Neural networks

Autoencoder - undercomplete vs. overcomplete hidden layer
**Topics:** autoencoder, encoder, decoder, tied weights

- Feed-forward neural network trained to reproduce its input at the output layer

**Encoder**

\[
\hat{h}(x) = g(a(x)) = \text{sigm}(b + Wx)
\]

\[
W^* = W^\dagger \quad \text{(tied weights)}
\]

**Decoder**

\[
\hat{x} = o(\hat{a}(x)) = \text{sigm}(c + W^*h(x))
\]

for binary inputs
Topics: undercomplete representation

- Hidden layer is undercomplete if smaller than the input layer
  - hidden layer “compresses” the input
  - will compress well only for the training distribution
- Hidden units will be
  - good features for the training distribution
  - but bad for other types of input

undercomplete hidden layer

\[ \hat{x} = \sigma(W'x + b) \]

\[ W^* = W^T \]

(tied weights)

\[ x \rightarrow h(x) \rightarrow \hat{x} \]
Topics: overcomplete representation

• Hidden layer is overcomplete if greater than the input layer
  ‣ no compression in hidden layer
  ‣ each hidden unit could copy a different input component

• No guarantee that the hidden units will extract meaningful structure