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of Venice

Software Architectures

Software architectures
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Eiffel tower - from PO1

- 18,038 metallic parts
- 5,300 workshop drawings
- 50 engineers and designers
- 150 workers in the Levallois-Perret factory
- Between 150 and 300 workers on the construction site
- 2,500,000 rivets 
- 7,300 tonnes of iron
- 60 tonnes of paint
- 2 years, 2 months and 5 days of construction
- History here

La tour Eiffel prise du Champ-de-Mars - Exposition universelle de 1889
© Parisienne de photographie - Neurdein / Roger-Viollet
https://artsandculture.google.com/asset/_/hQEdYmo3Gzetsw

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Engineering - from PO1

- Most of the tower was built somewhere else from some workers
- On the site pieces were only assembled, not constructed!
  - With first temporary rivets and then assembled rivets
  - But still, only a third of the rivets were used on site!
- About 500 workers involved in the construction with different skills
- They "communicated" through some standard means
  - Such as rivets, drawings, etc…
- A worker using some results of other works did not need to know the details of what the others have done!

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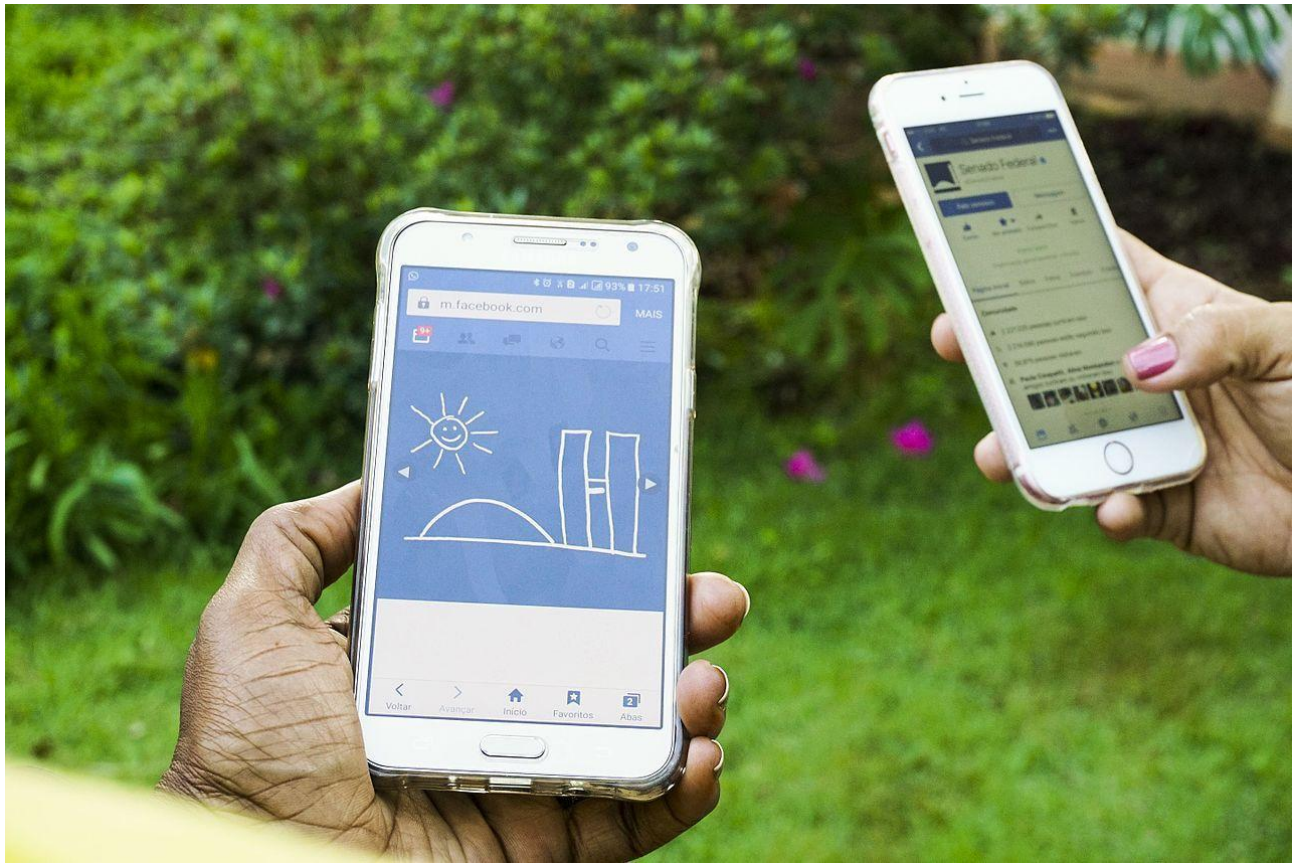
Smartphone (just as an example) - from PO1

- … what do we mean by smart?
- Android operating system
  - https://source.android.com/
  - https://github.com/aosp-mirror
- 99 GitHub repositories
- "Main" repository
  - ~ 280 branches
  - > 30K commits
  - Almost 150 contributors
  - > 10MLOCs



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Technologies

- https://www.youtube.com/watch?v=QgnJ8GpsBG8
  - Forrest Gump, 1994

- I'll feel often like Forrest Gump while running
  - Teaching technologies that I don't master
    - Indeed, often just with an high level idea of them!
  - To master a technology one needs months/years of experience
    - See job announcements
- But please… never be like the people following Forrest Gump!
  - Neither professors nor colleagues nor "experts" nor …
  - Always question yourself if this technology is what you need and why

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A typical Eiffel tower for sw developers

how to supervise the construction of the tower
Software architectures, Development Methodologies, …

how to build up more complex systems packaging and assembling basic blocks
Software engineering, Project management, Cloud computing, Web application …

how to build the basic blocks of the tower
Programming, Computer architecture, Object-oriented programming, Databases, Operating Systems

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Software developers career

CTOs

Software architects

Project managers

Software engineers

Software developers

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Content of the course

- Software architecture is a very practical topic
  - People tried many solutions
  - They started to copy each other
  - The most effective solutions took the lead
- Not always clear why a solution was preferred
  - Or better, a lot of speculation and different opinions
- Always think with your brain!
- The main goals of the course are to provide you
  - An overview of the main architectures adopted in the history
  - Critical thinking about architectures
- In 5 years software architectures will be different from today!

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What is software architecture?

*"Software architecture refers to the **fundamental structures of a software system** and the discipline of creating such structures and systems. (...) Software architecture is about making **fundamental structural choices** that are **costly to change** once implemented."*

- High level thinking about software systems
  - Not about programming languages, type of databases, etc…
- Make decisions before writing code (design)
  - That cannot be easily changed later on

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Concept vs technology

- Concept: abstract ideas that can be applied to different contexts and are not bound to specific situations
- Technology: the application of concepts for practical purposes, especially in industry
- University is about teaching concepts
- Enterprise is about developing and applying technologies
- Concepts are better understood and remembered if practiced
  - We need (some) technology to exemplify concepts
  - But which technology? Why?
- Lectures will be split between concepts and technologies

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Blended course

- Technologies will be covered with online material
  - ~10-15 minutes youtube video
    - Introducing the main points of the technology and connecting it with the conceptual part of the course
  - HTML pages with guided tutorials
  - Exercises at the end of the tutorials
    - To be done BEFORE moving to the next online lectures
- 12 online lectures on Friday 3:45-5:15
  - No need to be connected or whatever
  - I'll be always available by email to answer any questions

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Course outline

- ~ 10 in-presence lectures on concepts
- 12 online lectures on technologies
- 2 lectures on practical experience (with invited speakers)
  - Unox https://www.unox.com/us_us/
  - Gianluca Caiazza, Secura Factors, Zamperla project

Choosing a technology

- https://www.google.com/search?q=popularity+of+technologies+for+developing+microservices
- A lot of confusion, nothing really widely accepted
- Already from a programming language point of view
  - Java, Python, node.JS, …
- Need to make a completely arbitrary choice!
  - Is it the right one? The best one? … who knows!
- We'll go with Java and Spring (and some other technologies)
  - But feel free to experiment with others!!!
    - Especially if you are already familiar with other technologies

Course outline

- Third year I am teaching this course
  - Second year blended
- Topics might change during the course for different reasons
  - Maybe I'll be slower or faster than expected
  - Other topics might arise while teaching the lectures
  - Feel free to propose topics!
- We'll combine theory and practice
  - Theory: frontal lectures aligned with the textbook
  - Practice (a kind of lab): mostly coding and tutorials using different technologies
    - Online!

Course outline

Software architecture characteristics:

- Modularity and coupling
- Operational characteristics: availability, performance, scalability, recoverability
- Structural characteristics: deployability, configurability, extensibility, upgradeability
- Measurement of characteristics

Course outline

Architectural patterns (tentative list):

- Monolithic vs. distributed architectures
- Ball of Mud
- Layered
- Pipeline
- Microkernel
- Service-based
- Event-driven
- Space based
- Microservice

Course outline

Technologies (tentative list):

- Docker[compose]: from artifact to [virtual] machines/containers
- Gradle: from code to artifact
- Spring [Web]: hosted artifacts
- Hibernate: connecting code to data
- Camel: pipeline architecture
- REST: communications between distributed components
- RabbitMQ: asynchronous communication through messages
- Kubernetes: automatic replication and orchestration of machines
- AWS Lambda (?): serverless computing

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Textbook

- Mark Richards, Neal Ford: "Fundamentals of Software Architecture",O'Reilly Media, January 2020
  - http://fundamentalsofsoftwarearchitecture.com/
  - Available in the library (BAS), only about concepts (no code!)
- Additional material: Chris Richardson, "Microservices patterns: with examples in Java"
  - Available in the library (BAS)
  - Not needed, just if you want to deepen some topics for your interests
  - But this contains code!!!
  - And a lot of more details about popular architectural patterns

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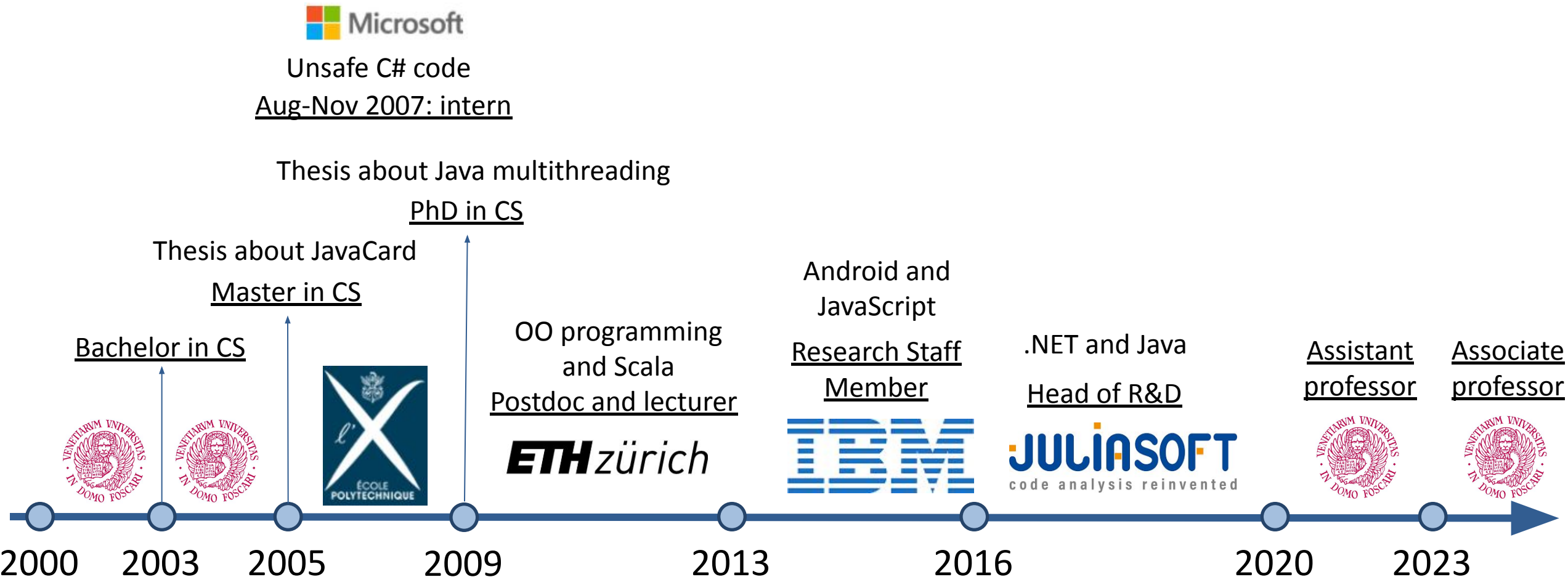

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Communicating with the professor

- Moodle Forum
  - Then the same forum, then the same forum…
- Obviously, you are still free to send me emails!
  - But please use the forum if it is a generic questions about the content of the course, sw architectures, etc..
  - And for questions about exams, grades, etc.. please always give a look to these slides before asking, usually the answer is already here
- E-mail address: pietro.ferrara@unive.it
- Linkedin: https://www.linkedin.com/in/pietroferrara/
  - Feel free to connect with me!

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Tutor 1

- Giacomo Zanatta
  - giacomo.zanatta@unive.it
  - PhD student in my research group
- He'll prepare most of the online material
- Reply to some of the questions in the forum
  - … and in Telegram!
  - https://t.me/+0-muEARUK9QwMjdk

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Telegram group

- For general Q&A about both in presence lectures and online material
- https://t.me/+0-muEARUK9QwMjdk

Your wooclap poll will be displayed here

Install the **Chrome** or
Firefox extension

Make sure you are in
presentation mode

wooclap

https://app.wooclap.com/events/SADM (questions from 1 to 7)

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Project and written exam (1/2)

- 3 group tasks during the course (two thirds of the grade)
  - 2 small ones at the beginning
    - To define the context and characteristics of the software architecture
  - 1 big task at the end implementing the architecture
    - Using any technology, not only the ones I'll introduce you
  - Part time students can instead submit a unique final project
  - Groups composed by 3 to 5 students, tell me the composition in the forum
- Topic: implement an IT system to <do something>
  - Still under discussion
  - It might be used as a baseline for projects of other courses!

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Project and written exam (2/2)

- You will have to deliver at the end of the project
  - A GitHub repository containing the code of your software (architecture)
  - The history of the repo should make clear the contribution of the different students in the group
  - It must contain a description (pdf, markdown, …) of the structure of the architecture with references to the code
- Written exam at the end of the course (one third of the grade)
  - **Only after submitting and passing** the tasks/project
  - Example from last year in Moodle
  - About **only all** the in presence lectures

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Tutor 2

- Filippo Vladimir Scapin
  - 879809@stud.unive.it
  - Master student in Computer Science
    - Took Software Architecture course last year

- He'll focus on the project structure

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Using SA project in other courses

- Development Methodologies (1st semester)
  - Only written exam
  - But you are highly encouraged to use the DevOps concepts you'll see in this course during the development of the SA project
- Software correctness, security and reliability (2nd semester)
  - Develop and apply some static analyses on some code
  - You can use the SA project as target application
    - Technical constraint: need to have Python or Go code!
- Software performance and scalability (2nd semester)
  - Project about the assessment of performances of an application
  - You can use the SA project as target application

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Software Architecture + Development Methodologies

- Some of you need to take also the Development Methodologies exams
  - Two modules of a 12 ECTS course
- In this case
  - You need to pass both the modules in the same academic year
    - i.e., if you pass one module but not the other one you'll need to retake the full exam next year
  - The final grade will be the average of the two grades
- The written exam of the two modules will be at the same time
  - Split in two sessions with a short break in the middle to allow people that take only one module to enter and exit the exam room

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Additional material

- We must provide additional material to some students
  - Working
  - With difficulties in learning
  - See here https://www.unive.it/pag/42819/
- As additional material, those students will have access to the recording of my lectures in the Moodle space
  - Note that I cannot decide who is allowed to have access
  - In case you think you should have access but you don't have it, contact directly Ca' Foscari offices

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Calendar

- (almost) All in presence lectures will take place in Aula B
  - Nov. 11th in Lab. 3
- Regular schedule
  - One in presence lectures on Thursday from 2pm to 3:30pm
  - One online lecture
    - Asynchronous lectures (even if scheduled in the calendar Fri 3:45-5:15pm)
    - Usually published at the beginning of the week

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Save the date! 16/11/2024 Google DevFest @ Campus

- Organized already last year and the year before
  - https://gdg.community.dev/events/details/google-gdg-venezia-presents-devfest-triveneto-2022/
  - https://www.devfest-triveneto.it/
- 15 enterprises will be at the event
  - Open for interviews for stages, jobs, etc etc…
- More details will follow in about a month

Technologies

- We will use various technologies (in addition to the ones aforementioned)
  - IDE (IntelliJ IDEA in particular)
  - Java
  - Git[Hub]
    - Premium account of GitHub for free for students and professors, https://education.github.com/benefits
  - Maven
  - Stackoverflow ☺️ or ChatGPT?
  - And much more TBD

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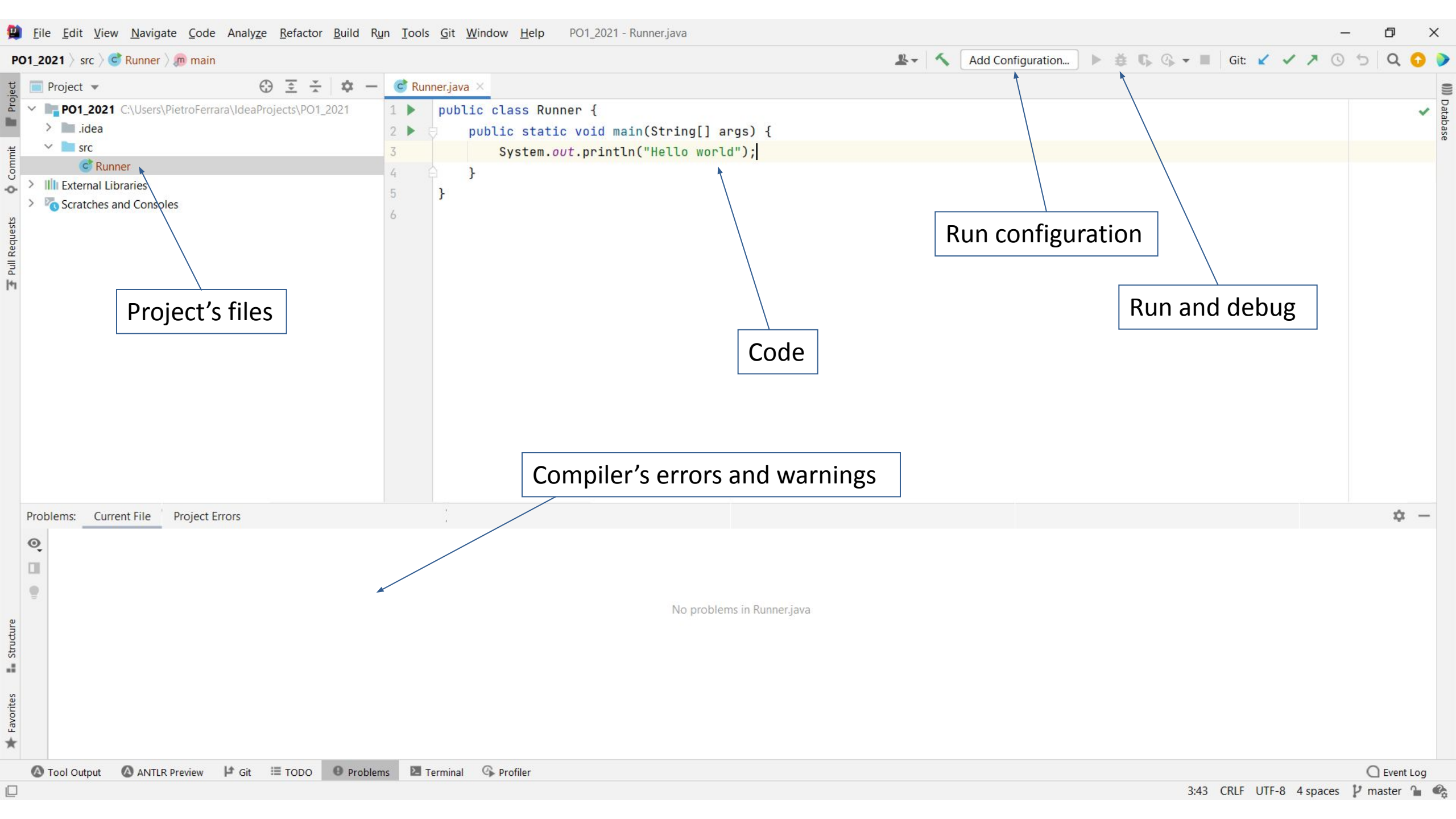
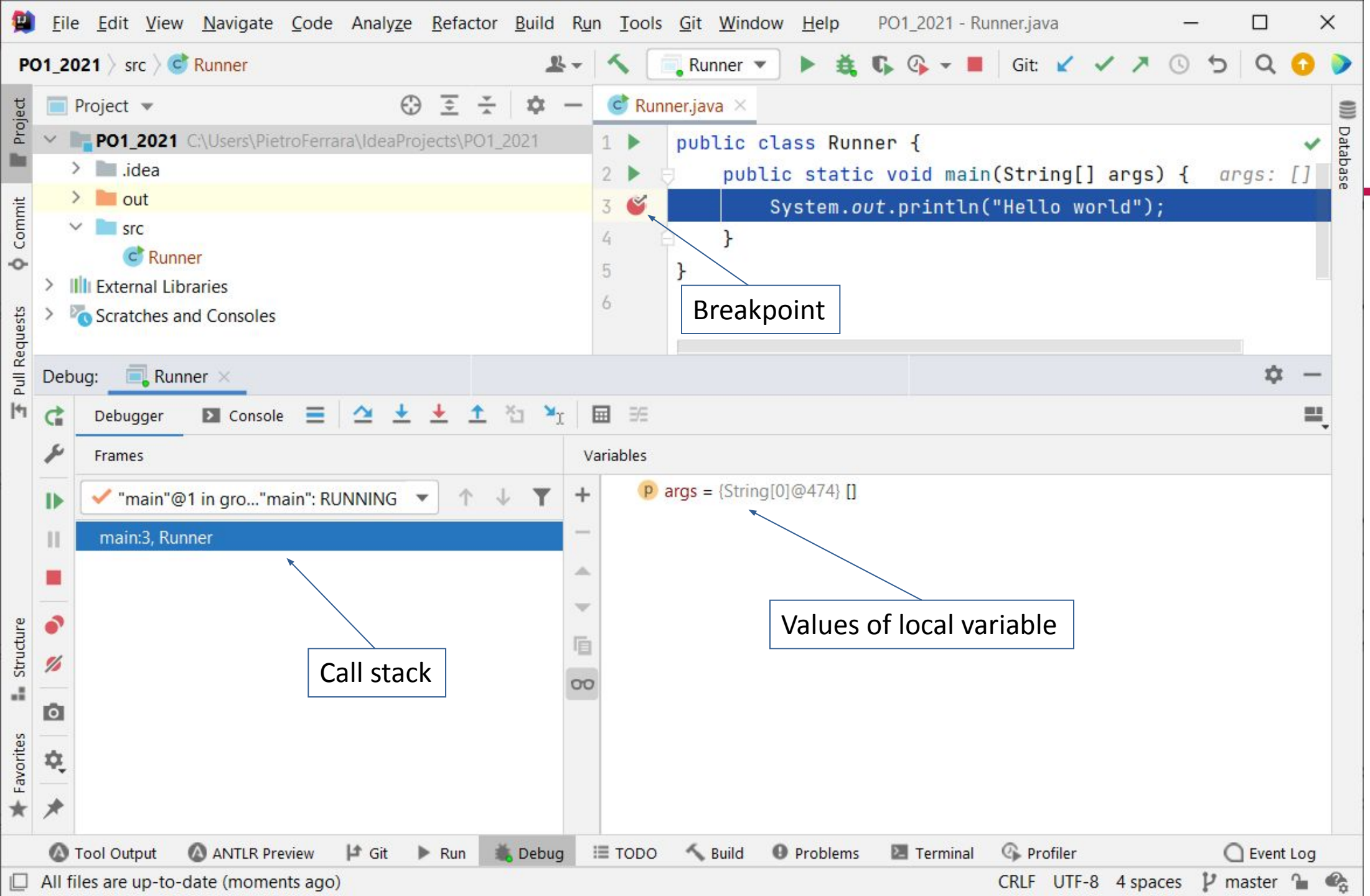
Integrated Development Environment

- IDEs are a fundamental tool for developers nowadays
- There are many different IDEs
  - Eclipse, IntelliJ IDEA, NetBeans, Visual Studio [Code]
- They are (more or less) the same
- I will use IntelliJ IDEA
  - Ultimate Edition for free for students and professors
  - https://www.jetbrains.com/community/education/#students
- GitHub repo
  - https://github.com/pietroferrara/SoftwareArchitectures_2024


File Edit View Navigate Code Analyze Refactor Build Run Tools Git Window Help
PO1_2021 - Runner.java
PO1_2021 src Runner main
Add Configuration...
Git:
Project
PO1_2021 C:\Users\PietroFerrara\IdeaProjects\PO1_2021
.idea
src
Runner
External Libraries
Scratches and Consoles
Runner.java
1 public class Runner {
2 public static void main(String[] args) {
3 System.out.println("Hello world");
4 }
5 }
6
Project's files
Code
Run configuration
Run and debug
Compiler's errors and warnings
Problems: Current File Project Errors
No problems in Runner.java
Tool Output ANTLR Preview Git TODO Problems Terminal Profiler Event Log
3:43 CRLF UTF-8 4 spaces master


File Edit View Navigate Code Analyze Refactor Build Run Tools Git Window Help
PO1_2021 - Runner.java
PO1_2021 src Runner
Runner
Git:
Project
PO1_2021 C:\Users\PietroFerrara\IdeaProjects\PO1_2021
.idea
out
src
Runner
External Libraries
Scratches and Consoles
Runner.java
1 public class Runner {
2 public static void main(String[] args) { args: []
3 System.out.println("Hello world");
4 }
5 }
6
Breakpoint
Debug: Runner
Debugger
Console
Frames
Variables
"main"@1 in gro..."main": RUNNING
main:3, Runner
args = {String[0]@474} []
Call stack
Values of local variable
Tool Output
ANTLR Preview
Git
Run
Debug
TODO
Build
Problems
Terminal
Profiler
Event Log
All files are up-to-date (moments ago)
CRLF
UTF-8
4 spaces
master
Project
Commit
Pull Requests
Structure
Favorites
Database