CISC 3250
Systems Neuroscience

Neural networks and information representation in computer science

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JMH 328A

dendrites nucleus

axon

axon ending

myelin sheath

cell body

r_1 w_1
r_2 w_2
r_3 w_3
$g\left(\sum_j w_j r_j\right)$

Artificial neuron – the perceptron

Perceptron – building block of artificial neural networks

- Weight inputs
- Perform summation
- Pass through non-linearity

r_1 w_1
r_2 w_2 $g\left(\sum_j w_j r_j\right)$
r_3 w_3

What are our inputs?
How should we construct a network?

Example: Optical character recognition

Task is to identify a letter from a picture of that letter

A $----\rightarrow$ "the letter A"

$----\rightarrow$ "the letter A"

Computational representations

- Input: black-and-white pixels – binary vector

13	14	15
23	24	25
33	34	35

← 15

- Output: ASCII (American Standard Code for Information Interchange) – single integer

A	C	E	G	I	K	M	O
65	67	69	71	73	75	77	79
B	D	F	H	J	L	N	P
66	68	70	72	74	76	78	80

Decision through threshold

Typical non-linearities

Sigmoid $g^{sig}(x) = \frac{1}{1+\exp(-x)}$ `1./(1+exp(-x))`

Radial-basis $g^{gauss}(x) = \exp(-x^2)$ `exp(-x.^2)`

$r_{out} = 1$

r_2

$r_{out} = 0$

r_1

r_2

$r_{out} = 1$

$r_{out} = 0$

r_1

Perceptron learning

Delta learning: Correct input weights when output is not correct

$$\Delta w_{ij} = \epsilon(y_i - r_i^{out})r_j^{in}$$