Exam:

Cumulative
Completable in 2 hour exam slot. (May 11, 2pm-4pm)
I will be available during 2 hour exam slot

Posted 12:01 am May 11, due 11:59 pm May 11.
Approximately same format as midterm.
More focus on RL than other topics.
Supervised Learning

\( l(w_k) = \text{loss function} \) (smaller is better \( w_k \))

Least squares loss:
\[
l(w_k) = \frac{1}{n} \sum_{i=1}^{n} (y_i - \hat{y}_i)^2
\]

Other forms:
\[
l(w_k) = \frac{1}{2n} \sum_{i=1}^{n} (y_i - \hat{y}_i)^2
\]

\( \hat{y}_i \): agent's prediction of \( y_i \) from \( x_i \).

\( w_k \): model parameters after \( k \) updates.

Linear parametric model:
\[
f_k(x_i) = \sum_j w_{kj} \phi_j(x_i)
\]

Gradient descent:
\[
wk_{k+1} = wk_k - \alpha \frac{\partial l(w_k)}{\partial w_{kj}}
\]

\( \alpha \): Step size.

\( \alpha_k \): Step size for \( k \)th update.

Convergence:

- Summable, not summable
  \[
  \sum_{k=0}^{\infty} \alpha_k < \infty \quad \sum_{k=0}^{\infty} \alpha_k = \infty
  \]

Lipschitz continuity

- If differentiable function
  - Max slope is \( L \).

Don't forget to normalize inputs!
- Each feature
  - Mean = 0
  - Variance = 1
\( a_0 = 1 \)

\[
\text{in}_j = \sum_{i=0}^{m} w_{ij} a_i \\
\text{out}_j = \sigma(\text{in}_j)
\]

\( \sigma(z) = \begin{cases} 
1 & \text{if } z \geq 0 \\
0 & \text{otherwise}
\end{cases} \)

\[
\sigma(z) = \frac{1}{1 + e^{-z}}
\]

\[
\frac{d\sigma(z)}{dz} = \sigma(z)(1 - \sigma(z))
\]
 Fully connected feedforward artificial neural network

Classification: one output per possible label.
Backpropagation:

\[
\frac{d l(w_k)}{d w_{kj}} = \frac{d f_{w_k}(x_i)}{d w_{kj}}
\]

**Old notation**

\[
\frac{d f_{w}(x)}{d w_{ij}} = (\text{chain rule over, and over})
\]

\[i = \text{prev layer} \]
\[j = \text{cur layer} \]
\[k = \text{next layer} \]
Other:

Vanishing gradients
over-fitting
train, validation, test
adaptive step sizes
generalization bounds (safety)
- Hoeffding’s inequality
  applied to $\|w_t\|
  - using test data!

fairness
psych/neuro
ethics
philosophy of mind