



# Master in Computer Vision *Barcelona*

Module: M2 — Optimization and inference techniques for  
Computer Vision

Lecture 0: Presentation

October 4th, 2022



# Contact information

- Module M2 Coordinator: Coloma Ballester [coloma.ballester@upf.edu](mailto:coloma.ballester@upf.edu)
- Project M2 Coordinator: Karim Lekadir [karim.lekadir@upf.edu](mailto:karim.lekadir@upf.edu)
  
- **Lecturers:**
  - Pablo Arias [pablo.arias@upf.edu](mailto:pablo.arias@upf.edu)
  - Coloma Ballester [coloma.ballester@upf.edu](mailto:coloma.ballester@upf.edu)
  - Karim Lekadir [karim.lekadir@upf.edu](mailto:karim.lekadir@upf.edu)
  - Oriol Ramos [Oriol.Ramos@uab.cat](mailto:Oriol.Ramos@uab.cat)

# Main goals of the module

## 1. Theoretical aspects:

- Learn about the optimization algorithms and inference techniques that are behind many tasks in computer vision.
- Main concepts: energy formulation and minimization, numerical techniques for variational problems, gradient descent optimization algorithms and tools useful for deep learning strategies. convex optimization, and graphical models.
- Special emphasis on the formulation of the optimization problem and its resolution.
- The tools learnt along this module and project are generic and present in a majority of computer vision applications (as found in other modules, e.g. M3, M4, M6).
- Exercises to practice and deliver.
  - More exercises: previous exams in the 'Evaluation' section.

# Main goals of the module

## 2. Practical aspects:

- The techniques will be applied in the context of image segmentation and inpainting.
- More detailed information on Thursday at 18:00h this week (room 52.S31 of UPF-Poblenou campus).



# Schedule

week	date	time	lecture	lecturer	university	room
1	Tue. Oct. 4th	16:00 -18:00	Introduction to optimization problems and energy minimization methods. Examples and overview of variational formulations. Numerical techniques for variational problems (I).	Coloma Ballester	UPF	zoom room aula global UPF
1	Thu. Oct. 6th	16:00 -18:00	Numerical techniques for variational problems (II): Gateaux derivative, Euler-Lagrange equation and gradient methods. Applications: denoising, image inpainting and Poisson editing. Review of numerical linear algebra (I).	Coloma Ballester	UPF	room 52.329, Roc Boronat building
1	Thu. Oct. 6th	18:00 -19:00	Project introduction	Karim Lekadir	UPF	room 52.329, Roc Boronat building
2	Tue. Oct. 11th	16:00 -18:00	Review of numerical linear algebra (II): least squares methods, singular value decomposition and applications. The Backpropagation strategy for gradient computation.	Pablo Arias	UPF	zoom room aula global UPF
2	Thu. Oct. 13th	16:00 -18:00	Gradient descent optimization algorithms useful for deep learning strategies.	Pablo Arias	UPF	room 52.329, Roc Boronat building
2	Thu. Oct. 13th	18:00 -19:00	Project follow-up	Karim Lekadir	UPF	room 52.329, Roc Boronat building
3	Tue. Oct. 18th	16:00 -18:00	Convex optimization (I). Convex sets and convex functions. Convex optimization. Segmentation with variational models. The Mumford and Shah Functional and the Level sets framework.	Pablo Arias / Karim Lekadir	UPF	zoom room - aula global UPF
3	Thu. Oct. 20th	16:00 -18:00	Convex optimization (II). Constrained optimization. Karush-Kuhn-Tucker optimality conditions.	Pablo Arias	UPF	room 52.329, Roc Boronat building
3	Thu. Oct. 20th	18:00 -19:00	HOMEWORK			
4	Tue. Oct. 25th	16:00 -18:00	Convex optimization (III). Duality principles and methods. Subgradient methods. Interior point methods. Non-convex problems and convex relaxation. Applications.	Coloma Ballester	UPF	zoom room - aula global UPF
4	Thu. Oct. 27th	16:00 -18:00	HOMEWORK			
4	Thu. Oct. 27th	18:00 -19:00	Project follow-up	Karim Lekadir	UPF	room 52.329, Roc Boronat building
5	Tue. Nov. 1st	16:00 -18:00	HOLIDAY		UPF	
5	Thu. Nov. 3rd	16:00 -18:00	Bayesian networks and MRFs. Inference types. Main Inference algorithms. Examples: stereo, denoising.	Oriol Ramos	UPF	room 52.329, Roc Boronat building
5	Thu. Nov. 3rd	18:00 -19:00	Project follow-up	Karim Lekadir	UPF	room 52.329, Roc Boronat building
6	Tue. Nov. 8th	16:00 -18:00	Belief propagation: message passing, loopy belief propagation. Applications in the context of some deep learning strategies. Exercise: inference for segmentation.	Oriol Ramos	UPF	zoom room - aula global UPF
6	Thu. Nov. 10th	16:00 -18:00	Sampling methods: Particle-based methods, Markov Chain Monte Carlo, Gibbs Sampling.	Oriol Ramos	UPF	room 52.329, Roc Boronat building
6	Thu. Nov. 10th	18:00 -19:00	Project follow-up	Karim Lekadir	UPF	room 52.329, Roc Boronat building
7	Thu. Nov. 17th	16:00 -19:00	Project Presentations	Karim Lekadir	UPF	room 52.329, Roc Boronat building
8	Tue. Nov. 22nd		HOMEWORK			
8	Thu. Nov. 24th		HOMEWORK			
9	Thu. Dec. 1st	16:00 -19:00	EXAM	Coloma Ballester	UPF	room 52.117, Roc Boronat building