ITiCSE 2024

Learn by Example in a Modern Embedded System Course

Rafael Corsi Ferrão (Insper), Igor dos Santos Montagner (Insper), Rodolfo Azevedo (Unicamp)

Insper Instituto de Ensino e Pesquisa

UNICAMP

Insper

A small private non-profit institution in São Paulo, Brazil

Scholarships + stipends for 10-15% of students

Cohort-based (no courses outside of major)

Enrollment: 50 students per semester

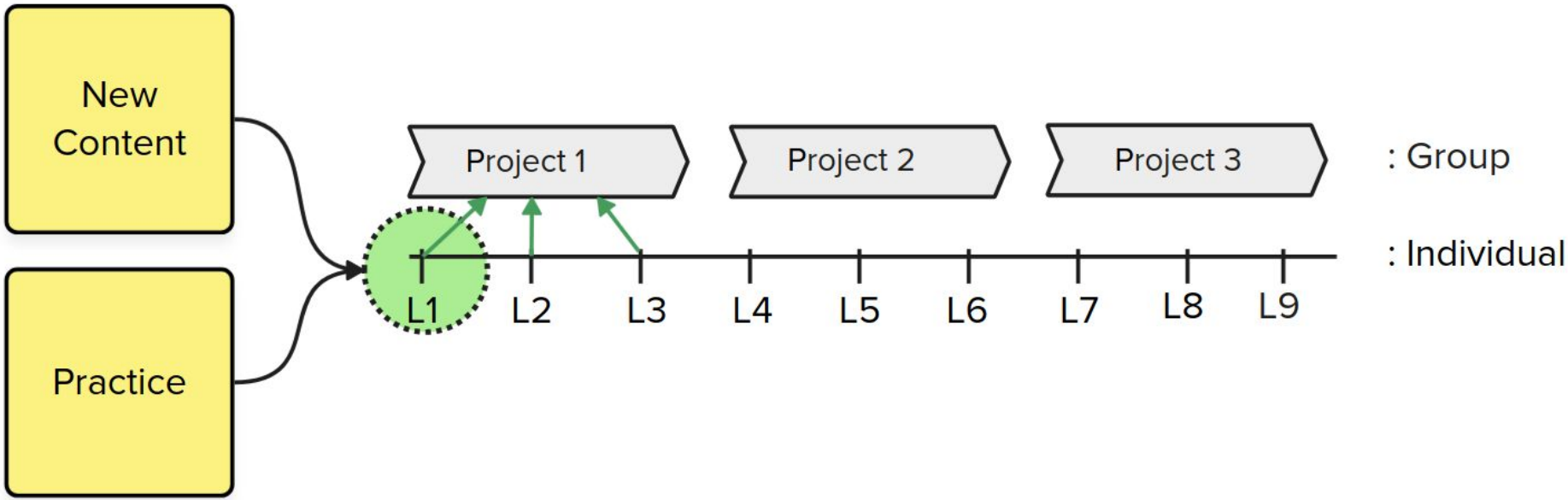
Context

Embedded Systems

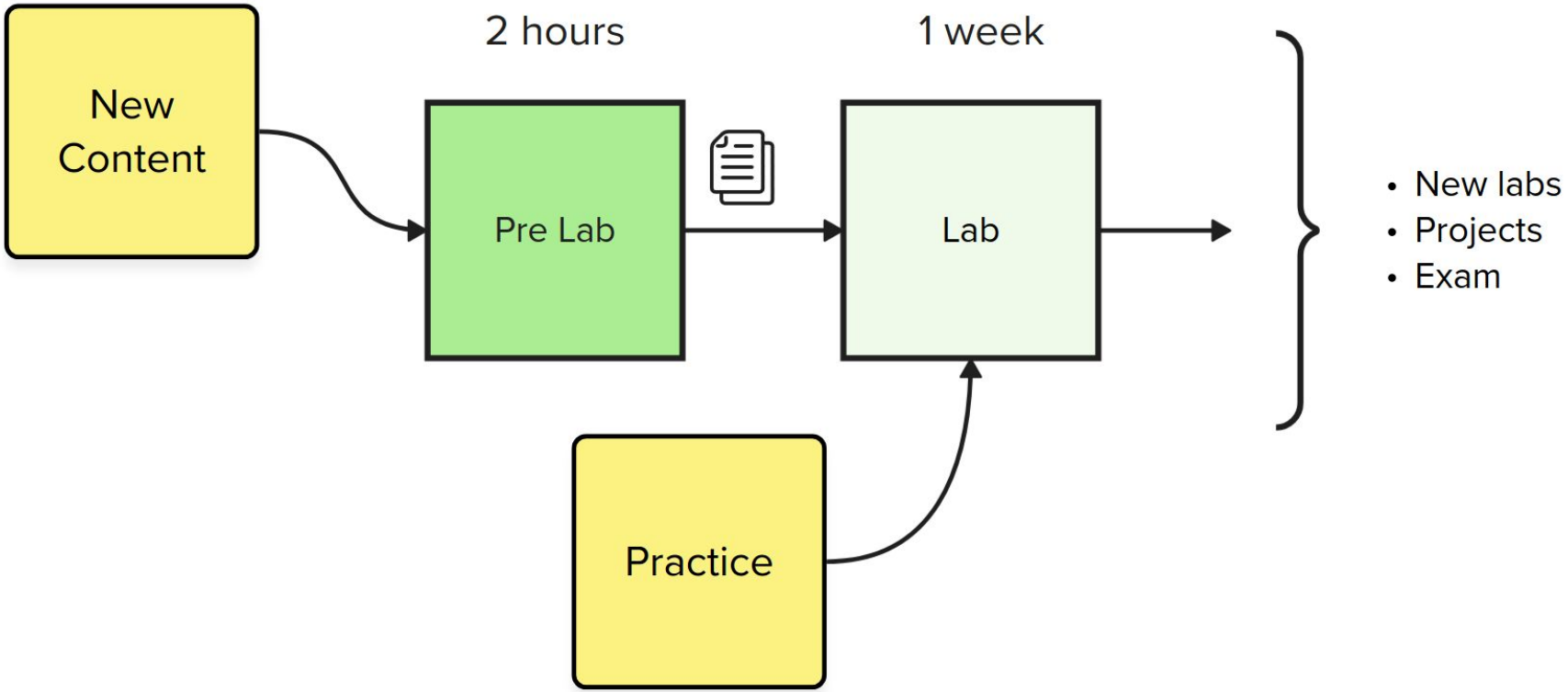
- Undergrad course
- ~ 50 students
- Offered in the fifth semester of CE
- Firmware focus (C language)
- Hands-on

Software ⟷ Design ⟷ Hardware

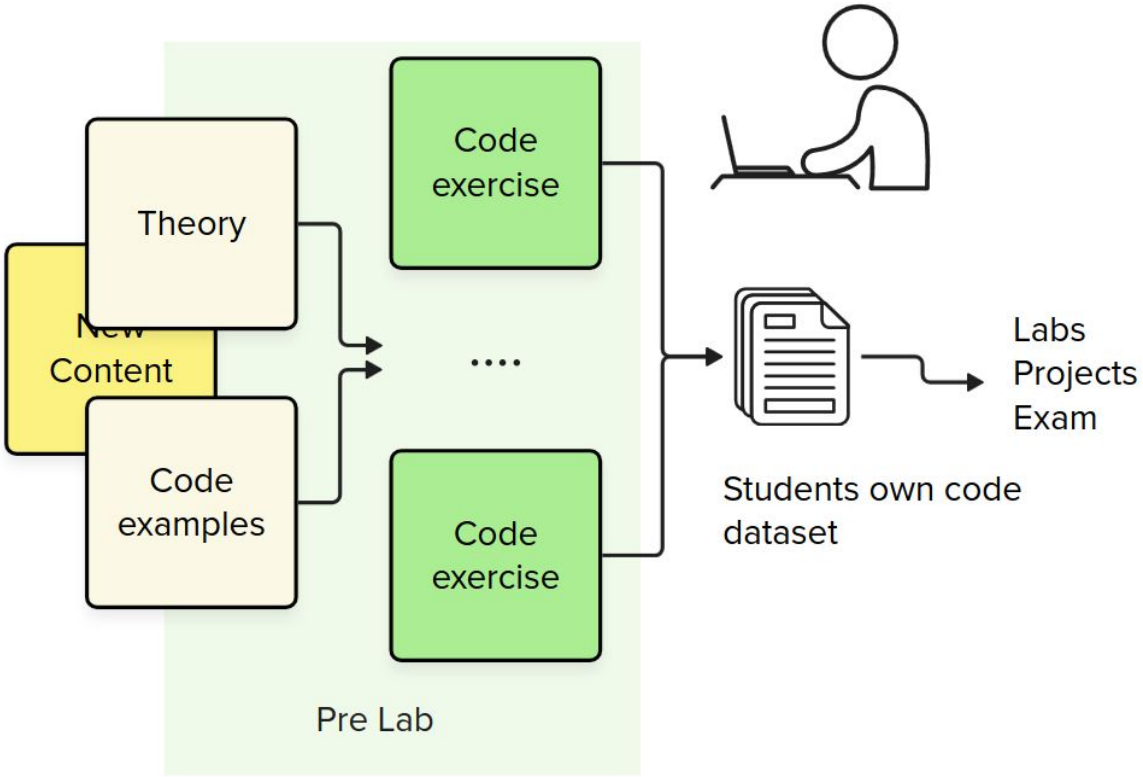
Course outline



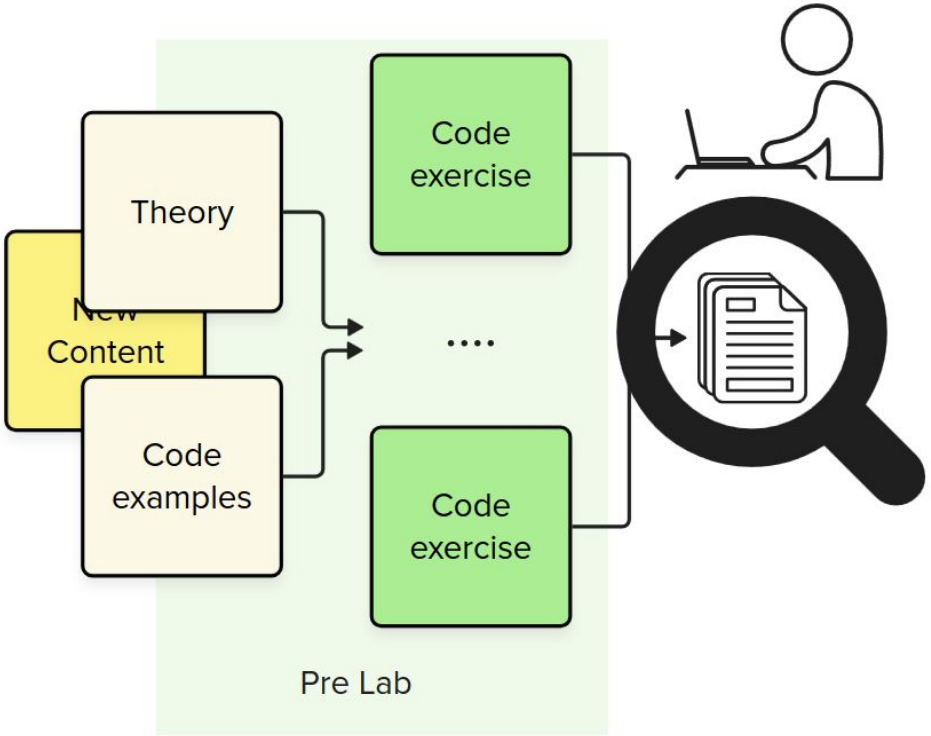
Labs


New Content
2 hours
Pre Lab
1 week
Lab
Practice
• New labs
• Projects
• Exam

Pre Labs

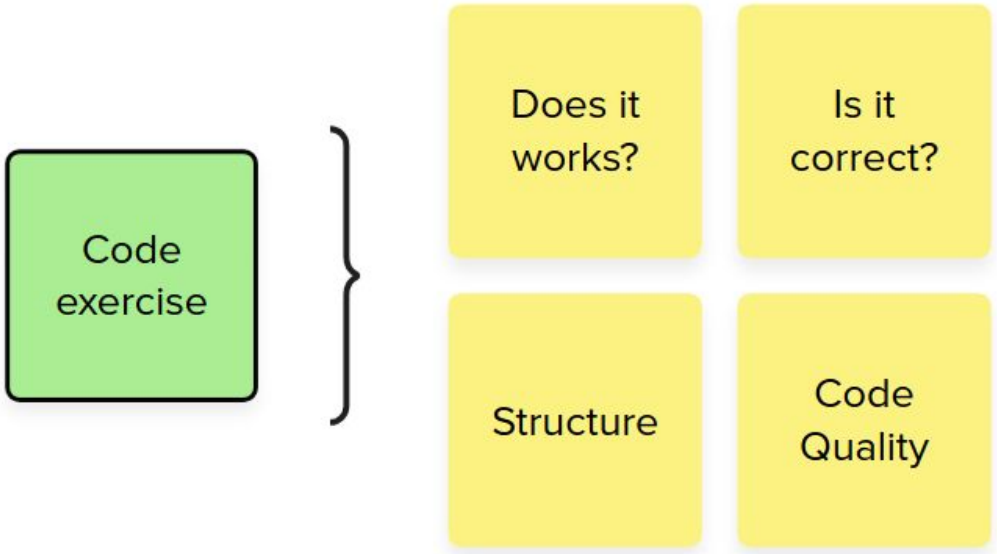

Theory
New Content
Code examples
Code exercise
....
Code exercise
Pre Lab
Labs
Projects
Exam
Students own code dataset

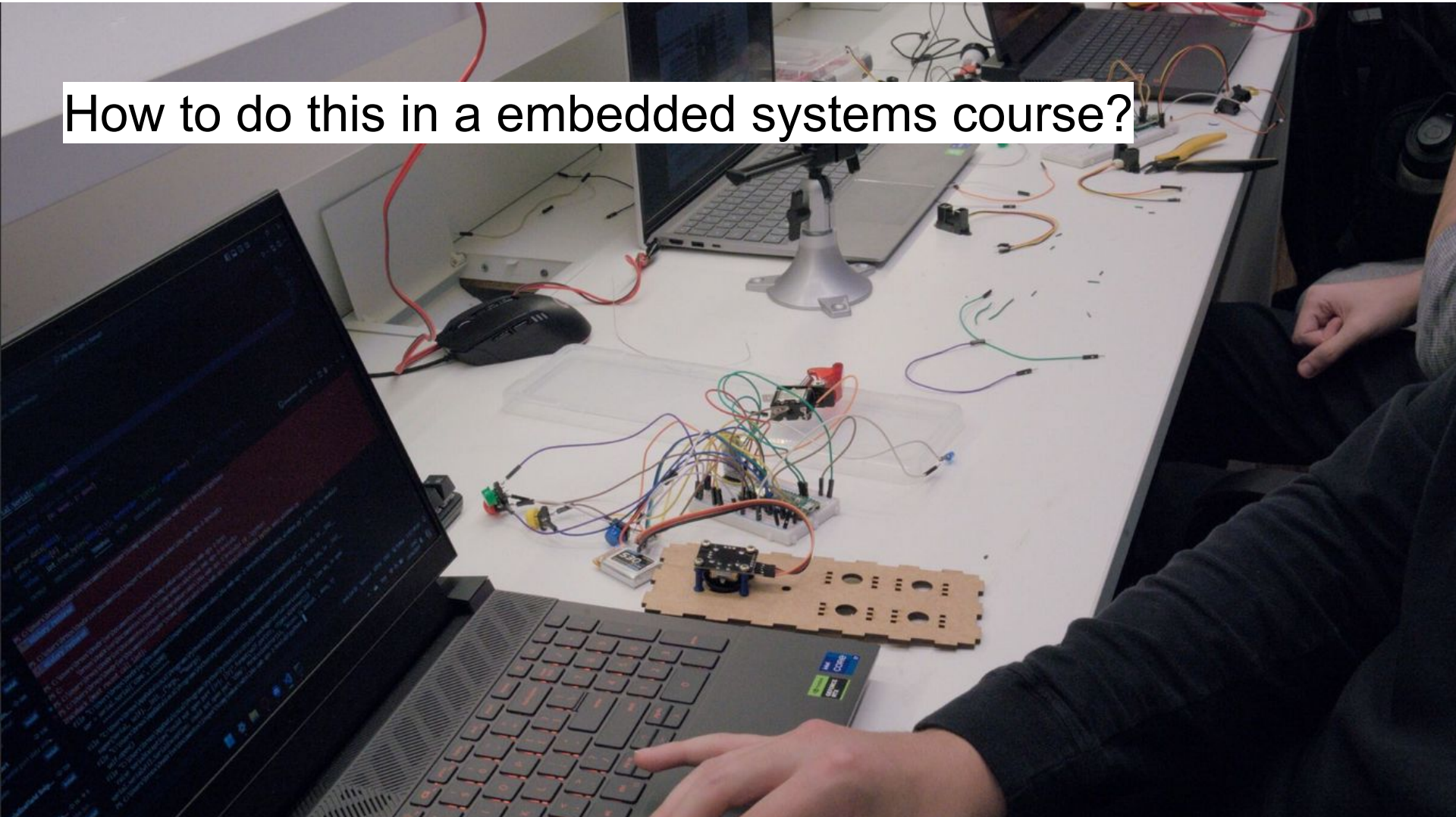
Active Learn by example



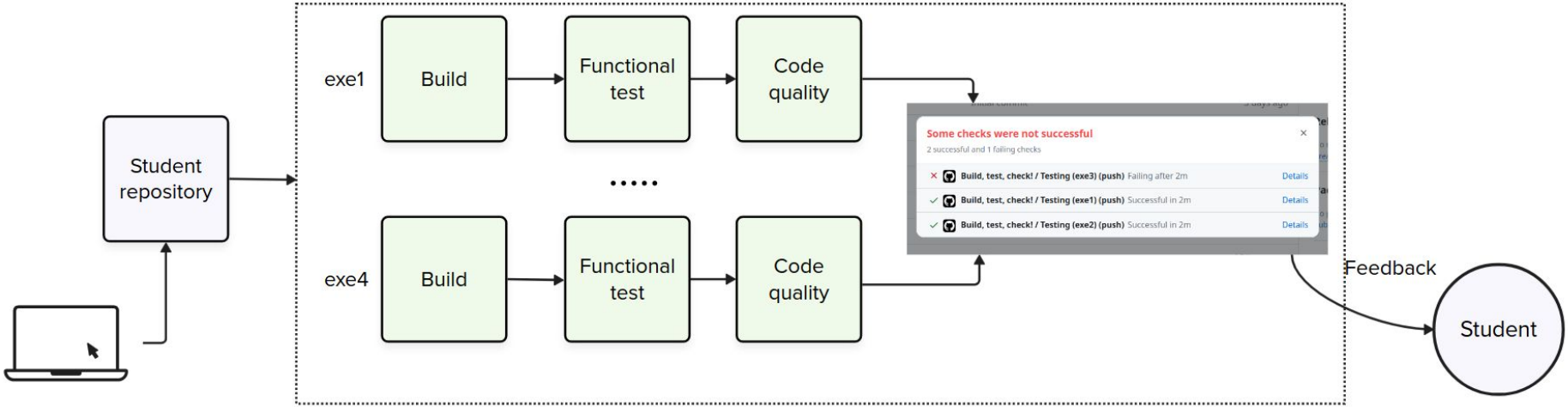
Students are creating their own code example dataset. **How can we validate it?**

Validation

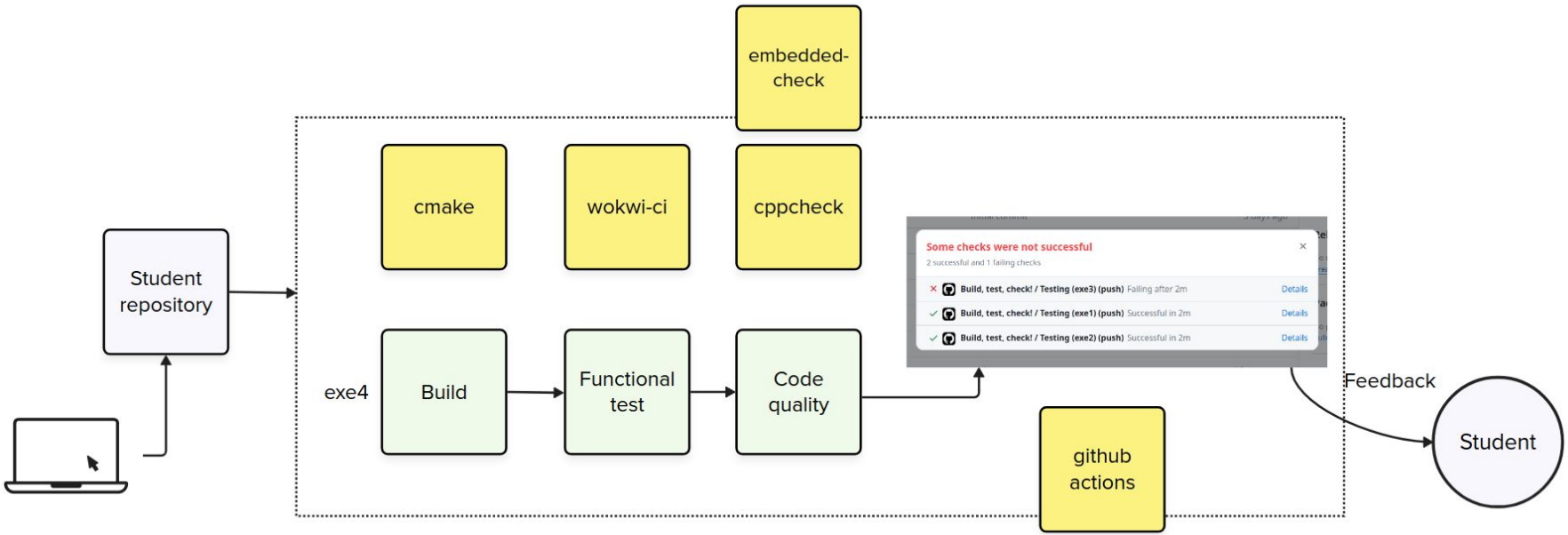

Code exercise
Does it works?
Is it correct?
Structure
Code Quality


How to do this in a embedded systems course?

Virtual!

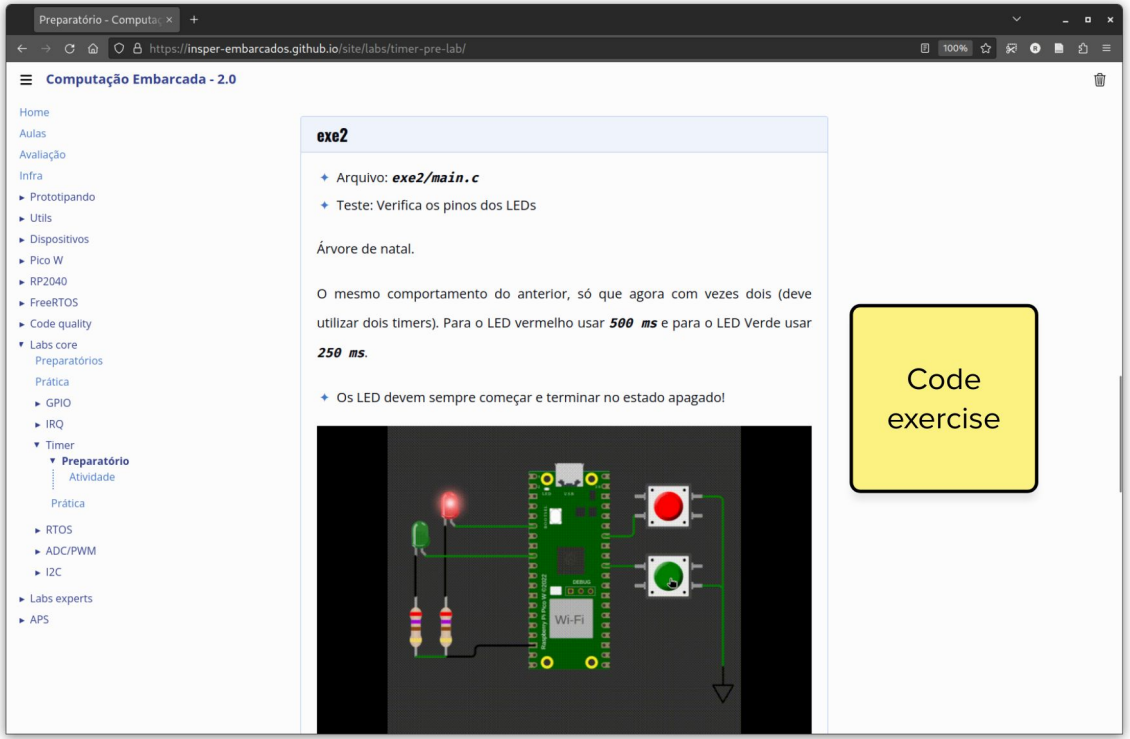

Student repository
exe1
Build
Functional test
Code quality
exe4
Build
Functional test
Code quality
Some checks were not successful
2 successful and 1 failing checks
Build, test, check! / Testing (exe3) (push) Failing after 2m
Details
Build, test, check! / Testing (exe1) (push) Successful in 2m
Details
Build, test, check! / Testing (exe2) (push) Successful in 2m
Details
Feedback
Student

Tools


embedded-check
cmake
wokwi-ci
cppcheck
Student repository
exe4
Build
Functional test
Code quality
Some checks were not successful
2 successful and 1 failing checks
Build, test, check! / Testing (exe3) (push) Failing after 2m Details
Build, test, check! / Testing (exe1) (push) Successful in 2m Details
Build, test, check! / Testing (exe2) (push) Successful in 2m Details
Feedback
Student
github actions

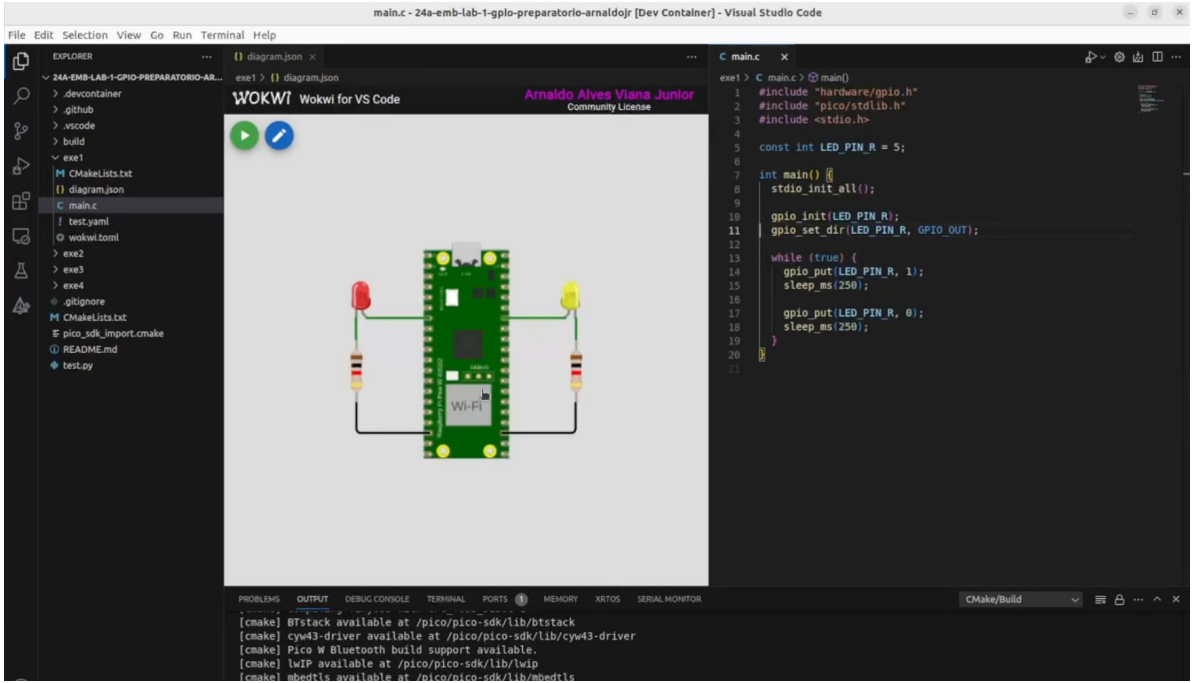
Students view

- All material in a website



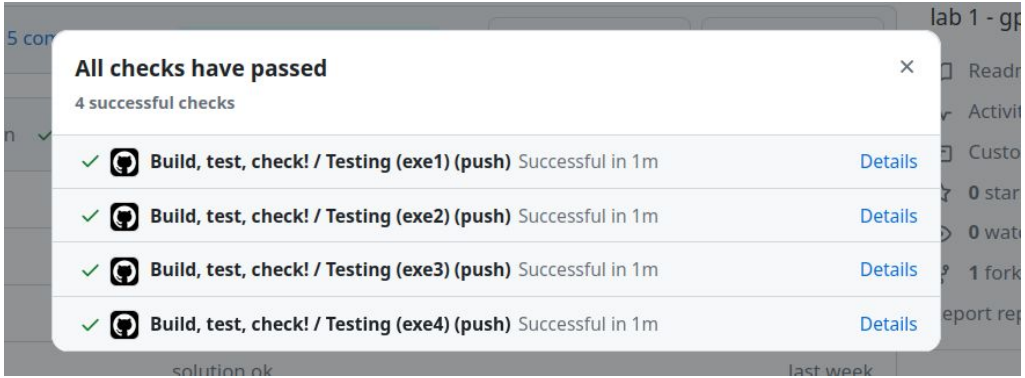
Programing

- Virtual development
- Students can't run autograder locally
- They can simulate and manually test



Checking

- Feedback in github actions log
- One test per exercise
- A little slow…



Conclusion and Discussions

Results:

- In a questionnaire (N=39) 97.44% of students reported referring back to the exercises completed during the pre-lab for the practical laboratory tasks
- 91% indicated that they found the pre-lab helpful in executing laboratory tasks, with scores ranging between 4 and 5 (likert scale)

Improvements

- We need to add new levels of testing
  - Code structure
  - Unit test
- Think aloud experiment

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github.com/rafaelcorsi

rafael.corsi@insper.edu.br

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