CS/ECE/ME 532
Activity 16

- Unit 3+4 Quiz – Thursday in class
  - 60 minutes
  - Units 3+4 (including ridge regression)
  - no interaction with anyone besides instructors
  - must sit at your table, **video must be on**

- Unit 3+4 Integrative Summary assignment due Thursday evening

- Today – Unit 5 (iterative methods)

Iterative Methods

loss function

Regularizer
(L2 gives solutions with small 2 norm)

$$\min_{\boldsymbol{w}} ||\boldsymbol{X}\boldsymbol{w} - \boldsymbol{y}||^2 + \lambda||\boldsymbol{w}||_2^2$$

$$\boldsymbol{w}^* = (\boldsymbol{X}^T\boldsymbol{X} + \lambda\boldsymbol{I})^{-1}\boldsymbol{X}^T\boldsymbol{y}$$

closed form solution

Some other regularizer
(maybe only a few non zero entries)

What if we want some other regularizer?

Or different loss function all together?

$$\min_{\boldsymbol{w}} ||\boldsymbol{X}\boldsymbol{w} - \boldsymbol{y}||^2 + \lambda r(\boldsymbol{w})$$

No closed form solution.
Optimization.

Gradient Descent

- main idea: use the gradient to head downhill

goal: $\min_{\boldsymbol{w}} f(\boldsymbol{w})$

for $k = 1 \ldots$

$$\boldsymbol{w}^{(k+1)} = \boldsymbol{w}^{(k)} - \tau\nabla f(\boldsymbol{w})$$

step size

goal: $\min_{\boldsymbol{w}} ||\boldsymbol{X}\boldsymbol{w} - \boldsymbol{y}||_2^2$

for $k = 1 \ldots$

$$\boldsymbol{w}^{(k+1)} = \boldsymbol{w}^{(k)} - \tau(2\boldsymbol{X}^T\boldsymbol{X}\boldsymbol{w} - 2\boldsymbol{X}^T\boldsymbol{y})$$

$$0 < \tau < \frac{1}{||\boldsymbol{A}||_{op}^2}$$

Problem 1 today – see video lecture 2.8, minute 14

- do it by hand (double check with starter script)
- Find $\boldsymbol{w}_{LS}$ first (using SVD) -- bottom of bowl

$\boldsymbol{w}^T\boldsymbol{X}^T\boldsymbol{X}\boldsymbol{w} = c$ define an ellipse

with $\boldsymbol{X} = \boldsymbol{U}\Sigma\boldsymbol{V}^T$

then columns of $\boldsymbol{V}$ define axis