Percentile Blobs for Image Similarity

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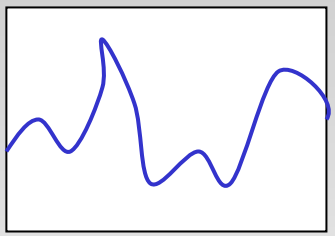
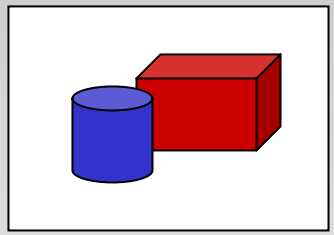
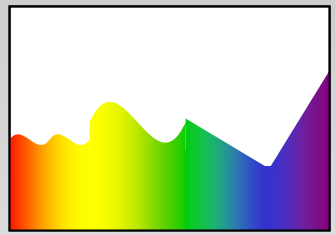
Approaches to Image Similarity



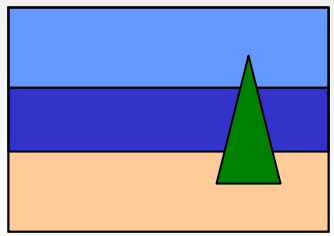
Eigenvalues



Geometry



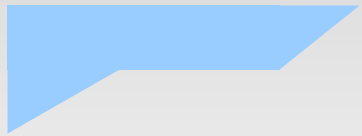
Holistic Properties
(Color, Texture)



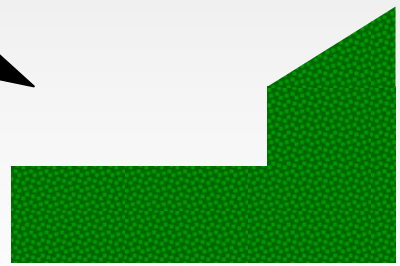
Geometry + Holistic Properties

Blob-Based Representation

- Approach: Identify and describe regions which possess particular color/texture properties.



Light Blue, Low Texture

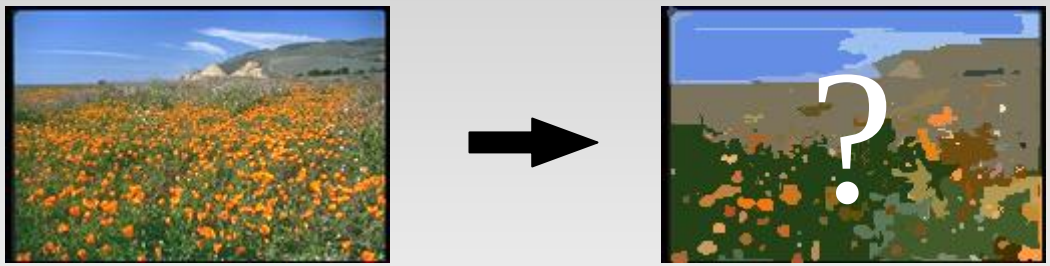


Green, High Texture

etc...

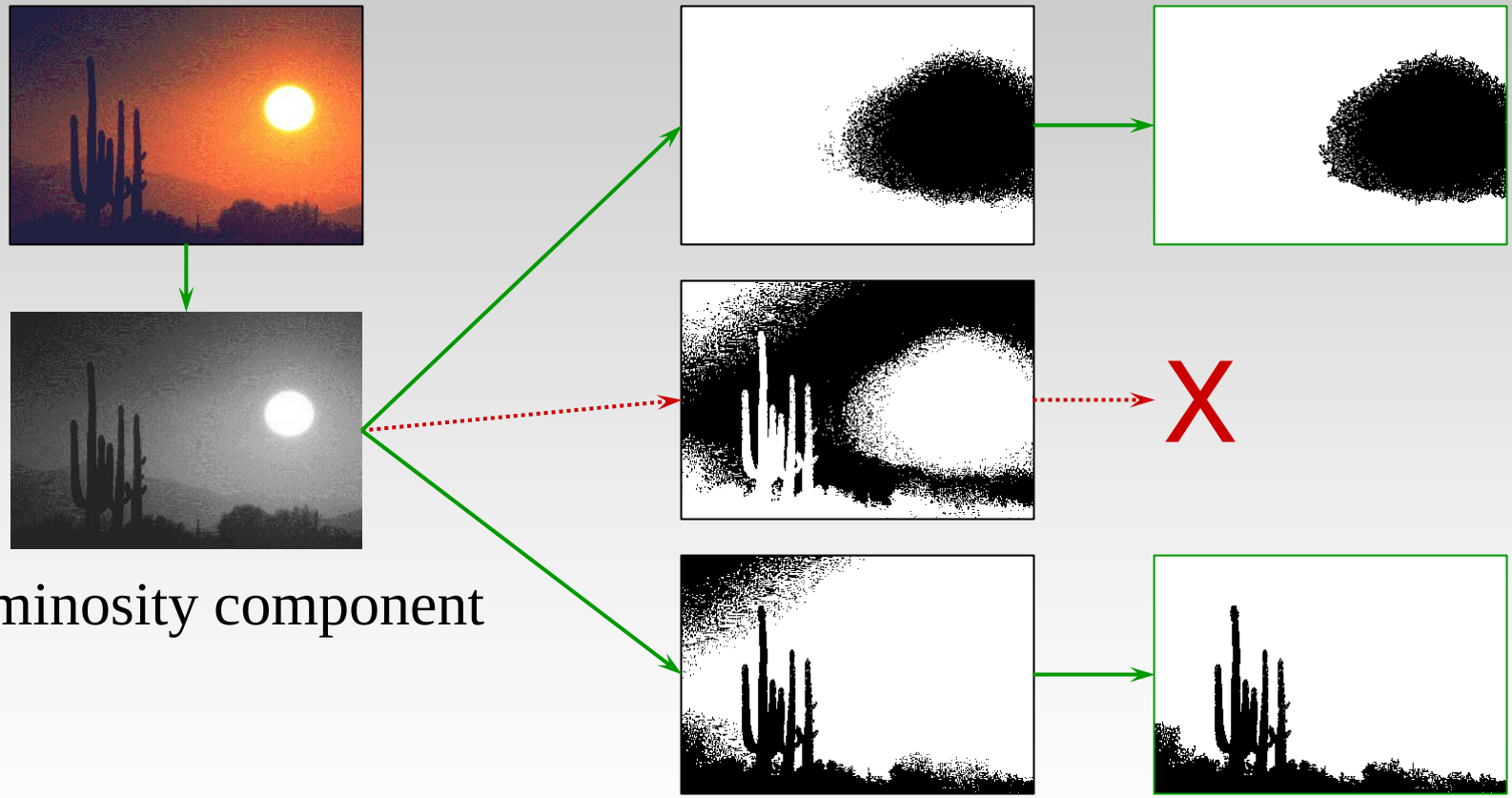
Segmentation

- Full segmentation is difficult:



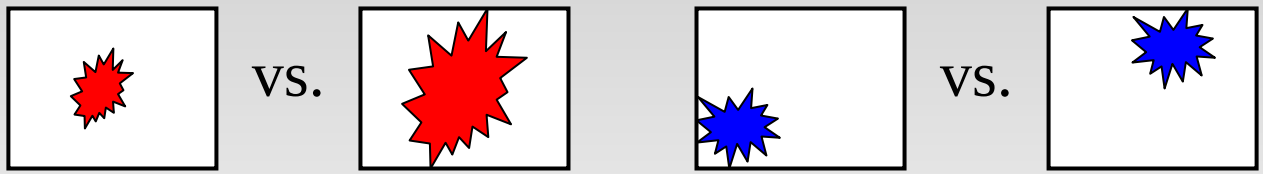
- Solution: Use intensity percentiles to form a working segmentation.
- Quartiles work well empirically.
- Applied to YUV components & texture map.

Example: Intensity Quartiles

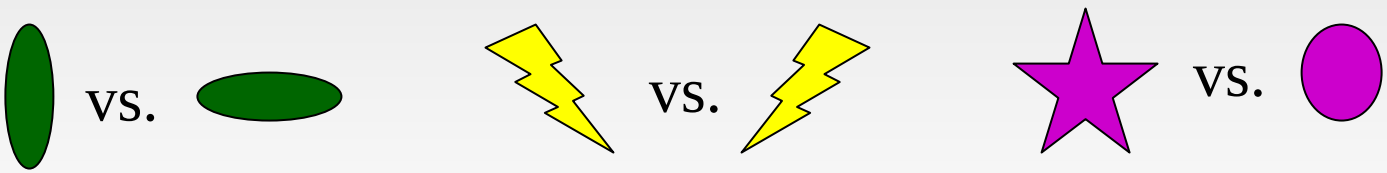


Blob Descriptors

- We use 11 statistics to describe each blob.



Size (area and extent) Location

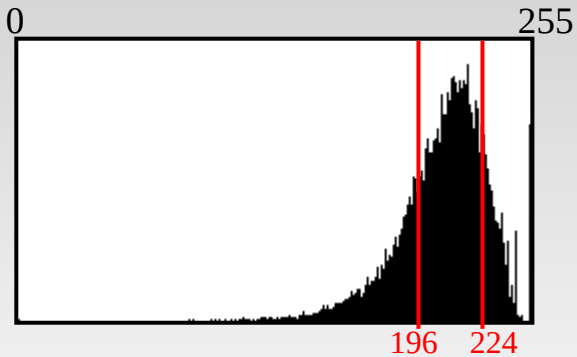


Aspect Slant Compactness

- All are expressed as dimensionless quantities.

Global Statistics

- Range of intensity covered by each quartile:

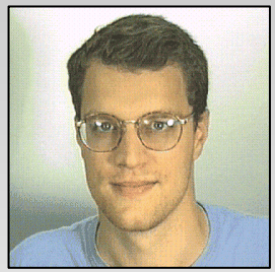


Low range: 0 - 196
Mid range: 196-224
High range: 224-255

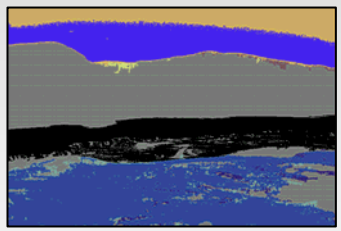
- Simple statistics on overall image intensity distribution:
  - Standard deviation
  - Skew & Kurtosis

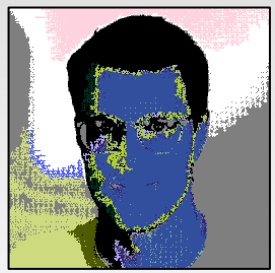
Importance of Global Statistics

Original:

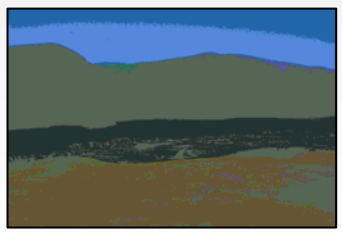


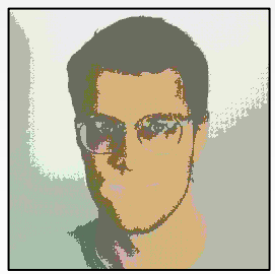
Without:





With:





Summary of Image Description

- 36 global numeric features.
- 8 blob features.
  - These may include several blobs of similar importance.
  - Each blob is described by 11 numeric statistics.

numeric features

blob features

$$(val(f_1), val(f_2), \ldots, val(f_{36}), val(f_{37}), val(f_{38}), \ldots, val(f_{44}))$$

$$\{B_{38:1}, B_{38:2}, \ldots\}$$

$$(val(g_1(B_{38:2})), val(g_2(B_{38:2})), \ldots, val(g_{11}(B_{38:2})))$$

Experiment

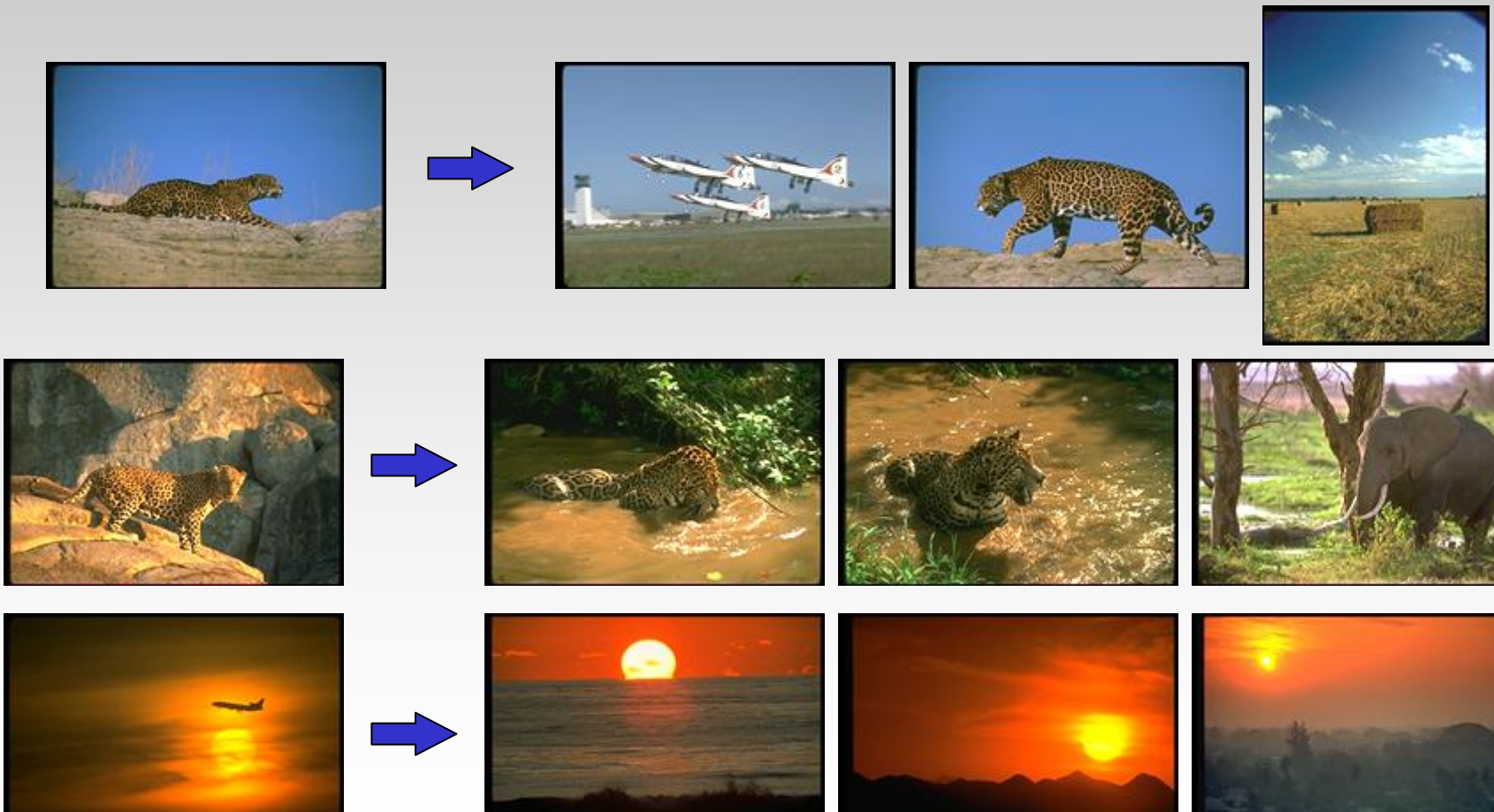
- Test set of 1011 images from Corel.
- 12 categories of images.
- Leave-one-out cross validation.
- Each image classified in the category of its nearest neighbor.
- Mean accuracy 73.7%.
  - Rises to 80.0% with feature weighting.

Results (Confusion Matrix)

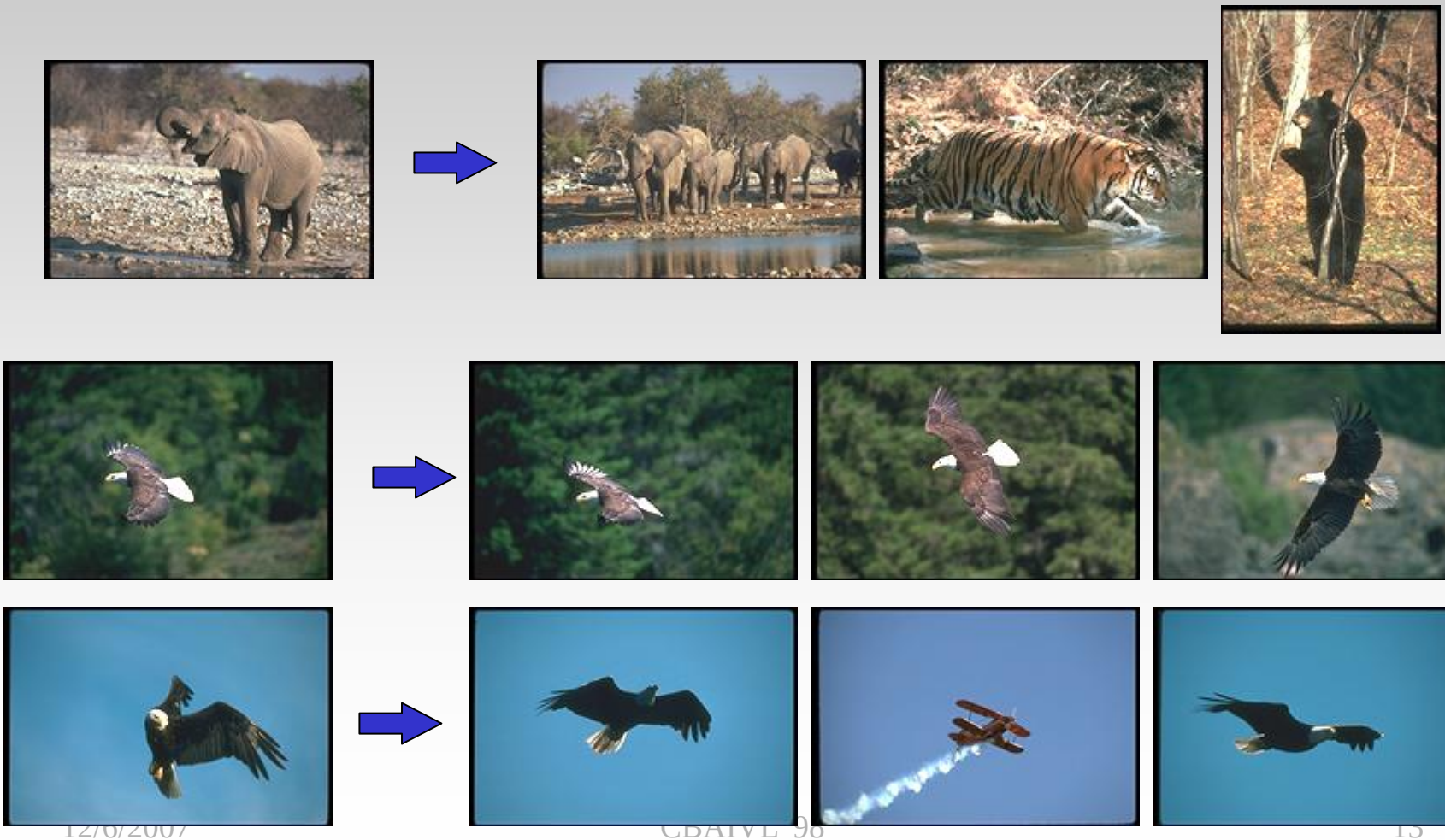
* numbers on diagonal are correct responses

	Airshows	Bald Eagles	Brown Bears	Cheetahs	Deserts	Elephants	Fields	Mountains	Night	Polar Bears	Sunsets	Tigers
Airshows	**72**	11	0	2	0	1	1	2	0	9	0	0
Bald Eagles	2	**86**	2	0	1	0	3	1	0	2	0	2
Brown Bears	0	5	**45**	3	9	15	8	6	0	2	0	8
Cheetahs	2	0	0	**73**	2	3	5	0	0	1	2	12
Deserts	0	1	4	4	**73**	0	8	1	4	1	1	1
Elephants	1	0	3	0	1	**88**	4	1	0	0	0	2
Fields	1	4	8	12	11	15	**36**	6	1	1	0	4
Mountains	1	2	4	0	2	3	2	**83**	1	0	0	0
Night	0	3	0	1	2	0	0	1	**79**	0	8	5
Polar Bears	14	6	3	3	0	6	0	0	0	**63**	0	6
Sunsets	0	0	0	3	1	1	0	0	9	0	**83**	2
Tigers	0	0	1	4	0	6	0	1	0	0	0	**88**

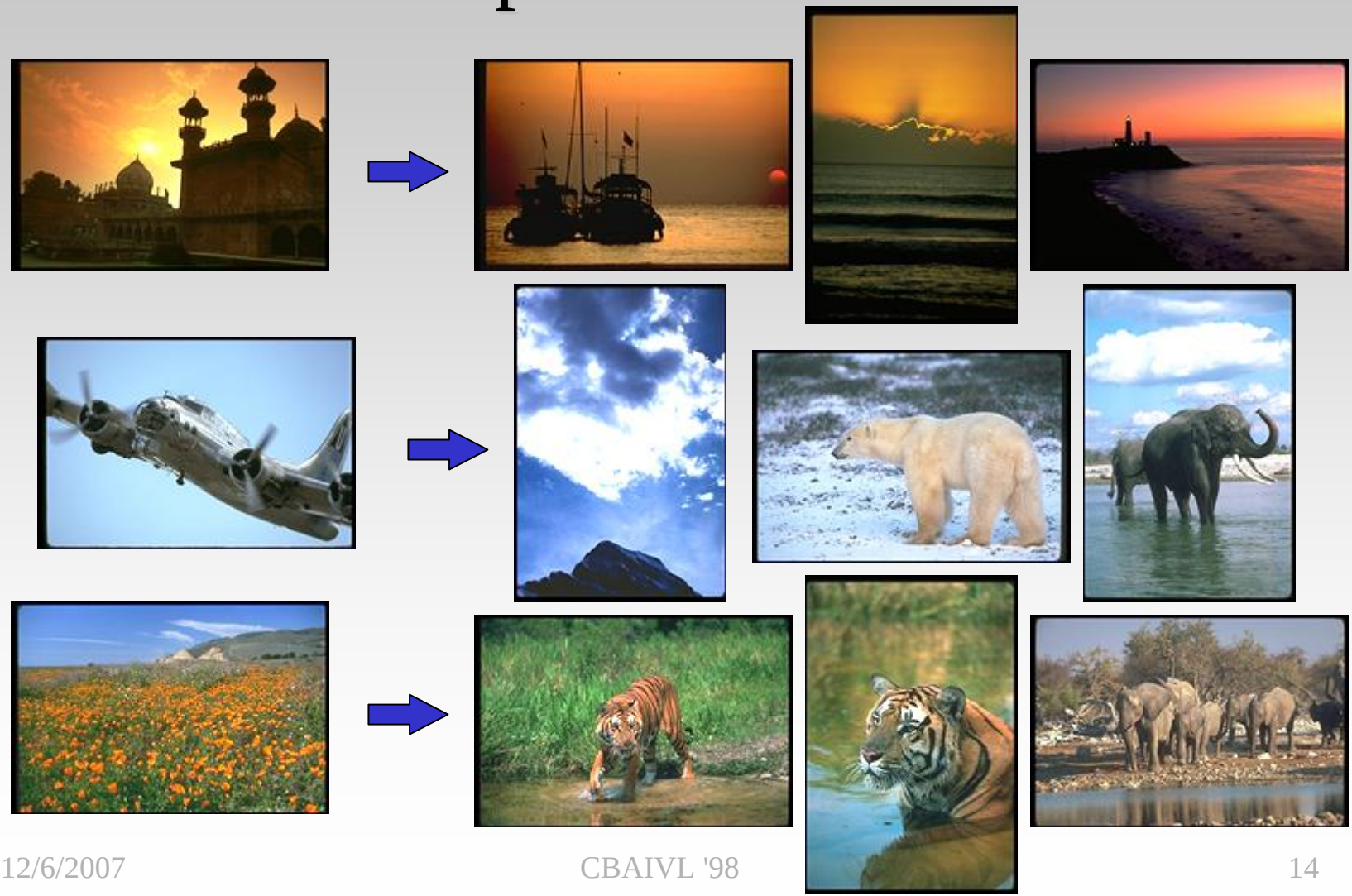
Sample Retrievals



Sample Retrievals



Sample Retrievals

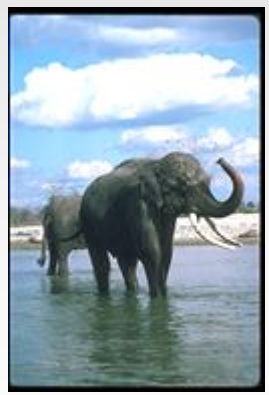


Comparison with Color Histograms

Query Image: Our Method: Color Histograms:

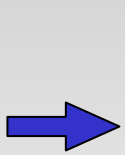
vs.

vs.



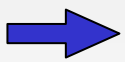
More on Color Histograms

Query Image: Our Method: Color Histograms:

vs.





vs.


Why Does It Work?

- Natural images, usually of a single subject.

- Extremes along selected dimensions tend to pick out important elements of a scene.

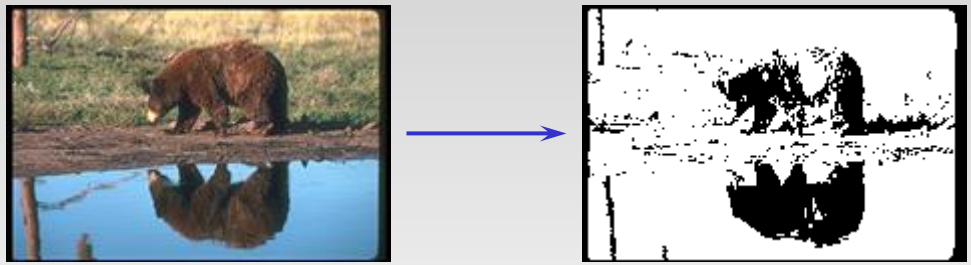
- Power of combining color and texture with spatial information.

Conclusions

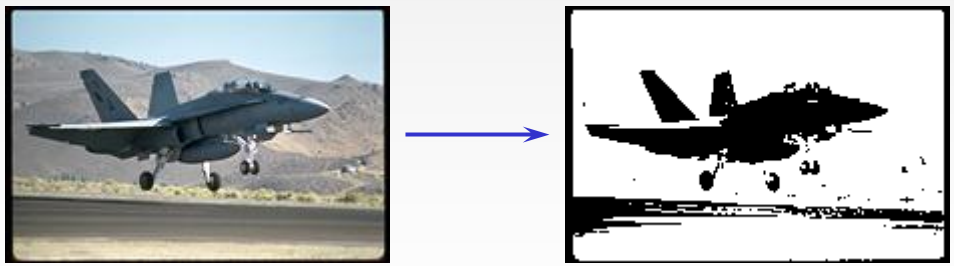
- For natural scenes, the distribution of intensity, color, and texture provides a good description of an image.
- Analysis of this distribution can be used to retrieve related images from a database.
- Future work: Handle a wider range of images.

Why Allow Multiple Blobs?

- Sometimes, it's not clear which blob is interesting.



- We want to allow multiple options.



The Similarity Metric

- Image descriptions consist of 36 numeric features and 8 set-like features.

numeric set-like

$$\Delta(I_1, I_2) = \sum_{i=1}^{36} \left| f_i(I_1) - f_i(I_2) \right| + \sum_{i=37}^{44} \left[\min_{B_1 \in f_i(I_1), B_2 \in f_i(I_2)} \left(\delta(B_1, B_2) \right) \right]$$

$$\delta(B_1, B_2) = \sum_{j=1}^{11} \left| g_j(B_1) - g_j(B_2) \right|$$

In Comparison