

# Machine Learning 2014: Summary

Diana Ponce-Morado, Joachim Ott, Benjamin Ellenberger

December 4, 2014

# Contents

0.1	Representations . . . . .	2
0.1.1	Measurements and Data . . . . .	2
0.1.2	Patterns . . . . .	2
0.1.3	Data Types, Transformations, Scale . . . . .	2
0.2	Regression . . . . .	2
0.2.1	Linear Regression . . . . .	2
0.2.2	Ridge Regression . . . . .	2
0.2.3	LASSO . . . . .	2
0.2.4	Nonlinear Regression by basis expansion . . . . .	2
0.2.5	Wavelet regression . . . . .	2
0.2.6	Bias variance Tradeoff . . . . .	2
0.2.7	Gaussian Processes . . . . .	2
0.3	Numerical Estimation Techniques . . . . .	2
0.3.1	Cross-Validation . . . . .	2
0.3.2	Bootstrap . . . . .	2
0.3.3	Jackknife . . . . .	2
0.3.4	Hypothesis Testing . . . . .	2
0.4	Classification . . . . .	2
0.4.1	Problem Setting for Bayesian Inference . . . . .	3
0.4.2	Bayes Rule . . . . .	3
0.4.3	Parametric Models, Bayesian Learning . . . . .	3
0.5	Parametric Models . . . . .	3
0.5.1	Maximum Likelihood Method . . . . .	3
0.5.2	Efficient Estimators . . . . .	3
0.5.3	Bayesian Learning (batch/online) . . . . .	3
0.6	Design of Linear Discriminant Functions . . . . .	3
0.6.1	Perceptrons . . . . .	3

0.6.2	Fisher's linear discriminant analysis . . . . .	3
0.7	Support Vector Machines . . . . .	3
0.7.1	Lagrangian optimization theory . . . . .	3
0.7.2	Hard margin SVMs . . . . .	3
0.7.3	Soft margin SVMs . . . . .	3
0.8	Nonlinear Support Vector Machines . . . . .	3
0.9	Ensemble Methods for Classifier Design . . . . .	3
0.9.1	PAC Learning . . . . .	4
0.9.2	Bagging . . . . .	4
0.9.3	Boosting . . . . .	4
0.9.4	Arcing . . . . .	4
0.9.5	Exponential Loss . . . . .	4
0.10	Unsupervised Learning . . . . .	4
0.10.1	Nonparametric Density Estimation . . . . .	4
0.10.2	Histograms . . . . .	4
0.10.3	Parzen Estimators . . . . .	4
0.10.4	k-Nearest Neighbor Estimator . . . . .	4
0.11	Neural Networks . . . . .	4
0.11.1	Motivation by Computational Neuroscience . . . . .	4
0.11.2	Multilayer Perceptrons and Backpropagation . . . . .	4
0.11.3	NETtalk and ALVINN . . . . .	4
0.11.4	Boltzmann machines . . . . .	4
0.11.5	Deep Neural Networks . . . . .	4
0.12	Mixture Models . . . . .	4
0.12.1	k-Means Algorithm . . . . .	5
0.12.2	Mixture Models . . . . .	5
0.12.3	Expectation Maximization Algorithm . . . . .	5
0.12.4	Convergence Proof of EM Algorithm . . . . .	5

## **0.1 Representations**

This is the chapter on Representations.

## **0.2 Measurements and Data**

### **0.2.1 Patterns**

### **0.2.2 Data Types, Transformations, Scale**

## **0.3 Regression**

This is the chapter on Regression.

### **0.3.1 Linear Regression**

### **0.3.2 Ridge Regression**

### **0.3.3 LASSO**

### **0.3.4 Nonlinear Regression by basis expansion**

### **0.3.5 Wavelet regression**

### **0.3.6 Bias variance Tradeoff**

### **0.3.7 Gaussian Processes**

## **0.4 Numerical Estimation Techniques**

This is the chapter on Numerical Estimation Techniques.

### **0.4.1 Cross-Validation**

### **0.4.2 Bootstrap**

### **0.4.3 Jackknife**

### **0.4.4 Hypothesis Testing**

## **0.5 Classification**

This is the chapter on Classification.

### **0.5.1 Problem Setting for Bayesian Inference**

### **0.5.2 Bayes Rule**

### **0.5.3 Parametric Models, Bayesian Learning**

## **0.6 Parametric Models**

This is the chapter on Parametric Models.

### **0.6.1 Maximum Likelihood Method**

### **0.6.2 Efficient Estimators**

### **0.6.3 Bayesian Learning (batch/online)**

## **0.7 Design of Linear Discriminant Functions**

This is the chapter on Linear Discriminant Functions.

### **0.7.1 Perceptrons**

### **0.7.2 Fisher's linear discriminant analysis**

## **0.8 Support Vector Machines**

This is the chapter on Support Vector Machines.

### **0.8.1 Lagrangian optimization theory**

### **0.8.2 Hard margin SVMs**

### **0.8.3 Soft margin SVMs**

## **0.9 Nonlinear Support Vector Machines**

This is the chapter on Nonlinear Support Vector Machines.

## **0.10 Ensemble Methods for Classifier Design**

This is the chapter on Regression.

### **0.10.1 PAC Learning**

### **0.10.2 Bagging**

### **0.10.3 Boosting**

### **0.10.4 Arcing**

### **0.10.5 Exponential Loss**

## **0.11 Unsupervised Learning**

This is the chapter on Unsupervised Learning.

### **0.11.1 Nonparametric Density Estimation**

### **0.11.2 Histograms**

### **0.11.3 Parzen Estimators**

### **0.11.4 k-Nearest Neighbor Estimator**

## **0.12 Neural Networks**

This is the chapter on Neural Networks.

### **0.12.1 Motivation by Computational Neuroscience**

### **0.12.2 Multilayer Perceptrons and Backpropagation**

### **0.12.3 NETtalk and ALVINN**

### **0.12.4 Boltzmann machines**

### **0.12.5 Deep Neural Networks**

## **0.13 Mixture Models**

This is the chapter on Mixture Models.

- 0.13.1 k-Means Algorithm**
- 0.13.2 Mixture Models**
- 0.13.3 Expectation Maximization Algorithm**
- 0.13.4 Convergence Proof of EM Algorithm**