Enterprise Programmering 1

Lesson 11: CI and Deployment

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About these slides

- These slides are just high level overviews of the topics covered in class
- The details are directly in the code comments on the Git repository

Continuous Integration (CI)

Code Evolution

- Every time there is a change in the code, you want to know if application is still working fine
- Possible problems:
  1. Code does not compile
  2. Changes broke some functionalities, and some tests now fail
- When to check? At each *Git Push*
- Could ask developers to always do a "*mvn clean verify*" before each commit, but:
  1. They might forget
  2. Test cases might take **hours** to run

CI Server

- A server that automatically pulls from Git at each push
- Build your application and run all tests
- Inform developers (eg by email) if a build fails
- Can keep track of build history
- Can check a Git PR (Pull Request) before merging it
- *Jenkins* is the most used CI server, which you can install on your machines
- Extremely useful when working in teams
  - If you end up working in a company not using CI, **run away!!!**

Travis CI

- A cloud CI provider: www.travis-ci.org
- Free for open-source projects
- Supporting many languages, not just Java
- Can be integrated with GitHub, eg build at each Git Push
- Quite easy to setup: besides creating an account, in project you just need a "*.travis.yml*" config file

Travis CI GmbH [DE] | https://travis-ci.org/arcuri82/testing_security_development_enterprise_systems

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build passing

Current Branches Build History Pull Requests More options

master ex 11 description

Commit c9506a1
Compare dabccf7..c9506a1
Branch master
arcuri82 authored and committed

#299 passed
Ran for 26 min 13 sec
about 15 hours ago
Restart build

Job log View config

Remove log Raw log

```
1  Worker information                                                    worker_info
6  mode of '/usr/local/clang-5.0.0/bin' changed from 0777 (rwxrwxrwx) to 0775 (rwxrwxr-x)
7  Build system information                                              system_info
414
415 removed '/etc/apt/sources.list.d/basho_riak.list'
416 W: http://ppa.launchpad.net/couchdb/stable/ubuntu/dists/trusty/Release.gpg: Signature by key
    15866BAFD9BCC4F3C1E0DFC7D69548E1C17EAB57 uses weak digest algorithm (SHA1)
417 W: Failed to fetch https://packagecloud.io/computology/apt-backport/ubuntu/dists/trusty/InRelease  Failed to
    connect to packagecloud-repositories.s3.dualstack.us-west-1.amazonaws.com port 443: Connection timed out
418 W: Some index files failed to download. They have been ignored, or old ones used instead.
419
420 127.0.0.1 localhost nettuno travis vagrant
421 127.0.1.1 travis-job-526c251a-9661-4619-8ef1-712c303e2a18 travis-job-526c251a-9661-4619-8ef1-712c303e2a18 ip4-
    loopback trusty64
```

GitHub, Inc. [US] | https://github.com/arcuri82/testing_security_development_enterprise_systems

build passing

This repository contains a set of examples related to the testing, security and development this repository focuses on Java/Kotlin, targeting frameworks like Spring and Java EE.

The material in this repository is used in two university-level courses at the university colleg particular:

- *PG5100 Enterpriseprogrammering 1*: introduction to enterprise programming.
- *PG6100 Enterpriseprogrammering 2*: advanced enterprise programming.

The repository is built with Maven, and it is divided in two main sub-modules:

- `intro`: material used in the first PG5100 course, where the goal is to be able to build database, and deployed on a cloud provider. Main technologies: Java, Java EE, JPA, EJE Security, Selenium, Docker.

Database Maintenance

Database Migrations

- So far, by configuring "*create-drop*" in Hibernate, we were always recreating the schema of the database
- This of course does not work in production… you do not want to delete your database at each application restart!!!
- A possible (but not good) solution is to use "*update*"
  - It will create a database (based on your entities) if not existing, otherwise will try to update the current one

Issues with “update”

- What if you are adding a new column in a *@Entity*?
- What if you are changing the schema by refactoring some *@Entity* classes (e.g., split one in two)?
- What if by mistake/bug some *@Entity* classes are deleted?
- *What will happen to the current rows in such tables in the database?*

Solution

- The evolution of a database has to be handled with special tools
- *@Entity* classes should just map what is currently in the database, not driving its schema creation/update
  - apart from the very beginning before doing a first production release
- No "*create-drop*", nor "*update*", but rather "**validate**"
  - throw exception if @Entity classes do not match what in database schema
- Tools to use: *Flyway* or *Liquibase*

Flyway

- All operations are done on SQL files, by writing SQL commands
- Each migration file has a version number, in increasing order
- Flyway will check if any new migration has not been applied yet, and apply them otherwise, just *once*
- It creates its own table to keep track of which migrations have been applied so far on a database
- SpringBoot *automatically* runs Flyway if found on classpath

Logging

Log Statements

- It is important to keep track of what is going on in an application
- Especially important when there are bugs, and you want to save the stack-trace of the exceptions
  - needed for example to help debugging such possible bugs
- Logging is a bit tricky, and so there are several libraries that help doing it
  - e.g., because doing I/O, it can impact the JIT compiler… and you could have optimizations in which a logging framework writes on a buffer, and then another thread reads from it to do the I/O…

SLF4J and Logback

- *SLF4J* is the most common library for logging in Java
- It is a "*facade*", i.e., set of base classes/interfaces, where the actual implementation is in a different library, and it is abstracted away
  - i.e., you only import classes from SLF4J in your code
- Can use different logging framework bindings for SLF4J, where *Logback* is the most popular
  - for example, think of *SLF4J* as *JPA*, and *Logback* as *Hibernate*
- Many third-party libraries use SLF4J, but will not provide a binding
  - this enables you to have a single binding for your whole app, including the 3rd-party libraries

Loggers

- Usually creating one logger per class, named with the full name of the class itself (including the package)
  - created using *LoggerFactory.getLogger(name)*, and typically stored in a final static variable
- Configurations will be in a *logback.xml* file
- For testing, can have a different *logback-test.xml* file which will have precedence
- Many possible configurations
  - eg, what to do with the logs? Should just be on the console? Should be written to a file? Should be sent to a remote server? Etc.

Log Statements and Levels

- Different methods: eg, **log.debug(msg)** and **log.error(msg)**
- Based on the LEVEL of logging, some messages can be discarded
  - for example, you could tell the system to discard DEBUG logs, have WARN only on console, and ERROR on console and also saved on a file
- Levels: **TRACE**, **DEBUG**, **INFO**, **WARN** and **ERROR**
- Those are in order: when you activate a level, all levels above it are activated as well
  - eg, activating DEBUG does activate everything but TRACE

Setting Log Levels

- Levels can be fine-tuned
- You can a have a log-level for the whole application, e.g. typically WARN or ERROR
- Then, can override the level for some specific loggers
  - e.g., you could put it to INFO for your classes, but not the ones of the 3rd-party libraries
- When testing/debugging some classes, you could put DEBUG for just those

String Concatenation

- Consider: *log.debug("" + x + "=" + y)*
- That would be bad: often debug-level logs are ignored (especially in production), and so computing ***"" + x + "=" + y*** would be a total waste of CPU cycles
- String concatenation is **expensive**: recall that Strings are immutable, and at each + we create a completely new String object
- Solution: *log.debug("{}={}", x, y)*
  - log statements allow string interpolation, with {} as placeholder
  - if a log is ignored (eg level WARN), then the string is discarded without the need to interpolate it

Cloud Deployment

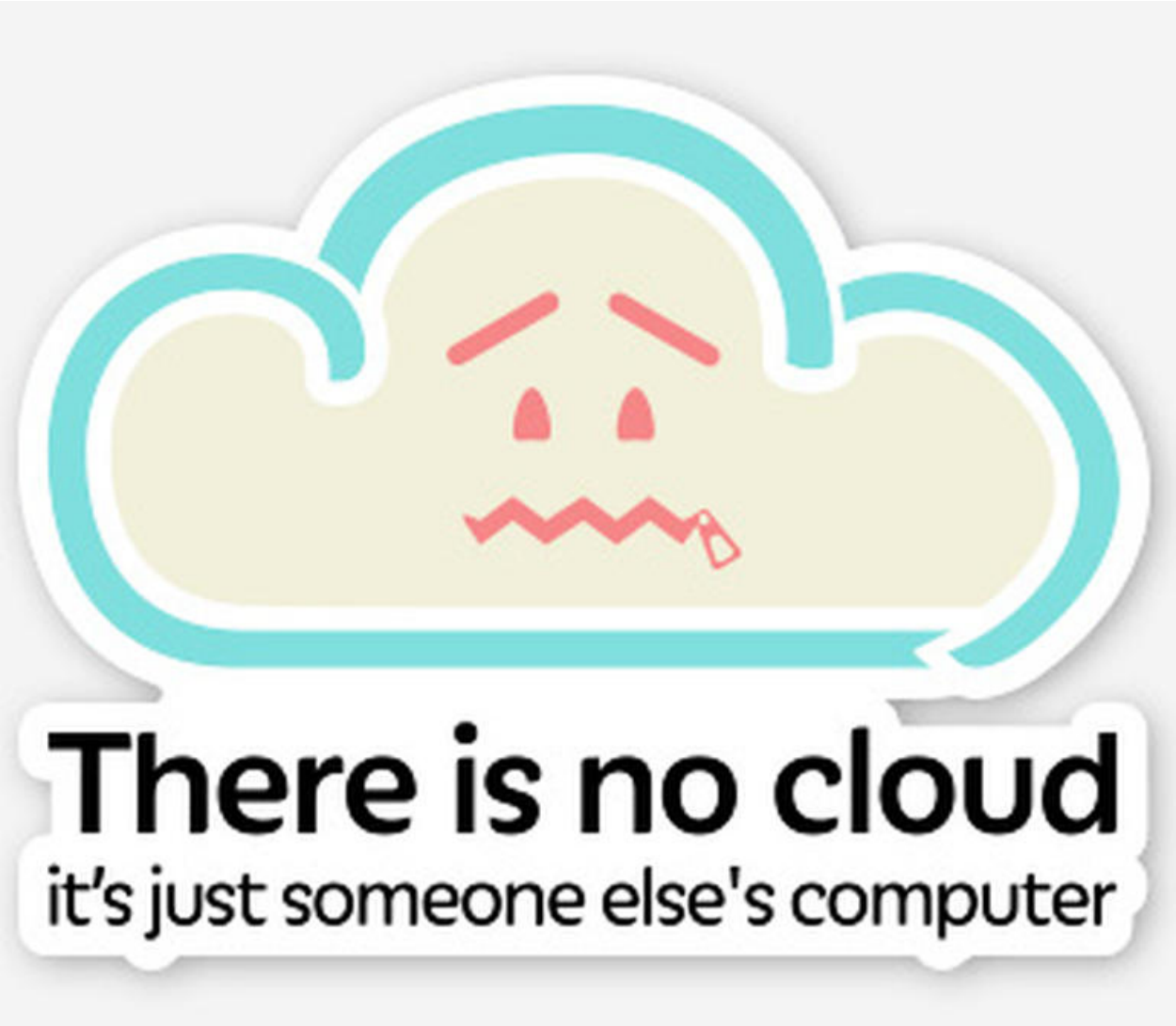
Deployment

- When your application is ready, you need to *deploy* it
- But where?
- You can host your own servers, but then you need to handle everything by yourself
  - hardware (purchasing and maintenance), backups, DNS, etc.
- Many companies do it, but can be difficult for startups and private individuals

Cloud Deployment

- Different companies provide cloud hosting solutions for your applications, which frees you from hardware issues, but for a price
- *Amazon Web Services* (AWS) is perhaps the most famous/used one
  - eg, *Netflix* runs on AWS
- *Automated scaling*: if you need more load, automatically rent more nodes, and automatically scale down if less load
  - this is also good for applications targeting a specific country (eg Norway), in which you will not get much load during the night

Definition of “Cloud”



Heroku

- One of the main cloud providers
- Using this one in the examples because, at the time of this writing, it provides *easy* to use *free* hosting
  - note, this might change at any time
- Supporting Java and SpringBoot applications
- Maven plugin to deploy your self-executable JAR by command line
- *Automatically* setting up environment variables to configure Spring to use Heroku's databases

Using Heroku

- First you need to create an account at www.heroku.com
- Install *Heroku CLI*, which allows you to interact with Heroku from command line
- On the web interface, create an “app” with a name of your choice. In these slides, I will use “*quizgame-pg5100*”
  - as names are unique, you will need to choose a different name

Jar Deployment

- Configure the *heroku-maven-plugin*
- Need to run Maven
- **mvn clean package heroku:deploy -Dheroku.logProgress=true**
- The application will then be available online at https://quizgame-pg5100.herokuapp.com
  - Note the HTTPS protocol, ie encrypted
- But before accessing it, you need to configure its environment

From Command Line (CLI)

- **heroku login**
  - will setup credential for the other commands.
  - note: if using Windows, this does not work on GitBash, and need to do this command once from a regular Terminal
- **heroku ps:scale web=1 --app quizgame-pg5100**
  - enable the node resources needed to run the application
  - Note: might get an error like "*Scaling dynos... ! Couldn't find that process type*" if you haven't deployed the JAR yet at least once
- **heroku addons:create heroku-postgresql --app quizgame-pg5100**
  - add a Postgres database
- **heroku pg --app quizgame-pg5100**
  - see current status of Postgres database
- Note: some (all?) these commands can also be done from web interface

You are not logged in

Log In Sign Up

Quiz Game

Log in to play!!!

Code available at:
https://github.com/arcuri82/testing_security_development_enterprise_systems

Continuous Delivery (CD)

- Deployment can be done from Maven, as part of the build
- You could trigger a deployment at each Git Push from a CI server (eg, Travis or Jenkins)
- Of course, only if code compiles and all tests pass…
- But you might want to have a special Git branch for deployment
  - eg, development on a "*development*" Git branch and deployment on a "*deployment*" branch, done only when changes in "*development*" are *merged* into the "*deployment*" branch

What Next?

- With what learned so far, you can build a whole functional web/enterprise application
  - GUI, security, testing, database, cloud deployment, etc.
- But this kind of *monolithic* application does not *scale* too well for large systems
- Enterprise 2 "*advanced*" course:
  - Dig into Web Services (eg REST) and details of HTTP
  - Distributed systems, in particular *Microservices*
  - Integration with frontends using JS + AJAX + WebSockets

Git Repository Modules

- *NOTE: most of the explanations will be directly in the code as comments, and not here in the slides*
- **.travis.yml**
- **intro/spring/flyway**
- **intro/spring/deployment**
- Exercises for Lesson 11 (see documentation)