BIOMEDICAL INFORMATICS (BMIN)

BMIN 5010 Introduction to Biomedical and Health Informatics
This course is designed to provide a survey of the major topic areas in medical informatics, especially as they apply to clinical research. Through a series of lectures and demonstrations, students will learn about topics such as medical data standards, electronic health record systems, natural language processing, clinical research informatics, clinical decision support, imaging informatics, public health informatics, and consumer health informatics. It is recommended that students have basic familiarity with biomedical concepts. Non-majors need permission from the department.
Fall
1 Course Unit

BMIN 5020 Database and Data Integration in Biomedical Research
This course is intended to provide in-depth, practical exposure to the design, implementation, and use of databases in biomedical research, and to provide students with the skills needed to design and conduct a research project using primary and secondary data. Topics to be covered include: database architectures, data normalization, database implementation, client-server databases, concurrency, validation, Structured-Query Language (SQL) programming, reporting, maintenance, and security. All examples will use problems or data from biomedical domains. MySQL will be used as the database platform for the course, although the principles apply generally to biomedical research and other relational databases. NOTE: Non-majors need permission from the department
Spring
1 Course Unit

BMIN 5030 Data Science for Biomedical Informatics
In this course, we will use R and other freely available software to learn fundamental data science applied to a range of biomedical informatics topics, including those making use of health and genomic data. After completing this course, students will be able to retrieve and clean data, perform explanatory analyses, build models to answer scientific questions, and present visually appealing results to accompany data analyses; be familiar with various biomedical data types and resources related to them; and know how to create reproducible and easily shareable results with R and GitHub. Recommended prerequisite: Introductory-level statistics course. Familiarity with programming or a willingness to devote time to learn it. NOTE: Non-majors need permission from the department.
Fall
Also Offered As: EPID 6000
1 Course Unit

BMIN 5040 Special Topics in Biomedical and Health Informatics
This course is designed to provide an in-depth look at topics that are of essential importance in biomedical informatics. Each topic will be arranged into thematic modules which will occur in consecutive weeks in the class schedule, with the intention that each module becomes its own "mini-course". The topics for each module may rotate from semester to semester, based on these criteria: Historical importance to the current field of biomedical informatics research and/or practice; Cutting-edge developments in biomedical informatics; Topics not covered in depth in BMIN 5010; Consensus of the program leadership and teaching faculty. It is recommended that students have completed BMIN 5020 and BMIN 5030 prior to enrolling in this course. NOTE: Non-majors need permission from the instructor.
Spring
Also Offered As: EPID 6020
1 Course Unit

BMIN 5050 Precision Medicine and Health Policy
Through a series of lectures, readings and response papers, students will learn about topics such as medical ethics, unintended consequences of medicine/research, genetics, genetic interpretation, hospital performance, and data mining and informatics methods to assess these factors. The informatics topics covered in this course include: decision support, clinical interpretation of genetics, detection of bias in EHRs, detection of bias in guidelines, methods to ameliorate bias, mapping clinical guidelines to computable standards, hospital performance assessment, machine learning, and artificial intelligence applications in this space. We also cover ways that Race, Sex/Gender, Socioeconomics, and Genetics can alter informatics algorithms and introduce biases into EHR data and algorithms. NOTE: Non-majors need permission from the department.
Spring
1 Course Unit

BMIN 5060 Standards and Clinical Terminologies
This survey course is designed to provide an overview of health information standards and clinical terminologies. Through a series of lectures, demonstrations, and hands-on exercises, students will learn about topics such as standards, interoperability, data modeling, vocabularies, and health information exchange. It is recommended that students have completed BMIN 5010 prior to enrolling in this course. NOTE: Non-majors need permission from the department.
Fall
0.5 Course Units

BMIN 5070 Human Factors
The course will cover four main topic areas: 1. Sociotechnical and human-centered design in biomedical informatics; 2. Evaluation and measurement of usability; 3. Implementation and optimization—including tensions among existing vs revised workflows, new software vs legacy systems, vendor software vs need for new builds, customization, retrofits, dongles, etc.; and 4. Ethics, policy, cybersecurity, and advocacy. Each topic area will incorporate definitions, principles, methods, and applications. We review the terminology, the concepts and underlying assumptions, how key concepts relate to each other, the ways we measure usability and outcomes, and then examine the relevance of the topic's to applied clinical informatics. The course will cover qualitative, quantitative, and computational methods used for the design, implementation, and evaluation of health information technology. The applications section for each topic will use relevant case studies that examine the real-world application of principles and methods. It is recommended that students have completed BMIN 5060 prior to enrolling in this course. NOTE: Non-majors need permission from the department.
Fall
0.5 Course Units

BMIN 5080 Biomedical Information Systems Analysis and Design
This course provides an introduction to the concepts and principles of information systems analysis and design, focusing on the techniques of the Unified Modeling Language and the Unified Process, specifically as these apply to healthcare settings. As a result, there is a strong emphasis on applying these techniques to real-world issues with clinical and clinical research information systems. These include the electronic health record, information systems in clinical specialties, and systems to support the management of data used for clinical research and healthcare administration. This course is required for MBMI students in the Healthcare Quality Informatics Track.
1 Course Unit

BMIN 5090 Consumer and Personal Health Informatics
This course is designed to develop intelligent consumers, managers, and researchers of telehealth and personal health/ consumer health informatics systems through guided exploration into the components of such systems. The course is designed to introduce many of the challenges facing designers and managers of telehealth/ mHealth and remote health care delivery networks. The spectrum of activity ranging from research into implications of system design for applications that bridge geographic distance to the development of practical applications to promote patient engagement is considered in both historical context and in case studies. The current status and future trends of this emerging domain are reviewed. It is recommended that students have some exposure to health care or health systems prior to enrolling in this course. NOTE: Non-majors need permission from the department.
Fall
Also Offered As: NURS 5290
1 Course Unit

BMIN 5100 Clinical Research Informatics in the Cloud: Analytic Workflows and Infrastructure
Machine learning, analysis, and meaningful visualizations can provide significant insights into clinical research datasets. One of the challenges is to make these tools, and workflows available at scale in a meaningful way for clinicians, data scientists, and patients. In this course, we will focus on cloud-based mechanisms and infrastructure to make analysis workflows broadly available to a wide range of potential users. Students will implement an analytic workflow related to a clinical research dataset and ultimately deploy the workflow as a publicly available service on the internet using AWS services. We will discuss all components related to the development life-cycle of cloud based analytic services including testing, logging, deploying infrastructure, APIs, front-end development and the value of doing research in the cloud. It is expected that students are comfortable with Python coding and have taken a data science class prior to enrolling in this course. Pre-requisites: - Students should have significant experience with programming in Python. - BMIN 5030 or BMIN 5200 or equivalent. - Students are interested in learning to work within the AWS environment.
Prerequisite: BMIN 5030 OR BMIN 5200
1 Course Unit

BMIN 5200 Foundations of Artificial Intelligence in Health
As a subfield of computer science, artificial intelligence is often used interchangeably with the term 'machine learning', which itself is more accurately a subfield of AI dealing with the broader concept of inductive reasoning. However, a wealth of key prerequisite topics that focus on deductive reasoning align with the bulk of biomedical informatics applications being actively utilized today. These founding principles of AI and their intersection with biomedical informatics are the focus of this first course on artificial intelligence. The course is divided into modules that cover (1) introductory/background materials, (2) knowledge representation, (3) logic, (4) essentials of rule-based systems, (5) search, (6) information structure and inference, and (7) special topics. These topics offer a global foundation for branches of AI application and research in biomedical domains, including concepts that will later support a deeper understanding of inductive reasoning and machine learning. In a practical sense, this course focuses on how biomedical data can be organized, represented, interpreted, searched, and applied in order to derive knowledge, make decisions, and ultimately make predictions while avoiding bias. It is expected that all students will be somewhat familiar with basic biomedical concepts and terminology, statistics. Additionally, students must be familiar with basic computer programming concepts including data structures, control flow, and I/O. Recommended, but not required, that students have taken Introduction to Biomedical Informatics (BMIN 5010), Data Science for Biomedical Informatics (BMIN 5030), and a programming course (any language). No previous exposure to artificial intelligence is assumed.
Fall
1 Course Unit

BMIN 5210 Advanced Methods and Health Applications in Machine Learning

Machine learning studies how computers learn from data and has enormous potential to impact biomedical research and applications. This course will cover fundamental topics in machine learning with an application focus on biomedical informatics. Specifically, the course will cover: supervised learning methods such as linear regression, logistic regression, nearest neighbors, support vector machines, decision trees and random forests; unsupervised learning topics such as clustering and dimensionality reduction; neural networks and deep learning methods for supervised or unsupervised learning tasks, including Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Auto Encoder (AE), Generative Adversarial Network (GAN), and Graph Neural Network (GNN); and the applications of these machine learning techniques to various biomedical informatics problems via analyzing imaging, biomarker, electronic health record, clinical and/or other biomedical data. The precise topics may vary from year to year based on student interest and developments in the field. Students are required to have completed BMIN525 (Python Class) or equivalent programming experience. It is recommended that students have basic knowledge in data analysis and biomedical research. Basic knowledge of machine learning, linear algebra, statistics and probability is preferred. NOTE: Non-majors need permission from the instructor.

Fall

1 Course Unit

BMIN 5220 Natural Language Processing for Health

The growing volume of unstructured health-related data presents unparalleled challenges and opportunities for informaticians, clinicians, epidemiologists and other public health researchers that seek to mine the rich information "locked" within free-texts. Clinical records, social media, published literature, are all sources designed for human eyes, but not necessarily for automatic processing. In this class, we will survey the most recent natural language processing methods used for identifying and classifying information present in these sources. The class provides learning of health language processing – that is, the fundamental principles and methods of both natural language processing and machine learning and how they are currently applied in the biomedical domain. The class will focus on real problems in the context of health research where data are inherently biased, e.g., noisy, missing, or extremely imbalanced (where instances of interest are rare in the data). Methods for addressing these biases, such as text normalization, rules-based systems, machine learning (supervised, unsupervised, active learning), deep learning, and large language models will be discussed. In-class lectures will be most often taught using Jupyter notebooks and guest speakers presenting how an NLP/ML method was used to solve a driving biomedical use case. This course requires proficiency in python programming demonstrated through examination. NOTE: Non-majors need permission from the instructor.

Spring

1 Course Unit

BMIN 5230 Informatics Prec Med

Spring

1 Course Unit

BMIN 5250 Introduction to Python Programming

This introductory course is designed to provide an overview of the Python programming language including data types, data structures, variables, packages, modules, programming practices, and more. Using lectures and hands-on demonstrations, students will learn how to write Python programs that store, retrieve, represent, transform, analyze, and visualize biomedical and clinical data. Upon completing this introductory course, students will have acquired foundational knowledge using Python to solve problems as well as gained the self-confidence to expand their knowledge of Python well beyond this course. Non-majors need permission from the department.

Fall

1 Course Unit

BMIN 5330 Statistics for Genomics and Biomedical Informatics

BMIN 5330 is an introductory course in probability theory and statistical inference for graduate students in Genomics and Computational Biology. The goal of the course is to provide foundation of basic concepts and tools as well as hands-on practice in their application to problems in genomics. At the completion of the course, students should have an intuitive understanding of basic probability and statistical inference and be prepared to select and execute appropriate statistical approaches in their future research.

Also Offered As: GCB 5330, IMUN 5770

1 Course Unit

BMIN 5490 Exploring Data Science Methods with Health Care Data

The growth and development of electronic health records, genetic information, sensor technologies and computing power propelled health care into the big data era. This course will emphasize data science strategies and techniques for extracting knowledge from structured and unstructured data sources. The course will follow the data science process from obtaining raw data, processing and cleaning, conducting exploratory data analysis, building models and algorithms, communication and visualization, to producing data products. Students will participate in hands-on exercises whenever possible using a clinical dataset.

Spring

Also Offered As: NURS 8490

1 Course Unit

BMIN 6060 Applied Clinical Informatics in Quality Improvement

This four-day intensive graduate institute applies core clinical informatics concepts in the context of quality improvement and patient safety initiatives. Content covered addresses foundational theories, frameworks, and policies of clinical informatics relevant to quality improvement and patient safety as well as practical application of informatics tools relevant to quality improvement efforts and local governance structure. Learners will be exposed to a variety of informatics leaders from across both the University of Pennsylvania Health System and Children's Hospital of Philadelphia. A hybrid structure of two full, in-person days with two half, virtual days with optional offers hours is intended to allow flexibility for learners while maximizing beneficial interactions between learner, instructors, and building the UPHS/CHOP informatics community

Spring

Also Offered As: HQS 6060

0.5 Course Units

BMIN 7990 Independent Study

An opportunity for the biomedical informatics student to become closely associated with a professor to develop a program of independent in-depth study in a subject area in which the professor and student have a common interest that is not covered (or covered in depth) in the biomedical informatics program curriculum. The challenge of the task undertaken must be consistent with the student's academic level. To register for this course, the student and supervising professor jointly submit a detailed proposal to the program Curriculum Committee via the Program Coordinator not later than two weeks before the beginning of the semester. This course is open only to students enrolled in one of the approved Biomedical Informatics programs. The course can be taken for 0.5 or 1.0cu, depending on the depth and breadth of the proposed independent study.

Fall or Spring

0.5-1 Course Unit

BMIN 9900 Capstone

The MBMI program requires that students engage in a mentored Capstone Project in clinical informatics during their final year. This is accomplished in the context of a weekly seminar in which students develop, propose, implement, and present their capstone project. During the semester, students meet with their Capstone Advisor, who is also invited to attend the seminars. The seminar affords both students and advisors the opportunity for cross-fertilization of ideas and skills, and ultimately the honing of projects to a high level of value for the students and the clinical environments in which they conduct their projects.

Required Pre-requisite: Minimum of 7 CUs of the required coursework of the MBMI Program

1 Course Unit