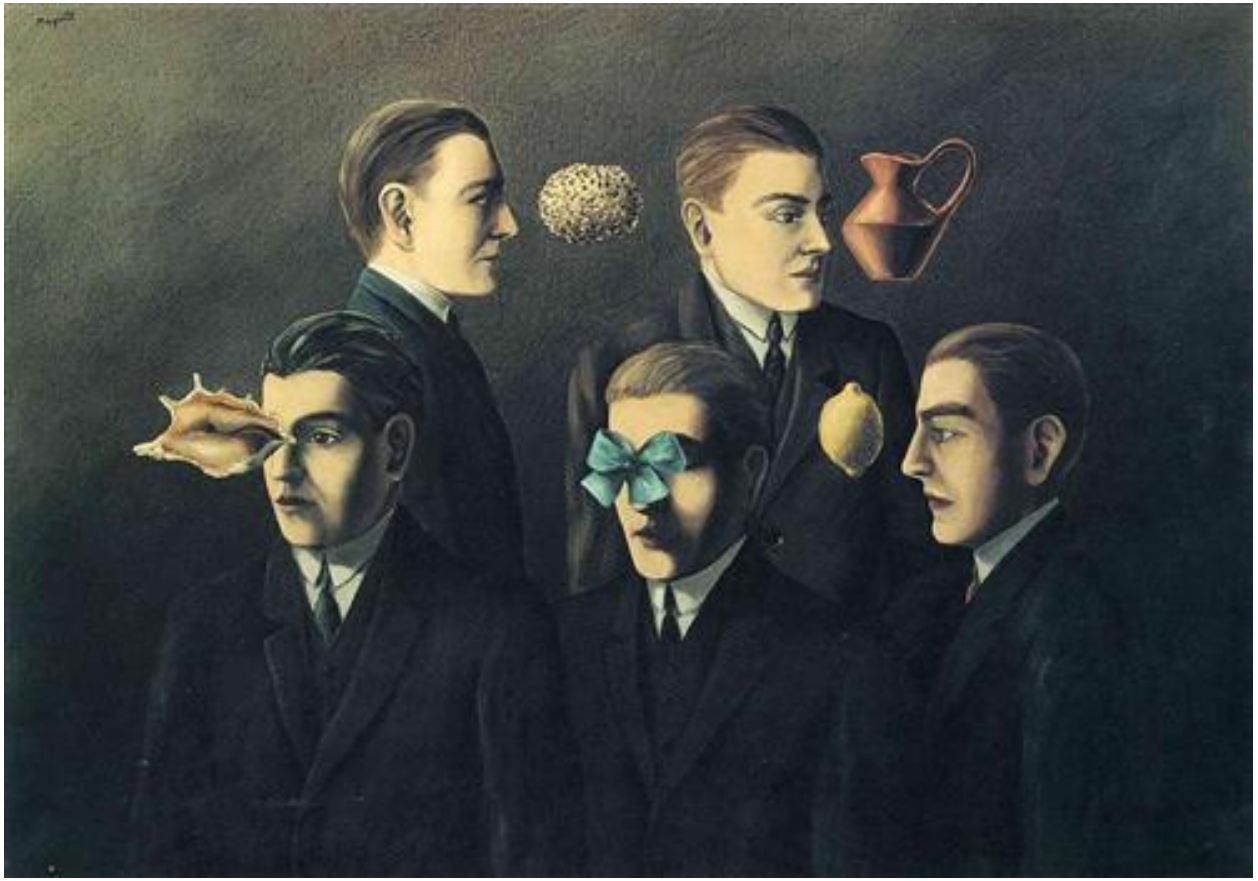
Object/Face Recognition (+PCA Review)



René Magritte, “The Familiar Objects”

Many slides from
Noah Snavely, Derek Hoeim

CSC320: Introduction to Visual Computing
Michael Guerzhoy

Simple idea for face recognition

1. Treat face image as a vector of intensities

$$\mathbf{x}$$

2. Recognize face by nearest neighbor in database

$$\mathbf{y}_1 \cdots \mathbf{y}_n$$

$$k = \operatorname*{argmin}_k \|\mathbf{y}_k - \mathbf{x}\|$$

Recognition ~ Detection of One Person

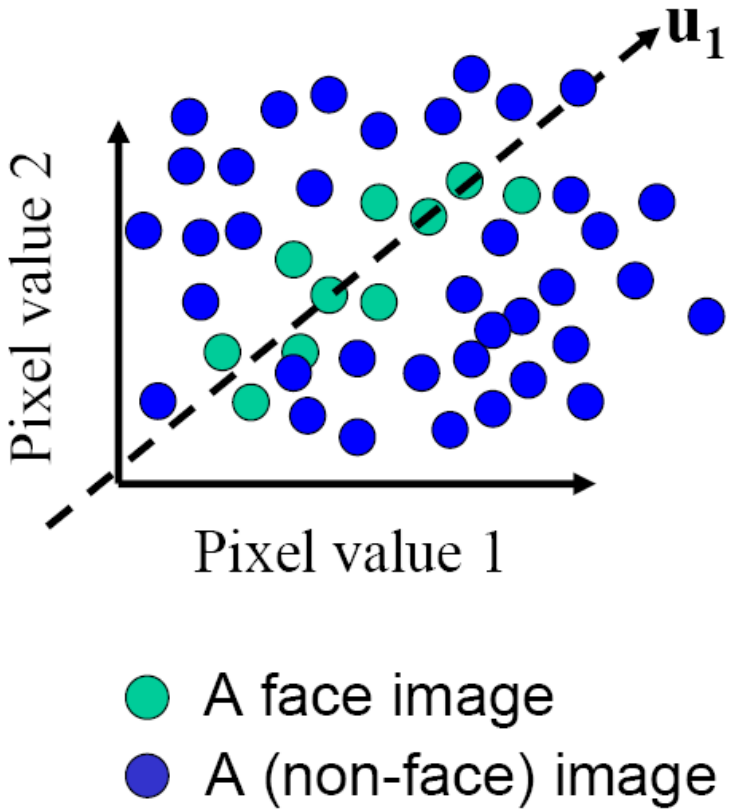
- Note that this is the same idea that we first considered for detection
  - No surprise, detecting faces is like recognizing *everyone's* faces

The space of all face images

- When viewed as vectors of pixel values, face images are extremely high-dimensional
  - 100x100 image = 10,000 dimensions
  - Slow and lots of storage
- But very few 10,000-dimensional vectors are valid face images
- We want to effectively model the subspace of face images

The space of all face images

- Eigenface idea: construct a low-dimensional linear subspace that best explains the variation in the set of face images



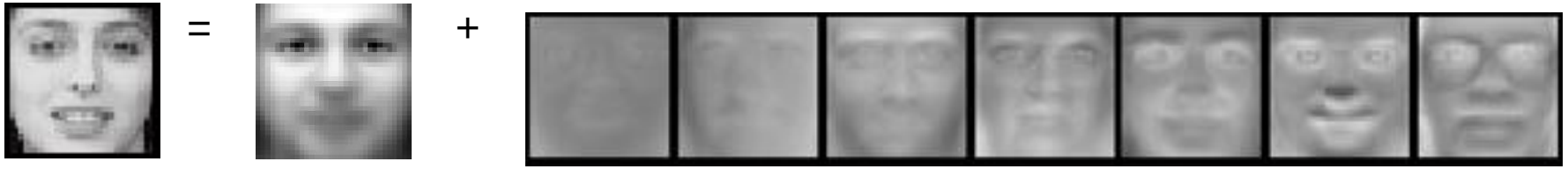
Representation and reconstruction

- Face **x** in "face space" coordinates:

$$\mathbf{x} \rightarrow [\mathbf{u}_1^{\mathrm{T}}(\mathbf{x} - \mu), \ldots, \mathbf{u}_k^{\mathrm{T}}(\mathbf{x} - \mu)]$$

$$= \quad w_1, \ldots, w_k$$

- Reconstruction:



x = μ + $w_1u_1+w_2u_2+w_3u_3+w_4u_4+$ …

Reconstruction

P = 4

P = 200

P = 400

After computing eigenfaces using 400 face images from ORL face database

Recognition with Eigenfaces

- For an unknown face:
  - Project to eigenspace: $\boldsymbol{X_{pca} = V(:, k)^T X}$
  - Optional check reconstruction error $\boldsymbol{VX - VX_{pca}}$ to determine whether image is really a face
  - Find the person whose face in eigenspace is the closest to $\boldsymbol{X_{pca}}$
    - Remember denoising with PCA: projecting to eigenspace gets rid of irrelevant details (hopefully), keeps the parts of the face that make it a face

Limitations

Global appearance method: not robust to misalignment, background variation