

# Performance Evaluation and Applications

 POLITECNICO DI MILANO

## Introduction to the course



# Course structure

2

The course will be composed by 2 hours of in-person sessions, on Wednesday and Friday. Each session will mix theory, exercises and applications.

It will be given by  
*Prof. Marco Gribaudo*

Slides will be published on the WeBeep web page.

Lessons will be streamed, recorded and video will be made available as soon as possible.

The screenshot shows a web browser window with the URL `webeep.polimi.it/course/view.php?id=1048`. The page header includes a green menu icon, the 'WeBeep' logo, and a user profile icon. The main content area is titled '056897 - PERFORMANCE EVALUATION AND APPLICATIONS (GRIBAUDO MARCO)' and includes a settings icon and an 'Attiva modifica' button. Below the title, there are four white boxes with the following content:

- Bacheca**: Consulta gli annunci del corso. Comunica con il docente, i tutor e i tuoi compagni di corso tramite il forum.
- Materiali**: Consulta i materiali forniti dal docente.
- Registrazioni**: Rivedi le lezioni del corso per cui è disponibile la registrazione.
- Consegne**: Consegna gli elaborati richiesti da un'esercitazione o da una prova in itinere.

On the right side, there is a 'Attività recente' section showing the date 'Attività a partire da domenica, 12 settembre 2021, 10:25' and a link to 'Report completo dell'attività recente...'. Below this, it states 'Non ci sono attività recenti'.

The footer contains two columns of links:

- AUTO**: Chiedi al bot, Scrivici, Chatta con noi.
- DOCUMENTAZIONE**: FAQ, Moodle Docs, Informativa sulla privacy.
- LINK**: Beep (versione precedente di WeBeep), Servizi online.



## Course structure

Theory will describe the techniques, the algorithms and the main results involved in Performance Evaluation.

Exercises will apply the proposed methods to study a several different types of systems, ranging from production to communication and computing.

The main structure of the course will be the following:

- Introduction to performance indices and measures
- Workload and Service characterization
- Analytical models
- Discrete event simulation techniques



# Detailed program

## 1. Introduction to performance indices and measures

The main performance indices that can be evaluated from a model, depending on the techniques being employed, will be presented. We will focus on response time, throughput, server utilization, confidence intervals, measures distributions, blocking probability, availability, reliability and more.

## 2. Workload and Service characterization

We will focus on the impact that different input and service processes have on the system performances. We will focus on measuring and analyzing data taken from real systems, and how to mathematically characterize them with probability distributions, through fitting and generation of random traces starting from estimated data.

## 3. Analytical models

We will consider how to accurately model single and multiple service centers, considering multiple servers, finite capacity, and general service and inter-arrival time distributions.

## 4. Discrete event simulation techniques

Finally we will focus on simulation techniques, to study modern computing infrastructures. We will mainly consider multi-class models to study systems with heterogeneous workloads, Fork / Join, finite capacity, and parallel processes. We will use Petri Nets to model resource contentions, and dynamic algorithms to model adaptive techniques.



## Relation with “Computing Infrastructure”

There is a *Performance Evaluation* part in the “Computing Infrastructure” Course.

This Course is meant to be the continuation of those subjects, and it is more effective if taken after the “Computing Infrastructure” exam.

However, the topics and the usage of the theory here, are sufficiently different to be considered an independent course with only a very marginal superposition with the other.

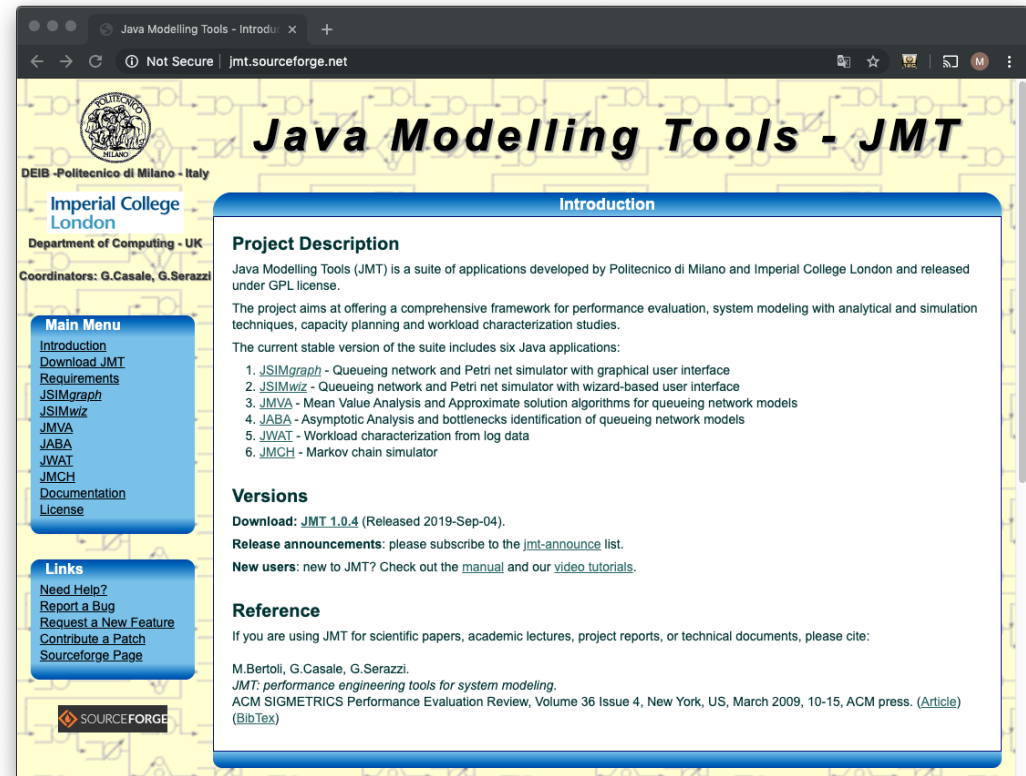
In the past, this course has been fruitfully followed and the exam has been passed by a lot of students before “Computing Infrastructure”, so do not worry if you have not taken that exam yet!



During the course we will use the following tool:

- JMT - Java Modeling Tool

The tool is free and easily available on-line (a Google search of “Java Modelling Tools” will immediately find the correct page, that is *jmt.sourceforge.net*).





We will also make an extensive use of tools for mathematical computations and statistics.

This year, I will use *Python*, since it is rapidly becoming the new standard for math computation.

Any other alternative, such as *Matlab*, *Octave*, *Scilab*, *Mathematica*, can be used if desired. However, beside *Matlab* which was used in the previous years, I cannot offer much support for other tools.



## Expected Outcomes and Application Fields

Expected outcomes are:

- Basic Knowledge of performance evaluation
- Basic Knowledge of discrete event simulation
- Basic Knowledge of performance measurement

There are many application fields, some may be:

- Design of complex infrastructures
- Evaluation of production processes
- Optimization of network communications





## Exam - materials

The evaluation will be based on a set of assignments and a small project.

The (mandatory) assignments will be given at the end of each lesson, to immediately put in practice what has been explained.

The project will consist in the analysis of a pilot system (specifically created for the exam), that will have to be studied using the tools and techniques discussed during the course.



## Exam - tracks

There will be two different ways of passing the exam:

- Standard version
- In-course version



## Exam tracks - standard version

The standard version of the exam is meant for students who wants to prepare the exam at their own pace.

- The *Assignments* and the *Project* are due for the date of the exam, and will be the base for an oral discussion meant at understanding the real knowledge of the topic.
- It will be a “classical” oral exam which:
  - It will start from the set of slides you will prepare for presenting your project.
  - It will then randomly pick some assignments, and use them as a starting point for further questions and discussions.



## Exam tracks - in-course version

The in-course version is meant for students who want to participate live and in-person to ALL the lessons.

- For each given assignment, the presence of the students at the lesson will be recorded to unlock the possibility of up-loading the results.
- Assignments will have a due date (reasonable and not strict).
- The project will be given in the last lessons as a special assignment.
- At the end of the course, the evaluation will be computed according to the deliveries, and a marking will be proposed.
- If accepted, it will be registered without a real oral exam.
  - Please be aware that the *correction process will be very long*, and that it might require up to a couple of months after the end of the course for being completed!



## Exam tracks - in-course version

There will be flexibility:

- During each lesson, a student will have the possibility to unlock assignments given in the previous lectures.
- However, keep in mind that this flexibility is meant to help students with momentary difficulties (i.e. illness, return to their home for a short period, travel for work related reasons) and cannot be done on a regular basis.
- For this reason, this opportunity CANNOT be given to students not regularly following this course (both days of the week) due to superposition with other lessons.



## Exam tracks - in-course version

Why the presence to lessons is required for this version of the exam?

- Based on the experience from the previous years, students tend to group to solve the assignments.
- In these groups, students discuss about the topic of the lessons, using the assignment as a guide to really understand the material.
- Coffee breaks, the set-up and closing part of each lessons, will be used to discuss with me the doubts which raised during the solution of the assignments.
  - This creates an active environment that leads to a more involved way of learning, not possible without coming to the lessons, and meeting both me and the other students in person.



## Exam tracks - in-course version

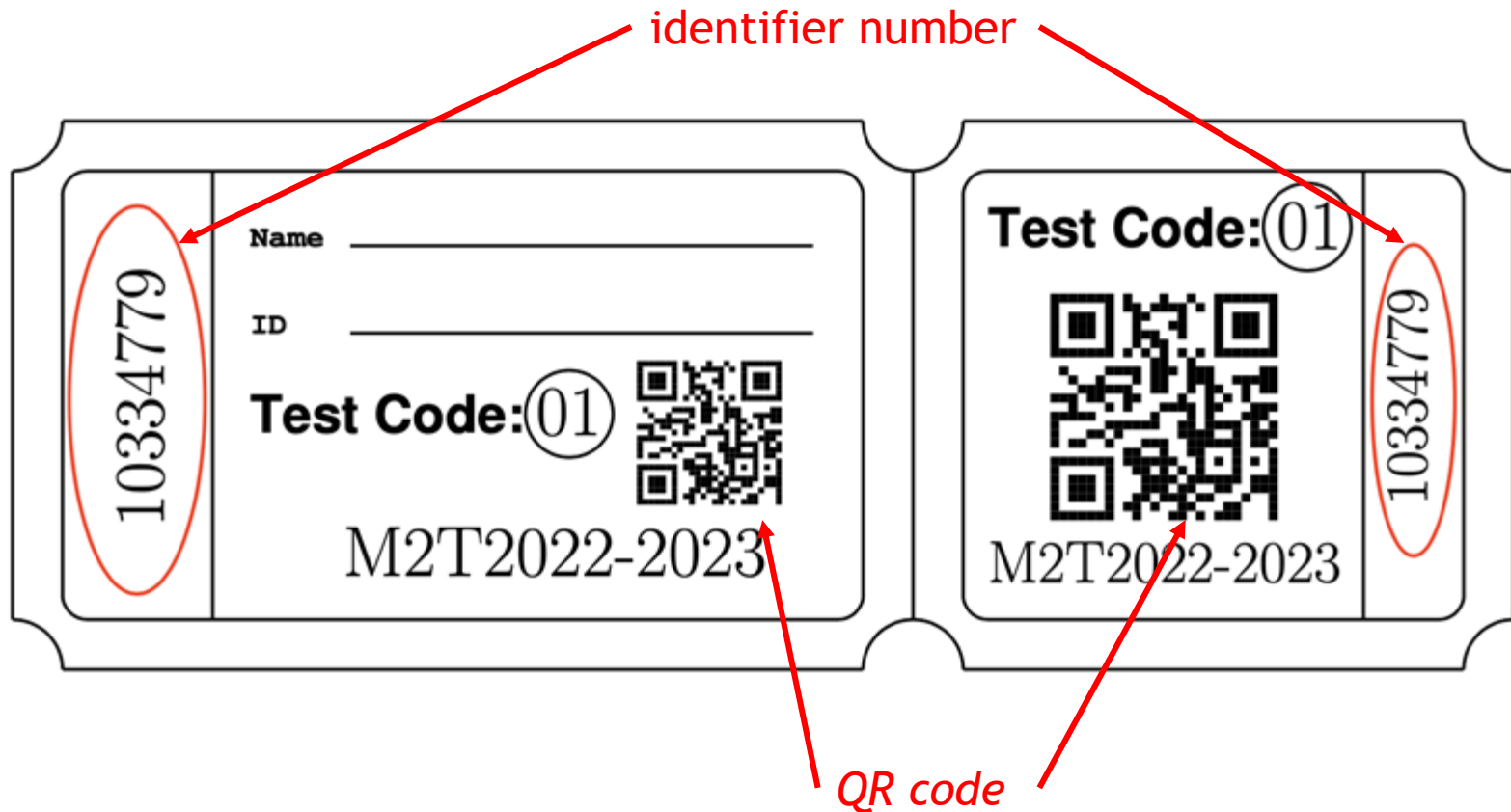
Why the presence to lessons is required for this version of the exam?

- Based on the experience from the previous years, students tend to group to solve the assignments.
- This will also be considered during the evaluation, allowing students who worked together to deliver the same results to the same assignments.



## Exam tracks - in-course version : unlocking correction

In the first lessons, students will be given a physical “Ticket” with a *QR code* and an *identifier number*.







## Exam tracks - in-course version : unlocking correction

On WeBeep, there will be a link to register the Ticket by filling a form: this will allow to associate the QR-code to the student who owns it.

Corso Impostazioni Partecipanti Valutazioni Report Altro -



### 056897 - PERFORMANCE EVALUATION AND APPLICATIONS (GRIBAUDO MARCO) [2022-23]

#### Introduzione

|  |                             |
|--|-----------------------------|
|  | Cartella<br>Slides          |
|  | Cartella<br>Assignments     |
|  | Cartella<br>Examples        |
|  | URL<br>QR-code registration |
|  | Cartella<br>Projects        |

Ciao, Marco. Quando invii questo modulo, il proprietario vedrà il tuo nome e indirizzo email.

\* Obbligatoria

1  
Family Name (Cognome) \*

Inserisci la risposta

2  
First Name (Nome) \*

Inserisci la risposta

3  
Student ID (Codice Persona): 8 digits starting with 1 \*

Inserisci la risposta

4  
QR-code Identifier (8 digits) \*

10334779

Name

ID

Test Code: 01

M2T2022-2023

Test Code: 01



M2T2022-2023

10334779

Inserisci la risposta



## Exam tracks - in-course version : unlocking correction

During the break, the QR code will be read by the Professor to unlock the assignment of the day for the corresponding student.

As outlined before, students who missed the previous assignment will be offered (for a limited number of times), the possibility of unlock it after the regular tickets have been scanned.





## Exam tracks - in-course version : unlocking correction

### Suggestions:

- Immediately fill the form after having received the QR-code:
  - In case of loss, this will allow me to restore the QR-code and give you the opportunity of receiving the same id again.
- Take a picture of the QR code and store it on your mobile phone:
  - The QR-code scanner can read the codes on pictures exactly as the ones on paper.
  - Usually, having the code as a picture on the phone is more handy than remembering where you put the one on paper.



## Exam mark rejection

Regardless of the track being followed, if a mark will be rejected, we will define together a way to improve it:

- The exact way a retake will be done, will then depend on the reasons that led to a marking not acceptable for the student.



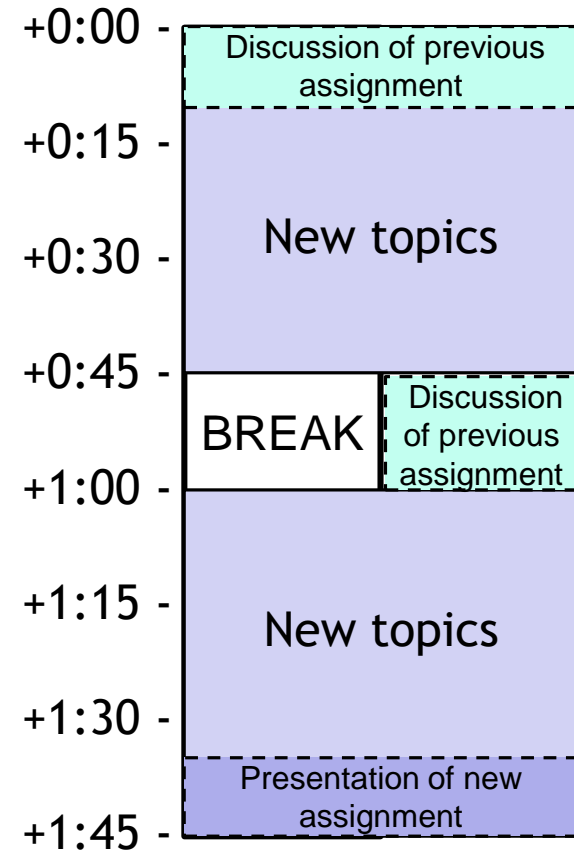
## Lesson structure

Most of the lessons will be divided into three phases:

1. Discussion of the assignment given in the previous lesson
2. Main lessons, with theory and hands-on examples
3. Presentation of the new assignment

The start will be at 12:30, and end at 14:15.

In the end, there will be a total of around 20 assignments.





Marco Gribaudo

02 2399 3568

[marco.gribaudo@polimi.it](mailto:marco.gribaudo@polimi.it)

(Phone is usually better than mail! )