Course Outline

Introduction to Machine Learning for Economists

Course Lecturer: Sonan Memon

IBA Karachi

December 2020

Course Basics

This is a mini course on machine learning for graduate students. The objective is to introduce students to machine learning methods and standard references in this literature, providing them with a launching pad, from which they can continue learning much more on their own.

Course will be conducted online during Dec 2020. The total number of lectures is 4. Each lecture will last for 2 hours. Course GitHub Page https://github.com/sonanmemon/Introduction-to-ML-For-Economists contains all lecture slides, ZOOM links, readings and all other resources.

Only a few, selected topics can be covered due to the non-trivial nature of content and limitations on time. See below for full list of topics to be covered.

There will be occasional, hands on applications in R to illustrate the ideas in lectures, but I will focus more on concepts and less on algorithm design/computational implementation. This is because the latter requires a lot of time, is better suited to self-learning since the nature of code needed can vary dramatically by application and design of ML algorithms does no lie in the expertise of economists.

Course Prerequisites

The course prerequisite is familiarity with at least advanced undergraduate econometrics, since we will draw parallels from econometrics and discuss the connection between the two fields.

Basic fluency with R programming is also highly useful and recommended.

Masters and PhD students are the main target audience. Of course, all faculty of economics department is also welcome.

Relevant Contact Persons

- Main: Sonan Memon (+923332764571 & smemon@iba.edu.pk)

- Ahmed Ali, Admin Economics Department of IBA

- Dr. Asma Hyder, Head of Economics Department

Useful Resources

- ML Course taught by Maximilian Kasy at Harvard: https://maxkasy.github.io/home/TopicsInEconometrics2019/

- Fundamentals of Machine Learning for Economists (IMF Course): https://michalandrle.weebly.com/machine-learning-for-economists.html (Michal Andrle).

- My lecture slides for this course on GitHub: https://github.com/sonanmemon/Introduction-to-ML-For-Economists

- Athey, Susan and Imbens, Guido W (2019), Machine Learning Methods That Economists Should Know About, Annual Review of Economics, https://doi.org/10.1146/annurev-economics-080217-053433

- Athey, Susan (2018), The Impact of Machine Learning on Economics, The Economics of Artificial Intelligence: An Agenda, University of Chicago Press, https://www.nber.org/system/files/chapters/c14009/c14009.pdf

- Mullanaithan, Sendhil, Speiss, Jann (2017), Machine Learning: An Applied Econometric Approach, Journal of Economic Perspectives, https://www.aeaweb.org/articles?id=10.1257/jep.31.2.87

- Varian, Hal (2014), Big Data: New Tricks for Econometrics, https://www.aeaweb.org/articles?id=10.1257/jep.28.2.3

- R repository for useful ML packages: https://CRAN.R-project.org/view=MachineLearning

- Hastie, T., Tibshirani, R., & Friedman, J. (2017), The elements of statistical learning: data mining, inference, and prediction. Springer Science & Business Media.

- Gareth, J., Daniela, W., Trevor, H., & Robert, T. (2013), An introduction to statistical learning: with applications in R. Spinger.

Course Content

Lecture 1: Introduction to ML and Shrinkage Estimators

1. Basic Decision Theory, Loss Functions, Integrated Risk, Bayes' Risk, Bayes' Optimality, Empirical Risk Minimization.

2. Basic Concepts of Machine Learning: Training Sample, Validation Sample, Cross Validation, Variance Bias Trade off.

3. Regularization and Shrinkage Estimators: Ridge Regression and LASSO, Tuning Shrinkage Parameters.

4. Discussion of LASSO applications in macroeconomic forecasting.

Lecture 1 Readings/Other Resources

- Robert, C. (2007). The Bayesian choice: from decision-theoretic foundations to computational implementation. Springer Verlag, chapter 2.

- Alpaydin, Ethem (2010), Introduction to Machine Learning, 2nd edition, MIT Press.

- Stachurski, John (2016), A Primer in Econometric Theory, MIT Press (Chapter 14).

Lecture 2: Multi Armed Bandits

1. Multi-Armed Bandit Problems.

2. Greedy Algorithms

3. Thompson Sampling.

4. UCB Algorithm

5. Applications: Cario, Gordon, Kasy et al (2020), Adaptive Treatment Assignment example in Syrian refugee context and Misra et al (2017), Dynamic Online Pricing with Incomplete Information Using Multi-Armed Bandit Experiments.

Lecture 2 Readings/Other Resources

- Bubeck, S. and Cesa-Bianchi, N. (2012). Regret Analysis of Stochastic and Nonstochastic Multi-armed Bandit Problems. Foundations and Trends in Machine Learning, 5(1):1-122

- Russo, D. J., Roy, B. V., Kazerouni, A., Osband, I., and Wen, Z. (2018). A Tutorial on Thompson Sampling. Foundations and Trends in Machine Learning, 11(1):1-96

- Application 1: Cario, Stefano, Gordon, Grant, Kasy, Maximilian et al (2020), An Adaptive Targeted Field Experiment: Job Search Assistance for Refugees in Jordan.

- Application 2: Misra et al (2017), Dynamic Online Pricing with Incomplete Information Using Multi-Armed Bandit Experiments.

Lecture 3: Deep Neural Networks

1. Deep Neural Networks.

2. Gradient Descent.

3. Stochastic Gradient Descent.

4. Back Propagation.

5. Economic Application.

Lecture 3 Readings/Other Resources

- Goodfellow, I., Bengio, Y., and Courville, A. (2016). Deep learning, MIT Press, chapters 6-8

- Bottou, L., Curtis, F. E., and Nocedal, J. (2018). Optimization methods for large scale machine learning. SIAM Review, 60(2):223-311

- Brief Discussion of Application: Solving High Dimensional Dynamic Programming Problems Using Neural Nets in Heterogeneous Agent Models in Macroeconomics (Professor Jesus Fernandez Villaverde, UPenn)

Lecture 4: Text as Data

1. Computational Linguistics: Analysis of Text Corpora.

2. Unsupervised Learning: Latent Dirichlet Allocation and Topic Modeling.

3. Economic Example: Linguistic Analysis of Monetary Policy Announcements and FOMC meeting minutes, Hansen et al (2018) QJE, News Driven Inflation Expectations (2020 Norges Bank Working Paper).

Lecture 4 Readings/Other Resources

- Blei, D. M., Ng, A. Y., and Jordan, M. I. (2003). Latent Dirichlet allocation. Journal of Machine Learning Research, 3(Jan):993-1022

- Gentzkow, M., Kelly, B. T., and Taddy, M. (2019). Text as data. Journal of Economic Literature

- Silge, J., & Robinson, D. (2017). Text mining with R: A tidy approach. O'Reilly Media, Inc

- Application 1: Hansen, Stephen, McMahon, Michael, Prat, Andrea (2018), Deliberation within the FOMC: A Computational Linguistics Approach, Quarterly Journal of Economics

- Application 2: Larsen, H Vegard, Thorsrud, A Leif and Zhulanova, Julia (2020), News Driven Inflation Expectations and Information Rigidities, Norges Bank Working Paper (Preliminary Paper)