Computational Astrophysics

Violeta González Pérez

2023

Computational Astrophysics

- Introduction to Computational Astrophysics
- Concepts of High-Performance Computing
- Numerical methods
- Summary of Astrophysical processes
  - Boltzman equation for a system of N-bodies
  - Gravity
  - (Magneto-)Hydrodynamics
- Gravity Solver, Tree codes
  - Direct simulation
  - Eulerian methods: PM, AMR
  - Lagrangian methods: trees and multiple expansions
  - Hybrid methods: TreePM, (A)P3M
- Gravity Solver, Grid codes
  - Eulerian methods: AMR
  - Lagrangian methods: SPH

What is your background?

Have you programmed before? What about C? and in parallel? What do you want out of this course? (the coding tutorials are highly adaptable!)

Computational Astrophysics: Lecturers

- Dr. Daniel Ceverino, Mod. 8 303, daniel.ceverino@uam.es
- Dr. Weiguang Cui, Mod. 8 312, weiguang.cui@uam.es (coordinator).
- Dr. Violeta González Pérez, Mod. 8 314, violeta.gonzalez@uam.es
- Prof. Gustavo Yepes, Mod. 8 307, gustavo.yepes@uam.es

Computational Astrophysics: Summary guide

- Course material in Moodle and for information from previous years: http://popia.ft.uam.es/ACO/
- Theory on Thursdays (15pm to 17pm).
- Coding Tutorials on Fridays (12 to 14pm), except the first week.
- Classes will take place in Aula 01.15.SS.201
- Evaluation in 2 parts that need to be passed independently:
  - Attempt to solve 3 problems (needed to be able to present the project):
    1. The Mandelbrot series.
    2. The difference between two distinct integration schemes for the equations of motion for two self gravitating bodies.
    3. A 1D code for solving the equations of gas dynamics using the Lagrangian SPH method.
  - Individual project (description to be uploaded **28th April**; 12 min. presentation **25th May**), it can consist of:
    a) Using an existing professional code for the study of an astrophysical system (solar system, galaxy collision, cosmic structure formation).
    b) Write your own code for approaching a physical phenomenon.
    c) Literature research about one of the topics of the course.

Computational Astrophysics: Schedule

Secretaría Virtual

32566-ACO classes 2022/23

day	date	time	teacher	topic	comments
Thu	23/03/2023	15-17	VGP	Introduction	
Fri	24/03/2023	10-12	VGP	HPC	
Thu	30/03/2023	15-17	VGP	Numerics Review	
Fri	31/03/2023	10-12	WC	Coding Tutorial	
Thu	06/04/2023		– – – – – – – –	– – – – – – – –	semana santa
Fri	07/04/2023		– – – – – – – –	– – – – – – – –	semana santa
Thu	13/04/2023	15-17	VGP	Physical Processes	
Fri	14/04/2023	10-12	WC	Coding Tutorial	Mandelbrot handout, Project discussion
Thu	20/04/2023	15-17	DC	Tree Codes	
Fri	21/04/2023	10-12	WC	Coding Tutorial	Kepler handout, Mandelbrot solution
Thu	27/04/2023	15-17	DC	grid N-body	
Fri	28/04/2023	10-12	WC	Coding Tutorial	SPH handout, Kepler solution
Thu	04/05/2023	15-17	GY	Hydrodynamics	
Fri	05/05/2023	10-12	WC	Coding Tutorial	
Thu	11/05/2023	15-17	GY	Hydrodynamics	
Fri	12/05/2023	10-12	WC	Coding Tutorial	
Thu	18/05/2023	15-17	GY	Hydrodynamics	
Fri	19/05/2023	10-12	WC	Coding Tutorial	SPH discussion
Thu	25/05/2023	10-14	WC+VGP+GY+DC	project presentations	
teachers	WC: Weiguang Cui (UAM, coordinator), VGP: Violeta Gonzalez-Perez (UAM), DC: Daniel Ceverino (UAM) GY: Gustavo Yepes (UAM)				

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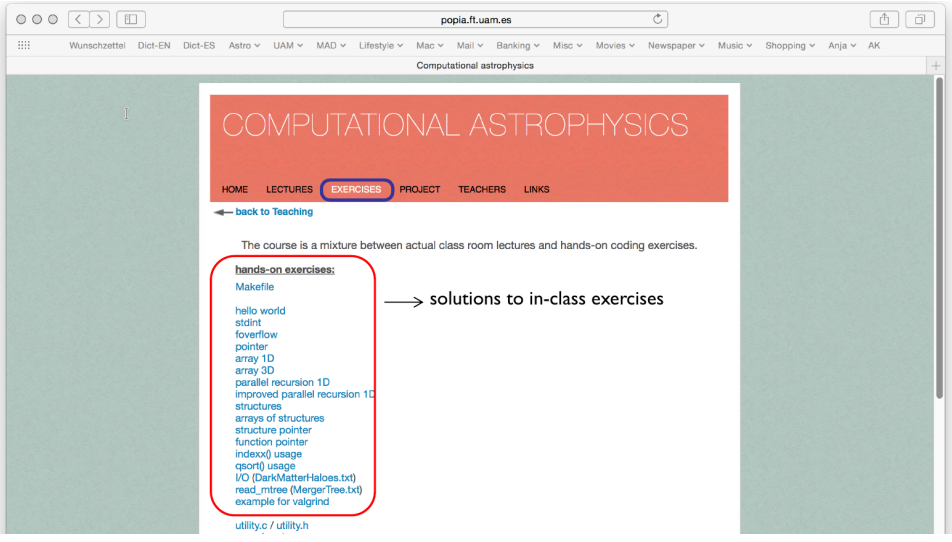
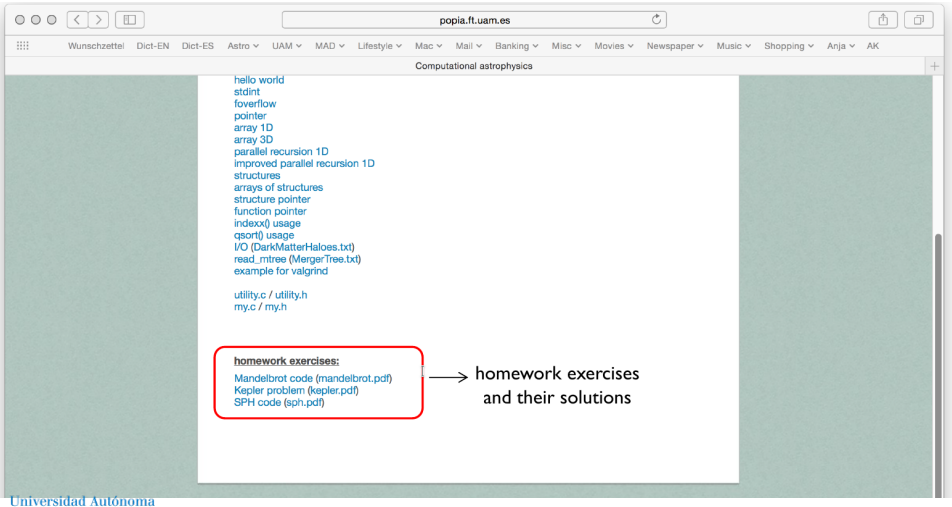
Coding tutorials: weekly excersises



Evaluation: attempt to write code for 3 problems (50%)

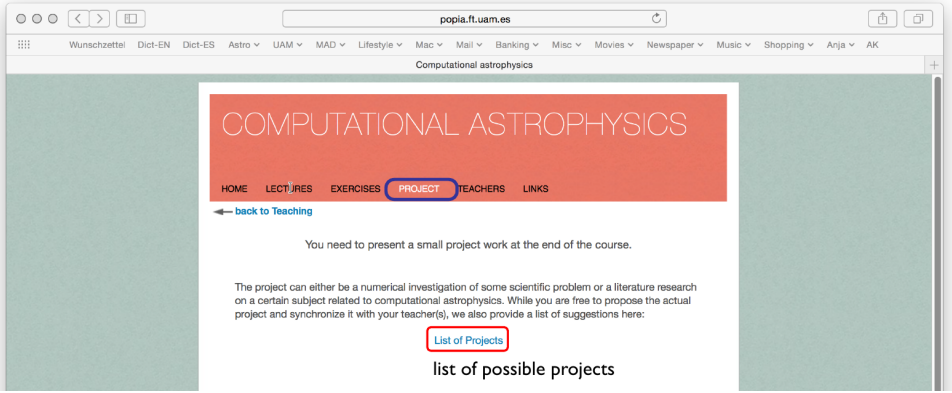
In order to pass this subject you need to attempt the following 3 excersises:



Evaluation: individual projects

Presentations: **25th May**

Deadline to upload to Moodle a paragraph describing your chosen project: **28th April**.



You can also come up with your own project. Talk to us!

Evaluation: retake exams

Students will only be permitted to attend the retake exam if they fail one or both of the evaluable parts (excersises and project).
The retake exam will be a written exam, lasting 2 hours. No books will be permitted.