

AML 491/501
Probability and Statistics with Applications to the Life and Social Sciences

Fall 2009
8/25 – 12/8 T, Th 10:30am–11:45am PSA 546

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“It is remarkable that this science, which originated in the consideration of games of chance, should become the most important object of human knowledge...The most important questions of life are, for the most part, really only problems of probability.”

Pierre Simon, Marquis de Laplace

This course is an introduction—at the advanced undergraduate and beginner graduate level—to probability and its statistical applications. Probability is of fundamental importance to scientific inquiry, with a range of applications that extend into economics and finance, medical tests, law, the design of networks, supply-chain management, mathematical sociology, urban studies, quantitative archaeology, ecology, population genetics, epidemiology, and genomics. The course is intended to be both accessible to hard working students and to lay a solid foundation for further work and applications (such as a course on statistical applications and econometrics). Although the focus of the course is on applications, we will not shy away from reading (and building) proofs so that the power of various results does not remain an unopened black box.

Helping students develop a command of both discrete and continuous probability is the major goal of the course. The Law of Large Numbers and the Central Limit theorems are two of the biggest results in this area and so are well covered. The Binomial, Poisson, Normal, Log-Normal and Power Law probability distributions will be studied. Applications to conditional probability, statistics, Markov chains and Polya Urn problems will also be covered. The mathematical prerequisites for the courses are knowledge of the elements of calculus (derivatives and integration) and a familiarity with the concepts and elementary properties of vectors and matrices.¹ No previous knowledge of probability or statistics is assumed.

¹ “Knowledge of calculus” means confidently applying the basic rules of differentiation and integration; grasping the concept of limit and the Fundamental Theorem of the Calculus; understanding that given a function f of a variable x and an interval $[a, b]$ in the real line, the integral $\int f(x)dx$ measures the area of the region in the xy -plane bounded by the graph of f , the x -axis, and the vertical lines $x = a$ and $x = b$; and knowing how to solve one or two variable constrained-optimization problems using partial derivatives. If you need to refresh your calculus, or want to keep a good calculus reference under your pillow, the following widely-used textbooks are good compendia: *Calculus With Analytic Geometry* (George Simmons), *Calculus* (Gilbert Strong) and *Thomas' Calculus* (George B. Thomas, Maurice D. Weir, Joel Hass, and Frank R. Giordano).

There will be weekly assignments, two examinations and a final exam (all three examinations will be open book and open notebook.) The allocation of the final grade is as follows: assignments (20%), first examination (20%), second examination (25%), and final exam (35%). Class attendance and participation will be used in borderline grade cases. Homework is one of the most important components of the course (one learns mathematics mainly through doing mathematics). You may discuss homework problems with other students—in fact, are encouraged to do so—but your write-ups of homework must be your own. Remember you are doing the assignments in order to understand the material. Of course we expect students to fully adhere to ASU's Student Code of Conduct.

The Textbook for the course is *Probability and Statistics* (Morris H. DeGroot and Mark J. Schervish, Addison Wesley, 2002) to be augmented by additional readings (mainly articles) made available online. It is a good idea to read the relevant portions of the text (or the assigned reading) before they are discussed in class. Learning will be greatly facilitated by students posing questions in class and by vigorous discussion among class participants of the topics covered.

Schedule and Topics

- 1) Week 1 (8/25, 27): Set Theory I
- 2) Week 2 (9/1, 3): Set Theory II
- 3) Week 3 (9/8, 10): Combinatorics
- 4) Week 4 (9/15, 17): Probability I
- 5) Week 5 (9/22, 24): Probability II
- 6) Week 6 (9/29, 10/1): Conditional Probability
- 7) Week 7 (10/6): Examination 1
- 8) Week 7 (10/8): Random variables
- 8) Week 8 (10/13, 15): Random Variables and Distributions
- 9) Week 9 (10/20, 22): Expectation
- 10) Week 10 (10/27, 29): Probability Distributions I
- 11) Week 11 (11/3, 5): Probability Distributions II
- 12) Week 12 (11/10, 12): Polya Urn problems
- 13) Week 13 (11/17, 19): Markov Chains
- 14) Week 14 (11/24): Examination II
- 15) Week 15 (12/1, 3): Statistical Inference