Statistics revolutionized the way we viewed and interacted with the world during the 20th century. From industrial quality control to psychometric assessment to design of experiments, statistical analysis was a key underpinning to advances in the quality of life we enjoy today. Statistical methods are also foundational to machine learning and AI that are shaping the 21st century. Statistics often seems like a collection of related methods. In a way, this is true. There may be several reasonable methods to tackle a problem, giving different answers. Statistics is the art of selecting the best method. This course introduces the art of statistics, exploring fundamental statistical concepts and their contemporary applications. The applications examined will include “hands-on” examples of common statistical methods.

Statistics provides the opportunity to combine creativity with analytical thinking. I hope that you enjoy this opportunity.

Welcome to MATH 5820!

Instructor

Dr. Michael Monticino is Chair of the UNT Advanced Data Analytics program, Director of the Interdisciplinary Program in Analytics & Computation Science, and a professor in the Department of Mathematics. He has served in many leadership roles as a university administrator and in private industry. Most recently, he was President of Academic Analytics LLC, a leading provider of business intelligence solutions for U.S. research universities. Previously, he was UNT Vice President of Advancement, Dean of the College of Arts and Sciences, and Dean of the Toulouse Graduate School, and (recently) Interim Chair of the Department of Physics.

Dr. Monticino has worked with a wide variety of companies and government agencies. He has worked as a consultant for the U.S. Navy, ABC Television, the Institute for Defense Analysis, IBM, Lockheed Martin, and Accenture to achieve tactical, operational and management solutions for clients. His areas of technical expertise include statistical decision analysis, optimal resource allocation, data analytics, and operations research.

He has also led numerous community engagement and economic development activities, including national security symposia and technology summits promoting business and R&D collaborations.
between Mexican and U.S. companies. Dr. Monticino is founder and past chair of the Dallas Regional Chamber’s Business University Roundtable, founder and past chair of the Mathematical Association of America’s Business, Industry and Government Special Interest Group, an advisor at the Dallas Entrepreneur Center and on the Advisory Board for The Study – City of Irving Innovation Center. He earned a bachelor’s degree in mathematics from the University of Florida and a Ph.D. in mathematics from the University of Miami.

Instructor Contact Information

Instructor: Dr. Michael Monticino
Office hours: Friday 9 – 11:00, and by appointment.
Email: michael.monticino@unt.edu

Course Description

This course introduces fundamental concepts of statistics: Bayesian and classical inference, parameter estimation, hypothesis testing, significance testing, maximum a posteriori probability rules, least mean squares estimation, maximum likelihood, regression, and likelihood ratio tests. The course focuses on applications of statistical methods to addressing important problems in business, science and industry.

Course Objectives

By the end of the course, students should be able to:

- Articulate foundational statistical principles and apply them to new problems.
- Select and implement the appropriate method(s) to solve statistical problems in science, business, and industry.
- Describe and apply the main concepts and assumptions underlying Bayesian and classical inference.
- Calculate and interpret parameter estimates and hypothesis tests values.
- Apply Bayesian methods to determine posterior distributions, point estimates, hypothesis tests, and Bayesian least mean squares estimates.
- Apply classical methods to estimate bias, location, dispersion, confidence sets, and hypothesis tests.
- Apply bootstrapping methods to determine parameter estimates, linear regression solutions, hypothesis tests, and significance tests.
- Understand and apply select dynamical systems as Markov chains and analyze their behavior.
- Effectively communicate analysis results and insights verbally and in writing, presenting methods in a business context and deriving actionable insights.
- Apply statistical methods to address business problems from real world case studies.

Required & Recommended Materials

Textbook:

Technology: Students will need access to a computer with MS 2016 Office Suite. Students will have the option to use their choice of software for modeling projects. Projects will be possible using Excel or other easily obtained software.

Technical Skills and Support
This course uses UNT’s (new) Learning Management System, Canvas. You will need a browser that interfaces well with Canvas, such as MS Internet Explorer or Mozilla Firefox.

The UNT UIT Student Helpdesk provides technical support for using Canvas and other supported resources.

Email: helpdesk@unt.edu
Phone: 940.565-2324
In Person: Sage Hall, Room 130
Monday-Thursday 8am-midnight
Friday 8am-8pm
Saturday 9am-5p
Sunday 8am-midnight

Students should have experience using MS Office tools, including the Data Analytics ToolPak in Excel (2016 version or later). Students should also be comfortable downloading and uploading files, using email, and learning computational tools.

In class and online Netiquette
Students should interact and communicate professionally and respectfully with other students, UNT staff and faculty. Below are some communication guidelines.

When emailing:
• Use clear and concise language.
• Remember that all college level communication should have correct spelling and grammar. Avoid slang and texting abbreviations. Limit the use of emoticons.
• Avoid using the caps lock – AS IT CAN BE INTERPRETTED AS YELLING.
• Be cautious when using humor or sarcasm. Tone is sometimes lost in an email or discussion post and your message may be taken seriously.
• Use a professor’s proper title – Dr. or Prof. – or if you are in doubt use Mr. or Ms. Don’t refer to faculty by their first name unless specifically invited.
• Use a descriptive subject line.
• Avoid attachments unless you are sure your recipients can open them.
• Sign your message with your name.
• Think before you send an e-mail to more than one person. Does everyone really need to see your message? Likewise, be sure you really want everyone to receive your response when you click, “reply all.”
• Be sure that a message’s author intended for the information to be distributed before you click the “forward” button.
• Be careful with personal information (both yours and other’s).

When posting on discussion boards:
• Make posts that are on topic and within the scope of the course material.
• Take your posts seriously. Review and edit your posts before sending.
• Be as brief as possible while still making a thorough comment.
• Always give proper credit when referencing or quoting another source.
• Be sure to read all messages in a thread before replying.
• Avoid short, generic replies such as, “I agree.” You should include why you agree or add to the previous point.
• Always be respectful of others’ opinions even when they differ from your own. Express differing opinions in a respectful, non-critical way.
• Do not make personal or insulting remarks.

Course Requirements
The course is organized around homework and real-world projects applying statistical methods. The homework is intended to build understanding and facility in applying statistical concepts. The projects will challenge students to apply concepts to a business/industry setting, as well as build professional skills. There will be an analysis report and/or a presentation associated with each project.

Due dates and instructions for submitting work will be posted on the Course Calendar and announced in class. Keep copies of everything you submit.

No late assignments/reports will be accepted without prior agreement between instructor and student.

Analysis reports and presentations should
• Demonstrate mastery of technical aspects of methods applied,
• Be clear and concise,
• Follow proper formatting, grammar and punctuation for written reports,
• Be well organized and delivered convincingly for presentations, and
• Demonstrate higher-order thinking (for example, going beyond the strict requirements of the project).

Specific grading rubrics will be provided for each report/presentation.
<table>
<thead>
<tr>
<th>Assignment</th>
<th>Deliverable</th>
<th>Possible Points</th>
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</thead>
<tbody>
<tr>
<td>Homework set 1 (Chapter 7)</td>
<td>Written solutions to exercises.</td>
<td>50</td>
</tr>
<tr>
<td>Project 1 – Application of Markov Chains</td>
<td>Report providing simulation description, analysis results, and conclusions.</td>
<td>50</td>
</tr>
<tr>
<td>Homework set 2 (Chapter 8)</td>
<td>Written solutions to exercises.</td>
<td>50</td>
</tr>
<tr>
<td>Project 2 – Application of Bayesian Inference</td>
<td>Report providing problem, data and methods description, analysis results, and conclusions.</td>
<td>50</td>
</tr>
<tr>
<td>Homework set 3 (Chapter 9)</td>
<td>Written solutions to exercises.</td>
<td>50</td>
</tr>
<tr>
<td>Project 3 – Application of Classical Inference</td>
<td>Report providing problem, data and methods description, analysis results, and conclusions.</td>
<td>50</td>
</tr>
<tr>
<td>Project 4 – Application of Bootstrapping Methods</td>
<td>Report providing problem, data and methods description, analysis results, and conclusions.</td>
<td>50</td>
</tr>
<tr>
<td>Project 5 – Aircraft Turn Performance Evaluation for American Airlines</td>
<td>Presentation/report providing analytical methods, analysis results, and conclusions.</td>
<td>100</td>
</tr>
</tbody>
</table>

**Grading**

Final grades will be based solely on class participation, homework, and project performance.

The total number of points received on assignments will be divided by the total possible number of points. Your final grade will be assigned based on this average and the standard 10 point grading scale (100 - 90, A; 89 - 80, B; 79 - 70, C; 69 - 60, D; 59 - 0, F).

**Course Expectations**

1. Students will attend class meetings (in-person and online) and participate in discussions.
2. Students will be responsible for checking course announcements in Canvas and checking course email daily.
3. Students will complete weekly readings and assigned work by stated deadlines.
4. Students will be responsible for downloading data used for projects as directed.
5. Students will be responsible for obtaining software required for completing assigned work as directed.

Policies
Be familiar with the UNT academic integrity policy: https://policy.unt.edu/sites/default/files/06.003_StudentStandardsOfAcademicIntegrity_8_2017.pdf. The policy applies to this course. If you are in doubt about expectations, please consult with me before you complete any requirements of the course.

Likewise, students are expected to follow the UNT Code of Student Conduct: https://policy.unt.edu/sites/default/files/07.012_CodeofConduct_2013_0.pdf

ADA Policy
The University of North Texas makes reasonable academic accommodation for students with disabilities. Students seeking reasonable accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide you with a reasonable accommodation letter to be delivered to faculty to begin a private discussion regarding your specific needs in a course. You may request reasonable accommodations at any time, however, ODA notices of reasonable accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of reasonable accommodation for every semester and must meet with each faculty member prior to implementation in each class. Students are strongly encouraged to deliver letters of reasonable accommodation during faculty office hours or by appointment. Faculty members have the authority to ask students to discuss such letters during their designated office hours to protect the privacy of the student. For additional information see the Office of Disability Accommodation website at http://www.unt.edu/oda. You may also contact them by phone at 940-565-4323.

Important Notice for F-1 Students taking Distance Education Courses

Federal Regulation
To read detailed Immigration and Customs Enforcement regulations for F-1 students taking online courses, please go to the Electronic Code of Federal Regulations website at http://ecfr.gpoaccess.gov. The specific portion concerning distance education courses is located at "Title 8 CFR 214.2 Paragraph (f)(6)(i)(G)" and can be found buried within this document: http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=8&PART=214&SECTION=2&TYPETEXT

The paragraph reads:
(G) For F–1 students enrolled in classes for credit or classroom hours, no more than the equivalent of one class or three credits per session, term, semester, trimester, or quarter may be counted toward the full course of study requirement if the class is taken on-line or through distance education and does not require the student's physical attendance for classes, examination or other purposes integral to completion of the class. An on-line or distance education course is a course that is offered principally through the use of television, audio, or computer transmission including open broadcast, closed circuit, cable, microwave, or satellite, audio conferencing, or computer conferencing. If the F–1 student's course
of study is in a language study program, no on-line or distance education classes may be considered to count toward a student's full course of study requirement.

**University of North Texas Compliance**

To comply with immigration regulations, an F-1 visa holder within the United States may need to engage in an on-campus experiential component for this course. This component (which must be approved in advance by the instructor) can include activities such as taking an on-campus exam, participating in an on-campus lecture or lab activity, or other on-campus experience integral to the completion of this course.

If such an on-campus activity is required, it is the student’s responsibility to do the following:

1. Submit a written request to the instructor for an on-campus experiential component within one week of the start of the course.
2. Ensure that the activity on campus takes place and the instructor documents it in writing with a notice sent to the International Student and Scholar Services Office. ISSS has a form available that you may use for this purpose.

Because the decision may have serious immigration consequences, if an F-1 student is unsure about his or her need to participate in an on-campus experiential component for this course, s/he should contact the UNT International Student and Scholar Services Office (telephone 940-565-2195 or email internationaladvising@unt.edu) to get clarification before the one-week deadline.
Calendar
Tentative calendar: Topics and assignment deadlines may adjust to accommodate pace of course.

<table>
<thead>
<tr>
<th>Module</th>
<th>Dates</th>
<th>Topics</th>
<th>Readings</th>
<th>Assignments</th>
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</thead>
<tbody>
<tr>
<td>Markov Chains</td>
<td>Week of 1/13/20</td>
<td>Introduction to discrete time Markov chains, classification of states</td>
<td>Textbook: Sections 7.1, 7.2</td>
<td>Homework Set 1</td>
</tr>
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<td></td>
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<td>Solutions due 2/9/20</td>
</tr>
<tr>
<td>Markov Chains</td>
<td>Week of 1/20/20</td>
<td>Steady state behavior</td>
<td>Textbook: Sections 7.3</td>
<td>Project 1</td>
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<td>Report due 2/16/20</td>
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<tr>
<td>Markov Chains</td>
<td>Week of 1/27/20</td>
<td>Absorption probabilities, expected time to absorption</td>
<td>Textbook: Section 7.4</td>
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</tr>
<tr>
<td>Markov Chains</td>
<td>Week of 2/3/20</td>
<td>Continuous time Markov chains</td>
<td>Textbook: Section 7.5, problem review</td>
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<tr>
<td>Bayesian Inference</td>
<td>Week of 2/10/20</td>
<td>Bayesian inference, posterior distributions</td>
<td>Textbook: Section 8.1</td>
<td>Homework Set 2</td>
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<tr>
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<td>Solutions due 3/1/20</td>
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<tr>
<td>Bayesian Inference</td>
<td>Week of 2/17/20</td>
<td>Point estimates, hypothesis testing, MAP rule</td>
<td>Textbook: Section 8.2</td>
<td>Project 2</td>
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<td>Report due 3/15/20</td>
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<tr>
<td>Bayesian Inference</td>
<td>Week of 2/24/20</td>
<td>Bayesian least squares estimation</td>
<td>Textbook: Sections 8.3, 8.4, problem review</td>
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<tr>
<td>Classical Inference</td>
<td>Week of 3/2/20</td>
<td>Classical parameter estimation</td>
<td>Textbook: Section 9.1</td>
<td>Homework Set 3</td>
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<td>Solutions due 3/29/20</td>
</tr>
<tr>
<td>Spring Break</td>
<td>Week of 3/9/20</td>
<td>Fun, sun</td>
<td>Beach book</td>
<td>Get outside</td>
</tr>
<tr>
<td>Classical Inference</td>
<td>Week of 3/16/20</td>
<td>Linear regression</td>
<td>Textbook: Section 9.2</td>
<td>Project 3</td>
</tr>
<tr>
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<td>Report due 4/5/20</td>
</tr>
<tr>
<td>Topic</td>
<td>Week</td>
<td>Content</td>
<td>Textbook: Sections 9.3, 9.4, problem review</td>
<td>Supplemental Material</td>
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<tr>
<td>Classical Inference</td>
<td>Week of 3/23/20</td>
<td>Hypothesis and significance testing</td>
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<tr>
<td>Bootstrap Methods</td>
<td>Week of 3/30/20</td>
<td>Introduction to bootstrapping</td>
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<td>Project 4</td>
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<td>Report due 4/26/20</td>
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<tr>
<td>Bootstrap Methods</td>
<td>Week of 4/6/20</td>
<td>Bootstrapping estimation</td>
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<tr>
<td>Bootstrap Methods</td>
<td>Week of 4/13/20</td>
<td>Bootstrapping confidence sets and hypothesis testing</td>
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<tr>
<td>Alternate Topics and American Airlines Project</td>
<td>Week of 4/20/20</td>
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<tr>
<td>Alternate Topics and American Airlines Project</td>
<td>Week of 4/27/20</td>
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<tr>
<td>Final class meeting (final exam time)</td>
<td>May 4</td>
<td>Wrap-up, class presentation</td>
<td></td>
<td>Presentation/report of AA Project results</td>
</tr>
</tbody>
</table>

**Notes:**
- Project 4 Report due 4/26/20