Wayne State University- Department of Economics
ECO 7100 (001) 25627- Econometrics I (Winter 2019)

Instructor: Vitor Kamada
Class: MW, 12:30- 2:10pm at 2072 FAB
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Office hours: MW, 4:10 – 5:40 pm, or by appointment.

1) Course Description

This course is an eclectic combination of Statistical and Econometric Methods frequently used in applied work. We are going to cover the core estimators for Causal Inference, such as Instrumental Variables (IV), Two-Stage Least Squares (2SLS), Fixed Effects (FE), Regression Discontinuity Design (RD), and Propensity Score Matching (PSM). The most common Machine Learning techniques will be also covered, such as: Ridge Regression, LASSO, Generalized Additive Models (GAMs), Random Forests, K-Means Clustering, etc.

If Econometrics is the "Queen" of Causal Inference; Machine Learning is the "King" of Prediction. Recently, cutting-edge research in Causal Inference methods in Economics is incorporating prediction techniques. For example, Bajari et al. (2015) use Support Vector Machines (SVM) to estimate the classical demand equation. Another interesting example is the Bayesian Structural Time-Series Model developed by Google (Brodersen et al. 2015) to estimate the causal impact of advertisement, using a predicted synthetic control group. It is worth mentioning that most of "new" techniques of Machine Learning have a long history in Bayesian Econometrics and Nonparametric Econometrics, such as Bootstrap, Regression Splines, and Kernel Regression.

As this course covers several methods and estimators, the emphasis will be on intuition, implementation, and interpretation of results. Mathematical derivation can be checked anytime in the textbooks, and optimization problems are outsourced to computers.

2) Learning Outcome

The main goal of this course is to exposure the student to a variety of methods and estimators from different branches of Statistics and Econometrics. The expected result after the treatment is that the students can creatively combine these different methods to solve real world problems and write the empirical part of their dissertation.

Another goal of this course is to provide a solid foundation to ECO 7110 Econometrics II, where I will teach more advanced Causal Inference material, Deep Learning methods (Neural Network and Genetic Algorithms), and Big Data tools (Hadoop and Spark).

3) Textbook

All textbooks below are open source or available online for free via Wayne Library website. Check the links:

Angrist, Joshua D. and Pischke, Jörn-Steffen (2009). **Mostly Harmless Econometrics: An Empiricist's Companion**. Princeton University Press. https://ebookcentral.proquest.com/lib/wayne/detail.action?docID=475846

Hansen, B. R. (2019). **Econometrics**. https://www.ssc.wisc.edu/~bhansen/econometrics/

Hastie, T., Tibshirani, R., Friedman, J. (2017). **The Elements of Statistical Learning**. Springer, 2ed. https://web.stanford.edu/~hastie/ElemStatLearn/

Heiss, F. (2016). **Using R for Introductory Econometrics**. CreateSpace. http://www.urfie.net/

James, G., Witten, D., Hastie, T., Tibshirani, R. (2017). **An Introduction to Statistical Learning with Applications in R**. Springer. http://www-bcf.usc.edu/~gareth/ISL/

Oehlert, G. A. (2010). **First Course in Design and Analysis of Experiments**. http://users.stat.umn.edu/~gary/Book.html

Wooldridge, Jeffrey (2010). **Econometric Analysis of Cross Section and Panel Data**, 2ed, Cambridge: MIT Press. https://ebookcentral.proquest.com/lib/wayne/detail.action?docID=3339196&query=Econometric+Analysis+of+Cross+Section+and+Panel+Data

4) Software

Be free to complete the assignments in any Software, such as R, Python, Stata, SAS, etc. Usually my Engineering Students submit the assignments in R or Python; whereas my Econ Students submit in Stata or SAS. Any Software works for the traditional methods, but R and Python have clear comparative advantage in Machine Learning and Big Data.

My lectures will be based on R. You can download R compiler from www.r-project.org. After installing R, you can install RStudio (https://www.rstudio.com), an open-source integrated development environment (IDE). James et al. (2017) and Heiss (2016) are excellent books to learn R.

5) Course Schedule

Date	Topics
Week 1 **Jan 7**	**1.1) The Experimental Ideal** Angrist and Pischke (2009): Ch 2 **1.2) Experiment: Randomization and Design** Oehlert (2010): Ch 1 and Ch 2
Week 1 **Jan 9**	**2) Analysis of Variance (ANOVA): Completely Randomized Designs** Oehlert (2010): Ch 3 Athey, S., Imbens, G. W. (2017). **The Econometrics of Randomized Experiments**. *Handbook of Economic Field Experiments*, Vol 1, 73-140.
Week 2 **Jan 14**	**3.1) Conditional Expectation and Projection** Hansen (2018): Ch 2 **3.2) Variance Inflation Factor (VIF) and Outliers** James et al. (2017): Ch 3
Week 2 **Jan 16**	**4.1) Algebra of Ordinary Least Squares (OLS)** Hansen (2017): Ch 3 **4.2) Gauss-Markov Theorem** Hansen (2017): Ch 4.1 to 4.7
Week 3 **Jan 21**	Holiday - University Closed Martin Luther King Jr. Day
Week 3 **Jan 23**	**5.1) Generalized Least Squares (GLS)** Hansen (2017): Ch 4.8 to 4:19 **5.2) Bootstrap** James et al. (2017): Ch 5.2 and 5.3.4
Week 4 **Jan 28**	**6) Fixed Effects (FE) and Random Effects (RE)** Wooldridge (2010): Ch 10
Week 4 **Jan 30**	**7) Instrumental Variables (IV) and Two-Stage Least Squares (2SLS)** Wooldridge (2010): Ch 5
Week 5 **Feb 4**	**8.1) Maximum Likelihood Estimator (MLE)** Hansen (2017): Ch 5 **8.2) Logistic and Probit Regression** Wooldridge (2010): Ch 15
Week 5 **Feb 6**	**9) K-Nearest Neighbors (KNN)** Hastie et al. (2017): Ch 2.3, 6.6, 13.3 James et al. (2017): Ch 4.6.5 to 4.6.6
Week 6 **Feb 11**	**10) Nonparametric and Kernel Regression** Hastie et al. (2017): Ch 6.1 to 6.5 Hansen (2017): Ch 19
Week 6 **Feb 13**	**11) Cross-Validation** Hastie et al. (2017): Ch 7.10 James et al. (2017): Ch 5.1, 5.3.1 to 5.3.3
Week 7 **Feb 18**	**12) Bayesian Information Criterion (BIC) and Subset Selection** James et al. (2017): Ch 6.1 and 6.5 Hastie et al. (2017): Ch7.1 to 7.9
Week 7 **Feb 20**	**13) Ridge Regression, and Least Absolute Shrinkage and Selection Operator (LASSO)** Hastie et al. (2017): Ch 3.3 to 3.4

	James et al. (2017): Ch 6.1 to 6.2, and 6.5 to 6.6
Week 8 **Feb 25**	**14) Principal Components Analysis** Hastie et al. (2017): Ch 14.5 James et al. (2017): Ch 10.2, and 10.4
Week 8 **Feb 27**	**15) Principal Components Regression, and Partial Least Squares** Hastie et al. (2017): Ch 3.5 James et al. (2017): Ch 6.3, and 6.7
Week 9 **Mar 4**	**16) Regression Splines** Hastie et al. (2017): Ch 5 James et al. (2017): Ch 7.4, 7.5, 7.6, and 7.8.2
Week 9 **Mar 6**	**17) Generalized Additive Models (GAMs)** James et al. (2017): Ch 7.7, and 7.8.3 Hastie et al. (2017): Ch 9.1
Week 10 **Mar 11**	**Holiday - No Classes** **(Spring Break)**
Week 10 **Mar 13**	**Holiday - No Classes** **(Spring Break)**
Week 11 **Mar 18**	**18) Regression and Classification Trees** Hastie et al. (2017): Ch 9.2 James et al. (2017): Ch 8.1, 8.3.1, and 8.3.2
Week 11 **Mar 20**	**19) Bagging, Random Forests, and Boosting** Hastie et al. (2017): Ch 10 and 15 James et al. (2017): Ch 8.2.3, and 8.3.4
Week 12 **Mar 25**	**20) K-Means Clustering, and Hierarchical Clustering** Hastie et al. (2017): Ch 13.2, and 14.3 James et al. (2017): Ch 10.3, 10.5 to 10.6
Week 12 **Mar 27**	**21) Support Vector Machines (SVM)** Hastie et al. (2017): Ch 12 James et al. (2017): Ch 9
Week 13 **Apr 1**	**22) Review: Machine Learning Methods** Bajari, P., Nekipelov, D., Ryan, S. P., Yang, M. (2015). **Machine Learning Methods for Demand Estimation**. *American Economic Review* 105(5): 481–485. Bajari, P., Nekipelov, D., Ryan, S. P., Yang, M. (2015). **Demand Estimation with Machine Learning and Model Combination**. *NBER Working Paper* No. 20955.
Week 13 **Apr 3**	**23) Bayesian Structural Time-Series Model** Brodersen et al. (2015). **Inferring causal impact using Bayesian structural time-series models**. Annals of Applied Statistics: Vol. 9, No. 1, 247–274.
Week 14 **Apr 8**	**24) Sharp Regression Discontinuity Design** Cattaneo et al. (2018): Ch 2, 3, and 4. A Practical Introduction to Regression Discontinuity Designs: Volume I, Cambridge University Press.
Week 14 **Apr 10**	**25) Fuzzy Regression Discontinuity Design** Cattaneo et al. (2018): Ch 5 Angrist and Pischke (2009): Ch 6
Week 15 **Apr 15**	**26) Propensity Score Matching (PSM)** Caliendo, M., Kopeinig, S. (2008). **Some Practical Guidance for the Implementation of Propensity Score Matching**. *Journal of Economic Surveys* 22(1): 31–72.

	Wooldridge (2010): Ch 21
Week 15 **Apr 17**	**27) Matching Estimator** Imbens, G. W. (2015). **Matching Methods in Practice: Three Examples**. *Journal of Human Resources* 50(2): 373-419.
Week 16 **Apr 22**	**28) Study Day**
Week 16 **Apr 24**	**Final Exam** **Research Proposal**

6) Grading

6.1) Your final grade will be assessed as follows:

Assignment*	Composition**	Weight	Date
Surveys	Individual	1%	Wednesday, Feb 6 (at 4:00 pm)
Replication	Group	40%	Check on Canvas
Lab	Group	40%	Check on Canvas
Research Proposal	Individual	19%	Wednesday, Apr 24
Total		100%	

*** Guidelines and detailed instructions for Assignment are on Canvas**

**** For Group Assignment, you must learn how to work in team, communicate properly, and negotiate with others. If you work alone, I will not accept the assignment and your grade will be automatically 0.**

Grading Scale

94+ = A
90+ = A-
87+ = B+
84+ = B
80+ = B-
77+ = C+
74+ = C
70+ = C-
67+ = D+
64+ = D
61+ = D-
Below 61 = F

6.2) Makeup Policy for any Assignment

If you miss any Assignment, I will provide a makeup activity in the case of an excused and unavoidable absence. Then it is YOUR RESPONSIBILITY to provide satisfactory written documentation of an excused and unavoidable absence as soon as possible. For example, if you are ill – the accompanying doctor's note must say that you cannot (or could not) do the Homework or Lab. If the doctor's note does not state this clearly, your score will be zero.

7. Course Expectations

7.1) Prerequisite

Official prerequisite stipulated by Department of Economics for this course is: ECO 6100 Introduction to Econometrics, and ECO 7020 Fundamentals of Economic Analysis I.

7.2) Clarifying Expectations

To succeed in this course, you'll need to invest a good amount of time and energy doing exercises outside the class time. If at any time you feel you're investing the required time and energy but aren't learning the material or improving your skills, contact me and I'll do my best to help you and to suggest additional resources and options. If you have questions or concerns that you believe can be handled via e-mail, feel free to contact me that way. If I cannot adequately respond to your question via e-mail, I'll ask you to come to my regular office hours or make an appointment.

7.3) Academic Integrity

Wayne State University aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Student Code of Conduct, please see https://doso.wayne.edu/conduct/codeofconduct.pdf. Students who commit or assist in committing dishonest acts are subject to sanctions described in the Student Code of Conduct.

7.4) Special Accommodations

If you have a documented disability that requires accommodations, you will need to register with Student Disability Services (SDS) for coordination of your academic accommodations. The Student Disability Services (SDS) office is located at 1600 David Adamany Undergraduate Library in the Student Academic Success Services department. SDS telephone number is 313-577-1851 or 313-577-3365 (TDD only). Once you have your accommodations in place, I will be glad to meet with you privately during my office hours to discuss your special needs. Student Disability Services' mission is to assist the university in creating an accessible community where students with disabilities have an equal opportunity to fully participate in their educational experience at Wayne State University.