

# Industrial informatics

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Paolo Burgio

paolo.burgio@unimore.it



**UNIMORE**  
UNIVERSITÀ DEGLI STUDI DI  
MODENA E REGGIO EMILIA

High Performance  
Real Time **Lab**



**SE NON LO SAI  
SPIEGARE  
IN MODO SEMPLICE,  
NON L'HAI CAPITO  
ABBASTANZA BENE**

- Einstein



# THE EXAM

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## **Mandatory** written test

- › A mix of multiple (closed) responses, and open questions
- › Up to 30/30
- › 3 dates, 1 of which in December (tentative). See Q&A on website

*Optionally*, to improve your mark you can choose between

- › Oral (3-4 questions)
- › Project (recommended for internship and theses)
- › (typically  $+4/-\infty$ )

# Course material

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## Course website

[https://hipert.unimore.it/people/paolob/pub/Industrial\\_Informatics/index.html](https://hipert.unimore.it/people/paolob/pub/Industrial_Informatics/index.html)

## Course slides

- › Available on Dolly, early preview on github
  - <https://github.com/HiPeRT/IndInf20.git>
- › Typically, enough to pass the exam, also if not attending class
- › Hands-on exercises



## Classes in streaming

- › I try to make recordings available asap
- › (Tentative) some physical labs, will be recorded

## Textbooks

- › See course website
- › Add reference at the end of each slides block



# Required skills

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Unix Programming

- › Also win is fine..
- › C/C++ preferred

A bit of electronics might help...but it's not mandatory

Passion, passion, passion!!



# Required material on your side

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## A laptop with GNU/Linux

- › For fast prototyping
- › Also win is fine...you can use Cygwin or Ubuntu Shell for Windows

## Embedded boards for hardcore hands-on

- › Raspberry Pi
  - You should already have it for the IoT course
- › Arduino (do you want this?)
- › NodeMCU (do you want this?)
  - ESP8266/ESP32 processor
- › ...plus some basic stuff (breadboard, electric cables, leds...)

## CAD tools

- › CODESYS by 3S-Smart Software Solutions GmbH
  - I will use V3.5 SP10 Patch 3+, better having the same
  - I can provide it, as well as textbook



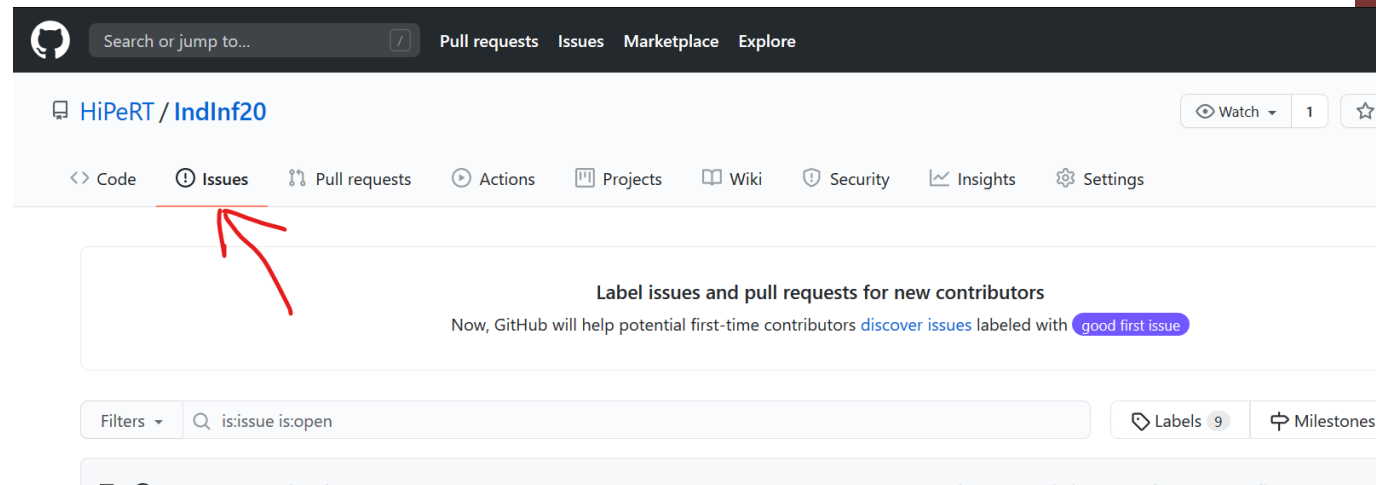
# How to contact me?

AKA: ricevimento

› [paolo.burgio@unimore.it](mailto:paolo.burgio@unimore.it)

But let's try something different..

- › For every question, open a ticket (“issue”) on GitHub
  - <https://github.com/HiPeRT/IndInf20.git>
- › So, all of your colleagues will enjoy the answers
- › Netiquette: before ask, search in “issues”





What is this about?





# Why “*Industrial*” informatics?

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What makes them different by “standard” informatics?

- › Applications
- › Computers
- › Requirements
- › Frameworks
- › Processes (industrial, not “OS processes” 😊 )
- › Technologies



# “domain driven”...?

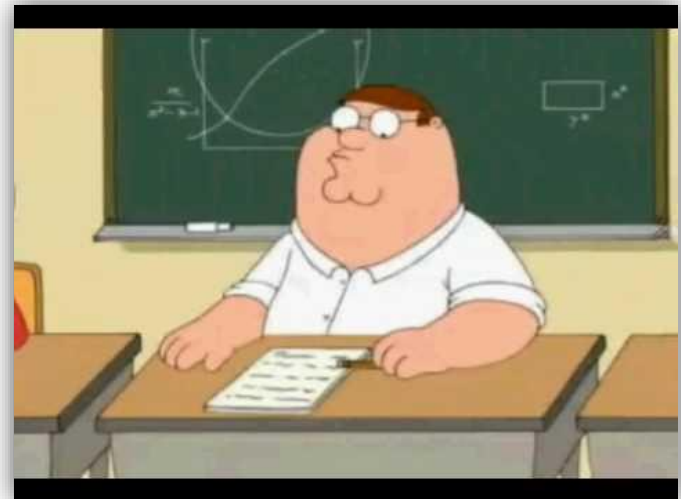
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Es: industrial plants are different than biotech, or nuclear plants

- › Tens of application domains..
- › Is automotive also industrial...today? (rhetorical)
  - And aerospace? Planes, ships, surveillance drones?
  - Safety critical systems
- › Rise of many-core computers
  - Size, Weight and Power constraints - SWaP
- › Internet 4.0 – Internet of Things
  - How can we use Machine Learning?

Past, present and future

- › Not easy to teach, not easy to structure





# What's common?

## › Tight interaction with the environment

- A plant, a machine
- Trough sensors and actuators
- A lot of computers
- Huge cost
- Centralized controller & data analytics w/human

- *Eco-System architecture*
- *Cyber-physical systems*
- *Embedded systems*

## › We want guarantees

- Worst-case timing behavior
- Often, safety
- Reliability, fail-tolerancy, also in monitoring
- Security (we won't see this)

- *Real-Time systems*
- *Dependable*
- *Observable*

## › Compliancy with previous technology

- Lombardia, ER are highly-industrial areas (consider also farms)
- Can't always use "startup-like" models
- Not easy to replace legacy HW/SW

- *Old technologies*
- *Legacy software*
- *Old processes*

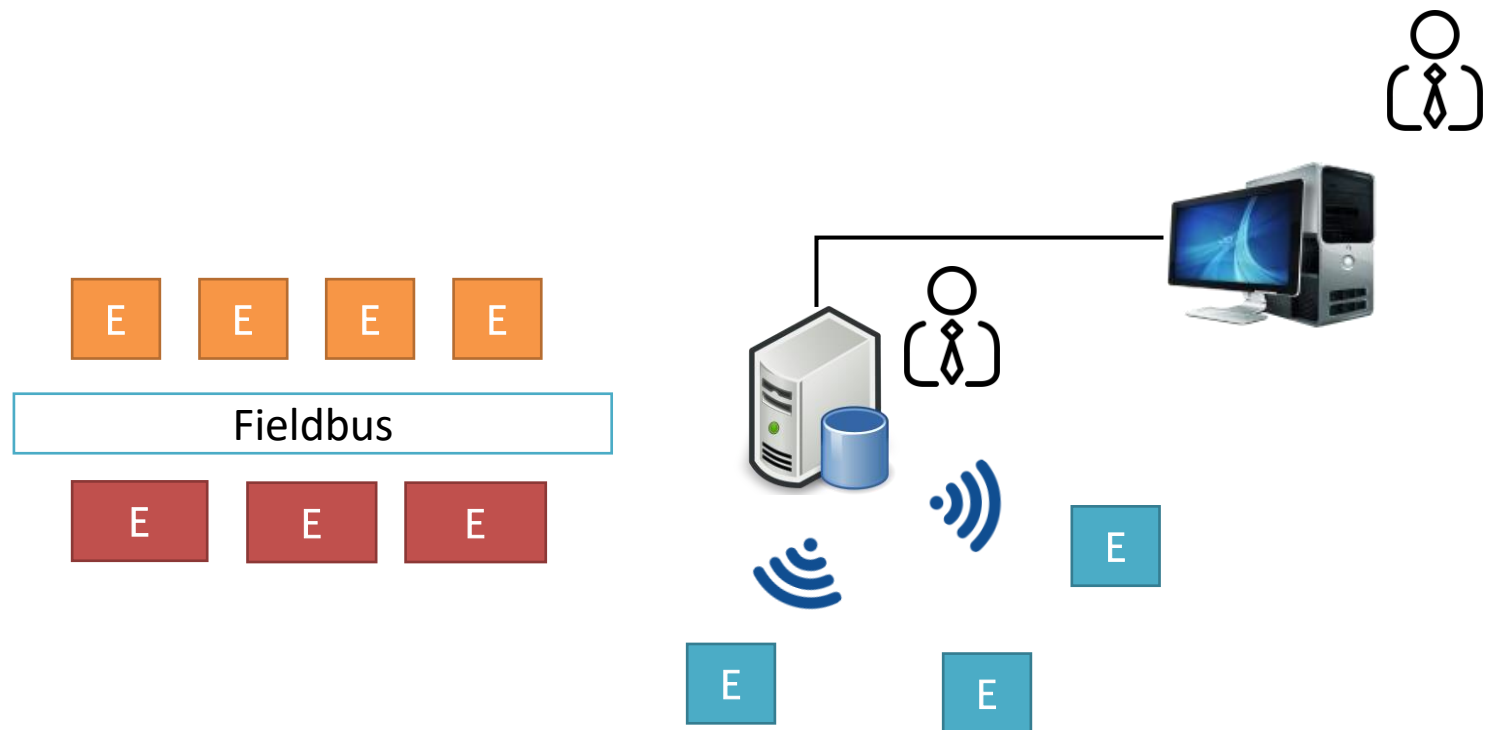
## › The future present

- *Machine Learning*
- *Big data*
- *IoT*
- *...?*

# CPS - Cyber Physical (Eco)Systems

Tight interaction with the environment

- › Typically, multiple embedded computing units close to the plant
- › And one (or more) centralized controller
- › Today, these computational edges have more and more computing power





# Real-Time, dependable systems

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We want it to go fast....**in the worst case!**

- › If humans are “around”, the system might be safety critical
- › Hard vs. Firm vs. Soft Real-Time

We want it to recover from faults

- › Fault tolerance
- › Fail-safe vs. Fail-operational

Achieved **by design**

- › Well-known industrial processes
- › Also, mathematical frameworks
- › Engineering



# Our journey

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## Will cover these main topics

- › Collaborative tool (quickly)
- › Languages & grammars, Automations & machines
- › Computing architectures: PLCs, GPGPUs, reconfigurable architectures, ...
- › Real-Time systems
- › Programming industrial systems: PLC, embedded GPGPUs & CUDA
- › A glance on embedded machine learning
- › Automotive systems
- › 2-3 seminars, chosen together

...always with an hands-on approach!

# References

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## My contacts

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- › <http://hipert.mat.unimore.it/people/paolob/>