2015/2016

Machine learning for computer vision

Code: 43083

Credits: 6

Type: OB/OT/TFM Course: 1 Semester: 1

Contact

Name: Maria Vanrell Martorell
Email: maria.vanrell@uab.cat

Lecturers

Joan Serrat (Module coordinator)
David Vázquez (Project coordinator)
Antonio López
Fernando Vilariño
Javier Marin
Oriol Pujol
David Masip
Gustavo Camps
Jose Manuel Álvarez

Use of languages

Principal working language: English

Prerequisites

Degree in Engineering, Maths, Physics or similar

Objectives and contextualisation

Machine learning deals with the automatic analisys of large scale data. Nowadays it conforms the basics of many computer vision methods, specially those related to visual pattern recognition or classification, where 'patterns' encompasses images of world objects, scenes and video sequences of human actions, to name a few. This module presents the foundations and most important techniques for classification of visual patterns, focusing on supervised methods. Also, related topics like image descriptors and dimensionality reduction are addressed. As much as possible, all these techniques are tried and assessed on a practical project concerning traffic sign detection and recognition, toghether with the standard metrics and procedures for performance evaluation like precision-recall curves and k-fold cross-validation. The learning outcomes are: (a) Distinguish the main types of ML techniques for computer vision: supervised vs. unsupervised, generative vs. discriminative, original feature space vs. feature vector kernelization. (b) Know the strong and weak points of the different methods, in part learned while solving a real pattern classification problem. (3) Being able to use existing method implementations and build them from scratch.

Skills and learning outcomes

E01 - Identify concepts and apply the most appropriate fundamental techniques for solving basic problems in computer vision.

01 - Identify the basic algorithms of computational learning and their application.

E02 - Conceptualise alternatives to complex solutions for vision problems and create prototypes to show the validity of the system proposed.

02 - Identify the best representations that can be defined for solving computational learning problems.

E03 - Choose the most suitable software tools and training sets for developing solutions to problems in computer vision.

03 - Choose computational learning techniques and train them to resolve a particular project.

E04 - Plan, develop, evaluate and manage solutions for projects in the different areas of computer vision.

04 - Use computational learning techniques to plan, develop, evaluate and manage a solution to a particular problem.

B06 - Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.

05 - Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.

B07 - Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.

06 - Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.

B10 - Continue the learning process, to a large extent autonomously

07 - Continue the learning process, to a large extent autonomously.

T02 - Understand, analyse and synthesise advanced knowledge in the area, and put forward innovative ideas.

08 - Understand, analyse and synthesise advanced knowledge in the area, and put forward innovative ideas.

T03 - Accept responsibilities for information and knowledge management.

09 - Accept responsibilities for information and knowledge management.

T04 - Work in multidisciplinary teams.

10 - Work in multidisciplinary teams.

Content

1. Local Image Descriptors : HOG, LBP, EOH...
2. Statistical learning: overview
3. SVM for classification
4. Ensemble methods 1 : boosting, bagging...
5. Ensemble methods 2 : Random forests
6. Multiclass methods
7. Dimensionality reduction
8. Kernel methods
9. Deep learning 1
10. Deep learning 2

Methodology

Supervised sessions:

- **Lecture Sessions**, where the lecturers will explain general contents about the topics. Some of them will be used to solve the problems.

Directed sessions:

- **Project Sessions**, where the problems and goals of the projects will be presented and discussed, students will interact with the project coordinator about problems and ideas on solving the project (approx. 1 hour/week)
- **Presentation Session**, where the students give an oral presentation about how they have solved the project and a demo of the results.
- **Exam Session**, where the students are evaluated individually. Knowledge achievements and problem-solving skills

Autonomous work:

- Student will autonomously study and work with the materials derived from the lectures.
- Student will work in **groups** to solve the problems of the projects with deliverables:
    - Code
    - Reports
    - Oral presentations

Activities

TYPE	ACTIVITY	HOURS	LEARNING OUTCOMES
Supervised			
	Project, Presentation and Exam Sessions	10	1, 2, 3, 5, 6, 7, 8, 9, 10, 11

Directed

Lecture Sessions	20	1, 2

Autonomous

Homework	120	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Evaluation

The **final marks** for this module will be computed with the **following formula**:

Final Mark = 0.4 x **Exam** + 0.55 x **Project**+ 0.05 x **Attendance**

where,

Exam: is the mark obtained in the Module Exam (must be >= 3)
Attendance: is the mark derived from the control of attendance at lectures (minimum 70%)
Projects: is the mark provided by the project coordinator based on the weekly follow-up of the project and deliverables. All accordingly with specific criteria such as:

- Participation in discussion sessions and in team work (inter-member evaluations)
- Delivery of mandatory and optional exercises.
- Code development (style, comments, etc.)
- Report (justification of the decisions in your project development)
- Presentation (Talk and demonstrations on your project)

Evaluation activities

TITLE	HOURS	WEIGHTING	LEARNING OUTCOMES
Exam	3	0,4	1, 2, 5, 6, 7, 8, 9
Project	7	0,5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Bibliography

Journal articles:

1. Barber, D. "*Bayesian Reasoning and Machine Learning"*. Cambridge University Press, 2012.
2. Yoshua Bengio. "*Learning Deep Architectures for AI"*. Foundations and Trends in Machine Learning, Vol. 2, No. 1, 2009.
3. Christopher J. C. Burges. "*Dimension Reduction: A Guided Tour"*. Foundations and Trends in Machine Learning, Vol. 2, No. 4, 2009.
4. Christoph H. Lampert. "*Kernel Methods in Computer Vision"*. Foundations and Trends in Computer Graphics and Vision, Vol. 4, No. 3, 2008.
5. Tinne Tuytelaars and Krystian Mikolajczyk. "*Local Invariant Feature Detectors: A Survey*". Foundations and Trends in Computer Graphics and Vision, Vol. 3, No. 3, 2007.

Book:

1. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, "*Foundations of Machine Learning*" MIT Press, 2012. http://www.cs.nyu.edu/~mohri/mlbook/
2. Z.H. Zhou. *Ensemble Methods: Foundations and Algorithms*. Chapman & Hall/CRC, 2012.

Report:

1. Criminisi, A. and Shotton, J. and Konukoglu, E. "*Decision Forests for Classification, Regression, Density Estimation, Manifold Learning and Semi-Supervised Learning*". Technical report MSR-TR-2011-114. Microsoft Research, 2011. http://research.microsoft.com/pubs/155552/decisionForests_MSR_TR_2011_114.pdf