

Introduction.

Let us give precisions on the terms in the name of the course, and in the broader space of semantics and verifications.

Verification. Formal techniques to ensure the correctness software or hardware of systems.

Model Checking. “Automatic” checking of the correctness by means of exhaustive exploration.

Example 1. Consider a program that is 10 lines long, contains 3 booleans variables and 5 integers variables in the range $\{0, \dots, 9\}$. The number of states for this program is:

$$10 \times 2^3 \times 10^5 = 8\,000\,000.$$

The real issue with the state exploration problem is the factor 10^5 , coming from the use of 5 integers.

Example 2. Consider a server and n clients. Clients can make requests to the server and the server can answer a client. The specification of this server should include the following:

- ▷ Each client which makes a request is eventually answered.
- ▷ We *abstract* away from precise quantitative constraints.

We will sometimes reason about an infinite amount of executions. For example, if some client makes infinitely-many requests (then it'll have infinitely-many answers). Infinite sequences are represented by ω -words, *i.e.* infinite words indexed by \mathbb{N} . Thus, ω -words on some

alphabet Σ are functions $\mathbb{N} \rightarrow \Sigma$. We will denote Σ^ω the set of those infinite words on the alphabet Σ .

If $|\Sigma| \geq 2$, then the set Σ^ω is uncountable.

This course will cover the following:

- ▷ Transition systems;
- ▷ Linear-time properties;
- ▷ Topology;
- ▷ Orders and Lattices;
- ▷ Linear Temporal Logic (LTL);
- ▷ Büchi automata;
- ▷ **Stone duality** (mostly in homework);
- ▷ Bisimilarity/bisimulation;
- ▷ Modal Logic.

Ressources from this course include:

- ▷ the [course notes](#) (available online, non-exhaustive);
- ▷ Baier, C. and Katoen, J.-P., Principles of Model Checking, MIT Press, 2008.

Prerequisites for this course include:

- ▷ First-order logic (*see my [course notes](#) for the “Logique” L3 course, in french*);
- ▷ Finite automata (“FDI” L3 course).

Evaluation for this course will be in two parts: the final exam (50 %) and the homework, in two parts (25 % each).

The tutorials will be done by Lison Blondeau-Patissier.