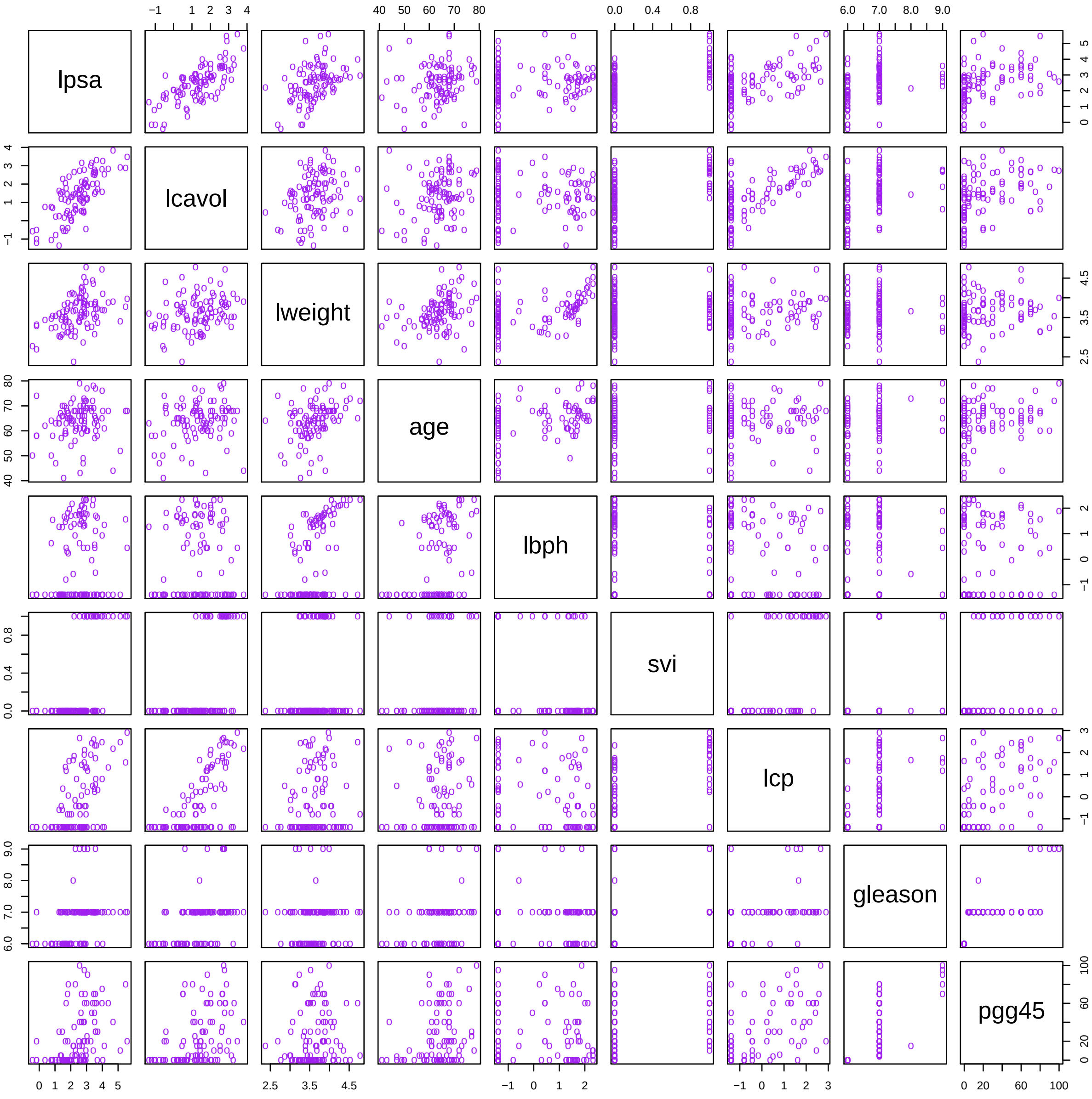
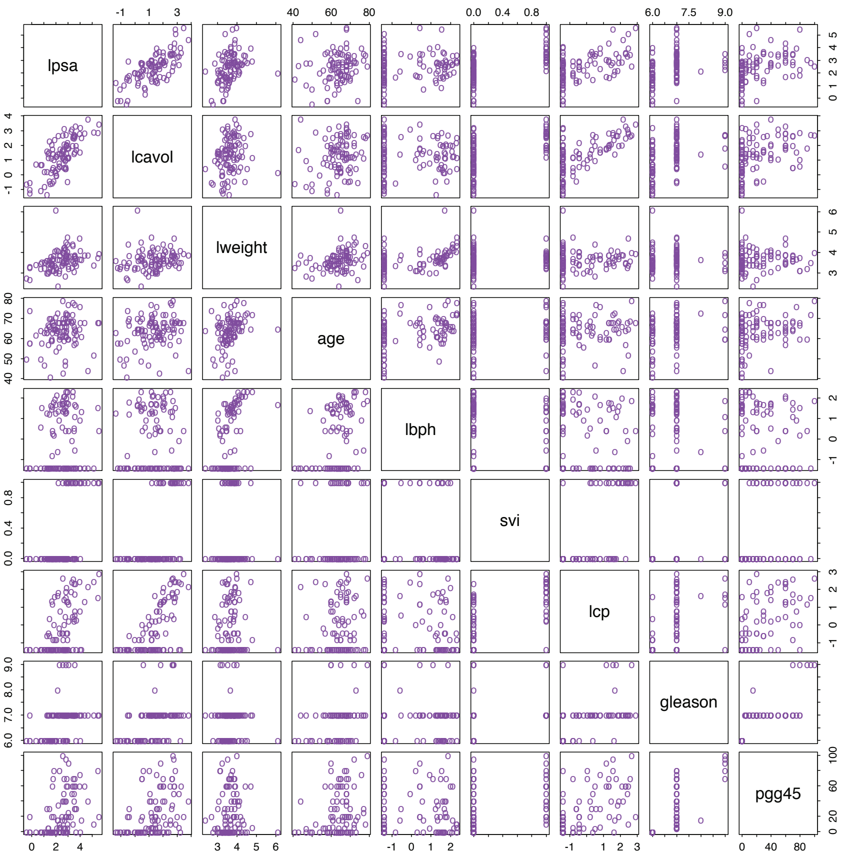
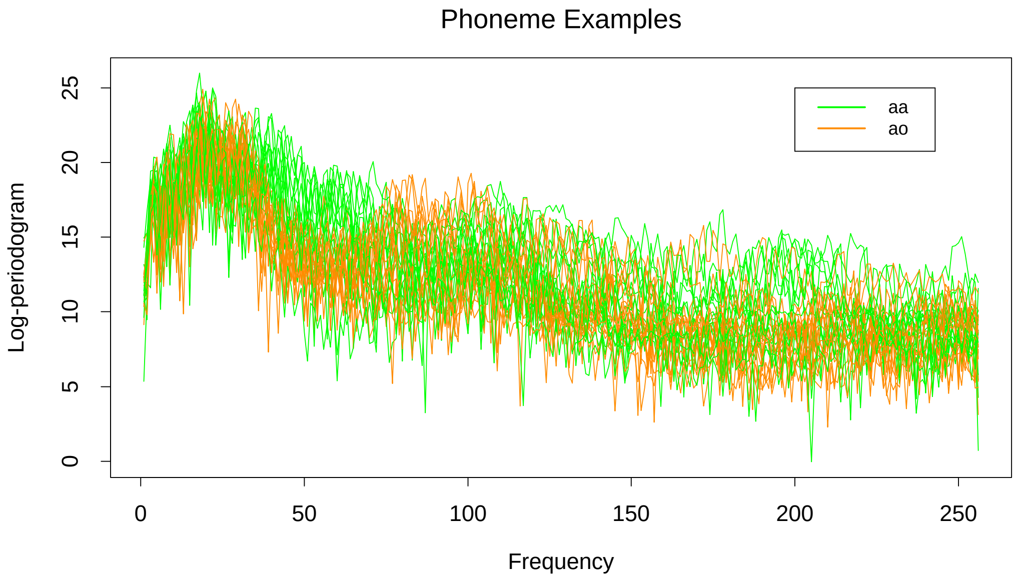
Statistical Learning Problems

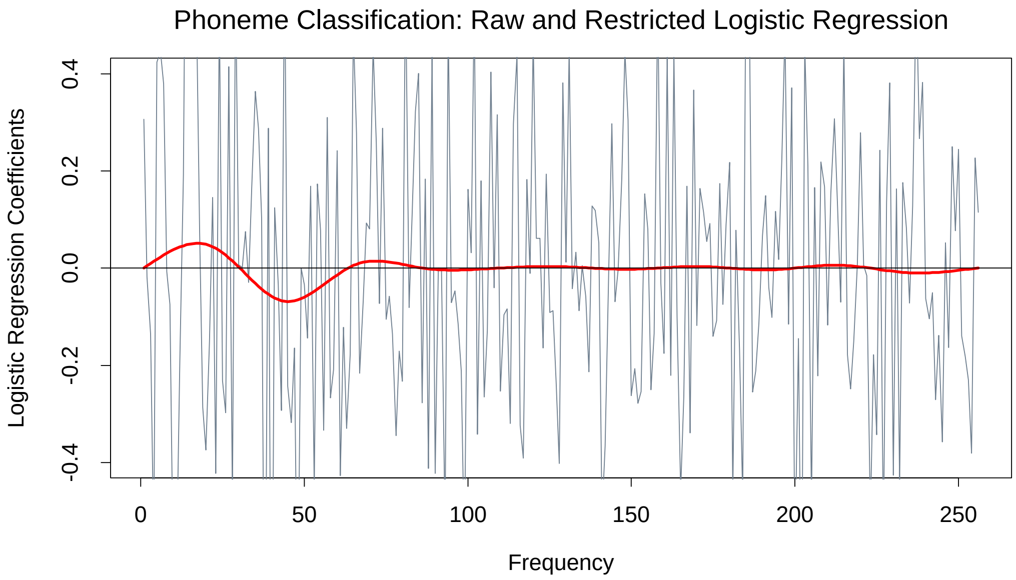
- Identify the risk factors for prostate cancer (Fig 1.1).
- Classify a recorded phoneme (Fig 5.5) based on a log-periodogram.
- Predict whether someone will have a heart attack (Fig 4-12) on the basis of demographic, diet and clinical measurements
- Customize an email spam (Tab 1.1) detection system.
- Identify the numbers in a handwritten zip code (Fig 1.2), from a digitized image
- Classify a tissue sample into one of several cancer classes, based on a gene expression (Fig 1.3) profile
- Classify the pixels in a LANDSAT (Fig 13.6) image, by usage:

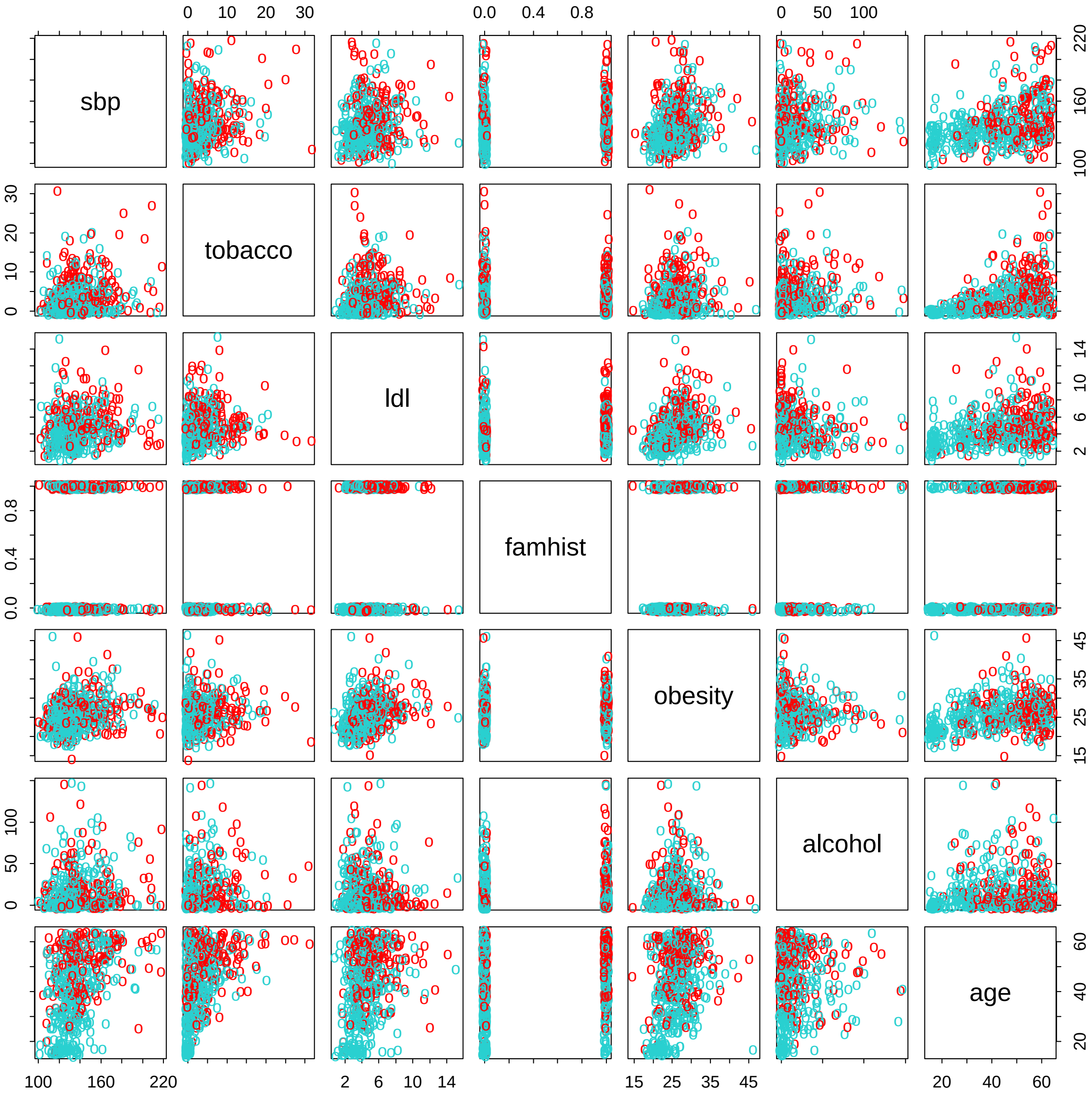
  {*red soil, cotton, vegetation stubble, mixture, gray soil, damp gray soil*}


lpsa
lcavol
lweight
age
lbph
svi
lcp
gleason
pgg45
−1 1 2 3 4
40 50 60 70 80
0.0 0.4 0.8
6.0 7.0 8.0 9.0
0 1 2 3 4 5
2.5 3.5 4.5
−1 0 1 2
−1 0 1 2 3
0 20 60 100


lpsa
lcavol
lweight
age
lbph
svi
lcp
gleason
pgg45
-1 1 3
40 60 80
0.0 0.4 0.8
6.0 7.5 9.0
0 1 2 3 4 5
3 4 5 6
-1 0 1 2
-1 0 1 2 3
0 20 60 100
-1 0 1 2 3 4
40 50 60 70 80
0.0 0.4 0.8
6.0 7.0 8.0 9.0
0 2 4
3 4 5 6
-1 0 1 2
-1 1 2 3
0 40 80


Phoneme Examples
aa
ao
Log-periodogram
0
5
10
15
20
25
0
50
100
150
200
250
Frequency


Phoneme Classification: Raw and Restricted Logistic Regression
Logistic Regression Coefficients
-0.4
-0.2
0.0
0.2
0.4
0
50
100
150
200
250
Frequency

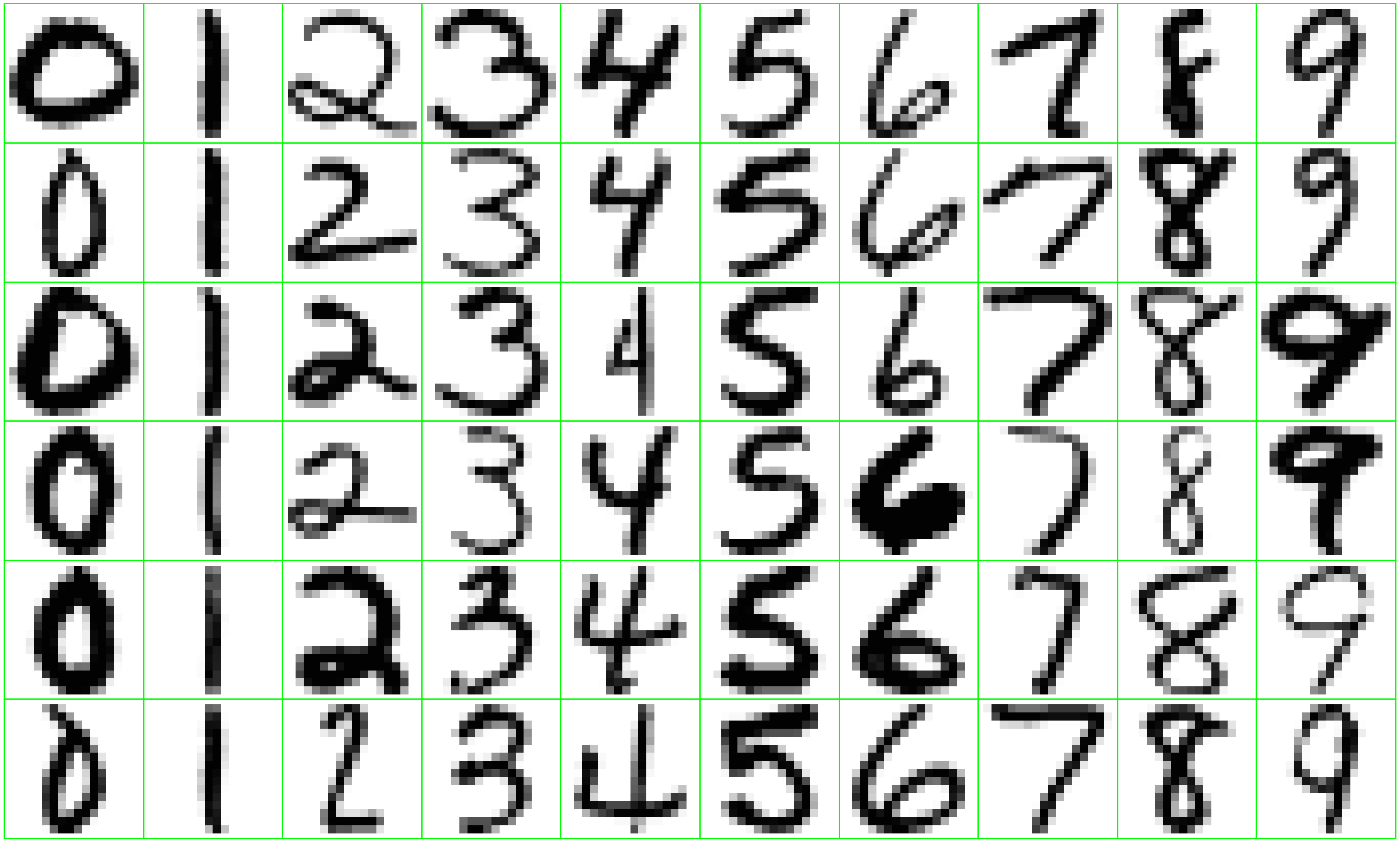

sbp
tobacco
ldl
famhist
obesity
alcohol
age
0 10 20 30
0.0 0.4 0.8
0 50 100
220 160 100
30 20 10 0
14 10 6 2
0.8 0.4 0.0
45 35 25 15
100 50 0
60 40 20
100 160 220
2 6 10 14
15 25 35 45
20 40 60

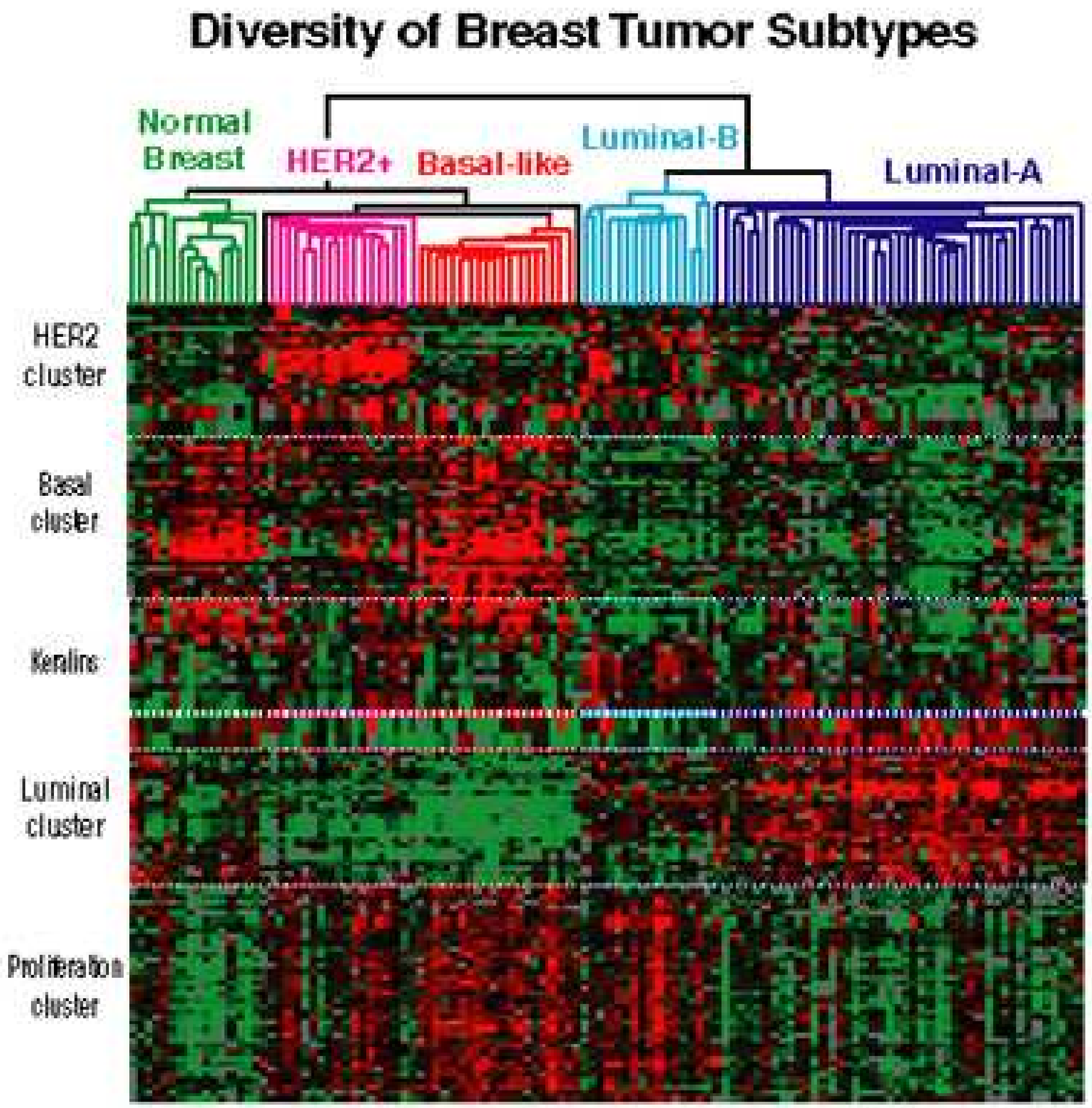
Spam detection

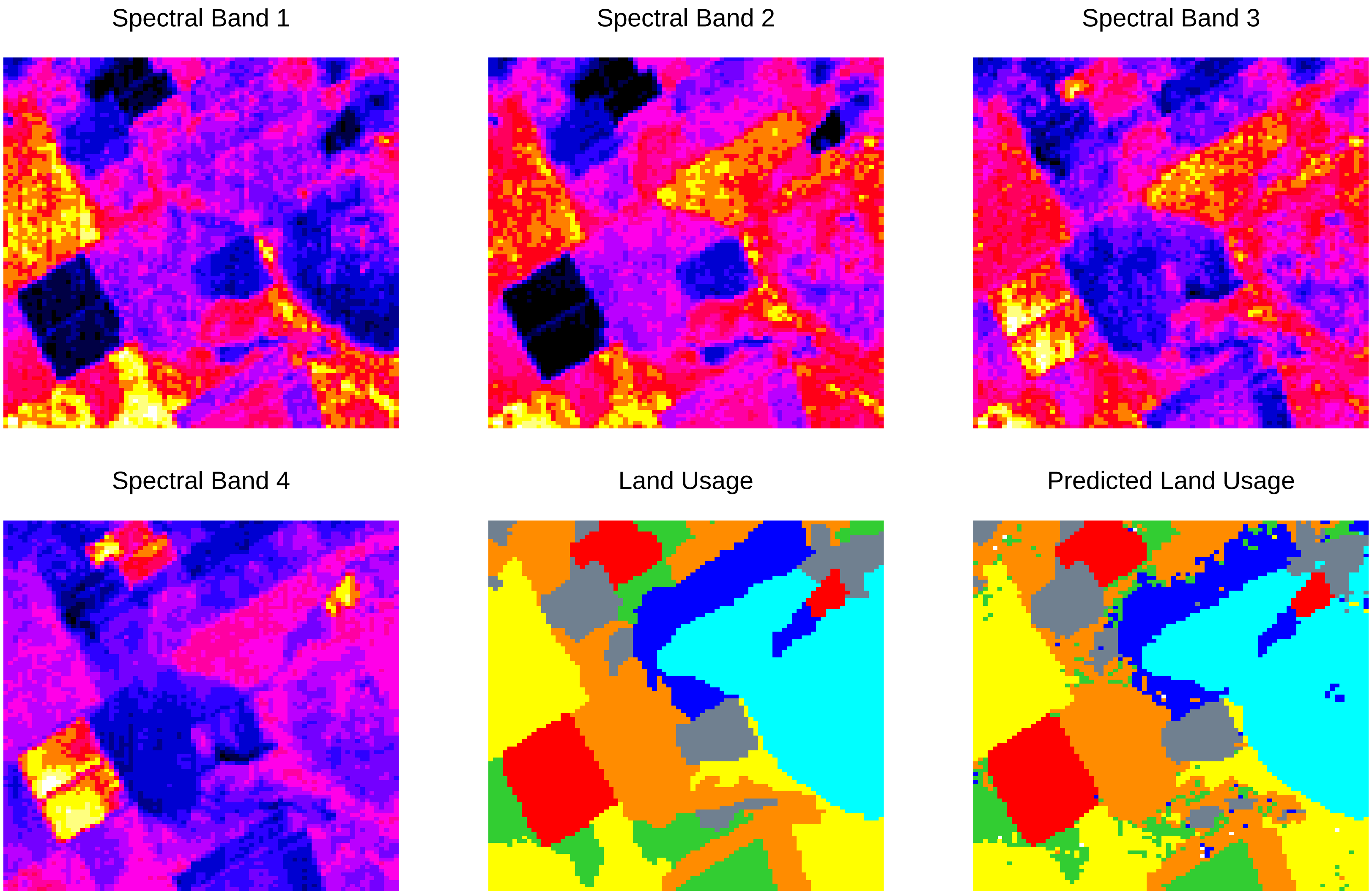
- data from 4601 emails sent to an individual (named George, at HP labs, before 2000). Each is labeled as *spam* or *email*.
- goal: build a customized spam filter.
- input features: relative frequencies of 57 of the most commonly occurring words and punctuation marks in these email messages.

	`george`	`you`	`hp`	`free`	`!`	`edu`	`remove`
`spam`	0.00	2.26	0.02	0.52	0.51	0.01	0.28
`email`	1.27	1.27	0.90	0.07	0.11	0.29	0.01

Average percentage of words or characters in an email message equal to the indicated word or character. We have chosen the words and characters showing the largest difference between `spam` *and* `email`*.*




Diversity of Breast Tumor Subtypes
Normal Breast
HER2+
Basal-like
Luminal-B
Luminal-A
HER2 cluster
Basal cluster
Keratins
Luminal cluster
Proliferation cluster



Spectral Band 1

Spectral Band 2

Spectral Band 3

Spectral Band 4

Land Usage

Predicted Land Usage

The Supervised Learning Problem

Starting point:

- Outcome measurement Y (also called dependent variable, response, target)
- Vector of p predictor measurements X (also called inputs, regressors, covariates, features, independent variables)
- In the *regression problem*, Y is quantitative (e.g price, blood pressure)
- In the *classification problem*, Y takes values in a finite, unordered set (survived/died, digit 0-9, cancer class of tissue sample)
- We have training data $(x_1, y_1), \ldots, (x_N, y_N)$. These are observations (examples, instances) of these measurements.

Objectives

On the basis of the training data we would like to:

- Accurately predict unseen test cases
- Understand which inputs affect the outcome, and how
- Assess the quality of our predictions and inferences

Philosophy

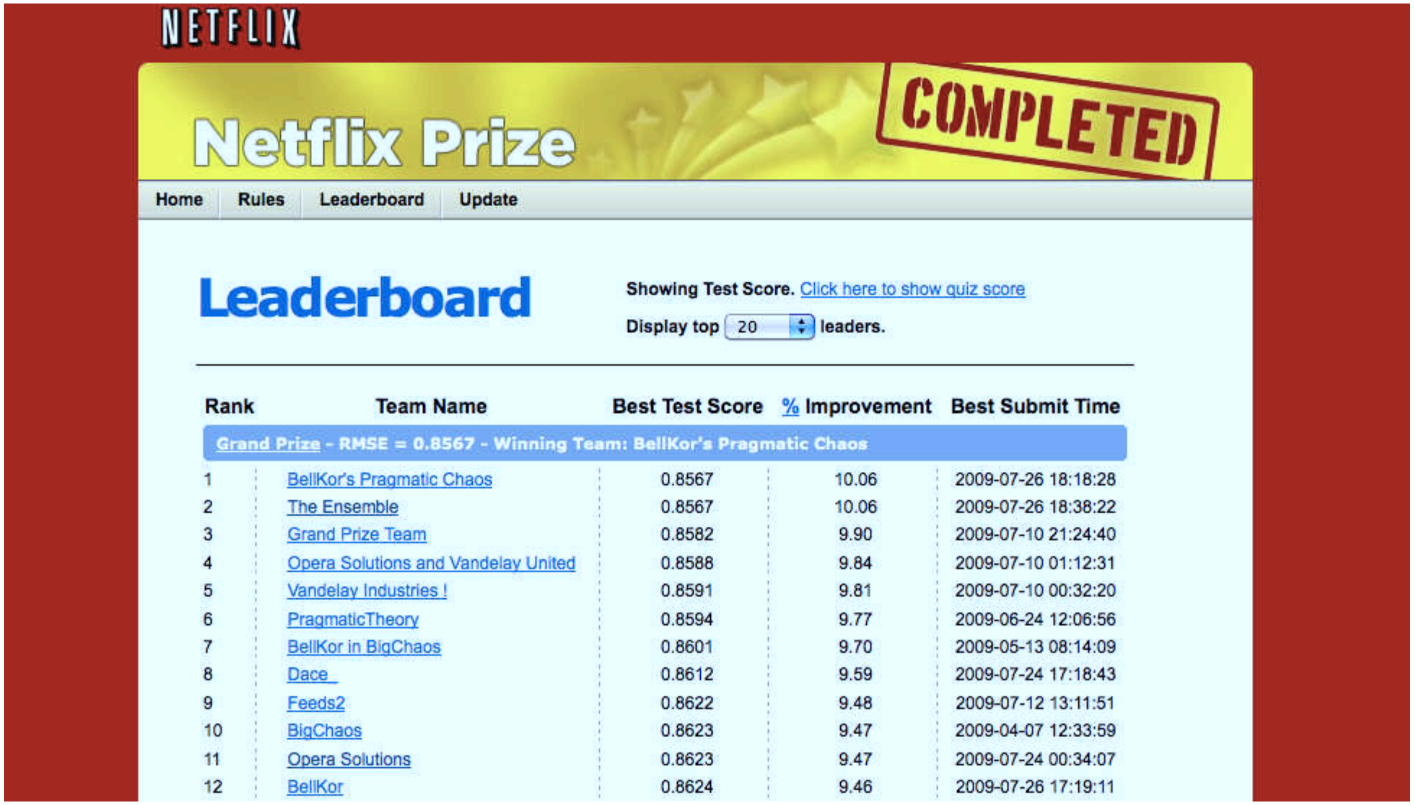
- It is important to understand the ideas behind the various techniques, in order to know how and when to use them.
- One has to understand the simpler methods first, in order to grasp the more sophisticated ones.
- It is important to accurately assess the performance of a method, to know how well or how badly it is working [simpler methods often perform as well as fancier ones!]
- This is an exciting research area, having important applications in science, industry and finance.

Unsupervised learning

- No outcome variable, just a set of predictors (features) measured on a set of samples.
- objective is more fuzzy — find groups of samples that behave similarly, find features that behave similarly, find linear combinations of features with the most variation.
- difficult to know how well your are doing.
- different from supervised learning, but can be useful as a pre-processing step for supervised learning

The Netflix prize

- competition started in October 2006. Training data is ratings for $18,000$ movies by $400,000$ Netflix customers, each rating between 1 and 5
- training data is very sparse— about 98% missing
- objective is to predict the rating for a set of 1 million customer-movie pairs that are missing in the training data
- Netflix's current algorithm achieves a root MSE of 0.95. The first team to achieve a RMSE of 0.85 wins 1 million dollars.
- is this a supervised or unsupervised problem?



Leaderboard

Showing Test Score. Click here to show quiz score

Display top 20 **leaders.**

Rank	Team Name	Best Test Score	% Improvement	Best Submit Time
Grand Prize - RMSE = 0.8567 - Winning Team: BellKor's Pragmatic Chaos				
1	BellKor's Pragmatic Chaos	0.8567	10.06	2009-07-26 18:18:28
2	The Ensemble	0.8567	10.06	2009-07-26 18:38:22
3	Grand Prize Team	0.8582	9.90	2009-07-10 21:24:40
4	Opera Solutions and Vandelay United	0.8588	9.84	2009-07-10 01:12:31
5	Vandelay Industries !	0.8591	9.81	2009-07-10 00:32:20
6	PragmaticTheory	0.8594	9.77	2009-06-24 12:06:56
7	BellKor in BigChaos	0.8601	9.70	2009-05-13 08:14:09
8	Dace_	0.8612	9.59	2009-07-24 17:18:43
9	Feeds2	0.8622	9.48	2009-07-12 13:11:51
10	BigChaos	0.8623	9.47	2009-04-07 12:33:59
11	Opera Solutions	0.8623	9.47	2009-07-24 00:34:07
12	BellKor	0.8624	9.46	2009-07-26 17:19:11