Pattern Associator Networks
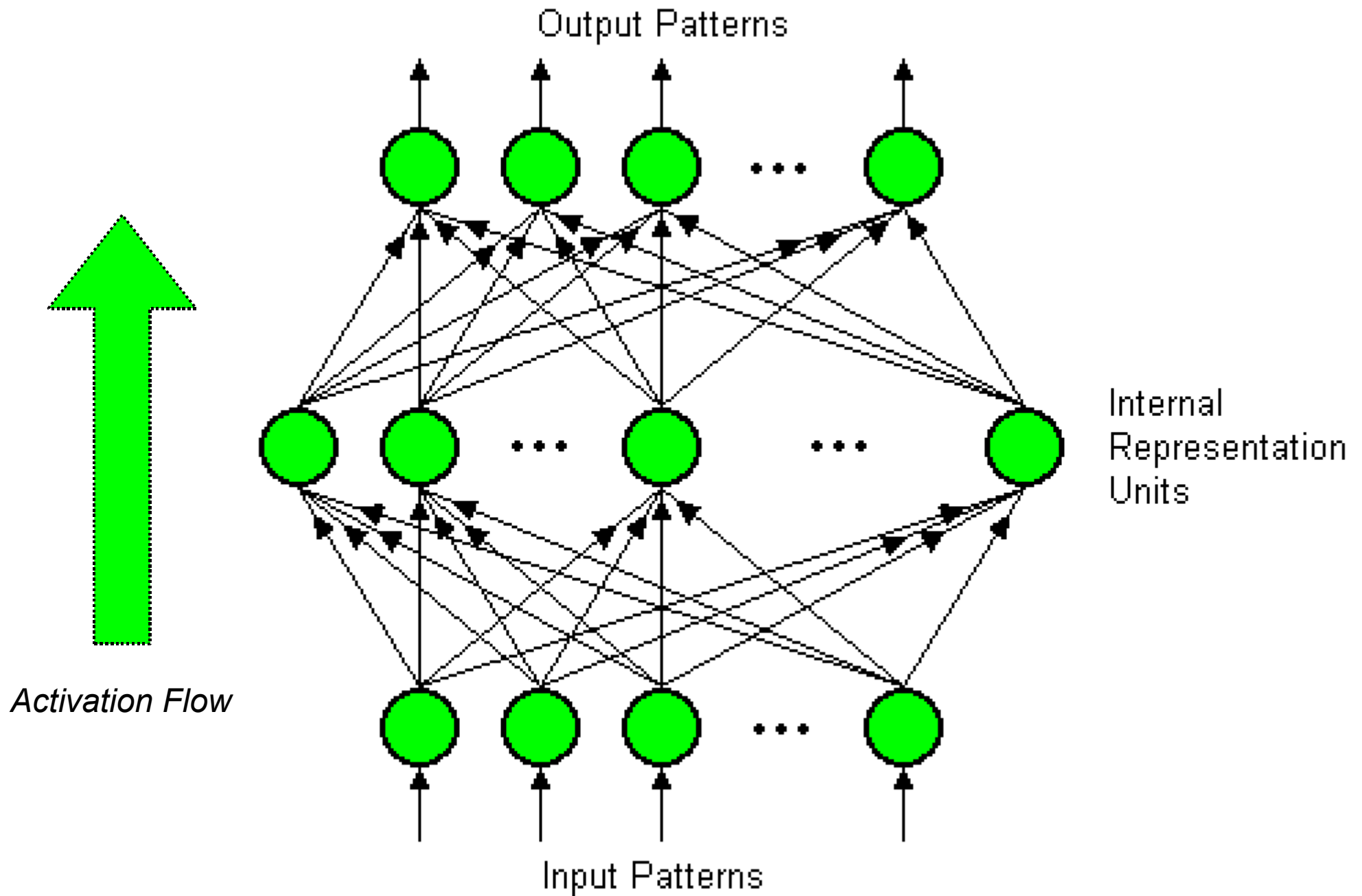
Output Patterns

Internal Representation Units

Activation Flow

Input Patterns

Pattern Associator Networks

- Typically use **backpropagation** learning algorithm

- Connection strengths change during training

- No feedback connections

- Nodes are arranged into successive layers

- Node activations represent stimulus/response associations

- Can behave as a pattern classifier

Pattern Associator Networks

- Connection weights determine network behavior

- Behavior could be "good" or "bad"

- **Error function** quantifies this measure

$$Error = (target_1 - output_1)^2 + (target_2 - output_2)^2 + \ldots$$
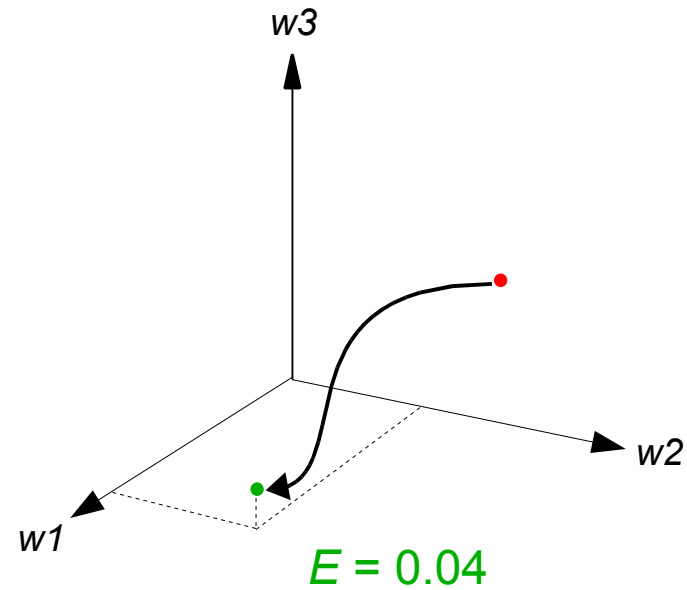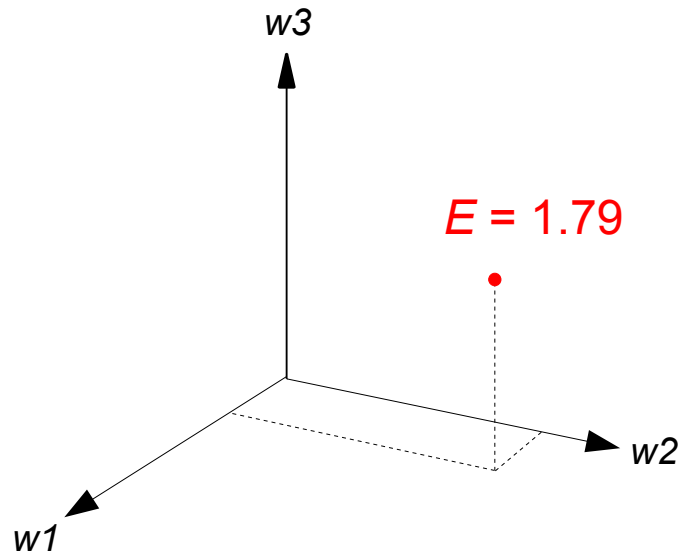
- Example:

Input	Target	Actual
0 0 0	0	0.50
0 0 1	0	0.67
0 1 0	0	0.82
0 1 1	1	0.90
1 0 0	0	0.53
1 0 1	1	0.69
1 1 0	1	0.83
1 1 1	1	0.91

0.12   1.5   0.7

w3

E = 1.79

0.7

0.12

1.5   w2

w1

"Weight space"
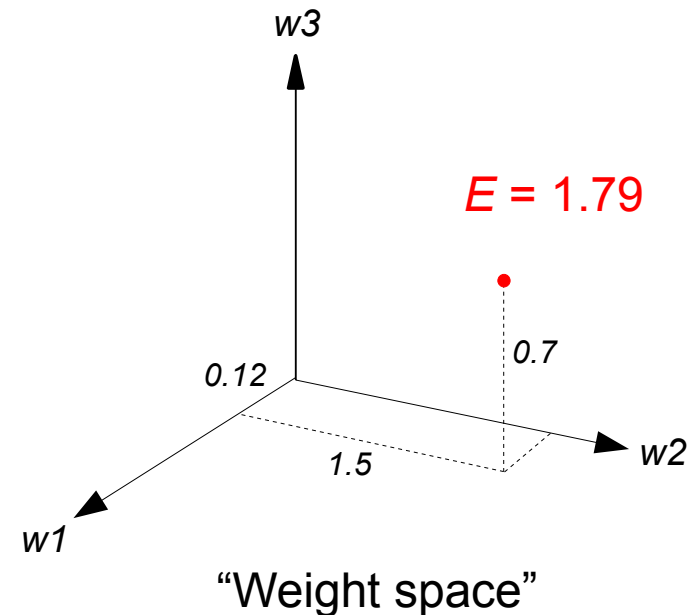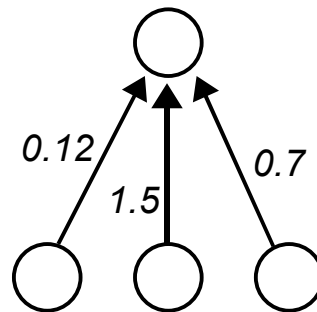
Pattern Associator Networks

- How to change the weights so that *E* goes down?

- Backpropagation algorithm modifies the weights on each time step so that the overall error of the network moves in the direction of the **gradient** ("downhill")
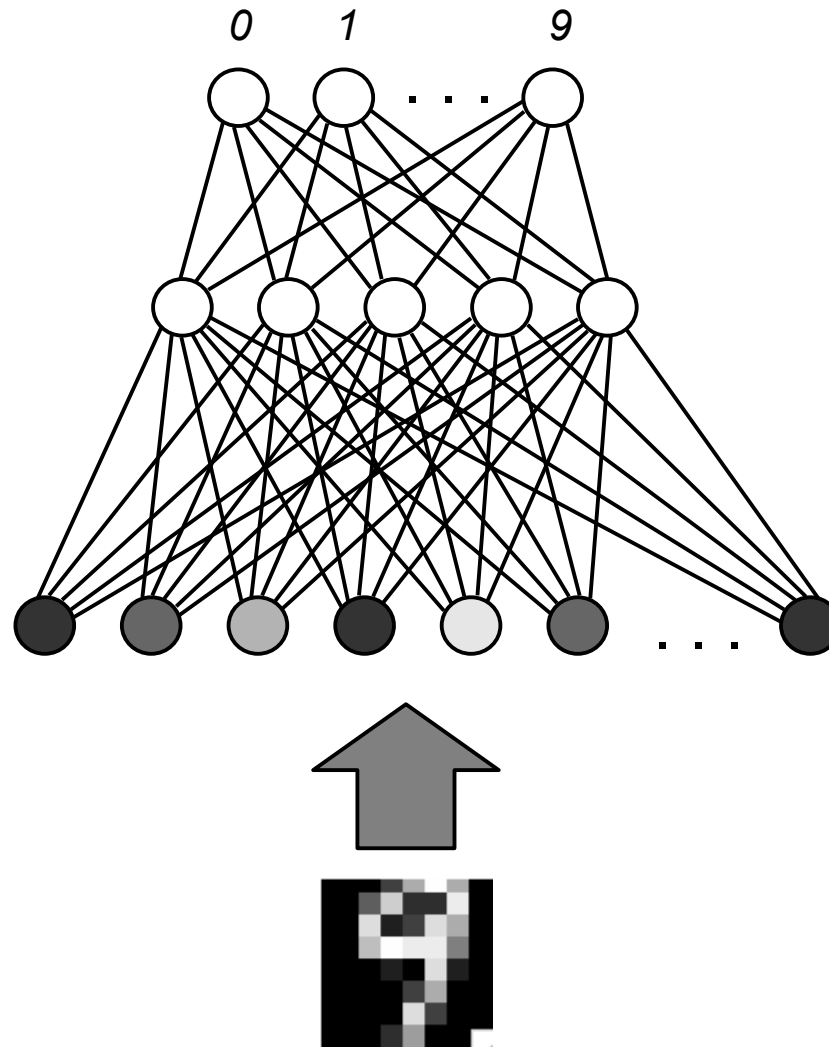
Pattern Associator Networks

- Examples:

    - Backpropagation animation

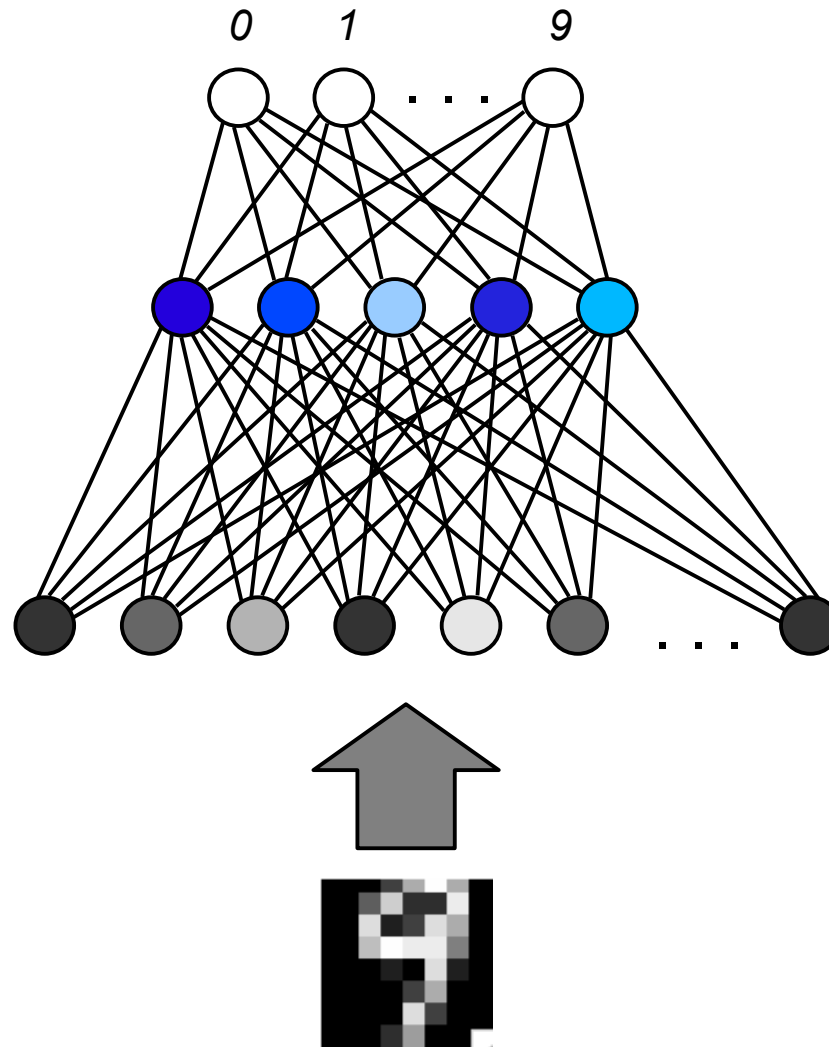   - Recognizing handwritten digits

    - Recognizing faces
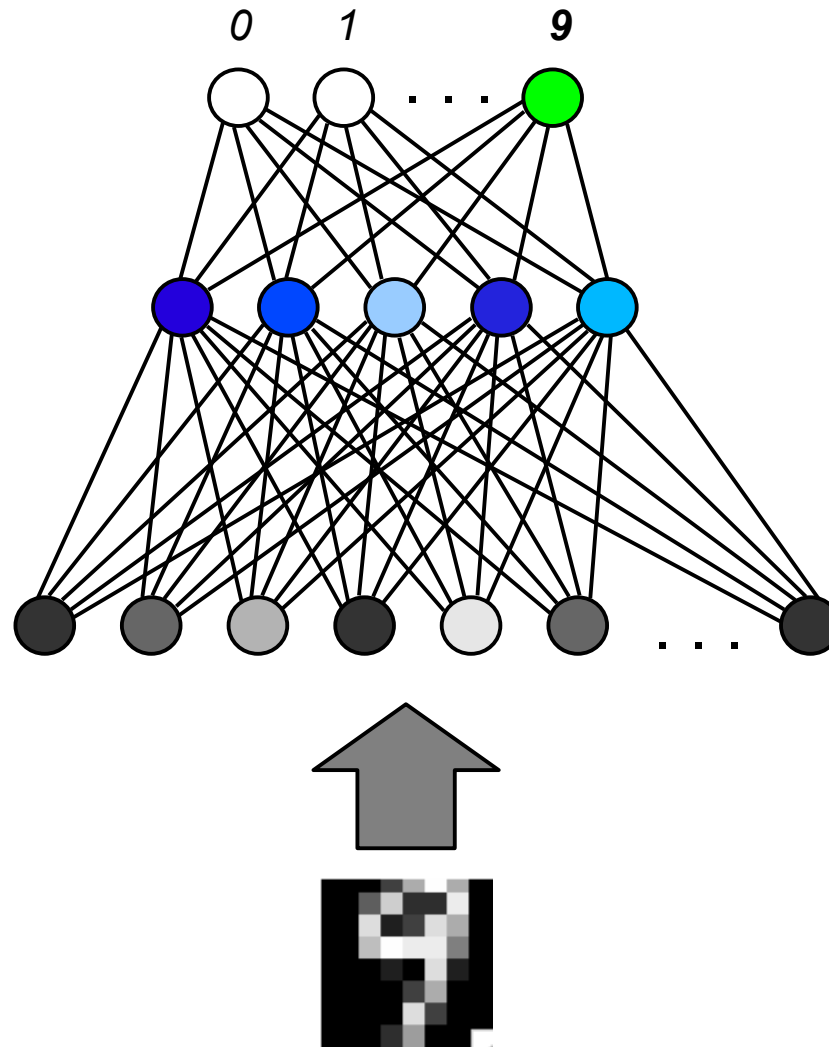
Example: Recognizing Handwritten Digits
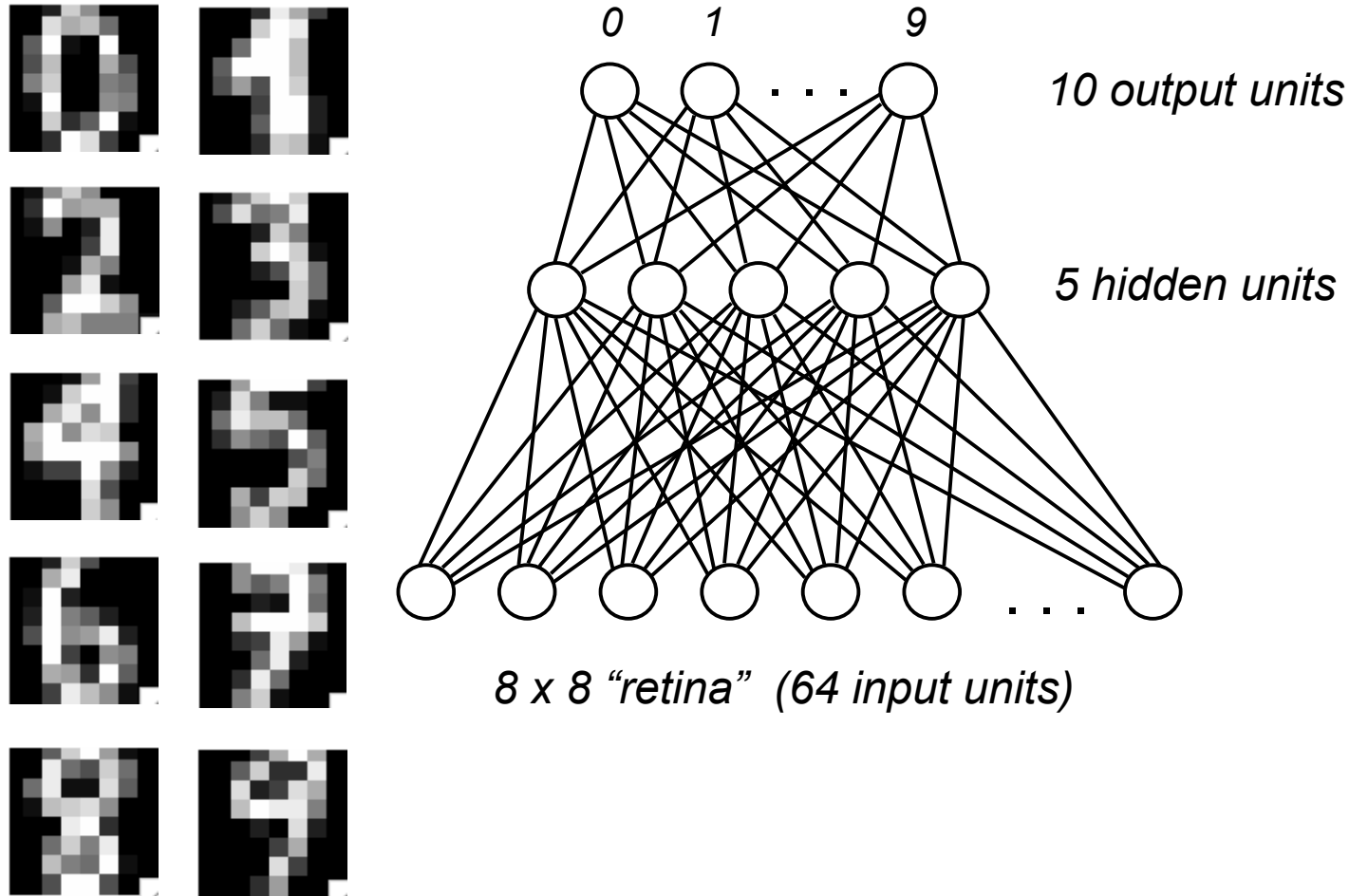
10 output units

5 hidden units

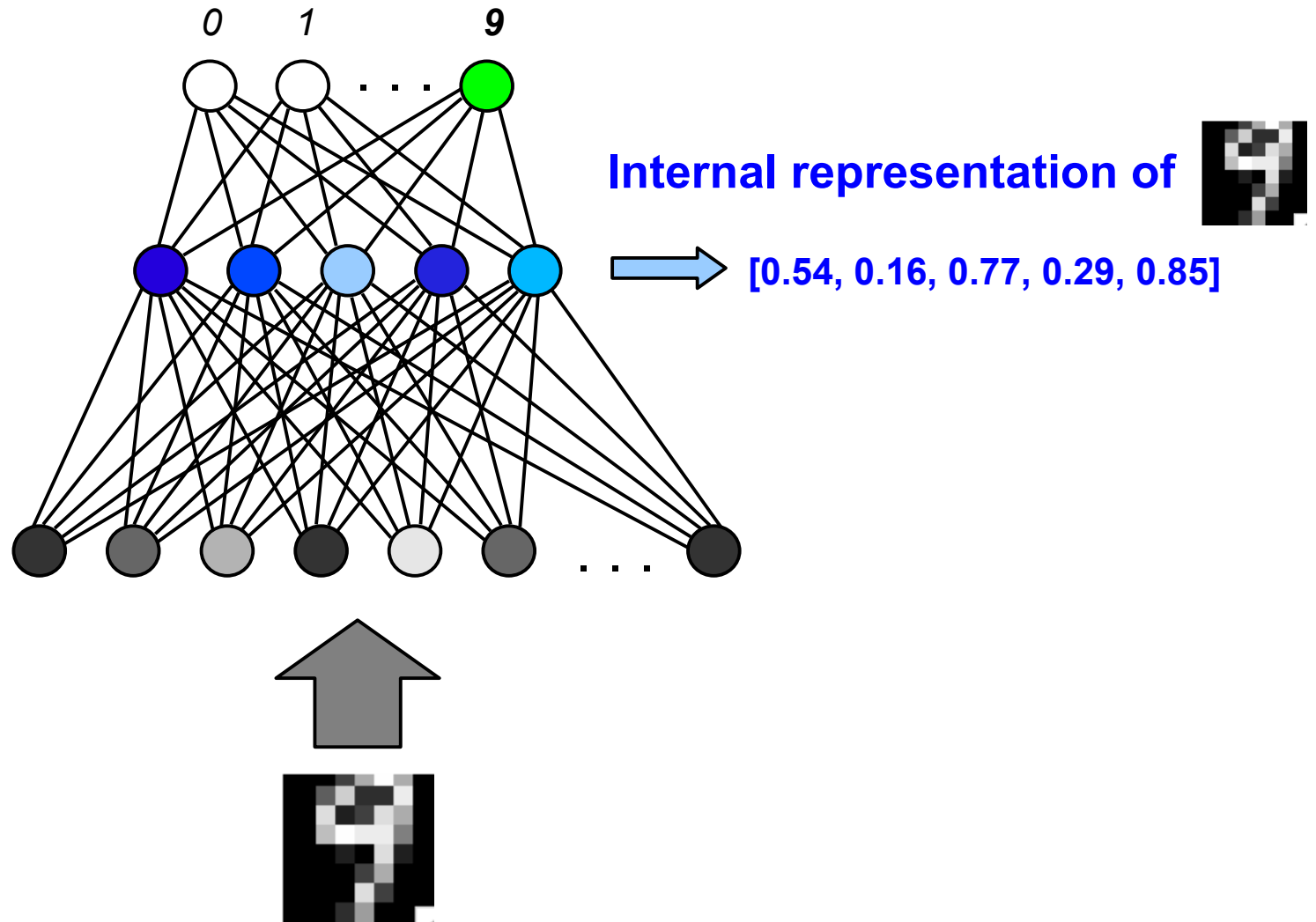8 x 8 "retina" (64 input units)

Example: Recognizing Handwritten Digits

Example: Recognizing Handwritten Digits
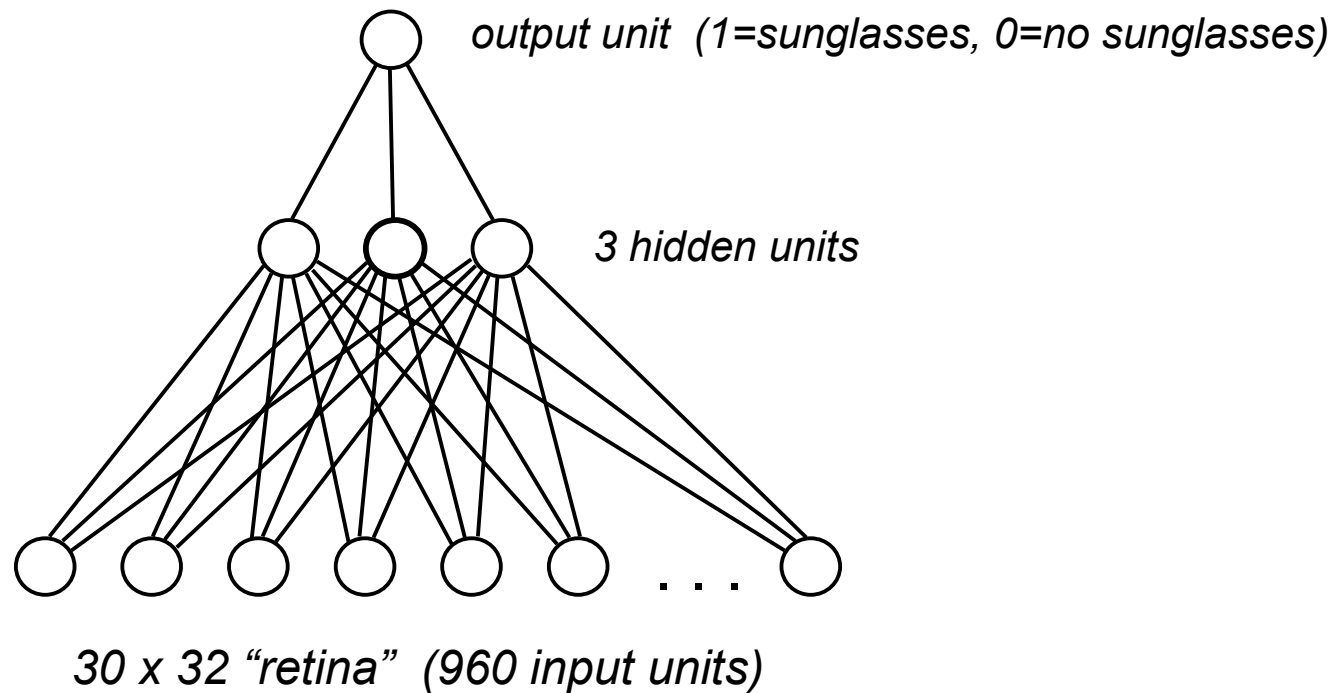
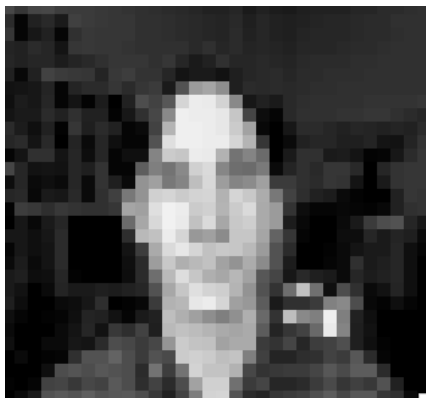# Example: Recognizing Handwritten Digits

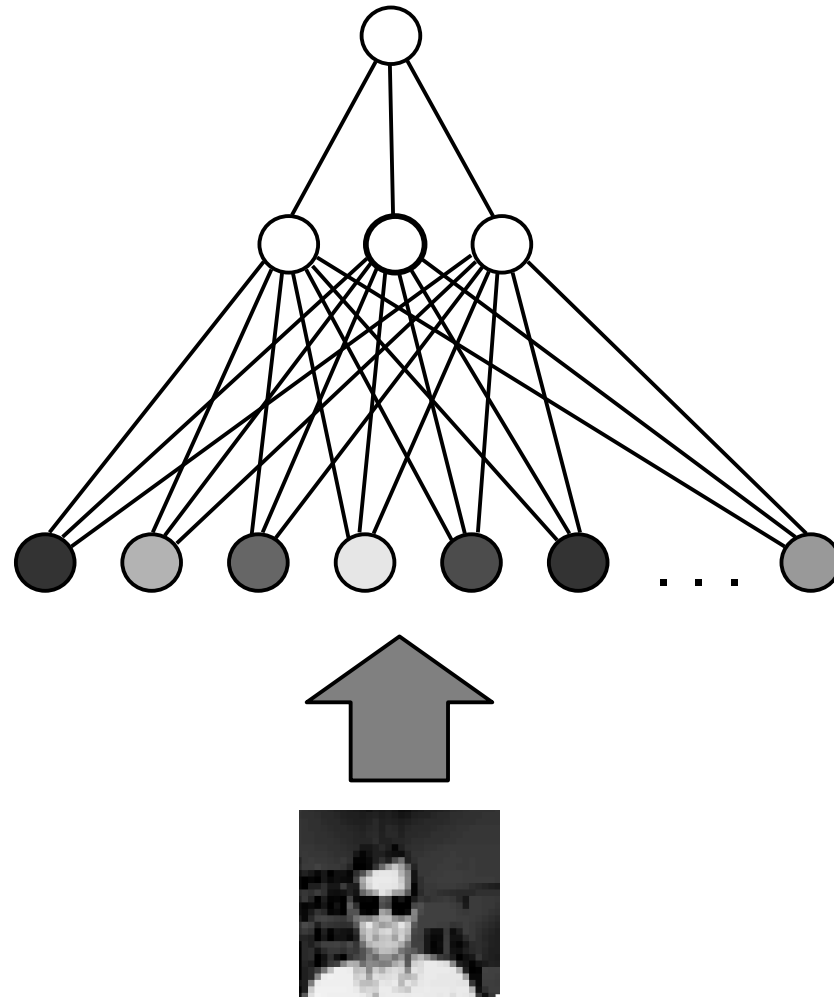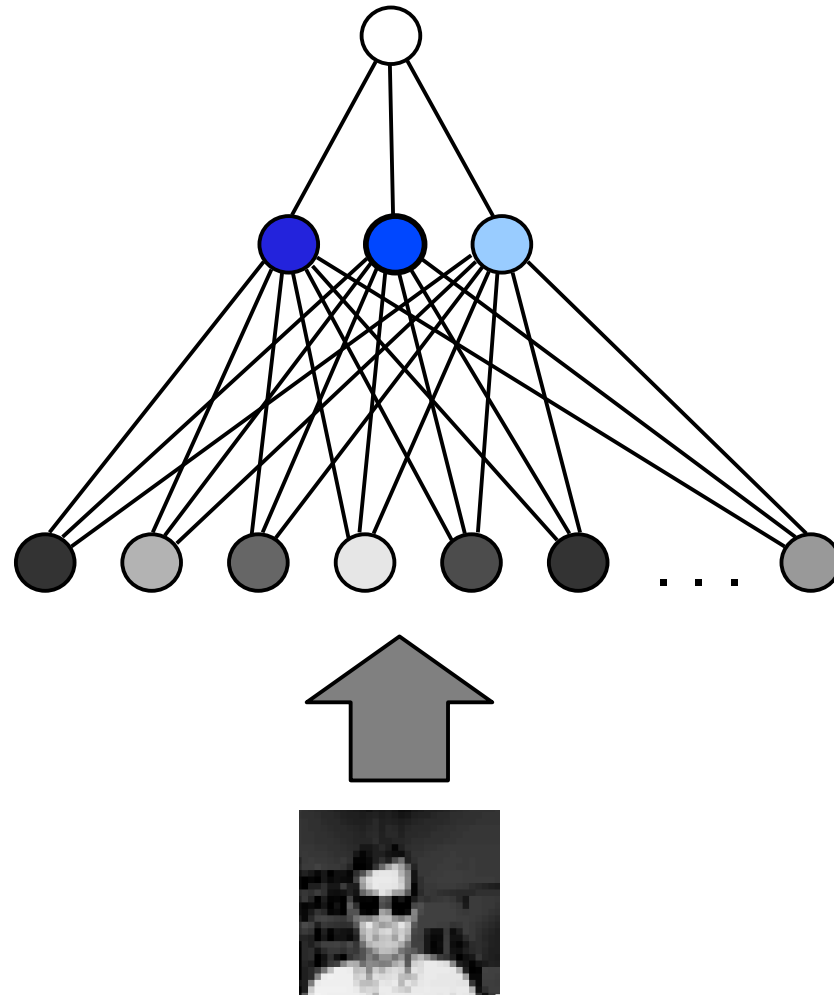# Example: Recognizing Handwritten Digits

Handwritten Digits Demo

Example: Recognizing Sunglasses

output unit (1=sunglasses, 0=no sunglasses)

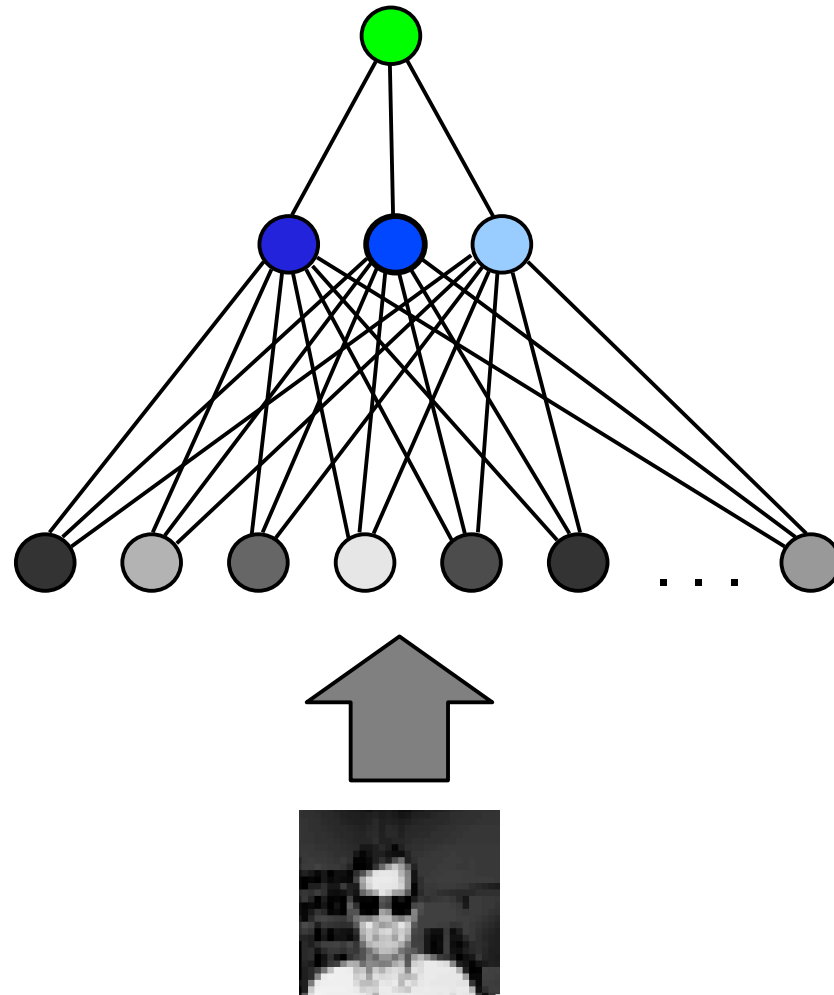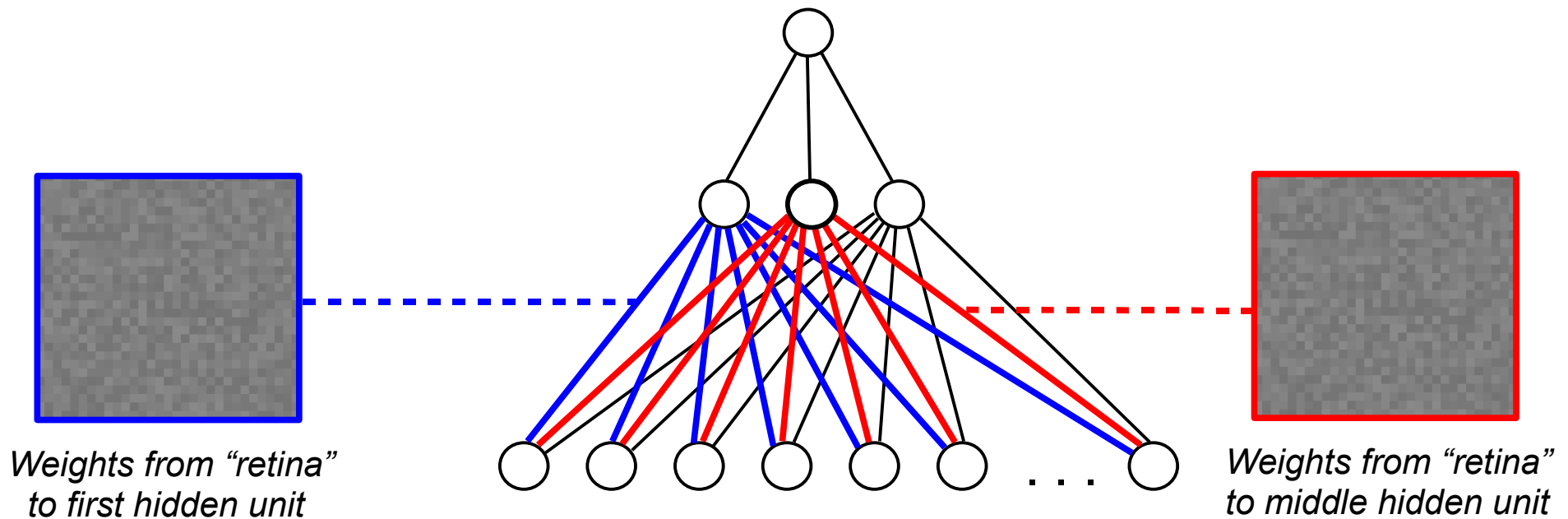3 hidden units

30 x 32 "retina" (960 input units)

Example: Recognizing Sunglasses

Example: Recognizing Sunglasses

Example: Recognizing Sunglasses

Example: Recognizing Sunglasses

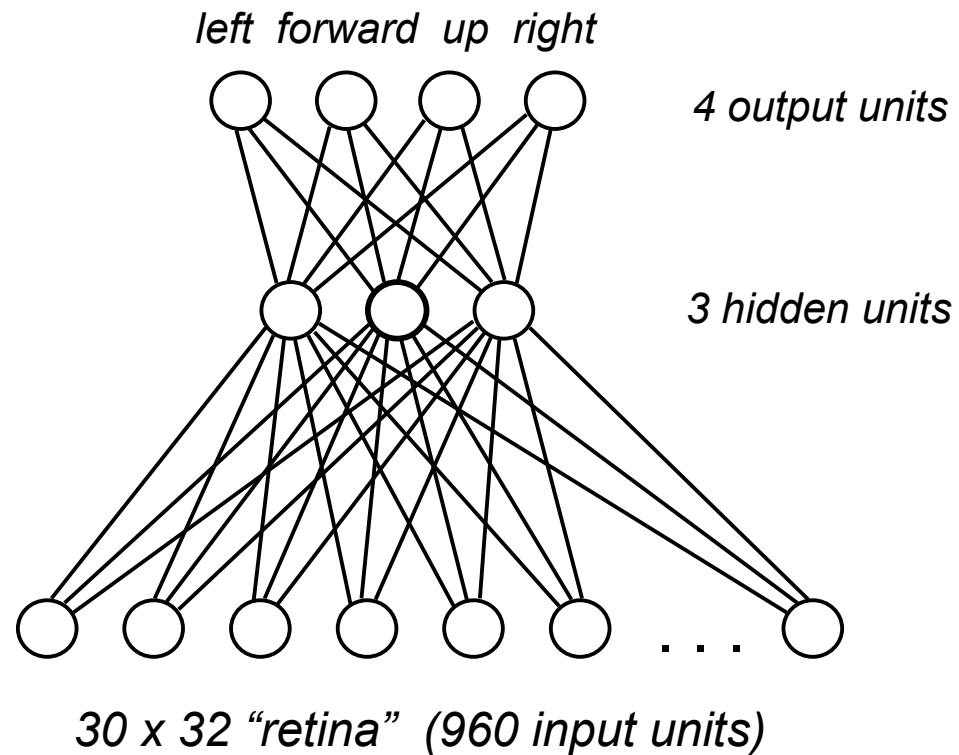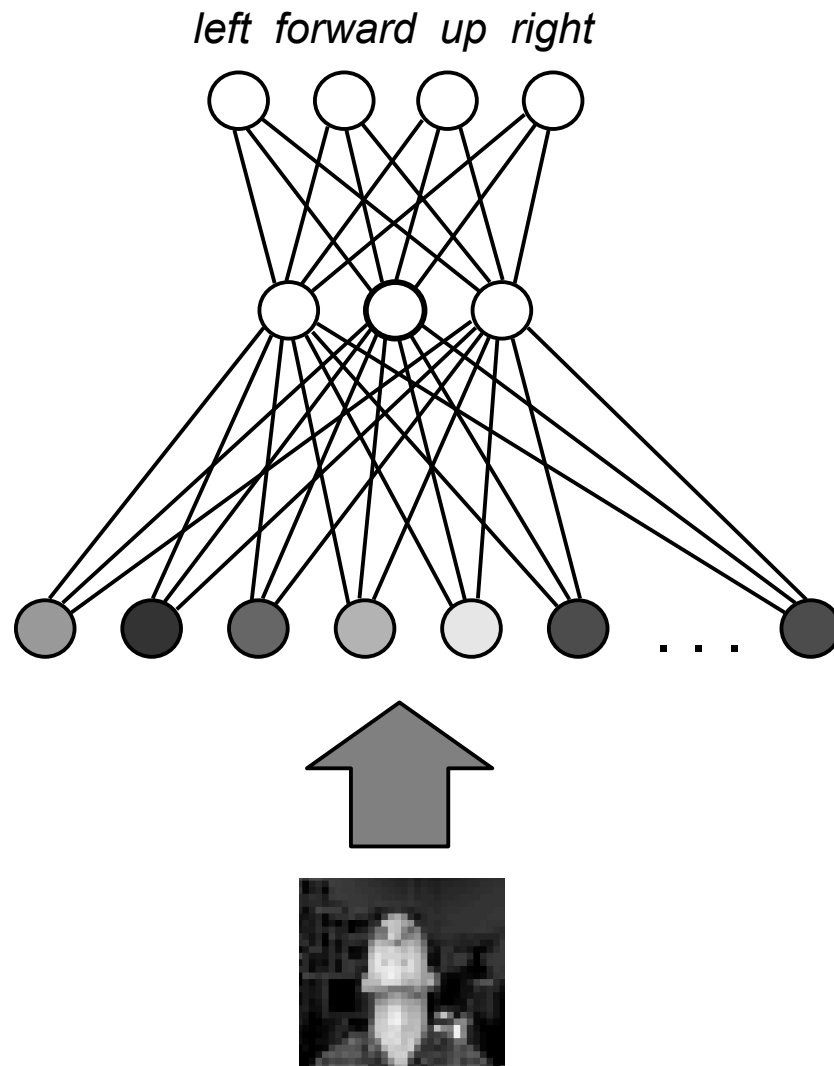Weights from "retina" to first hidden unit

Weights from "retina" to middle hidden unit

Sunglasses Recognizer Demo

Example: Recognizing Poses

left forward up right

4 output units

3 hidden units

30 x 32 "retina" (960 input units)

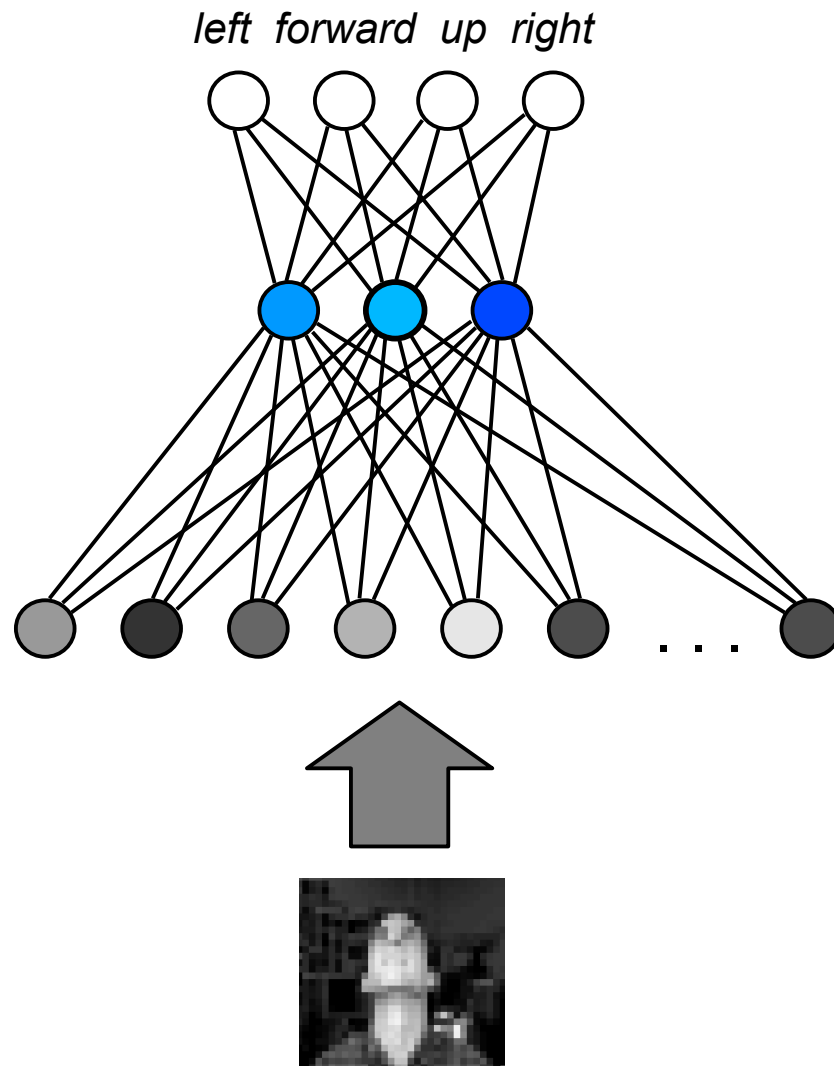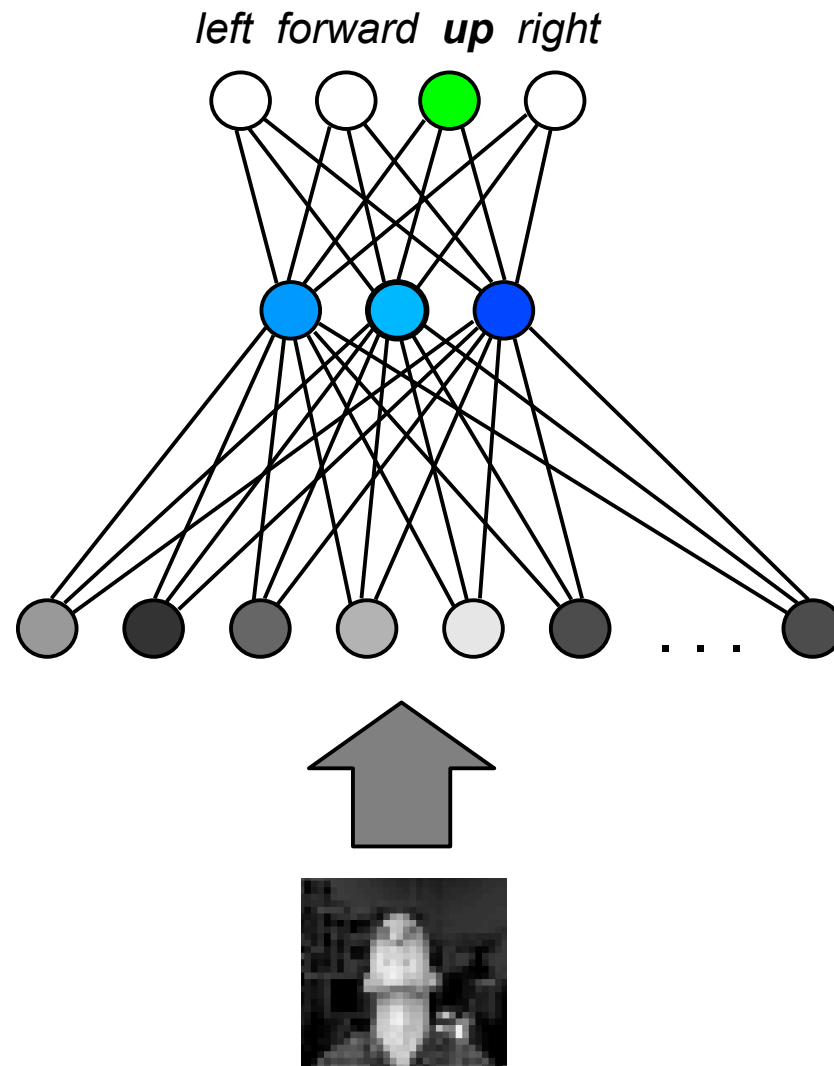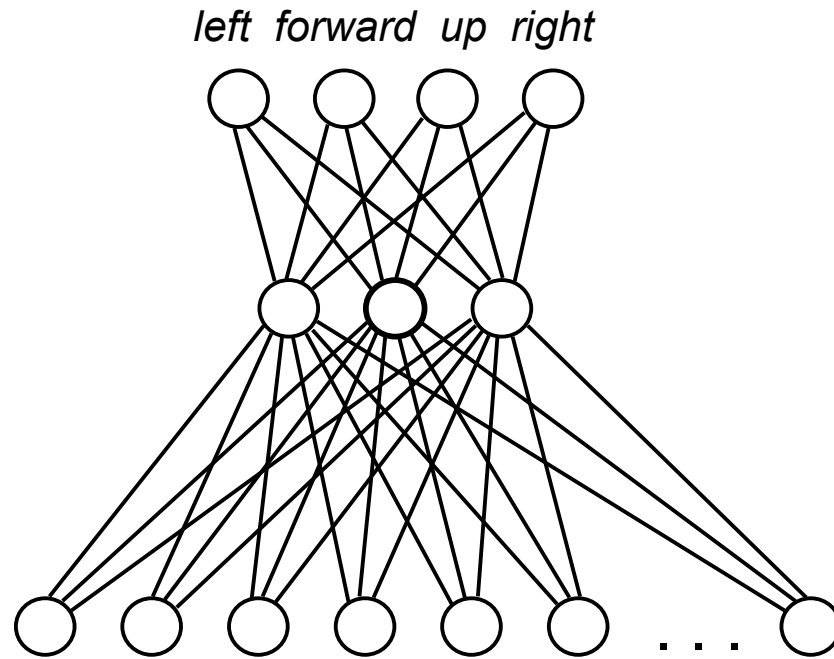# Example: Recognizing Poses

left forward up right

Example: Recognizing Poses

Example: Recognizing Poses

Example: Recognizing Poses
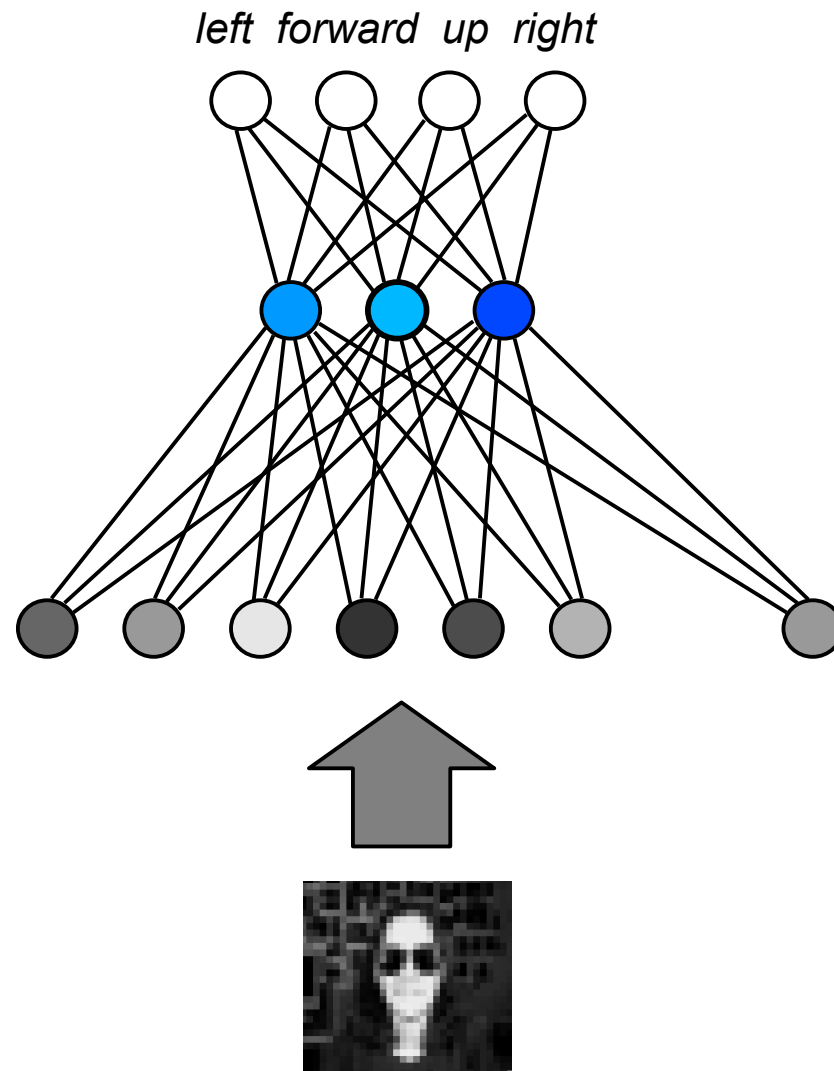
left forward up right

Example: Recognizing Poses

left forward up right
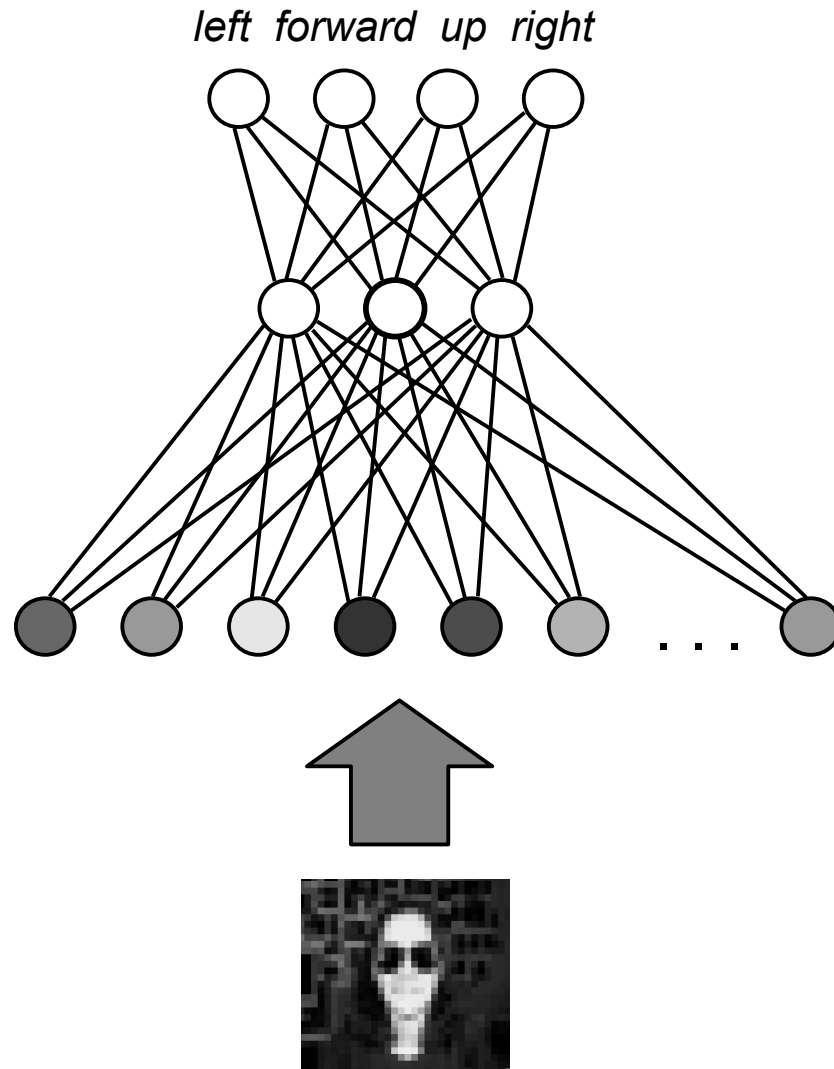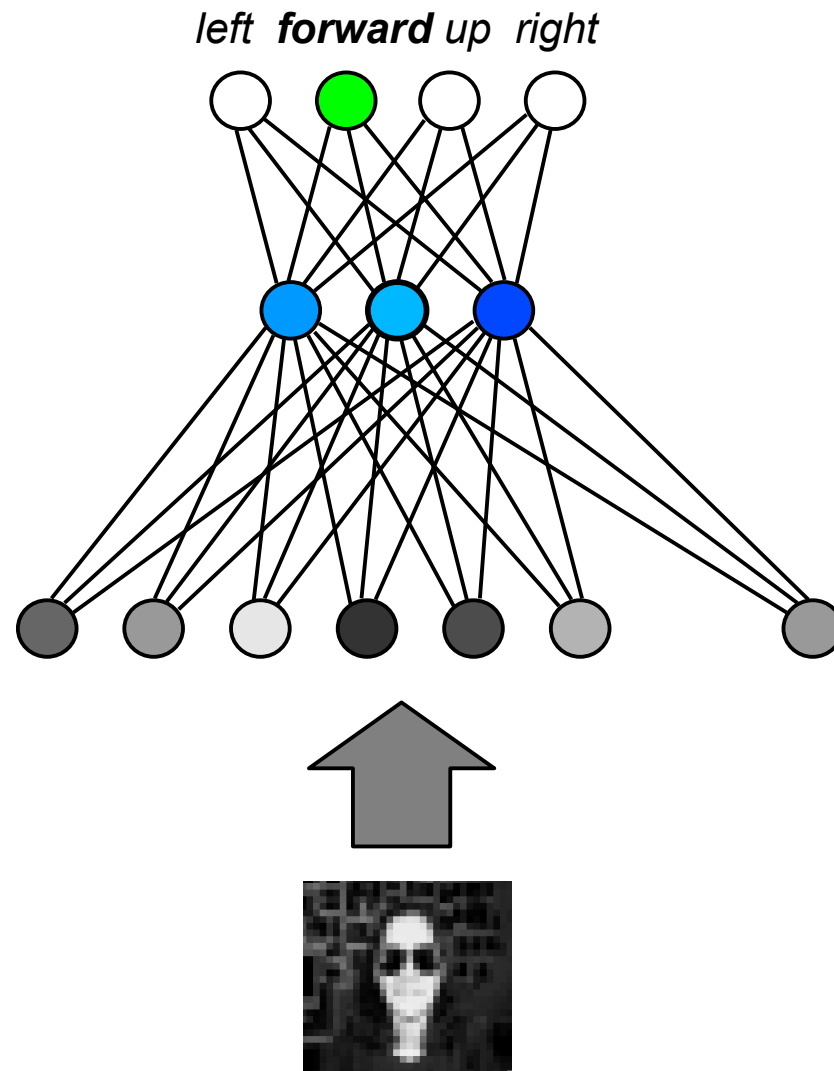
Example: Recognizing Poses

Example: Recognizing Poses

Pose Recognizer Demo