Course guide
270747 - MLCG - Machine Learning in Computer Graphics

Last modified: 02/02/2024

Unit in charge: Barcelona School of Informatics
Teaching unit: 1004 - UB - (ENG)Universitat de Barcelona.

Degree: MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2017). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: RICARDO JORGE RODRIGUES SEPULVEDA MARQUES

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA13. Capability to understand advanced techniques of Modeling , Reasoning and Problem Solving, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP1. Capability to solve the analysis of information needs from different organizations, identifying the uncertainty and variability sources.
CEP3. Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity.
CEP4. Capability to design, write and report about computer science projects in the specific area of ??Artificial Intelligence.

Generical:
CG2. Capability to lead, plan and supervise multidisciplinary teams.
CG3. Capacity for modeling, calculation, simulation, development and implementation in technology and company engineering centers, particularly in research, development and innovation in all areas related to Artificial Intelligence.

Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Basic:
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.

TEACHING METHODOLOGY

The weekly schedule of in-person activities is distributed in two hours of class that includes theory and practice.

As far as possible, the gender perspective will be incorporated in the development of the subject. In addition, teachers will be attentive to those specific gender needs that students may raise, such as being able to choose a partner of the same gender if group work is carried out or being able to pose challenges against the gender gap.

LEARNING OBJECTIVES OF THE SUBJECT

1.Acquire an overview of the field of Computer Graphics, and of Physically-Based Rendering techniques in particular.
2.Achieve an in-depth understanding of Monte Carlo Methods for Physically-Based Rendering
3.Learn and experiment with Machine Learning (ML) techniques for Boosting Monte Carlo Methods in PBR.

STUDY LOAD

Type	Hours	Percentage
Hours large group	12,0	16.00
Guided activities	3,0	4.00
Self study	48,0	64.00
Hours small group	12,0	16.00

Total learning time: 75 h

CONTENTS

Block 1: Introduction to Computer Graphics and Rendering Techniques

Description:
This first block provides an overview of the Computer Graphics field and the main current challenges. It will also provide details about the open problem of Physically-Based Rendering (PBR) and the Light Transport Equation (LTE) on which we will focus during this course.

Block 2: Monte Carlo Methods for Physically-Based Rendering

Description:
This block presents the use of Monte Carlo methods for PBR. We will see why Monte Carlo methods are needed and ubiquitous in photo-realistic image synthesis, how to improve their performance through variance reduction techniques, and the main limitations of the typical approaches.

Block 3: Machine Learning (ML) for Boosting Monte Carlo Methods in PBR

Description:
In this third block we will cover different ML-based approaches to overcome some of the limitations identified in the previous block.

ACTIVITIES

Theory

Description:
Theory

Specific objectives:
1, 2, 3

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CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.

Full-or-part-time: 25h
Theory classes: 12h
Self study: 13h

Practice

Description:
Practice

Specific objectives:
1, 2, 3

Related competencies :
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Full-or-part-time: 45h
Laboratory classes: 12h
Self study: 33h

Students' Presentation

Description:
Students' Presentation

Specific objectives:
3

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Full-or-part-time: 5h
Theory classes: 1h
Laboratory classes: 1h
Self study: 3h

GRADING SYSTEM

The course will follow a continuous evaluation consisting of:

Practical Project (60%) + Presentation and Report on a Research Paper (40%).

Students will work in groups. Marks for oral presentations, project development and submitted reports will be awarded on an individual basis.

BIBLIOGRAPHY

Basic:
- Pharr, Matt; Jakob, Wenzel; Humphreys, Greg. Physically based rendering : from theory to implementation. 3rd ed. Amsterdam: Morgan Kaufmann Publisher, 2016. ISBN 9780128007099.
- Dutré, Philip; Bala, Kavita; Beckaert, Philippe. Advanced global illumination. 2nd ed. A. K. Peters, Ltd., 2006. ISBN 9780367659417.
- Bishop, C. M. Pattern recognition and machine learning. New York: Springer, cop. 2006. ISBN 9780387310732.
- Rasmussen, Carl Edward. Gaussian processes for machine learning. Cambridge, Mass.: The MIT Press, cop. 2006. ISBN 9780262261074.
- Marques, R.; Bouville, C.; Santos, L.P.; Bouatouch, K. Efficient quadrature rules for illumination integrals: from Quasi Monte Carlo to Bayesian Monte Carlo. San Rafael, California: Morgan & Claypool Publishers, 2015. ISBN 9781627057691.

Complementary:
- Keller, Alexander; Kriványek, Jaroslav; Novák, Jan; Kaplanyan, Anton; Salvi, Marco. "Machine Learning and Rendering". ACM SIGGRAPH 2018 Courses (SIGGRAPH '18) [on line]. [Consultation: 09/03/2022]. Available on: https://dl.acm.org/doi/pdf/10.1145/3214834.3214841.