Statistics 430: Probability

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Prerequisite: The class assumes knowledge of multivariate calculus at the level of Math 114. In particular students are expected to have studied change of variables in multiple integrals.

Topics: The following topics will be discussed in depth.

1. Quick review of some basic combinatorics including Binomial and Multinomial coefficients. Stirling's approximation to $n!$.

2. Axioms of probability. Inclusion-exclusion identity.

3. Conditional probability and Bayes Formula. Conditional probability as a probabilty.

4. Independence and conditional independence.

5. Random Variables as mappings from the Sample Space to Real Line. Probability Mass Functions and Densities of Discrete and Continuous Random Variables. Expectation of a function of a single random variable or of several random variables. Variance and Covariance. Variance of sums of random variables.

6. Binomial, Poisson, Geometric, Negative Binomial and Hypergeometric Random Variables.

7. Poisson Approximations and some discussion of the Poisson Process.

8. Normal Random Variables.

9. Gamma and Beta Functions and the corresponding Gamma and Beta distributions.

10. Joint Distribution of Random Variables. Conditional and Marginal Distributions.

11. Conditional Expectation and Conditional Variance.

12. Understanding $E(Y) = E(E(Y|X))$ in a variety of contexts. In particular we are interested in the cases where X is discrete or X is continous and Y can also be either discrete or continous.

13. Understanding $Var(Y) = Var(E(Y|X)) + E(Var(Y|X))$ with examples as above.

14. Sums of Independent Random variables.

15. Moment Generating Functions and Joint moment generating functions

16. Multivariate Normal Random Variables and as an important special case bivariate Normal random variables.

17. Limit Theorems. Weak and Strong Law of Large Numbers. Central Limit Theorems.