• CR/NC deadline TODAY
  – If you’re considering this, we can discuss in office hours today (or before/after)
• Poll for Alternative presentation times
  ![Poll for alternative presentation times chart]
• Tentative schedule
  – Lab 6 due April 5
  – Lab 7 due April 15
  – Project Proposal due April 19
  – Midterm 2 on April 24
Outline for March 29

• Lab 3 followups
• SVM optimization
  – Coordinate ascent
  – Incremental algorithm
• Next week: Start Neural Networks
  – Reading posted
Outline for March 29

• Lab 3 followups
  • SVM optimization
    – Coordinate ascent
    – Incremental algorithm
• Next week: Start Neural Networks
  – Reading posted
Lab 3
(solutions not posted online)
Lab 3, Part (a)

- Always good to start by identifying the goal and the variable(s) to predict. Classification or Regression?

- Think about train and test holistically, not separately. Normally will not have them separated or be able to visualize them.
• As alpha decreases, we generally see the SGD solution become closer to the analytic solution.

• But if alpha becomes *really* small, we see it get further away.... Why?
Lab 3, Part (g)

- RMSE has several advantages over cost, even though it is very closely related! Why?
Outline for March 29

• Lab 3 followups

• SVM optimization
  – Coordinate ascent
  – Incremental algorithm

• Next week: Start Neural Networks
  – Reading posted
Loop until convergence: 

For $i = 1, \cdots, n$ 

$$\alpha_i \leftarrow \arg \max_{\hat{\alpha}_i} W(\alpha_1, \cdots, \alpha_{i-1}, \hat{\alpha}_i, \alpha_{i+1}, \cdots \alpha_n)$$
Coordinate Ascent

Loop until convergence: 

\[
\text{For } i = 1, \cdots, n \{ \\
\alpha_i \leftarrow \arg \max_{\hat{\alpha}_i} W(\alpha_1, \cdots, \alpha_{i-1}, \hat{\alpha}_i, \alpha_{i+1}, \cdots, \alpha_n) \\
\}
\]

• In practice, need to choose pairs of alphas since we have the constraint:

\[
\sum_{i=1}^{n} y_i \alpha_i = 0
\]

More details: see Andrew Ng notes
Meta-optimization process

• Incremental SVM optimization algorithm
Meta-optimization process

• Incremental SVM optimization algorithm

• Choose a subset $S$ of examples and run coordinate ascent fully
Meta-optimization process

• Incremental SVM optimization algorithm

• Choose a subset $S$ of examples and run coordinate ascent fully

• Identify which alpha values are 0 $\Rightarrow$ these cannot be support vectors in final solution!
Meta-optimization process

• Incremental SVM optimization algorithm

• Choose a subset $S$ of examples and run coordinate ascent fully

• Identify which alpha values are 0 $\Rightarrow$ these cannot be support vectors in final solution!

• Discard these points and add new ones; repeat
Incremental SVM Optimization Algorithm

* $K = \text{subset size}$
* $S = \text{subset}$
* $|S| = K$
* randomize order of examples
* initially $S = \{x_1, x_2, \ldots, x_K\}$

Repeat until no more examples:

- run coordinate ascent with train data $S$
- $\Rightarrow \alpha$'s on all these examples + hyperplane
- if $\alpha_i = 0$ for $x_i \in S$, discard $x_i$
- add examples to $S$ until $|S| = K$
Meta-optimization: example
Meta-optimization: example

$K = 4$
Round 1:
* $S = \{x_1, x_2, x_3, x_4\}$
* Support vectors are: $x_1, x_2, x_4$
* Alpha 0: $x_3$
* Hyperplane:
Round 1:
* $S = \{x_1, x_2, x_4, x_5\}$
* Support vectors are: $x_4, x_5$
* Alpha 0: $x_1, x_2$
* Hyperplane: 

![Diagram illustration]
Round 3:
* $S = \{x_4, x_5, x_6, x_7\}$
* Support vectors are: $x_4, x_5, x_7$
* Alpha 0: $x_6$
* Hyperplane: $\text{---}$
Round 4:
* $S = \{x_4, x_5, x_7, x_8\}$
* Support vectors are: $x_4, x_5, x_7$
* Alpha 0: $x_8$
* Hyperplane: —
Round 5:
* $S = \{x_4, x_5, x_7, x_9\}$
* Support vectors are: $x_4, x_7, x_9$
* $\alpha_0$: $x_5$
* Hyperplane: 

\[
x_2 = x_1
\]
Handout 12, Final Solution