Math-3094-UConn

View the Project on GitHub jeremy9959/Math-3094-UConn

Course outline

See this page for help on Anaconda, Jupyter, and Python.

Part One

Linear Regression

Goals

- Learn the mathematics of Linear Regression (ordinary least squares) using Linear Algebra
    - Simple Linear Regression
    - Linear Regression - Geometry
    - Multivariate Regression - Introduction
        - Multivariate Regression - Calculus
    - Multivariate Regression - Geometry
    - Multivariate Regression - Centered Coordinates
- Lab:
    - get a working installation of anaconda, python, and jupyter on your computer.
    - a basic introduction to working with the Jupyter notebook
    - fundamentals of Python
    - calculations and plotting examples of linear regression

References

- Linear Regression html pdf
- Linear Regression lab - includes datafiles and ipynb file. zip tgz
- See also the Lab Resources page for help.

Gradient Descent

Goals:

- Learn the basic theory of gradient descent and how it is applied to find maxima and minima of functions
- Apply Gradient Descent to some specific examples.
    - Gradient Descent
    - Animation

References

- Gradient Descent lab - zip

Probability

Goals:

- Get an introduction to the key ideas from probability that play a role in machine learning.
- Learn about mean, variance, independence, conditional probability, and Bayes theorem.
- Try out the Naive Bayes classification method
- Introduce the ideas of statistical models and maximum likelihood.

- Probability Basics
- Conditional Probability 1
- Conditional Probability 2
- Probability - Independence
- Probability - Random Variables 1
- Probability - Random Variables 2
- Probability - Expectation and Variance

- Probability - Statistical Models

References

- Probability Notes html pdf
- Naive Bayes Notes html pdf
- Naive Bayes Lab - includes datafiles and ipynb file. zip tgz

Logistic Regression

Goals:

- Understand the statistical model underlying logistic regression
- See how the ideas of likelihood and gradient descent combine to solve the logistic regression problem
- Do some sample computations to see Logistic Regression in action
- Generalize binary logistic regression to multi-class logistic regression
    - Logistic Regression

References

- Logistic Regression lab - zip

Principal Component Analysis

Goals:

- Learn about how the covariance matrix encodes variation in linear combinations of features
- Learn the correlation coefficient
- Understand principal components and their relationship to eigenvectors of the covariance matrix
- See how to use principal components for dimension reduction.
- Do some examples.

- Variance, Covariance, Correlation, and the Covariance Matrix
- Scores
- Geometry of Scores
- Principal Directions - First Look
- Finding the Principal Directions
- The Spectral Theorem
- Dimension Reduction
- Loadings

References

- Principal Component Analysis html pdf
- PCA Lab – includes notebook(s) and data zip tgz

Bayesian Regression

Goals:

- Learn the process of Bayesian inference (see also the notes on probability above).
    - Intro to Bayesian Inference
    - Bayesian Coin Flipping

- Understand over-fitting in linear regression
- Study Bayesian linear regression
- Understand the ideas of linear discriminant analysis
    - Bayesian Linear Regression
    - Linear Discriminant Analysis
    - Dimensionality Reduction via LDA

References

- Bayesian Regression Lab – includes notebook(s) and data zip tgz

Support Vector Machines

Goals:

- Learn the ideas behind support vector machine classifiers

    - Introduction
    - Optimal Margins

- Understand the relationship between convex hulls, supporting hyperplanes, and support vector machines
    - Convexity, Convex Hulls, and Supporting Hyperplanes
- Formulate the convex optimization problem yielding the optimal margin classifier
    - Closest Points and Optimal Margins 1
    - Closest Points and Optimal Margins 2
    - Formulating the Optimization Problem
- Learn the sequential minimum optimization algorithm
    - The SMO Algorithm
- Further ideas
    - Kernels, inseparable sets, multiclass classification

References:

- Notes on support vector machines html pdf
- Support Vector Machines Lab (includes jupyter notebook and data files) zip tgz

Neural Networks

Goals:

- Learn the ideas of neural networks and understand forward-propagation and back-propagation
- Derive the back-propagation formula
- Learn the mechanisms of basic convolutional neural networks
    - Basic Neural Networks
    - Convolutional Neural Networks

References

- Neural Networks Lab – includes notebook(s) and data zip tgz

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This project is maintained by jeremy9959

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