

# Formal Methods: Automated Reasoning & Model Checking

## Ch. 00: Course Overview

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URL: <http://disi.unitn.it/rseba/DIDATTICA/fm2021/>

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M.S. in Computer Science, Mathematics, & Artificial Intelligence Systems  
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- 1 Practical Information
- 2 About the Course
- 3 About Covid19-Compliant Protocols & Restrictions

## Important:

Please be aware that all classes are video-recorded (including students' questions & speeches) and that the recordings will be made available online.

# Target

- The course will be given in **English**.
- For students of M.S. “**Computer Science**” and “**Mathematics**”:  
“Formal Methods” is split into two consecutive modules:
  - **Module 1: Automated Reasoning** [6CFU]
  - **Module 2: Model Checking** [6CFU]
- For students of M.S. “**Artificial Intelligence Systems**”:  
the above modules are mutated respectively into the courses:
  - **Automated Reasoning** [6CFU]
  - **Model Checking** [6CFU]
- These courses are open to whoever may be interested
  - in particular to PhD students of ICT school

# Timetable

## Timetable:

2<sup>nd</sup> Semester, **March 1<sup>st</sup> – June 11<sup>th</sup>**

- CLASS: Tuesday 08.30-11.30 Room A205 (Povo 1)
- LAB: Wednesday 11.30-13.30 Room B106 (Povo 2)
- CLASS: Thursday 09.30-11.30 Room A205 (Povo 1)

The course is given in "mixed" remote/in presence modality (a.k.a. "blended"), see later.

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# Office Hours & Forum

## Office hours:

- No weekly fixed-day
- Anytime in the week, **upon appointment only**
- In presence (only after class) or via zoom
- Appointments to be set in class or via email
- **Office hours only during class period (see above)!**

## Forum

A forum for Q&A is available at the course page in the [Moodle](#) platform

Note: You must register to [Moodle](#)!

# Important: Email Communications

## Important

Teaching this course is only part of our job, and we receive a huge amount of email. Thus:

- email for **relevant** reasons only
- email to both me and the teaching assistant
- use as subject “[Formal Methods]: *⟨subject⟩*”
- email only from your “official” UNITN email address  
“name.surname@studenti.unitn.it”
- be polite and respectful, with both me and the T.A.  
(see e.g. [“Bad Email Reply – What not to say to your professor”](#))

PS: Notice that even professors use social media ([example](#))



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# Motivations & Goals

- Formal reasoning & verification methods are increasingly used
  - as powerful **specification**, **verification** and **early debugging** methods in the development of industrial SW and HW systems.
  - as **backend engines** for many AI applications (e.g., planning, KR)
  - and **backend engines** for many NP-hard problems (e.g., cryptanalysis, circuit designs,...)
- The course will concentrate mainly on
  - **Automated Reasoning (AR)**
  - **Model Checking (MC)**
- A laboratory will be given in which the students will experience
  - the usage of AR techniques (SAT, FOL TP, SMT)
  - the usage of MC techniques

# Topics

## Automated Reasoning

The main topics covered in the course are (not necessarily in order):

- Boolean Reasoning & Propositional Satisfiability (SAT)
- Ordered Binary Decision Diagrams
- Modern SAT Solving (CDCL)
- Extended SAT Functionalities
- First-Order Automated Reasoning
- Satisfiability Modulo Theories (SMT)
- Extended SMT Functionalities
- Automated-Reasoning in Modal & Description Logics (hints)
- Noteworthy Applications

Note: Depending on various circumstances, the covered topics might be subject to variations.

## Topics (cont.)

### Model Checking

The main topics covered in the course are (not necessarily in order):

- Formal specification & formal validation
- Formal Representation of Systems
- Model Checking (MC): generalities
- Temporal logics: LTL, CTL and CTL\*
- Explicit-State MC and Symbolic MC
- CTL MC
- LTL MC
- SAT-based MC,
- abstraction in MC (hints)
- MC with Timed and Hybrid Systems

Note: Depending on various circumstances, the covered topics might be subject to variations.

## Topics (cont.)

### Laboratory:

- SAT solvers
- SMT/AR solvers
- The MC NuXMV

# References

Both Automated Reasoning and Model Checking courses/modules:

- Notes from the lessons
- Slides (available from the URL of the course)
- Other material (available from the URL of the course)

Model Checking course/module only:

- The NuXMV manual
- Suggested books (in alternative):
  - *Edmund Clarke, Orna Grumberg and Doron Peled.*  
"Model Checking"  
MIT Press
  - *Christel Baier and Joost-Pieter Katoen .*  
"Principles of Model Checking"  
MIT Press

# Disclaimer

Some of the material presented in these slides (text, figures) is courtesy of the following people, listed in alphabetical order:

- **Massimo Benerecetti** (bene@na.infn.it)
- **Alessandro Cimatti** (cimatti@fbk.eu)
- **Paritosh Pandya** (pandya@tifr.res.in)
- **Marco Pistore** (pistore@disi.unitn.it)
- **Marco Roveri** (roveri@fbk.eu)
- **Stefano Tonetta** (tonettas@fbk.eu).

Furthermore, some examples are taken from the book:

[E. Clarke, O. Grunberg & D. Peled, “Model Checking”, MIT Press]

# Requirements

- It is assumed some basic background in the following topics:
  - basic mathematics
  - algorithms and data structures
  - programming
- Some background in the following topics could be useful (but not strictly necessary):
  - Boolean logic
  - automata and formal languages
  - software engineering



# Exam

## Formal Methods module 1 & 2 – 12 CFU (M.S. in Computer Science or M.S in Mathematics)

2 parts:

- Script
  - lab test
  - the script test, on the topics of the course
- Oral Interview
  - interview on the topics of the course.

## Automated Reasoning or Model Checking – 6 CFU each (M.S. in Artificial Intelligence Systems)

2 parts:

- lab test
- the script test, on the topics of the course

To copy at exams very dangerous is!



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# Remote attendance & Lesson Recordings

- Due to the handling of the COVID-19 pandemic, and modulo further different decisions, the course classes will be given in "mixed" remote/in presence modality (a.k.a. "blended"):
  - for a restricted number of students, in turn, it will be possible to follow the class physically in the classroom **following the [safety access protocols](#)**
  - for everybody else it will be possible to follow the classes remotely in synchronous modality, via the [Zoom](#) platform
- Classes will be video-recorded, the recordings will be made available at [the URL of the course](#)
- Zoom links are available at the course page in the [Moodle](#) platform

# Notice: Safe Behaviour for COVID-19 at DISI

The following rules are STRICT

All students are **always** supposed:

- to access DISI only if personally authorized (via the UNITN app)
- to follow the access rules:
  - to check-in/check-out with the app
  - to follow the paths
- to **wear a mask**, covering both mouth and nose
- to **sanitize hands when both entering and exiting classes**
- to respect inter-personal safety distance ( $\geq 1 m$ )
- to access/exit rooms one at a time, respecting safety distances
- to sit only on admissible and available seats
- after breaks, to sit in the same seats as before the break
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## Notice: Safe Behaviour for COVID-19 at DISI [cont.]

- ...
- not to enter the classroom after the class has begun
- not to exit the class before the class has finished
- to minimize movements inside the classroom
- to bring only indispensable material with them
- to bring a backup mask (latex gloves might be of help)
- to avoid any exchange of personal items
- to avoid putting items in the intermediate empty seats/desks
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## What if...

- If a student feels sick **at home**, in particular with flu/COVID-like symptoms, **he/she must stay at home!**
- If a student feels sick **in classrooms**, in particular with flu/COVID-like symptoms:
  - he/she (and classmates) must **immediately** notify the teacher
  - he/she must immediately leave the room and move to outside the porter, avoiding any contact  $\implies$  he/she will be taken care of
  - classmates must stay away from him/her and not touch him/her without safety gloves
- if a student who has previously attended classes is found positive to COVID, **he/she must immediately inform DISI**

## Remark

If a student willingly refuses to comply to the rules (e.g., to wear a mask) the teacher is supposed to take his/her data and to call the DISI COVID19-safety responsible, **who is supposed to call the police.** (No kidding!)

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Marsellus Wallace doesn't like students who don't wear masks...



©"Pulp Fiction", by Q. Tarantino