SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF MINNESOTA

PUBH 6450, SECTION 001

Biostatistics I
Spring 2019

COURSE & CONTACT INFORMATION

Credits: 4
Meeting Day(s): Mondays and Wednesdays
Meeting Time: 10:10a–12:05p
Meeting Place: Bruininks 432

Instructor: Marta Shore
Email: shore007@umn.edu
Office Hours: Mondays 1:00p-2:00p
Office Location: Mayo A449

Instructor: Laura Le
Email: free0312@umn.edu
Office Hours: Tuesdays 12:30p–1:30p
Office Location: Mayo A455

TA: Jonathan Kim
Email: kim00225@umn.edu
Lab: 003 Tuesday 11:15a–12:05p
Office Hours: Fridays 12:00p–1:00p

TA: Boyang Lu
Email: lu000083@umn.edu
Lab: 002 Monday 12:20p–1:10p
Office Hours: Thursdays 12:00p–1:00p

All labs take place in Mayo C381
All TA office hours take place in Mayo A446

Office Hours (Mayo A446 unless otherwise noted)	
Monday	Marta Shore (Mayo A449): 1:00p–2:00p
Tuesday	Laura Le (Mayo A455): 12:30p–1:30p
Wednesday	
Thursday	Boyang Lu: 12:00p–1:00p
Friday	Jonathan Kim: 12:00p–1:00p

COURSE DESCRIPTION

In this course, we will explore the basic concepts of exploratory data analysis and statistical inference, including: descriptive statistics, random variables and their distributions, point/interval estimation for means, proportions, and odds/risk, hypothesis testing, ANOVA, simple regression/correlation, multiple regression, and nonparametric methods (if possible). We will focus on health science applications using output from statistical packages.

COURSE PREREQUISITES

College Algebra (e.g. Math 1031), health science grad student, or instructor permission.

COURSE GOALS & OBJECTIVES

By the end of the course, students should have a basic understanding of the fundamentals of biostatistical methods. This includes:

- Summarizing data with numerical measures and graphs
- Basic concepts of randomness and data distributions
- Point/Interval estimation for categorical and continuous outcomes
- Hypothesis testing for categorical and continuous outcomes
- Simple and multiple linear regression
- Basic SAS and/or R programming language skills

METHODS OF INSTRUCTION AND WORK EXPECTATIONS

Course Workload Expectations

PubH 6450: Biostatistics I is a 4-credit course. The University expects that for each credit, you will spend a minimum of three hours per week attending class, reading, studying, and completing assignments, etc. over the course of a 15-week term. Thus, this course requires approximately 180 hours of effort spread over the course of the term in order to earn an average grade.

Methods of Instruction

The course will utilize both traditional lectures and active learning experiences.

Here is the breakdown of the weekly work expectations for class:

- **Preceding weekend**: Students will be expected to prepare for each class meeting by reading from the textbook.
- **In-class on Day 1 of the week**: The first part of class will be devoted to working collaboratively in a small group on the quiz that was completed at the end of the previous week. Because of this, it will be essential that you attend class on Day 1 of the week so that you can contribute to your group's learning. Groups will be required to submit their answers via Moodle. The remaining time will be devoted to learning the topic of the week via a lecture.
- **Between Day 1 and Day 2 of the week:** Students will be expected to look over the lectures and readings for the week and prepare any questions they have. In addition, students will be expected to attend lab and learn the new programming skills related to the topic of the week. After students attend lab, they will be encouraged to download the Problem Set and review the questions in preparation for Day 2 of class.
- **In-class on Day 2 of the week:** The first part of class will be devoted to finishing up learning the topic of the week via lecture or in class discussion. The remaining time will be working on an activity, called Problem Set, that allows you to apply and further solidify your knowledge of the concept and of analyzing the data via your chosen software while having instructors available for assistance. The Problem Sets are best carried out in small groups, but you may also work independently if you prefer.
- **After class on Day 2 of the week:** Students will be working collaboratively (with guidance from instructors and TAs) to create the answer key for the Problem Set. Your learning experience will be thus dependent–to some extent–on your classmates and vice versa. Each student will be expected to contribute at least once to the key each week. Your contribution to the collaborative key will be **due each Friday by 5:00pm.**
- **At the end of the week**: An online quiz covering the material of the week, as well as concepts from earlier weeks, will be **due each Saturday by 11:55pm**. Students will be expected to complete this end-of-week quiz independently.

Lab

In the weekly lab sessions, you will learn how to analyze data via your chosen software (SAS or R). Your lab TA will be on hand to help you as you work through the lab documents for your chosen software. Within each lab document, there will be *Guided Questions* that ask you to interpret the output from the code in the document. In addition, there will be *Challenge* questions that try to push you in your coding abilities and may force you to utilize external resources (e.g., internet) to answer the question.

Projects

There will be two projects within the semester that assess your ability to analyze data via your chosen software and interpret the results. Students are expected to complete these projects independently, **except** where the instructors specifically note collaboration is acceptable.

Computing
The course includes examples of data analysis from SAS and R. You will need access to SAS or R to complete your assignments.

Technology
You will use the following technology tools in this course. Please make yourself familiar with them.

- Google Docs for the activity collaborative keys. Training is available via OIT.
- WebEx or Google Hangout for any group meetings. Information on using Google Hangout can be found here, and information using WebEx can be found here.

Learning Community
School of Public Health courses ask students to discuss frameworks, theory, policy, and more, often in the context of past and current events and policy debates. Many of our courses also ask students to work in teams or discussion groups. We do not come to our courses with identical backgrounds and experiences and building on what we already know about collaborating, listening, and engaging is critical to successful professional, academic, and scientific engagement with topics.

In this course, students are expected to engage with each other in respectful and thoughtful ways.

In group work, this can mean:

- Setting expectations with your groups about communication and response time during the first week of the semester (or as soon as groups are assigned) and contacting the TA or instructor if scheduling problems cannot be overcome.
- Setting clear deadlines and holding yourself and each other accountable.
- Determining the roles group members need to fulfill to successfully complete the project on time.
- Developing a rapport prior to beginning the project (what prior experience are you bringing to the project, what are your strengths as they apply to the project, what do you like to work on?)

In group discussion, this can mean:

- Respecting the identities and experiences of your classmates.
- Avoid broad statements and generalizations. Group discussions are another form of academic communication and responses to instructor questions in a group discussion are evaluated. Apply the same rigor to crafting discussion posts as you would for a paper.
- Consider your tone and language, especially when communicating in text format, as the lack of other cues can lead to misinterpretation.

Like other work in the course, all student to student communication is covered by the Student Conduct Code (https://z.umn.edu/studentconduct).

COURSE TEXT & READINGS

The required textbook for the course is **Diez, Barr, Cetinkaya-Rundel. (2016). *OpenIntro Statistics* (3rd ed.).**

- This book is free for download or available for a very low cost through the site https://www.openintro.org.

Other resources:

Sullivan. (2018). Essentials of Biostatistics in Public Health (3rd ed., Jones & Bartlett Learning).
Various online resources

The chapters or sections will be listed in a particular week and are available free to download through the University Library system, up to 60 pages, or to check out (eBook) for a short period of time.

COURSE OUTLINE/WEEKLY SCHEDULE

Week	Topic	Readings	Activities/Assignments

Week 1
Jan. 22–26
	INTRODUCTION & SAMPLING	**Textbook Reading:**
		• OpenIntro Statistics (OIS)
		  ○ Chapter 1.1: Case Study: Using Stents to Prevent Strokes
		  ○ Chapter 1.3: Overview of Data Collection Principles
		  ○ Chapter 1.4.2: Four Sampling Methods
			• **NO LAB**
			• Week 1 Individual & Group Quiz (in-class)
			• Homework (due Saturday, Jan. 26 @ 11:55p)

Week 2
Jan. 27–
Feb. 2
	DATA SUMMARIES, RANDOM VARIABLES, & POPULATION DISTRIBUTIONS	**Textbook Reading:**
		• OIS
		  ○ Chapter 1.2: Data Basics
		  ○ Chapter 1.6: Examining Numerical Data
		  ○ Chapter 1.7: Considering Categorical Data
		  ○ Chapter 1.8: Case Study: Gender Discrimination (OPTIONAL)
		  ○ Chapter 2.5: Continuous Distributions
		  ○ Chapter 3: Distributions of Random Variables **(except 3.3.2 & 3.5)**
			• Lab
			• Problem Set activity (in-class Wednesday)
			• Contribution to Problem Set Collaborative Key (due Friday, Feb. 1 @ 5:00p)
			• Week 2 Individual Quiz (due Saturday, Feb. 2 @ 11:55p)

Week 3
Feb. 3–9
	CONFIDENCE INTERVALS FOR A PROPORTION	**Online Resources:**
		• OIS:
		  ○ Chapter 4: Foundations for Inference (**except 4.3 & 4.5.2)**
		  ○ Chapter 6.1: Inference for a single proportion **(except 6.1.3 & 6.1.4)**
		• Online Resources:
		  ○ https://www.spss-tutorials.com/sampling-distribution-what-is-it/
		  ○ https://courses.lumenlearning.com/boundless-statistics/chapter/sampling-distributions/
			• Week 2 Group Quiz (in-class Monday)
			• Lab
			• Problem Set activity (in-class Wednesday)
			• Contribution to Problem Set Collaborative Key (due Friday, Feb. 8 @ 5:00p)
			• Week 3 Individual Quiz (due Saturday, Feb. 9 @ 11:55p)

Week 4
Feb. 10–16
	CONFIDENCE INTERVALS FOR A MEAN	**Textbook Reading:**
		• OIS
		  ○ Chapter 5.1: One-sample means with the *t*-distribution (**except 5.1.5)**
		• Online Resources:
		  ○ http://my.ilstu.edu/~wjschne/138/Psychology138Lab10.html
			• Week 3 Group Quiz (in-class Monday)
			• Lab
			• Problem Set activity (in-class Wednesday)
			• Contribution to Problem Set Collaborative Key (due Friday, Feb. 15 @ 5:00p)
			• Week 3 Individual Quiz (due Saturday, Feb. 16 @ 11:55p)

Week 5 **Feb. 17–23**	**INTRODUCTION TO HYPOTHESIS TESTING**	**Textbook Reading:** • OIS ○ Chapter 4.3: Hypothesis Testing	• Week 4 Group Quiz (in-class Monday) • Lab • Problem Set activity (in-class Wednesday)

		○ Chapter 4.5.2: Hypothesis Testing for Nearly Normal Point Estimates ○ Chapter 5.1.5: One sample *t*-tests ○ Chapter 5.2: Paired data	• Contribution to Problem Set Collaborative Key (due Friday, Feb. 24 @ 5:00p) • Week 4 Individual Quiz (due Saturday, Feb. 23 @ 11:55p)
Week 6 Feb. 24– March 2	**INFERENTIAL METHODS FOR COMPARING MEANS**	**Textbook Reading:** • OIS ○ Chapter 5.3: Difference of Two Means	• Week 5 Group Quiz (in-class Monday) • Lab • Problem Set activity (in-class Wednesday) • Contribution to Problem Set Collaborative Key (due Friday, March 1 @ 5:00p) • Week 6 Individual Quiz (due Saturday, March 2 @ 11:55p)
Week 7 March 3–9	**STUDY DESIGN & MORE SAMPLING**	**Textbook Readings:** • OIS ○ Chapter 1.4.1: Observational Studies ○ Chapter 1.5: Experiments ○ Chapter 5.4: Power Calculations for a Difference of Means • Essentials of Biostatistics in Public Health (EBPH) ○ Chapter 8.1: Issues in Estimating Sample Size for CI Estimates	• Week 6 Group Quiz (in-class Monday) • Lab • Problem Set activity (in-class Wednesday) • Contribution to Problem Set Collaborative Key (due Friday, March 8 @ 5:00p) • Week 7 Individual Quiz (due Saturday, March 9 @ 11:55p)
Week 8 March 10– 16	**PROJECT 1**		• Week 7 Group Quiz (in-class Monday) • Project 1 (due Saturday, March 16 @ 11:55p)
SPRING BREAK			
Week 9 March 24– 30	**ANOVA**	**Textbook Reading:** • OIS ○ Chapter 5.5: Comparing Many Means with ANOVA	• Lab • Problem Set activity (in-class Wednesday) • Contribution to Problem Set Collaborative Key (due Friday, March 29 @ 5:00p) • Week 9 Individual Quiz (due Saturday, March 30 @ 11:55p)
Week 10 March 31– April 6	**COMPARING CATEGORICAL DATA IN 2x2 TABLES: ODDS RATIOS AND RELATIVE RISKS**	**Textbook Readings:** • EBPH ○ Chapter 3.4: Comparing the Extent of Disease Between Groups	• Week 9 Group Quiz (in-class Monday) • Lab • Problem Set activity (in-class Wednesday)

		○ Chapter 6.6: Confidence Intervals for Two Independent Samples, Dichotomous Outcome • Andrade. (2015). Understanding Relative Risk, Odds Ratios, and Related Terms: As Simple as It Can Get. J Clin Psychiatry 76(7):e857-861	• Contribution to Problem Set Collaborative Key (due Friday, April 5 @ 5:00p) • Week 10 Individual Quiz (due Saturday, April 6 @ 11:55p)
Week 11 April 7–13	**HYPOTHESIS TESTING FOR COMPARING TWO OR MORE CATEGORIES**	**Textbook Readings:** • OIS ○ Chapter 6.3: Testing for Goodness of Fit using Chi-square ○ Chapter 6.4: Testing for Independence in Two-way Tables • EBPH ○ Chapter 7.7: Tests with Two Independent Samples, Dichotomous Outcome ○ Chapter 7.9: Tests for Two or More Independent Samples, Categorical & Ordinal Outcomes	• Week 10 Group Quiz (in-class Monday) • Lab • Problem Set activity (in-class Wednesday) • Contribution to Problem Set Collaborative Key (due Friday, April 12 @ 5:00p) • Week 11 Individual Quiz (due Saturday, April 13 @ 11:55p)
Week 12 April 14–20	**CORRELATION & SIMPLE LINEAR REGRESSION**	**Textbook Reading:** • OIS ○ Chapter 7: Introduction to Linear Regression (**except 7.2.2 & 7.4)**	• Week 11 Group Quiz (in-class Monday) • Lab • Problem Set activity (in-class Wednesday) • Contribution to Problem Set Collaborative Key (due Friday, April 19 @ 5:00p) • Week 12 Individual Quiz (due Saturday, April 20 @ 11:55p)
Week 13 April 21–27	**INFERENCE FOR SIMPLE LINEAR REGRESSION**	**Textbook Reading:** • OIS ○ Chapter 7.2.2: Conditions for the Least Squares Line ○ Chapter 7.4: Inference for Linear Regression	• Week 12 Group Quiz (in-class Monday) • Lab • Problem Set activity (in-class Wednesday) • Contribution to Problem Set Collaborative Key (due Friday, April 26 @ 5:00p) • Week 13 Individual Quiz (due Saturday, April 27 @ 11:55p)
Week 14 April 28–May 4	**MULTIPLE LINEAR REGRESSION**	**Textbook Reading:** • OIS ○ Chapter 8: Multiple & Logistic Regression **(except 8.2.2, 8.2.3, & 8.4)**	• Week 13 Group Quiz (in-class Monday) • Lab • Problem Set activity (in-class Wednesday) • Contribution to Problem Set Collaborative Key (due Friday, May 3 @ 5:00p)

			• Week 14 Individual Quiz (due Saturday, May 4 @ 11:55p)
Week 15 **May 5–11**	**PROJECT 2**		• Week 14 Group Quiz (in-class Monday) • Project 2 (due Saturday, May 11 @ 11:55p)

SPH AND UNIVERSITY POLICIES & RESOURCES

The School of Public Health maintains up-to-date information about resources available to students, as well as formal course policies, on our website at www.sph.umn.edu/student-policies/. Students are expected to read and understand all policy information available at this link and are encouraged to make use of the resources available.

The University of Minnesota has official policies, including but not limited to the following:

- Grade definitions
- Scholastic dishonesty
- Makeup work for legitimate absences
- Student conduct code
- Sexual harassment, sexual assault, stalking and relationship violence
- Equity, diversity, equal employment opportunity, and affirmative action
- Disability services
- Academic freedom and responsibility

Resources available for students include:

- Confidential mental health services
- Disability accommodations
- Housing and financial instability resources
- Technology help
- Academic support

EVALUATION & GRADING

Grading is determined by:

- **Weekly work** (Total: 65%)
  - Active and timely participation in the Problem Set Collaborative Keys (20%)
  - Quizzes (Total: 45%)
    - Individual (35%)
    - Group (10%)
- **Projects** (Total: 35%)
  - Project 1 (15%)
  - Project 2 (20%)

Grading Scale
The University uses plus and minus grading on a 4.000 cumulative grade point scale in accordance with the following, and you can expect the grade lines to be drawn as follows:

% In Class	Grade	GPA
93 - 100%	A	4.000
90 – 92.99%	A-	3.667
87 – 89.99%	B+	3.333
83 – 86.99%	B	3.000
80 – 82.99%	B-	2.667
77 – 79.99%	C+	2.333
73 – 76.99%	C	2.000
70 – 72.99%	C-	1.667
67 – 69.99%	D+	1.333
63 – 66.99%	D	1.000
< 62.99%	F	

- A = achievement that is outstanding relative to the level necessary to meet course requirements.
- B = achievement that is significantly above the level necessary to meet course requirements.
- C = achievement that meets the course requirements in every respect.
- D = achievement that is worthy of credit even though it fails to meet fully the course requirements.
- F = failure because work was either (1) completed but at a level of achievement that is not worthy of credit or (2) was not completed and there was no agreement between the instructor and the student that the student would be awarded an I (Incomplete).
- S = achievement that is satisfactory, which is equivalent to a C- or better
- N = achievement that is not satisfactory and signifies that the work was either 1) completed but at a level that is not worthy of credit, or 2) not completed and there was no agreement between the instructor and student that the student would receive an I (Incomplete).

Evaluation/Grading Policy	Evaluation/Grading Policy Description
Scholastic Dishonesty, Plagiarism, Cheating, etc.	The goal of this course is to enable students to read and interpret statistical results in the primary literature. We expect that students will complete all end-of-week quizzes INDEPENDENTLY, without assistance from any other people. If we have any reason to suspect that a student gave assistance on an end-of-week quiz to another student or received assistance on an end-of-week quiz from another student or a person outside the class, all students involved will receive a score of zero on that quiz. If we believe that scholastic dishonesty has occurred, we are required by the University to report the incident to the Office of Community Standards (https://communitystandards.umn.edu/). You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis (As defined in the Student Conduct Code). For additional information, please see https://z.umn.edu/dishonesty The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: https://z.umn.edu/integrity.

	If you have additional questions, please clarify with your instructor. Your instructor can respond to your specific questions regarding what would constitute scholastic dishonesty in the context of a particular class-e.g., whether collaboration on assignments is permitted, requirements and methods for citing sources, if electronic aids are permitted or prohibited during an exam. Indiana University offers a clear description of plagiarism and an online quiz to check your understanding (http://z.umn.edu/iuplagiarism).
Late Assignments	This course covers a large amount of material in a short time. The group and class activities depend on the active and timely participation of all students. Therefore late assignments or quizzes will not be accepted. For every day the Project assignment is late, you will be docked 20% of the grade.

CEPH COMPETENCIES

Competency	Learning Objectives	Assessment Strategies* (*see Assessment Descriptions below this table)
Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate.	**Descriptive and Graphical Summaries** • Create summary statistics, tables, and graphs are appropriate for each variable type (e.g., categorical variable(s): bar plot, count, proportion, 2x2 table, risk, odds, odds ratio, relative risk, difference in proportions; continuous variable(s): histogram, boxplot, mean, median, SD, IQR, difference in means) via your chosen software. • Calculate any of screening test summary statistics from a table of cell counts, or the equivalent information in words (e.g. in an article) (e.g., prevalence, sensitivity, specificity, false positive, false negative, PPV, NPV). **Confidence Intervals** • Calculate a confidence interval for a population parameter (e.g., mean(s), relative risk, odds ratio) from data or summary statistics via your chosen software. **Hypothesis Testing** • Identify situations when a particular statistical test would be used (e.g., one, paired, and two-sample t-test; Chi-squared test; Fisher's exact test; McNemar's test; ANOVA) and carry out the tests via your chosen software. • Be aware of some of the statistical analysis options that exist if your sample is from a severely non-normal population and carry out the analyses via your chosen software. **Regression** • Create a scatterplot via your chosen software to assess the relationship between variables. • Identify situations when a particular statistical regression method would be used (e.g., simple linear regression, multiple linear regression, logistic regression, proportional hazards regression). • Calculate the correlation or the fitted regression coefficients to obtain slope values (for simple or multiple regression) for each predictor via your chosen software. • Create diagnostic plots via your chosen software to assess how well the model fits the data.	• Projects
Interpret results of data analysis for public health research, policy or practice.	**Descriptive and Graphical Summaries** • Recognize the variable type, categorical or continuous. • Distinguish between the standard deviation (SD or s) and the standard error of the mean (SE or SEM).	• Weekly quizzes

	• Interpret summary statistics, tables, and graphs for each variable type (e.g., categorical variable(s): bar plot, count, proportion, 2x2 table, risk, odds, odds ratio, relative risk; continuous variable(s): histogram, boxplot, mean, median, SD, IQR, difference in means). • State the limitations of the commonly-used measures of center and spread. • Interpret a Z-score value. • Define screening test summary statistics (e.g., prevalence, sensitivity, specificity, false positive, false negative, PPV, NPV) and correctly interpret them. • Explain how the screening test summary statistics are related to each other. **Confidence Intervals** • Explain the purpose of a confidence interval and meaning of the confidence level. • Make a conclusion about the significance of a result, based off of the confidence interval (e.g., for a mean, for a proportion, for a difference in means, for an OR, for a RR, for a slope). **Hypothesis testing** • Know the terminology of hypothesis testing (e.g., null hypothesis, alternative hypothesis, test statistic, sampling distribution of the test statistic, *p*-value, false positive result, false negative result, Type I error, Type II error, power). • For a particular statistical test, state the appropriate null and alternative hypotheses (e.g., one, paired, and two-sample t-test; Chi-squared test; Fisher's exact test; McNemar's test; ANOVA). • For a particular statistical test, make a conclusion based off of the p-value and a significance level (e.g., one, paired, and two-sample t-test; log-rank test; Chi-squared test; Fisher's exact test; McNemar's test; ANOVA). • Recognize situations in which multiple comparisons may be an issue. • Explain the consequences of failing to properly account for multiple comparisons. • Explain the purpose of post-hoc tests following ANOVA and interpret the results. • Explain the difference between statistical significance and clinical/practical significance. **Regression** • Know what it means to say that two variables are "associated". • Interpret statistics (correlation or fitted coefficients) from regression methods and make a conclusion from its confidence interval or *p*-value (e.g., simple linear regression, multiple linear regression). • Write down the equation for a regression model and describe what each parameter means (e.g., simple linear regression, multiple linear regression).	

	• Interpret both the diagnostic plots and the model R^2 value.	
Communicate audience-appropriate public health content, both in writing and through oral presentation	• Complete a data analysis project by analyzing data via their chosen software and interpreting the results.	• Projects

Assessment Descriptions	
Weekly quizzes	The weekly quizzes are intended to assess what the students have learned both from the readings and lectures and from the activities and discussions as outlined in the unit learning objectives. The questions are both multiple-choice and short essay format. During the quizzes, students are encouraged to consult the textbook and the course materials, particularly the completed activity worksheets and any notes you may have made on lectures or other content, but they may not consult with other people during the individual attempt on the quiz. The group attempt on the same quiz occurs the first class period after the due date of the quiz. The group quiz is intended to further solidify the concepts by forcing students to discuss the questions and come to a consensus on the answers. Students are encouraged to check all of the forums and collaborative keys for any comments or clarifications from the instructor *before* beginning the quizzes.
Projects	The projects are intended to assess students' ability to analyze the data via their chosen software and interpret the results. The projects are more comprehensive in that they assess students' ability to integrate the concepts and programming from multiple weeks, apply their knowledge to a new scenario, and evaluate the results based on the output from the software. Students are given questions with minimal direction on the type of summary or inferential method to assess their ability to identify and use the concepts and programming learned in the course. The projects must be completed independently, **except** where the instructors specifically note collaboration is acceptable.