Syllabus

Bus241f: Machine Learning and Data Analysis for Business and Finance: Preliminary Spring 2019

Key information

Instructor

- Blake LeBaron
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- http://www.brandeis.edu/~blebaron
- Sachar 204
- Office hours: TBA

TA

- TBA

Times:

Class Times: TBA

Detailed information

Course Description

This course is a general topics course on machine learning tools, and their implementation through Python, and the Python package, Scikit Learn. Students will finish the class with a basic understanding of how to execute predictive analytic algorithms. They will also have a good sense for how to evaluate and test their predictive models. The course is statistical in nature, but will use only basic statistics from a standard one semester econometrics class. Given the time horizon (6–7 weeks) the course can only provide a birds eye view of the many different ML technologies that are available. There is not enough time to cover all the tools in use today. Finally, the course assumes a good working knowledge of the Python programming language at the start. Online courses in Python may be acceptable to meet this requirement.

Learning Goals

1. Basic data processing and handling with Python/Pandas
2. Machine learning tools available in Scikit Learn
3. Implementation of machine learning algorithms
4. Testing and evaluating forecasts/predictions (cross validation)
5. Presenting/describing results (graphics)

Prerequisites:

1. ECON213a/ECON184a (equivalent to most undergrad 1 semester classes in econometrics, can be concurrent)
   1. Random variables, expectations, PDF’s, CDF’s
   2. Linear regression (Ordinary least squares)
2. Bus215f: Python for Business and finance or good working Python knowledge
   2. FIN285a is another course covering this material
   3. Online options such as Datacamp may be useful
3. Basic calculus (about 1 semester, undergrad level)
4. Basic matrix algebra (know what a matrix is, and the rules for matrix multiplication)

Required Readings:


Optional books:

1. (M) McKinney, *Python for Data Analysis: Data Wrangling with Pandas, Numpy, and IPython*, O'Reilly, 2017, second edition. (This book is a must have for Python data analytic types. Covers all the necessary extensions to Python needed for data.)
2. (JWHT) James, Witten, Hastie, Tibshirani, *An Introduction to Machine Learning*, Springer, 2013. (A kind of easy to access overview of machine learning along with R code. We will refer to this a few times in the class. This book provides a lot of technical math foundations which are not present in (MG).)
3. (EH) Efron/Hastie, *Computer Age Statistical Inference*, Cambridge University Press, 2016. (A more recent book on computational methods in modern statistics. Not totally machine learning, but very useful to many of the methods we will talk about in this class. I will refer to it occasionally.)
core of machine learning. Available online as a pdf file. The level of
technical rigor of this book is well beyond this course, but if you need more,
this is the place to go. While it is complete, it is getting a little dated.)

5. There are new books on machine learning appearing everyday, and I may
add some other recommendations as the semester proceeds.

Occasionally, the notes will give pointers to these readings.
They will use the initials. The pointers to
the primary text (MG) are always given.

Required Software

1. Python 3.6 and the entire Anaconda suite of tools. (This is open source and
runs on all major operating systems.)
2. Textbook code and workbooks

Data resources

1. Machine learning repository
2. Kaggle

Grading

Grades will be based on:

1. Problem sets (20%)
2. Final exam (50%)
3. Group project (30%)

Rules and responsibilities

Communications

You are responsible for all announcements and materials in class. Also, much of
the information in class will be sent over Latte and the class website.

Rules specific to Bus241f

• Exams
  ◦ Your own work.
  ◦ Closed book (no notes).
  ◦ No laptops, no cell phones, no calculators, no pda's.

• Problem sets
Hand in your own work.
Can talk and assist each other.
Use all resources.

- Group projects
  - Own work for the group.
  - Hand in one writeup per group.

- Laptops: Please bring to class if you want to.

**Academic Integrity**

You are expected to be honest in all of your academic work. Please consult Brandeis University Rights and Responsibilities for all policies and procedures related to academic integrity. Students may be required to submit work to TurnItIn.com software to verify originality. Allegations of alleged academic dishonesty will be forwarded to the Director of Academic Integrity. Sanctions for academic dishonesty can include failing grades and/or suspension from the university. Citation and research assistance can be found at LTS – Library guides.

**Work Load**

Success in this two-credit course is based on the expectation that students will spend a minimum of 9 hours of study time per week in preparation for class (readings, papers, discussion sections, preparation for exams, etc.).

**Disability Statement**

If you are a student with a documented disability on record at Brandeis University and wish to have a reasonable accommodation made for you in this class, please see me immediately.

**Spring calendar dates**

- Jan 15: first day of classes
- Jan 21: MLK day, no class
- Tuesday, Jan 22: Brandeis Monday
- Feb 18–Feb 22: winter break, no class
- Wed, March 13th: First module II class
- April 19–April 26: Passover, no class
- Thursday, May 2: Brandeis Friday
- Thursday, May 2: Last day of instruction
- Monday, May 6 – Tuesday, May 14: Final exams

**Course Outline**
1. Introduction: What is **Machine Learning**? What is **Artificial Intelligence**?

2. Landscape of problems
   1. Supervised versus unsupervised learning
   2. Classification versus forecasting
   3. Time series/ cross section
   4. Classifying data sets: Tall, wide, and dense data
   5. Predictive modeling/ policy intervention

3. Python basics (very short) (MG chapter 1: 1–12), (M, chapter 4, 8)
   1. Anaconda
   2. Spyder
   3. Numpy, Scipy
   4. Matplotlib
   5. Scikit Learn

4. Model complexity (MG 27–32)
   1. Overfitting (figure 2–1)
   2. Training/validation/testing

5. Simplest models (MG 32–51, MG skip chapter 1)
   1. Getting started with scikit-Learn
   2. K nearest neighbors
   3. Application: Iris data (MG 13–25)
   4. Linear regression (MG 51–58)

6. Controlling model complexity
   1. Regularization
   2. Ridge regression
   3. Lasso regression
   4. The Bias/Variance trade off

7. Classification
   1. Logistic regression (MG 58–65)
   2. Support vectors (SVC)
   3. Naive Bayes (MG 70–72)
   4. Linear discriminant
   5. Multi(k>2) class problems (MG 65–68)

8. Decision trees
1. Implementation
2. Feature importance
3. Time series example
4. Forecast variable usage

9. Model combinations
   1. Bagging predictors
   2. Random forests
   3. Boosting

10. Nonlinear models and kernels (MG 94–106)
    1. Kernelized support vector machines
    2. The kernel trick
    3. Kernel ridge regression

11. Predictive objectives (MG chapter 5)
    1. Classification issues
    2. Evaluation metrics
       1. More cross-validation

12. Neural networks and deep learning (MG pp 106–121)
    1. Activation functions
    2. Tuning networks
    3. Regularization

13. Unsupervised learning
    1. Tool overview
    2. K–means
    3. Evaluation

14. Advanced topics (may not get here)
    1. Text analysis/sentiment (MG 325–336)
    2. Recommender systems
    3. Measuring classifier uncertainty (MG pp 121–129)