CS 171: Intro to ML and DM

Christian Shelton

UC Riverside

Slide Set 1: Introduction

Slides from CS 171

- From UC Riverside
  - CS 171: Introduction to Machine Learning and Data Mining
  - Professor Christian Shelton
- DO NOT REDISTRIBUTE
  - These slides contain copyrighted material (used with permission) from
    - Elements of Statistical Learning (Hastie, et al.)
    - Pattern Recognition and Machine Learning (Bishop)
    - An Introduction to Machine Learning (Kubat)
    - Machine Learning: A Probabilistic Perspective (Murphy)
  - For use only by enrolled students in the course

Syllabus

Lecture:
Mondays, Wednesdays, and Fridays
6:10pm – 7:00pm
Bourns A125

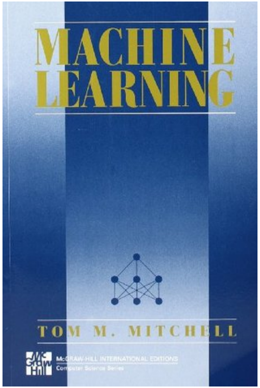
Instructor:
Christian Shelton
cshelton@cs.ucr.edu
off hrs: Wednesdays, 10am–12pm, Chung, 327

TA:
Jacob Fauber
jfaub001@ucr.edu

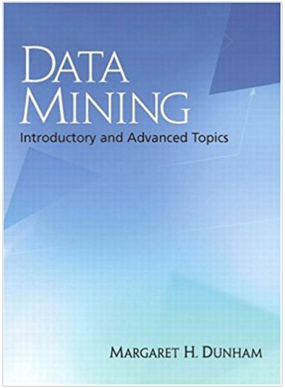
Syllabus

Possible (all optional) Texts:

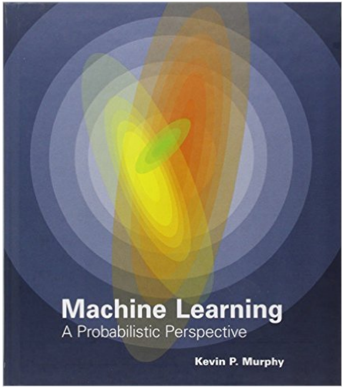
Machine Learning
by Tom M. Mitchell



Data Mining: Introductory and Advanced Topics
by Margaret H. Dunham



Machine Learning: A Probabilistic Perspective
by Kevin P. Murphy



Syllabus

due		Monday		Wednesday		Friday
	4/3	Introduction	4/5	Overfitting	4/7	Bayes classifier
	4/10	Linear regression	4/12	Linear regression	4/14	Linear regression
PS1	4/17	Linear classification	4/19	Linear classification	4/21	Linear classification
	4/24	**Midterm**	4/26	Nearest neighbor	4/28	Nearest neighbor
PS2	5/1	Nonlinear class.	5/3	Nonlinear class.	5/5	Neural networks
	5/8	Neural networks	5/10	Neural networks	5/12	Decision trees
PS3	5/15	Decision trees	5/17	Association Analysis	5/19	Association Analysis
	5/22	**Midterm**	5/24	Data normalization	5/26	Dim. reduction
PS4	5/29	Feature Generation	5/31	Clustering	6/2	Clustering
	6/5	Data Encodings	6/7	Data Visualization	6/9	Review
Final: Wednesday June 14, 2017, 7–10pm						

Syllabus

- Course Work:
  - 4 problem sets (25 pts each)
  - 2 midterms (50 pts each)
  - 1 final (100 pts)
- Problem Sets
  - Due Sunday night (11:59pm)
  - 10% deduction for every hour late!
  - programming in Matlab
  - non-programming questions
  - no external sources (friends, web, etc), except on clarification on Matlab
- Discussion sections Wednesdays
- On-line discussions at Piazza
- Matlab tutorials on iLearn

What's this Course About

Machine Learning:

- Grew out of AI
- How can a computer improve based on experience?

Data Mining:

- Grew out of Databases
- How can we make useful information out of a large database?

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Machine Learning:

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Statistics:

- What can we say mathematically about data?

Optimization:

- How can we improve a function, utility, or score

Face Detection

Face Detection

Face Detection

↓

Is this a face?

↓

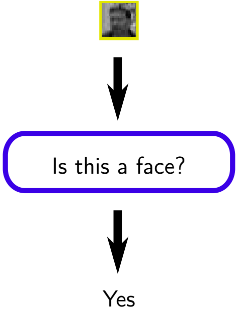
No

Face Detection

Is this a face?

No

Face Detection



Face Detection

Is this a face?

No

Face Detection

Is this a face?

Yes

Face or Not Face?

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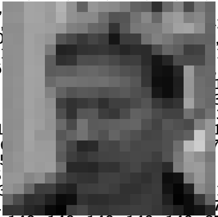
Face Detection

Face or Not Face?



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Face Detection

Face or Not Face?

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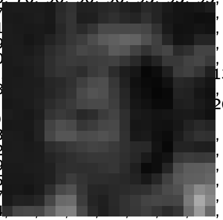
37, 19, 19, 19, 21, 21, 21, 36, 36, 36, 36, 36, 36, 27, 27, 27  , 31, 31, 43, 43, 43, 51, 51, 51, 60, 60, 60, 71, 71, 71, 67,
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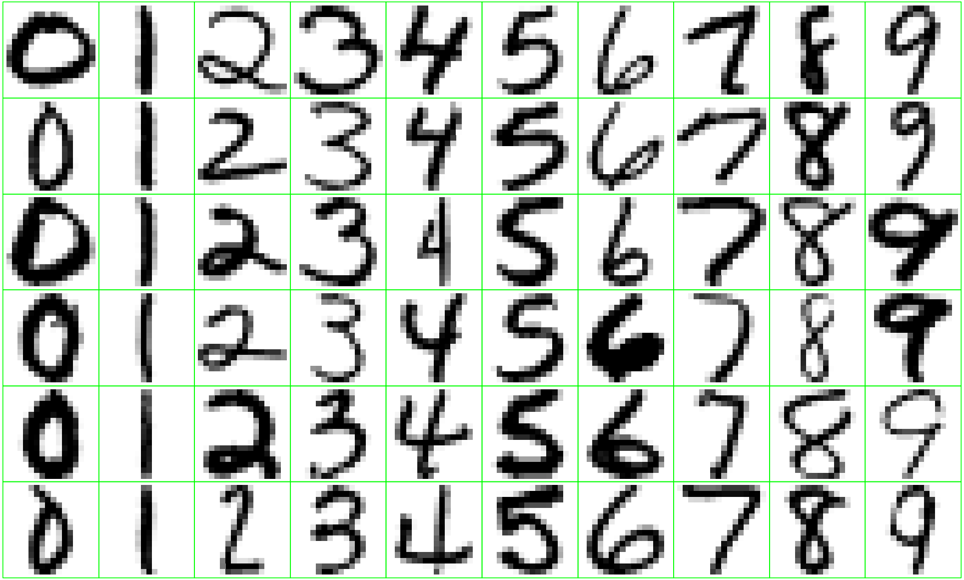
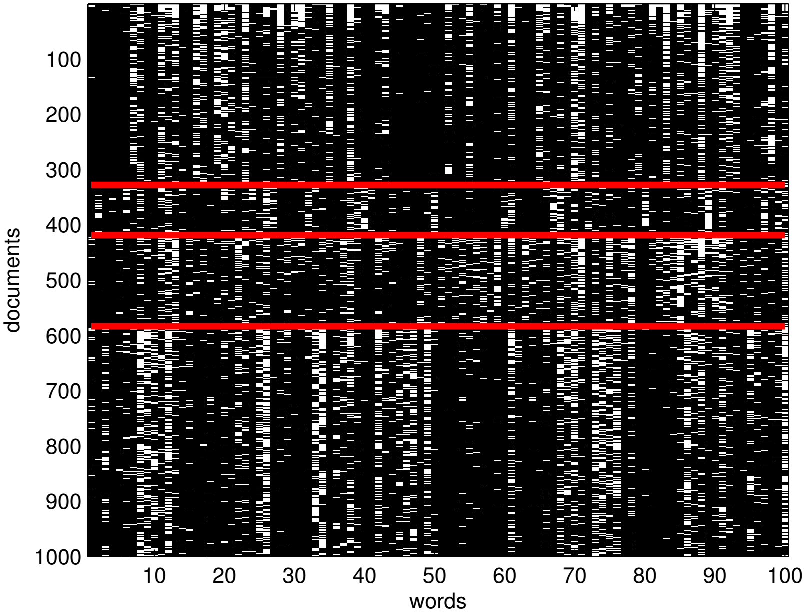
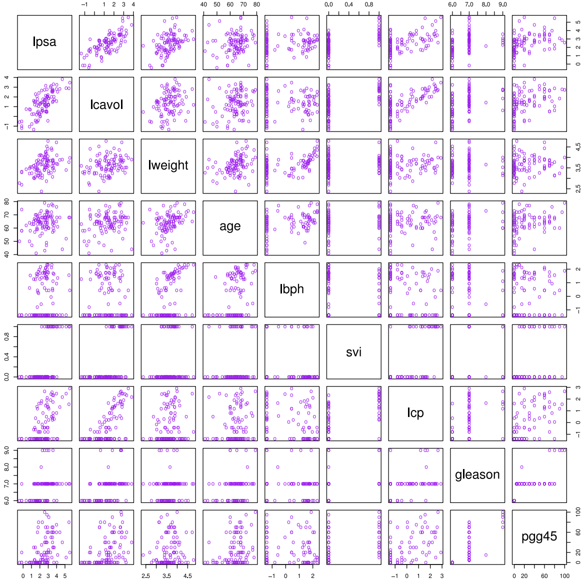
Postal Code Digit Data



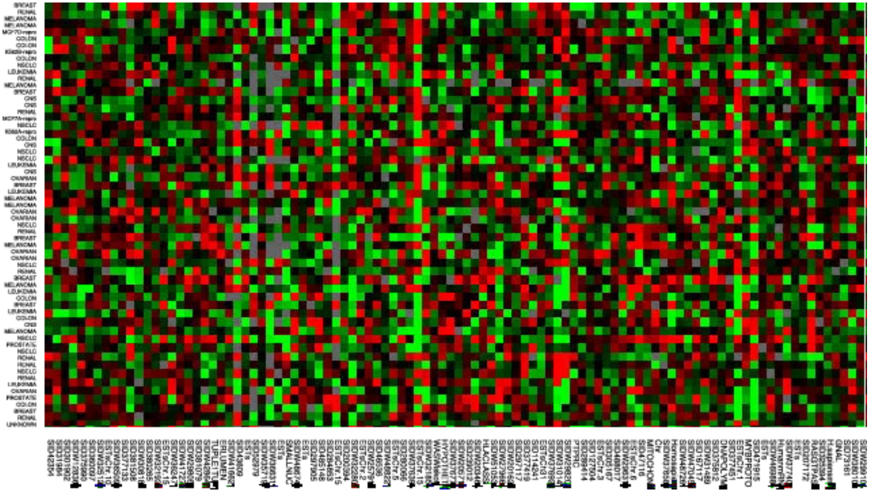
Document Topic Data



Prostate Cancer Data



Genomics Data



Supervised Learning

The Data (**training set**):

- An (unordered) set of examples
- Each example has a set of **features** or **attributes**
  - binary (ex: is the word "health" present in the document or not?)
  - categorical (ex: relationship status)
  - real-valued (ex: weight)
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The Goal:

- Given the data above as the input to the learning algorithm,
- Produce a rule (**classifier** or **regressor**)
- that will map the feature values to the target
- The rule should work well on future, as-yet-unseen examples

Supervised Learning, Example

The Data (**training set**):

$$
X = \begin{array}{cccc} \text{sepal length (cm)} & \text{sepal width (cm)} & \text{petal length (cm)} & \text{petal width (cm)} \\ \end{array}
$$

$$
X = \left[\begin{array}{cccc} 5.1 & 3.5 & 1.4 & 0.2 \\ 7.0 & 3.2 & 4.7 & 1.4 \\ 6.4 & 3.2 & 4.5 & 1.5 \\ 6.3 & 3.3 & 6.0 & 2.5 \\ \vdots & \vdots & \vdots & \vdots \\ 4.9 & 3.0 & 1.4 & 0.2 \end{array}\right] \quad \begin{array}{c} \text{class} \\ Y = \left[\begin{array}{c} 0 \\ 1 \\ 1 \\ 2 \\ \vdots \\ 0 \end{array}\right] \end{array}
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where class 0 = Setosa, 1 = Versicolor, 2 = Virginica

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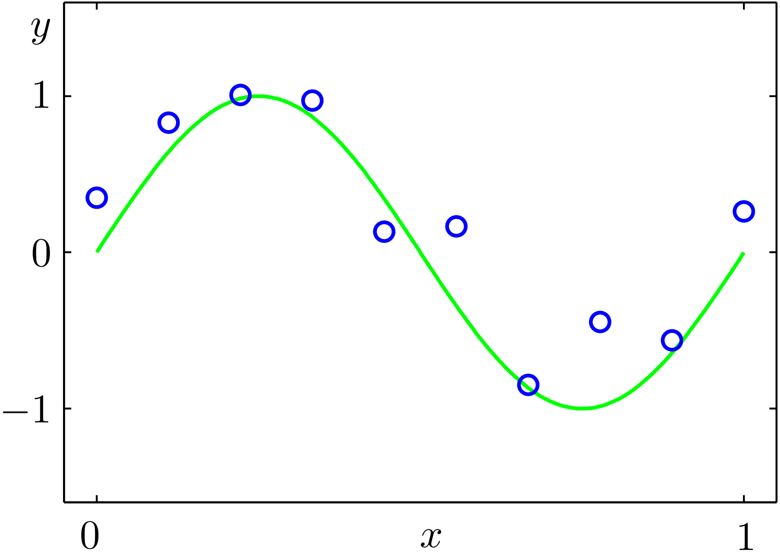
where class 0 = Setosa, 1 = Versicolor, 2 = Virginica

The Output (possible):

f(x):
```
If x(1) < 6 then y = 0
Else If x(3)+x(4) > 8 then y = 2
Else y = 1
```

Simple Example



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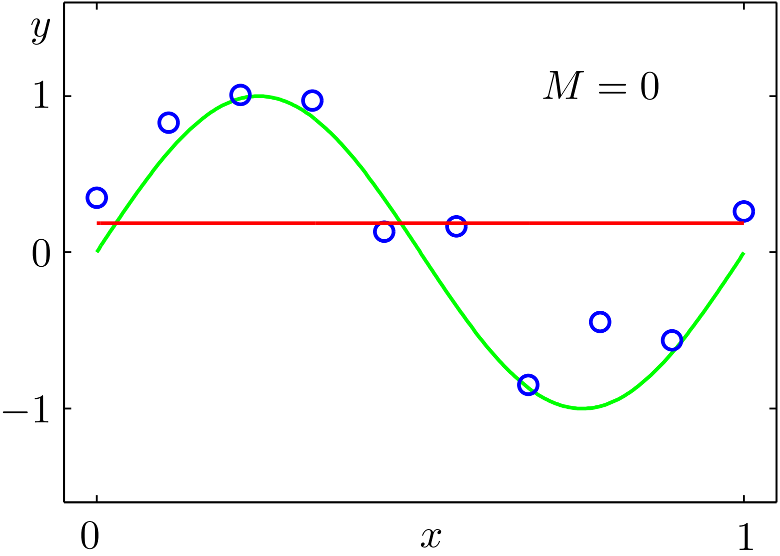

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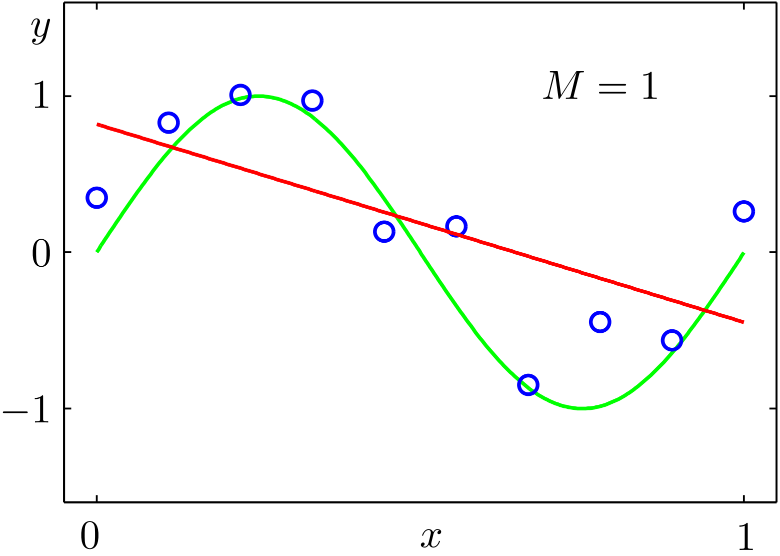

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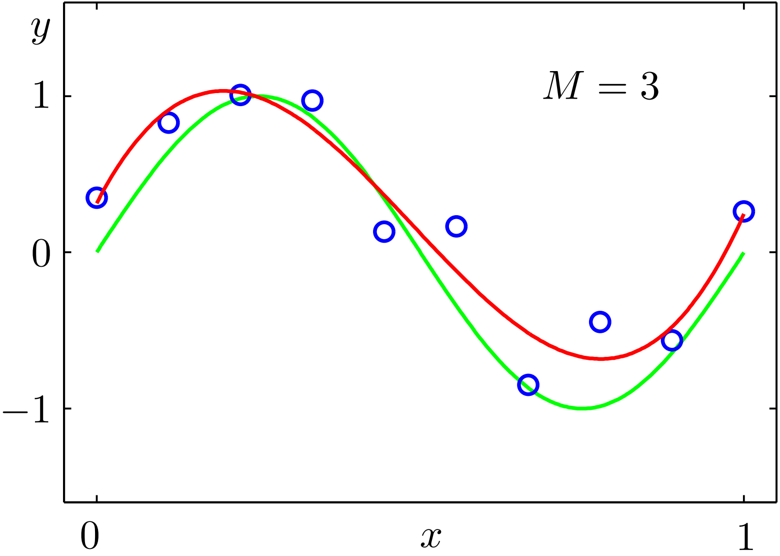

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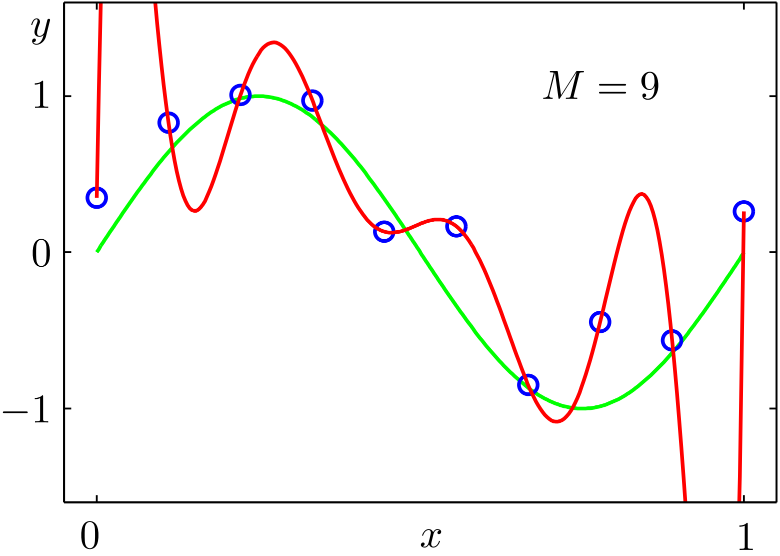

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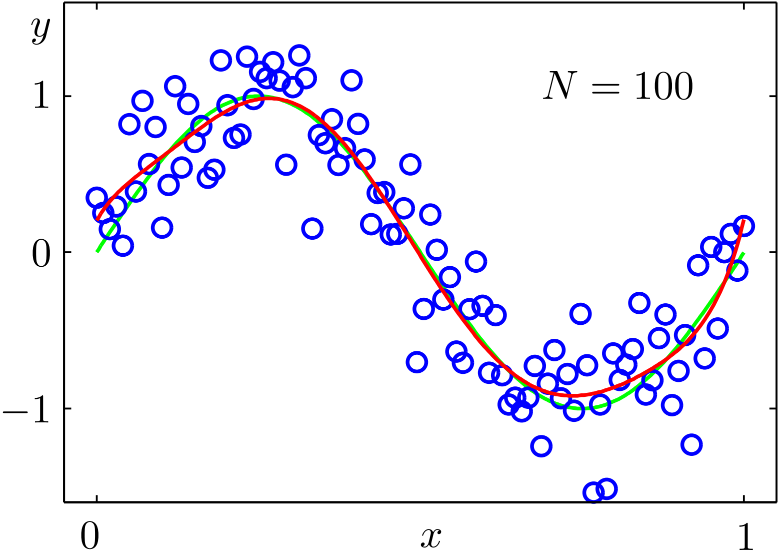
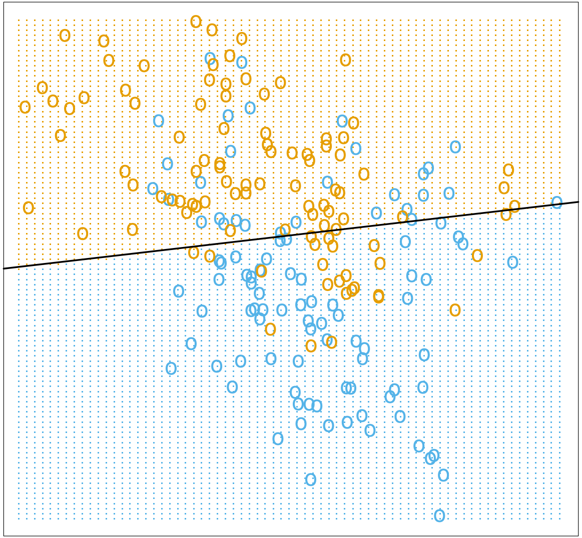


Another Example



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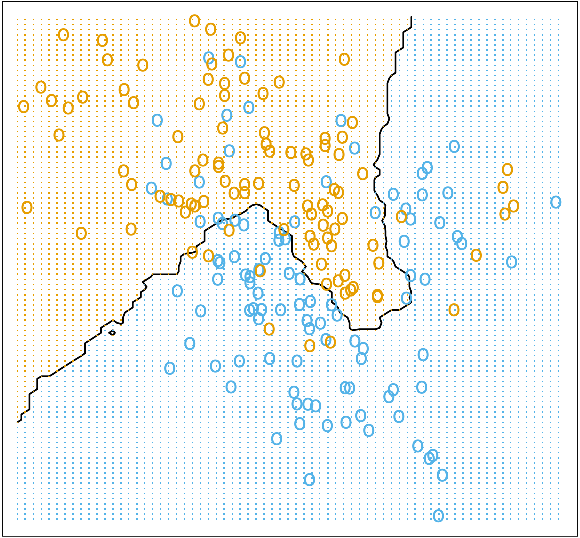

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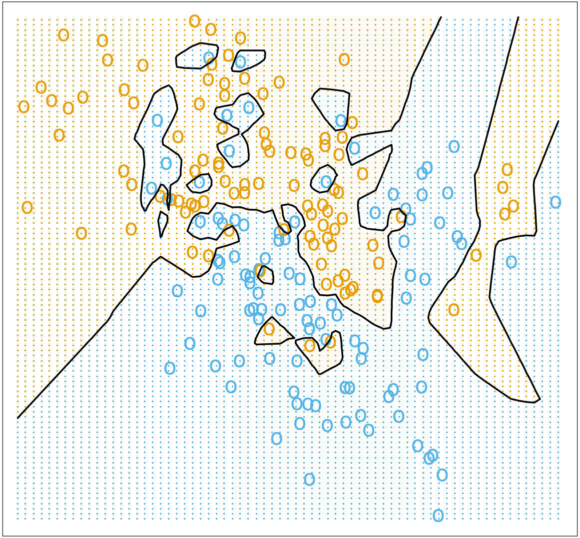

Common Approach

Define the **hypothesis space**, the set of all possible output rules.
Examples:

- Degree-3 polynomials
- Linear dividing surfaces
- Other "crazy" things we'll discuss

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Examples:

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- sum of squared errors (regression)

Common Approach

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Pick a definition of error
Examples:

- number incorrect (classification)
- sum of squared errors (regression)

Develop an algorithm to

- pick the member of the hypothesis space that
- minimizes the error on the training set
- perhaps slightly modified

Testing Set

The error on the training set may not be indicative of the performance of the classifier or regressor

Testing Set

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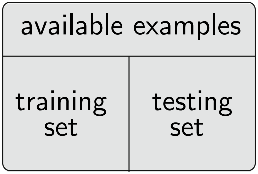
Thus, we often use a **testing set**



Feed the training set into the learning algorithm.
Find the error of the resulting rule on the testing set.

Why is this hard?

- High dimensional spaces are weird
- Irrelevant attributes
- Redundant attributes
- Missing attributes
- Attribute noise
- Label noise

Terms defined

features or **attributes**: measured values associated with each example
target or **label** or **output**: desired output of the rule for each example
classifier, **regressor**: the rule that maps the features to the label
hypothesis space: the space of all rules that the machine learning algorithm is considering
training set: the data used as input to the machine learning algorithm
testing test: the data used to check the performance of the resulting rule