**ECON 484 - Machine Learning for Econ**

**Fall 2019**

**Section 001: 103 KMBL on T Th from 3:00 pm - 4:15 pm**

**Instructor/TA Info**

**Instructor Information**

**Name**: Brigham Frandsen **Office Location**: 435M CTB **Office Phone**: 801-422-4049 **Email**: frandsen@byu.edu

**TA Information**

**Name**: Ben Branchflower **Email**: benbranchflower@gmail.com

**Course Information**

**Description**

Students will learn the theory and practice of machine learning methods for applications in economics

**Prerequisites**

Econ 380, Econ 388

**Materials**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Item | Price (new) | Price (used) |

|  |  |  |  |
| --- | --- | --- | --- |
| EmptyCoverPicture.png | [Intro Statistical Learning](http://booklist.byu.edu/Items/ById/526757) *Required* by James, G | [79.99](http://booklist.byu.edu/Items/ById/526757) | [60.00](http://booklist.byu.edu/Items/ById/526757) |

|  |  |  |  |
| --- | --- | --- | --- |
| EmptyCoverPicture.png | [The Elements of Statistical Learning 2E](http://booklist.byu.edu/Items/ById/156979) *Required* by Hastie, T | [89.95](http://booklist.byu.edu/Items/ById/156979) | [67.50](http://booklist.byu.edu/Items/ById/156979) |

**Learning Outcomes**

**Machine learning method implementation**

Students will demonstrate ability to implement several machine learning methods (e.g. decision trees, random forests, LASSO, neural network, support vector machines) using Python

**Distinction between prediction and causality**

Students will articulate difference between predictive and causal relationships and know in what situations each is useful

**Application to economics**

Students will show where machine learning methods can be fruitfully applied in economic analysis

**Grading Policy**

Grades will be based on the midterm exam (20%), comprehensive final exam (40%), a quantitative project (25%), problem sets (10%), and class participation (5%).

**Participation Policy**

Students should come to class having studied the textbook sections listed for that day, and be prepared for possible quizzes on the reading, and come with any questions they have on the material.

**Attendance Policy**

Class attendance is a crucial part of the course, and learning outcomes depend on it. Part of the grade is determined by class attendance and participation.

**Problem sets**

There will be a problem set due approximately every two weeks. These will consist of theoretical proofs and derivations, and empirical exercises using Stata. Students may consult in groups, but each student must complete, write up, and submit his or her own work. Problem sets are due in class at the beginning of class on the date listed.

**Exams**

The midterm will be in class during the scheduled class time during the 8th week of classes (see exam schedule on learning suite). The final exam will cover all material and will be in the classroom during our assigned final exam time.

**Assignments**

**University Policies**

**Honor Code**

In keeping with the principles of the BYU Honor Code, students are expected to be honest in all of their academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact be your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university. Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university's expectation, and every instructor's expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 422-2847 if you have questions about those standards.

**Preventing Sexual Misconduct**

In accordance with Title IX of the Education Amendments of 1972, Brigham Young University prohibits unlawful sex discrimination against any participant in its education programs or activities. The university also prohibits sexual harassment-including sexual violence-committed by or against students, university employees, and visitors to campus. As outlined in university policy, sexual harassment, dating violence, domestic violence, sexual assault, and stalking are considered forms of "Sexual Misconduct" prohibited by the university.  
  
University policy requires all university employees in a teaching, managerial, or supervisory role to report all incidents of Sexual Misconduct that come to their attention in any way, including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Incidents of Sexual Misconduct should be reported to the Title IX Coordinator at [t9coordinator@byu.edu](mailto:t9coordinator@byu.edu) or (801) 422-8692. Reports may also be submitted through EthicsPoint at <https://titleix.byu.edu/report> or 1-888-238-1062 (24-hours a day).  
  
BYU offers confidential resources for those affected by Sexual Misconduct, including the university's Victim Advocate, as well as a number of non-confidential resources and services that may be helpful. Additional information about Title IX, the university's Sexual Misconduct Policy, reporting requirements, and resources can be found at <http://titleix.byu.edu> or by contacting the university's Title IX Coordinator.

**Student Disability**

Brigham Young University is committed to providing a working and learning atmosphere that reasonably accommodates qualified persons with disabilities. If you have any disability which may impair your ability to complete this course successfully, please contact the University Accessibility Center (UAC), 2170 WSC or 422-2767. Reasonable academic accommodations are reviewed for all students who have qualified, documented disabilities. The UAC can also assess students for learning, attention, and emotional concerns. Services are coordinated with the student and instructor by the UAC. If you need assistance or if you feel you have been unlawfully discriminated against on the basis of disability, you may seek resolution through established grievance policy and procedures by contacting the Equal Employment Office at 422-5895, D-285 ASB.

**Academic Honesty**

The first injunction of the Honor Code is the call to "be honest." Students come to the university not only to improve their minds, gain knowledge, and develop skills that will assist them in their life's work, but also to build character. "President David O. McKay taught that character is the highest aim of education" (The Aims of a BYU Education, p.6). It is the purpose of the BYU Academic Honesty Policy to assist in fulfilling that aim. BYU students should seek to be totally honest in their dealings with others. They should complete their own work and be evaluated based upon that work. They should avoid academic dishonesty and misconduct in all its forms, including but not limited to plagiarism, fabrication or falsification, cheating, and other academic misconduct.

**Schedule**

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| --- | --- | --- | --- |
| Date | Topic | Due | Readings (before class) |
| T Sep 03 Tuesday | Machine Learning Demo |  | ISLR 1 |
| Th Sep 05 Thursday | The Forest |  | ISLR 2.1-2.2, Varian (2014) "Big Data: New Tricks for Econometrics" |
| T Sep 10 Tuesday | Prediction vs. Causality |  | ISLR 3.1-3.5  Athey and Imbens (2019) "Machine Learning Methods Economists Should Know About" |
| Th Sep 12 Thursday | Unsupervised machine learning |  | ISLR 10.1-10.2 |
| T Sep 17 Tuesday | Unsupervised machine learning |  | ISLR 10.3 |
| Th Sep 19 Thursday | Supervised machine learning overview |  | ISLR 4.1-4.5  Mullainathan and Spiess (2017) |
| T Sep 24 Tuesday | Supervised machine learning general |  | ISLR 5.1-5.2 |
| Th Sep 26 Thursday | Lasso |  | ISLR 6.1-6.4 |
| T Oct 01 Tuesday | Regression trees |  | ISLR 8.1 |
| Th Oct 03 Thursday | Random forests |  | ISLR 8.2 |
| T Oct 08 Tuesday | Support Vector Machines |  | ISLR 9.1-9.3 |
| Th Oct 10 Thursday | Support Vector Machines |  | ISLR 9.4-9.5 |
| T Oct 15 Tuesday | Neural networks |  | ESL 11.1-11.3 |
| Th Oct 17 Thursday | Neural networks |  | ESL 11.4-11.10 |
| T Oct 22 Tuesday | Creating structured data from unstructured data, Joe Price guest teaches |  |  |
| Th Oct 24 Thursday | Machine learning and Instrumental Variables |  | Belloni, Chernozhukov, and Hansen (2014) "High-Dimensional Methods" |
| T Oct 29 Tuesday | Machine learning and Instrumental Variables |  |  |
| Th Oct 31 Thursday | Controlling for high-dimensional covariates in causal analysis |  | Chernozhukov, et al (2018) "Double/debiased machine learning", sections 1,2,3,5 |
| T Nov 05 Tuesday | Controlling for high-dimensional covariates in causal analysis |  |  |
| Th Nov 07 Thursday | Controlling for high-dimensional covariates in causal analysis |  |  |
| T Nov 12 Tuesday | Estimating causal effect heterogeneity |  | Athey and Imbens (2016) "Recursive partitioning" |
| Th Nov 14 Thursday | Estimating causal effect heterogeneity |  | Wager and Athey (2018) |
| T Nov 19 Tuesday | Estimating causal effect heterogeneity |  |  |
| Th Nov 21 Thursday | Flex |  |  |
| T Nov 26 Tuesday | **Friday Instruction** |  |  |
| Th Nov 28 Thursday | **Thanksgiving Holiday** |  |  |
| T Dec 03 Tuesday | Flex |  |  |
| Th Dec 05 Thursday | project presentations |  |  |
| T Dec 10 Tuesday | project presentations |  |  |
| Th Dec 12 Thursday | project presentations |  |  |
| W Dec 18 Wednesday | Final Exam:  103 KMBL  3:00pm - 6:00pm |  |  |