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# Face recognition

## What is face recognition?

# Face recognition

[Courtesy of Baidu]

# Face verification vs. face recognition

- Verification
  - Input image, name/ID
  - Output whether the input image is that of the claimed person
- Recognition
  - Has a database of K persons
  - Get an input image
  - Output ID if the image is any of the K persons (or "not recognized")

1:1 99% 99.9

1:K K=100

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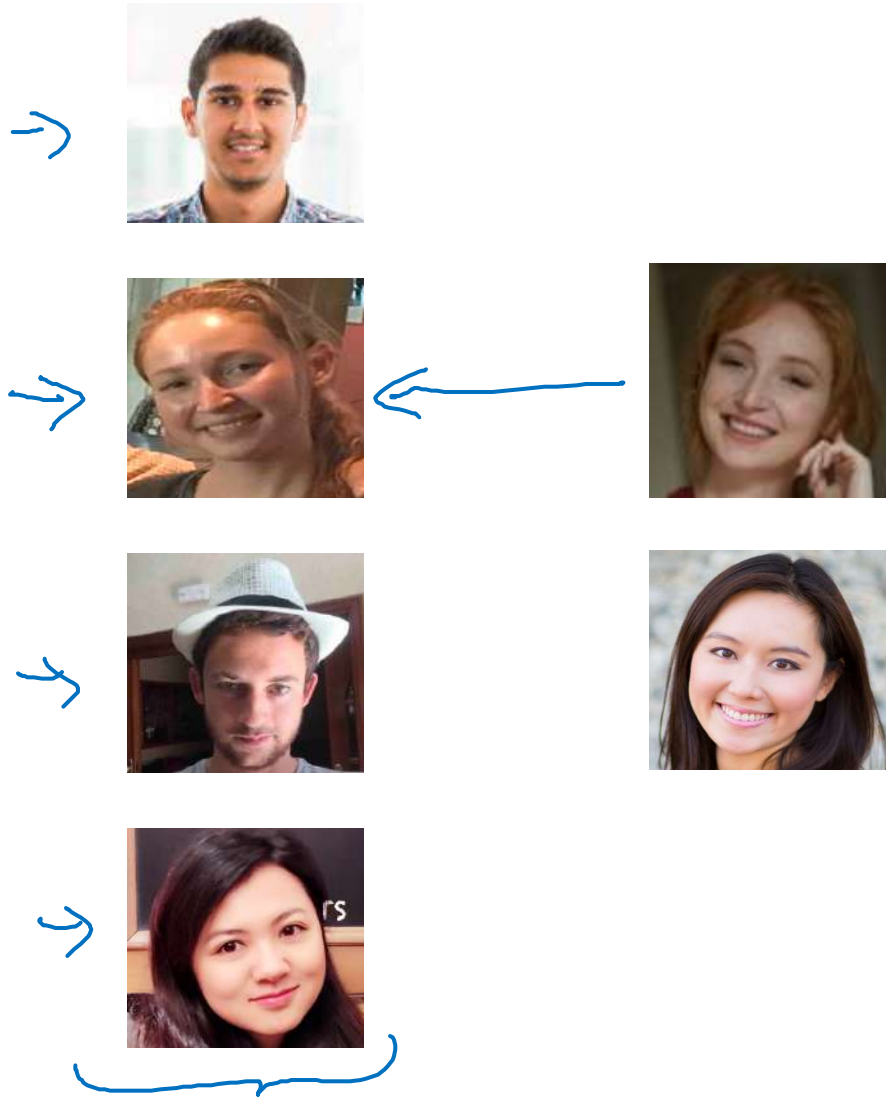
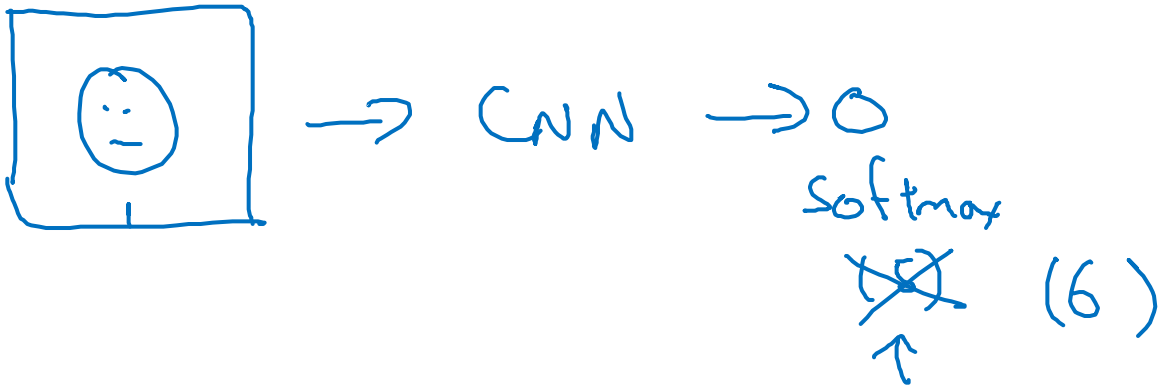
# Face recognition

# One-shot learning

# One-shot learning



Learning from one example to recognize the person again



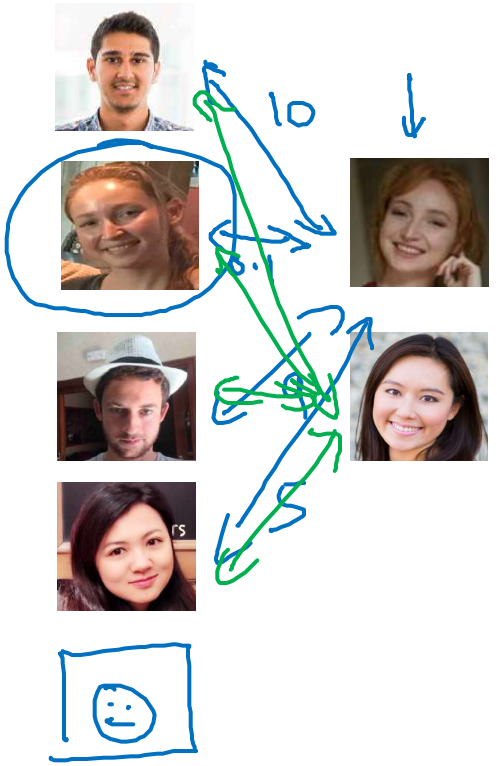
# Learning a "similarity" function

→ d(img1,img2) = degree of difference between images

If d(img1,img2) $\leq \tau$ "same"

$> \tau$ "different"

} Verification.



d(img1, img2)

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# Face recognition

# Siamese network

# Siamese network

$x^{(1)}$

"encoding of $x^{(1)}$"

128

$f(x^{(1)})$

128

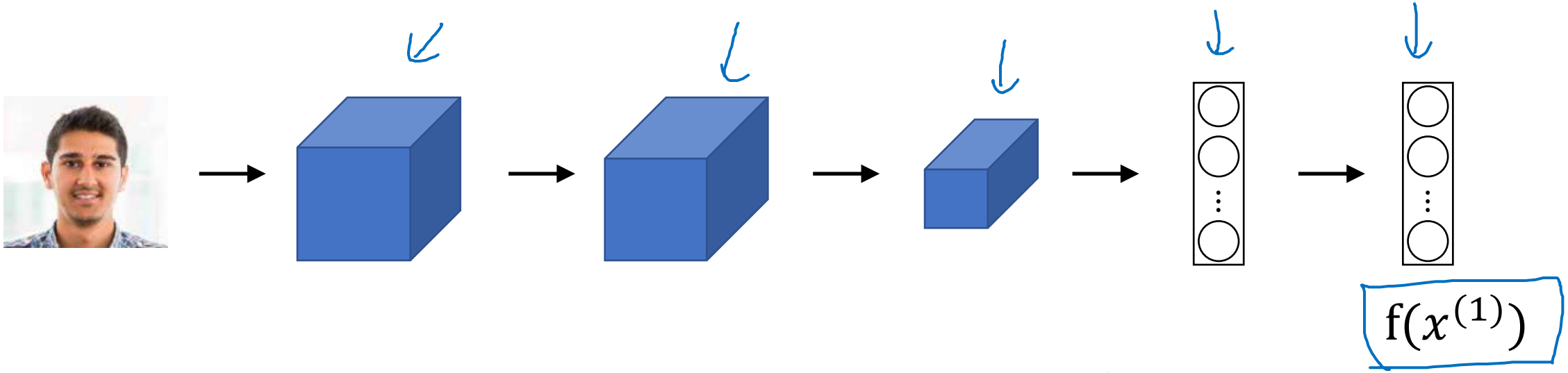
$x^{(2)}$

$f(x^{(2)})$

$$d(x^{(1)}, x^{(2)}) = \| f(x^{(1)}) - f(x^{(2)}) \|_2^2$$

[Taigman et. al., 2014. DeepFace closing the gap to human level performance]

# Goal of learning




Parameters of NN define an encoding $f(x^{(i)})$ 128

Learn parameters so that:

If $x^{(i)}, x^{(j)}$ are the same person, $\left\|f(x^{(i)}) - f(x^{(j)})\right\|^2$ is small.

If $x^{(i)}, x^{(j)}$ are different persons, $\left\|f(x^{(i)}) - f(x^{(j)})\right\|^2$ is large.

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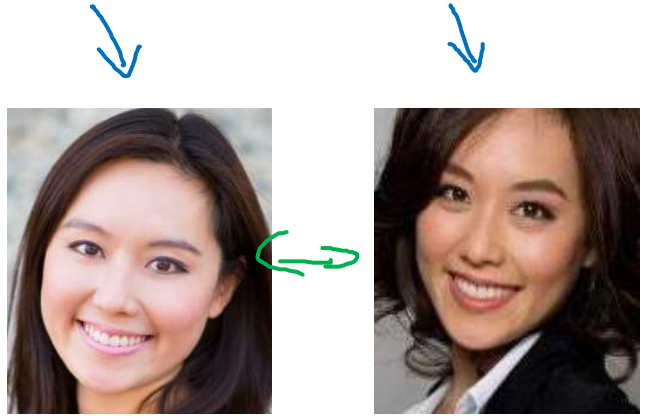
# Face recognition

## Triplet loss

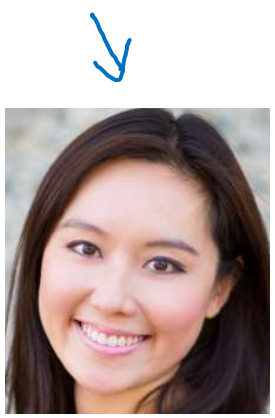
# Learning Objective

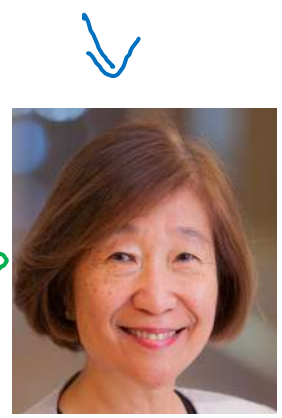




Anchor

Positive





Anchor

Negative

$A$ $d(A,P) = 0.5$ $P$ $d(A,N) = \cancel{0.5}$ $N$ $0.7$

Want: $\|f(A) - f(P)\|^2 + \alpha \leq \|f(A) - f(N)\|^2$ ($\alpha$: $0 \to 0.2$)

$d(A,P)$ $d(A,N)$

$$\|f(A) - f(P)\|^2 - \|f(A) - f(N)\|^2 + \alpha \leq 0$$

$0$ $0$ $\alpha$: margin

$f(\text{img}) = \vec{0}$

[Schroff et al.,2015, FaceNet: A unified embedding for face recognition and clustering]

# Loss function

Given 3 images A, P, N:

$$\mathcal{L}(A, P, N) = \max\left(\|f(A) - f(P)\|^2 - \|f(A) - f(N)\|^2 + \alpha, 0\right)$$

$$J = \sum_{i=1}^{m} \mathcal{L}(A^{(i)}, P^{(i)}, N^{(i)})$$

A, P

Training set: 10k pictures of 1k persons

[Schroff et al.,2015, FaceNet: A unified embedding for face recognition and clustering]

# Choosing the triplets A,P,N

During training, if A,P,N are chosen randomly, $d(A,P) + \alpha \leq d(A,N)$ is easily satisfied.

$\|f(A) - f(P)\|^2 + \alpha \leq \|f(A) - f(N)\|^2$

Choose triplets that're "hard" to train on.

$d(A,P) + \alpha \leq d(A,N)$

$d(A,P) \approx d(A,N)$

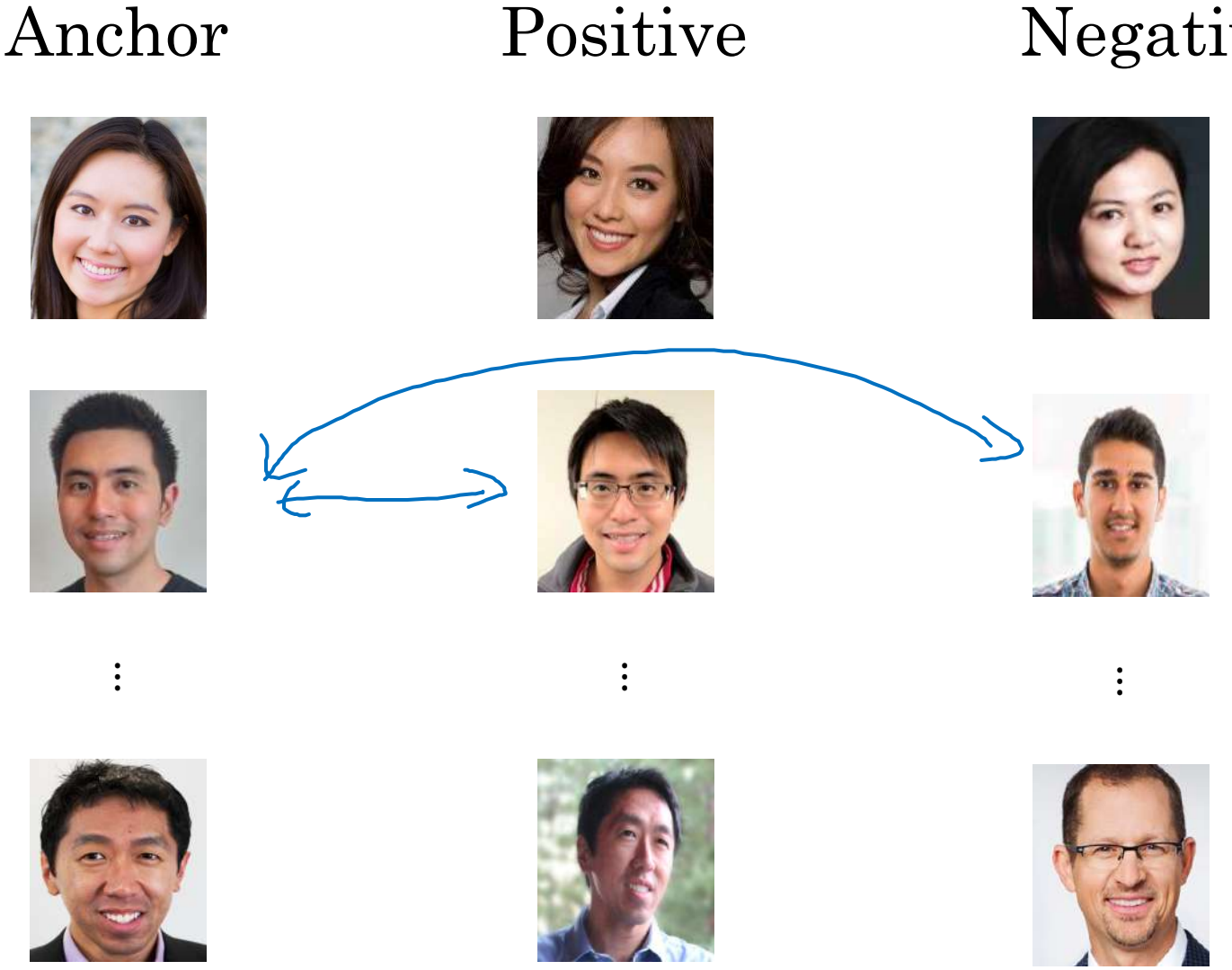
↓ ↑

Face Net

Deep Face

[Schroff et al.,2015, FaceNet: A unified embedding for face recognition and clustering]

# Training set using triplet loss




$J$

$d(x^{(i)}, x^{(j)})$

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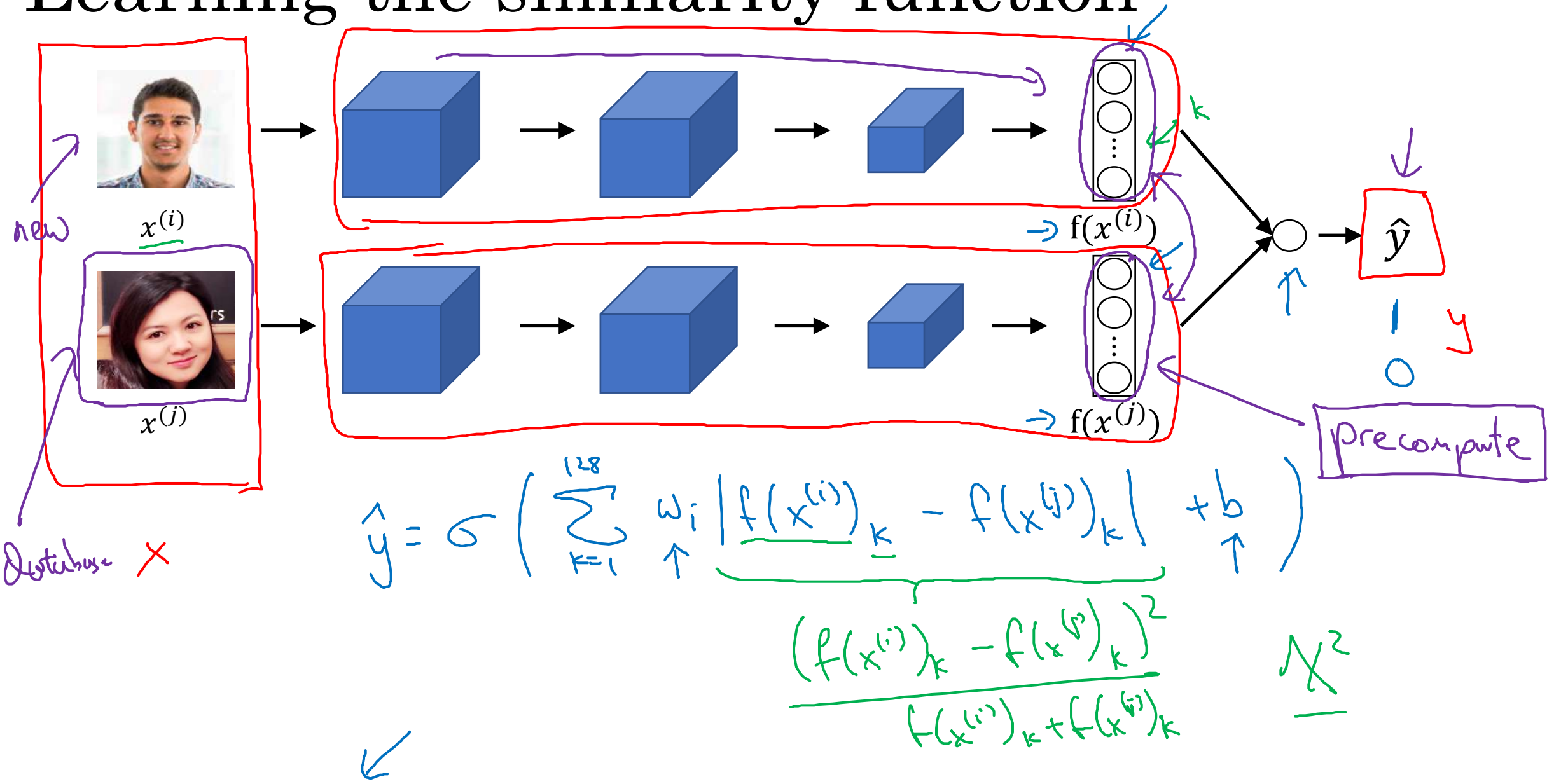
# Face recognition

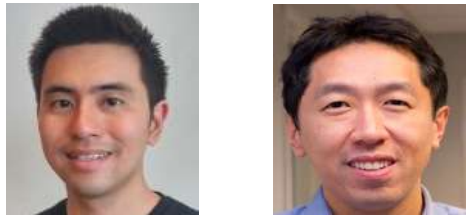
# Face verification and binary classification

# Learning the similarity function




[Taigman et. al., 2014. DeepFace closing the gap to human level performance]

# Face verification supervised learning

| $x$ | $y$ | |
|---|---|---|
|  | 1 | "Same" |
|  | 0 | "Albert" |
|  | 0 | |
|  | 1 | |

[Taigman et. al., 2014. DeepFace closing the gap to human level performance]