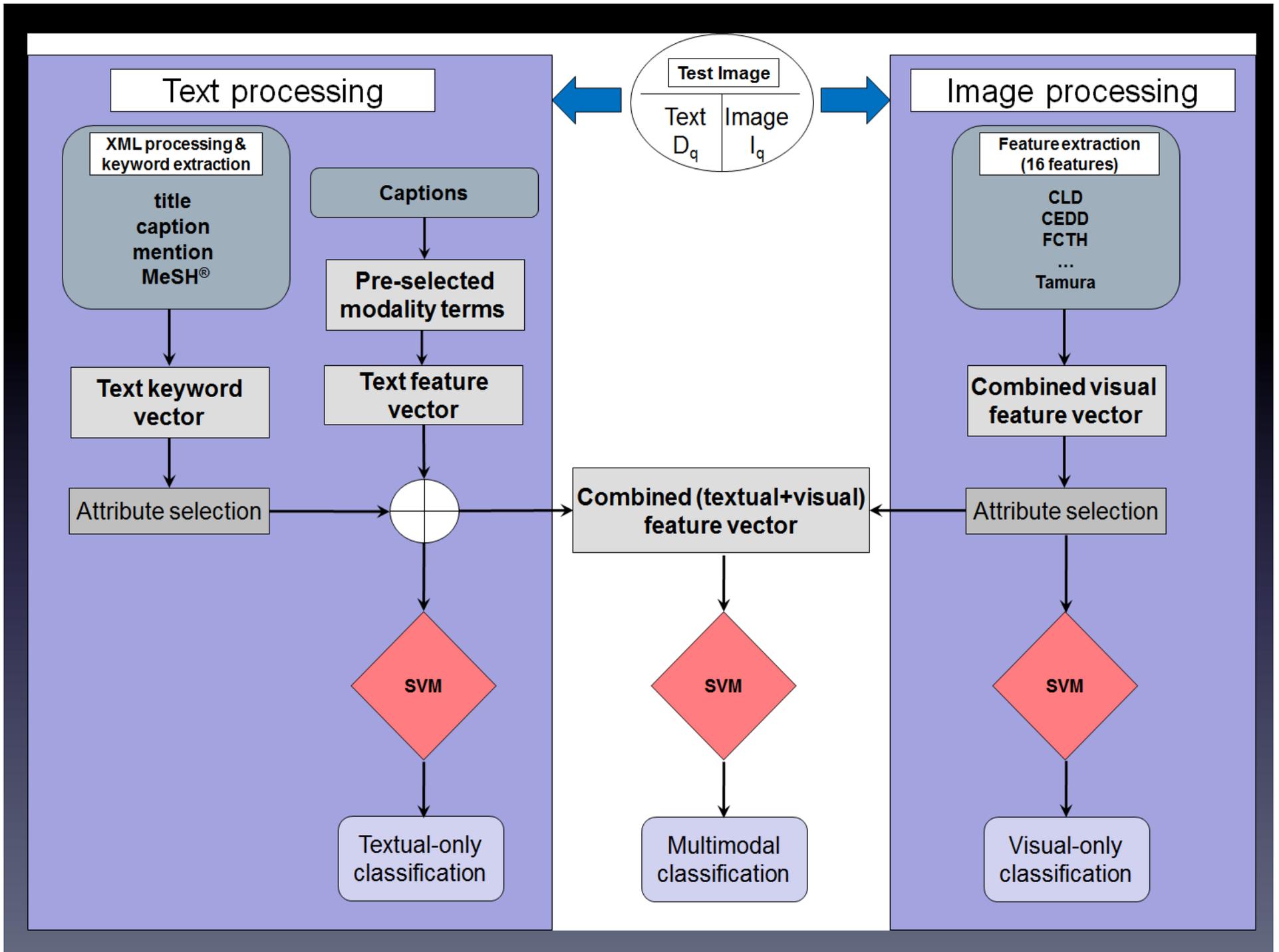
Text Features: Enriched Citations



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  + <MeSH>
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Classification Overview

- **Image Features:** Represent each image by either textual, visual, and mixed features.
- **Attribute selection:** Use the lower-dimensional feature vectors to train multi-class SVMs using WEKA data mining software
 - 10-fold cross-validation (due to insufficient training samples for several classes)
 - Training set size: 2,992 images
 - Evaluation set size: 2,582 images
- **Combined feature vector:** Merge selected features into a feature vector
- Use label from classifier for **illustration** images.
- Experimented with both **Flat** and **Hierarchical** classification strategies.

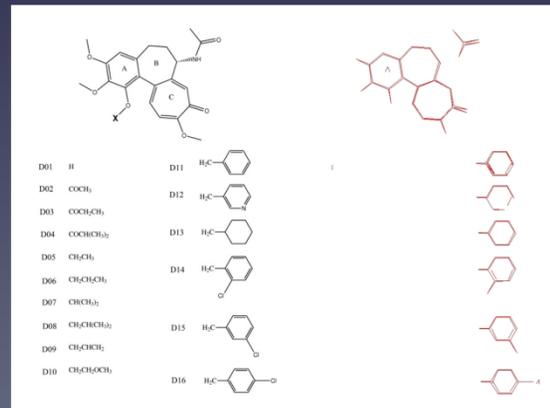
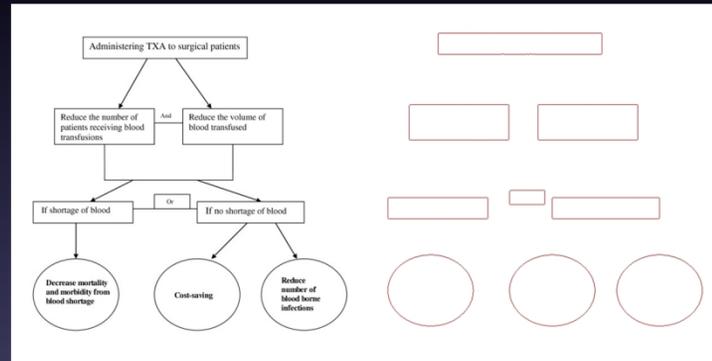


Special classifier for Illustrations

- Visual features perform poorly on illustrations
- Images consist of line drawings and/or text strings
 - Extract text strings from program listings, equations, etc.
 - Extract polygons (rectangle, hexagons, etc.) from flow charts, tables, chemical diagrams, etc.

```

Require: Set the initial parameters of the phantom, light source and optical imaging system.
1: Take out the preset photon package number  $n$  and initialize detection matrix  $P(r_d) = 0$ .
2: for  $k = 1$  to  $n$  do
3:   Sample the light source and obtain the information of the  $k$ th photon package.
4:   Trace the transport process of the  $k$ th photon package in tissues.
5:   if photon_dead = 0 then
6:     Record the parameters  $r, s$  and  $P(r)$ .
7:     Compute the visibility factor  $\epsilon(r, r_d)$  with (6).
8:     if  $\epsilon(r, r_d) = 1$  then
9:       Compute the imaging spot or the imaging facula center  $r_d$ .
10:      Compute the power  $P'(r_d)$  with (9).
11:      Update the power at the point  $r_d$ :  $P(r_d) = P(r_d) + P'(r_d)$ .
12:    else
13:      Break the current loop.
14:    end if
15:  else
16:    Break the current loop.
17:  end if
18: end for
    
```



Classifier Observations

- **Modality classifiers**
 - SVM-based classifications outperform others provided in WEKA.
 - Six classifiers implemented for a hierarchical classification.
 - Every classifier used a different set of attributes.
- Class specific features used to improve illustration classification
- Classification is changed if:
 - Illustration class content is reliably detected, AND
 - SVM classification contradicts finding (i.e., SVM result can be considered a “false alarm”)

Results

Features	Classification method	Accuracy (%)
Textual + visual (Late fusion)	Hierarchical	69.28
Textual + visual (Combined feature vector)	Hierarchical	67.31
Visual	Hierarchical	61.50
Textual	Flat	51.23

Observations:

- **Hierarchical classification** performs better than flat classification
- **Mixed feature**-based classification performs better than visual or textual features
- **Class-specific** content detection helps improve accuracy.

Thanks!

Questions?