Matrix factorization for representation learning

Reminders/Comments

- All due dates listed on schedule in canvas, including final

- Assignment 2 marks should be back this week
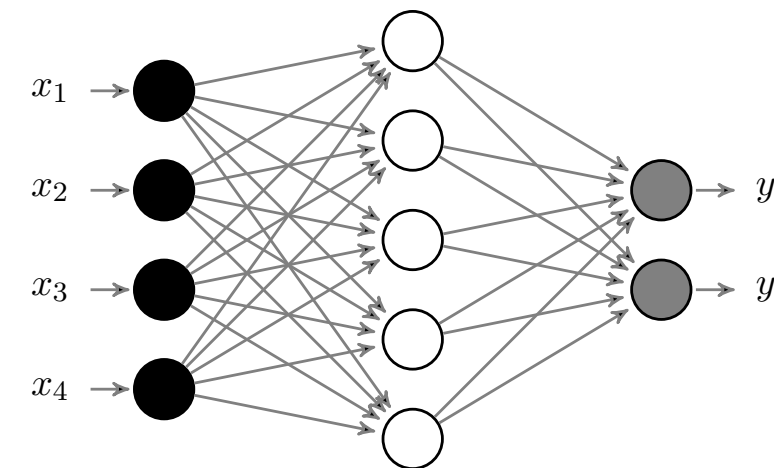
- Office hours end at 3:30 p.m. today

Representation learning

- For generalized linear models, learning $f(xW) = E[y \mid x]$

- Augment observations, phi(x) and learn $f(phi(x) \, W) = E[y \mid x]$

- There are many strategies to augmenting x

  - fixed representations, like polynomials, wavelets
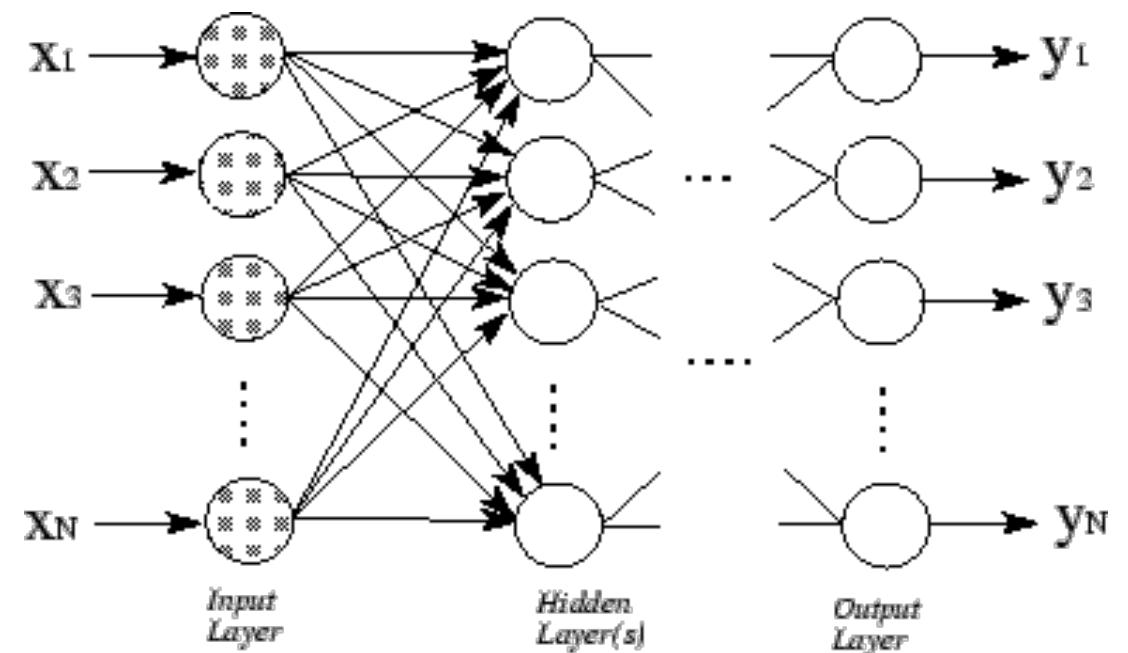
  - neural networks

  - matrix factorization
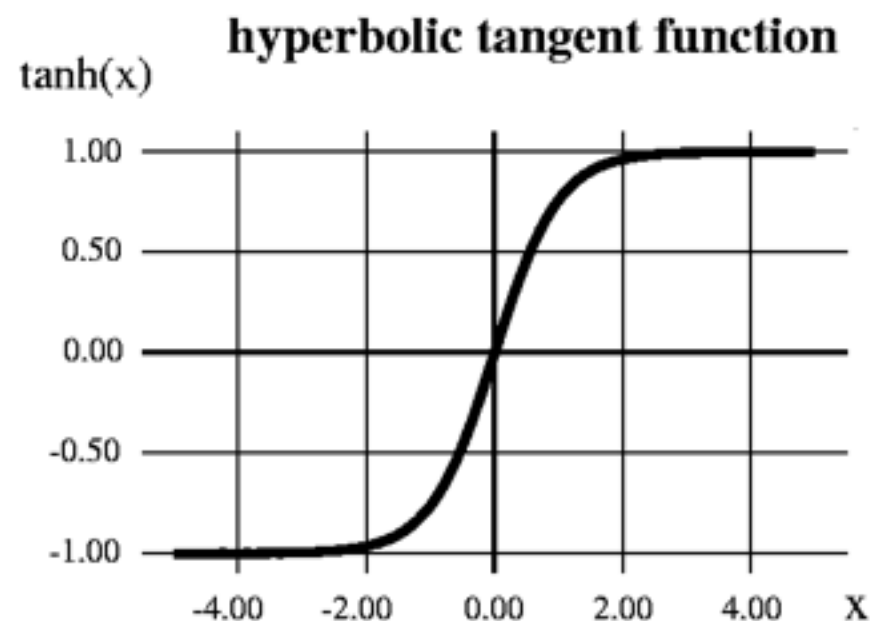
Whiteboard

- Derive update for multi-output neural network
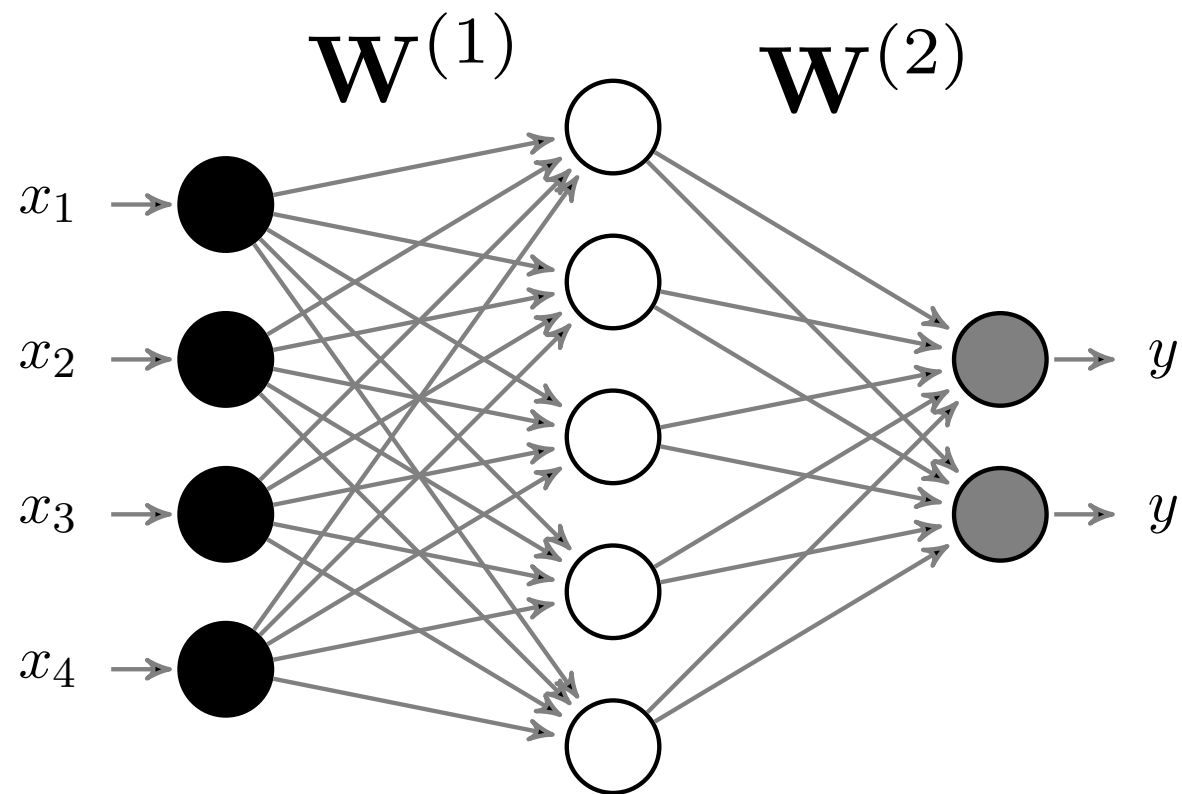

- Derive update for multi-layer neural network

- Derive update for tanh transfer
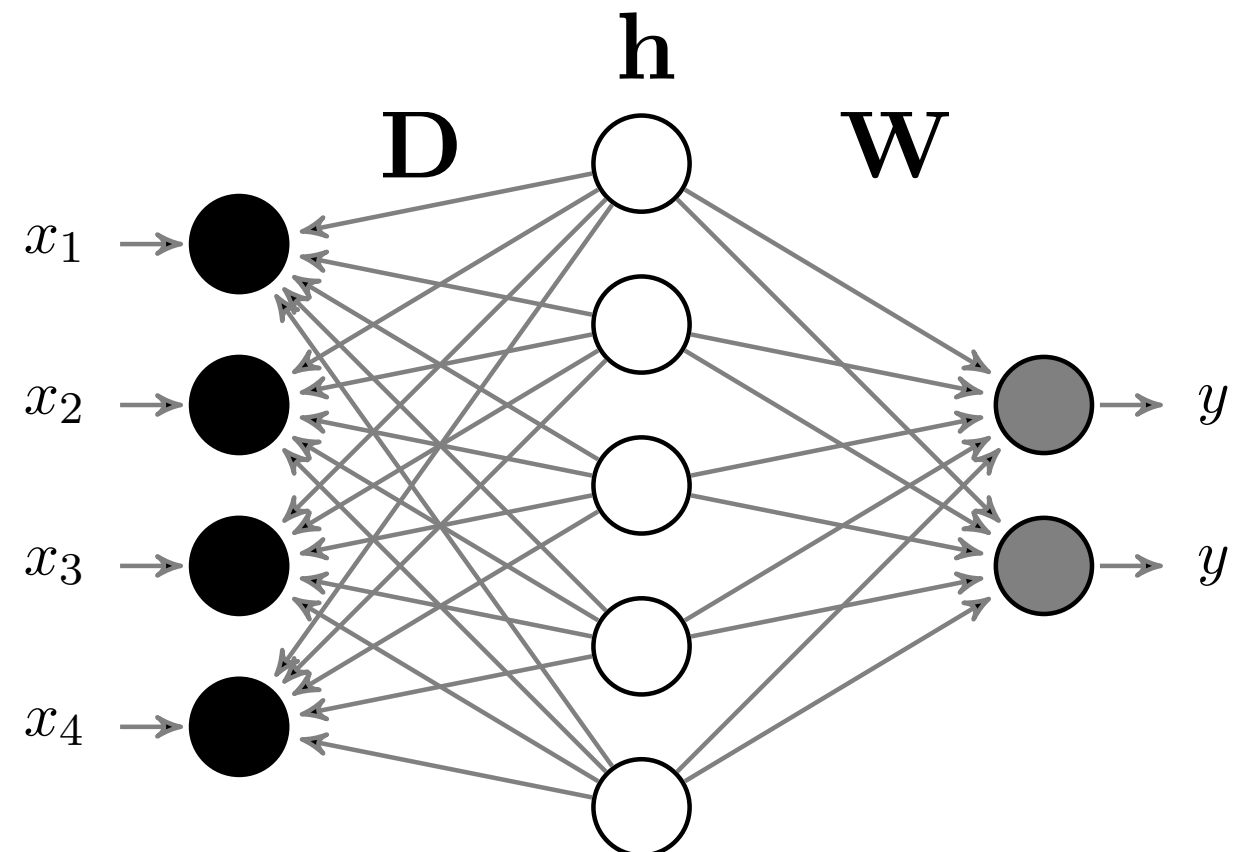
Representation learning

Neural network

$$\mathbf{W}^{(1)} \in \mathbb{R}^{k \times d}, \mathbf{W}^{(2)} \in \mathbb{R}^{m \times k}$$

$$d = 4, k = 5, m = 2$$

$$\hat{\mathbf{y}} = f_2(\mathbf{W}^{(2)} f_1(\mathbf{W}^{(1)} \mathbf{x}))$$

Regularized factor model

$$\mathbf{D} \in \mathbb{R}^{k \times d}, \mathbf{W} \in \mathbb{R}^{k \times m}$$
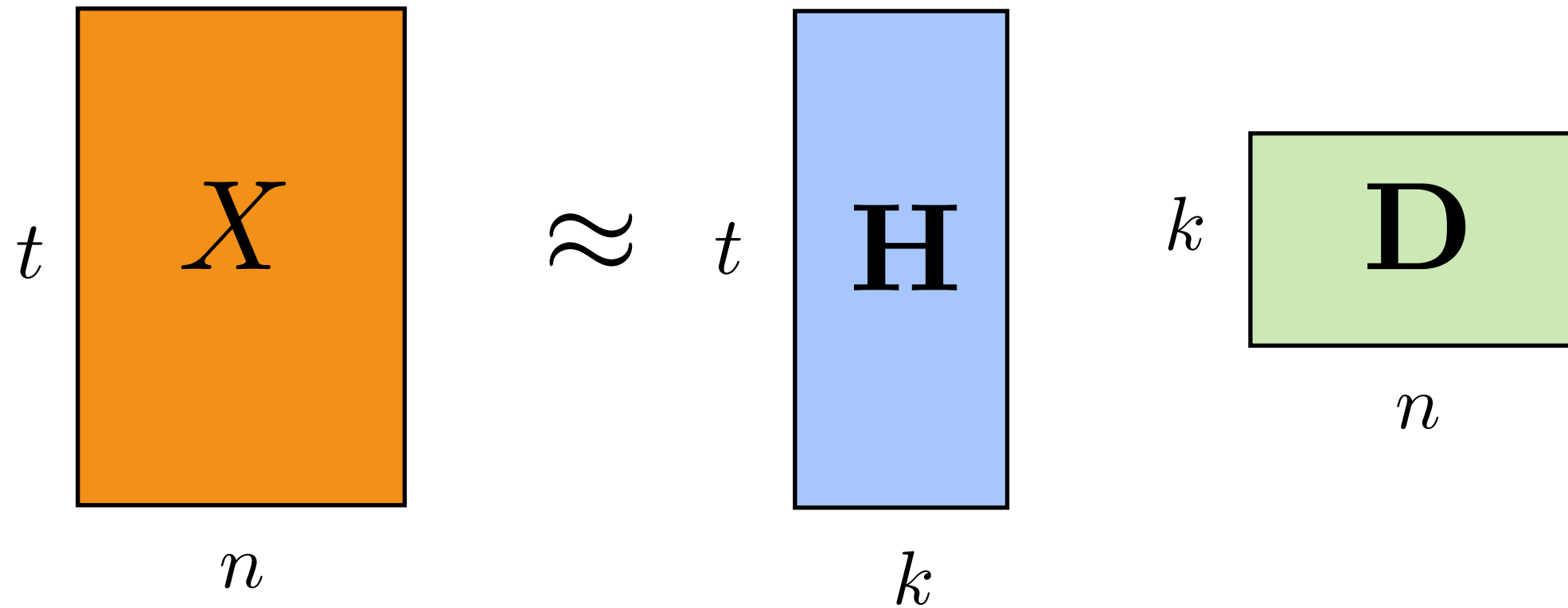
$$d = 4, k = 5, m = 2$$

$$\hat{\mathbf{y}} = f_2(\mathbf{h}\mathbf{W})$$

$$\mathbf{h} = \arg \min_{\mathbf{h} \in \mathbb{R}^{1 \times k}} L_x(\mathbf{h}\mathbf{D}, \mathbf{x})$$

Unsupervised RFMs

$$X \approx H \, D$$

Whiteboard

- Regularized factor models

  - formulation for unsupervised learning

  - example with principal components analysis