  

**MATHS FOR COMPUTING**

AREA: Human Sciences MASTER IN DIGITAL

BUSINESS AND INNOVATION

Nº OF SESSIONS: 15

Professor: **MANUELE LEONELLI**

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# Manuele Leonelli is an Assistant Professor in the School of Human Sciences and Technology at IE University. He obtained a PhD in Statistics from the University of Warwick in 2015 under the supervision of Jim Q. Smith. He then won a CAPES post-doctoral fellowship working at the Federal University of Rio de Janeiro, Brazil, under the direction of Dani Gamerman. Before joining IE University, he was a Lecturer in Statistics in the School of Mathematics and Statistics at the University of Glasgow and a Visiting Professor in the Faculty of Medicine at McGill University, Montreal.

# Manuele’s research focuses on probabilistic graphical models for decision-making under uncertainty and inference over extreme values, with a focus on approximated inferential algorithms within the Bayesian paradigm. His PhD thesis “Bayesian decision support in complex systems: an algebraic and graphical approach,” won the John Copas Prize for the best PhD Thesis in Statistics at the University of Warwick in 2015. Manuele has been recently appointed as editor of Bernoulli News.

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# OBJECTIVES

The main goal of this course is to provide a mathematical foundation for analyzing data and drawing inferences from that analysis. Moreover, the course aims to increase the student's mastery of the deductive nature of reasoning and understanding the nature of critical thinking while increasing the student's problem-solving abilities and abstract deduction.

In this course, students will learn a particular set of mathematical facts and how to apply them. They will work with discrete structures including sets and graphs. Students will investigate the basic techniques of counting as well as the foundations of both linear algebra and calculus. Real world applications will motivate and illustrate the methodology.

The course is divided into four modules:

1. Introduction to mathematical reasoning
2. Matrices and linear algebra
3. Calculus
4. Additional topics in mathematics

# METHODOLOGY

The module will consist of both synchronous and asynchronous lectures. Students are required to attend both actively. Asynchronous lectures will consist of forum where students will summarize and comment articles discussing the use of mathematical techniques in the real-world.

# PROGRAM

**Module 1: Introduction to mathematical reasoning**

# *Session 1 (synchronous):* Module’s structure and assessment. Introduction to set theory.

# *Session 2 (synchronous):* Definition of functions, domain and codomain. Applied use of functions.

**Module 2: Matrices and linear algebra**

# *Session 3 (synchronous):* Introduction to matrices and their use for data representation. Operations between matrices.

# *Session 4 (synchronous):* Use of matrices for regression problems. Definition of the determinant, matrix inverse, minors and rank.

# *Session 5 (synchronous):* Matrix decompositions and systems of linear equations. Use of these techniques in machine learning.

# *Session 6 (asynchronous):* Use of matrices in image processing.

**Module 3: Calculus**

# *Session 7 (synchronous):* Introduction to calculus, derivatives and optimization. Use of calculus in statistics.

# *Session 8 (synchronous):* Integration of real functions and its use in probability.

# *Session 9 (asynchronous):* An overview of multivariate calculus.

**Module 4: Additional topics in Mathematics**

# *Session 10 (synchronous):* Foundations of combinatorics. Examples from password security.

# *Session 11 (synchronous):* An introduction to probability

# *Session 12 (synchronous):* Definitions of graphs and their properties.

# *Session 13 (asynchronous):* Analysis of social networks via graph theory.

# *Session 14 (synchronous):* General review.

# *Session 15 (synchronous):* Final exam.

# EVALUATION CRITERIA

The final note is based on the following criteria: 20% work and participation in class, 40% quizzes and 40% final exam. Notice that although the module is graded, the curve method will not be applied.

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| --- | --- | --- |
| **Criteria** | **Percentage** | **Comments** |
| Work and participation in class | 20% | Quality and not quantity of participation is graded |
| Quizzes | 20% |  |
| Final exam | 60% |  |

**Participation (20%)**

Active participation in class activities is an especially important aspect in this course because our focus will be on understanding how the concepts discussed in class can be applied in real-world contexts. Your grade will be based on: active engagement in synchronous classes and asynchronous classes.

**Short Quizzes (20%)**

Throughout the course, you will be given four quizzes, one for each module of the course. These quizzes are intended to evaluate your understanding of the material discussed in the prior classes. Each quiz will consist of 10 multiple choice questions. Quizzes must be taken within the time frame given or a score of zero is assigned to the students.

**Final Exam (60%)**

The exam format will consist of multiple choice questions. The final exam will be held during the scheduled class time.

# BIBLIOGRAPHY

Title: Discrete Mathematics and its Applications

Authors: Rosen, Kenneth H.

Publisher / Edition / Year: McGraw Hill / 7th edition/ 2013

ISBN / ISSN: 978-0-07-131501-2

Medium:  PRINT  ELECTRONIC

Title: Essential Mathematics for Economic Analysis

Authors: Sydsaeter, Knut & Hammond, Peter & Strom, Arne

Publisher / Edition / Year: Pearson / 4th edition/ 2012

ISBN / ISSN: 9780273760689 0273760688

Medium:  PRINT  ELECTRONIC

Additional documents will be posted on Campus Online throughout the module.