Feature Extraction

CPS592 – Visual Computing and Mixed Reality
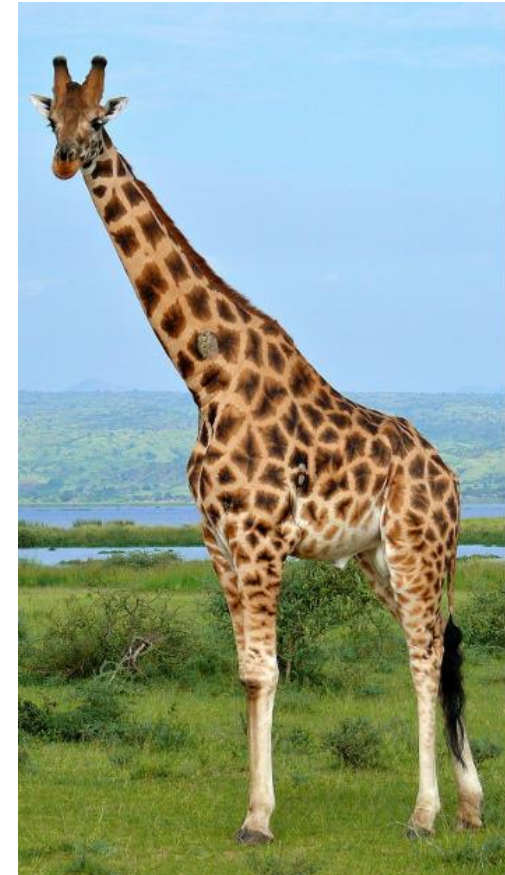
Outline

- **Introduction**
- Features
  - Histograms
  - Tiny images
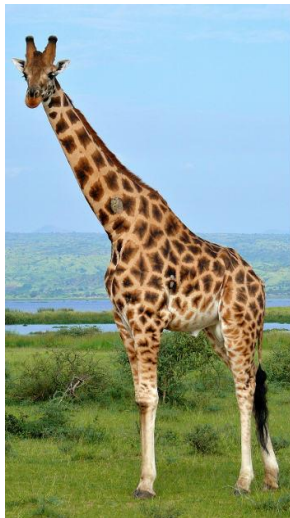 - Local Binary Pattern

Introduction

Which images are similar?

Problems

- Need visual features (representation) which can describe the images.
- Note that the images are varied in terms of size, aspect ratio, lighting, etc.

Lots of applications

Features are used for:
- Object recognition
- Indexing and database retrieval
- Robot navigation
- … other

Application

Image

Google image search

Similar images

Application

Outline

- Introduction

- Features
  - Histograms
  - Tiny images
  - Local Binary Pattern

Image Histogram

Bright image

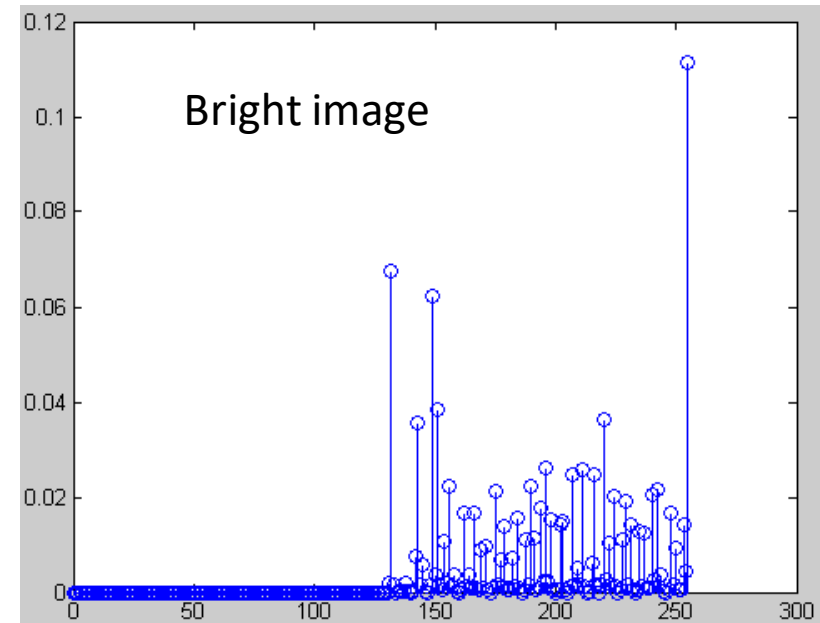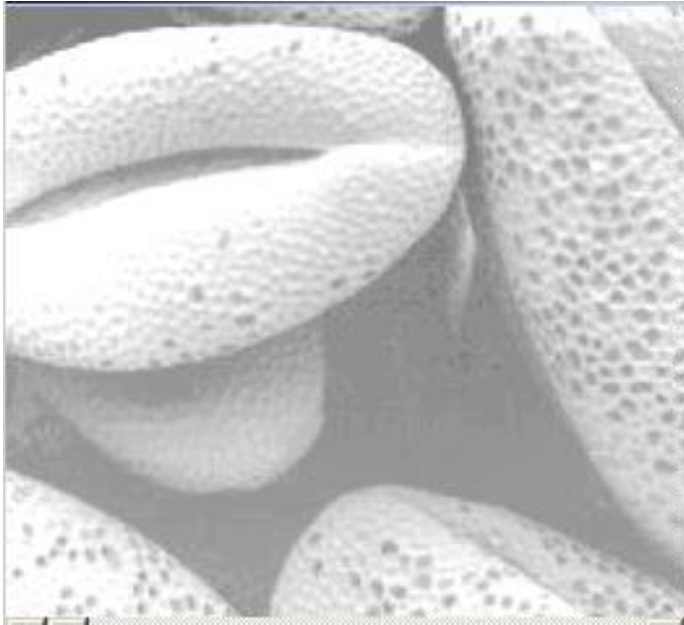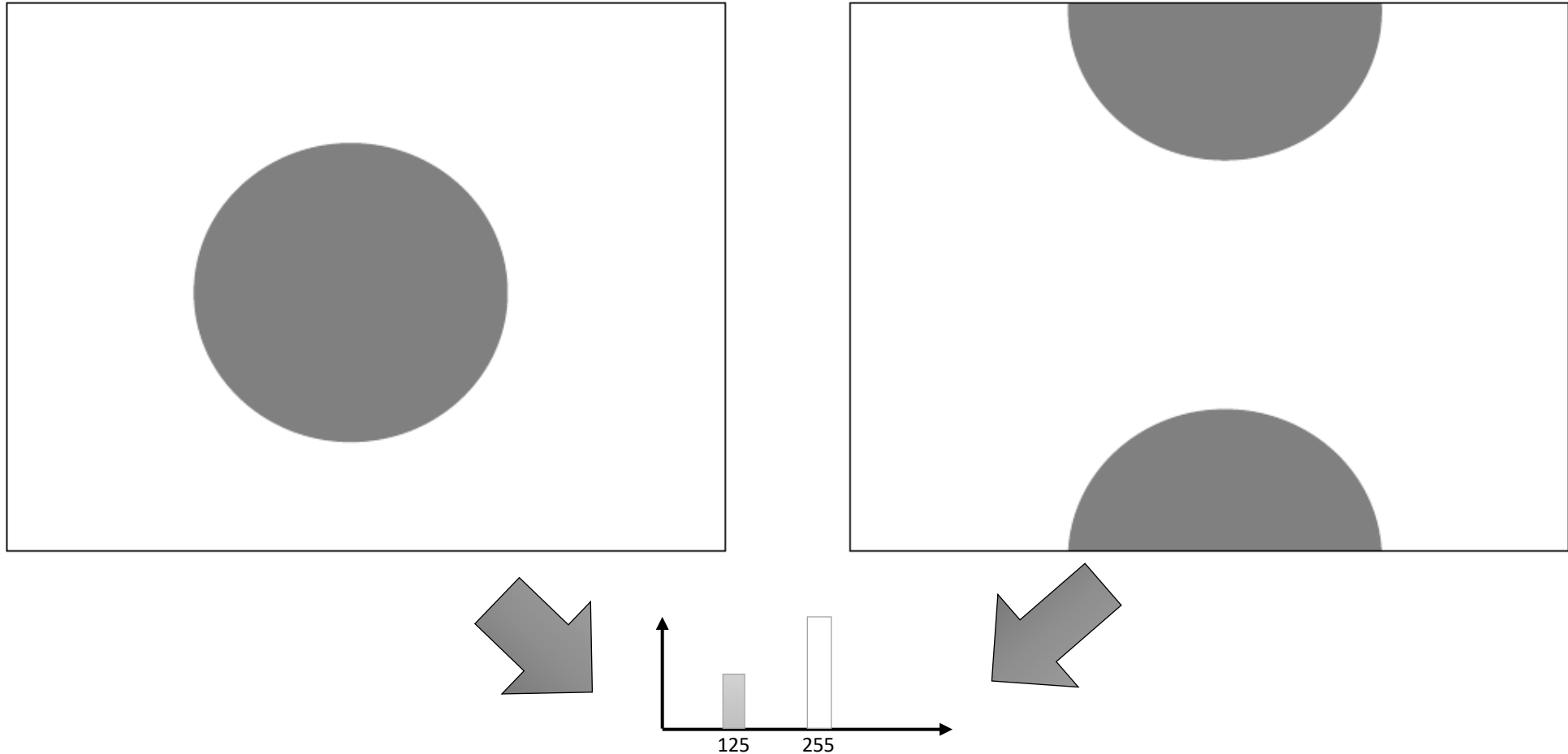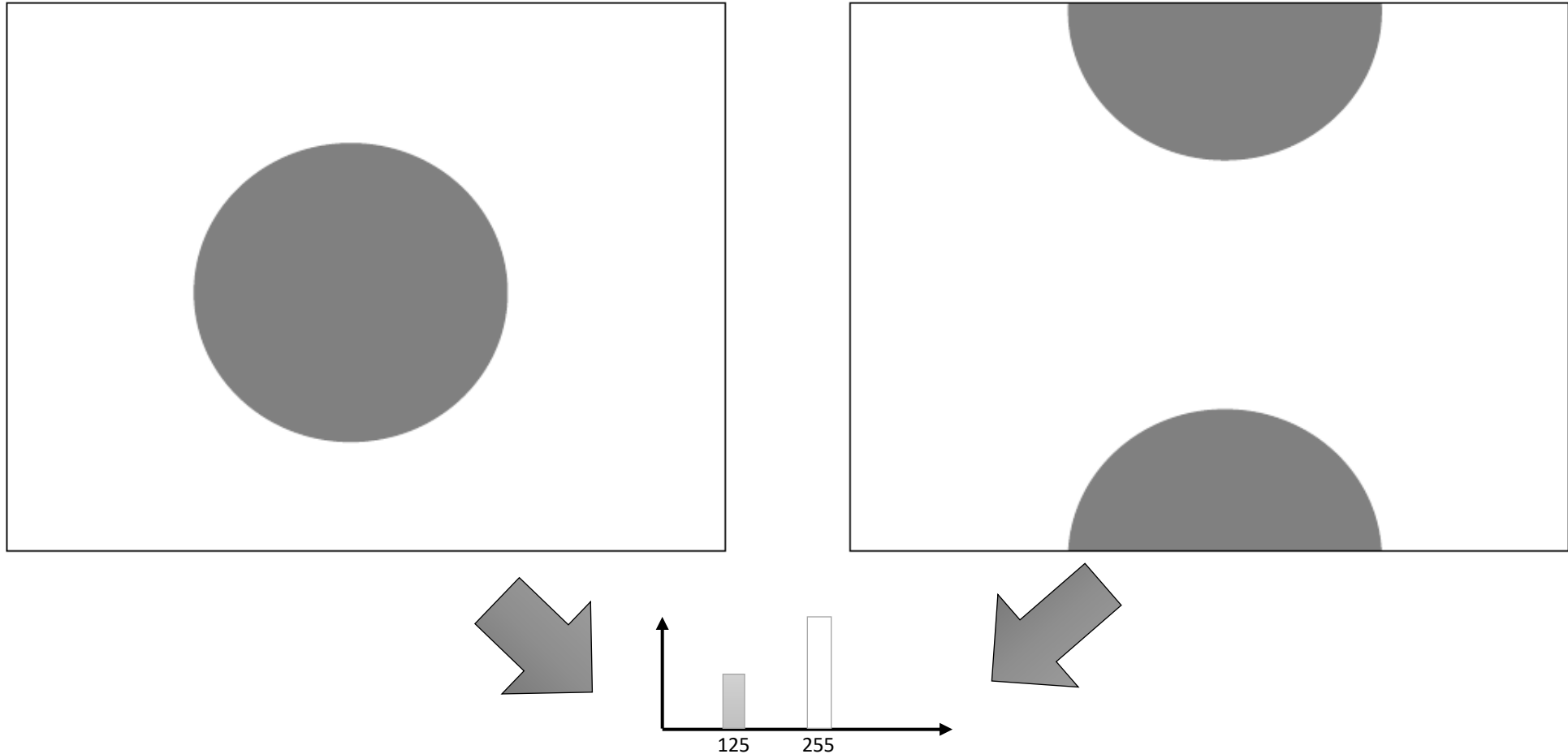What is the dimensionality? 256 dims

Image Histogram

- Keep in mind that histograms are not unique

Image Histogram

• How to solve this problem? • Use more local histograms.

Image Histogram

Extract histogram from different local regions.

125   255

255
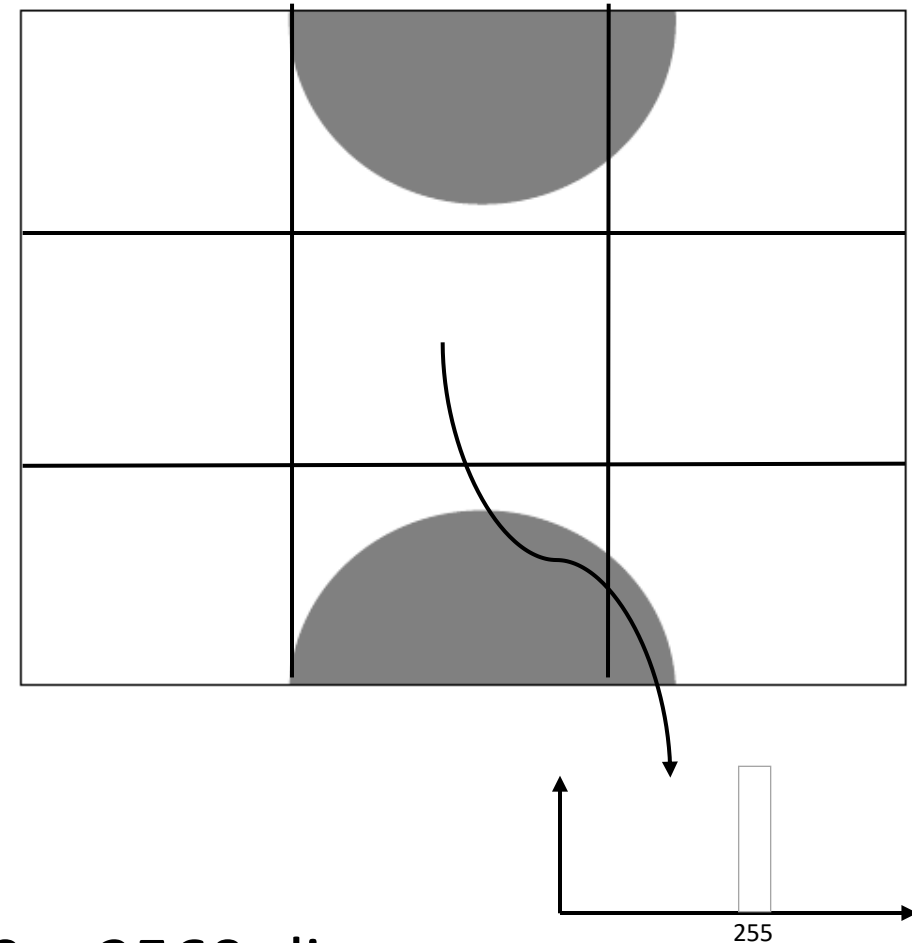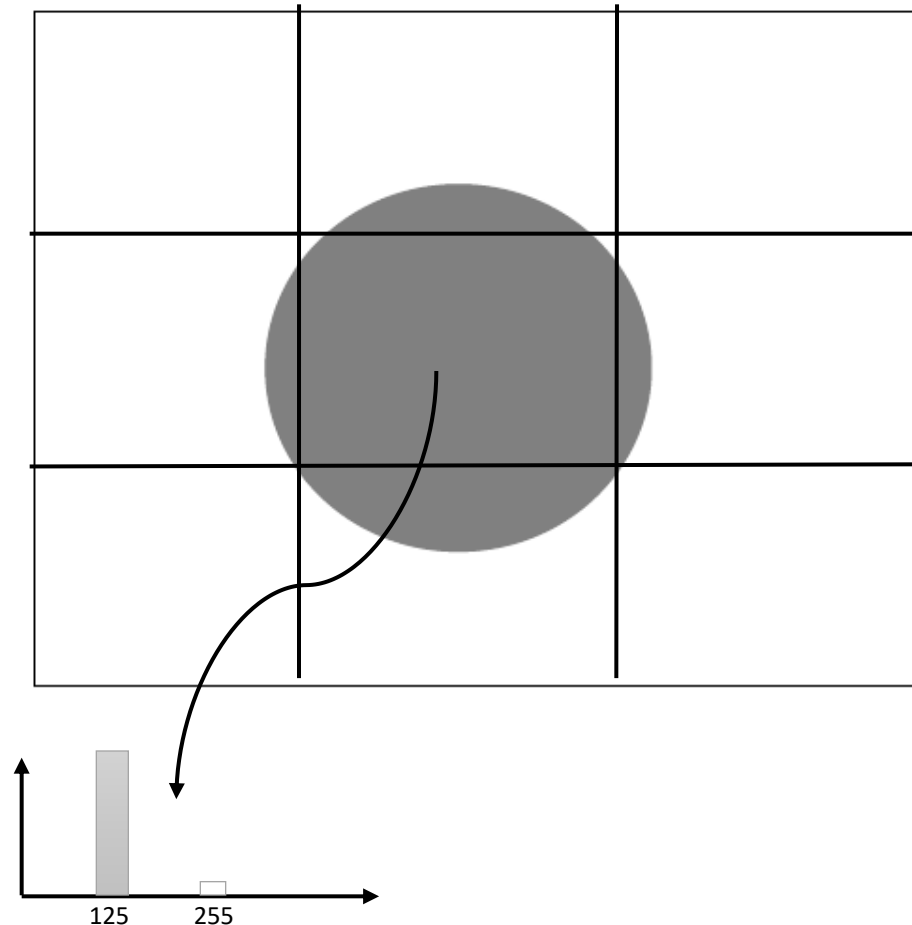
What is the dimensionality? 256 x 10 = 2560 dims

Histogram normalization

For images with discrete gray values, compute normalized histogram:

$$p_{in}(r_k) = \frac{n_k}{n} \qquad 0 \le r_k \le 1 \qquad 0 \le k \le L-1$$

L: Total number of gray levels

n_k: Number of pixels with gray value r_k

n: Total number of pixels in the image

What is the value of $\sum_{r_k=0}^{L-1} p_{in}(r_k)$?

Tiny Images

- 80 million tiny images: a large dataset for non-parametric object and scene recognition Antonio Torralba, Rob Fergus and William T. Freeman. PAMI 2008.

http://groups.csail.mit.edu/vision/TinyImages/

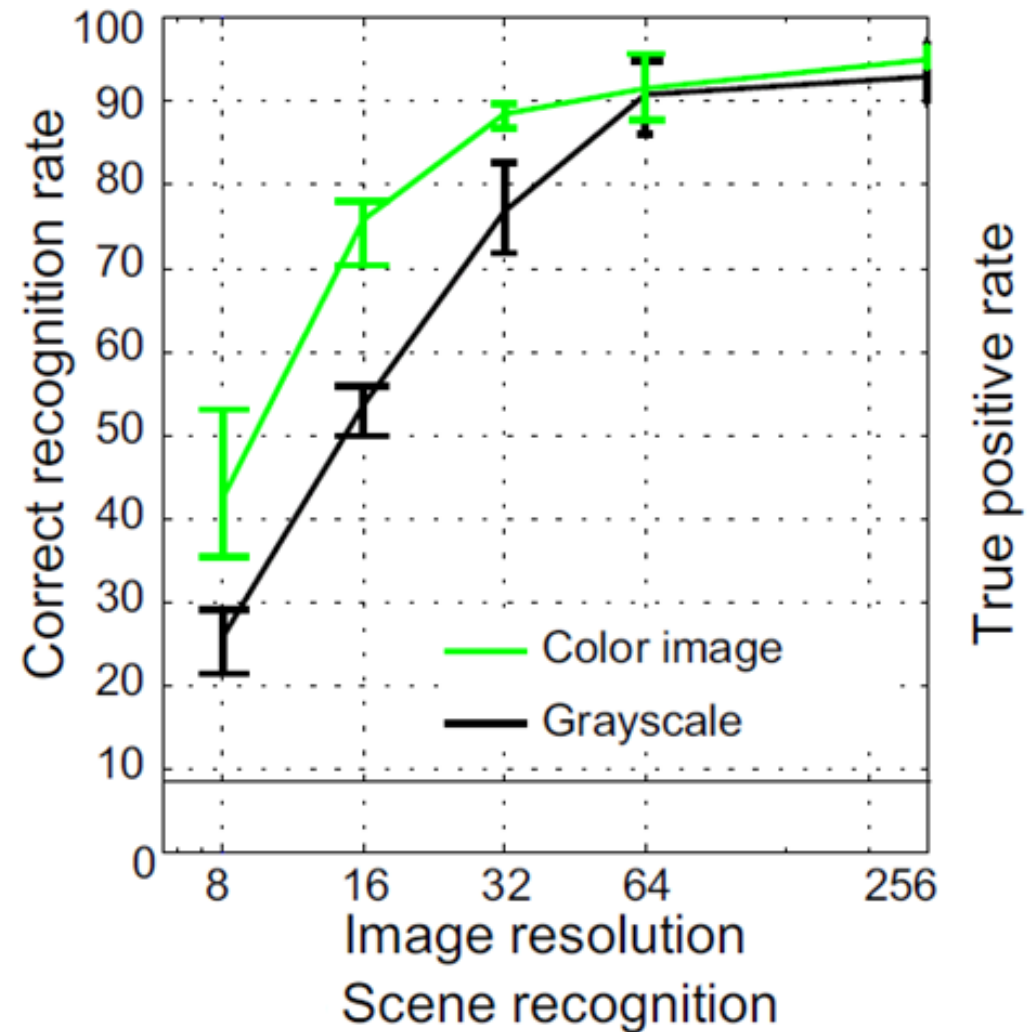# Low dimensional image representations

What is the smallest image dimensionality that human still can perform well?

Ask human !!!

Human Scene Recognition

Scene recognition

Low dimensional image representations

32 x 32 is very ~~very~~ small

180 x 150

130 x 100

90 x 90

32 x 32

Low dimensional image representations

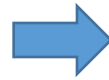

Segmentation of 32x32 images

How to extract "tiny image" feature?

Input image → Tiny image (32 x 32) → Raw pixel values

$$\begin{bmatrix} 84 \\ 83 \\ \dots \\ 250 \\ 255 \end{bmatrix}$$
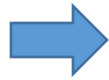
What is the dimensionality? 32 x 32 x 3 = 3072 dims

Local Binary Patterns

- Local Binary Patterns (LBP) is one of the best performing texture descriptors and widely used in various applications.

- It has proven to be highly discriminative and because its invariance to monotonic gray level changes and computational efficiency, make it suitable for demanding image analysis tasks.

T. Ojala, M. Pietikäinen, and D. Harwood (1996), "A Comparative Study of Texture Measures with Classification Based on Feature Distributions", Pattern Recognition, vol. 29, pp. 51-59.

How to extract Local Binary Pattern

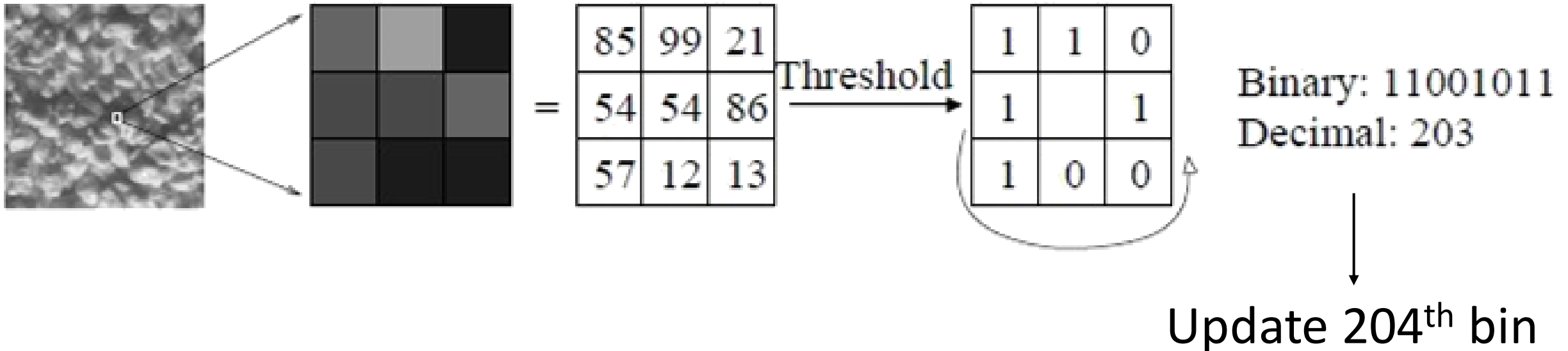- For each pixel p, create an 8-bit number $b_1\ b_2\ b_3\ b_4\ b_5\ b_6\ b_7\ b_8$, where $b_i = 0$ if neighbor i has value less than or equal to p's value and 1 otherwise.

- Represent the texture in the image (or a region) by the histogram of these numbers.

1	2	3
100	101	103
40	50	80
50	60	90

8 ... 4

7 ... 6 ... 5

→ 1 1 1 1 1 1 0 0 → 252
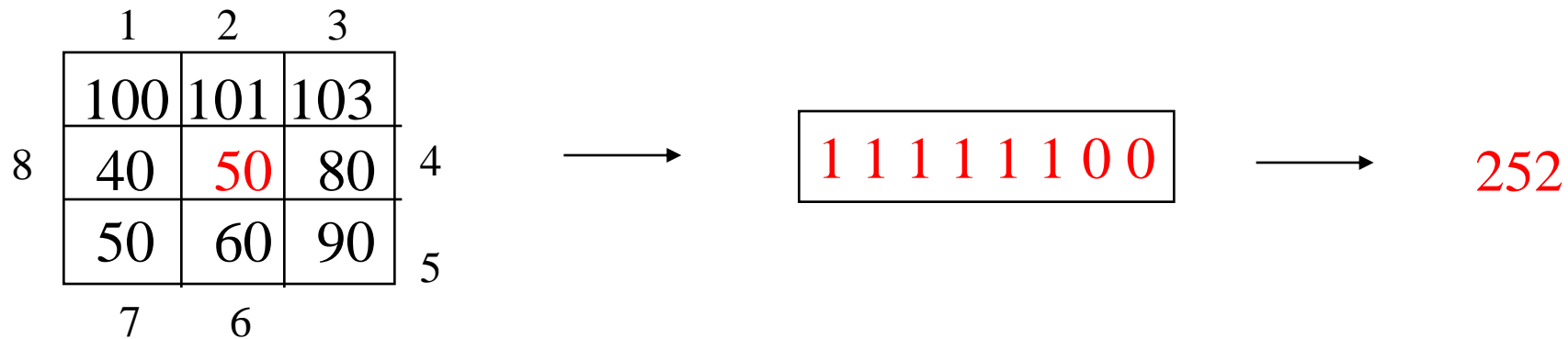
How to extract Local Binary Pattern

The histogram of the labels used as a texture descriptor.

85	99	21
54	54	86
57	12	13

Threshold →

1	1	0
1		1
1	0	0

Binary: 11001011
Decimal: 203

Update 204th bin

What is the dimensionality? 256 dims

Q&A