INFO B585 Biomedical Analytics
Department of BioHealth Informatics

Instructor: Ling Tong

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Time: Wednesday 2:30 – 4:30 pm

Location: [Insert location]

Office hours: [Insert location]

Prerequisites: None

Required Course Book

1. Hoyt, Robert., Muenchen, Robert. Introduction to Biomedical Data Science. ISBN: 9780988752955

Required Website & Software Access:

Canvas website: Additional Materials will be shared in Canvas on a weekly basis.

Microsoft Excel: Microsoft Excel Spreadsheet Software.

Anaconda: A data science platform for Python and R programming for Scientific Computing.

Course Description

This graduate-level introductory course teaches students how to apply biomedical analytics methods to electronic health records and patient data to improve patient care, making healthcare systems more efficient. The course examines clinical intelligence and the role of biomedical analytics in supporting a data-driven healthcare system.

In the healthcare field, it is becoming more important to understand, analyze, and interpret data. Data analytics are one of the most essential parts of the healthcare, both in terms of improving efficiency, healthcare outcomes, and reducing costs. Biomedical analytics includes the technologies and skills to give clinical, business and programmatic insights into the complex interdependencies that drive medical outcomes, costs, and oversight. Through data modeling, optimization, predictive analytics, and business intelligence, Healthcare organizations can learn how to improve their financial performance, deepen their relationships with patients and healthcare customers. Biomedical analytics change the way healthcare is planned and delivered for better results across the entire health industry. Therefore, biomedical data analysis is one of the most desirable skill set in the industry of healthcare technology and management.

This course is designed for students to learn the highly sought-after health analytics skills to collect, prepare, analyze, interpret, evaluate, and present clinical and operational data to improve healthcare outcomes, including quality, effectiveness, efficiency, and safety in the current healthcare job market. The course also help students get prepared for the data insights they need to grow in the healthcare industry.

Learning outcomes:

On completion of the course, the student will be able to:

1. Describe the changing context of healthcare services, including the trend toward value-based healthcare systems and the role of data in promoting improved outcomes.
2. Mine data from electronic health record systems using advanced statistical and data programming techniques in Python and R programming language.
3. Design data models that integrate patient data from multiple sources to create comprehensive, patient-centered views of data.
4. Design an analytic strategy to frame a potential issue and solution relevant to the health improvement of patient populations.
5. Using descriptive and summarized data views to discover meaningful patterns and trends in large-scale data systems.
6. Analyze the distribution of disease and health outcomes in relevant populations of interest (e.g., general population, health system members, patient subgroups).
7. Apply clinical analytics to various contexts of quality improvement (e.g., chronic disease, patient use, population health, public health).
8. Understand the current trends of big data, Artificial Intelligence on healthcare industry.

Core Competencies:

The core competencies of this course include the following:

1. Define the field of biomedical analytics and understand the importance of interdisciplinary collaboration in solving healthcare challenges.
2. Use spreadsheet to organize, manage, describe and create visualizations of data. Create pivot table and pivot charts to enable analysis, identifying patterns, trends, and comparisons of data.
3. Understand the importance of data visualization. Students can choose the right form of charts to complete the correct visualizations from different types of data.
4. Develop basic skills to use data analysis tools and examine data correction, data validation, perform descriptive statistics, and simple statistical tests.
5. Understand the common types of research methodologies, including Meta-analysis, Interventional studies and observational studies.
6. Interpret results of data analyses found in public health studies and research.
7. Understand the core roles of database in electronic health records, perform Structured Query Language (SQL) in a relational database structure.
8. Understand the six V's of big data related to health care: value, volume, velocity, variety, veracity and variability.
9. Apply programming languages (Python, R) for medical data analysis and avoid common errors.
10. Understand the Artificial intelligence in medicine, what AI can perform in Clinical Decision Making, Medical Image Analysis, Natural Language Processing, and future trends in health care.

How This Course Works

There are weekly lectures scheduled to cover all topics. There will be weekly assignments after most lectures. You need to submit weekly assignments in a word document, completing listed questions and include sufficient descriptions. There will be a midterm project, and a final project at the end of class. The mid-term and final project need to be delivered in a 15-minute presentation in the class, and an analysis report to describe the objective, your analysis, results, and highlight the value of your work. All information, including all files required to do the assignments, project, and final exam and helpful tutorials, will be posted on Canvas course site.

Grading

Grading Item	Weight
Take-home weekly assignments (10 in total) – Submit to Canvas website	40%
Mid-term Project – Includes documents and presentations Document Presentation	20% - 10% - 10%
Final Project - Includes documents and presentations Document Presentation	30% - 15% - 15%
Discussion and Class Attendance	10%
Total	100%

Grading Rubric:

The assignments and projects will be evaluated on the following criteria:

- Content (20%): The project or assignment document shows a clear understanding of the topic and meet the study goals. A project needs to include appropriate background research and analysis.
- Clarity (10%): The document in the assignment or project is well-written and free of errors. The project or the assignment uses appropriate language and style and is easy to understand.
- Analytical Skills (40%): Students show a clear knowledge and approach to conducting biomedical analysis and can interpret the results from a high perspective to support data-driven healthcare systems.
- Presentation (30%): The project has a well-thought-out layout, clear communication, and uses the right media and/or technology to deliver the message clearly.

Class Policy on Weekly Assignments

Weekly assignments will provide practice opportunities for students to apply what has been presented in the lecture. These assignments will be explained in your lecture in a weekly basis with time in office hours to address any specific questions. They are due no later than the indicated due date, usually by the time of next lecture, but can be turned in earlier if desired. If an assignment is turned in earlier than the due date listed on the syllabus, and you do not receive full credit for it, you will have one opportunity to re-submit a corrected version of that assignment. If you turn the assignment(s) in on the due date you will not have the opportunity to re-submit it.

Note: This re-submission opportunity is only for the weekly assignments, not for the mid-term project or final projects.

Class Policy on Mid-term and Final Projects:

Mid-term or final projects should be submitted by the due date specified in the syllabus. Late submissions will not be accepted unless there is a documented and approved excuse, such as an illness or family emergency. Projects must be submitted in the specified format and through Canvas. Failure to follow the submission guidelines may result in a penalty. Projects will be graded based on the rubric provided in the syllabus. Students are encouraged to review the rubric and seek clarification on any unclear criteria.

Class Policy on Late Work:

Late work will not be accepted for points or credit. All assignments or projects must be completed during the weeks they are scheduled. There are no make-up exams or presentations, and none of the exam or presentations grades will be dropped. Assignments are due on or before the date listed on the syllabus schedule. Late assignments will not be graded for any point value.

College of Health Sciences
Honor Code

The Honor Code provides a framework for moral, ethical, and professional behavior for all members of the College of Health Sciences, including students, faculty, and staff. With all members of the College committed to upholding and promoting the tenets of the Honor Code, we will continue to work and learn in a supportive and stimulating environment. Commitment to this Honor Code supports the mission of the College of Health Sciences to prepare future health professionals and conduct nationally and internationally recognized research in the health sciences.

Honor Code

As a member of the University of Wisconsin–Milwaukee, College of Health Sciences community of scholars and professionals, I will abide by the following tenets of this honor code:

I will demonstrate respect for the dignity of others by:
• Understanding and respecting social and cultural difference among students, classmates, and colleagues.
• Respecting others' expectations of confidentiality and privacy.
• Not engaging in intimidating, harassing, violent, or discriminating behavior or language.

I will demonstrate respect for the rights and property of others by:
• Actively working to promote a positive learning, work, and research environment.
• Allowing other individuals to express their opinions, even if they are different from my own.
• Not committing theft, vandalism, destruction, or desecration of another's physical or intellectual property.

I will take responsibility for my learning, teaching, research, and service by:
• Demonstrating enthusiasm and being prepared for classes, labs, meetings, and other activities.
• Being prompt in completing duties and assignments, and punctual in attending classes, labs, meetings, and other activities.
• Communicating promptly and making suitable arrangements if a scheduled conflict arises.
• Contributing equitably in discussion and group work.
• Providing fair and constructive feedback when asked to evaluate others.

I will practice personal, professional, and academic integrity by:
• Being reliable, honest, and ethical.
• Following through on commitments.
• Avoiding bias and conflicts of interest.
• Adhering to the policies and procedures of organizations with which I am involved.
• Not misrepresenting or falsifying information and/or actions, including acts of plagiarism.
• Not engaging in self-destructive behavior, such as misuse of alcohol, drugs, or tobacco, that would compromise my learning, teaching, research, and service.

I will follow the Professional Codes of Ethics relevant to my profession by:
• Knowing and upholding the Professional Codes of Ethics that is set forth by my professional governing body.
• Upholding the ethical standards set forth by the professional and governing bodies associated with the performance and dissemination of research.
• Knowing and upholding relevant local, state, and federal laws and regulations.

Adopted by the College of Health Sciences on 05/04/2017

COVID-19 Statement - Fall 2022

Community Health and Safety Standards: UWM has implemented reasonable health and safety protocols, taking into account recommendations by local, state and national public health authorities, in response to the COVID-19 pandemic. As a member of our campus community, you are expected to abide by the Panther Interim COVID-Related Health & Safety Rules, which were developed in accordance with public health guidelines. These standards apply to anyone who is physically present on campus, UWM grounds, or participating in a UWM-sponsored activity:

- All individuals visiting UWM facilities must wear face coverings while indoors;
- Unvaccinated students coming to campus are required to test weekly for COVID-19;

And,

- You should check daily for COVID-19 symptoms and not come to campus if you are feeling sick. Additional details about student and staff expectations can be found on the UWM COVID-19 webpage.

Grading Scale:

A+	97-100	Outstanding achievement, given at the instructor's discretion
A	93-100	Excellent achievement
A-	90-92.99	Very good work
B+	87-89.99	Good work
B	83-86.99	Marginal work
B-	80-82.99	Very marginal work
C+	77-79.99	Unacceptable work (Course must be repeated)
C	73-76.99	Unacceptable work (Course must be repeated)
C-	70-72.99	Unacceptable work (Course must be repeated)
D+	67-69.99	Unacceptable work (Course must be repeated)
D	63-66.99	Unacceptable work (Course must be repeated)
D-	60-62.99	Unacceptable work (Course must be repeated)
F	below 60	Unacceptable work (Course must be repeated)

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Fall 20XX - Course Syllabus

Date	Weekly Topics	Weekly Tasks and Content Needed
Week 1 9/7/2023	**Lecture: Overview of Biomedical Analytics** - Overview of course and Biomedical analytics, healthcare, and biomedical data science careers. - Introduction to different types of biomedical data and the characteristics. - Syllabus review, and how to use the book and software.	Read textbook Chapter 1: Overview of Biomedical data science. Install software: Microsoft Excel and Anaconda **Assignment 1: Course Survey**, complete selected questions for discussion (1 page) Due Date: September 14th (11:59 PM)
Module 1:	**Learn to Understand and Perform Data Analysis**	
Week 2 9/15/2023	**Lecture: Application of Microsoft Excel** - Microsoft Excel: Sorting, filtering and conditional formatting data - Perform calculations, descriptive analysis, and create visualizations to display data. - Learn how to use pivot table and pivot charts to summarize data.	Read textbook Chapter 2: Spreadsheet tools and tips **Assignment 2:** Complete a summary of patient satisfaction data analysis from patient data using Microsoft Excel. Step-by-step instruction will be provided. Due Date: September 21st (11:59 PM)
Week 3 9/22/2023	**Lecture: Common topics in Biostatistics** - Biostatistics: Why biostatic sis important in healthcare analysis - Descriptive Statistics: mean; median, variance, standard error, interquartile range. - Distribution: Contingency table; Frequency distribution; Histograms - Normal distribution; Log-normal distribution; central limit theorem. Law of large numbers.	**Assignments:** Read textbook Chapter 3: Biostatistics Primer **Assignment 3**: Complete a descriptive analysis of patient lab test data. Create a histogram to understand the central limit theorem: How a sufficiently large random examples from the population will be approximately normally distributed. Due Date: September 28th (11:59 PM)
Week 4 9/29/2023	**Lecture: Statistical Tests in Biostatistics** - Basics of parametric tests: Independent t-tests; Paired t-tests; ANOVA tests; F-tests; Correlation tests. - Non-parametric tests: Basics of Chi-square tests; Kruskal-Wallis tests. - Biomedical application of the tests.	Reading material of statistical tests: PDF will be provided. **Assignment 4:** Complete a **[Jupyter notebook]** of Statistical tests and applications based on data from a clinical trial study. Due Date: October 5th (11:59 PM)

Week 5 10/6/2023	**Lecture: Linear regression in Biostatistics** - Linear regression model; Correlation; Estimated regression coefficient; Confidence interval; P-value. - Linear regression with one variable; Linear regression with multiple variable. - Clinical Example and in-class analysis	Reading material of linear regressions: PDF will be provided. **Assignment 5:** Complete an example of linear regression analysis in **[Jupyter Notebook]** Due Date: October 12th (11:59 PM)
Week 6 10/13/2023	**Lecture: Types of research studies in Biomedical analysis** - Learning how to apply statistical tests into research studies - Observational Studies: A example of cohort study - Interventional Studies: Clinical trials - Meta-analysis: A study of pooled studies	Reading material of research study type: PDF will be provided. **Preparing for Mid-term project:** Complete a [**review]** the paper you selected: How does this study use the statistical tools to complete a result? Evaluate the validity of the methodologies, and how the analysis adds value to the conclusions. Due Date: October 19th (11:59 PM)
Week 7 10/20/2023	- Mid-term project presentations	Submission of Mid-term project document Due date: October 26th (11:59 PM)
Module 2:	**Data Management and Biomedical Data Applications**	
Week 8 10/27/2023	**Lecture: Database in Biomedical Applications** - Electronic Health Records: The pipeline of acquisition, storage and use - How a database model efficiently manage the patient data in a healthcare facility: Epic system as an example - Structured query language (SQL) Application	Read Chapter 5: Introduction to databases **Assignment 6**: Complete the SQL queries in provided examples in **[Jupyter Notebook]**. Due Date: November 2th (11:59 PM)
Week 9 11/3/2023	**Lecture: Big Data** - The use of big data analytics in industrial scenario, such as wearables, consumer-grade ECGs, and streaming videos. - Understand the six V's of big data related to health care: value, volume, velocity, variety, veracity and variability. - Big Data platforms: Apache - May invite Guest speakers from industry to share insights -	Read Chapter 6: Big Data **Assignment 7**: Complete a **[review]** to compare the use of precise data in research analysis and the use of big data in industry. Due Date: November 9th (11:59 PM)
Week 10: 11/10/2023	**Lecture: Data Visualization** - Frequency-based data visualization - Longitudinal data visualization - Categorical and continuous data visualization - Communication of results to stakeholders in the biomedical field	Read chapter 4: Data Visualization **Assignment 8:** Complete a data visualization tasks in **[Jupyter Notebook]** Due Date: November 16th (11:59 PM)

Week 11: 11/22/2023	**Lecture: Machine Learning, Deep learning and Artificial Intelligence in health care analysis** - Introduction to supervised and unsupervised learning techniques - What is 'features' in Machine Learning? - Decision trees, random forests, and ensemble methods - Clustering and dimensionality reduction techniques	Read Chapter 9: Machine Learning Additional Reading of AI in medicine: PDF will be provided. **Assignments 9**: Complete a **[Jupyter notebook]** to complete an application of supervised Machine learning clinical decision support model. Due Date: November 23rd (11:59 PM)
Week 12: 11/23/2023	**NO Class – Thanksgiving break**	
Week 13: 12/1/2023	**Lecture: Text Analytics for Biomedical Data** - Introduction to natural language processing (NLP) techniques - Text mining and sentiment analysis for biomedical data - Topic modeling and entity extraction for biomedical data	Reading material of Text analytics: PDF will be provided. **Assignments 10:** Complete a **[Jupyter notebook]** to complete an application of Topic modelling. Due Date: December 7th (11:59 PM)
Week 14: 12/8/2023	**Lecture:** - Applications of biomedical analytics in healthcare, such as disease prediction, drug discovery, and clinical decision support - Case studies and examples of successful biomedical analytics projects	Preparing for Final Project: Prepare your final project in biomedical applications, Select topics in healthcare population analysis, AI-based analysis, Text analysis or Clinical decision support, etc. Due Date: December 12th (11:59 PM)
Week 15: 12/13/2023	**Final Project Presentation**	Submission of Final project document Due date: December 17th (11:59 PM)