

COURSE NAME:
DATA WAREHOUSING & DATA MINING

LECTURE 21

TOPICS TO BE COVERED:

- × Multimedia databases

SIMILARITY SEARCH IN MULTIMEDIA DATA

× Description-based retrieval systems

- + Build indices and perform object retrieval based on image descriptions, such as keywords, captions, size, and time of creation
- + Labor-intensive if performed manually
- + Results are typically of poor quality if automated

× Content-based retrieval systems

- + Support retrieval based on the image content, such as color histogram, texture, shape, objects, and wavelet transforms

QUERIES IN CONTENT-BASED RETRIEVAL SYSTEMS

- ✘ Image sample-based queries:
 - + Find all of the images that are similar to the given image sample
 - + Compare the feature vector (signature) extracted from the sample with the feature vectors of images that have already been extracted and indexed in the image database
- ✘ Image feature specification queries:
 - + Specify or sketch image features like color, texture, or shape, which are translated into a feature vector
 - + Match the feature vector with the feature vectors of the images in the database

APPROACHES BASED ON IMAGE SIGNATURE

× Color histogram-based signature

- + The signature includes color histograms based on color composition of an image regardless of its scale or orientation
- + No information about shape, location, or texture
- + Two images with similar color composition may contain very different shapes or textures, and thus could be completely unrelated in semantics

× Multifeature composed signature

- + The signature includes a composition of multiple features: color histogram, shape, location, and texture
- + Can be used to search for similar images

WAVELET ANALYSIS

× Wavelet-based signature

- + Use the dominant wavelet coefficients of an image as its signature
- + Wavelets capture shape, texture, and location information in a single unified framework
- + Improved efficiency and reduced the need for providing multiple search primitives
- + May fail to identify images containing similar in location or size objects

× Wavelet-based signature with region-based granularity

- + Similar images may contain similar regions, but a region in one image could be a translation or scaling of a matching region in the other
- + Compute and compare signatures at the granularity of regions, not the entire image

C-BIRD: CONTENT-BASED IMAGE RETRIEVAL FROM DIGITAL LIBRARIES

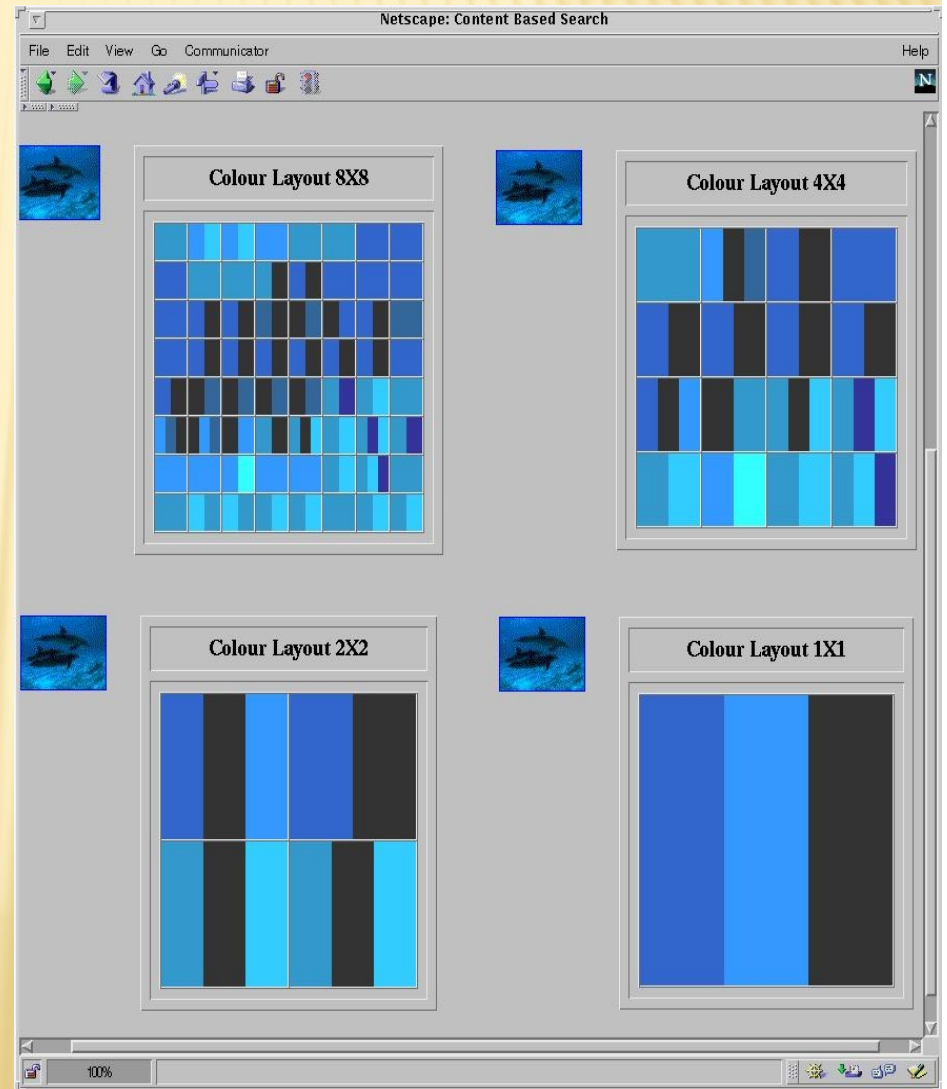
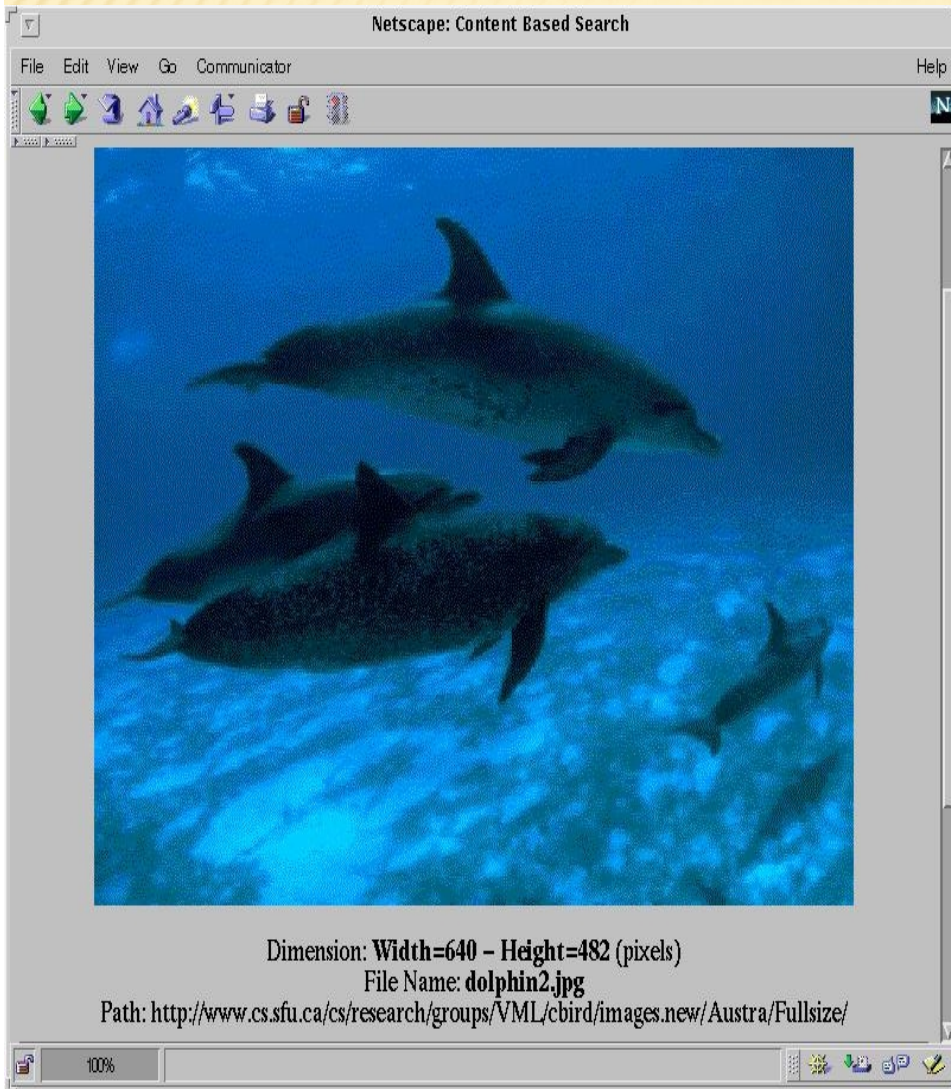


Search

- by image colors
- by color percentage
- by color layout
- by texture density
- by texture Layout
- by object model
- by illumination invariance
- by keywords

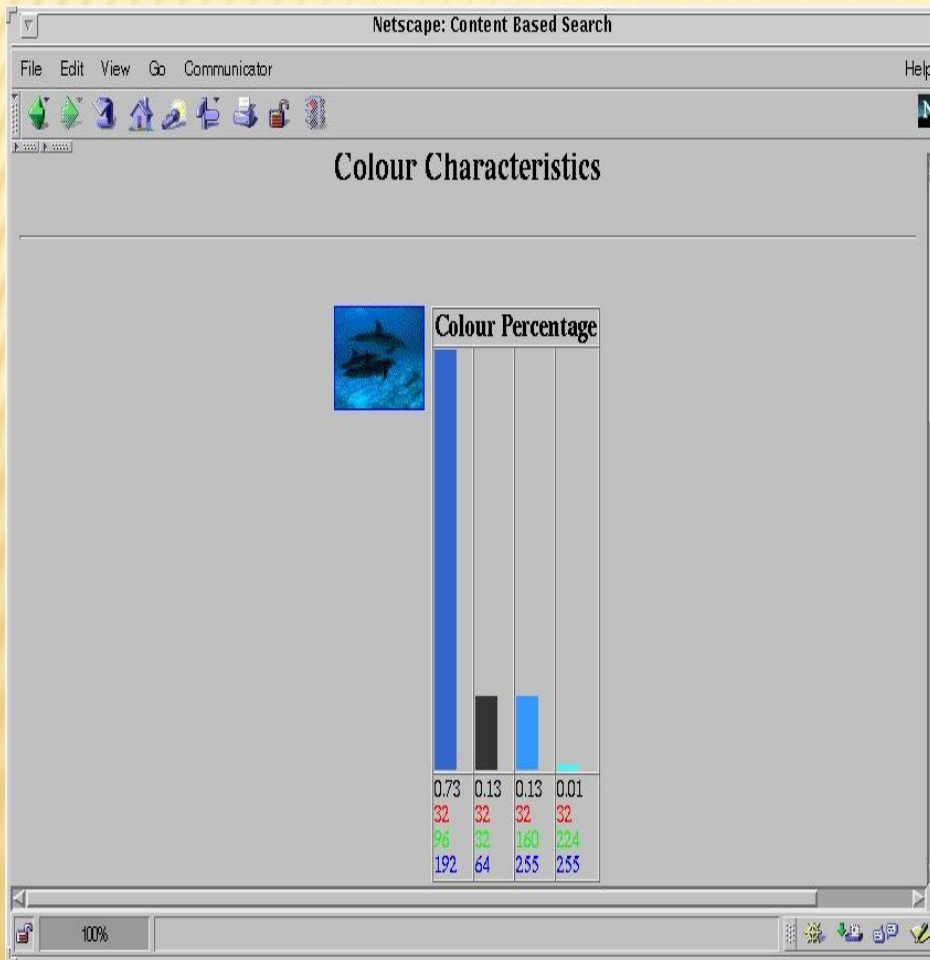
MULTI-DIMENSIONAL SEARCH IN MULTIMEDIA DATABASES

Color layout

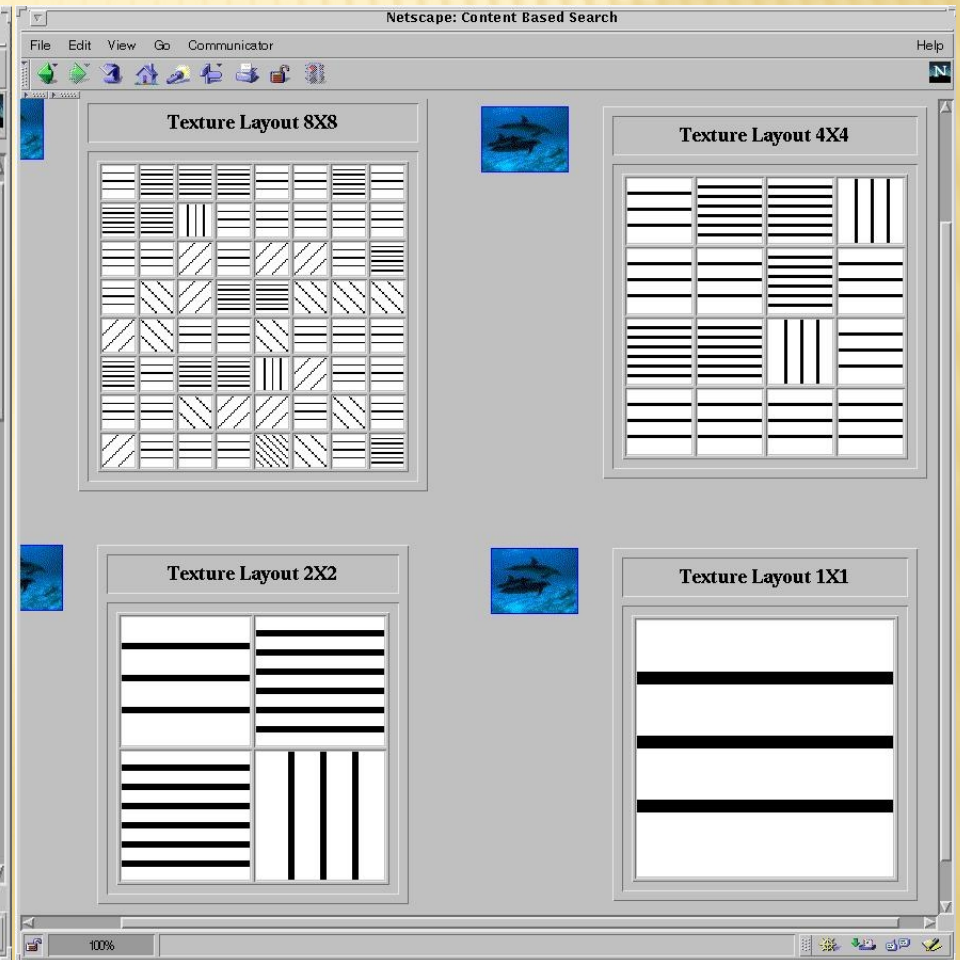


MULTI-DIMENSIONAL ANALYSIS IN MULTIMEDIA DATABASES

Color histogram



Texture layout



MINING MULTIMEDIA DATABASES

Refining or combining searches



Search for “blue sky”
(top layout grid is blue)



Search for “airplane in blue sky”
(top layout grid is blue and
keyword = “airplane”)



Search for “blue sky and
green meadows”
(top layout grid is blue
and bottom is green)

MULTIDIMENSIONAL ANALYSIS OF MULTIMEDIA DATA

- × Multimedia data cube
 - + Design and construction similar to that of traditional data cubes from relational data
 - + Contain additional dimensions and measures for multimedia information, such as color, texture, and shape
- × The database does not store images but their descriptors
 - + **Feature descriptor**: a set of vectors for each visual characteristic
 - × Color vector: contains the color histogram
 - × MFC (Most Frequent Color) vector: five color centroids
 - × MFO (Most Frequent Orientation) vector: five edge orientation centroids
 - + **Layout descriptor**: contains a color layout vector and an edge layout vector

MINING MULTIMEDIA DATABASES IN MultiMediaMiner

The screenshot displays the MultiMediaMiner application window. The interface is divided into several sections:

- Menu Bar:** File, Edit, Query, View, Window, Options, Help.
- Toolbar:** Contains icons for file operations (open, save, print), editing (copy, paste), and search (magnifying glass).
- Left Panel (Ontology Tree):** A hierarchical tree structure for classifying multimedia objects. The root is 'entity', which branches into 'causal_agent', 'life_form', and 'object'. Under 'object', there are several sub-categories, including 'artifact', 'instrumentality', 'vehicle', and 'craft'. The 'craft' category is further divided into 'aircraft', which includes 'airplane', 'airliner', 'biplane', and 'bomber'. The 'airliner' category is further subdivided into 'airbus', 'airlanka', 'balair', 'boeing', and '707'.
- Right Panel (Image Grid):** A large grid of small images, all depicting various types of airplanes in flight, on the ground, or in close-up views of engines and cockpits.
- Bottom Bar:** Includes the text 'For Help, press F1' on the left and a 'NUM' button on the right.

For Help, press F1

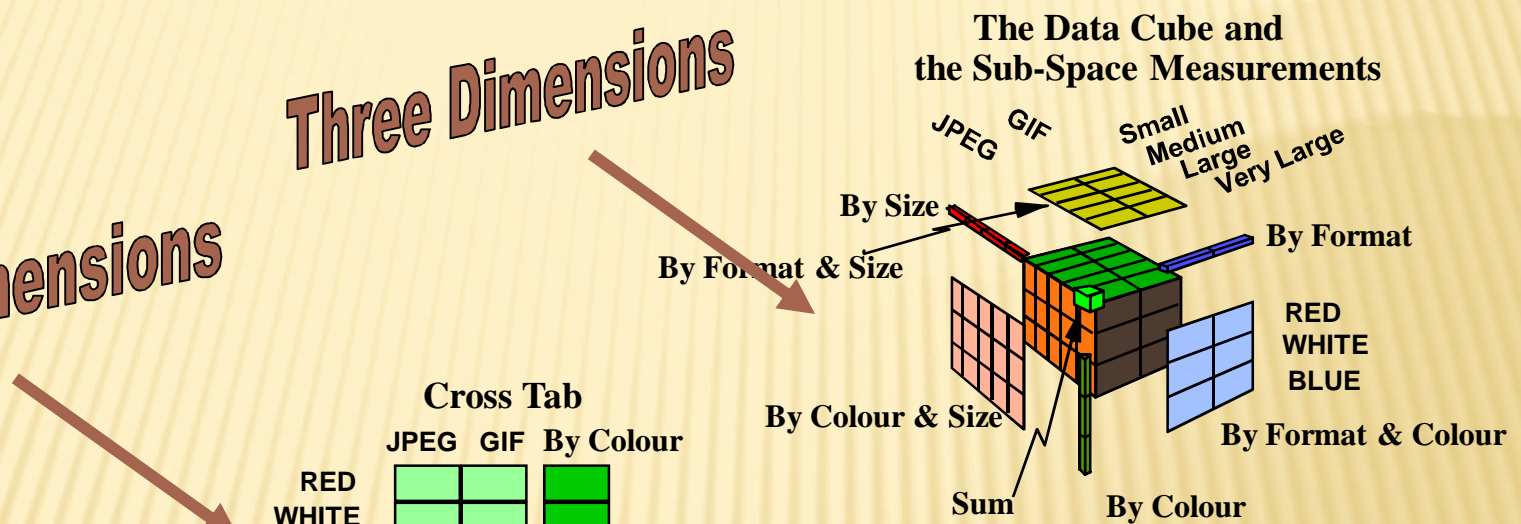
NUM

MINING MULTIMEDIA DATABASES

Two Dimensions

Three Dimensions

The Data Cube and the Sub-Space Measurements



Cross Tab

JPEG GIF By Colour

RED
WHITE
BLUE

RED	Light Green	Light Green	Light Green
WHITE	Light Green	Light Green	Light Green
BLUE	Light Green	Light Green	Light Green

By Format

Blue	Blue	Dark Green
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Sum

Group By

Colour

RED	Light Green
WHITE	Light Green
BLUE	Light Green

Measurement

Sum

- Format of image
- Duration
- Colors
- Textures
- Keywords
- Size
- Width
- Height
- Internet domain of image
- Internet domain of parent pages
- Image popularity

Dimensions

CLASSIFICATION IN MULTIMEDIAMINER

The screenshot displays the MultiMediaMiner application window. At the top, the menu bar includes File, Edit, Query, View, Window, Options, and Help. Below the menu is a toolbar with various icons for file operations and navigation. The main interface features a search bar with 'Keyword' and 'Level0' selected, and sliders for 'Class%' (set to 95) and 'Noise%' (set to 1.00). The central area shows a hierarchical tree for the domain 'jupiter.cs.sfu.ca'. The root node is 'All', which branches into 'Book', 'Building', 'Airplane', 'Animal', 'Plant', 'Flower', and 'Tree'. Each node is accompanied by a pie chart representing the distribution of media formats. Three windows are open: 'Animal' (showing a grid of animal images), 'Book' (showing a grid of book covers), and 'Flower' (showing a grid of flower images). A legend titled 'Media Format' on the right lists the following formats with corresponding colored cylinders: MOV (yellow), AVI (magenta), MPG (blue), GIF (red), and JPEG or JPG (green). The status bar at the bottom left indicates 'For Help, press F1' and the bottom right shows a 'NUM' button.

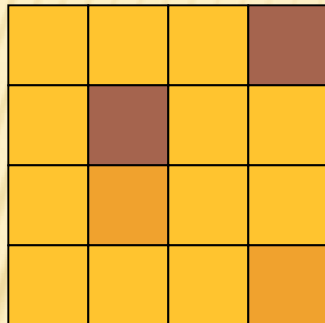
Mining Associations in Multimedia Data

- ✗ Special features:
 - + Need # of occurrences besides Boolean existence, e.g.,
 - ✗ “Two red square and one blue circle” implies theme “air-show”
 - + Need spatial relationships
 - ✗ Blue on top of white squared object is associated with brown bottom
 - + Need multi-resolution and progressive refinement mining
 - ✗ It is expensive to explore detailed associations among objects at high resolution
 - ✗ It is crucial to ensure the completeness of search at multi-resolution space

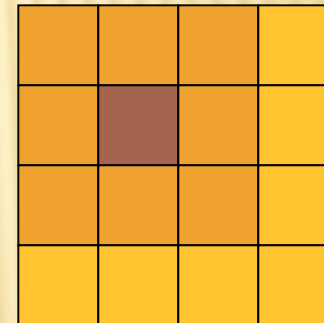
MINING MULTIMEDIA DATABASES

Spatial Relationships from Layout

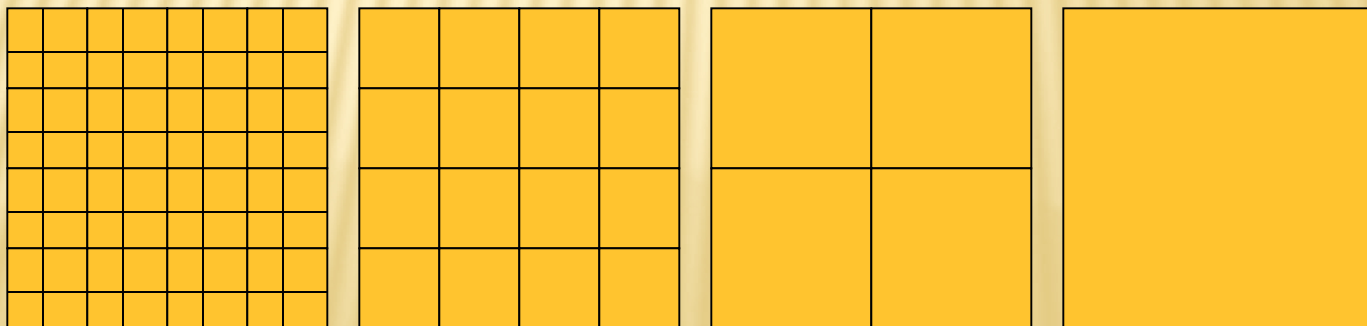
property **P1** *on-top-of* property **P2**



property **P1** *next-to* property **P2**

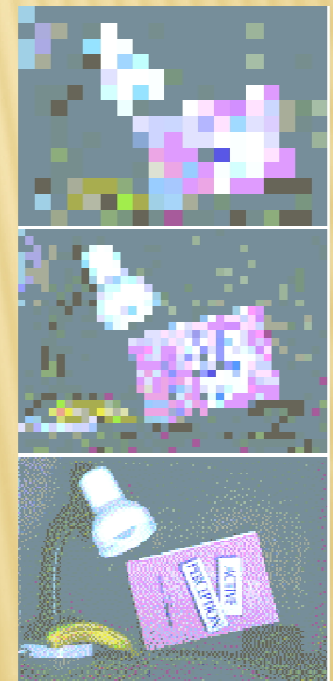
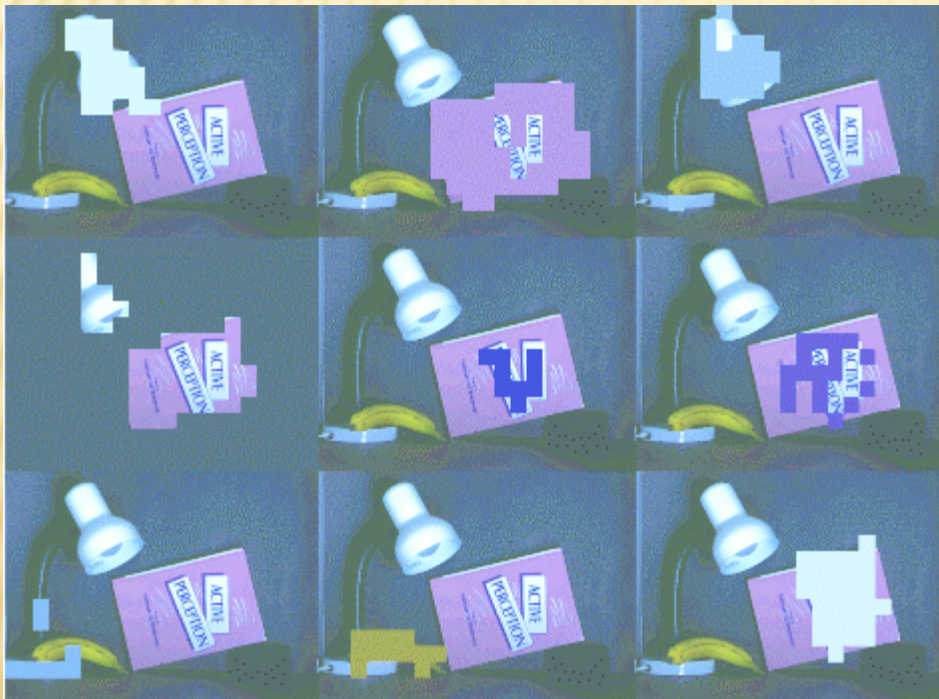


Different Resolution Hierarchy



MINING MULTIMEDIA DATABASES

From Coarse to Fine Resolution Mining



CHALLENGE: CURSE OF DIMENSIONALITY

- ✘ Difficult to implement a data cube efficiently given a large number of dimensions, especially serious in the case of multimedia data cubes
- ✘ Many of these attributes are set-oriented instead of single-valued
- ✘ Restricting number of dimensions may lead to the modeling of an image at a rather rough, limited, and imprecise scale
- ✘ More research is needed to strike a balance between efficiency and power of representation