ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

ΣΧΟΛΗ ΕΠΙΣΤΗΜΩΝ & ΤΕΧΝΟΛΟΓΙΑΣ ΤΗΣ ΠΛΗΡΟΦΟΡΙΑΣ
SCHOOL OF INFORMATION SCIENCES & TECHNOLOGY

ΜΕΤΑΠΤΥΧΙΑΚΟ στην ΕΠΙΣΤΗΜΗ ΔΕΔΟΜΕΝΩΝ
MSc in DATA SCIENCE

CALL FOR APPLICATIONS FOR ADMISSION

GRADUATE STUDY PROGRAM "MASTER OF SCIENCE in DATA SCIENCE"

Part Time Program 2015-2016

Data Science is the study of data through computational and statistical techniques, in order to answer questions, develop explanatory and predictive models, perform analyses and communicate the results in revealing ways. Data science draws from a wide variety of disciplines such as computer science, artificial intelligence, statistics, economics, and operations research. It applies quantitative methods to uncover relationships in data drawn from business, medicine, financial, social or other domains. It is a key driver of improvements to all aspects of business, including strategy, operations, marketing, finance, and human resource management.

The Master of Science in Data Science, the first of its kind in Greece, offers students in-depth focus in data science while allowing them to tailor it their particular interests. Students will be interacting with diverse faculty members and other students, given the opportunity to complete innovative data science projects and be exposed to industry needs and real-life data science challenges.

The program focuses on computation and quantitative techniques and offers students new opportunities for building sustainable competitive advantage through data analysis. The part time includes 21 months of taught courses and potentially a 3 month-long Analytics Capstone project that enables students to work on a real-world data-intensive problem using the tools and skills learned in the program.

The Informatics Department of the Athens University of Economics and Business

The program is offered by the Department of Informatics of Athens University of Economics and Business. The Department has been in existence, in its present form, since 1984 and is focused on providing innovative undergraduate and postgraduate education, along with research for the information and computing professions. Each year, we welcome approximately 200 undergraduate and over 100 graduate students. Faculty members have over 20 years of academic teaching experience on average and collectively have contributed more than 1.000 research publications, which have attracted over 10.000 references from other researchers worldwide. Furthermore, more than half of our faculty have been faculty members in leading American and other European Universities.

Athens University of Economics and Business (AUEB) was founded in 1920. It is considered one of the most competitive universities, at the European level, in the fields of Economics, Business Administration, Informatics, Statistics, Marketing, Accounting and Finance. AUEB was the first Greek University to establish postgraduate studies, at the Master's as well as the doctoral level. Today it enrolls over 2000 students in 35 part-time and full-time Master's level postgraduate programs with a duration of 1 to 2 years. It is the first university in Greece to receive the distinction of Excellence, according to the internationally accepted EFQM (European Foundation of Quality Management) Excellence Model, and it has also received the corresponding "Ever to Excel" Greek distinction. AUEB is by far the most international of Greek universities: It has the largest ratio of Erasmus students to its active student population, as well as a large number of undergraduate and postgraduate students participating in the Erasmus and Erasmus+ programs. It also offers one of the most active branches of AIESEC, through which it provides valuable opportunities for internships abroad.

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Program's Target audience

- FULL TIME program (starting in 2016): Recent graduates or midcareer professionals looking to upskill, with strong existing technical skills, from engineering, mathematics, statistics, finance, economics, and computer science. Prospective students will want to focus on quantitative, computational methods to unlock the potential of data assets to reveal patterns, make predictions and improve decision-making.

- PART TIME: Early- and Mid-career professionals (at least 2 years full time professional experience required) wanting to face the challenge of understanding and exploiting the deluge of data in their organizations. Any professional (in private or public sector) with a mandate to gather, measure and analyze information. Professionals especially in business consulting, retail banking, market research, quantitative marketing, IT, Business Intelligence, finance, operations as well as managers focused on using data to extract business value. Recent programming experience and facility with basic mathematical concepts and quantitative techniques are necessary.

All applicants should have demonstrated academic success as evidenced by undergraduate and graduate courses and grades. The admissions committee considers the totality of a candidate's experience, skills, personality and potential to reach a decision, aiming for a diverse class of motivated students who can most benefit from and contribute to our rigorous program of study.

Application process and admission requirements

The application period for the MSc in Data Science for this academic year (2015-2016) is as follows: Part Time (PT): **September 28th, 2015 to October 15th, 2015**. The admissions committee may review submitted applications at any time and send acceptance/rejection letters earlier than the respective deadline. Acceptance letters will be sent out at the latest by October 23rd.

Each application is required to include the following:

- Completed and signed application form
- Copy of all university degrees/diplomas received
- Copy of transcripts of grades in Greek or English. Accepted candidates must submit official transcripts
- Certificate of equivalence for degrees from foreign Universities, issued by DOATAP (or proof that an application for certification has been filed -- admission is contingent on submission of certificate by December 2015).
- Excellent knowledge of English (Certificate of Proficiency in English from U. of Michigan/ Cambridge), TOEFL (at least 80), IELTS (at least 6.5)
- GRE scores (if available)
- Two recommendation letters
- Proofs of employment (required for part-time program)
- CV in English
- Photo
- Application fee of €25 (**WAIVED**)

The Program does not discriminate on the basis of race, color, religion, national origin, sex, sexual orientation, gender identity, age, genetics information or disability. Our nondiscrimination policy applies to all phases of its admission and scholarship process, and to all aspects of its educational programs and activities.

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Applications are accepted until **October 15th, 2015.** Places are limited. Acceptance letters will be sent out at the latest by October 20th. Applications may be submitted in person or via mail at the following address:

Secretariat for Graduate Programs, Informatics Department, Athens University of Economics and Business, Evelpidon 47A & Lefkados, Athens 11362 Greece, 7th Floor, Office 705 (Monday-Thursday 12:00-14:00 and Friday 11:00-13:00, tel.: (+30) 210-82.03.645, Ms. Elpida Chiona.)

 For clarifications and any other information, interested parties may also contact the Secretariat during the same hours. Application materials can be downloaded from http://www.cs.aueb.gr/el/datascience or http://www.cs.aueb.gr/en/datascience

Program Structure

The Part Time (PT) program is a 2-year program. Students need to complete 75 units of coursework, of which 40 units of core courses and 35 units of electives. Full courses are worth 5-6 units, half courses are worth 3 units. Teaching is organized into 3 teaching periods per year (for a total of 6 teaching periods), each of a 10 week duration. Students can replace 15 units of coursework with an integrated Capstone Project in collaboration with industry, or a faculty-supervised research thesis, with Director approval.

Before the beginning of classes students are required to complete 1-3 preparatory courses in Statistics, Mathematics, and Computer Science, as decided by the Admissions Committee. Each course comprises 4 3-hour lectures and a final exam.

Classes take place twice a week, 6:00-9:00pm. Attendance of lectures and laboratory sessions is mandatory. The maximum number of students per academic year is forty (40).

Tuition Fees

The Part Time (PT) program fees are €7500, payable as follows:

€1000 upon enrollment in the Program, by November 1st

€2000 to be paid by January 10th of the first year,

€2000 to be paid by June 10th of the first year,

€1500 to be paid by September 10th of the second year,

€1000 to be paid by January 10th of the second year.

Tuition fees are non-refundable. Program LAEK of OAED funds part of tuition fees for a number of students, if the necessary conditions apply. A limited number of merit-based scholarships is available.

Athens, September 28, 2015

Rector   Program Director

Professor K. Gatsios   Professor V. Vassalos

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Additional Information - Curriculum

Core courses:

Probability and Statistics for data analysis (6 units)

Basic principles of Probabilities. Basic theorems in Probability e.g. law of large numbers, the Central Limit theorem etc. Common probability distributions. Principles of statistics. Data summarization. Statistical inference and causality, Experimental design and sampling methods, Estimation and hypothesis testing. Bootstrap and variants.

Practical Data Science (6 units)

The course gives students a set of practical skills for handling data that comes in a variety of formats and sizes, such as texts, spatial and time series data. These skills cover the data analysis lifecycle from initial access and acquisition, modeling, transformation, integration, querying, application of statistical learning and data mining methods, and presentation of results. (The course is hands-on, using python, in iPython interactive computing framework.)

Large Scale Data Management (6 units)

Methods and techniques for database design and management, operational data management and transaction processing, data warehouse creation, and information retrieval. New approaches for storage and querying (column stores, NewSQL) will be discussed and experimented upon. Management of large scale structured and unstructured data in different information systems environments.

Machine Learning and Computational Statistics (7 units)

Introduction to the basic ideas of statistical learning models (supervised and unsupervised learning). Model selection, feature selection and cross-validation. Linear regression and logistic regression. Generalized linear models. K-nearest neighbor classification, Bayes and naive Bayes classifiers. Kernel Discriminant Analysis and Support Vector Machines. Unsupervised learning methods. Clustering using k-means and mixtures models. The EM algorithm. Dimensionality reduction using PCA, probabilistic PCA, factor analysis and independent component analysis.

Numerical optimization and Large Scale Linear Algebra (6 units)

Floating point arithmetic; Stability of numerical algorithms; Norms; Fundamentals of matrix theory; Solution of systems of linear equations: direct methods, error analysis, structured matrices; Iterative methods for linear equations and least squares; Eigenanalysis; important matrix factorizations and their algorithms. Application to case studies.

Data visualization and communication (6 units)

Communicating clearly and effectively about the patterns we find in data is a key skill for a successful data scientist. Visualizations are graphical depictions that can improve comprehension. Collaborative filtering Visualizations will be paired with verbal analyses and reporting. Different tools will be used to transform

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data and create visualizations, including Python, Google Charts, Tableau, and Spotfire. Assignments will give students experience with reporting on complex patterns and results with graphics and prose.

Legal, ethical and policy issues in data science (3 units)

Discusses issues of privacy, surveillance, security, classification, discrimination and decisional autonomy from a legal, ethical, and policy perspective (whether business or public policy). Areas of relevance include health, marketing, employment, law enforcement, and education.

Electives (indicative list):

Data mining (6 units)

Data-oriented techniques for extracting patterns from data. Association rules, decision trees. Collaborative filtering and recommendation algorithms Finding similar items and frequent itemsets. Mining data streams. Mining social network graphs. Mining for Web advertising. Implementing machine learning schemes.

Bayesian Statistics and simulation methods (6 units)

Bayesian inference. Simulation and random number generation. Markov models and hidden Markov models. Probabilistic graphical models. Bayesian statistical methods, Markov chain Monte Carlo, Metropolis-Hastings algorithm, Gibbs sampling, sequential Monte Carlo methods, approximate Bayesian computation.

Advanced Large Scale Data Management (5 units)

Distributed and parallel data-oriented computation and transaction processing. Integration and management of large scale structured and unstructured data in different information systems environments.

Big Data Systems and techniques (3 units)

Cloud services, engineering issues, stream processing, graph processing, Cassandra, Dremel, Pregel, Storm, parallel data mining systems (Graph Lab, Mahout).

Statistical methods for Big data (3 units)

Small n large p problems, regularizations, model and variable selection techniques, LASSO, elastic net. Multiplicity. Graphical Models. Techniques for sparse matrices and graphical LASSO. Compressed sensing.

Time series and Forecasting methods (3 units)

Basic principles, autocorrelation and autocovariance, Holt-Winters method, AR, ARMA, ARIMA models. Regression models, ARCH – GARCH, volatility models.

Optimization (5 units)

Convex and semidefinite optimization (Convex sets and functions, Problems, duality, unconstrained and constrained minimization), Combinatorial optimization (Branch and bound, tabu search, Simulated annealing), Multivariate function optimization (e.g. gradient descent). Linear Programming (Formulations, Algorithms).

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Text analytics (6 units)

Language models, text normalization. Applying feature extraction, classification, sequence labeling algorithms (e.g., PCA, naive Bayes, logistic regression, SVMs, HMMs, CRFs) to texts (for document classification, entity recognition etc.). Parsing (CKY, Earley, probabilistic CFGs). Semantics (logic-based, distributional, word embeddings, sense disambiguation) and discourse analysis (co-reference, rhetorical relations). Machine translation. Information extraction (incl., relation extraction) and sentiment analysis. Question answering. Text summarization. Concept-to-text generation. Speech recognition fundamentals.

Data science and optimization for operations management (5 units)

Overview of basic concepts from operations management: Process Analysis, queues, inventory management, revenue management. Demand Forecasting. Inventory/Replenishment Optimization. Lead Time Analysis. MRP/Production Planning. Fleet Allocation. Route Optimization

Marketing and sales analytics (6 units)

Overview of data mining techniques: clustering, classification, dimensionality reduction, sequence modeling. Techniques for Customer Segmentation. Churn management. Cross-/Up-sell Campaign Targeting. Next Best Action. Marketing Mix optimization. Omni-Channel Optimization. Loyalty Analytics. Basket Analysis

Data Science for medicine (3 units)

Introduction to epidemiological methods: bias, confounding, sample size. Survival analysis: hazard functions, parameter inference. Methods for categorical data. Analysis of contingency tables, risk assessment in retrospective and prospective studies

Information retrieval (3 units)

Text vocabulary, automatic indexing, inverted files, fast inversion algorithm, index compression. Evaluation of information retrieval systems. Information retrieval models (Boolean model, vector space model, probabilistic retrieval model), latent semantic indexing. Computing scores, result ranking. Crawling. Link analysis. Search engine architecture and systems issues.

Data curation (3 units)

Data lifecycle and value chains. Data provenance, curation and preservation: models, practices and tools. Using ontologies and metadata. Data and metadata aggregators and repositories.

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Additional information - Academic Calendar for 2015-2016

PREPARATORY COURSES (2 weeks)

START		MONDAY	**2/11/2015**
END		FRIDAY	13/11/2015
1st TEACHING PERIOD			
START		MONDAY	**16/11/2015**
WINTER HOLIDAY BREAK			
START		*MONDAY*	*21/12/2015*
END		*FRIDAY*	*1/1/2016*
END		FRIDAY	5/2/2016
EXAMS			
START		MONDAY	8/2/2016
END		FRIDAY	12/2/2016
2nd TEACHING PERIOD			
START		MONDAY	**15/2/2016**
END		FRIDAY	**23/4/2016**
EXAMS			
START		MONDAY	24/4/2016
SPRING HOLIDAY BREAK			
START		*THURSDAY*	*28/4/2016*
END		*TUESDAY*	*3/5/2016*
END		FRIDAY	6/5/2016
3rd TEACHING PERIOD			
START		MONDAY	9/5/2016
END		FRIDAY	15/7/2016
EXAMS			
START		MONDAY	18/7/2016
END		FRIDAY	23/7/2016

The academic year of 2016-2017 will start on **5/9/2016**, with preparatory courses.
The 1st teaching period will start on **26/9/2016**. The academic year will end on **16/6/2017.**