Training/Testing and Regularization

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Weekly Objectives

- Understand the concept of bias and variance
  - Know the concept of over-fitting and under-fitting
  - Able to segment two sources, bias and variance, of error
- Understand the bias and variance trade-off
  - Understand the concept of Occam's razor
  - Able to perform cross-validation
  - Know various performance metrics for supervised machine learning
- Understand the concept of regularization
  - Know how to apply regularization to
    - Linear regression
    - Logistic regression
    - Support vector machine

CONCEPT OF BIAS AND VARIANCE

Up To This Point…

- Now, you are supposed to have some knowledge in classifications
  - Naïve Bayes
  - Logistic Regression
  - Support Vector Machine
- SVM is still a commonly used machine learning algorithm for classifications

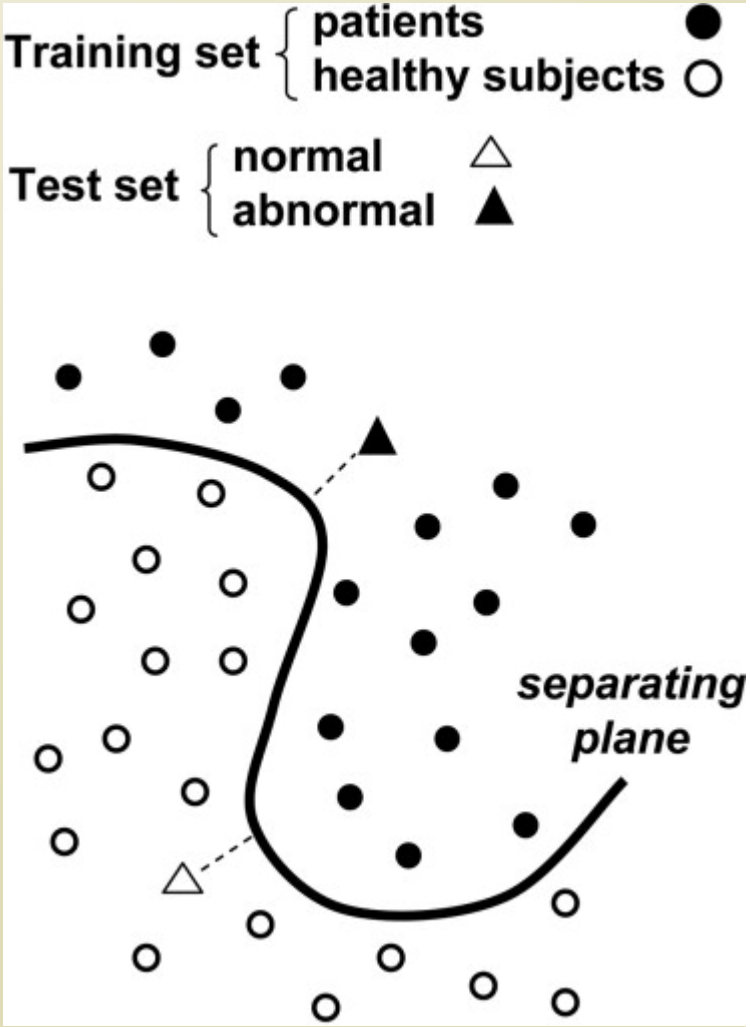
- Functioning is ***kind of*** done
- Efficiency and accuracy now becomes a problem

Better Machine Learning Approach?

- Accurate prediction result
  - Ex) with this NB classifier, I can filter spams with 95% accuracy!
- Is this a right claim?
  - The validity of accuracy
    - No clear definition
    - Why not use other performance metrics? Such as Precision/Recall, F-Measure
  - The validity of dataset
    - Spams??
    - How many spams?
    - Where did you gathered?
    - Big variance in the spams?
    - Is the spam mail evolving?
      - From Nigerian prince scheme to something else?

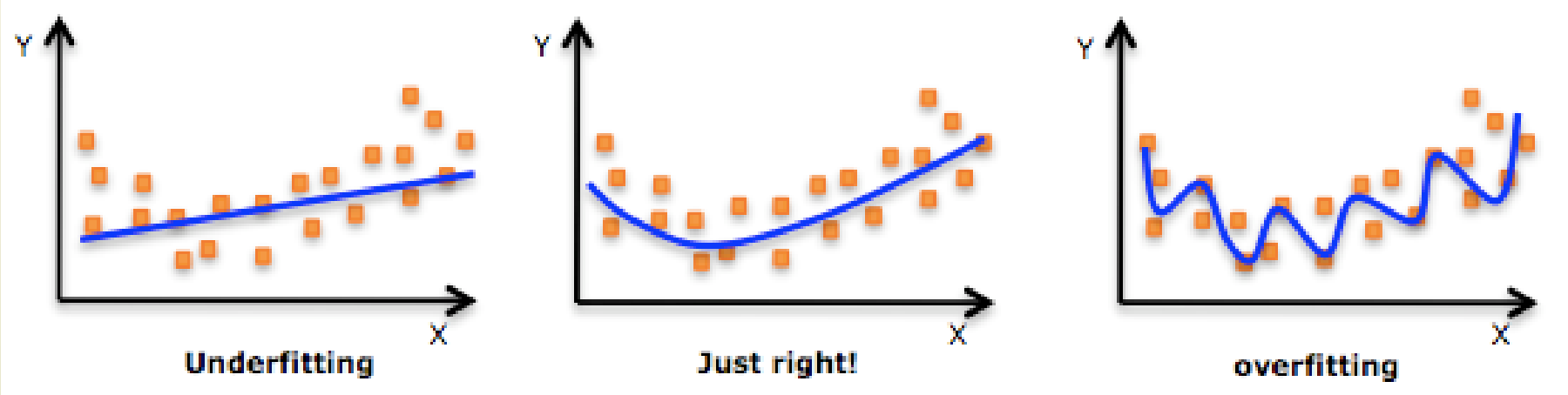
Training and Testing

- Training
  - Parameter inference procedure
  - Prior knowledge, past experience
  - There is no guarantee that this will work in the future
    - ML's Achilles gun is the stable/static distribution of learning targets.
  - Why ML does not work in the future?
    - The domain changes, or the current domain does not show enough variance
    - The ML algorithms inherently have problems
- Testing
  - Testing the learned ML algorithms/the inferred parameters
  - New dataset that is unrelated to the training process
  - Imitating the future instances
    - By setting aside a subset of observations



Over-Fitting and Under-Fitting

- Imaging this scenario
  - You are given N points to train a ML algorithm
  - You are going to learn a simple polynomial regression function
    - Y=F(x)
    - The degree of F is undetermined. Can be linear or non-linear
- Considering the three Fs in the below, which looks better?



Tuning Model Complexity

- One degree, two degree, and N degree trained functions
  - As the degree increases, the model becomes complex
  - Is complex model better?
- Then, where do we stop in developing a complex model?
  - Is there any measure to calculate the complexity and the generality?
- There is a trade-off between the complexity of a model and the generality of a dataset.