

Software design

Course introduction

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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

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

<http://hipert.unimore.it/people/paolob/pub/ProgSW/index.html>

Course slides

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



Textbooks

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





Required skills

Object oriented programming

- › You should know about Java..but any OO language is fine!
- › MS C# is the most modern/advanced for the things I'll teach you
- › IDE (Eclipse? VS Code? CLion?)

The Python ~~X~~ problem

- › PY and other "dynamic" languages are less suitable for large-scale methodologies
- › Better for faster prototyping

Tools for creating diagrams

- › MS Visio, Miro, Draw.io, even powerpoint!!!

Passion, passion, passion!!



How to contact me?

AKA: ricevimento

- › pao.lo.burgio@unimore.it

But let's try something different..

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



A screenshot of a GitHub repository page for 'HiPeRT / IndInf20'. The top navigation bar includes links for 'Pull requests', 'Issues', 'Marketplace', and 'Explore'. Below the bar, the repository name 'HiPeRT / IndInf20' is displayed, along with a 'Watch' button and a star icon. The main navigation bar features tabs for 'Code', 'Issues' (which is underlined and has a red arrow pointing to it), 'Pull requests', 'Actions', 'Projects', 'Wiki', 'Security', 'Insights', and 'Settings'. A prominent message in the center of the page reads: 'Label issues and pull requests for new contributors. Now, GitHub will help potential first-time contributors discover issues labeled with good first issue.' At the bottom, there are filters for 'is:issue is:open', a search bar, and buttons for 'Labels' and 'Milestones'.



What is this about?



Software design methodologies

AKA: software engineering

- › Not really the same thing, but it helps!
- › Focus on the **process**, not on the **code**

One solution to rule 'em all?

- › Multiple methodologies, tailored for different needs
- › All of them boil down to few principles/families
- › If you structure the process, you can create tools to automate it!
 - Ex: folder structure for your documents

Why?

- › "Few weeks of debugging can save you 2 hour of design"
- › "Weeks of coding can save you hours of planning"
- › Code/Technical debt

TECHNICAL DEBT





"But...will this restrict my talent?"

Absolutely NOT!!

- › On the contrary, it will help you express your talent to its full potential

This course will:

- › teach you collaborative teamwork
- › help you removing repetitive tasks that take unnecessary time, by automating them
- › let you produce good documentation, and yet no unnecessary documentation

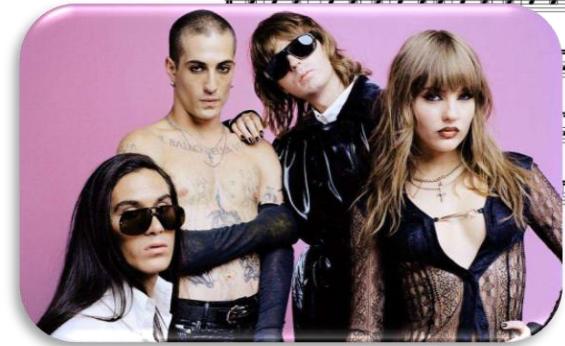
Where's the catch?

- › + 15/20% time, but well spent!



(Software) Architects

- › Even architects and artists move in a well-defined framework
- › To simplify their job, and make the product of their work usable by humanity
- › Not what, but how





Documentation: why?

No-one programs alone!!

(...no-one programs **large scale software** alone)

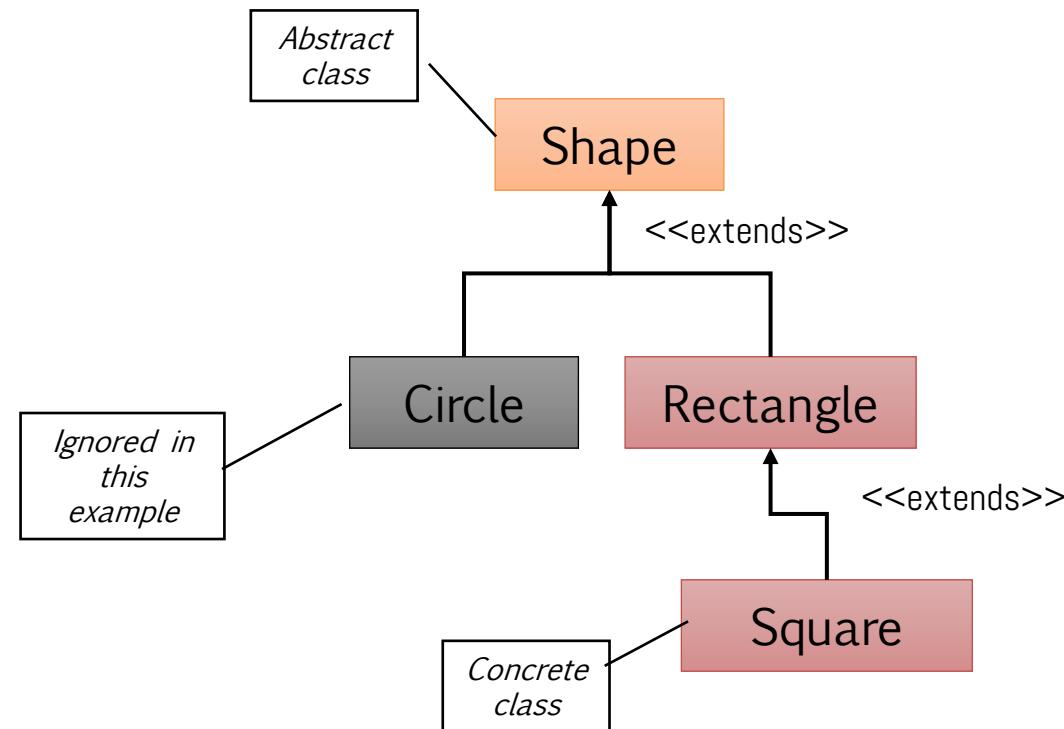
Code documentation to

- › Teach how to use our SW artifacts
- › Explain how to modify them
- › Show how to test/deploy/use them/their code in other projects...

Licensing!!!

Communicate

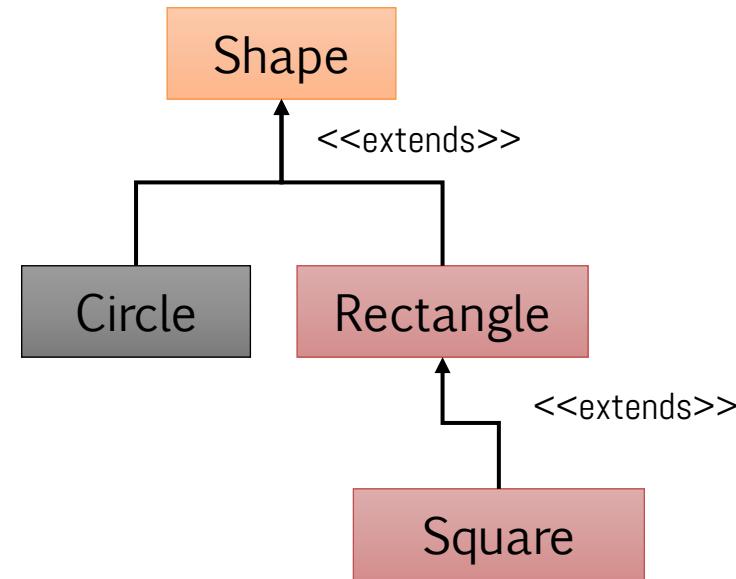
- › A standardized way of expressing concepts



Of rectangles and squares

A classical example

- › Do you remember that?



The story so far...

Programming is taught using very simple concepts

- › Object-Oriented Programming
- › Often **mixed** with procedural/functional programming
- › **Dynamic typing** as powerful mean to deal, e.g., with polymorphism



Clutter is removed

- › Pointers and explicit memory management are powerful yet dangerous!
 - C++ managed, RUST try to get rid of them
- › Parallel programming hidden within libraries, e.g., Python modules
- › Production code often is written in languages more suitable for fast prototyping (e.g., Python)

Software structured in monolithic manner

- › Middlewares are often seen as a library, or a communication mechanism
- › E.g., MPI, MQTT, .netCore



The present: agile and microservices

How do we develop today?

- › Traditional project management and tools are still used
- › New generation of agile methodologies to enable quick Time-To-Market
- › *“Code today, deploy tomorrow, get worried about that next year”*

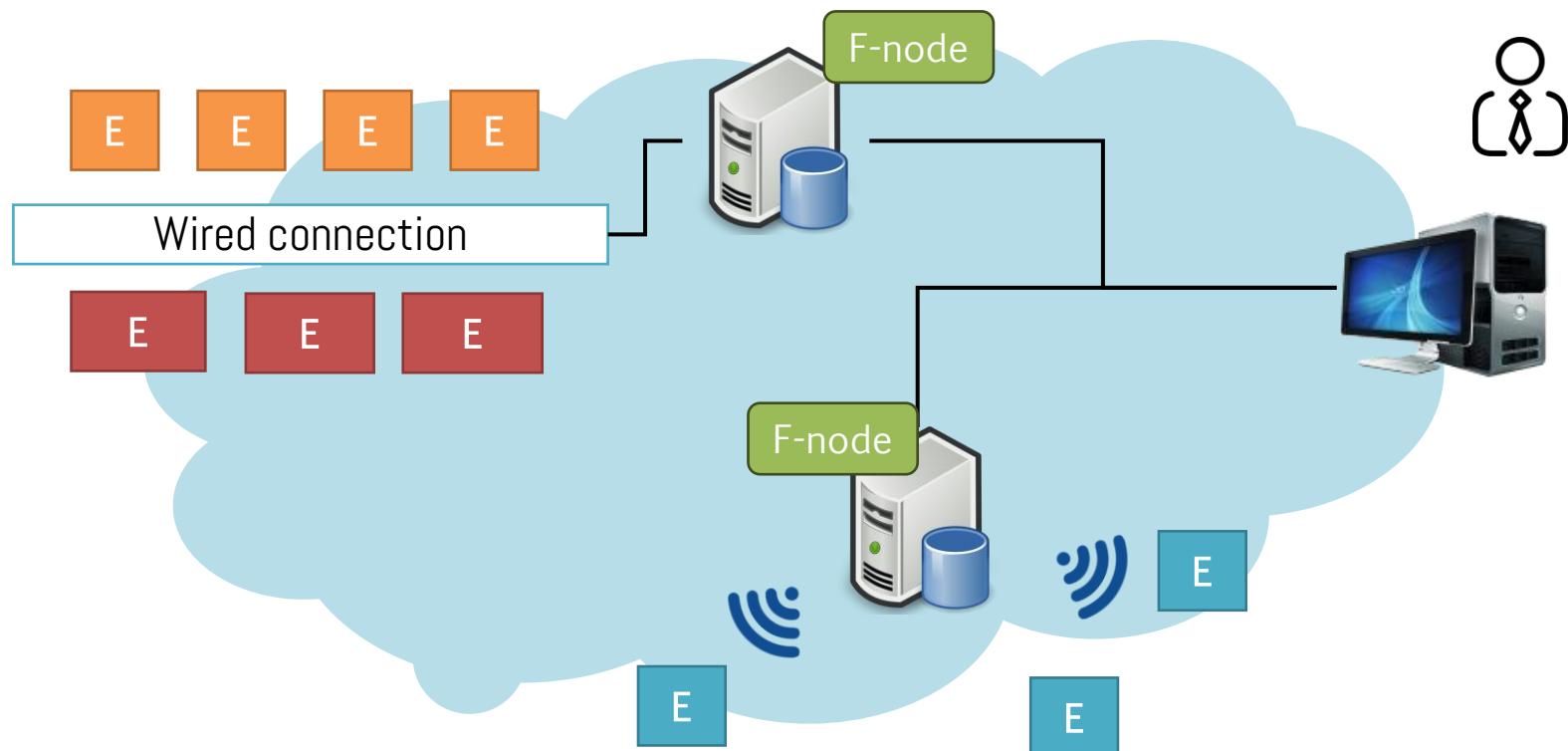
Large scale projects require flexible and resilient structures

- › E.g., Google server farms
- › First design the communication channels and protocols
 - MQTT, Sockets, ROS with JSON, etc
 - Aka: the **interaction** between software components
- › ...then, design single **SMALL** components, with very restricted functionalities
 - DB, Web API/Frontend, aggregation logics...

The future: CPS - Cyber Physical (Eco)Systems

Tight interaction with the environment

- › Computational edges with highest energy efficiency (Performance => Performance/Watt)
- › Highly scalable hierarchy of computers, with (multiple) Cloud/Fog nodes
- › Parallel/distributed computation: GPGPUs, multi-threading, MQTT, ROS, MPI...





Our journey

Will cover these main topics

- › Requirements, KPIs and test-driven design
- › Collaborative tools
- › Design tools: UML, E/R diagrams, ...
- › Design patterns
- › Advanced programming: how to structure my software?
- › GenAI: yes or no?

..and...

- › Use-case: we'll meet some companies...
- › Side seminars: licensing? Real world expertise? You choose

...always with an hands-on approach!

Credits to

- › Prof. Cabri, for the material of the past "Progetto del SW" course



- › Uncle Bob (& Friends), for the insightful details on modern structures for SW
(And for being always harsh in code/SW reviewing)





References



Course website

- › <http://hipert.unimore.it/people/paolob/pub/ProgSW/index.html>

My contacts

- › palo.burgio@unimore.it
- › <http://hipert.mat.unimore.it/people/paolob/>
- › <https://github.com/pburgio>