# Statistics 302, An Accelerated Introduction to Statistics

*Spring 2014, Larget*

The following tentative schedule contains a plan of what topics we will present each day in class. As a tentative schedule, it is *subject to change* — I have selected a pace I expect to be appropriate for an accelerated course; we shall all see if I selected well.

## Tentative Schedule

| Date | Topic<br>Concepts | Methods & Skills | Reading | Exercises |
|---|---|---|---|---|
| Jan. 22 | Course Overview<br>Introduction to Data | | | |
| | ▶ cases and variables<br>▶ categorical and quantitative variables<br>▶ explanatory and response variables | ▶ recognizing parts of a data set;<br>▶ distinguishing between categorical and quantitative variables;<br>▶ when appropriate, distinguishing explanatory and response variables. | Section 1.1 | 1.1, 1.3, 1.5, 1.7, 1.11 |
| Jan. 24 | Sampling from a Population | | | |
| | ▶ samples and populations<br>▶ statistical inference<br>▶ sampling bias<br>▶ simple random samples | ▶ distinguish between samples and populations<br>▶ recongnize when inference is appropriate<br>▶ identify sources of sampling bias<br>▶ use the computer to take random samples from finite populations | Section 1.2 | 1.27, 1.29, 1.31, 1.35, 1.39, 1.41, 1.45 |
| Jan. 27 | Experiments and Observational Studies | | | |
| | ▶ association<br>▶ causation<br>▶ confounding variables<br>▶ placebos<br>▶ blinding<br>▶ observational studies<br>▶ randomized experiments<br>▶ randomized comparative experiments<br>▶ matched pairs experiments | ▶ association need not imply causation<br>▶ identify confounding variables<br>▶ distinguish between observational studies and experiments<br>▶ distinguish some kinds of experiments<br>▶ know how to design and implement a randomized experiment | Section 1.3 | 1.65, 1.69, 1.71, 1.75, 1.77, 1.79 |
| Jan. 29 | Describing Variables | | | |

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| | ▶ proportions<br>▶ two-way tables<br>▶ shape of a distribution<br>▶ outliers<br>▶ skew<br>▶ symmetry<br>▶ mean<br>▶ median<br>▶ resistance<br>▶ standard deviation<br>▶ the 95% rule<br>▶ z-scores<br>▶ percentiles<br>▶ quartiles<br>▶ empirical cumulative distribution functions<br>▶ range and interquartile range | ▶ graph categorical data<br>▶ find proportions<br>▶ use a computer to construct dotplots, histograms, and density plots<br>▶ calculate medians and means, by hand and with the computer<br>▶ identify approximate means and medians from histograms<br>▶ understand how skewness and outliers affect the mean and median<br>▶ compute a standard deviation with a computer<br>▶ compute and interpret z-scores<br>▶ know advantages and disadvantages of different measures of spread | Sections 2.1–2.3 | 2.3, 2.5, 2.9, 2.11, 2.33, 2.35, 2.37, 2.39, 2.41, 2.45, 2.49, 2.69, 2.73, 2.75, 2.77, 2.81, 2.85, 2.89, 2.91 |
| Jan. 31 | Graphing Single Variables | | | |
| | ▶ boxplots<br>▶ side-by-side plots | ▶ identify potential outliers<br>▶ construct and understand boxplots<br>▶ construct and compare side-by-side plots | Section 2.4 | 2.121, 2.123, 2.127 |
| Feb. 3 | Describing Two Quantitative Variables | | | |
| | ▶ scatterplots<br>▶ correlation<br>▶ simple linear regression<br>▶ residuals<br>▶ least squares line<br>▶ slope and intercept of a regression line<br>▶ extrapolation | ▶ use the computer to construct a scatterplot<br>▶ use the computer to compute a correlation<br>▶ explain what positive and negative associations mean<br>▶ recognize that correlation does not imply cause and effect<br>▶ understand the importance of plotting data<br>▶ interpret correlation coefficients<br>▶ use a computer to find a simple linear regression line between two variables<br>▶ find predicted values<br>▶ interpret slope and intercept of regression lines<br>▶ understand residuals | Sections 2.5–2.6 | 2.149, 2.151, 2.155, 2.159, 2.161, 2.163, 2.187 |
| Feb. 5 | Sampling Distributions | | | |

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| | ▶ parameters and statistics<br>▶ point estimation<br>▶ estimation variability<br>▶ sampling distributions<br>▶ standard error<br>▶ sample size | ▶ distinguish between parameters (fixed in populations) and statistics (change from sample to sample).<br>▶ use statistics for estimation<br>▶ understand how sample size affects the sampling distribution | Section 3.1 | 3.1, 3.5, 3.7, 3.9, 3.15, 3.17, 3.19 |
| Feb. 7 | Understanding Confidence Intervals | | | |
| | ▶ margin of error<br>▶ confidence interval<br>▶ confidence level | ▶ construct 95% confidence intervals<br>▶ interpret confidence intervals in context | Section 3.2 | 3.39, 3.41, 3.43, 3.47, 3.49 |
| Feb. 10 | Bootstrap Confidence Intervals Using the SE | | | |
| | ▶ bootstrap samples<br>▶ bootstrap statistic<br>▶ bootstrap distribution | ▶ understand the mechanics of the bootstrap<br>▶ use the computer to create a bootstrap distribution<br>▶ construct confidence intervals using the standard error of the bootstrap distribution | Section 3.3 | 3.65, 3.67, 3.69, 3.73 |
| Feb. 12 | Bootstrap Confidence Intervlas Using Percentiles | | | |
| | ▶ percentiles of the bootstrap distribution | ▶ mechanics of using the bootstrap percentiles for confidence intervals<br>▶ understand when it is *and is not* appropriate to use bootstrap percentiles as shown in the text to construct confidence intervals | Section 3.4 | 3.88, 3.89, 3.91, 3.95, 3.97 |
| Feb. 14 | Introducing Hypothesis Tests | | | |
| | ▶ statistical test<br>▶ null and alternative hypotheses<br>▶ statistical significance | ▶ know how to specify null and alternative hypotheses.<br>▶ understand the logic behind statistical hypothesis testing<br>▶ understand statistical significance | Section 4.1 | 4.1, 4.3, 4.7, 4.9, 4.13, 4.15 |
| Feb. 17 | P-Values | | | |

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| | ▶ p-values<br>▶ null (randomization) distribution | ▶ correct interpretation of a p-value<br>▶ estimate a p-value from a randomization distribution<br>▶ distinguish between one- and two-tailed tests | Section 4.2 | 4.41, 4.45, 4.47, 4.51 |
| Feb. 19 | Statistical Significance | | | |
| | ▶ statistical decisions<br>▶ significance level<br>▶ type I and type II errors | ▶ understand mechanics of statistical decisions in hypothesis testing<br>▶ understand conclusions from hypothesis testing<br>▶ know how to interpret type I and type II errors<br>▶ understand limitations the hypothesis testing framework | Section 4.3 | 4.67, 4.69, 4.71, 4.73, 4.75 |
| Feb. 21 | Randomization Distributions | | | |
| | ▶ randomization distributions | ▶ use the computer to create randomization distributions in multiple settings. | Section 4.4 | 4.107, 4.110, 4.113, 4.116, 4.117, 4.121 |
| Feb. 24 | Connections between Confidence Intervals and Hypothesis Tests | | | |
| | ▶ confidence interval interpretation as nonsignificant null means<br>▶ practical importance versus statistical significance.<br>▶ the issue of multiple testing | ▶ determine testing decisions from a confidence interval | Section 4.5 | 4.147, 4.149, 4.151 |
| Feb. 26 | Review Day | | | |
| | | | Unit A and Unit B Syntheses | — |
| Feb. 28 | Exam 1 | | | |
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| Mar. 3 | Normal Distributions | | | |
| | ▶ density curves<br>▶ normal density curves<br>▶ mean and standard deviation of normal distributions<br>▶ the standard normal distribution | ▶ finding areas under normal distributions<br>▶ estimate probabilities as areas under densities<br>▶ find quantiles for normal distributions using the computer | Section 5.1 | 5.1, 5.3, 5.4, 5.5, 5.7, 5.9,5.11, 5.13, 5.15, 5.17, 5.19, 5.23, 5.27 |
| Mar. 5 | Inference Using Normal Distributions | | | |

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| | ▶ the central limit theorem<br>▶ confidence intervals using normal distributions<br>▶ hypothesis tests using normal distributions | ▶ find confidence intervals and p-values with normal theory | Section 5.2 | 5.43, 5.45, 5.49, 5.51, 5.53, 5.57 |
| Mar. 7 | Probability Rules | | | |
| | ▶ probability<br>▶ equally likely outcomes<br>▶ conditional probability<br>▶ basic probability rules<br>▶ independence<br>▶ disjoint events | ▶ calculating probabilities with equally likely outcomes<br>▶ calculating probabilities for combinations of events using *and*, *or*, *not*, and *if*.<br>▶ recognizing events that are independent or disjoint | Section 11.1 | 11.1–11.7, 11.15, 11.21, 11.23, 11.26 |
| Mar. 10 | Bayes' Rule | | | |
| | ▶ tree diagrams<br>▶ total probability<br>▶ Bayes' rule | ▶ know how to use Bayes' rule with or without a tree diagram for flipped conditional probability calculations | Section 11.2 | 11.45, 11.49, 11.51, 11.53, 11.55 |
| Mar. 12 | Random Variables | | | |
| | ▶ discrete and continuous random variables<br>▶ discrete probability distributions<br>▶ mean of a probability distribution<br>▶ standard deviation of a probability distribution | ▶ complete an incomplete discrete distribution<br>▶ find mean and standard deviation of a discrete distribution<br>▶ know in principle how to find mean and standard deviation from a continuous distribution | Section 11.3 | 11.65, 11.67, 11.69, 11.71, 11.73, 11.77, 11.81 |
| Mar. 14 | Binomial Probabilities | | | |
| | ▶ The binomial setting<br>▶ parameters of binomial distributions<br>▶ formula for a binomial probability<br>▶ mean and standard deviation of a binomial distribution | ▶ identify when a random variable is binomial<br>▶ compute binomial probabilities by formula and computer<br>▶ compute mean and standard deviation of a binomial distribution | Section 11.4 | 11.97, 11.99, 11.107, 11.111, 11.113 |
| Mar. 24 | Probability Theory for a Sample Proportion | | | |
| | ▶ standard error for a sample proportion<br>▶ connection to the binomial distribution<br>▶ connection to the central limit theorem | ▶ set up problems about a sample proportion | Section 6.1 | 6.1, 6.5 |
| Mar. 26 | Inference for a Single Proportion | | | |

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| | ▶ confidence intervals for a population proportion<br>▶ sample size determination<br>▶ hypothesis tests for a population proportion | ▶ find confidence intervals for $p$ with normal approximation<br>▶ find sample size to achieve a specified margin of error<br>▶ find a p-value using a normal approximation and a computer for an exact calculation | Sections 6.2–6.3 | 6.27, 6.33, 6.57, 6.61 |
| Mar. 28 | Probability Theory for a Sample Mean | | | |
| | ▶ standard error for a sample mean<br>▶ central limit theorem<br>▶ t distributions | ▶ find areas and quantiles of t distributions | Section 6.4 | 6.73, 6.77, 6.79 |
| Mar. 31 | Inference for a Single Mean | | | |
| | ▶ confidence intervals for a population mean<br>▶ sample size determination<br>▶ t test for a population mean | ▶ find the appropriate t distribution<br>▶ find a sample size for a specified margin of error and confidence<br>▶ conduct a t test | Sections 6.5–6.6 | 6.106, 6.109, 6.113, 6.135, 6.139 |
| Apr. 2 | Probability Theory for Differences in Sample Proportions | | | |
| | ▶ central limit theorem | ▶ Recognize when problem is a difference in population proportions<br>▶ Recognize when normal approximation is okay | Section 6.7 | 6.153, 6.157 |
| Apr. 4 | Inference for Differences in Proportions | | | |
| | ▶ confidence intervals for differences in proportions<br>▶ hypothesis tests for differences in proportions | ▶ use normal approximations for confidence intervals and testing | Sections 6.8–6.9 | 6.171, 6.173, 6.189, 6.193 |
| Apr. 7 | Probability Theory for Differences in Sample Means | | | |
| | ▶ central limit theorem | ▶ Recognize when a t distribution is appropriate | Section 6.10 | 6.211, 6.213, 6.215, 6.217 |
| Apr. 9 | Inference for Differences in Means | | | |

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| | ▶ confidence intervals for differences in population means<br>▶ hypothesis testing for differences in population means | ▶ know how to use t distribution for inference between two populations and know when it is appropriate<br>▶ distinguish between independent samples and matched difference samples | Sections 6.11–6.13 | 6.229, 6.251, 6.253, 6.279, 6.281 |
| Apr. 11 | Review | | Unit C Essential Synthesis | — |
| Apr. 14 | Exam 2 | | — | — |
| Apr. 16 | Testing a Single Categorical Variable | | | |
| | ▶ expected counts<br>▶ the chi-square statistic<br>▶ randomization goodness-of-fit test<br>▶ chi-square distributions<br>▶ chi-square goodness-of-fit test<br>▶ comparison to proportions for two categories | ▶ hypothesis testing and estimation for a single categorical variable | Section 7.1 | 7.1, 7.3, 7.7, 7.11 |
| Apr. 18 | Testing an Association Between Two Categorical Variables | | | |
| | ▶ expected counts in two-way tables<br>▶ chi-square test for association | ▶ testing an association in a two-way table by multiple methods | Section 7.2 | 7.31, 7.33 |
| Apr. 21 | Analysis of Variance | | | |
| | ▶ total, among group, and within group variability<br>▶ the F statistic<br>▶ F distributions<br>▶ ANOVA table<br>▶ inference about differences in group means | ▶ use ANOVA to test for differences in group means | Section 8.1–8.2 | 8.1, 8.3, 8.5, 8.9, 8.13, 8.33, 8.36, 8.39, 8.43 |
| Apr. 23 | Inference for Regression | | | |
| | ▶ linear model<br>▶ inference for slope and intercept<br>▶ coefficient of determination | ▶ interpret $R^2$<br>▶ use a computer to fit a linear model<br>▶ check for departures from model assumptions | Section 9.1 | 9.3, 9.7, 9.9, 9.13 |
| Apr. 25 | ANOVA for Regression | | | |
| | ▶ partitioning variability<br>▶ ANOVA for regression | ▶ inference for simple linear regression | Section 9.2 | 9.29, 9.33, 9.39 |

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| Apr. 28 | Confidence and Prediction Intervals<br>▸ regression confidence intervals<br>▸ regression prediction intervals<br>▸ inference for estimation intervals | ▸ use the computer for confidence and prediction intervals | Section 9.3 | 9.57 |
| Apr. 30 | Review | | Unit D essential synthesis | — |
| May 2 | Exam 3 | | — | — |
| May 5 | Introduction to Bayesian Inference | | Course notes | — |
| May 7 | Bayesian Inference for Proportions | | — | — |
| May 9 | Bayesian Inference for Means | | — | — |
| May 12 | Final Exam, 5:05–7:05pm | | | |