UNIVERSITÄT
DUISBURG
ESSEN

Open-Minded

AdaLinE & Multilayer Perceptron

Neuroinformatics Tutorial 8

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Content

- Revision: Practical Task (Already uploaded)
- **Revision: Lecture (AdaLinE)**
- New Practical Tasks (Already uploaded)
- Revision: Lecture (MLP)

Revision: Lecture

- Which methods were presented in the lecture to train AdaLinE?

AdaLinE Pseudo Inverse

- Step by step:
  (Assume data set that stores samples by row)

  AdaLinE calculates scalar product of each row with weight vector

  Output should be close to desired output

  Basically: $X \cdot w = Y$

$$\begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \end{pmatrix} \cdot \begin{pmatrix} w_0 \\ w_1 \end{pmatrix} = \begin{pmatrix} 1 \\ 4 \\ 4 \end{pmatrix}$$

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This is an over determined linear equation system!
Use Pseudo Inverse to find weight vector!

AdaLinE Pseudo Inverse

- This is the Pseudo Inverse of X: $(\mathrm{X}^T X)^{-1} X^T$
- It is the Pseudo Inverse since multiplication with X results in the identity matrix

$$(\mathrm{X}^T X)^{-1} X^T X \cdot w = (\mathrm{X}^T X)^{-1} X^T Y$$

$$w = (\mathrm{X}^T X)^{-1} X^T Y$$

Content

- Revision: Practical Task (Already uploaded)
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- **Revision: Lecture (MLP)**

Revision: Lecture

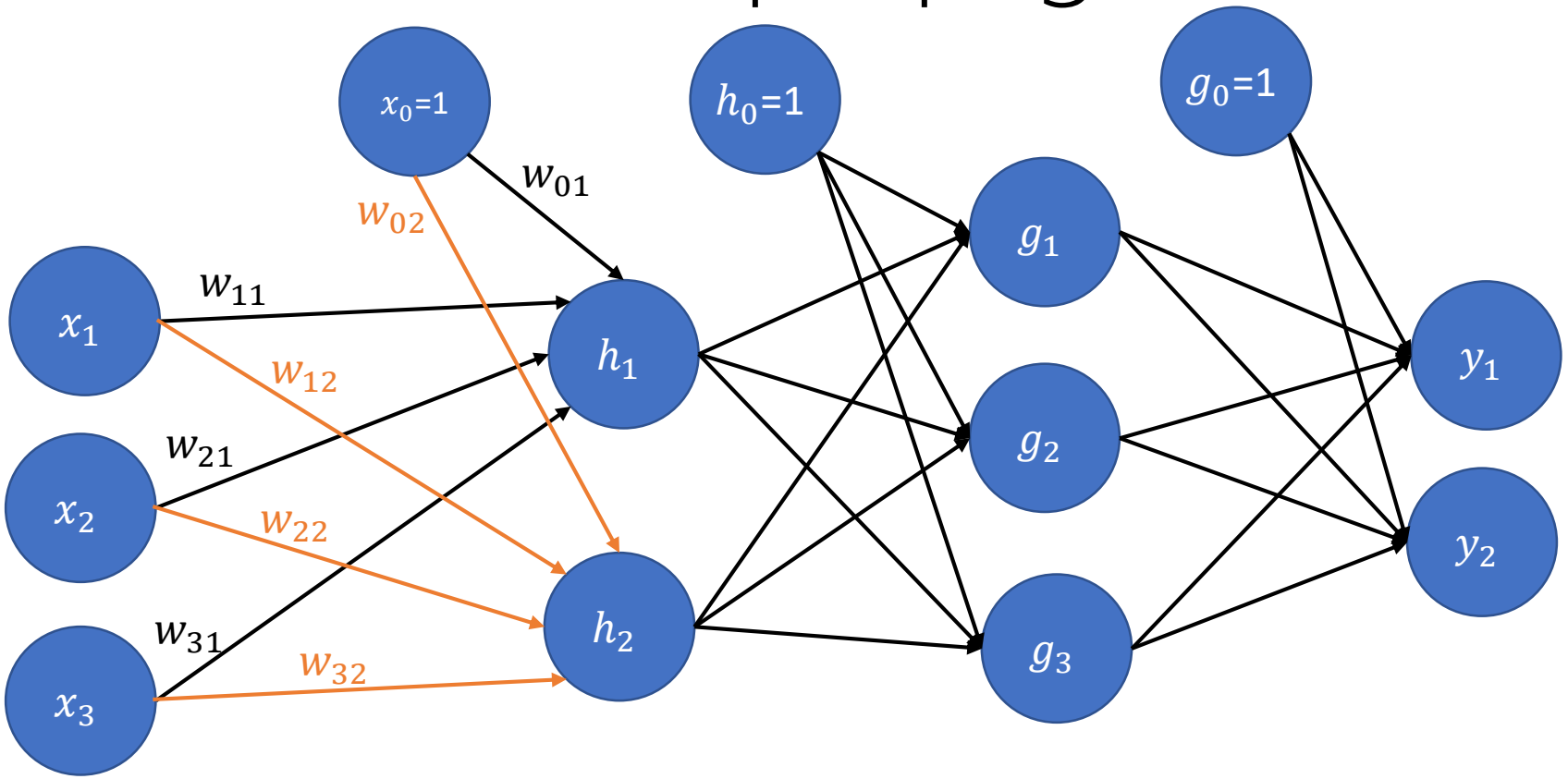
- What is a Multilayer Perceptron?

MLP - Definition

- Network of Perceptrons
- Perceptrons organized in multiple layers
- Weighted connection between each Perceptron of one layer to each perceptron of the next layer
- Propagation function of perceptrons: Linear Associator
- Activation function (usually) defined per layer

- 1 Input layer (your usual input vector)
- (Multiple hidden layers)
- 1 Output layer

Calculation of propagated value



$$x = \begin{bmatrix} x_0 \\ x_1 \\ x_2 \\ x_3 \end{bmatrix} \qquad W = \begin{bmatrix} w_{01} & w_{02} \\ w_{11} & w_{12} \\ w_{21} & w_{22} \\ w_{31} & w_{32} \end{bmatrix} \qquad \begin{bmatrix} h_1 \\ h_2 \end{bmatrix} = W^T \cdot x$$

MLP – Caution with number of layers

- Various conventions about number of layers
- Sometimes including/excluding input layer
- In scope of this course: Excluding input layer

- 3 layer Perceptron:
  - 1 input layer
  - 2 hidden layers
  - 1 output layer

Revision: Lecture

- What are the hyperparameters of a Multilayer Perceptron?