

# INF656L

## Decision Procedures for Artificial Intelligence

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2022-2023

### 1 Contacts

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### 2 Course description

The goal of this course is to present the main algorithms to solve Boolean logic formulas modeling of different problems such as path planning, task planning, diagnostics. In particular, the DPLL algorithm, and its extension CDCL, will be presented in a first part of the course to solve purely boolean problems (satisfiability or unsatisfiability of logical formula). Then, extensions of logic formulas with terms coming from other theories (linear expressions in integers, real numbers, or non-linear expressions or recursive data structures), which are at the origin of SMT techniques (SAT Modulo Theories), will be presented. This second part will make the link between CDCL algorithms and classical constraint programming or mathematical programming algorithms. This teaching will show how complex decision problems can be solved effectively with exploratory techniques.

### 3 Course objectives

- Learn how to model decision problems into logical forms
- Learn how SAT and SMT solvers work efficiently
- Learn how to use state-of-the-art solvers

## 4 Advised readings

Logical formula can be used for decision problem and can be used in different contexts. We will look at two main point of view in Artificial Intelligence and System Verification.

### Artificial intelligence point of view

- “Artificial Intelligence: A Modern Approach” by Stuart Russell and Peter Norvig

### System verification point of view

- “Decision procedures: an algorithmic point of view” by Daniel Kroening and Ofer Strichman
- “The calculus of computation: decision procedures with applications to verification” by Aaron R. Bradley et Zohar Manna

## 5 Grading policy

- 20% of your grade will be determined by MCQ on weekly courses
- 80% of your garde will be determined by a final exam consisting in text summary and oral presentation of a scientific article.

## 6 Class schedule

### SAT part by Alexandre Chapoutot

- Week 1 (November 30, 2022): Propositional Logic and Modelling
- Week 2 (December 7, 2022): Into Algorithms of SAT Solvers
- Week 3 (December 14, 2022): AI Applications

### SMT part by Sergio Mover

- Week 4 (January 4, 2023): First Order Logic and Modelling
- Week 5 (January 11, 2023): Equality and Uninterpreted Functions (EUF) Theory
- Week 6 (January 18, 2023): Linear (Real/Integer) Artithmetic Theories
- Week 7 (January 25, 2023): System Verification Applications

## **Final exam**

- Week 8 (February 1, 2023): Paper presentation