Introduction to Statistical Reasoning
MAT 1300                    Winter 2016

Statistics is…“the most important science in the world, for upon it depends the practical application of every other science and of every art. The one science essential to all political and social administration, all education, all organization based on experience, for it only gives the results of our experience.”

– Florence Nightingale

“In God we trust, all others bring data.”

– William Edwards Deming

(Assignment to Deming is ironically not supported by data)

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University and Departmental Mission: Seattle Pacific University seeks to be a premier Christian university fully committed to engaging the culture and changing the world by graduating people of competence and character, becoming people of wisdom, and modeling grace-filled community.

The mathematics department at Seattle Pacific University seeks to provide excellent instruction to enable our students to be competent in the mathematics required for their chosen fields, and to share our expertise with the community through service and leadership. Hence, common goals for students in mathematics courses include 1) becoming competent in the topics covered in the course, 2) demonstrating skills and attitudes which contribute to professional, ethical behavior, 3) the ability to communicate mathematically, in both written and verbal form, and 4) learning to appreciate the beauty and utility of mathematics.

Course Goals: The aim of this course is to develop critical reasoning skills necessary to understand our quantitative world. The focus of the course is the process of learning how to ask appropriate questions, how to collect data effectively, how to summarize, interpret, and draw conclusions from that data, and how to understand the limitations of statistical inference. Students should gain an understanding of fundamental statistical concepts, including randomization, estimation, confidence, testing, and significance. Students should also have an appreciation for the fundamental role that statistics plays in a host of disciplines, such as business, economics, law, and medicine.

Learning Objectives: By the end of the course, you should be able to:

- describe and critique various methods of data collection, sampling, and experimental design;
- understand the importance of random assignment and random sampling in statistical inference;
- draw appropriate inferences regarding cause and effect and/or generalization based on study design;
- understand characteristics of distributions (including shape, center, and variability) and be able to use them to describe and compare distributions of quantitative data;
- construct, analyze, and interpret verbal, numerical, and graphical summaries of data;
- understand and articulate the role that probability plays in statistical inference;
- use simulation to model real-world random processes, investigate the long run behavior of the processes, and estimate probabilities;
- understand the idea of a p-value as a quantification of the strength of evidence against a particular model, interpret the meaning of the p-value in the context of real-world problems, and state appropriate conclusions for studies based on a p-value;
- conduct and interpret randomization tests in a variety of contexts;
- understand and interpret confidence intervals and margins of error;
- approach and solve practical problems and analyze genuine data using statistical reasoning;
- use computer software to analyze data and to solve statistical problems; and
- communicate the results of statistical analyses through graphical and verbal means.

Course Prerequisites: Mathematics Placement Level B. You are expected to be able to perform mathematically at the level of basic high school algebra.

Course Overview

What is Statistics? Statistics is the science of collecting and analyzing data for the purpose of drawing conclusions and making decisions. There are three main topics of statistics: data collection, descriptive statistics, and inferential statistics. One of the primary goals of statistics is inferential statistics, which can be defined as drawing conclusions and/or making decisions concerning a large population based only on data about a sample from the population. When trying to draw conclusions about an entire population based only on a sample, it is essential that the sample be representative of the population. Poorly collected data can lead to misleading (if not completely meaningless) conclusions. As a result, proper data collection is a fundamental concern. Once data has been collected, it needs to be
Textbooks and Course Materials:

- **Statistical Thinking: A simulation approach to uncertainty**, 3rd edition, by Zieffler and the Catalysts for Change project. This is a workbook, and you will need to write in the book, so you are required to have a blank copy of the book to start with (be careful of used copies!). You should plan to bring this text with you to class every day.
- **Statistics: Concepts and Controversies**, 8th Edition, by David Moore and William Notz. You must also have an access code for LaunchPad, which comes bundled with new copies of the textbook at the bookstore. Note that LaunchPad includes access to a complete electronic version of the textbook. If you are comfortable using an online copy of the text, you might consider just purchasing access to LaunchPad and skipping the printed version of the text entirely.

A tentative list of topics to be covered from each of these texts can be found at the end of this syllabus. There will typically be daily reading assignments and online reading quizzes from Statistics: Concepts and Controversies, but we will not generally directly use this text during class. The readings will often not be directly aligned with the in-class activities on a day-to-day basis, but we will tie together all of the ideas as the quarter progresses.

**Technology:** This course is taught in an active learning classroom and you are strongly encouraged to bring a laptop to class on a daily basis. You will use your laptop in class for a variety of things, including exploring data and conducting simulations, writing reports, and taking notes. The classroom is equipped with wireless Internet access, power outlets, and projection capabilities for students as well as the instructor. We will make substantial use of the following online tools and software package:

**LaunchPad:** LaunchPad is an online learning system which will be used for a variety of purposes, including...
Homework:

Attendance and Class Participation: There will be four general types of homework assignments. If you will be absent from class, you must contact me before class begins (in person or by phone or by e-mail) to make arrangements for the day. Failure to do so will reduce your attendance/class participation grade and will result in a grade of zero for any assessments completed in class that day.

NOTE: Things such as oversleeping or lack of preparation are NOT acceptable excuses. Acceptable excuses include illness, a death in your family, and official SPU athletics trips. If requested, you are responsible for providing me with documentation of your excuse.

TinkerPlots: TinkerPlots is an interactive software package that allows you to explore data and conduct simulations of random processes. We will regularly use TinkerPlots as a part of in-class group activities, and it will also be needed for many homework assignments. You will be sent instructions for downloading and installing the software during the first week of class. A code for a one-year license for the software will be provided for each student in the class, and you will need to install it on your own computer. If you do not have a computer of your own on which you can install and use TinkerPlots, please make an appointment to meet with me as soon as possible so that we can make arrangements for you to have access to the software.

Grading and Course Expectations

Attendance and Class Participation: Unless you have an acceptable excuse and make special arrangements with me before class begins, you are expected to attend class every day, arrive on time, and remain until class is over. During class, you are expected to actively participate in all activities and to work only on statistics – activities such as texting, emailing, tweeting, facebooking, surfing the internet, playing games, doing work for other classes, or chatting about your weekend social activities are not acceptable behaviors during class. It is expected that cell phones will be turned off and put away for the duration of the class. Computers and tablets will be used only for tasks related to the course. Attendance and class participation will count as a part of your course grade.

If you will be absent from class, you must contact me before class begins (in person or by phone or by e-mail) to make arrangements for the day. Failure to do so will reduce your attendance/class participation grade and will result in a grade of zero for any assessments completed in class that day.

NOTE: Things such as oversleeping or lack of preparation are NOT acceptable excuses. Acceptable excuses include illness, a death in your family, and official SPU athletics trips. If requested, you are responsible for providing me with documentation of your excuse.

Homework: There will be homework assignments given virtually every class period which will typically be due by the next class meeting. All assignments will be posted on the course website; however, you are also responsible for all announcements made in class (whether or not they are posted on the web). Many assignments require the use of TinkerPlots. There will be four general types of homework assignments:

1. Written assignments that each student must complete and submit individually. These are typically due at the start of the next class period. These assignments will often be exercises related to the in-class activities from the previous class period. General policies for the written assignments can be found below.

2. Reading assignments or videos to watch. These will not be directly counted as a part of your grade, but completion of them will be necessary for success on other written assignments, online quizzes, and exams.

3. Online reading quizzes through LaunchPad. These online quizzes will cover content from the reading assignments. The quizzes are adaptive and adjust the questions asked based on your correct or incorrect answers to previous questions. You will receive points for each correctly answered question, and each quiz will have a target number of points that you must earn in order to get credit for completion of the quiz. As long as you complete the quiz and achieve at least the target number of points before the deadline for completion, you will receive a score of 100% for the quiz (regardless of incorrect answers along the way). Each of these quiz scores will count as a part of your homework grade.

4. Reports on results of group activities. During most class periods, you will work in small groups on statistical explorations. You will often be asked to type up and submit the results of these explorations. See the section below on group activities for more information about these assignments.

General policies for written homework assignments:

- Written homework must be turned in by 1:30 (the start of the class period) on the day it is due; late homework will not be accepted for any reason (and homework is considered late at 1:31). If you have an excused absence and make arrangements with me before class starts, the homework score will be dropped.
- You are strongly encouraged to come to my office to ask me questions about the homework.
- You are also encouraged to work with other students on the homework, but unless otherwise indicated for a particular assignment, you must individually write up and turn in your own solutions.
- You are required to list on your paper all other individuals that you worked with or that gave you assistance with the homework – failing to do this could be considered a form of plagiarism (since you are in essence turning in someone else’s work as your own without proper attribution).
- Written homework must be neat and easily readable or you will receive NO credit. You must show all of your work—a correct answer with no justification will also be worth NO credit.
- When explanations are called for on the homework, you should respond in complete sentences with proper grammar, spelling, and punctuation.
- Not all homework exercises will be graded, but solutions for exercises which are not graded will be posted on the course webpage.
- Your two lowest homework or quiz scores will be dropped from your final grade.

online reading quizzes and tutorials that you will be asked to work through outside of class.
**Group Activities:** During most class periods, you will be asked to work through activities/explorations in small groups (typically 3 students). As a part of some of these activities, you will be asked to write up and turn in a short report of your results. These reports should be typed and sent to me by email. A single copy should be submitted for the entire group, and all group members should be CC’d on the email when the report is sent to me.

**Exams:** There will be two midterm exams and a cumulative final exam. You will be permitted to use the *Statistical Thinking: A simulation approach to uncertainty* textbook and one sheet of handwritten notes during each exam. Use of computer software such as TinkerPlots may be required as a part of the exams. The midterm exams are tentatively scheduled for Friday, January 29 and Friday, February 26, but these dates are subject to change. The final exam is scheduled for 1:00-3:00 on Tuesday, March 15.

**Course Grades:** Written reports from group activities will count for 10% of our course grade. Individual homework assignments and online quizzes together will be worth 20% of your course grade. The two midterm exams will each be worth 20% of the course grade, and the final exam will be worth 25% of the course grade. Attendance and class participation will determine the remaining 5% of the grade. Course grades will be based on the following scale:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Range</th>
<th>Letter</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-</td>
<td>90-92%</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>80-82%</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>70-72%</td>
<td></td>
</tr>
<tr>
<td>C-</td>
<td>67-69%</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>60-66%</td>
<td></td>
</tr>
<tr>
<td>D+</td>
<td>57-59%</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Below 60%</td>
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</tbody>
</table>

A grade of I (incomplete) is only given for on-academic reasons such as a severe illness that prevents you from completing the course. You must have a passing grade on the material that you have completed in order to receive an incomplete.

**Academic Integrity:** The current edition of the SPU Undergraduate Catalog describes the University’s commitment to academic integrity, which is breached by academic dishonesty of various kinds. Examples of academic dishonesty include copying another’s work on an exam, bringing concealed answers to an exam, turning in another person’s work as your own, committing plagiarism, assisting another student in cheating, or lying to the instructor. The minimum penalty for academic dishonesty in any form will be a zero for the assignment or exam in question; in severe cases, academic dishonesty will result in a failing grade for the course. In addition, all students have an obligation to make efforts to prevent other students from cheating and to report incidents of cheating or plagiarism.

**Office Hours:** My regular office hours will be posted on the course webpage. You are strongly encouraged to drop by my office to ask questions, discuss problems, and just to get to know me better. If you are unable to meet with me during my scheduled office hours, I am available at other times by appointment. I also maintain an “open door” policy at my office – any time that my door is open you are welcome to drop in to talk to me, even if it is not during my scheduled office hours.

**Tutoring:** Free tutoring for this course is available through the Mathematics Study Center, which is located in OMH 249. The schedule for the tutoring room can be found at [http://www.spu.edu/depts/math/tutoring.htm](http://www.spu.edu/depts/math/tutoring.htm).

**NOTE:** The tutors are generally familiar with the conceptual ideas of statistics, but they do not have experience using TinkerPlots, so they will be unable to help you with technical details of using the software.

**Additional Notes:**

**E-mail:** All SPU students have an SPU e-mail address. I will occasionally make use of these SPU e-mail addresses to send information to all members of the class, so you should check your e-mail regularly. If you do not use your SPU e-mail account, there is a utility available through Banner to set up your SPU e-mail account to forward messages to some other e-mail address. I strongly recommend doing this so that you do not miss any important messages.

Please note that while it can be a great tool for quick communication, *e-mail is rarely a good substitute for face-to-face conversations and is very poorly suited for answering mathematical questions*. When you come to my office to ask me questions, I engage you in a discussion about the problem, ask questions about what ideas you have for approaching the problem, explore various possible approaches (and what goes wrong with some of them), etc. In the process, I can usually find out precisely where your difficulties lie and help you to learn how to get past them. Such a conversation is impossible by e-mail. Furthermore, typing and e-mailing mathematical symbols is very time consuming, and the resulting equations in the e-mail often come out garbled (or even completely missing).

**Students with Disabilities:** In accordance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990, students with specific disabilities that qualify for academic accommodations need to contact Disabled Student Services in the Center for Learning. Disabled Student Services in turn will send a Disability Verification Letter to me indicating what accommodations have been approved. Once you have done this, you should also make an appointment to meet with me as early as possible in the quarter to discuss the details of how we will implement the accommodations in this course.
**Inclement Weather:** SPU maintains an Emergency Closure Hotline (206-281-2800). In the event of inclement weather or an emergency that might close the university, please call the Hotline for the most up-to-date closure information or check the SPU website. Both will be updated before 6:00 a.m.

**Emergency Procedure:** A one-page summary of SPU’s emergency procedures is attached at the end of this syllabus. Please note the emergency procedures posted in the classroom and note all emergency exits. In case of an emergency requiring evacuation of the building, the class will leave the building via the rear stairwell immediately to the left when exiting the classroom and then will gather in the Alumni Center parking lot on the Nickerson Street side of Otto Miller Hall. Please try to stay together so that we can check that everyone has made it safely out of the building.

**Modifications to the course requirements can be made at any time. It is your responsibility to know all course requirements as described here or announced in class.**

“... statistical techniques are tools of thought, and not substitutes for thought.”

– Abraham Kaplan

“It is easy to lie with statistics, but it is easier to lie without them.”

– Frederick Mosteller

“While nothing is more uncertain than the duration of a single life, nothing is more certain than the average duration of a thousand lives.”

– Elizur Wright

“Probability is the very guide of life.”

– Cicero

“Chance is perhaps a pseudonym of God when he does not wish to sign his work.”

– Anatole France

“You believe in a God who plays dice, and I in complete law and order.”

– Albert Einstein in a letter to Max Born
Tentative Class Schedule

The table below provides a tentative listing of topics that we will cover each day in class and a tentative schedule of reading assignments from the textbook *Statistics: Concepts and Controversies* (SCC). After reading each chapter of SCC, you will be asked to complete an online reading quiz through LaunchPad. A more detailed schedule of homework assignments, due dates, and material covered will be posted on the course webpage. The exact dates on which we cover material will likely vary somewhat from the list below. Also, topics may be added or removed at any time.

<table>
<thead>
<tr>
<th>Date</th>
<th>Tentative In-Class Activities and Discussions (page numbers are from the Statistical Thinking text)</th>
<th>Tentative Reading Assignment from Statistics: Concepts and Controversies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/6</td>
<td>Introduction to Statistical Inference: Helper or Hinderer? (handout)</td>
<td>Chapter 1: Where Do Data Come From?</td>
</tr>
<tr>
<td>1/11</td>
<td>Group Activity: iPod Shuffle (p. 25-29)</td>
<td>Chapter 18: Probability Models</td>
</tr>
<tr>
<td>1/13</td>
<td>Activity: Modeling Random Behavior (p. 31-46) Introduction to TinkerPlots Software</td>
<td>Chapter 19: Simulation</td>
</tr>
<tr>
<td>1/18</td>
<td><strong>No Class: Martin Luther King, Jr. Day</strong></td>
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</tr>
<tr>
<td>1/20</td>
<td>Introduction to Hypothesis Testing (p. 56-59) Group Activity: Helper or Hinderer revisited (p. 60-71)</td>
<td>Chapter 2: Samples, Good and Bad</td>
</tr>
<tr>
<td>1/22</td>
<td>Group Activity: Monday Breakups (p. 73-78) Group Activity: Racial Disparities in Police Stops (p. 79-84)</td>
<td>Chapter 3: What Do Samples Tell Us?</td>
</tr>
<tr>
<td>1/25</td>
<td>Group Activity: Comparing Airlines (p. 106-112)</td>
<td>Chapter 4: Sample Surveys in the Real World</td>
</tr>
<tr>
<td>1/27</td>
<td>Review for Exam Group Activity: Features of Distributions (p. 207-217)</td>
<td>Chapter 10: Graphs, Good and Bad</td>
</tr>
<tr>
<td>1/29</td>
<td><strong>Midterm Exam #1</strong></td>
<td>Chapter 11: Displaying Distributions with Graphs</td>
</tr>
<tr>
<td>2/1</td>
<td>Group Activity: Memorization (p. 113-122) Introduction to randomized experiments and comparing groups</td>
<td>Chapter 12: Describing Distributions with Numbers</td>
</tr>
<tr>
<td>2/3</td>
<td>Group Activity: Sleep Deprivation (p. 124-138) Hypothesis testing using randomization tests</td>
<td>Chapter 5: Experiments, Good and Bad</td>
</tr>
<tr>
<td>2/5</td>
<td>Group Activity: Latino Achievement (p. 139-145)</td>
<td>Chapter 6: Experiments in the Real World</td>
</tr>
<tr>
<td>2/8</td>
<td>Group Activity: Strength Shoes (p. 147-158) More on randomized experiments and hypothesis testing</td>
<td>Chapter 7: Data Ethics</td>
</tr>
<tr>
<td>2/10</td>
<td>Group Activity: Sampling (p. 162-176)</td>
<td>Chapter 8: Measuring</td>
</tr>
<tr>
<td>2/12</td>
<td>Group Activity: Dolphin Therapy (p. 196-204) More on Sampling and Random Selection</td>
<td>Chapter 9: Do the Numbers Make Sense?</td>
</tr>
<tr>
<td>2/15</td>
<td><strong>No Class: Presidents’ Day</strong></td>
<td>Chapter 14: Describing Relationships: Scatterplots &amp; Correlation</td>
</tr>
<tr>
<td>2/19</td>
<td>Group Activity: Medical Testing (supplemental handouts) Sensitivity and Specificity; False Positives &amp; False Negatives</td>
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<tr>
<td>2/24</td>
<td>Review/catch-up day</td>
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<tr>
<td>2/26</td>
<td><strong>Midterm Exam #2</strong></td>
<td></td>
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<tr>
<td>3/2</td>
<td>Group Activity: Memorization Part II (p. 234-241) Effect Size</td>
<td>Chapter 22: What is a Test of Significance?</td>
</tr>
<tr>
<td>3/7</td>
<td>Additional Discussion of Confidence Intervals</td>
<td>Chapter 16: The Consumer Price Index and Government Statistics</td>
</tr>
<tr>
<td>3/9</td>
<td>Review and tie together key concepts from course</td>
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<tr>
<td>3/11</td>
<td>Review/Wrap-up</td>
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<tr>
<td>3/15</td>
<td><strong>Final Exam – 1:00 to 3:00</strong></td>
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Emergency Preparedness Information

Report an Emergency or Suspicious Activity
Call the Office of Safety and Security to report an emergency or suspicious activity by dialing 206-281-2911 or by pressing the call button on a campus emergency phone. SPU Security Officers are trained first responders and will be dispatched to your location. If needed, the SPU Dispatcher will contact local fire/police with the exact address of the location of the emergency.

SPU-Alert System
The SPU-Alert System is SPU’s emergency notification system. It can send information via text message, email, electronic reader board, computer pop-ups (for SPU computers), loudspeaker, and recorded cell phone messages. Text messaging has generally proven to be the quickest way to receive an alert about a campus emergency. In order to receive text messages from SPU-Alert, you must provide SPU with your cell phone number through the Banner Information System on the web, https://www.spu.edu/banweb/. Select the Personal Menu then choose the Emergency Alert System tab. Contact the CIS Help Desk if you have questions about entering your personal contact information into the Banner Information System. Emergency announcements may also be made by SPU staff members serving as Building Emergency Coordinators (“BECs”).

Lockdown / Shelter in Place – General Guidance
The University will lock down in response to threats of violence such as a bank robbery or armed intruder on campus. You can assume that all remaining classes and events will be temporarily suspended until the incident is over. Lockdown notifications are sent using the SPU-Alert System.

If you are in a building at the time of a lockdown:
- Stay inside and await instruction, unless you are in immediate visible danger.
- Move to a securable area (such as an office or classroom) and lock the doors.
- Close the window coverings then move away from the windows and get low on the floor.
- Remain in your secure area until further direction or the all clear is given (this notification will be sent via the SPU-Alert System).

If you are outside at the time of a lockdown:
- Leave the area and seek safe shelter off campus. Remaining in the area of the threat may expose you to danger.
- Return to campus after the all clear is given (this notification will be sent via the SPU-Alert System).

Evacuation – General Guidance
Students should evacuate a building if the fire alarm sounds or if a faculty member, a staff member, or the SPU-Alert System instructs building occupants to evacuate. In the event of an evacuation, gather your personal belongings quickly and proceed to the nearest exit. Most classrooms contain a wall plaque or poster on or next to the classroom door showing the evacuation route and the assembly site for the building. Do not use the elevator.

Once you have evacuated the building, proceed to the nearest evacuation assembly location. The “Stop. Think. Act.” booklet posted in each classroom contains a list of assembly sites for each building. Check in with your instructor or a BEC (they will be easily recognizable by their bright orange vests). During emergencies, give each BEC your full cooperation whenever they issue directions.

Additional Information
Additional information about emergency preparedness can be found on the SPU web page at http://www.spu.edu/info/emergency/index.asp or by calling the Office of Safety and Security at 206-281-2922.

Last updated 9/10/15