

# Artificial Intelligence (Toolbox)

Overview

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# Outline

General description

Generalities and Case Study

Problem solving

Knowledge and Reasoning

Learning

# General description

## Context and motivation

- ▶ Automated reasoning on the accessible sources of heterogeneous data
- ▶ Management of the complexity, heterogeneity and dynamics of the systems operating in this world by increasing their decision autonomy
- ▶ AI is one of the pillars of computer science that offers models, methods and generic technologies to tackle these challenge
- ▶ Takes inspiration from different fields (biology, economics, computer science, etc.)  
⇒ Open-mindedness for every generalist engineer
- ▶ Field techniques and technologies increasingly used in the industrial world in multiple applications (banking, logistics, games, medicine, education, robotics, defense, etc.)

# General description (cont.)

## Educational objectives

- ▶ **Pragmatic approach** which faces the problem solving and the design of intelligent systems
- ▶ Based on the renown AIMA book from Russell & Norvig [RN12].
- ▶ **making accessible the ideas** that have emerged over the last 50 years of application of AI techniques
- ▶ Show **how these ideas are disseminated** in current computer systems
- ▶ Expose the **multi-disciplinary nature of the disciplines**
- ▶ The students will incrementally build intelligent agents with capabilities such as ...
  1. **problem solving**
  2. **reasoning**
  3. **learning**
- ▶ ... through a **thread case study**

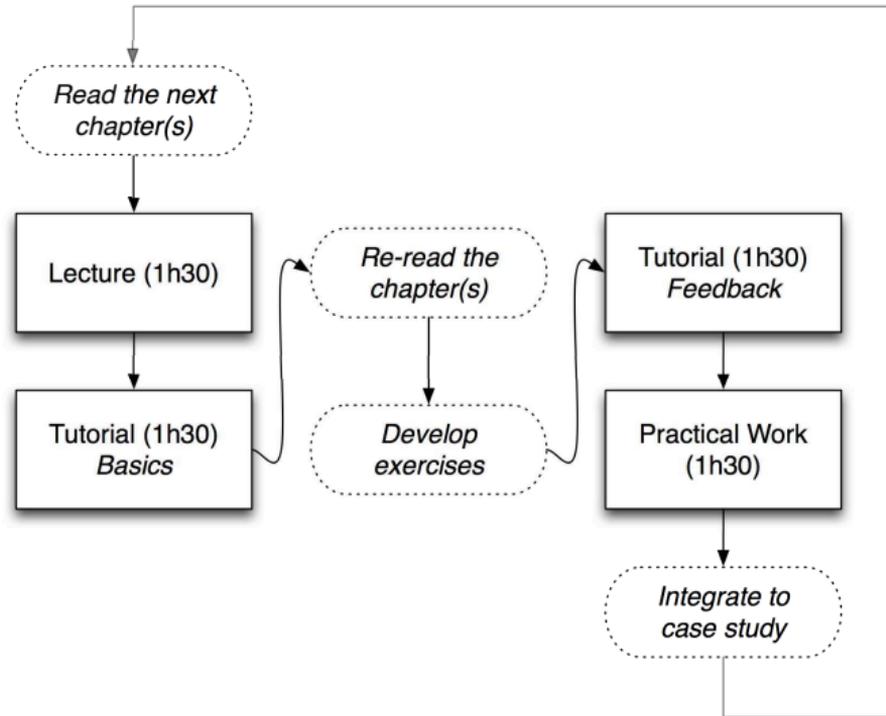
# General description (cont.)

## Organisation

1. Generalities and Case Study (UP1)
2. Problem Solving (UP2)
3. Knowledge and Reasoning (UP3)
4. Learning (UP4)

# General description (cont.)

## Structure



# General description (cont.)

## Pre-requisites

- ▶ **Algorithmics**
- ▶ **Procedural programming**
- ▶ **Object-oriented programming** (e.g. Java)
- ▶ **Logics**
- ▶ **Functional programming** skills are optional

## Evaluation

- ▶ Continuous evaluation using homework or exercises developed during/between tutorials
- ▶ Review of the report on the case study
- ▶ Defense of the approach/solution to resolve the case study

# Generalities and Case Study

## AG1.1– Introduction (3h)

- ▶ Historical overview
- ▶ Intelligent agents
- ▶ "Intelligence" = solve, reason, learn, decide and cooperate
- ▶ References: [RN12, Chapters 1-2]

## AG1.2– Case Study (3h)

This AG consists in the defense of the chosen approach to attack the case study, at the end of the GP

UP1 Evaluation = Review of the report on the case study + Defense

# Problem solving

## AG2.1– Solving Problems by Searching (6h)

- ▶ Goal-based agent called a **problem-solving agent**
- ▶ **Atomic representations**
- ▶ References: [RN12, Chapter 3]

## AG2.2– Adversarial Search (6h)

- ▶ Competitive environments : agents' goals are in **conflict**
- ▶ Adversarial search problems-often known as **games**
- ▶ References: [RN12, Chapter 5]

# Problem solving (cont.)

## AG2.3– Constraint Satisfaction Problems (6h)

- ▶ **Factored representation** for each state: a set of variables
- ▶ A problem is solved when each variable has a value that satisfies all the constraints on the variable
- ▶ References: [RN12, Chapter 6]

## IG2– Problem Solving in Case Study (3h)

UP2 Evaluation = Exam (1h) + homework and exercises

# Knowledge and Reasoning

## AG3.1– Logical Agents (6h)

- ▶ Logic as a general class of representations to support **knowledge-based agents**
- ▶ References: [RN12, Chapter 7]

## AG3.2– First-Order Logic and Inference (6h)

- ▶ Expressiveness to represent a good deal of our commonsense knowledge
- ▶ Either subsumes or forms the foundation of many other representation languages
- ▶ References: [RN12, Chapters 8-9]

# Knowledge and Reasoning (cont.)

## AG3.3– Planning (6h)

- ▶ Representation for planning problems
- ▶ References: [RN12, Chapters 10-11]

## AG3.4– Knowledge Representation (6h)

- ▶ What content to put into such an agent's knowledge base?
- ▶ How to represent facts about the world?
- ▶ References: [RN12, Chapter 12]

# Knowledge and Reasoning (cont.)

## AG3.5– Expert Systems (6h)

- ▶ Specify rules of behavior, rather than algorithms
- ▶ Solutions involve application of human knowledge and/or uncertain knowledge, rather than intricate calculations
- ▶ References: [Lig06]

## IG3– Knowledge and Reasoning in Case Study (3h)

UP3 Evaluation = Exam (1h) + homework and exercises

# Learning

## AG4.1– Learning from Examples (6h)

- ▶ Overview of the various forms of learning
- ▶ Decision-tree learning
- ▶ Theoretical analysis of learning
- ▶ References: [RN12, Chapter 18]

## AG4.2– Reinforcement Learning (6h)

- ▶ How agents can learn what to do in the absence of labeled examples ?of what to do?
- ▶ References: [RN12, Chapter 21]

# Learning (cont.)

IG4– Learning in Case Study (3h)

UP4 Evaluation = Exam (1h) + homework and exercises