Automated Classification of Bitmap Images Using Decision Trees

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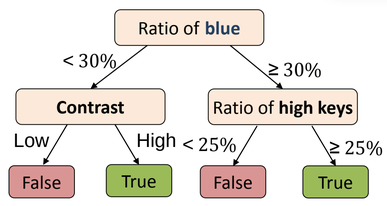
Bitmap Classification

- the task is to **automatically classify** bitmap images into predefined classes
  - finite set of bitmap images $\mathcal{J}$
  - finite set of classification classes $\mathcal{K}$
- for each $t \in \mathcal{K}$ a **characterization** d(t) of the class t in the natural language is given (*example:* „image depicting landscape“)
- the correct classification of the set of images $\mathcal{J}$ is defined with respect to a **fixed user** using a function c:
  - $c: \mathcal{J} \rightarrow 2^{\mathcal{K}}$ such that $\forall I \in \mathcal{J}\ \ \forall t \in c(I)$ ***d(t)* characterizes *I well***
- we need to learn $c': \mathcal{J} \rightarrow 2^{\mathcal{K}}$ such that it gives the same answer as ***c*** on as many as possible images
  - c is not known **explicitly**
  - the condition cannot be checked for **all** the images
  - **training/testing** sets are used

Decision Trees

- the concept of **decision tree** is used as underlying technology
- it is crucial to propose a set of good **characterizing attributes** and attribute **extraction techniques**
  - different classification classes have different important characteristics
    example: straight lines are characteristic for images of buildings



Classification Classes

- landscapes

- drawings

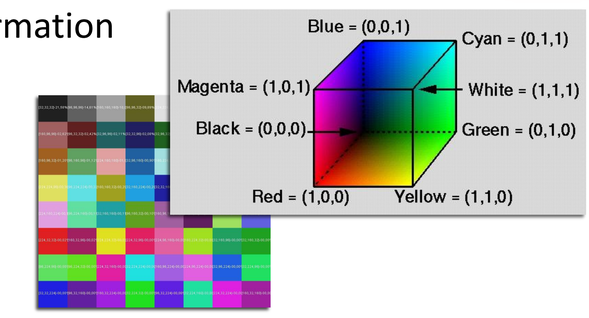
- photographs/not a photo

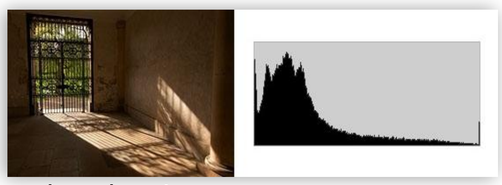
- macro objects

- buildings

Selected Attributes

- attributes based on **color** information
  - number of colors
  - color palette
  - important for distinguishing **photographs** and **drawings**

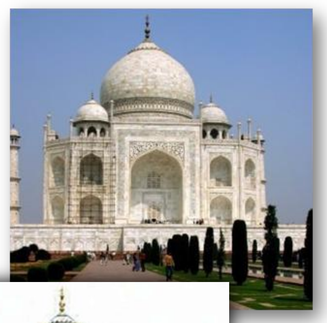




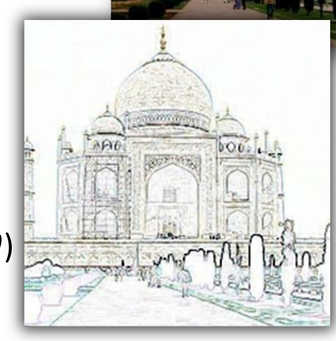
- low-key image

- high-key image

- attributes based on **histogram**
  - low, mid, and high keys
  - local contrast
  - important for **landscapes** and **macro objects**



- attributes based on **edge information**
  - occurrence of straight lines
  - occurrence of right angles
  - important for **buildings**
- three stage transformation of the image
  - **(i)** edge detection at bitmap level
  - **(ii)** Hough transformation for obtaining lines expressed analytically: $\rho = x*\cos(\vartheta) + y*\sin(\vartheta)$
  - **(iii)** segmentation of lines



Experimental Evaluation

- photography

	Number of Images	Correctly Classified	Success Ratio
Learning Set	155	154	99.35%
Set A	297	243	81.82%
Set B	405	300	74.07%

- color palette
- buildings

	Number of Images	Correctly Classified	Success Ratio
Learning Set	104	104	100.00%
Set A	297	232	78.11%
Set B	405	350	86.42%

- number of right angles
- drawings

	Number of Images	Correctly Classified	Success Ratio
Learning Set	104	104	100.00%
Set A	297	251	84.51%
Set B	405	331	81.73%

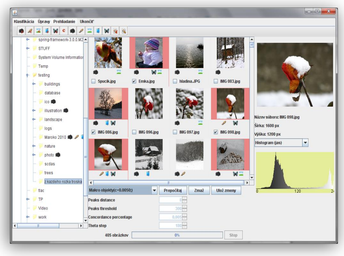
- number of local maxima in histogram
- macro objects

	Number of Images	Correctly Classified	Success Ratio
Learning Set	118	118	98,89%
Set A	297	259	87.20%
Set B	405	295	72.84%

- local contrast

Conclusions

- **modular** and **extensible** method for image classification
  - set of classification classes $\mathcal{K}$ can be extended
  - accuracy can increased by extending the set of attributes
- software tool has been implemented
- future work
  - run a classification system on-line
  - allow users to give natural language descriptions



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