**Dynamic Programming and Reinforcement Learning**
Prof: [Daniel Russo](http://djrusso.github.io/) djr2174@gsb.columbia.edu

**Course Description**

This course offers an advanced introduction Markov Decision Processes (MDPs)–a formalization of the problem of optimal sequential decision making under uncertainty–and Reinforcement Learning (RL)–a paradigm for learning from data to make near optimal sequential decisions. The first part of the course will cover foundational material on MDPs. We'll then look at the problem of estimating long run value from data, including popular RL algorithms like temporal difference learning and Q-learning. The final part of the course looks at the design and analysis of efficient exploration algorithms, i.e. those that intelligently probe the environment to collect data that improves decision quality. This a doctoral level course. Students should have experience with mathematical proofs, coding for numerical computation, and the basics of statistics, optimization, and stochastic processes.

**Course Requirements**

There will be some homework problems in the beginning of class covering fundamental material on MDPs. Afterward, the course will run like a doctoral seminar. You will be expected to engage with the material and to read some papers outside of class. The main assignment will be a course project, which could involve literature review, implementation of algorithms, or original research.

**Textbooks**

**Strongly Reccomended:** [Dynamic Programming and Optimal Control, Vol I & II, Dimitris Bertsekas](http://www.athenasc.com/dpbook.html)
These two volumes will be our main reference on MDPs, and I will recommend some readings from them during first few weeks. The books also cover a lot of material on approximate DP and reinforcement learning.

[Reinforcement Learning: An Introduction, Second Edition, Richard Sutton and Andrew Barto](http://incompleteideas.net/sutton/book/bookdraft2017june19.pdf)
A pdf of the working draft is freely available.

[Algorithms for Reinforcement Learning, Csaba Czepesvári](https://sites.ualberta.ca/~szepesva/papers/RLAlgsInMDPs.pdf)
A concise treatment, also freely available.