# Master in Innovation and Research in Informatics (MIRI)
## Oscar Romero
## Vice-dean of Postgraduate Studies

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FIB

# FIB:
# Facultat d'Informàtica de Barcelona

Universitat Politècnica de Catalunya (UPC-Barcelona**Tech**)

# About UPC

Universitat Politècnica de Catalunya (UPC-BarcelonaTech) is a public higher education and research institution that is specialised in the fields of architecture, science and engineering and one of the leading technical universities in Europe.

Every year, more than 6,000 bachelor's and master's students and more than 500 doctoral students graduate.

UPC values:



*Social responsibility*          *Sustainability*          *Equal opportunities*          *Cooperation and solidarity*

# About FIB

The Facultat d'Informàtica de Barcelona (Barcelona School of Informatics) belongs to UPC and it is the reference centre for Informatics studies since its inception in 1976, and the beginning of the educational activities during 1977-1978.

Throughout these 40 years, the faculty has been in charge of the bachelor's degree, diploma courses, technical engineering and master degrees and currently the formal qualifications in the field of Computer Science and related subjects.

# FIB: Where?
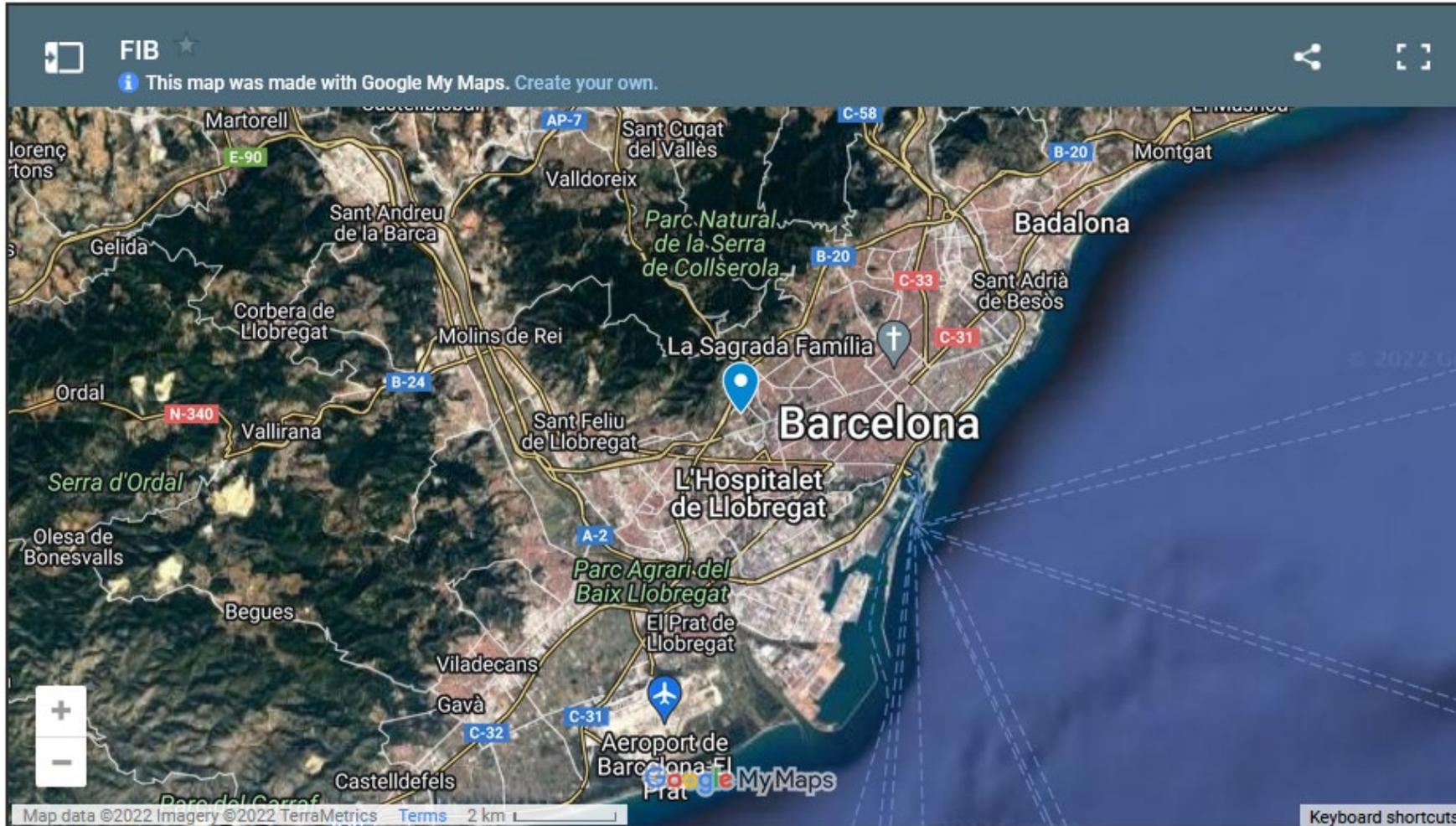


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Jordi Girona street,1-3
08034 Barcelona

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Email: fib.info.masters@upc.edu

Web: http://www.fib.upc.edu/

**Social Networking**
https://www.facebook.com/fib.upc
https://www.youtube.com/user/mediafib
https://www.instagram.com/fib.upc/
https://bsky.app/profile/fib.upc.edu/

# FIB: Why?

- It is one of the top 10 computer science schools in Europe. We have the resources, professors and experience to offer a wide range of high-value courses

- It is a pioneering school at university-level in Informatics in Spain and has been spearheading Catalonia's progress in the field since 1977. Its contribution to society can clearly be seen in the number of top-quality professionals it has produced, who are required by organizations that seek to innovate and make progress

- Excellence quality certified by external and independent quality agencies

For more details about UPC and FIB go to:

https://masters.fib.upc.edu/masters/ choose your preferred specialisation

and check our general information session **presentation** and **video** of 2025

- Professionals who have the skills to implement ICTs in all types of companies and organizations

- Professionals who can lead R&D departments and projects with a substantial research component

- Graduate employment rate of practically 100% and salaries among the highest for university graduates

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# Master in Innovation and Research in Informatics

Summary

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F I B

# Master in Innovation and Research in Informatics

*This master offers a strong and rigorous background in research and innovation in 4 fields of informatics:*
  - *Advanced Computing (AC),*
  - *Computer Graphics and Virtual Reality (CGVR),*
  - *Computer Networks and Distributed Systems (CNDS),*
  - *High-Performance Computing (HPC).*

- Accreditations: EQUAINE, AQU-Excellence

- Language: English (B2)

- 120 ECTS: 2 years
  - 30 Common compulsory
  - 48 Specialisation (4 specialisations)
  - 12 Electives
  - 30 Master thesis

- 4 Specialisations:
  - AC: https://masters.fib.upc.edu/masters/miri-advanced-computing
  - CGVR: https://masters.fib.upc.edu/masters/miri-computer-graphics-and-virtual-reality
  - CNDS: https://masters.fib.upc.edu/masters/miri-computer-networks-and-distributed-systems
  - HPC: https://masters.fib.upc.edu/masters/miri-high-performance-computing

- Industrial Agreements – Curricular Internships, Professional Experience (elective ECTS)

- Complementary courses might be required

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# Research and Innovation

- UPC is a leading research institution
  - Top university obtaining H2020 projects: https://www.upc.edu/en/press-room/news/the-upc-is-still-the-top-spanish-university-in-obtaining-funds-from-the-h2020-programme
  - Start-ups, spin-offs, innovation and technology transfer: https://www.upc.edu/en/r-d-i/innovation
  - UPC's centre for Development Cooperation: https://www.upc.edu/ccd/en
- Complement your time during the masters with added-value tasks!
- One strong aspect of our masters is that our teaching staff are also researchers with wide experience on the topics they teach
  - Belong to different departments and research groups
  - Have strong networks with researchers all over the world
    - You may want to do research under international mobility
- Formalise your research experience with research grants or CCE agreements

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# Advanced Computing

# Advanced Computing

Advanced Computing approaches complex computational problems from both theoretical and practical angles:

- Understand the limitations of computational problems.
- Use these insights to provide novel and efficient algorithmic solutions.
- Acquire analytical tools and skills to understand the fundamental principles of computing.
- Develop problem-solving skills to build cutting edge solutions through the understanding and the interplay between theory and practice.

- Applications:
  - Intelligent systems
  - Social networks
  - Machine learning and data mining
  - Human language processing
  - Cloud and web technologies
  - Algorithmics
  - Game theory
  - VLSI design
  - …

# Opportunities

- Participation with research groups
  - ALBCOM: Algorithms, Computational Biology, Complexity and Formal Methods
  - TALP: Center for Language and Speech Technologies and Applications
  - LOGPROG: Logic and Programming
  - LARCA: Relational Algorithmics, Complexity and Learning Laboratory
  - …
- Job opportunities
  - Academy: local and international universities
  - Big tech companies: Google, Amazon, …
  - CAD Companies: Qualitech, Marvell, SemiDynamics, Mentor Graphics, …
  - Data Science: Planeta, Factorial HR, Quida, …

# Exemplary Master Theses

- Student: Josep Sànchez-Ferreres
- Advisors: Josep Carmona, Lluís Padró
- Abstract: Modeling techniques in Business Process Management often suffer from low adoption due to the variety of profiles found in organizations. This project aims to provide a novel alternative to BPM documentation, ATD, based on annotated process descriptions in natural language.

- Further outcomes:
  - Spin-off co-founder: Process Talks, SL
  - Patent: PCT/EP2021/064772
  - PhD with top journal and conference publications: IEEE TLT, SoSym, DKE, CAiSE, BPM, etc.

- Student:  Juan Pablo Royo Sales
- Advisors:  Edelmira Pasarella, Maria-Esther Vidal, Cristina Zoltan
- Abstract: This work tackles the problem of providing an algorithm for incrementally enumerating bitriangles in large bipartite networks.

- Further outcomes:
  - Publications: PROLE2021
  - Software: Dynamic Pipeline Framework
    - https://hackage.haskell.org/package/dynamic-pipeline
    - https://github.com/jproyo/upc-miri-tfm/tree/main/bt-graph-dp

# Computer Graphics and Virtual Reality

# MIRI - Computer Graphics & Virtual Reality

- State-of-the-art computer graphics
  - Design efficient algorithms and solutions for real-life problems (education, medicine, architecture, cultural heritage, urban design, animation).
  - Virtual Reality: building VR applications for HMDs and 3D large screens (powerwal). Hands on experience with 3D interaction and navigation.

# Opportunities

- Participate in research projects
  - by taking SIRI credits
  - working as an intern at ViRVIG
  - Master tesis with us or our international collaborators
  - Co-authoring research papers
  - Attend the ViRVIG seminar and other online conferences

## Topics
- Advanced 3D graphics
- Procedural modeling
- Real-time rendering
- Immersive interaction
- Geometry processing
- Virtual and Augmented Reality
- Computer Animation and Simulation
- Physically-based animation & rendering
- Modeling complex systems
- Visualization of complex n-dimensional information
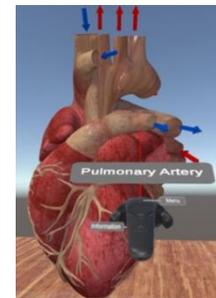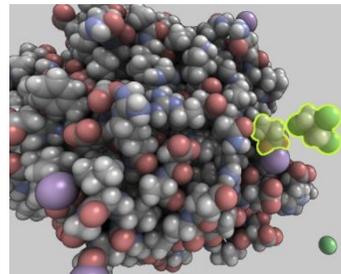
- Private sector: Engineering, medical imaging, 3D printing, graphics processors, special effects, Virtual Reality
- Research centers and Universities

# Exemplary Master Theses

**A WebXR-based plattform for mixed geometry-based and image-based exploration of cultural heritage models**

TFM: Arnau Farràs (2019-2021)
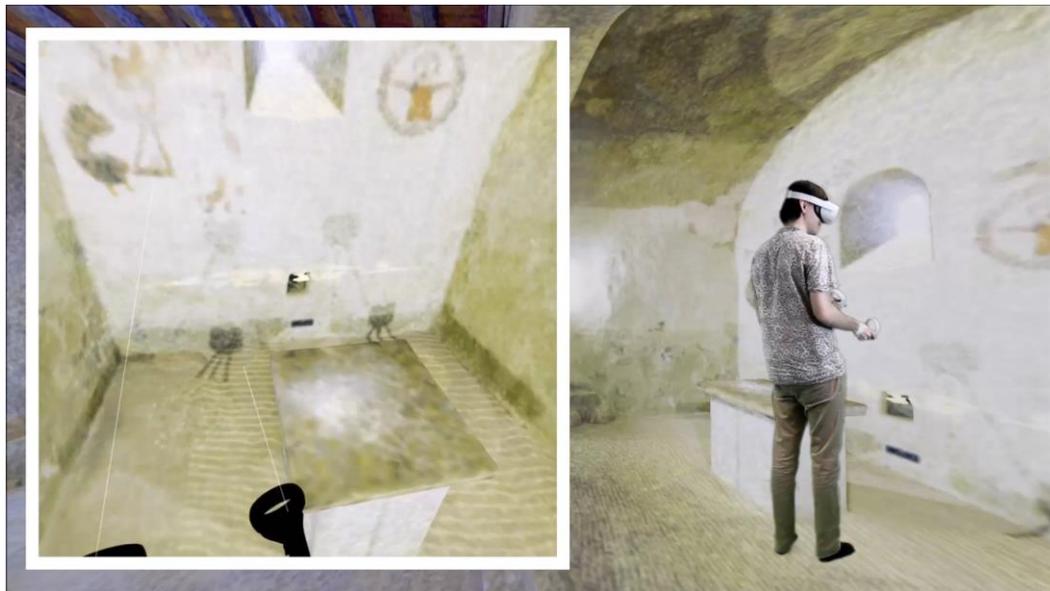


Eurographics Workshop on Graphics and Cultural Heritage 2021

## Visualization of ensembles of molecular simulation trajectories
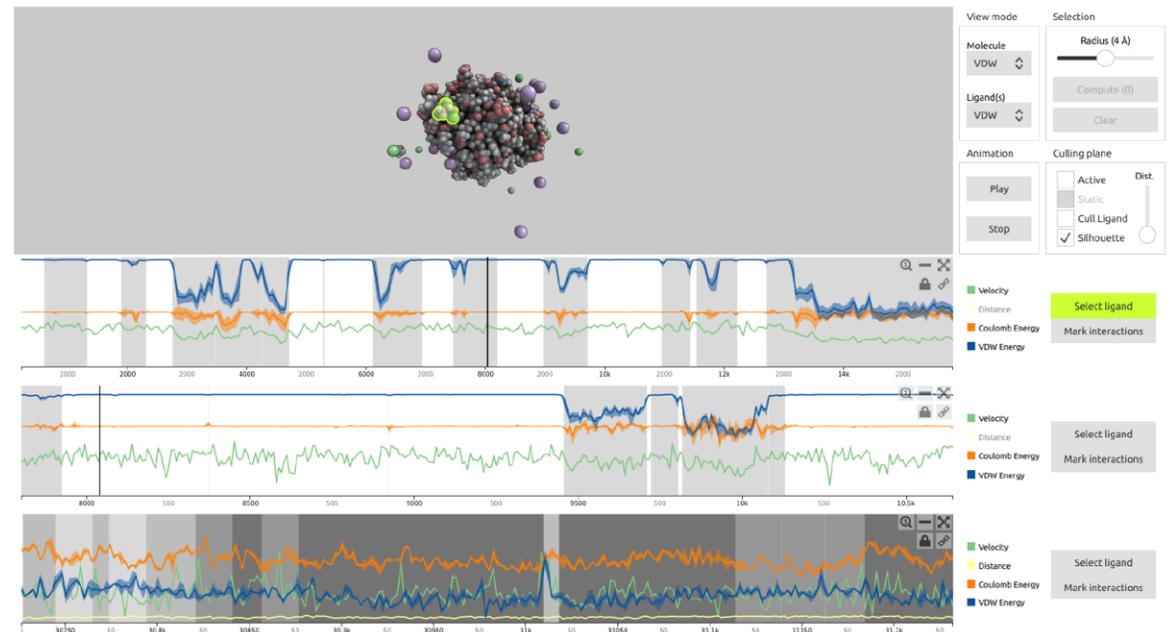
TFM: David Duran (2016-2018)



Fig. 1. Overview of the system: The 3D exploration of the molecular trajectory appears on top of the enhanced charts of three different ligands involved in a simulation. The plots are linked bidirectionally: researchers can perform selections in 2D or 3D to see relevant information highlighted in the other view. A 3D selection, for instance, will highlight the intervals of the 2D plots where the ligand interacts with the selected region.

IEEE Transactions on Visualization and Computer Graphics 2019

# Computer Networks and Distributed Systems

# Computer Networks

It is a set of devices that allows us to move data across nodes, including documents, sensor data, content sharing, audio, video, etc. They provide a fast a reliable way to share information and resources within business. Examples: Internet, mobile networks, cellular networks, sensor networks, optical networks, nano-networks, etc.

**Topics covered**

- Trends in the evolution of network architectures
- Routing and inter-networking
- Transport networks (backbone)
- New network and transport protocols
- Resource management
- 5G network architecture
- Software defined networks (SDN)
- Next generation Internet
- Energy oriented Internet
- New networking paradigms (nano-networks, graphene, miniaturizes wireless comm)
- Data centres and clouds
- Security in applications including blockchain and quantum security
- multimedia content transmission

# Distributed Systems

DS is a computing environment in which various components are spread across multiple computers (or other computing devices) on a network. These devices split up the work, coordinating their efforts to complete the job more efficiently than if a single device had been responsible for the task. DS provide scalability, reliability, efficiency and a better performance. Applications: WWW, P2P systems, network file systems, wireless sensor networks, distributed cache systems, distributed databases, blockchains, infrastructures for big data, etc.

**Topics covered**

- Cloud computing fundamentals (models for large scale systems, middelware, content distribution, virtualization, etc)
- Cloud service providers (such as AWS, Google AppEngine, Open Stack, OpenNebula
- IoT systems: sensor networks
- Big data analytics in the cloud
- ML and DL techniques to improve data quality
- P2P networks and overlay networks. Routing
- Publish/subscribe, group communication, self-properties, incentives, management, resource allocation, security and anonymity, characterization and evaluation
- Content and media distribution, storage, file sharing, communication, computing, social networks

# Opportunities

- **Research groups associated to CNDS specialization (opportunities to get fellowships to collaborate with some of the research groups and opportunities to pursue the Master Thesis in some research topics in which these groups are involved):**
  - Statistical Analysis of Network and Systems (SANS): http://sans.ac.upc.edu
    - IoT, wireless sensor calibration, machine learning, deep learning, human mobility patterns characterization, smart cities, …
  - Distributed Systems Group (DSG): http://dsg.ac.upc.edu
    - cloud computing, community networks, descentralized systems, resource management through virtualization, …
  - VIRTOUS: https://virtuos.site.ac.upc.edu
    - Virtualization and cloud computing, …
  - Broadband Communication Systems: https://cba.upc.edu
    - Optical networks, traffic monitoring and analysis, nanonetworking communications, networks –on-chip, green networking networks architectures, low-energy networks, cybersecurity, …
  - High Performance Computing:
    - management of Software Defined Infrastructures, IoT stream processing platforms, automated characterization of cost-effectiveness of Big Data deployments, Build hardware prototypes for accelerating data-centric workloads, …
    - Deep Learning, Machine Learning & Artificial Intelligence, …

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# Exemplary Master Theses

- Student: Pau Marcer Albareda
- Advisors: Beatriz Otero and Eva Marín
- Title: Fog - Applying blockchain to secure a distributed set of clusters
- Abstract: we can affirm that we are moving towards a world where everything will be connected (i.e. our cars, our houses, our wearable devices). The current centralized security architectures do not scale well enough in order to be applied on the Fog. Those models such as Certificate Authorities (CA's) are centralized, usually on cloud providers, and offer a much more static security. Therefore, we require new and completely distributed security architectures, capable of being flexible and scalable, while at the same time providing fault proof security to the Fog.

- Student: Pau Ferrer Cid
- Advisors: José M. Barceló and Jorge Garcia Vidal
- Title: Calibration of low-cost air pollutant sensors using machine learning techniques
- Abstract: Nowadays concern about air pollution has risen due to the effects of the climate change. The application of machine learning methods for the calibration of low-cost sensors is studied. The short-term, long-term, sensor fusion and training set size needed are analysed considering real scenarios.

# High Performance Computing

# MIRI-High Performance Computing

- HPC is the foundation for scientific, industrial, and societal advancements.

- It is through data that groundbreaking scientific discoveries are made, game-changing innovations are fueled, and quality of life is improved for billions of people around the globe.

- Simulation, data storage and analysis, artificial intelligence (AI), and machine learning (ML) technology all demand growing compute power that can only be leveraged through HPC

- HPC solutions are used for a variety of purposes across multiple industries. Examples include:
  - **Research labs**. HPC is used to help scientists find sources of renewable energy, understand the evolution of our universe, predict and track storms, and create new materials.
  - **Media and entertainment**. HPC is used to edit feature films, render mind-blowing special effects, and stream live events around the world.
  - **Oil and gas**. HPC is used to accurately identify where to drill and to help boost.
  - **Artificial intelligence** and **machine learning**. HPC is used to detect credit card fraud, provide self-guided technical support, teach self-driving vehicles, and improve cancer screening techniques.
  - **Financial services**. HPC is used to track real-time stock trends and automate trading.
  - It is used to **design** new products, **simulate** test scenarios, and make sure that parts are kept in stock so that production lines aren't held up.
  - It is used to help **develop cures** for diseases like diabetes and cancer and to enable faster, more accurate patient **diagnosis**.

- The European Union considers HPC a strategic investment priority. Yet there is a significant lack of professionals in the HPC domain, therefore formation in the field is becoming critical.

# Opportunities

- While you are studying, collaboration with research groups/centers:
  - ARCO group
  - CAP group
  - VIRTUOS group
  - Barcelona Supercomputing Centre

**EU4HPC**:

https://eumaster4hpc.uni.lu/

- Professional opportunities:
  - Participate in the design of: future processors, supercomputers, mobile systems, robotic systems, control systems
  - Develop supercomputer applications and/or Improve applications performance: Weather prediction, Crash-tests, Bio-informatics, Genomics, Machine Learning, …
  - Improve performance on other areas: after all a smartphone is not that different from supercomputer.
  - Develop/optimize application kernels.
  - Develop tools/compilers.

# Exemplary Master Theses

- Student: Joel Sanchez Moreno
- Advisors: Roger Espasa and Miquel Izquierdo
- Title: Analysis and optimization of a debug post-silicon hardware architecture
- Abstract: The goal of this thesis is to analyze the post-silicon validation hardware infrastructure implemented on multicore systems taking as an example Esperanto Technologies SoC, which has thousands of RISC-V processors and targets specific software applications. Then, based on the conclusions of the analysis, the project proposes a new post-silicon debug architecture that can fit on any System on-Chip without depending on its target application or complexity and that optimizes the options available on the market for multicore systems.

- Student: Marc Solé i Bonet
- Advisors: Leonidas Kosmidis (BSC)
- Title: Hardware-software co-design for low-cost AI processing in space processors
- Abstract: In the recent years there has been an increasing interest in artificial intelligence (AI) and machine learning (ML). The advantages of such applications are widespread across many areas and have drawn the attention of different sectors, such as aerospace. However, these applications require much more performance than the one provided by space processors. In space the environment is not ideal for high-performance cutting-edge processors, due to radiation. For this reason, radiation hardened or radiation tolerant processors are required, which use older technologies and redundant logic, …

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# Internships

# Internships

- *Convenis de col·laboració universitat – empresa (CCE): https://www.fib.upc.edu/en/companies/industrial-practices*

# Internships

CCE can be established between companies and FIB

- Curricular Practices:
  - Maximum of 900 hours (without accounting the Master Thesis)
    - For the master thesis, you may account 450 underline additional hours (i.e., for a total of 1350h)
  - Elective ECTS (minimum 6, maximum 12) [+ Master Thesis ECTS]
  - Master Thesis (Modality B –at a company- or D –at a foreign company-)
  - 30 hours →  1 ECTS

Professional Experience as elective ECTS (via work contract):
- Previous or during the master
- 1600 hours per 6 credit
  - Then, proportional

# Mobility and Internationalisation

# Mobility and Internationalisation

Plenty of options! 205 universities in 42 countries

- Study abroad (one or two semesters)
    - Conditions (max ECTS): 60 ECTS: 30 ECTS of courses + master thesis
    - Mobility programs (many with scholarships)
        - CERN
        - Erasmus+
        - UNITECH
        - Latin America, USA and Canada
        - National Institute of Informatics (NII) Tokyo and Vulcanus in Japan
        - China

- 2 Double degree
- Internship abroad
    - Ever-open calls: Erasmus+, IAESTE, AIESEC, Entrypark
    - Academic institutions
    - Industry
- Other activities (summer schools, short stays...)

>200 requests including bachelor and master students for 2024/2025

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# Double Degrees: Polito



- Politécnico di Torino
  - MIRI (1$^{st}$ year, 60 ECTS)
    - All mandatory courses (common and specialization) + 6 ECTS of elective courses
  - Laurea Magistrale in Ingegneria Informatica (2$^{nd}$ year, 60 ECTS)
    - If the student is following MIRI-HPC: *Orientamiento Embedded Systems*
    - Otherwise, the student loses the MIRI specialisation and there gets: *Orientamiento Software*

https://www.fib.upc.edu/ca/mobilitat/dobles-titulacions/politecnico-di-torino-polito

# Double Degrees: GeorgiaTech

- GeorgiaTech
  - MIRI (1st year, 60 ECTS)
    - All mandatory courses (common and specialization) + 6 ECTS of elective courses
  - Master of Science in Computer Science (2nd year, 60 ECTS)
    - First semester in Metz (GeorgiaTech Europe)
    - Second semester in Atlanta

https://www.fib.upc.edu/en/mobility/double-degrees/georgia-tech

# Mobility and Internationalisation

https://www.fib.upc.edu/en/mobility

# Mobility and Internationalisation

• Information Sessions: https://www.fib.upc.edu/en/mobility/outgoing/information-sessions

## Mobility information session 2024-2025

For mobility stays during the academic year 2025-2026

### 1st semester

**Wednesday, 20 November 2024**

In this first session we will inform on the various mobility programs, but we will focus on those whose call is in December-January and on the stays at US universities. Infomation sessions will be recorded.
Place:  A5E01(96)

• Morning session: **12:15 pm**

**Necessary prior registration: (outdated)**

Mobility Presentation 2024-2025 Q1

### 2nd semester

**Wednesday, 12 February 2025**

In this second session we will inform on the various mobility programs, but we will focus on Erasmus+,SICUE and double degree calls. Information sessions will be recorded.
Place: Sala d'actes del Vèrtex

• Morning session: **12:15 pm**;
• Afternoon session: **15:00 pm**

**Necessary prior registration**

Mobility Presentation 2024-2025 Q2

Still have doubts?
Contact us at:
fib.rel.int@upc.edu

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# Enrolment Procedure

# Procedure

Interested in one of our masters? This is the procedure to follow

## The admission process, step by step

**1** ✏️ Register. Enter your personal and academic details.

**2** € Pay the €30 pre-enrolment fee to start the process.

**3** 📄 Check the decision on admision

**4** 🔍 You must accept the place

**5** € Pay €300, which will be deducted from your enrolment fees.

**6** 👤 Enrol and provide the original documents.

https://www.upc.edu/en/masters/access-admission-enrolment

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# Important Dates

- **Pre-enrolment**: From 24th February to 21st May 2025
- Two (three) admission periods:
  - First period:
    - Deadline to apply: 4th April 2025
    - Tentative admission notification: 25th April 2025
  - Second period:
    - Deadline to apply: 21st May 2025
    - Tentative admission notification: 15th June 2025
  - *Third period:*
    - *Not guaranteed, only if seats available*
    - *Tentative deadline: 30th June*
    - *Tentative admission notification: 7th July*
- Check the specific website of each master to know about its admission criteria: masters.fib.upc.edu

# Pre-enrolment

- Start the procedure from the masters.fib.upc.edu website. Look for your favourite master, scroll down and look for the pre-enrolment button as shown below
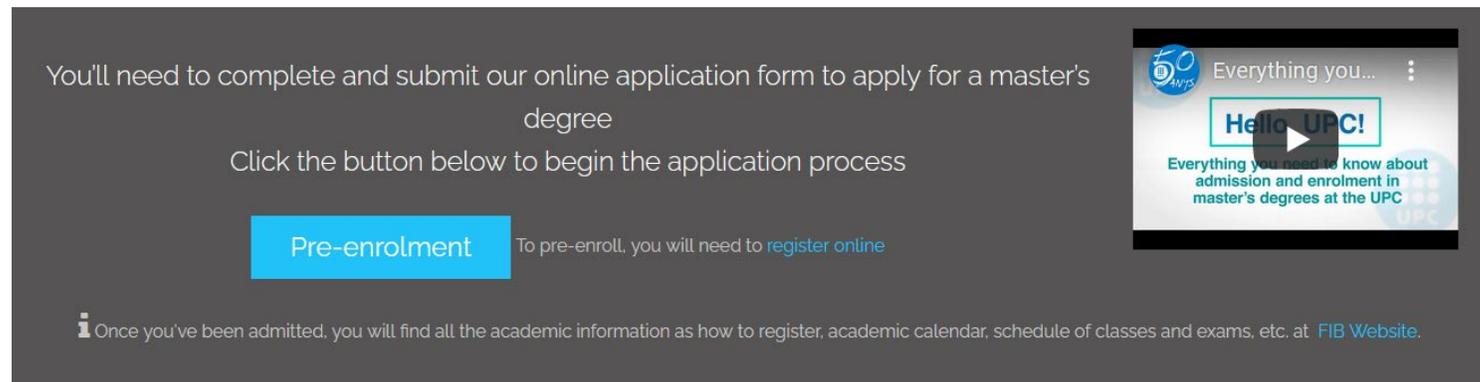


- To pre-enrol follow the instructions
  - Provide the required documentation to evaluate your admission
  - Pay 30,21€ (tax) – **Important**: the button to pay does not appear until you enter all required fields

You can learn more about the pre-enrolment process here:
https://www.upc.edu/en/masters/access-admission-enrolment/pre-enrolment

# Prices

## Prices 2024/25 for European Union applicants

- MIRI: 27,67€ / ECTS

## Prices 2024/25 for Non-European Union applicants

- MIRI: 102,52€ / ECTS

*Note: prices for 2025/2026 will be published in July. Once published, UPC list the prices here:* https://www.upc.edu/en/masters/fees-grants

# More Information

- General:
  - Information: fib.info.masters@upc.edu
  - Specific academic questions:
    - MIRI-AC: Amalia Duch (duch@cs.upc.edu)
    - MIRI-CGVR: Nuria Pelechano (npelechano@cs.upc.edu)
    - MIRI-CNDS: José M. Barceló (joseb@ac.upc.edu)
    - MIRI-HPC: Josep Llosa (josepll@ac.upc.edu)

- Websites:
  - MIRI-AC: https://masters.fib.upc.edu/masters/miri-advanced-computing
  - MIRI-CGVR: https://masters.fib.upc.edu/masters/miri-computer-graphics-and-virtual-reality
  - MIRI-CNDS: https://masters.fib.upc.edu/masters/miri-computer-networks-and-distributed-systems
  - MIRI-HPC: https://masters.fib.upc.edu/masters/miri-high-performance-computing
  - Academic calendars: https://www.fib.upc.edu/en/studies/academic-management/academic-calendars

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# Grants and Aids

# Grants and Aids

- Find all details at: https://masters.fib.upc.edu/grants-and-financial-aid

## General information

There are multiple ways to fund your studies at the **Universitat Politècnica de Catalunya** - BarcelonaTech (UPC). Grants, scholarships, mobility grants and loans are offered by the University and other bodies.

Complete information about grants and financial aid at the UPC.

Below you will find information on specific scholarships and grants that you can apply for at the FIB. **It is necessary to have applied for admission in the corresponding Master to qualify for any of them**.

## Grants

| Accenture - Barcelona Digital Talent grants (2021-2022) | ⌄ |
| --- | --- |
| Seidor grants (2021-2022) | ⌄ |
| NTT DATA (everis) (2021-2022) | ⌄ |
| "Nacho Navarro" grants (2021/2022) | ⌄ |
| FIB Visiona - FIB grants (MEI, MIRI and MAI) - 2020-2021 | ⌄ |
| Fundació Catalunya-La Pedrera (MAI) | ⌄ |
| Fundació Catalunya-La Pedrera (MIRI) | ⌄ |

## Scholarships

| ARCO Scholarships for MIRI Students | ⌄ |
| --- | --- |
| CBA scholarships in AI for networking for MIRI Students | ⌄ |
| inLab FIB | ⌄ |

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# FAQs

- If I'm finishing my undergraduate studies this year, can I apply to a master?

Of course! You can be admitted. You only need to finish on time your registration in September. Indeed, if you finalize your bachelor thesis in October you can yet be admitted in our masters. Contact us for more details

- Can I work and study at the same time?

Of course! there are several opportunities to do extracurricular practices in companies or you can get a job on your own. Part-time enrolment is possible

- I am a foreigner student. Can I do mobility or sign internships?

Yes! You are a UPC student at all effects and you have the same rights and opportunities

- For new incoming students... what about enrolment?

Registration has been online in the last courses. If you require to hand in some documentation you can do later before the lectures start

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Do you have further questions?
Do not hesitate to contact us at
fib.info.masters@upc.edu