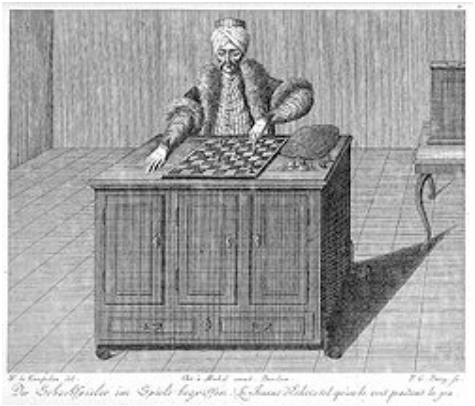
Artificial intelligence: a primer

Mayank Kejriwal

What is AI?



- Logicians:”
  - Can we define ‘the laws of thought’? (Ancient Greece, also India, China)”
  - Can we automate the laws of thought (since the Industrial Revolution)
- Mechanical Turk (1770): Highly influential hoax (‘automatic’ chess player); arguably first hyped-up ’AI’ that didn’t work out
- Now, IBM’s DeepBlue beat Kasparov in 1997, and our phones can beat us
  - Numerous other games ‘conquered’ (AlphaZero)

Other examples

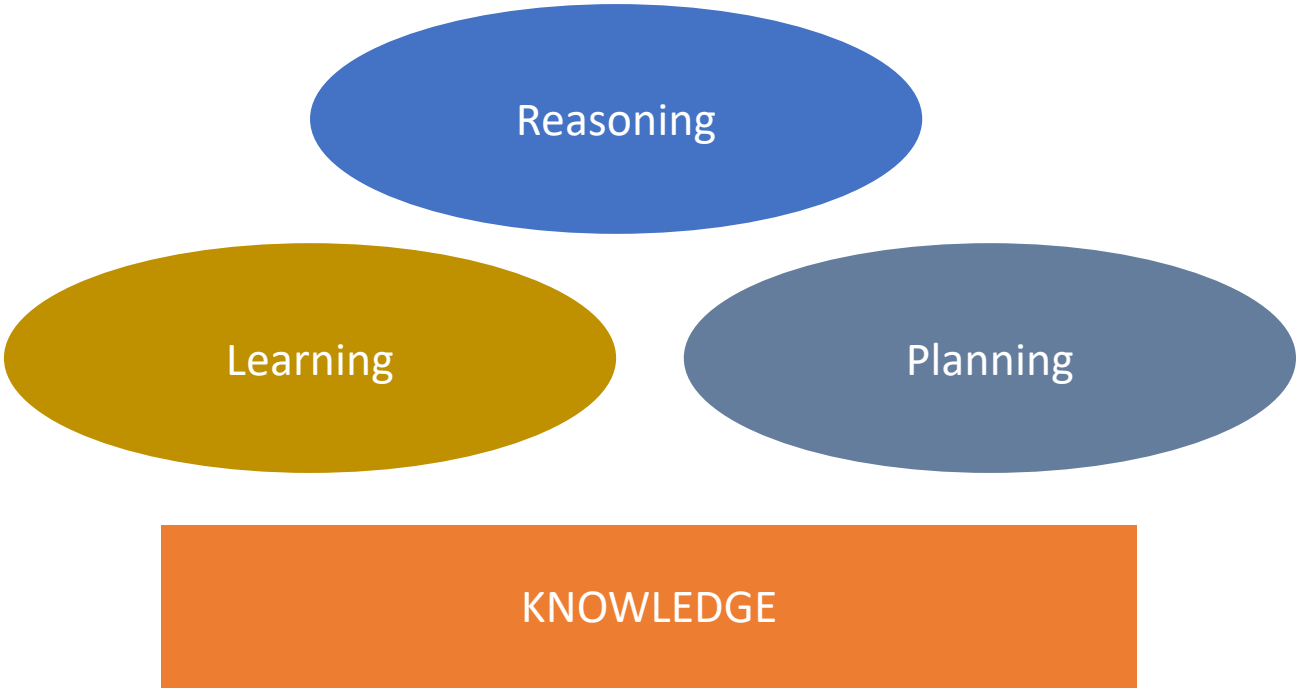
Vacuum-cleaning robots (Roomba)

NASA's Mars exploration rovers

Autonomous vehicles
(EUREKA's Prometheus Project, DARPA's Grand Challenge, Google's Driverless car)

What is ‘intelligence’?

- We’ll take a computational perspective



AI ‘tasks’

Reasoning:
Solve sudoku; play a game of chess

Robotics:
Move towards a goal, avoiding obstacles

Natural language processing:
Understand/produce sentences

Computer vision:
Recognize faces in an image

Areas of AI

- Reasoning/problem solving
- Knowledge representation
- Machine learning
- Planning
- Computer perception (vision, audio/speech)
- Natural language processing
- Robotics

Reasoning

Simple problem

- Modus Ponens:
  - Given (1) IF A THEN B, (2) A, we can conclude (3) B
  - (1) and (2) are premises, (3) is the conclusion
- Example:
  - If today is Monday, then it is the first day of the week
  - Today is Monday
  - Modus Ponens allows us to conclude that it is the first day of the week

Is it really that obvious?

Either Shakespeare or Hobbes wrote *Hamlet*.

If either Shakespeare or Hobbes wrote *Hamlet*, then if Shakespeare didn't do it, Hobbes did.

Therefore, if Shakespeare didn't write *Hamlet*, Hobbes did it.

What if we make it probabilistic?

What if we are given B, and not A *(abductive* reasoning)*?*

What other ’laws’ can we work with?

Learning

Mainly taken to mean **machine learning**

- Supervised machine learning
  - Classification problems (we'll see much more on this on Wed.)
- Unsupervised machine learning
  - Usually taken to mean clustering
  - We just saw an example with K-means!
- Reinforcement learning
  - Considered its own special branch of machine learning
  - Typically applicable to gameplaying, robotics and any application that lies at the intersection of control and AI

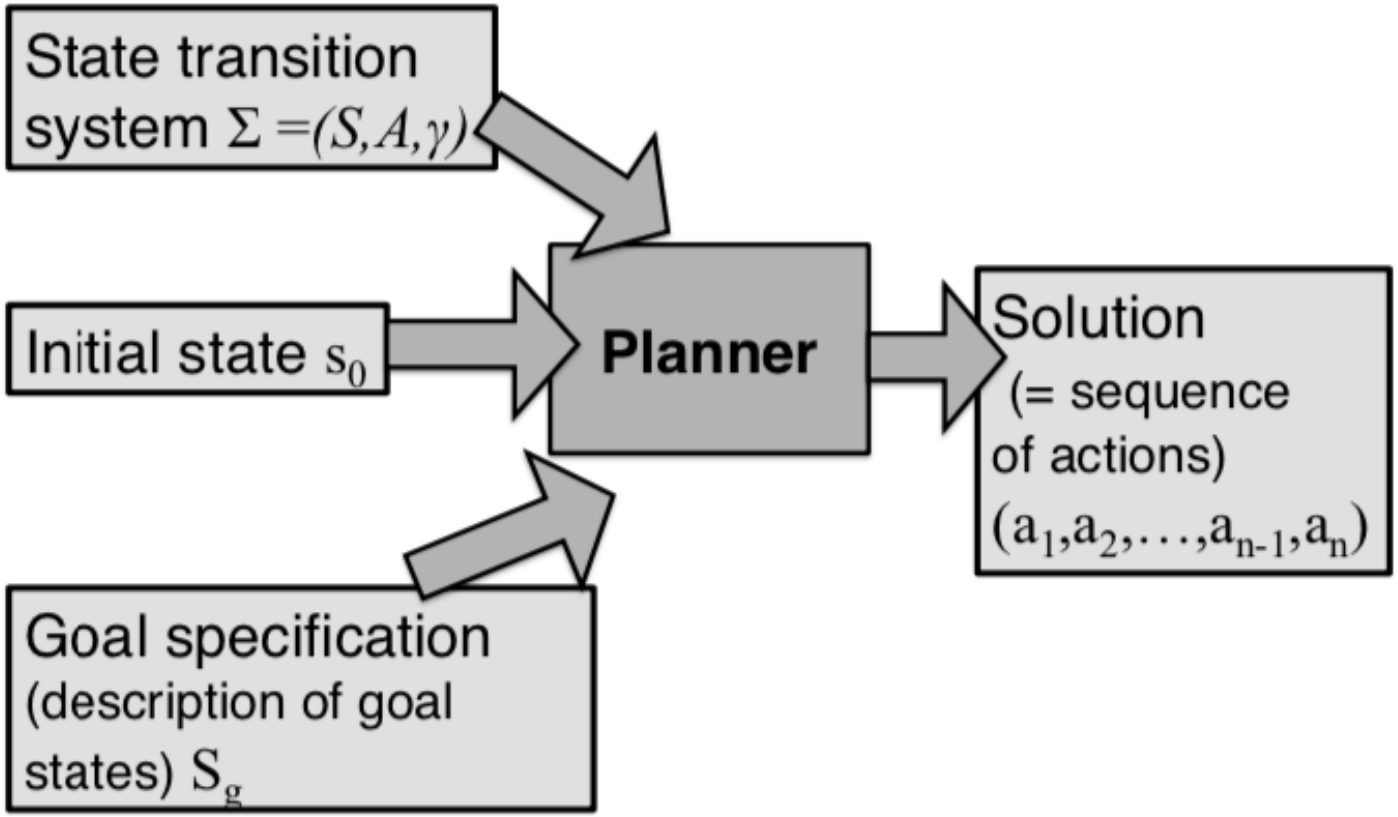
BLOG POST
RESEARCH

06 DEC 2018

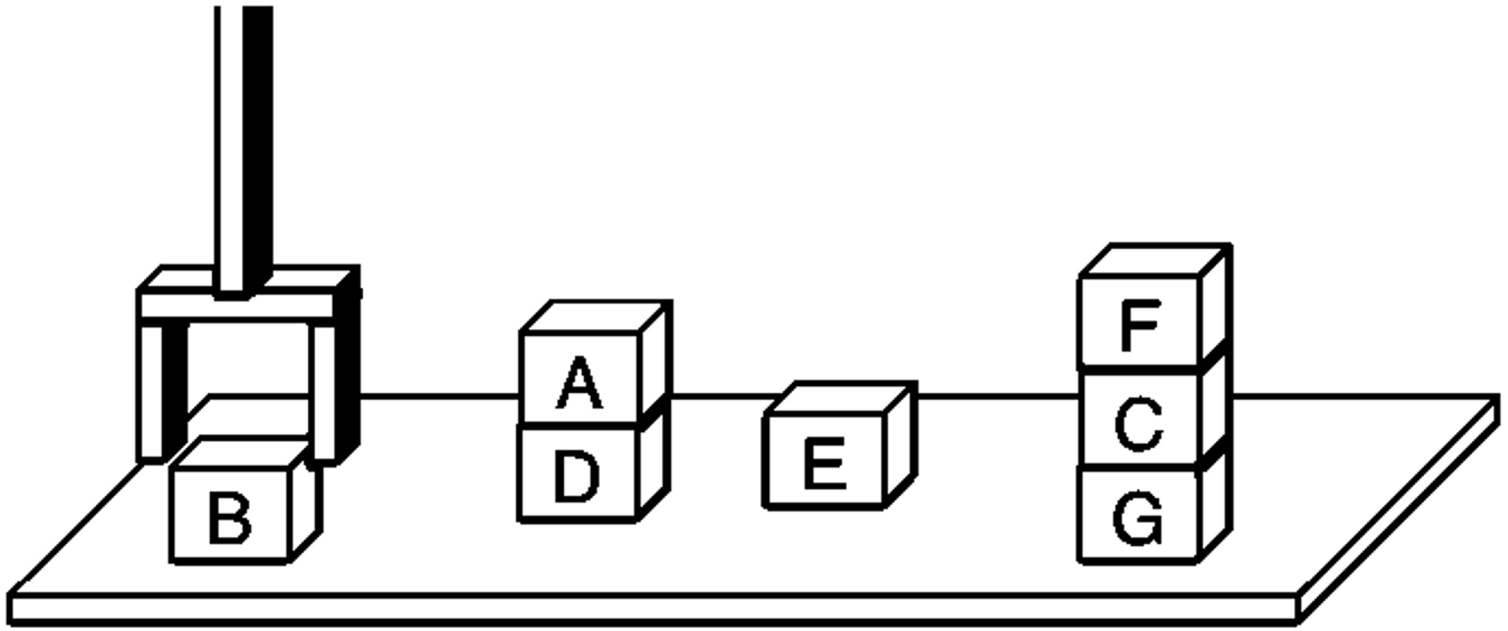
AlphaZero: Shedding new light on chess, shogi, and Go

Planning

Classical planning



EXAMPLE: BLOCKS WORLD



Goals:

- Build a tower of A,B,C,…
- Get block G,
- ….

Silly domain, but concisely illustrates many general planning issues

Planning as Theorem Proving

Planning: given the initial state, find a sequence of actions that yield a situation where goal holds.
= Use operators to *derive* goal from initial state.

Operator: carry(x)
General knowledge of one kind of action: preconditions and effects

Action: carry(BlockA)
Ground instance of an operator

Key questions and challenges

How do we represent states?

- What information do we need to know?
- What information can we (safely) ignore?

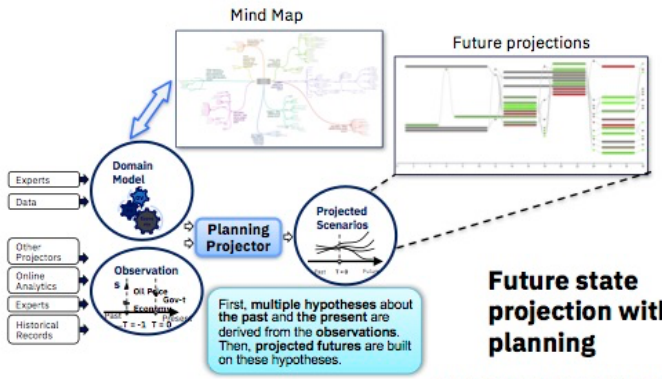
How do we represent actions?

- When can we perform an action?
- What changes when we perform an action?
- What stays the same?
- What level of detail do we care about?

Planning: Summary

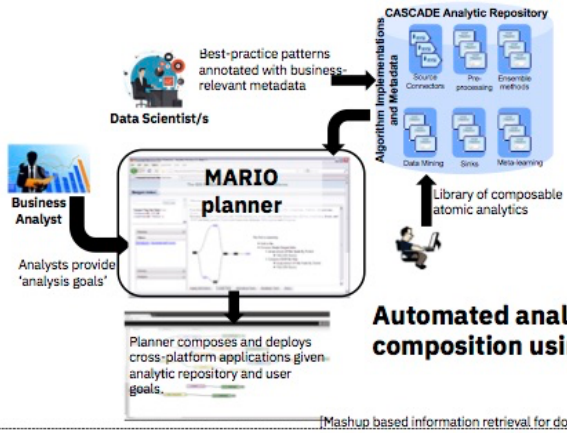
- Planning is the task of finding a procedural course of action for a declaratively described system to reach its **goals** while **optimizing overall performance** measures
- General features of planning problems:
  - Declarative
    - You want to find a procedural course of action for a declaratively described system to reach its goals while optimizing overall performance measures.
  - Domain Knowledge can be elicited or learned over time
    - Existing domain knowledge can/should be exploited for building the model
    - Human involvement controllable. Humans build the model and can contribute to the solution by introducing knowledge.
  - Favor consistency over learning transient behaviors
    - There is a structure of the problem that cannot be learned just training
    - When no large training data is available
    - Changes in the problem can make previous data irrelevant

Example planning projects in IBM



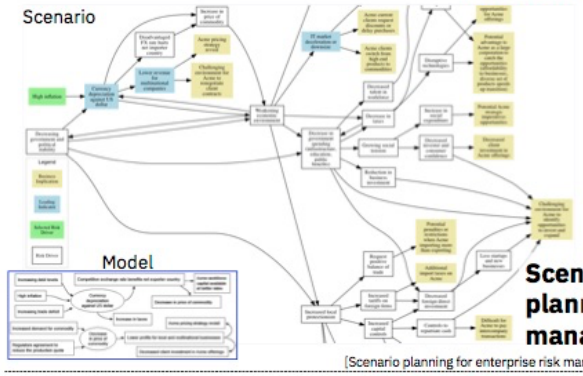
Future state projection with planning

[State projection via AI Planning. AAAI 2017]



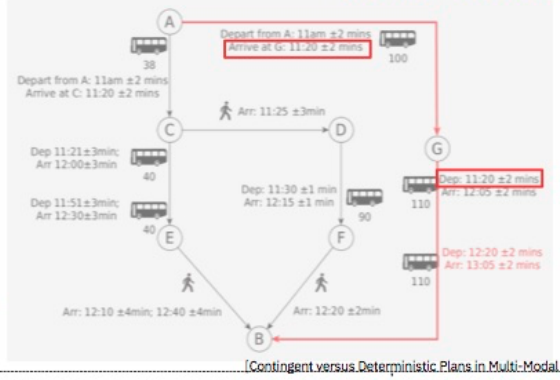
Automated analytics composition using planning

[Mashup based information retrieval for domain experts, CIKM 2009]



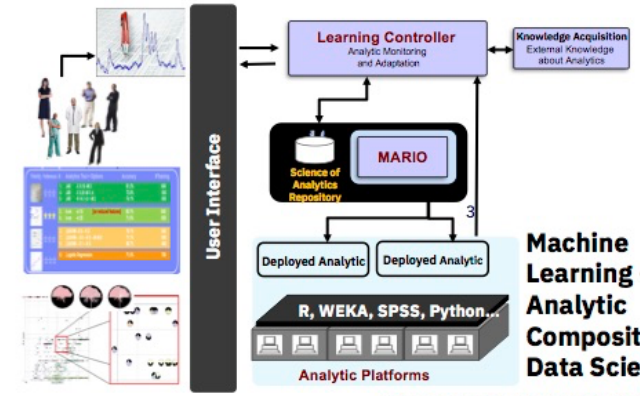
Scenario planning for risk management

[Scenario planning for enterprise risk management. ICAPS 2017]



Dynamic optimization of city intermodal transportation

[Contingent versus Deterministic Plans in Multi-Modal Journey Planning. ICAPS 2015]



Machine Learning + Analytic Composition for Data Science

[Towards Cognitive Automation of Data Science. AAAI 2015]

Planners and tools developed at IBM

- **Top-K planners**
- **Semi-black box for transportation**
- **Planner4J**
- **DOCIT (multi-modal transportation)**
- **Plan recognition as planning**