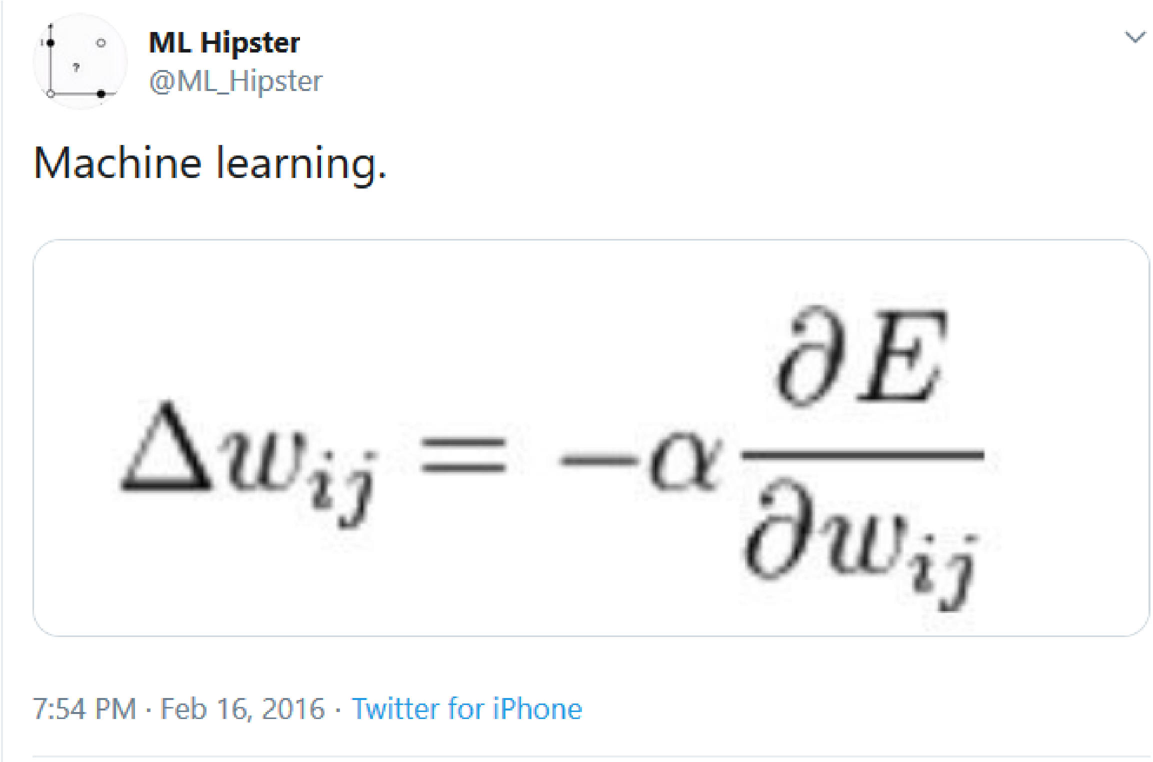
Training Machine Learning Classifiers: Recap



ML Hipster
@ML_Hipster

Machine learning.

$$\Delta w_{ij} = -\alpha \frac{\partial E}{\partial w_{ij}}$$

7:54 PM · Feb 16, 2016 · Twitter for iPhone

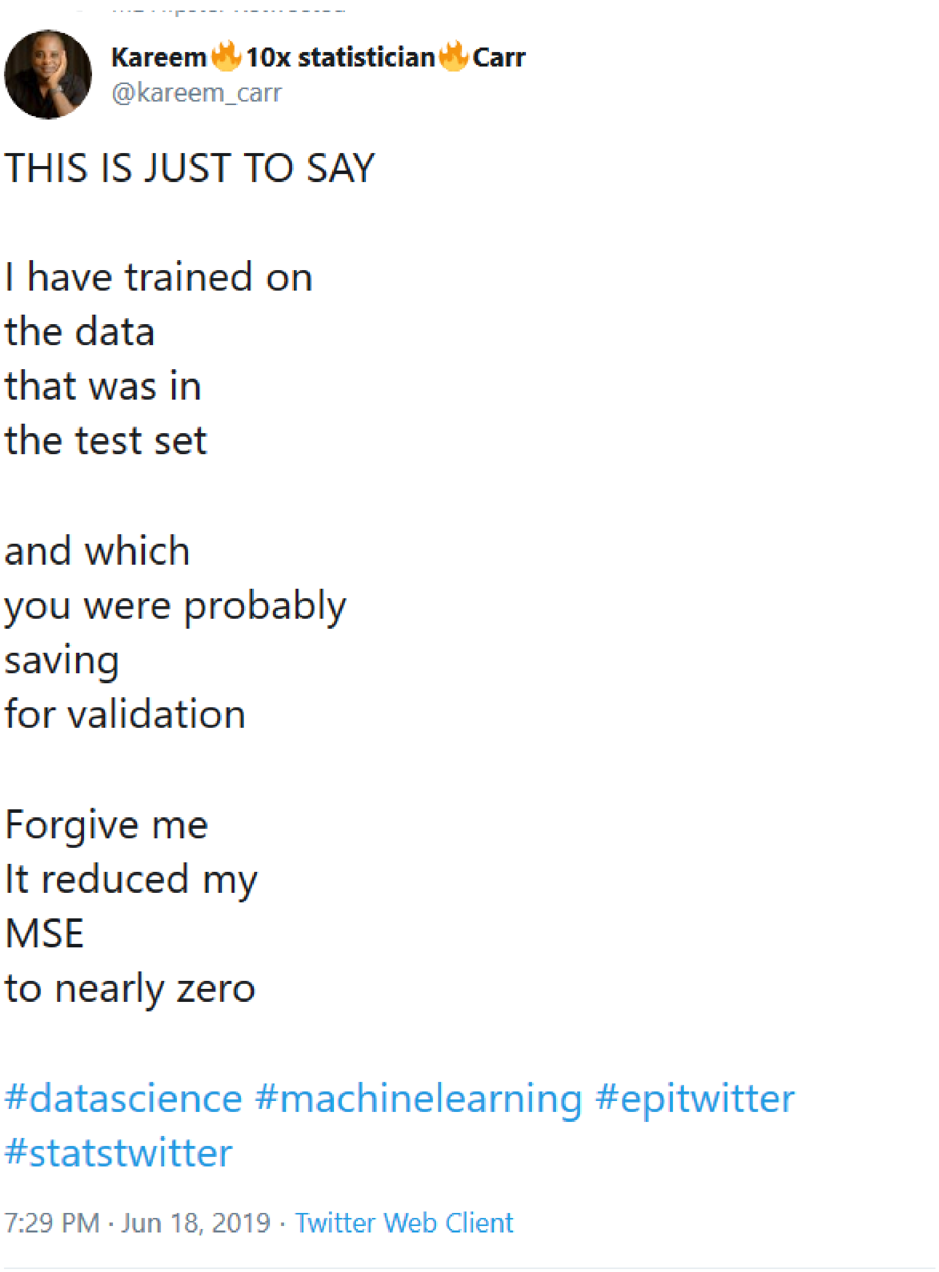
SML310: Research Projects in Data Science, Fall 2019

Michael Guerzhoy

Some slides from Geoffrey Hinton

Training/Validation/Test split

- Split the data into
  - Training set
    - Fit the classifier on the training data
  - Validation set
    - A “mock” test set: train different models, and run them on the validation set; pick the model that works best
      - “Model” can mean neural network architecture, or the parameters of the optimization, or the regularization parameters
  - Test set
    - Data that is held out and not used until the design process is over. Use for evaluating how the model will do on new data.



Kareem🔥10x statistician🔥Carr
@kareem_carr

THIS IS JUST TO SAY

I have trained on
the data
that was in
the test set

and which
you were probably
saving
for validation

Forgive me
It reduced my
MSE
to nearly zero

#datascience #machinelearning #epitwitter
#statstwitter

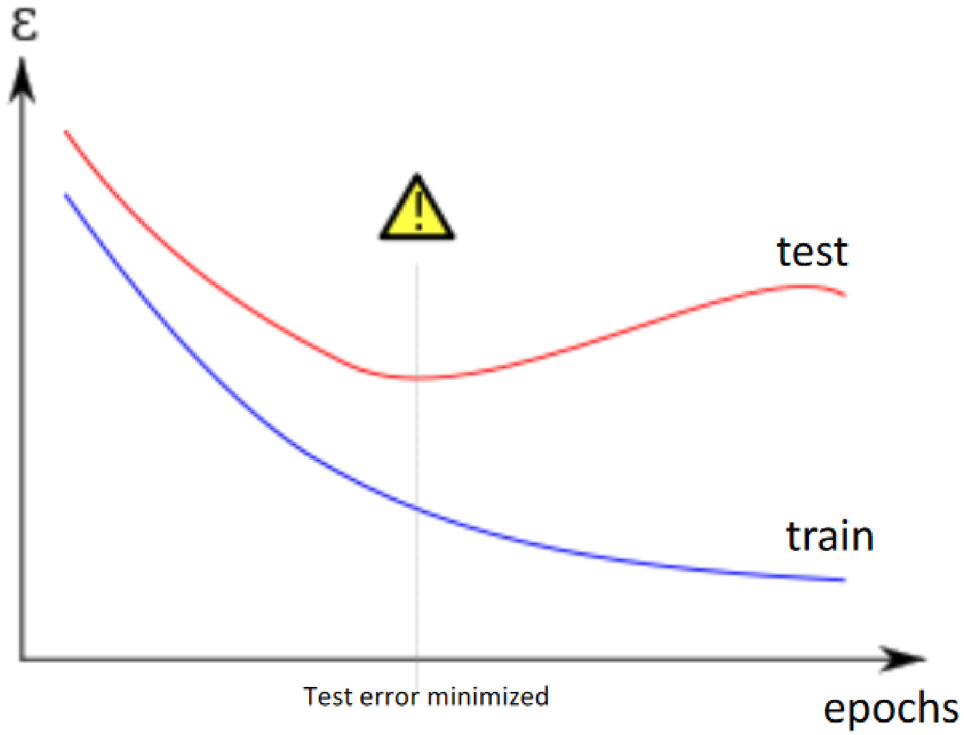
7:29 PM · Jun 18, 2019 · Twitter Web Client

Training process

- For neural networks/logistic regression/linear regression, we train with gradient descent
- Obtain the training and validation cost at every iteration
    - Can also obtain the error (e.g. incorrect classification rate) at every iteration

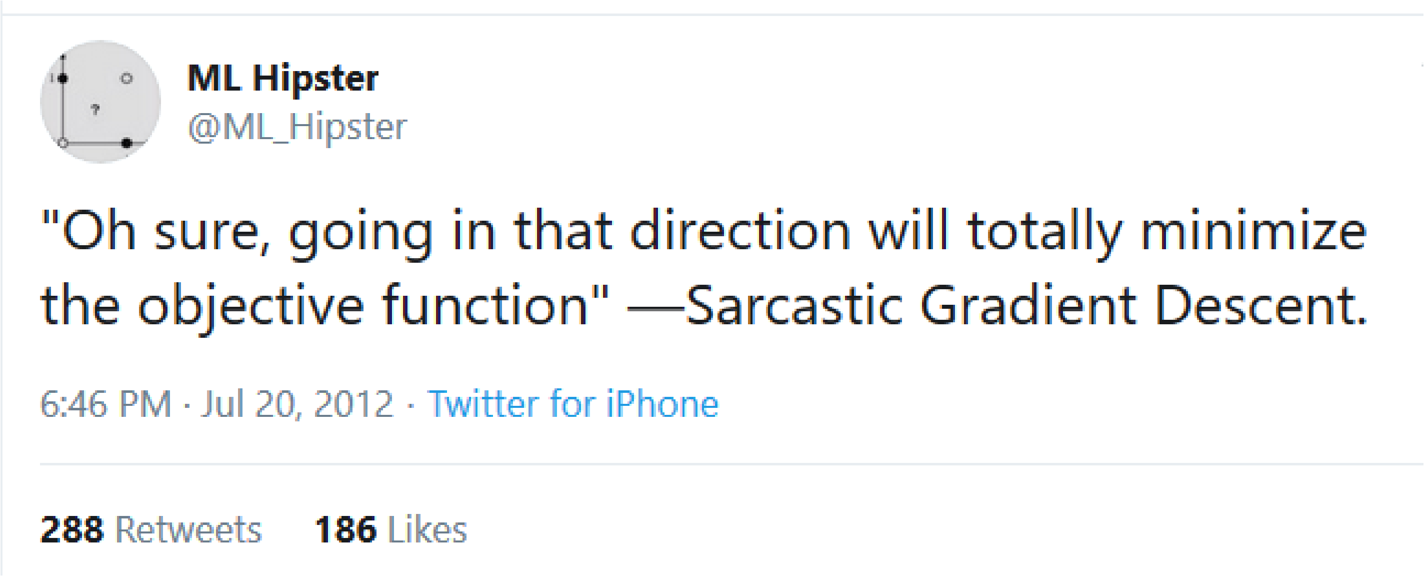
Learning curves

Learning curves



Stochastic gradient descent

- At every iteration, minimize the cost for a *batch* of data from the training set (rather than the entire training set)
- Easier computationally
- Usually works better
- “Stochastic” because at every iteration, there is a randomness element
  - We are not necessarily decreasing the training cost this way
    - Why?



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"Oh sure, going in that direction will totally minimize the objective function" —Sarcastic Gradient Descent.

6:46 PM · Jul 20, 2012 · Twitter for iPhone

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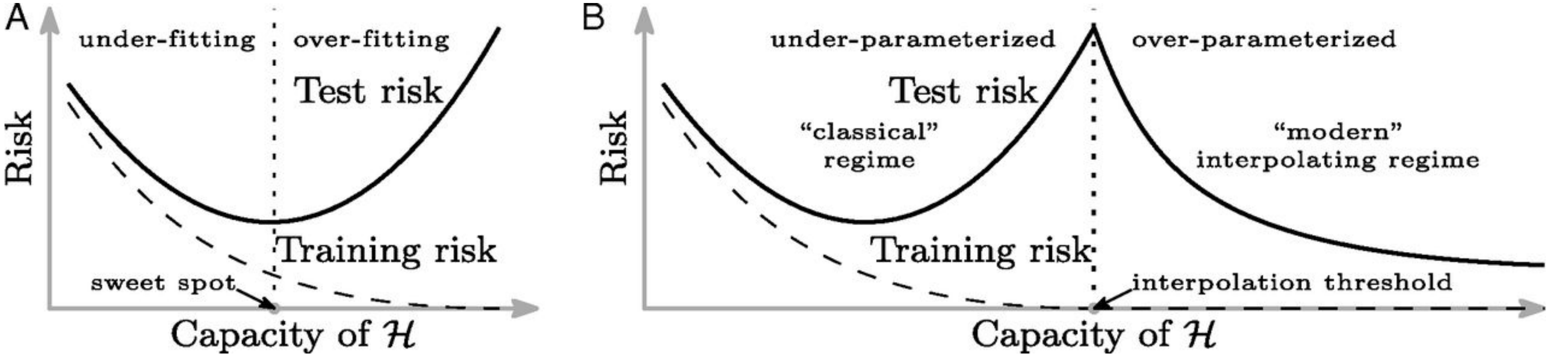
Regularization

- Want to do well on *new* data rather than on the training set
- There is sometimes a tradeoff
- Want to constrain the capacity of the classifier
    - It won’t do as well on the training set, but may do well on new data
- Methods
    - Early stopping: take the weights that minimize the cost on the validation set
    - L2 and L1 regularization: minimize cost+lambda*penalty
    - Train and average multiple models
    - Droupout
    - …
- Usually want to regularize in some way

Belkin et al. (2019)


A
under-fitting
over-fitting
Test risk
Risk
Training risk
sweet spot
Capacity of $\mathcal{H}$
B
under-parameterized
over-parameterized
Test risk
"classical" regime
"modern" interpolating regime
Risk
Training risk
interpolation threshold
Capacity of $\mathcal{H}$