

## COURSE READINGS OUTLINE

### Textbooks to use for reference:

There is not a required textbook for the course. The following books may be useful references:

Causal Inference:

*Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction.* Guido Imbens, Donald Rubin. Cambridge University Press, 2015. (advanced research text)

*Mostly Harmless Econometrics.* Joshua Angrist and Stephen Pischke. (undergrad level)

Machine Learning:

*The Elements of Statistical Learning.* Trevor Hastie, Robert Tibshirani, and Jerome Friedman, Springer, 2009. Available online at <http://www-stat.stanford.edu/~tibs/ElemStatLearn/>

*Machine Learning: A Probabilistic Perspective.* Kevin P. Murphy, MIT Press, 2012.

*Pattern Recognition and Machine Learning.* Christopher M. Bishop, Springer, 2006.

*Statistical Learning with Sparsity: The Lasso and Generalizations.* Trevor Hastie, Robert Tibshirani, Chapman and Hall, 2015.

**NOTE: The outline and timeline is subject to change. Please check Canvas each week for updates.**

### **Friday, April 6: A Model for Causal Inference (The Potential Outcomes Model); Unconfoundedness; Average Treatment Effects in Low Dimensions; Propensity Score Weighting; Matching; Balancing**

*Required reading:* Background reading from Imbens and Rubin and/or Angrist and Pishke, if unfamiliar with the potential outcomes model. Become familiar with the basic ideals of the model, so that you could explain these concepts: potential outcomes, unconfoundedness, propensity scores, ATE, ATT, matching. These concepts will be reviewed in class, but it will go fast.

Imbens G. "Matching Methods in Practice." *Journal of Human Resources*, 2015;50(2):373-419. (Canvas: Average Treatment Effects in Low Dimensions)

Imbens G. "Nonparametric Estimation of Average Treatment Effects under Exogeneity: A Review." *Review of Economics and Statistics*, 2004;86(1):4-29. (Canvas: Average Treatment Effects in Low Dimensions)

Athey, Susan, et al. "Estimating Average Treatment Effects: Supplementary Analyses and Remaining Challenges." *arXiv preprint arXiv:1702.01250* (2017). <https://arxiv.org/abs/1702.01250>

Zubizarreta, José R. "Using mixed integer programming for matching in an observational study of kidney failure after surgery." *Journal of the American Statistical Association* 107.500 (2012): 1360-1371. <https://www.tandfonline.com/doi/abs/10.1080/01621459.2012.703874>

Wager, Stefan, Wenfei Du, Jonathan Taylor, and Robert J. Tibshirani. "High-dimensional regression adjustments in randomized experiments." *Proceedings of the National Academy of Sciences* 113, no. 45 (2016): 12673-12678. <http://www.pnas.org/content/113/45/12673>

### Friday, April 13: Introduction to Supervised Machine Learning and Econometrics

*Required reading:* Hal Varian, "Big Data: New Tricks for Econometrics," *The Journal of Economic Perspectives*, 28 (2), Spring 2014, 3-27. <http://people.ischool.berkeley.edu/~hal/Papers/2013/ml.pdf> (Canvas: Introduction and Overviews)

S. Athey (2017) "Beyond prediction: Using big data for policy problems," *Science*, 355(6324):483-485. <http://people.stanford.edu/athey/research#econometric>

S. Athey (2018, January) "The Impact of Machine Learning on Economics," Sections 1-3. <http://bit.ly/2EENtvY>

S. Mullainathan and J. Spiess (2017) "Machine learning: an applied econometric approach" *Journal of Economic Perspectives*, 31(2):87-106. <http://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.31.2.87>

Kleinberg, Jon, Jens Ludwig, Sendhil Mullainathan, and Ziad Obermeyer. "Prediction policy problems." *The American Economic Review* 105, no. 5 (2015): 491-495. (Canvas: Prediction Policy)

Additional reading in Canvas Modules: Introduction and Overviews; Cross-Validation; Regularized Regression-Prediction; Prediction Policy

### Friday, April 20: Machine Learning for Average Treatment Effects

*Required reading:*

S. Athey (2018, January) "The Impact of Machine Learning on Economics," Sections 4.0, 4.1. <http://bit.ly/2EENtvY>

A. Belloni, V. Chernozhukov, C. Hansen: "High-Dimensional Methods and Inference on Structural and Treatment Effects," *Journal of Economic Perspectives*, 28 (2), Spring 2014, 29-50. <https://www.aeaweb.org/articles?id=10.1257/jep.28.2.29> (Canvas: Regularized Regression-Causal)

S. Athey, G. Imbens, S. Wager: "Efficient Inference of Average Treatment Effects in High Dimensions via Approximate Residual Balancing," <http://arxiv.org/abs/1604.07125>.

Chernozhukov, Victor, Denis Chetverikov, Mert Demirer, Esther Duflo, Christian Hansen, Whitney Newey, and James Robins. "Double/debiased machine learning for treatment and structural parameters." *The Econometrics Journal* (2017). <https://arxiv.org/abs/1608.00060>

Additional reading in Canvas Modules: Regularized Regression-Causal; High Dimensional Methods - Causal

### Friday, April 27: Regression Trees; Heterogeneous Treatment Effects: Subgroup Analysis/Nonparametric Analysis

*Required reading:*

S. Athey (2018, January) "The Impact of Machine Learning on Economics," Section 4.2. <http://bit.ly/2EENtvY>

Athey, S., & Imbens, G. (2015). "A measure of robustness to misspecification." *The American Economic Review*, 105(5), 476-480. (Canvas: Robustness)

Athey, S. and G. Imbens, 2016, "Recursive Partitioning for Heterogeneous Effects," *Proceedings of the National Academy of Science*, <http://arxiv.org/abs/1504.01132> (Canvas: Heterogeneous Treatment Effects: Treatment Effect Estimation)

Wager, S. and S. Athey, "Estimation and Inference for Heterogeneous Treatment Effects Using Random Forests," forthcoming, *Journal of the American Statistical Association*, <http://arxiv.org/abs/1510.04342>. (Canvas: Heterogeneous Treatment Effects: Treatment Effect Estimation)

Hill, Jennifer L. "Bayesian nonparametric modeling for causal inference." *Journal of Computational and Graphical Statistics* 20.1 (2011): 217-240. <https://www.tandfonline.com/doi/abs/10.1198/jcgs.2010.08162>

Künzel, Sören, Jasjeet Sekhon, Peter Bickel, and Bin Yu. "Meta-learners for Estimating Heterogeneous Treatment Effects using Machine Learning." arXiv preprint arXiv:1706.03461 (2017). <https://arxiv.org/abs/1706.03461>

Additional reading in Canvas Modules: Nonparametric Methods-Kernels and KNN; Heterogeneous Treatment Effects: Treatment Effect Estimation, Optimal Policy Estimation, Adaptive Experiments

#### **Friday, May 4: High-dimensional methods for Instrumental variables; Neural Nets**

*Required reading:*

Y. LeCun, Y. Bengio and G. Hinton, (2015) "Deep learning" *Nature*, Vol. 521(7553): 436-444. (Canvas: Supervised Learning – Neural Nets)

Jason Hartford, Greg Lewis, Kevin Leyton-Brown, Matt Taddy, "Counterfactual Prediction with Deep Instrumental Variables Networks" <https://arxiv.org/abs/1612.09596>

S. Athey, Tibshirani, J., and S. Wager "Generalized Random Forests" forthcoming, *Annals of Statistics*. <http://arxiv.org/abs/1610.01271>

Additional reading in Canvas Modules: Robustness; Heterogeneous Treatment Effects: Treatment Effect Estimation

#### **Friday, May 11: Heterogeneous Treatment Effects in Observational Studies**

*Required reading:*

S. Athey, Tibshirani, J., and S. Wager "Generalized Random Forests" forthcoming, *Annals of Statistics*. <http://arxiv.org/abs/1610.01271>

Zhao, Qingyuan, Dylan S. Small, and Ashkan Ertefaie. "Selective inference for effect modification via the lasso." arXiv preprint arXiv:1705.08020 (2017). <https://arxiv.org/abs/1705.08020>

Athey, Susan, and Stefan Wager. "Efficient policy learning." arXiv preprint arXiv:1702.02896 (2017). <https://arxiv.org/abs/1702.02896>

Additional reading in Canvas Modules: Nonparametric Methods-Kernels and KNN; Heterogeneous Treatment Effects: Treatment Effect Estimation, Optimal Policy Estimation, Adaptive Experiments

**Friday, May 18: Optimal Policy Estimation; Contextual Bandits**

*Required reading:*

Athey, Susan, and Stefan Wager. "Efficient Policy Learning." *arXiv preprint arXiv:1702.02896* (2017).  
<https://arxiv.org/abs/1702.02896>

Li, Lihong, et al. "A contextual-bandit approach to personalized news article recommendation." *Proceedings of the 19th international conference on World wide web*. ACM, 2010. <https://arxiv.org/abs/1003.0146>

M. Dudik, D. Erhan, J. Langford, and L. Li, (2014) "Doubly Robust Policy Evaluation and Optimization" *Statistical Science*, Vol 29(4):485-511. <https://arxiv.org/abs/1503.02834>

S. Scott (2010), "A modern Bayesian look at the multi-armed bandit," *Applied Stochastic Models in Business and Industry*, vol 26(6):639--658. <https://onlinelibrary.wiley.com/doi/abs/10.1002/asmb.874>

M. Dimakopoulou, S. Athey, and G. Imbens (2017). "Estimation Considerations in Contextual Bandits." <http://arXiv.org/abs/1711.07077>

Additional Reading in Canvas Modules: Heterogeneous Treatment Effects: Adaptive Experiments

**Friday, May 25: Regression Discontinuity; Optimization**

*Required Reading:*

Guido Imbens, Thomas Lemieux, (2007) "Regression Discontinuity Designs: A Guide to Practice,"  
<http://www.nber.org/papers/w13039>

Guido Imbens, Stefan Wager, "Optimized Regression Discontinuity Designs," <https://arxiv.org/abs/1705.01677>

Calonico, Sebastian, Matias D. Cattaneo, and Rocio Titiunik. "Robust nonparametric confidence intervals for regression-discontinuity designs." *Econometrica* 82.6 (2014): 2295-2326.  
<https://onlinelibrary.wiley.com/doi/abs/10.3982/ECTA11757>

Additional Reading in Canvas Modules: Regression Discontinuity, Optimization

**Friday, June 1: Panel Data Models**

*Required Reading:*

S. Athey, M. Bayati, N. Doudchenko, G. Imbens, and K. Khosravi (2017) "Matrix Completion Methods for Causal Panel Data Models." <http://arXiv.org/abs/1710.10251>

F. J. R. Ruiz, S. Athey, D.M. Bei (2017) "SHOPPER: A Probabilistic Model of Consumer Choice with Substitutes and Complements." <https://arxiv.org/abs/1711.03560>

S. Athey, D. Bei, R. Donnelly, F. Ruiz, T. Schmidt (2018) "Estimating Heterogeneous Consumer Preferences for Restaurants and Travel Time Using Mobile Location Data." <https://arxiv.org/abs/1801.07826>

Additional Reading in Canvas Modules: Modeling Text and Language, Recommendation Systems, Matrix Completion and Factor Models