

Edit, Compile, Execute and Debug C++ on the Web

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Advisor

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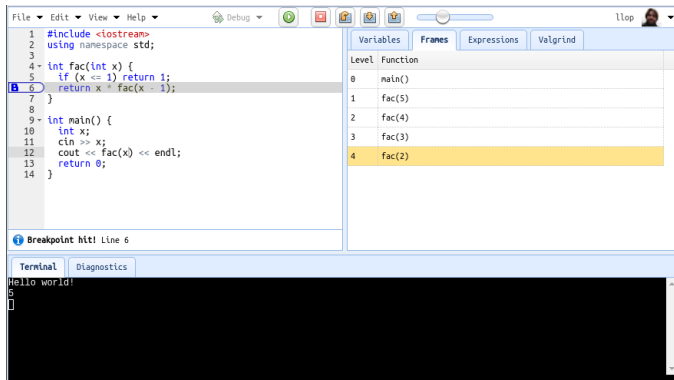
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ide.jutge

A web application to edit, compile, and debug C++ programs

<https://ide.jutge.org>



Overview

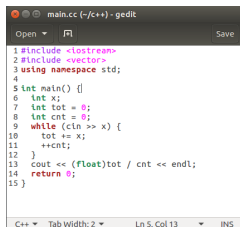
- Introduction
- Design and implementation
- Evaluation
- Conclusions

- Demo


Introduction

Development Utilities

Unrelated tools

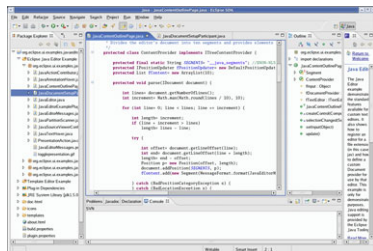


```
1 #include <iostream>
2 #include <vector>
3 using namespace std;
4
5 int main() {
6     int x;
7     int tot = 0;
8     int cnt = 0;
9     while (cin >> x) {
10         tot += x;
11         ++cnt;
12     }
13     cout << (float)tot / cnt << endl;
14     return 0;
15 }
```



```
llopgllopg-S301LP:~/c++$ ls
main.cc
llopgllopg-S301LP:~/c++$ g++ -o main -O2 -Wall main.cc
llopgllopg-S301LP:~/c++$ ls
main main.cc
llopgllopg-S301LP:~/c++$ ./main
1
2
3
2
llopgllopg-S301LP:~/c++$
```

IDE



Debugging

Debug

Identify and remove errors from software

Debugging is difficult for new students

- ✗ Installation of compatible software
- ✗ Learning of debugging commands
- ✗ Advanced knowledge of C++!

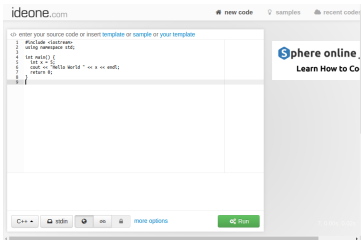
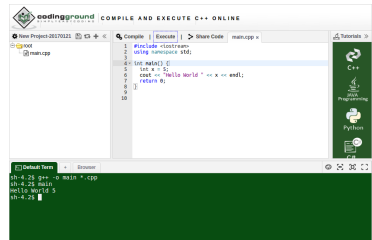
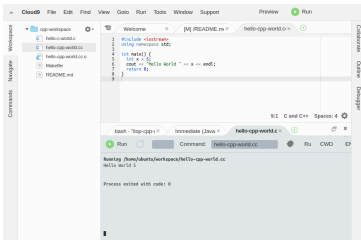
Aim of the Project

Provide a user-friendly web application
to edit, compile and debug C++ programs

Secondary objectives

- Make the infrastructure scalable, stable and secure
- Provide a plugin system for customizing the IDE
- Detect memory errors in the users' programs
- Offer a slow-motion execution mode
- Allow interaction with cloud-based repositories

State of the Art



- Cloud9
- CodingGround
- ideone

None of them provide
debugger features

Benefits

- `ide.jutge` will become part of the *Jutge.org* platform
- Educational tool for introductory programming courses in the FIB

For students

- ✓ No installation and configuration of software
- ✓ Focus on learning to program
- ✓ Stimulate interest in the course

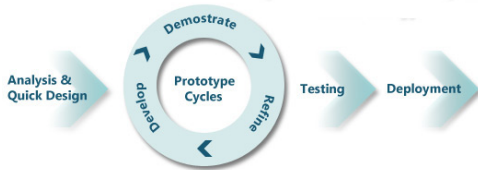
For instructors

- ✓ More engaging classes
- ✓ Possibility to add new features

Design and implementation

Methodology

- Rapid Application Development (RAD)



- Version control
- Best programming practices

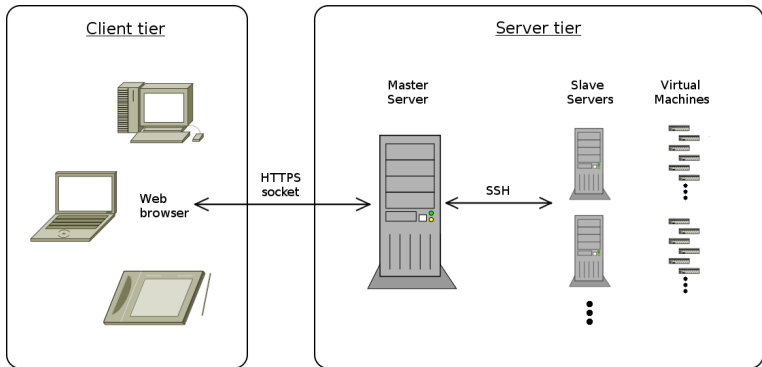
Security Concerns

Users can execute potentially malicious code!

Risks

- Accessing restricted information
- Misusing the network
- Modifying or harming the environment
- Exploiting covert channels
- Exploiting bugs in the OS

Architecture



Prototypes

1. Interaction with the debugger
2. Server application to communicate with the client
3. Secure environment to execute user programs
4. Web application to operate the debugger
5. Infrastructure to support activation and operation of plugins
6. Enhanced Web user-interface
7. Full-featured solution

Technologies

- GNU Project Tools
- LinuxContainers



- Node.js
- Express.js
- Socket.io

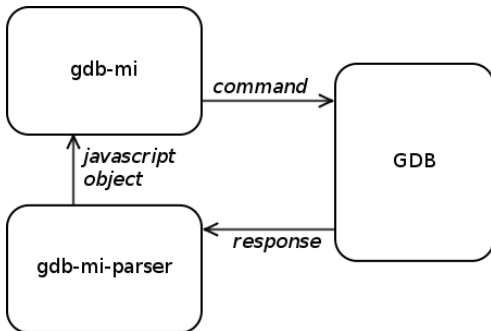


- AngularJS
- jQuery EasyUI



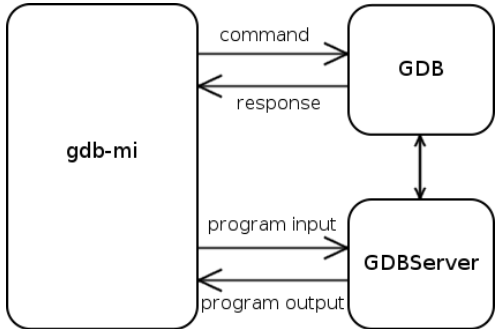
Debugger (I)

- gdb-mi
- GDB



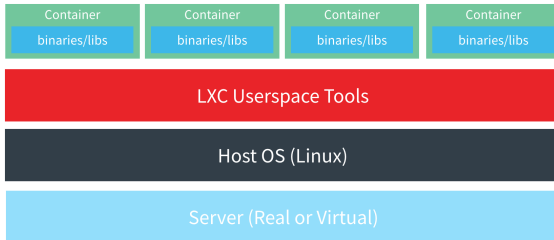
Debugger (II)

- `gdb-mi`
- *GDB*
- *GDBServer*

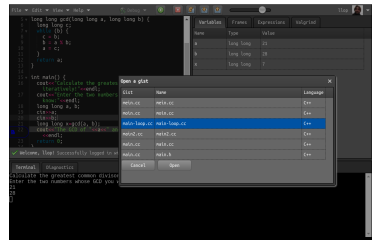
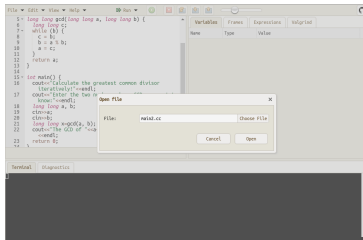
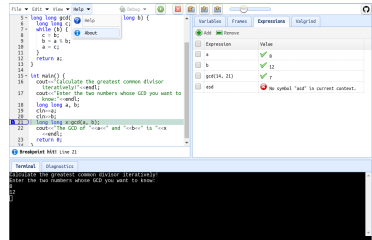
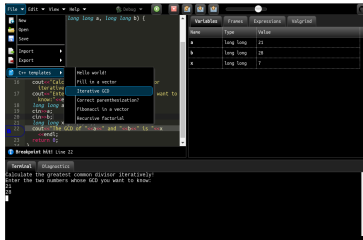


Sandbox

- User workspace feels like a complete OS
- LXC uses operative-system virtualization

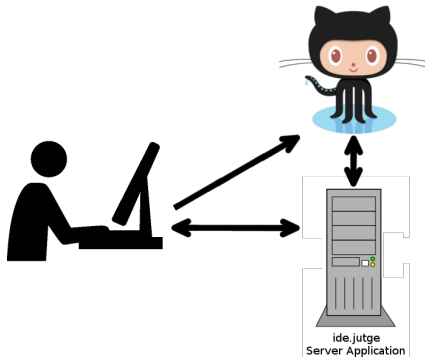


EasyUI



Gists

- Use the *GitHub* API to import/export code
- OAuth2 authentication flow



Evaluation

Usability Test

Purpose of the test

Get direct input on how real users experience the system

Eleven persons were presented with `ide.judge`:

- Usability expert Pere-Pau Vázquez
- UPC faculty members
- UPC students

Usability Test - Feedback + Enhancements

Algunes observacions meves:

Important:

La barra d'estat podria donar informació sobre si s'està executant, o si el programa està corrent, o si està llest...

Es podria posar un breakpoint automàtic al main?

He trobat una cosa que diria que es un bug.

- Agafo un programa qualsevol (p.e. de les plantilles) i l'executo. Tot va bé.
- Modifico lleugerament el programa, per fer alguna cosa diferent, i al fer-ho, introdueixo un error (p.e. falta un ";")
- Quan faig "run", obtinc un error de compilació, com es d'esperar.
- Arreglo l'error
- Un cop arreglat l'error, no puc tornar a executar el programa, perquè el boto de "run" ha quedat desactivat.

IDE Judge

La primera impressió és que l'IDE és molt clar i el disseny és bastant net.

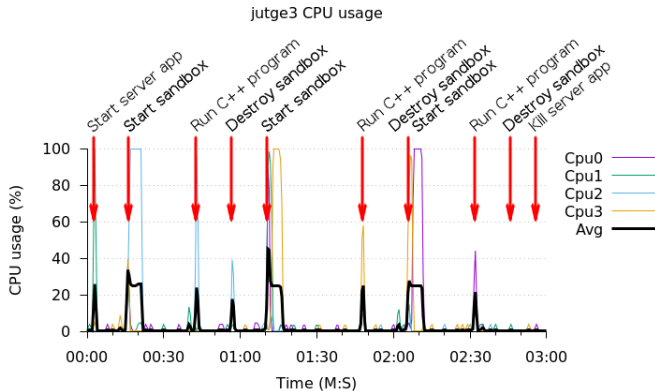
He trobat algunes cosetes de funcionament i algunes més estètiques. Començo per les primeres.

L'execució l'he fet en un Firefox sota Windows però també he fet proves en un Safari en MacOS. La major part dels comentaris es refereixen a la prova més llarga que he fet, que és en Firefox.

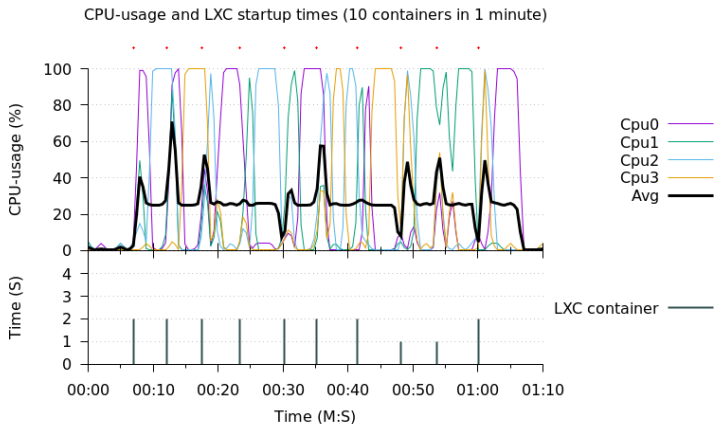
No volia que passés Nadal sense dir-vos alguna cosa.
Però molt poca cosa! Realment, tot ho he trobat bé, útil, intuïtiu i funcionant.
No he provat la pestanya del Valgrind.
L'execució en Slow Motion, una canya.

CPU Profiling

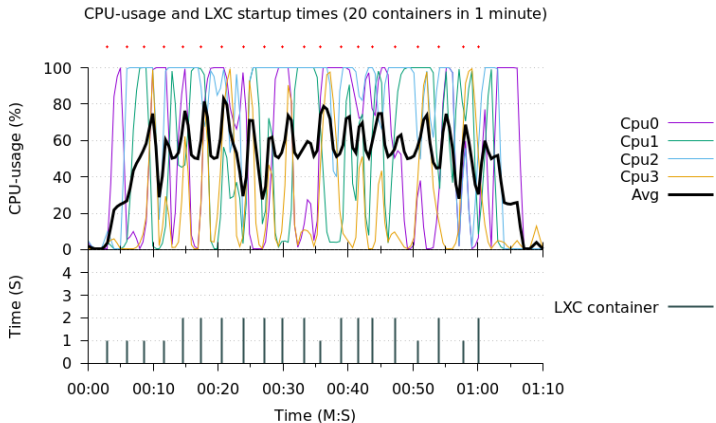
The most CPU-consuming task is starting the sandboxes



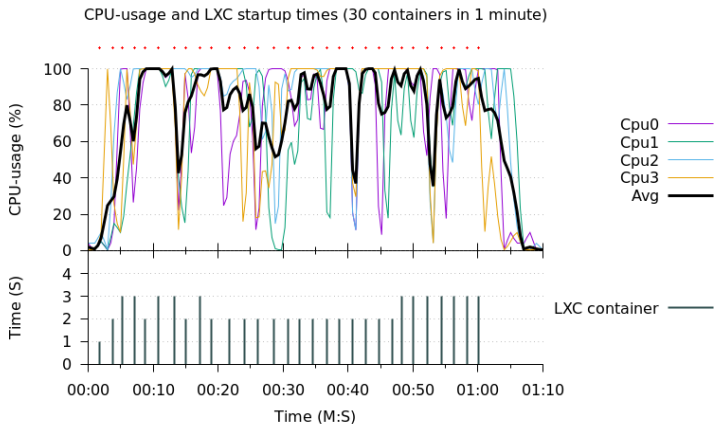
CPU Stress Test - Poisson Random Point Field (I)



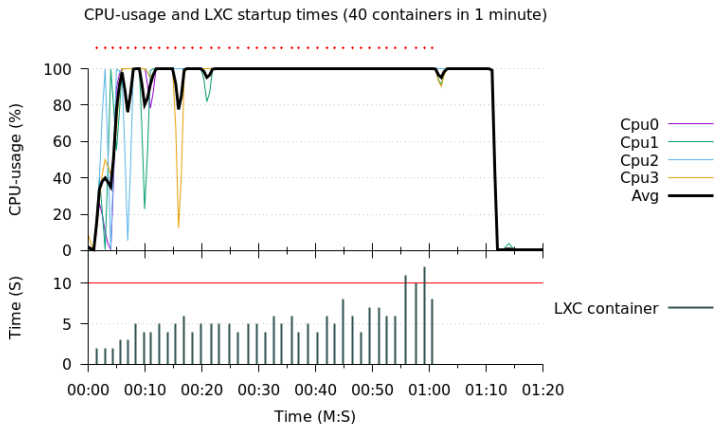
CPU Stress Test - Poisson Random Point Field (II)



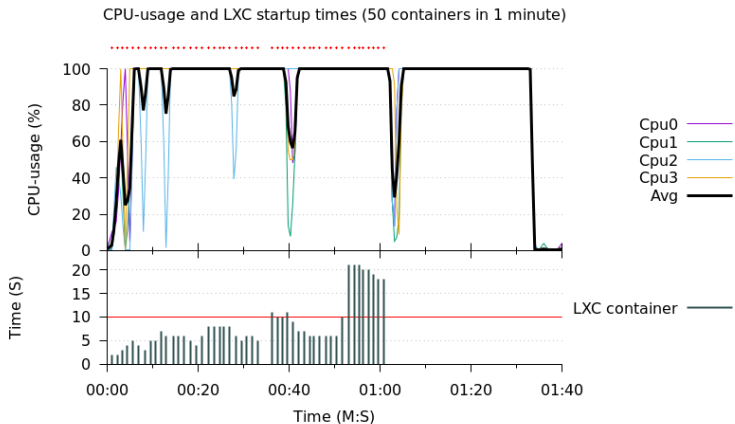
CPU Stress Test - Poisson Random Point Field (III)



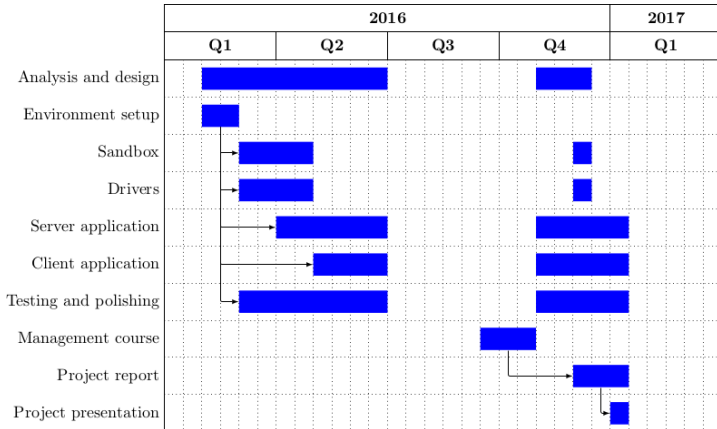
CPU Stress Test - Poisson Random Point Field (IV)



CPU Stress Test - Poisson Random Point Field (V)



Final Timeline



Validation Summary

Main objective

- ✓ Build a Web IDE to edit, compile, execute and debug C++

Secondary objectives

- ✓ Make the infrastructure scalable, stable and secure
- ✓ Provide a plugin system for customizing the IDE
- ✓ Detect memory errors in the users' programs
- ✓ Offer a slow-motion execution mode
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Conclusions

Future Work

- Preallocation of sandboxes
- Offer a complete desktop (disk storage)
- Addition of plugins
- Take `ide.jutge` to the *cloud*

Conclusions

- Usability test results were used to enhance the IDE, and ensured it is easy to use
- Results of the stress tests revealed the solution's operational limits
- `ide.jutge` satisfies and exceeds the project's requirements
- It is a good educational tool for the *Jutge.org* platform

Demo

<https://ide.jutge.org>



[illegible]

Economic Cost

Resource	Total cost(€)
Hardware	66.66
Software	209.77
Staff	28850.00
Electricity	5.77
Internet	9.45
Subtotal	29141.65
Contingency (10%)	2914.16
Total	32055.81



Sustainability

	Project Development	Exploitation	Risks
Environmental	Consumption Design	Ecological footprint	Environmental risks
	10	20	0
Economic	Project bill	Viability plan	Economic risks
	10	20	0
Social	Personal impact	Social impact	Social risks
	10	20	0
Sustainability range	30	60	0
	90		