BU.510 (QUANTITATIVE METHODS)

Courses

BU.510.601. Statistical Analysis. 2 Credits.
Students learn statistical techniques for further study in business, economics, and finance. The course covers sampling distributions, probability, confidence intervals, hypothesis testing, regression and correlation, basic modeling, analysis of variance, and chi-square testing. The course emphasizes statistics to solve management problems. Case studies, spreadsheets, and Excel Add-in Data Analysis ToolPak computer software are used.

BU.510.615. Python for Data Analysis. 2 Credits.
This is an introductory course in using Python for analytical purposes. Python (www.Python.org) is a general-purpose cross-platform programming language that has a strong presence in the diverse areas of analytics. This course will provide a pragmatic and hands-on introduction to the fundamental aspects of Python programming language with a focus on data exploration, analysis, and driving insights from data. Additionally, towards the end of the semester, students will be exposed to using Python for introductory optimization and machine learning. Class time will be used for short overview lectures followed by analysis of worked-out examples and in-class coding exercises. As the course progresses, students will learn to work with libraries such as statistics, random, numpy, scipy, pandas, matplotlib, seaborn, and plotly. By the end of this course, students should be able to start writing useful Python programs on their own or to understand and modify Python code written by others. Additionally, they should have a solid understanding of forecasting using time series.This course is an introductory Python course for students with a working statistical analysis knowledge. It does not assume any prior coding experience. If you have an extensive knowledge of Python, you might experience significant repetition.Starting the 3rd week, students will be exposed to basic time series analysis. Not only does time series analysis have a strong presence in all areas of business; it also provides a rich context for practicing Python's data handling capabilities (from applying a regression model for forecasting to data aggregation, dataset merging, slicing, and grouping). Time series analysis theory will be covered via a pre-recorded video; students are required to watch the videos prior to each class. The instructor will briefly review this theory at the beginning of each lecture; the majority of the lecture will be spent on learning and practicing Python's capabilities.

BU.510.650. Data Analytics. 2 Credits.
This course prepares students to gather, describe, and analyze data, using advanced statistical tools to support operations, risk management, and responses to disruptions. Analysis is done targeting economic and financial decisions in complex systems that involve multiple partners. Topics include probability, statistics, hypothesis testing, regression, clustering, decision trees, and forecasting.
Prerequisite(s): BU.510.601 OR BU.914.610 OR BU.920.621 OR PH.140.611 OR PH.140.621

BU.520.601. Business Analytics. 2 Credits.
Business analytics makes extensive use of data and modeling to drive decision making in organizations. To become a leader in a data driven world, it is therefore critical to acquire hands-on experience of both data-related (statistical) and modelling skills. This class focuses on the latter: it introduces students to analytical frameworks used for decision making to make sense of the data. The methodologies covered include Linear and Integer Linear Programming, Decision Analysis, Foundations of utility and risk, and Monte Carlo Simulation. For each topic/methodology students are first exposed to the basic mechanics of the framework, and then apply the methodology to several business problems using software.
Prerequisite(s): BU.510.601 OR BU.920.621 OR PH.140.611 OR PH.140.621

BU.520.620. Advanced Business Analytics. 2 Credits.
This course trains decision makers to function in the face of multi-dimensional uncertainty, through the development and use of optimization models. Mathematical abstractions are created which deal with issues including resource allocation, scheduling, pricing, and other responses to the realization of a variety of "known unknowns". Topics include linear programming, dynamic programming, multi-criteria optimization, and non-linear optimization.
Prerequisite(s): BU.520.601 OR BU.913.610 OR BU.920.711 OR BU.920.721

BU.520.650. Data Visualization. 2 Credits.
This project-based course prepares students to make informed decisions based on data using descriptive-analytical techniques. Students will view examples from real-world business cases in which data visualization helps the decision makers to visualize, discover, and decode the hidden information from within the data, and to exploit such information for making educated decisions. We will use Tableau to import, clean, transform, analyze, visualize, and present data. As the course progresses, students will learn to work with Tableau features such as data connectors, data blending, data preparation, interactive dashboards, and calculations and functions. During the eight weeks of the course, students will collaborate with each other in small teams to analyze real-world datasets as well as design, build, and deliver interactive visualizations and dashboards.

BU.520.690. Analytics Consulting Project. 2 Credits.
In this course, students will assume the role of analytics consultants, engaging with a real-world business problem presented by an industry client. Throughout the course, they will acquire the skills to scope complex business problems, select and apply pertinent analytics methodologies, prepare and analyze data, and generate actionable insights. The students will be trained to effectively communicate their findings to a variety of audiences through writing, data visualizations, and presentations. The course will equip students with the soft skills necessary to complete analytics projects. Topics covered include the basics of consulting, project management strategies, collaborative teamwork dynamics, and an examination of ethical considerations in the field of analytics.
Prerequisite(s): BU.510.650 AND BU.520.775 AND BU.120.601

BU.520.720. Financial Decisions and Investment Analysis. 2 Credits.
This course intends to provide the BAAI students with an opportunity to learn the fundamental finance principles and their applications in (i) corporate decisions on capital budgeting and capital structure and (ii) investor decisions on portfolio allocations and risk management. The discussion of these topics will necessarily include basic concepts in finance, such as the opportunity cost, the discounted cash flow method, risk attitude toward risk, and the financial market efficiency. Students will acquire proficiency in essential financial analysis as well as strong financial intuition through this course.

BU.520.750. AI-Driven Sequential Decision Making. 2 Credits.
This course will serve as a nexus between business analytics and cutting-edge artificial intelligence (AI) methodologies, which are increasingly vital in strategic business decision-making, encompassing areas from sales forecasting and inventory optimization to revenue management and supply chain analytics. There is a strong emphasis on the art, theory, and applications of Markov decision processes (MDPs) in modeling and optimizing large-scale business analytics problems in the presence of uncertainty. While MDPs can be applied to a broad range of decision analytics problems in practice, they often encounter the curse of dimensionality, which leads to exponential growth in the size of these models. To address this challenge, state-of-the-art AI methods, reinforcement learning (RL) and deep RL, are extensively discussed as solutions to overcome the curse of dimensionality. Additionally, if time permits, the course will present further recent advancements in AI-empowered decision analytics. This course will balance theory and practical applications of AI-empowered decision analytics, making it accessible to a diverse range of students and practitioners in fields like business, economics, finance, and engineering. Each lecture is composed of three components: theory, case studies, and tools. These are designed to equip students with an understanding of the underlying art and theory of MDPs and RL, insights into real-world applications, and proficiency in Python programming. Additionally, through a final group project, students will gain hands-on experience in the entire process of predictive and prescriptive analytics in practice. The final outcomes will be showcased through presentations.
Prerequisite(s): BU.510.601 AND BU.520.601 AND some skill and experience in programming required.

BU.520.775. Practical Machine Learning. 2 Credits.
This course provides hackathon- and project-based learning opportunities for students to develop, assess, and explain supervised machine learning solutions for common business use cases using tabular and text data. Additionally, the course will explore the development and assessment of either reinforcement learning or causal machine learning models at the option of the instructor. Students will develop solutions using Python and machine learning platforms.
Prerequisite(s): BU.510.615 AND BU.520.601

BU.610.615. Simulation for Business Applications. 2 Credits.
This course provides a foundation for applying Simulation in managerial decision making in all areas of an organization. These decision areas could be in both predictive and prescriptive analytics area. Students learn to build quantitative models, in the presence/absence of reliable data, for quantifying and understanding impact of uncertain future on performance metrics under consideration. Simulation constructs probabilistic estimates of quantities of interest such as net present value of an investment, rate of a disease spread under a certain policy, or cost and time of a mega-project. This provides a very insightful information for decision makers to evaluate risks involved and make decisions accordingly. Results of Monte Carlo Simulation could be used for short-term and strategic planning of an organization. @Risk software package will be used for this part of the course. Additionally, in real world complex problems, where closed-form solutions, offered by classical mostly deterministic optimization methodologies, are not readily available/reachable, Simulation enables decision makers to see the distribution of all possible outcomes as a function of underlying uncertainties and using simulation-optimization methodology to make the best decision in the presence of uncertainty. Students will learn RiskOptimizer for this part of the course.
Prerequisite(s): BU.520.601 OR BU.232.620 OR BU.920.711 OR BU.920.721

BU.610.740. Forecasting Models for Business Intelligence. 2 Credits.
Students learn advanced statistical models and state-of-the-art machine learning methods for modeling and analyzing time series data with applications in business, economics, and finance. Time series analysis is a methodology to exploit historical data generated by real-world systems to forecast the future values of these systems. This course will balance theory and practical applications of time series modeling and analysis at a level accessible to a wide variety of students and practitioners in business, economics, finance, engineering, and quantitative social sciences. Emphasis is placed on the development and choice of appropriate models, how to estimate and test model parameters, and forecast future values for making better business decisions. Furthermore, challenges in dealing with big time series data problems are discussed and recent advances in overcoming their practical issues are presented. Each lecture consists of three components including theory, case studies, and tools, to train students with the underlying theory of time series models, real-world applications, and Python programming practices. Moreover, students will experience the whole process of predictive analytics in practice through a final group project, by finding appropriate real-world time series data, modeling and analyzing the data, making predictions, and providing managerial decisions. The final outcomes will be showcased through poster presentations.
Prerequisite(s): BU.510.601