Department of Information Engineering
and Computer Science

UNIVERSITÀ
DI TRENTO

Interactive Code Playgrounds on Android

Using mobile devices to make educational technologies more accessible in contexts of scarcity

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PROBLEM STATEMENT

Scarcity:

- 1/3 of the global population lacks internet access, which might not be peristent when present
- Access to only low-end, less performant devices
- Universities can not afford enough computers to accomodate all their students
- Lack of digital skills

Educational technologies used in these contexts must take into account such constraints

PROBLEM STATEMENT

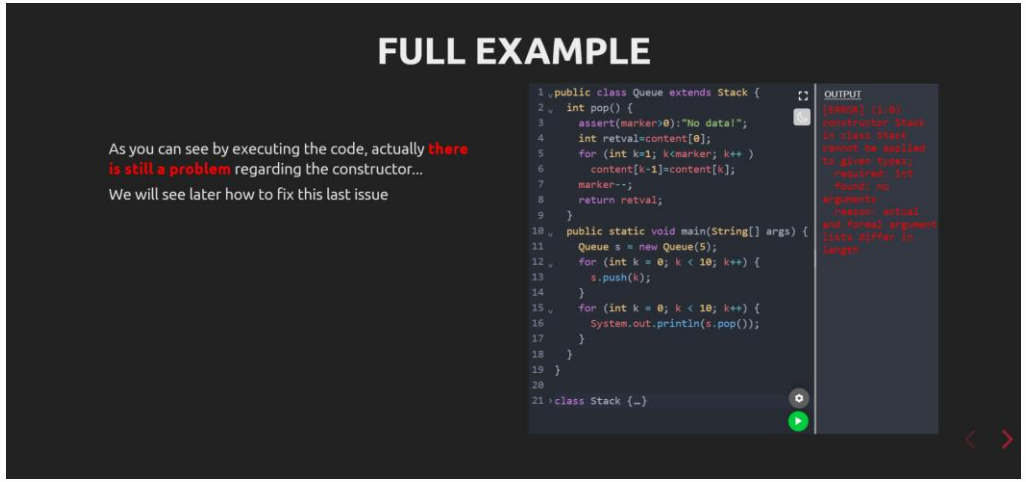
At the same time, an educational technology should:

- Blend theory with hands-on activities
- Present an alternative to IDEs, which can be difficult to set up and use
- Provide a standardized environment

INTERACTIVE CODE PLAYGROUNDS (ICP)

An alternative slideshow system with core ideas of accessibility and inclusivity

- Standardized and platform-independent
- Accessed through browsers
- Familiar environment: editors put into slides
- Works offline
- Different languages available



Example of ICP slides

GOAL

Interactive Code Playgrounds on mobile:

- Need self or cloud hosting
- Hidden contents in the slides

Mobile devices are an important tool for inclusivity:

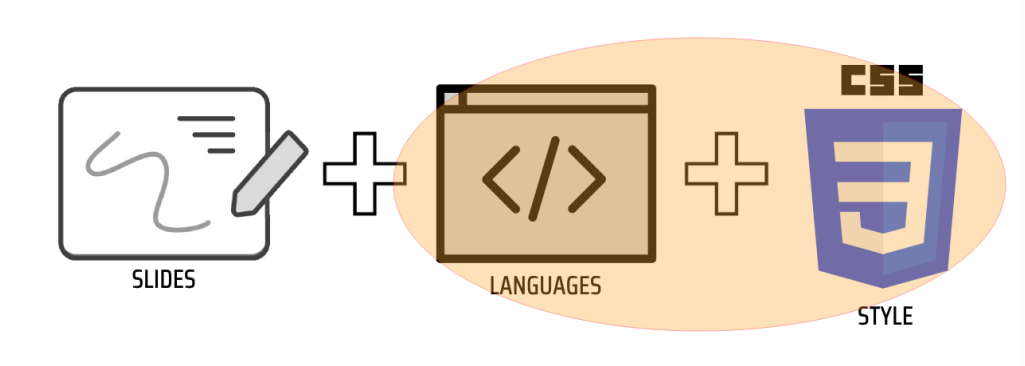
- Important percentage of mobile-only users in the Global South
- Easier to use and more affordable than computers

Create an app to better distribute ICP slides on Android mobile devices

DEVELOPMENT: 1st ARCHITECTURE

- Hosts the slides and shows them in an embedded browser
  - Embedded browser: GeckoView

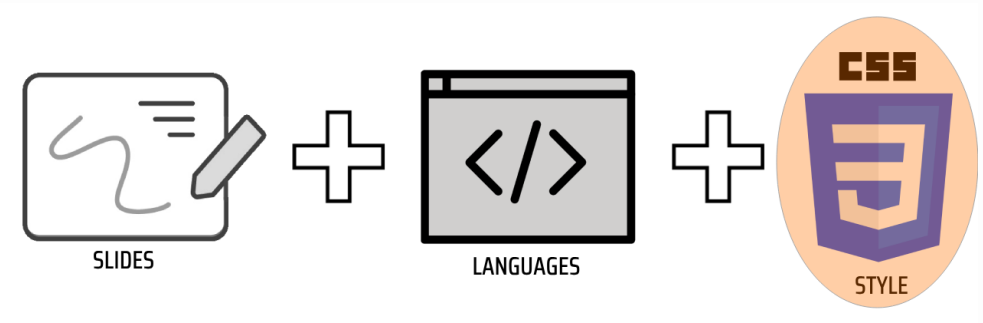
- App contains support for all ICP languages and style files



- Big storage usage (around 400MB) and slow (initialization times can take up to 3 minutes)

DEVELOPMENT: FINAL ARCHITECTURE

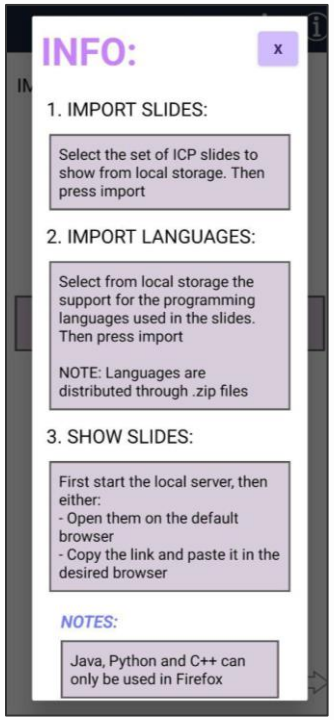
- Modular structure: app only provides style files, user imports slides and support for languages

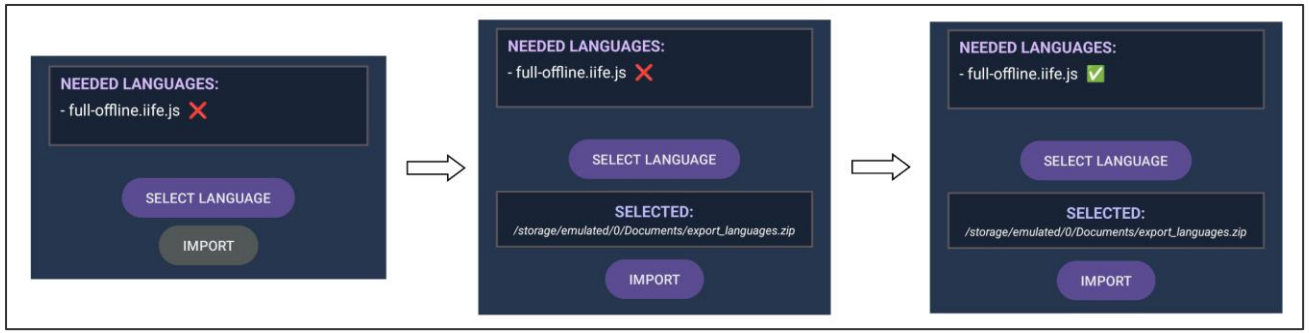


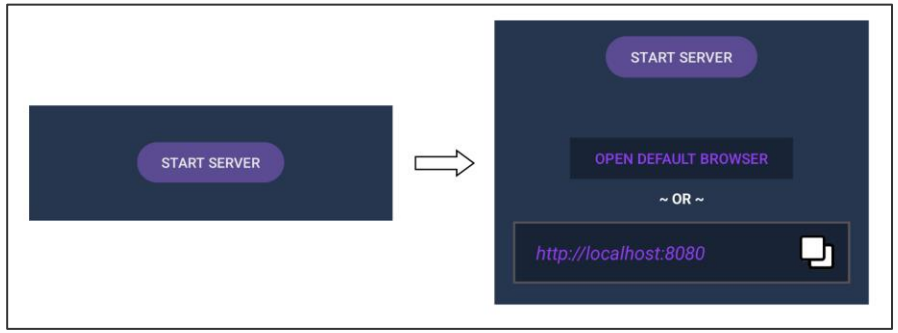
- Uses browsers natively available on the device, only takes care of locally hosting
- Much faster and lighter (around 30MB)
- Targets down to Android 5

DEVELOPMENT: FINAL ARCHITECTURE

- UI focuses on guiding the user through the app in a simple way

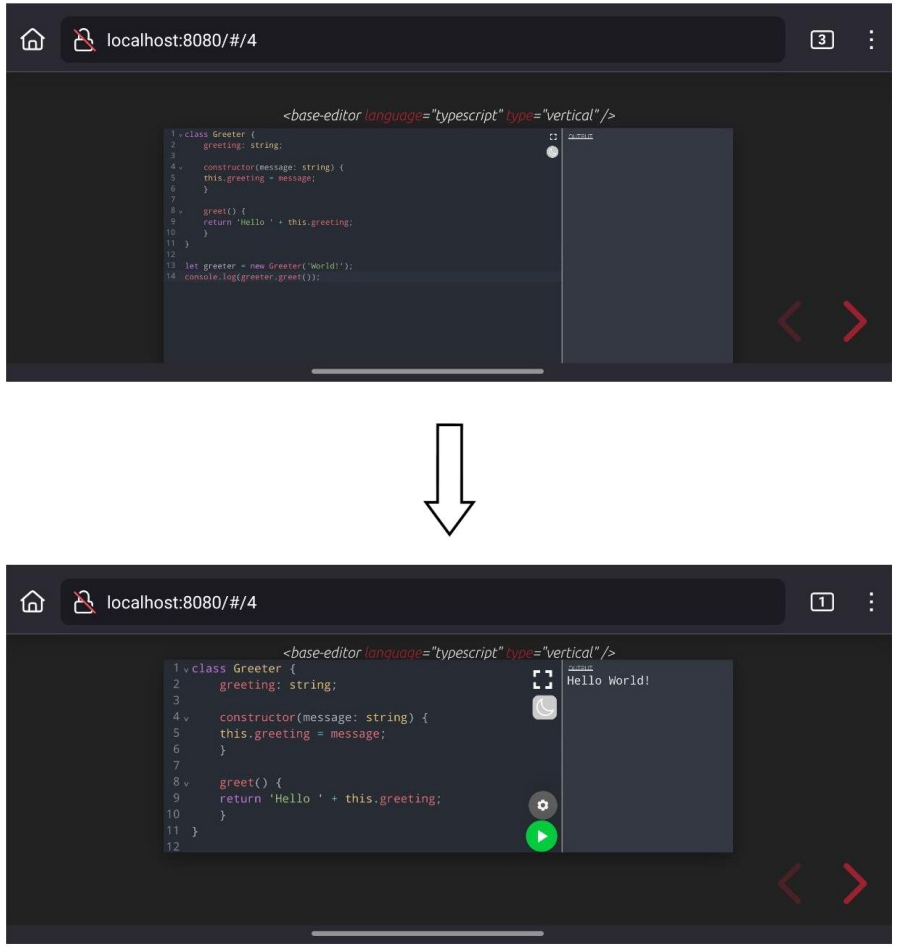






DEVELOPMENT: ORIGINAL ICP PROJECT

- Added possibility to export support for languages for mobile devices
- Fixed style to fit mobile screens



RESULTS: PERFORMANCES

The app was tested on:

- OnePlus Nord 2t, Android 14, 8GB RAM (2022)
- Huawei Nova Young, Android 6, 2GB RAM (2017)
- Huawei Mediapad T3 7, Android 7, 1GB RAM (2017)

Following the example of the original ICP project, the app was mainly tested on the lowest-end device available: the **Huawei Mediapad T3 7**

RESULTS: PERFORMANCES

Programming Language	Initialization (s)	Code Execution (s)
Java & java-offline	100	18.5
Java & full-offline	105	19
Python & python-offline	41	Immediate
Python & full-offline	46.5	Immediate
C++ & cpp-offline	[Hangs]	[Hangs]
C++ & full-offline	[Hangs]	[Hangs]
Standard ML	Immediate	9
Typescript	Immediate	1.7
SQL	Immediate	8
Processing, P5, Javascript	Immediate	Immediate

- On the top, the performances of ICP on a Huawei Mediapad T3 7 using the app

- On the bottom, the performances of ICP on a PC with 4GB DDR3 RAM and a dual-core AMD E-300 1.3GHz CPU

Programming Language	Initialization (s)	Code Execution (s)
Java	59	15.5
Python	59	Immediate
C++	209	0.5 to 8
Processing	Immediate	Immediate
P5	Immediate	Immediate
Standard ML	Immediate	4.6
Javascript	Immediate	Immediate
Typescript	Immediate	0.6
SQL	Immediate	0.5

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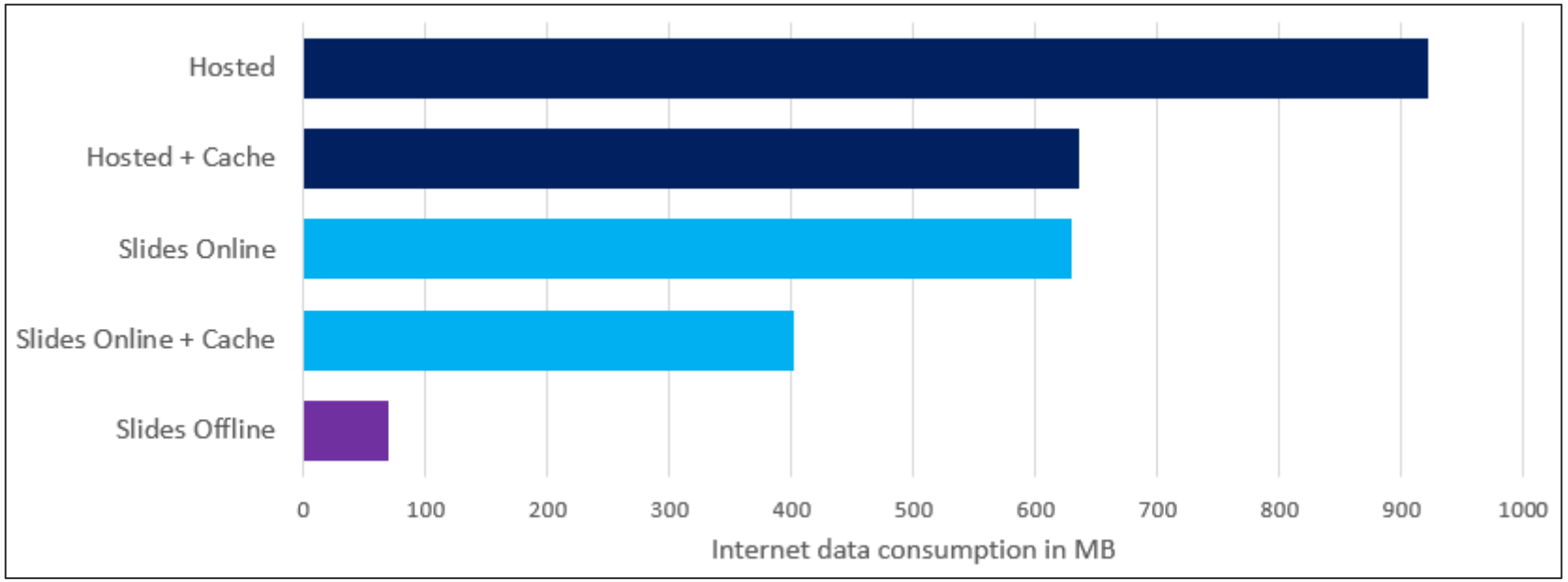
RESULTS: PERFORMANCES

- Simulated an use case: 12 EC introductory course to programming
  - Average of 25 sets of slides, each containing 40 slides

- Assumption: during a course, each set of slides is reproduced 3 times



RESULTS: LIMITATIONS

Two kind of limitations:

1. Some bugs, possibly caused by incompatibilities with mobile browsers
   - They do not affect the usability of ICP slides, but can compromise their quality

2. Uncertainty about mobile devices characteristics in contexts of scarcity

CONCLUSIONS

Strengths

- Good performances on low-end devices with no internet connection (Internet data usage can be reduced to 0)
- Works on old devices (Android 5 was released at the end of 2014)
- Keeps all the advantages of using an educational technology like ICP
- Possibility to use mobile devices instead of computers is an important inclusivity factor

Limitations

- Some minor bugs due to compatibility issues
- Missing testing in real courses and contexts of scarcity

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