Formal Methods: Automated Reasoning & Model Checking Ch. 00: **Course Overview**

Roberto Sebastiani

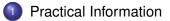
DISI, Università di Trento, Italy - roberto.sebastiani@unitn.it URL:http://disi.unitn.it/rseba/DIDATTICA/fm2021/ Teaching assistant: Giuseppe Spallitta - giuseppe.spallitta@unitn.it

M.S. in Computer Science, Mathematics, & Artificial Intelligence Systems Academic year 2020-2021

last update: Monday 10th May, 2021, 16:07

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Outline





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 mutuated 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:

2nd Semester, March 1st – June 11th

- 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

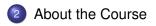
Teaching this course is only part of our job, and we receive a huge amount of email. Thus:

- 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 <u>both</u> 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)

Outline





3 About Covid19-Compliant Protocols & Restrictions

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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., criptanalysis, 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
- OTL 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.

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]

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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
 - Iab 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:

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

To copy at exams very dangerous is!



Outline







About Covid19-Compliant Protocols & Restrictions

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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 <u>Zoom</u> 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 <u>Moodle</u> platform

The following rules are STRICT

All students are always supposed:

- to access DISI only if personally autorized (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 (> 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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- to respect inter-personal safety distance ($\geq 1 m$)
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- to sanitize hands when both entering and exiting classes
- to respect inter-personal safety distance (≥ 1 m)
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- 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 ⇒ 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

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Remark

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



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