MARBELLA INTERNATIONAL UNIVERSITY CENTRE

Module Study Guide

Academic Year 2021–2022

(Spring semester)

ML – Machine Learning

Level: 6

Credits: 5 ECTS; 10 UK credits

Table of contents

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1 Module overview

1.1 Introduction

Machine Learning is interdisciplinary by nature and draws on computer science, mathematics, statistics, biology, neuroscience, cognitive science, linguistics, ethics, psychology and law. Machine learning offers you an integrative and cutting-edge approach to the field and its application to real scenarios. The emphasis is on practical techniques—and a solid theoretical background—for designing and constructing intelligent systems, enabling to apply the skills in a variety of settings. These skills are in high demand in the market. You will have the skills to identify how ML techniques can provide intelligent solutions to IT problems in companies and organizations.

1.2 Module summary content and aims

The machine learning Intelligence module is designed to provide you the knowledge in how to address and solve real-life problems based on data: you will get expertise in supervised, unsupervised and reinforcement learning, which are the three main branches of machine learning, and will also learn how to build predictive models of different nature (parametric and non-parametric) that will allow you to predict an event of interest for a new given record.

The module is composed mainly of lectures and seminars and will run throughout the semester (14 weeks).

1.3 Learning outcomes to be assessed

At the end of the module you will be able to:

1. Critically evaluate the efficacy of advanced data preparation methods and contrast main supervised and unsupervised learning algorithms.
2. Design and implement various machine learning algorithms in a range of real-world applications and critically evaluate the outcome of learning on a given problem
3. Design and create predictive models of different nature (parametric and non-parametric).
4. Articulate decisions, recommendations and other relevant information in a clear, concise presentation tailored to a wide range of audiences within both academic and real-world settings.

1.4 Indicative Contact Hours

Teaching Contact Hours	42 hours
Guided Independent Study	18 hours
Independent Study Hours	144 hours
Total Learning Hours	200 hours

1.5 Summative assessment grid

Type of Assessment	Word Count or equivalent	Threshold (if Professional Body-PSRB applies)	Weighting	Pass Mark	Indicative Submission week	Method of Submission & Date of Feedback (refer to NEOlms)
Written Assignment	2000	n/a	100%	50	Week 15 (Date and Time TBC)	Via NEOLMS & 10 working days after in-class exercises

1.6 Assessment brief including criteria mapped to learning outcomes

Assessment 1: Final report.

In the assessment, you have to submit a final report that justifies all the modelling decisions made for the predictive model you built. During the semester, you will carry out a project in which you will have to provide a solution to a specific problem based on a case. You will be expected to choose an appropriate machine learning model to make predictions and provide one evaluation strategy to assess the performance of the model.

The report could be structured in the following way:

- Introduction: provide an overview of the data and the event of interest that is being predicted.
- Materials and Methods: describe in detail the data and artificial intelligence techniques used in the project.
- Results: performance of the predictive model built in new unseen data.
- Conclusion: discussion and conclusion reached in the project.

Assessment criteria for Assessment 1 (LO1, LO2 and LO3 will be assessed)
This assessment will be marked according to the following criteria:

- **Knowledge and Understanding (20%):** Demonstrate an understanding of the principles, terms and concepts of the artificial intelligence and predictive modelling. The project report provides accurate information that shows the knowledge of the student in the availability of several supervised and unsupervised machine learning models. In addition, the report includes the use of an evaluation strategy that allows the student to give a performance of the build model in future unseen data.
- **Cognitive Skills (20%):** Ability to analyze problems and apply learned concepts into multidisciplinary areas. For a given project, the student shows outstanding abilities in identifying and using artificial intelligence techniques, i.e., the student can choose the appropriate machine learning model to solve a specific problem among all the possibilities available.
- **Practical/Professional Skills (30%):** Independence, capacity, creativity and initiative to provide practical solutions to the questions proposed. Given a specific problem and once

the appropriate machine learning model is identified, the student demonstrates the ability to use standard tools and build a predictive model capable of predicting the desired outcome for new unseen samples with an acceptable predictive accuracy.

- **Transferable Skills (30%):** Demonstrate outstanding skills in presenting information and results. Independent work abilities with minimal guidance will also be considered. The report is well-structured and contains a clear explanation on each decision made during the different stages involved in predictive modelling.

For guidance on online submission of assignments, including how to submit and how to access online feedback, please refer to the MIUC lms student guideline.

1.7 Learning materials

The reading list for this module is available on lms in the module area

1.7.1. Core textbook(s):

Russel, S., Norvig, P. (2014). *In Artificial Intelligence: A Modern Approach* 3rd Edition. Pearson Education Limited.

1.7.2. Other recommended reading:

- Burkov A. (2019). *The Hundred-Page Machine Learning Book*. The ML Book.
- Neapolitan R. E., Jiang X. (2018): *Artificial Intelligence: With an Introduction to Machine Learning.* Chapman and Hall/CRC.

1.7.3. Other resources:

- Mehryar M., Rostamizadeh A., Talwalkar A. (2018): *Foundations of Machine Learning.*The MIT Press.
- Shalev-Shwartz S., Ben-David S. (2014): *Undestanding Machine Learning: From Theory to Algorithms.* CUP.

Remember to log into MIUC lms daily to receive all the latest news and support available at your module sites!

2 Things you need to know

2.1 Engagement

During the academic year 2021-22, the health, welfare and safety of all our students and staff is our top priority as Spain continues to deal with the ongoing implications of the COVID-19 outbreak.

Face to-face-teaching, access to MIUC facilities and being part of our unique University community are key parts of the excellent student experience at MIUC. We have been working to create a safe and efficient plan that will allow us to deliver these elements when you start with us in the fall semester, subject to government regulation.

MIUC will be ready to teach in September and we are committed to engaging with you as closely as we can, and to ensuring that you have a rich educational experience that is safe and protected to ensure that you continue to get the most from the University life and the city of Marbella.

Whether you are engaging with teaching and learning activities on site or via the MIUC Virtual Learning Environment, we expect the same level of commitment and engagement from you. If you are unable to attend scheduled on site or online activities or complete activities in the timeframes set out, you should let your module leaders know. You should aim to stick to assessment deadlines; if you are concerned that you will not be able to complete your assessments on time, you should talk to your module leaders. Your engagement, whether online or on site, will be tracked and if we see that you are not engaging, we will get in contact with you. However, we encourage you to let us know if you are struggling so we can work with you to find solutions and get you back on track as soon as possible. Give yourself the best possible chance to succeed by engaging with the full range of learning and teaching activities available to you.

2.2 Need help, just ask

The University recognises that there are times when you may encounter difficulties during your course of study and provisions are made to help you. If you are struggling with meeting deadlines please talk to us, whether it's your course/module leader, personal tutor or any member of staff, speak to them so they can get you the support you need to succeed. You can extend your deadline if you have a good reason why you are not able to submit a piece of coursework on time, apply online for an extension before your deadline. An extension will allow you an extra 10 working days. If an extension is not sufficient and circumstances beyond your control are preventing you from completing your assessment, then you can, apply online for mitigation.

Please remember late submission without extension or mitigation will result in penalties depending on how late it is, see Academic Regulations.

You are reminded that MIUC applies penalties to students who commit an academic offence, in which case the Academic Offences Regulations will be used to deal with any cases of academic misconduct including examination offences, plagiarism and other means of cheating to obtain an advantage.

You are encouraged to seek advice from the Students' Union and counselling service which support you with all aspects of your academic experience by providing advice and guidance to ensure you are fully informed of the academic regulations as well as advocate for student views.

You are expected to behave in line with University expectations, irrespective of whether your interactions with staff and other students are in person or online. As you will be engaging with others online and a range of online materials, it is important to consider how to stay safe online and ensure your communications are secure and appropriate. If you have any questions about how to manage your online activities, please contact your module leader.

If you have an issue about the module, you should speak to your Module Leaderor Course Leader informally in the first instance. Your Course Representative can also raise your concerns at Course Committees, which take place each semester. If you are unable to resolve it informally, you should refer to the Complaints Procedure which is outlined in the student handbook and consult the Students' Union about it. The University aims to ensure that issues are resolved informally as quickly as possible to have minimum impact on your studies.

2.3 Getting support for your studies

Throughout your course of study, you will have access to a wide variety of sources of support depending on your individual circumstances and needs. Your first point of call for getting general academic support is your Personal Tutor. As well as approaching your Module Leader with any questions specifically related to your module and your Course Leader with questions on your Course, do contact your Personal Tutor for academic advice in relation your studies and your academic development.

Apart from the University-wide support framework, which encompasses the Module Leaders, Course Leader, the Subject Librarian and your Course Administrator, you will also have at your disposal the MIUC Academic Support Team. The Team offers Academic Skills Workshops throughout the year, helping you to develop skills relevant to your degree. Workshops include for instance Essay Planning and Writing; Critical Thinking; Reflective Writing; Group Work and Presentation Skills.

English Language support and One-to-one academic support opportunities are also available. For information about all these services, please consult the Academic Office.

2.4 Student support

In addition to the support listed in the previous section, there is also more help offered by MIUC Student services, consisting of Student Life Department, Internship Support, Life Coaching Service and Counselling service. They offer a wide range of support and services consisting of extracurricular activities; Careers and internship support; Student Welfare and Counselling.

Contact Student Services for more information at:

Student Life Department: student.life@miuc.org

Internship Support: TBC

Life Coaching Service: Ms. Ana Cantle, ana.cantle@miuc.org

Counselling Service: Ms. Eva Berkovic, eva@miuc.org

2.5 Module evaluation – have your say!

Towards the end of the module you will be invited to provide someanonymousfeedback to the Module Leader through a (online) survey. This is your opportunity to give some direct feedback about the module through a series of questions and free text. Your constructive feedback will help the Module Leader and teaching team to understand the module experience from your perspective and helps inform the development of the module.

3 Appendix: Weekly Content

Week 1 - Introduction to Artificial Intelligence and Machine Learning.

Key concepts/issues:
Course introduction; Artificial Intelligence; Machine Learning

Literature for this session:

- Russel, S., Norvig, P. (2014) Chapter 1. In *Artificial Intelligence: A Modern Approach*. 3rd edition. Pearson Education Limited.
- James, G., Witten, D., Hastie, T., Tibshirani, R (2013) Chapter 1. In *An Introduction to Statistical Learning with Applications in R*. Springer Texts in Statistics.

Independent study:
Download and install R, RStudio, Weka
Description:
This session will introduce you to the module organization, structure and assessments. You will be exposed to the time commitments you will need to make and the skills you will develop through the duration of the module. Furthermore, you will get an understanding of what artificial intelligence and machine learning refer to.

Week 2 - Artificial intelligence: types of algorithms

Key concepts/issues:

Search algorithms; Knowledge-based algorithms; Learning algorithms

Literature for this session:

- Russel, S., Norvig, P. (2014) Chapter 1. In *Artificial Intelligence: A Modern Approach*. 3rd edition. Pearson Education Limited.
- James, G., Witten, D., Hastie, T., Tibshirani, R (2013) Chapter 1. In *An Introduction to Statistical Learning with Applications in R*. Springer Texts in Statistics.

Independent Study:
Assigned Reading

Description:
In this session, you will be introduced to a brief classification of artificial intelligence algorithms like search, knowledge-based and learning ones. You will be able to learn the philosophy behind each of these types of algorithms and when they are suitable to be applied.

Week 3 – Use of Artificial Intelligence.

Key concepts/issues:

Artificial Intelligence, Machine Learning, Deep Learning.

Literature for this session:

- James, G., Witten, D., Hastie, T., Tibshirani, R (2013) Chapter 5. In *An Introduction to Statistical Learning with Applications in R*. Springer Texts in Statistics.
- Hastie, T., Tibshirani, R., Friedman, J. (2009) Chapter 8. In *The Elements of Statistical Learning*. Springer Texts in Statistics.

Independent Study:
Complete exercises

Description:

This module aims to achieve the following objectives:

• Understand what Artificial Intelligence is.

• Analyze the current situation of this technology.

• Know its characteristics and components.

• Become familiar with its main applications.

Week 4 - Linear models

Key concepts/issues:

Linearly separable; Regression; Classification.

Literature for this session:

- Russel, S., Norvig, P. (2014) Chapter 18. In *Artificial Intelligence: A Modern Approach*. 3rd edition. Pearson Education Limited.
- James, G., Witten, D., Hastie, T., Tibshirani, R (2013) Chapters 2, 3. In *An Introduction to Statistical Learning with Applications in R*. Springer Texts in Statistics.
- Hastie, T., Tibshirani, R., Friedman, J. (2009) Chapters 10, 15, 21, 22. In*The Elements of Statistical Learning*. Springer Texts in Statistics.

Independent Study:
Complete exercises

Description:

In this session, you will be introduced to the simplest predictive model in machine learning: linear models. You will learn that this type of model is suitable when it exists a linear relationship between the dependent and independent variables. Moreover, you will learn the concepts of regression and classification problems.

Week 5 - Implementation

Key concepts/issues:

L1 and L2 penalties; Over-fitting; Feature selection

Literature for this session:

- Russel, S., Norvig, P. (2014) Chapter 18. In *Artificial Intelligence: A Modern Approach*. 3rd edition. Pearson Education Limited.
- James, G., Witten, D., Hastie, T., Tibshirani, R (2013) Chapter 6. In *An Introduction to Statistical Learning with Applications in R*. Springer Texts in Statistics.
- Hastie, T., Tibshirani, R., Friedman, J. (2009) Chapters 13, 22. In *The Elements of Statistical Learning*. Springer Texts in Statistics.

Independent Study:
Complete exercises

Description:

You have already discovered that AI is useful in many areas of your business, but for AI projects to be successful, the organization has to be ready to embrace this technology and include it as one of its pillars organizational. In this unit, you will see some examples of what the challenges faced by most of the companies when launching initiatives related to AI

Week 6 – Application of the AI to the company

Key concepts/issues:

Distance definition; Non-parametric model; Local position

Literature for this session:

- Russel, S., Norvig, P. (2014) Chapter 18. In *Artificial Intelligence: A Modern Approach*. 3rd edition. Pearson Education Limited.
- Hastie, T., Tibshirani, R., Friedman, J. (2009) Chapter 11. In *The Elements of Statistical Learning*. Springer Texts in Statistics.

Independent Study:
Complete exercises
Description:
So far this year we have learned what AI is, its main applications, its fundamental characteristics and the great challenges your company faces. Now in this unit we are going to analyze how AI affects the most important functional areas of any organization. You will see examples, case studies, applications and companies that already have very interesting and directly applicable AI-based products and services. Some of the examples that you will see in this unit are focused on companies that have a large amount of data to generate their own models. Other of the companies mentioned in this unit already sell services in trained models that you can use with a small adjustment to adapt to your reality.

Week 7 – Examples of AI in the main sectors

Key concepts/issues:
Decision tree; Bagging

Literature for this session:
- Hastie, T., Tibshirani, R., Friedman, J. (2009) Chapters 8, 9. In *The Elements of Statistical Learning*. Springer Texts in Statistics.

Independent Study:
Complete exercises

Description:

In the previous unit, you saw many examples of companies and use cases that apply to the different functional areas of a company. In this unit you will analyze examples and use cases referring to different sectors of importance in the Andalusian economy, such as: the industrial sector, tourism and hospitality, agriculture and professional services. At the end of this unit, you will also spend time learning the basics of building your own chatbot

Week 8 – Test Use of Artificial Intelligence

Key concepts/issues:

Kernel-based model; Types of kernels

Literature for this session:
- Russel, S., Norvig, P. (2014) Chapter 18. In *Artificial Intelligence: A Modern Approach*. 3rd edition. Pearson Education Limited.
- James, G., Witten, D., Hastie, T., Tibshirani, R (2013) Chapter 9. In *An Introduction to Statistical Learning with Applications in R*. Springer Texts in Statistics.
- Hastie, T., Tibshirani, R., Friedman, J. (2009) Chapters 5, 19, 24. In *The Elements of Statistical Learning*. Springer Texts in Statistics.

Independent Study:
Complete exercises

Description:
In this session, you will be doing a test to do a recapitulation of the learned concepts and connect them with other areas like big data, cloud and the impact in the informed intelligent decisions.

Week 9 – Test linear models

Key concepts/issues:

Clustering; Distance-based measure; Types of distances

Literature for this session:

- James, G., Witten, D., Hastie, T., Tibshirani, R (2013) Chapter 10. In *An Introduction to Statistical Learning with Applications in R*. Springer Texts in Statistics.
- Hastie, T., Tibshirani, R., Friedman, J. (2009) Chapters 2, 26. In *The Elements of Statistical Learning*. Springer Texts in Statistics.

Independent Study:
Complete exercises

Description:
In this session, you will be introduced to the simplest unsupervised machine learning model: k-means. You will learn to use this model to perform predictions or discover clusters in your data by using different distance definitions.

Week 10 – Test implementation

Key concepts/issues:
Latent variable; Matrix decomposition; Recommender system
Literature for this session:

- R bloggers.

https://www.r-bloggers.com/nonnegative-matrix-factorization-and-recommendor-systems/
https://www.r-bloggers.com/quick-intro-to-nmf-the-method-and-the-r-package/

Independent Study:
Complete exercises

Description:

In this exercise, the student will pull data from a social network (Twitter) to apply text mining analysis techniques.

Week 11 – Test application of AI to the company

Key concepts/issues: Data representation; Chromosome; Local search; Heuristics; Population evolution; Cross-over and mutation operations

Literature for this session:

- Russel, S., Norvig, P. (2014) Chapter 4. In *Artificial Intelligence: A Modern Approach*. 3rd edition. Pearson Education Limited.

Independent Study: Complete exercise

Description:

In this example the student will experience how the companies predict if a customer will purchase a new product based on different variables.

Week 12 – Predictive models comparison

Key concepts/issues: Minimization cost; Optimality

Literature for this session:

- Russel, S., Norvig, P. (2014) Chapter 3. In *Artificial Intelligence: A Modern Approach*. 3rd edition. Pearson Education Limited.

Independent Study: Complete exercise

Description:

n the exercise the student will compare the performance of different algorithms to do prodictions based on Google Analytics data

Week 13-14 - Project submission and Recapitulation, Remarks, Doubts

Key concepts/issues: Recapitulation, Remarks, Doubts

Literature for this session:

- Review of previous material
- Submit the assessment on Week 13

Description:

In this session, we will review the material covered in class and you will have the opportunity to solve your doubts to deepen your knowledge.