Industrial informatics

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

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/-∞)

Course material

Course website

https://hipert.unimore.it/people/paolob/pub/Industrial_Informatics/index.html

Course slides

› Available on Molly, early preview on github
  – https://github.com/HiPeRT/IndInf22.git
› Typically, enough to pass the exam, also if not attending classes
› Hands-on exercises

Classes are recorded (by last year)

› Some physical labs

Textbooks

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

Required skills

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

A laptop with GNU/Linux

› For fast prototyping

› Also win is fine...you can use Cygwin or Windows Subsystem for Linux (WSL)

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 Softfare Solutions GmbH
  – I will use V3.5 SP10 Patch 3+, better having the same
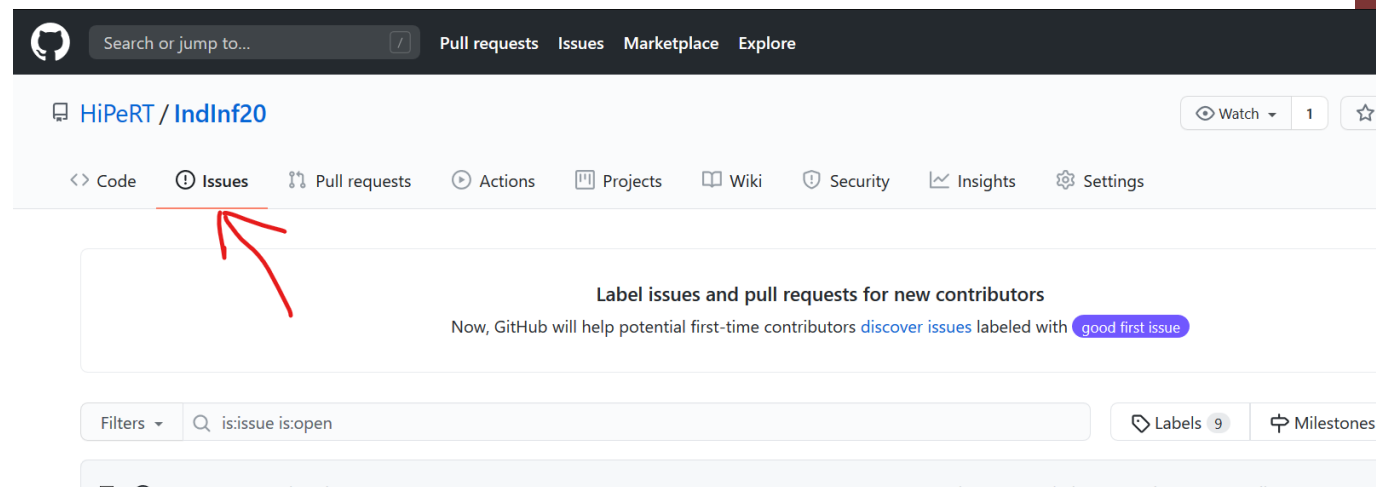 – I can provide it, as well as textbook

How to contact me?

AKA: ricevimento

› paolo.burgio@unimore.it

But let's try something different..

› For every question, open a ticket ("issue") on GitHub
  – https://github.com/HiPeRT/IndInf22.git

› So, all of your colleagues will enjoy the answers

› Netiquette: before asking, **<u>search in "issues"</u>**

What is this about?

Why *"Industrial"* informatics?

What makes them different by "standard" informatics?

› Applications

› Computers

› Requirements

› Frameworks

› Processes (industrial, not "OS processes" ☺)

› Technologies

"domain driven"…?

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

› Tens of application domains..

› Is automotive also industrial…today? (rhetorical)
  – And aerospatial? 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
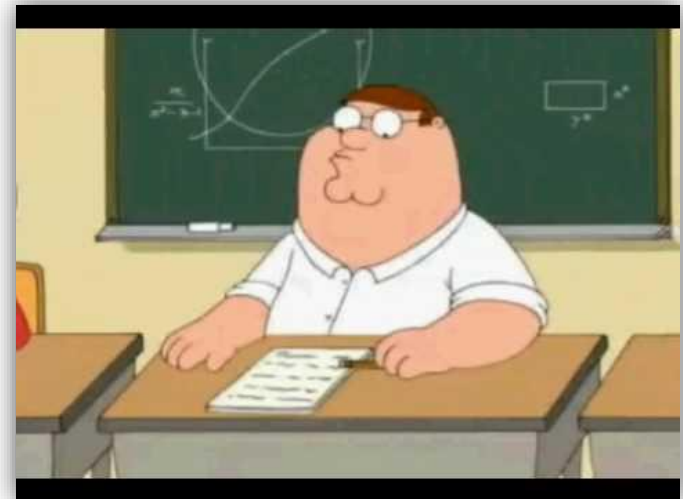
What's common?

> 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
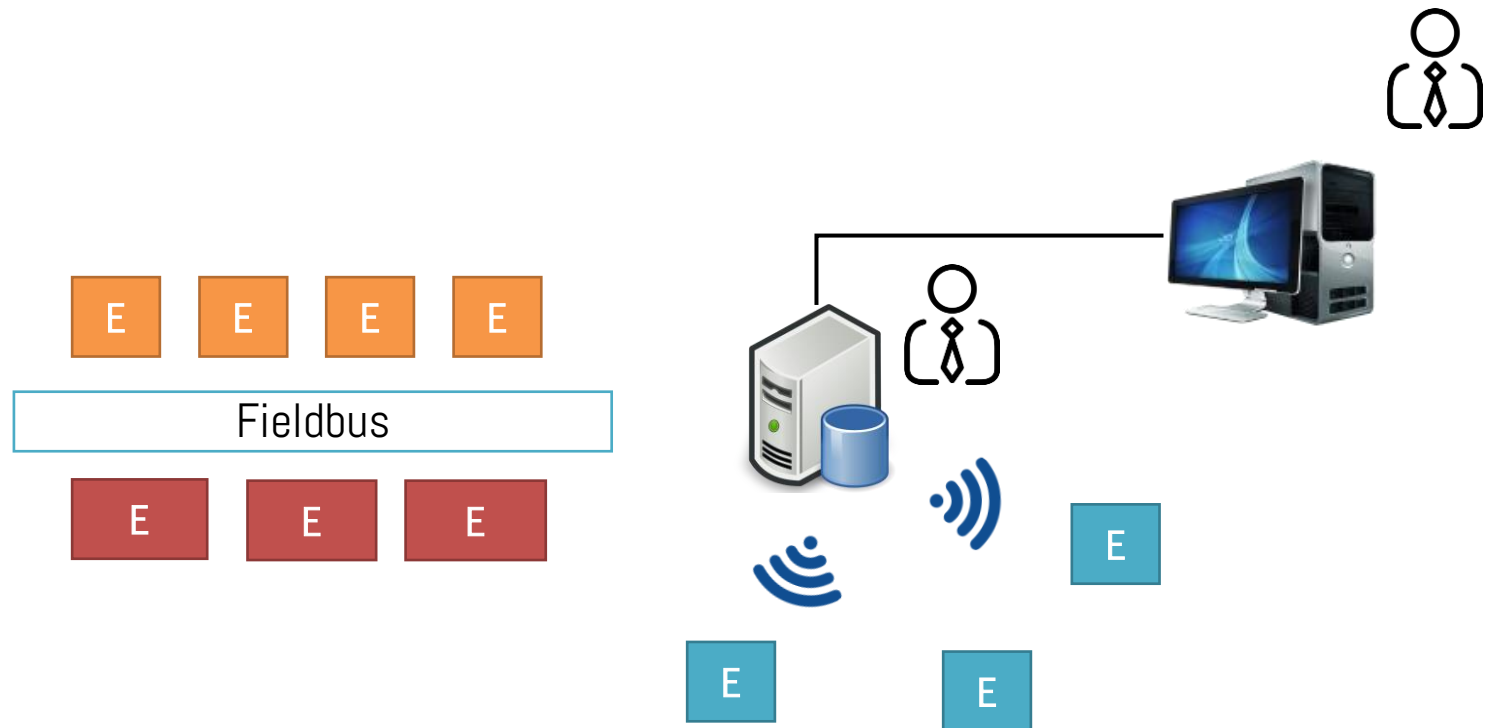- Legacy software
- Old processes

> 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

Fieldbus

Real-Time, dependable systems

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

Will cover these main topics

› Collaborative tool (quickly)

› Languages & grammars, Automations & machines

› Computing architectures: PLCs, GPGPUs, reconfigurable archiectures, …

› 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

Course website

› http://hipert.unimore.it/people/paolob/pub/Industrial_Informatics/index.html

My contacts

› paolo.burgio@unimore.it

› http://hipert.mat.unimore.it/people/paolob/