Large Scale Learning - Challenge

(Learning with Millions of Examples and Dimensions)

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Outline

1. Large Scale Learning
2. Motivation
3. Challenge

Large Scale Problems

What makes a Problem Large Scale?

- Large number of data points
- Extremely high dimensionality
- High effort algorithms $\mathcal{O}(N^3)$
- Large memory requirements

⇒ **Anything that reaches current computers limits: computational, memory, transfer costs**

Applications

- Bioinformatics (Splice Sites, Gene Boundaries,. . .)
- IT-Security (Network traffic)
- Text-Classification (Spam vs. Non-Spam)
- Image Recognition

Our Motivation

Current SVM solvers

- Joachims 2005, SVM^{perf} is *much* faster than SVM^{light}
- Own experiments: SVM^{light} is *much* faster than SVM^{perf}
- Shalev-Shwartz et.al. 2007, Pegasos is much faster than SVM^{light,perf}
- Own experiments: Pegasos is much slower than SVM^{light,perf}
- Teo et.al. 2007, SVM^{perf} is a special case of BMRM
- Own experiments: BMRM is much faster than SVM^{perf}
- new SVM$^{perf\,2.1}$ similar in speed to BMRM
- Bottou 2007, SGD done right outperforms competitors

There is no reliable way to tell which method is faster!

Reasons

Evaluation was done using different criteria!

- Different Parameters $C, \varepsilon, \lambda, \ldots$
- Meaning of parameters different
- Evaluation based on test error, objective value, . . .
- Programming Errors, Inefficient Code
- Other accidental mistakes.

We need a fair comparison!

Proposal for a Large Scale Learning Challenge

- **Main Goal**
  - Evaluation under exact same fair conditions to answer: **Which learning method is most accurate given limited resources?**
  - Evaluation based on training time, test error (or objective value, etc. specific to method)
- **Additional Goals**
  - Which method gives the overall best classification performance?
  - Which classifier is the most training time efficient while achieving a good test error?
  - Approximation vs. Exact Algorithms?
  - What should one tune? Data representation? Feature selection? Core algorithm?

Competition

- **Two tracks:**
  - Wild Competition
  - Method Specific:
    - Linear SVM
    - RBF SVM
- **Setup:**
  - Method are trained on diverse labeled datasets (size $10^{2,3,4,5,6,7,\cdots}$); unlabeled validation set and test set
- **Evaluation**
  - Record training time, validation and test output for 10 intermediate points
  - Timing "calibrated" using program measuring floating point, integer, memory speed; At the end re-evaluation on a single machine.
  - Live feedback for validation set
  - Feedback for test set after end of competition
  - Competitors are required to submit a detailed explanation of the used methods.

Datasets

Different properties: sparse/dense, high/low dimensional.
Different splits: training, testing and validation parts.

- Real World Datasets:
  - 55M examples - human splice dataset (strings of length 201)
  - 500K examples - web-spam data (16M dims)
  - 3M examples - face detection 1K dimensions
  - 5M examples - OCR 1K dimensions
- Artificial Datasets:
  - Generated from known distribution ⇒ results can be compared with the optimal classifier.
  - Datatsets with different properties will be generated:
    - Separable versus Non-separable data.
    - Data with low and high intrinsic dimensionality.
    - Data with different scale of features.

Time Line

- February - Start of Competition
- Beginning of June - End of Open Competition
- We perform re-evaluation on a single CPU Linux machine with 32G of memory
- 9 July 2008 - Evaluation in an ICML'2008 workshop

Proceedings in LNCS Springer for best performing methods

Setup and Evaluation Criteria

Setup Evaluation Criteria

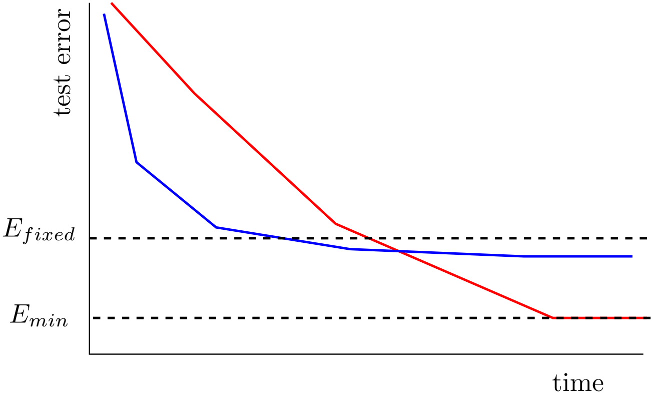
- Time vs. Test Error or Objective Value
- Dataset Size vs. Time ($\mathcal{O}(n^s)$)
- Dataset Size vs. Test Error or Objective Value

We will compute **Performance Figures** and **Scalar Measures**.

Categories

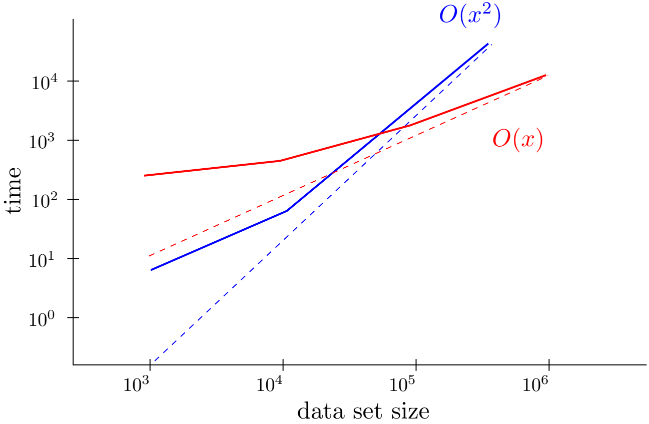
- Overall winner for given dataset based on test error.
- Overall winner based on average rank computed on scalar measures over datasets.
- ...

Evaluation: Time vs. Test Error



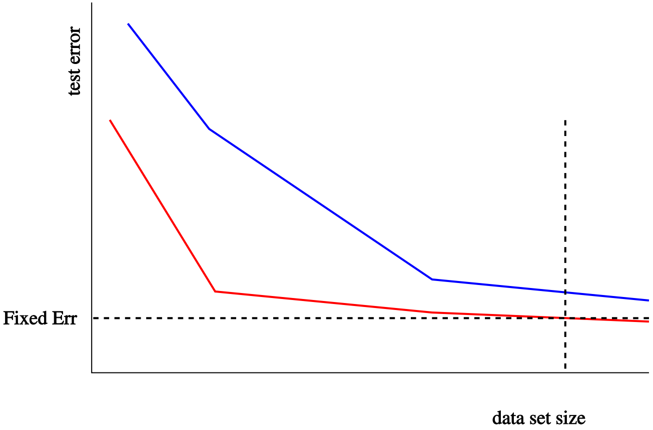
Scalar Measures: Test Error, Time for fixed error, Area under curve

Dataset Size vs. Time



Scalar Measure - Slope in Log-Log Plot $\mathcal{O}(n^s)$

Dataset Size vs. Test Error



Scalar Measures: Dataset size for fixed error, Area under curve

Adjusted Goals and Evaluation for SVMs

Goals for SVMs

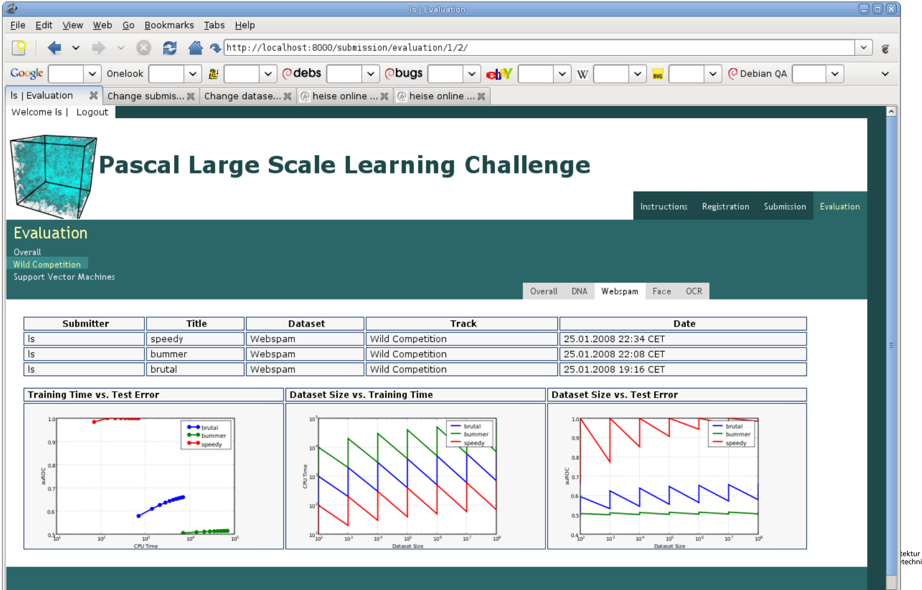
- What is the relation between objective value vs. test error?
- What is the relation between stopping conditions and test error?
- Which algorithm is good on what kind of data set ((un)balanced,high or low dimensional,range of C, etc.)

Adjusted Evaluation for SVMs

Setup and Evaluation Criteria for SVMs

- Linear SVM with sparse data representation
- RBF Kernel SVM with dense data representation
- Run SVM for given fixed values of C and kernel width
- Record objective value while training
- Additional stopping criterion: target objective value
- Figures: Time vs. C, Time vs. Objective, Time vs. Test Error and Objective
- Scalars: Total time for model selection (all Cs and kernel widths), Time to reach target objective

Take part in the Challenge!



Submitter	Title	Dataset	Track	Date
ls	speedy	Webspam	Wild Competition	25.01.2008 22:34 CET
ls	bummer	Webspam	Wild Competition	25.01.2008 22:08 CET
ls	brutal	Webspam	Wild Competition	25.01.2008 19:16 CET

Summary

Start of Competition in February / End: June

- **Two Tracks**:
  - Wild Competition
  - SVM
- **10 Datasets**
  - 4 real world datasets (up to 55Mio examples)
  - 6 artificial datasets
- **Evaluation**
  - Figures: Time vs. Error
  - Dataset Size vs. Time
  - Dataset Size vs. Error

Take part in the Challenge!