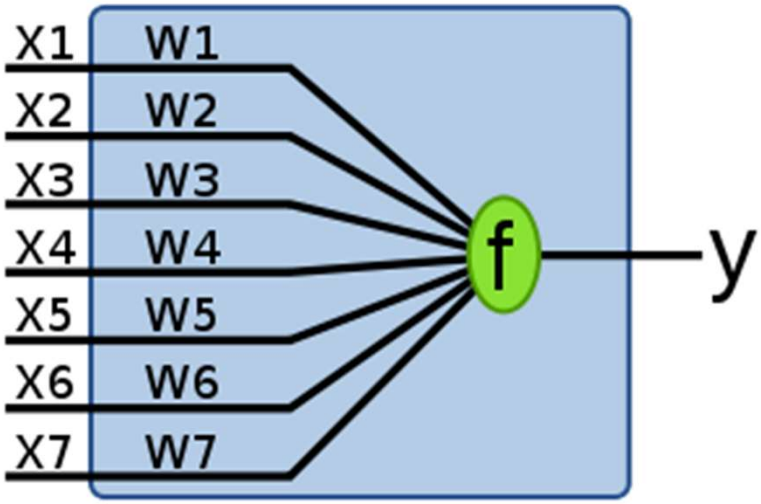
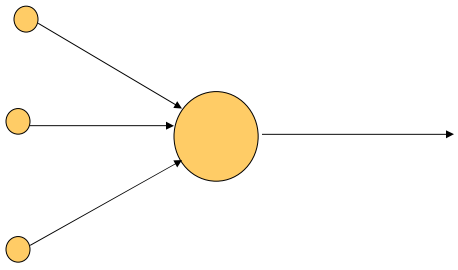
Perceptron



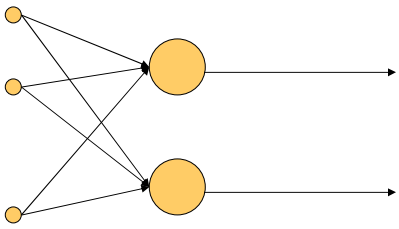
Perceptron: architecture

- We consider the architecture: feed-forward NN with one layer
- It is sufficient to study single layer Perceptron with just one neuron:



Single layer perceptrons

- Generalization to single layer Perceptrons with more neurons is easy because:

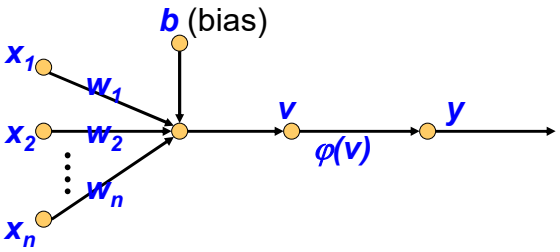


•The output units are independent among each other
•Each weight only affects one of the outputs

Perceptron: Neuron Model

- The (McCulloch-Pitts) Perceptron is a single layer NN with a non-linear φ, the sign function

$$\varphi(v) = \begin{cases} +1 \text{ if } v \geq 0 \\ -1 \text{ if } v < 0 \end{cases}$$



Perceptron for single Character recognition

- Practical Examples of recognizing character D or not D:
- In this application single layer Perceptron is used to recognize a single characters, Particularly D or not D
- Shape of **character D** should be converted into digital form, i.e., 1s and 0s
- Useful to take more shapes with variation of **Character D** for accurate learning
- Here total 21 inputs used in which 3 are D and 18 are not D

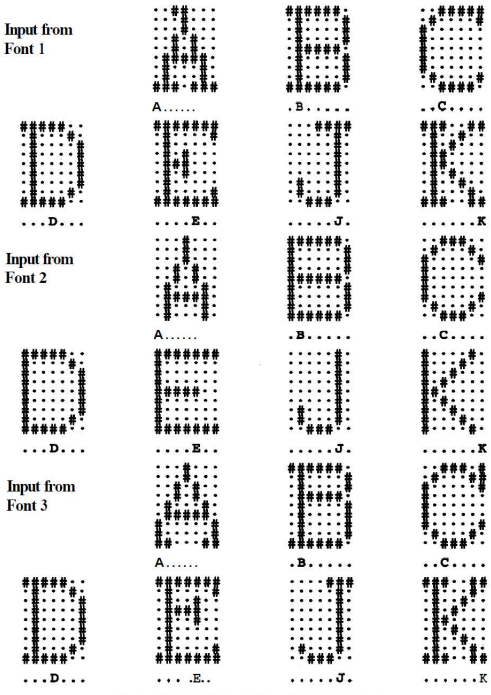


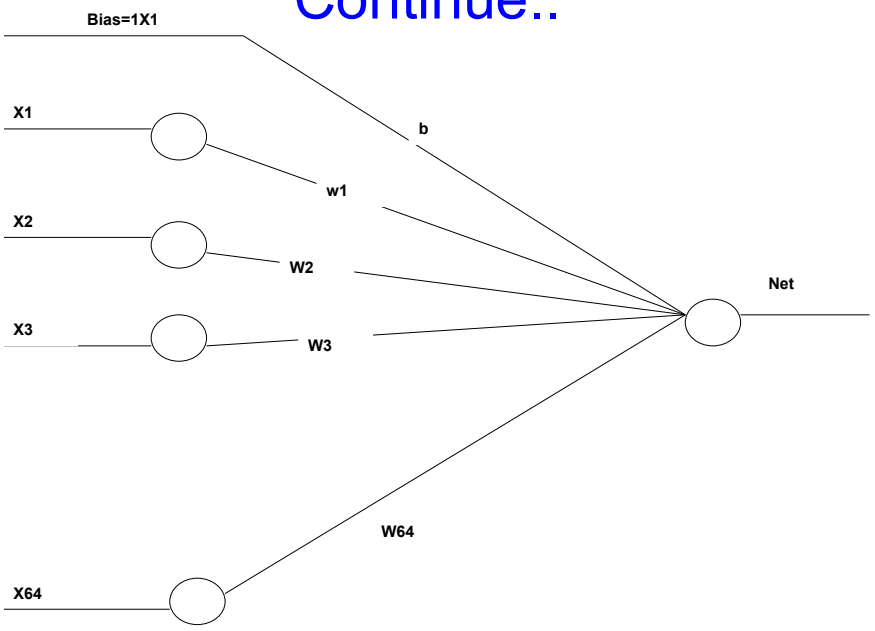
Figure 2.20 Training input and target output patterns.

-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	+1	-1	-1	-1	-1	-1
-1	-1	#	#	-1	-1	-1	-1
-1	-1	#	-1	#	-1	-1	-1
-1	-1	#	-1	-1	#	-1	-1
-1	-1	#	-1	-1	#	-1	-1
-1	-1	#	-1	#	-1	-1	-1
-1	-1	#	#	-1	-1	-1	-1

Structure of the network

- Each character is a grid of 64 cells so the input layer of the ANN will consists of 64 neurons
- And the output layer consists of only 1 neuron because it has to recognize just one character at a time

Continue..



Continue..

- For Training & solving, Either
  - Use some language platform like Python
  - **We can think of weighs and bias and activation function to do it MANUALLY as well**

Example

-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	+1	+1	+1	+1	-1	-1
-1	-1	-1	-1	-1	+1	-1	-1
-1	-1	-1	+1	+1	+1	-1	-1
-1	-1	-1	-1	-1	+1	-1	-1
-1	-1	-1	-1	- 1	+1	-1	-1
-1	-1	+1	+1	+1	+1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1

O/P = 3 if sum > 0, otherwise its not

Example

- How to train a Perceptron to recognize this 3?
  - PRE-PROCESS
  - USE OF ALGORITHM
  - POST-PROCESS

Example

- A possible solution (many other possible)
  - Assign (–)1 to weights of input values that are -1,
  - (+)1 to weights of input values that are +1, &
  - (–) 63 to the bias
  - Maximum +1 are 14, so cant multiply more +1 with +1
  - Then the output of the Perceptron will be 1 when presented with a “prefect” 3,
  - Also keep a check on total no of +1

Wherever this 3 is in the region

Example

- A possible solution (many other possible)
  - Lets see the Generalization to unknown patterns

Example(WRONG PATTERN)

-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	+1	+1	+1	+1	-1	-1
-1	-1	+1	-1	-1	+1	-1	-1
-1	-1	+1	+1	+1	+1	-1	-1
-1	-1	+1	-1	-1	+1	-1	-1
-1	-1	+1	-1	- 1	+1	-1	-1
-1	-1	+1	+1	+1	+1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1

+1 to +1
And
-1 to -1

Correct

4 extra +1 will be multiplied with -1 as max +1 can be 14 from previous slide to result in total sum of -7, so will be rejected as being 3, (46+14-4-63=-7)

Example

-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	+1	-1	-1
-1	-1	-1	-1	-1	+1	-1	-1
-1	-1	-1	-1	-1	+1	-1	-1
-1	-1	-1	-1	-1	+1	-1	-1
-1	-1	-1	-1	- 1	+1	-1	-1
-1	-1	-1	-1	-1	+1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1

Correct

Here sum will be -15 so again will be rejected as red -1 will be multiplied or 8 extra -1 will be multiplied by +1 to result in -63+6+50-8=-15 **14 Times +1 will be multiplied as per previous slides…may it be +1 or -1 (8 times -1 and 6 times +1)**

Example

-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	+1	+1	+1	+1	-1	-1
-1	-1	-1	-1	-1	+1	-1	-1
-1	-1	-1	+1	+1	+1	-1	-1
-1	+1	-1	-1	-1	+1	-1	-1
-1	-1	-1	-1	- 1	+1	-1	-1
-1	-1	+1	+1	+1	+1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1

Wrong

Answer is 49+14-63-1=-1, so wrongly classified or it will not be taken as 3

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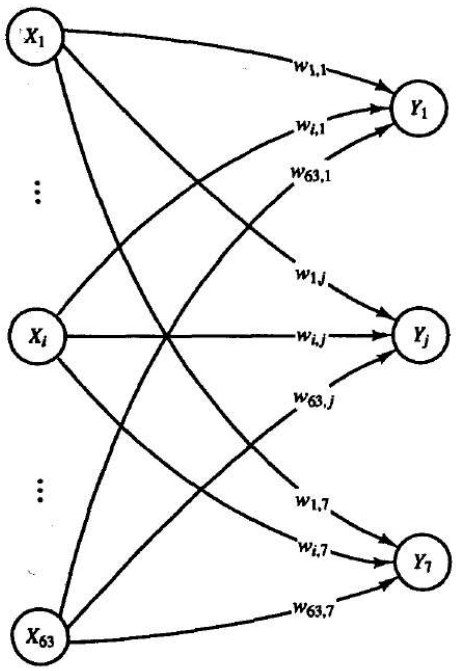
Example

- What if a slightly different 3 is to be recognized, like the one in the previous slide?
- The original 3 with one bit corrupted would produce a sum equal to –1.
- If the bias is set to –61 then also this corrupted 3 will be recognized, as well as all patterns with one corrupted bit.
- The system has been able to generalize by considering only one example of corrupted pattern!

Answer will be 50+14-1-61=2 that is greater than 1 so it will be taken as 3

Perceptron for multi-Character recognition

- For example a situation could be
  - 21 inputs are used in which 7 different character (A,B,C,D,E,J,K) are available
  - Each character appeared three times



Perceptron to classify input into seven categories.

Structure of the network

- Each character is a grid of 64 cells so the input layer of Perceptron consists of 64 neurons
- And the output layer consists of 7 neurons because it has to recognize 7 characters this time

Continue..