Escola Politécnica da USP - Depto. de Enga. Mecatrônica

PMR-3510 Inteligência Artificial

Aula 12- Planejamento não-clássico

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06/11 - texto (pdf) apresentando a aplicação

~~13/11 - resumo da análise completa~~

27/11 - apresentação do trabalho final

Planejamento automático

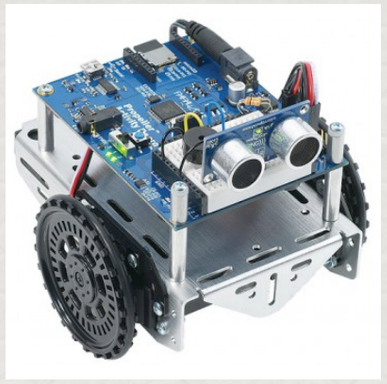
Robô Valkyrie mede 1,8 metro e pesa 125 quilos. (Foto: Nasa)

métodos de busca clássica e informada

programação lógica

métodos de inferência

Forms of (AI) planning: motion planning



Path and motion planning is concerned with the synthesis of a geometric path from a starting position in space to a goal and of a control trajectory along that path that specifies the state variables in the configuration space of a mobile system, such as a truck, a mechanical arm, a robot, or a virtual character.

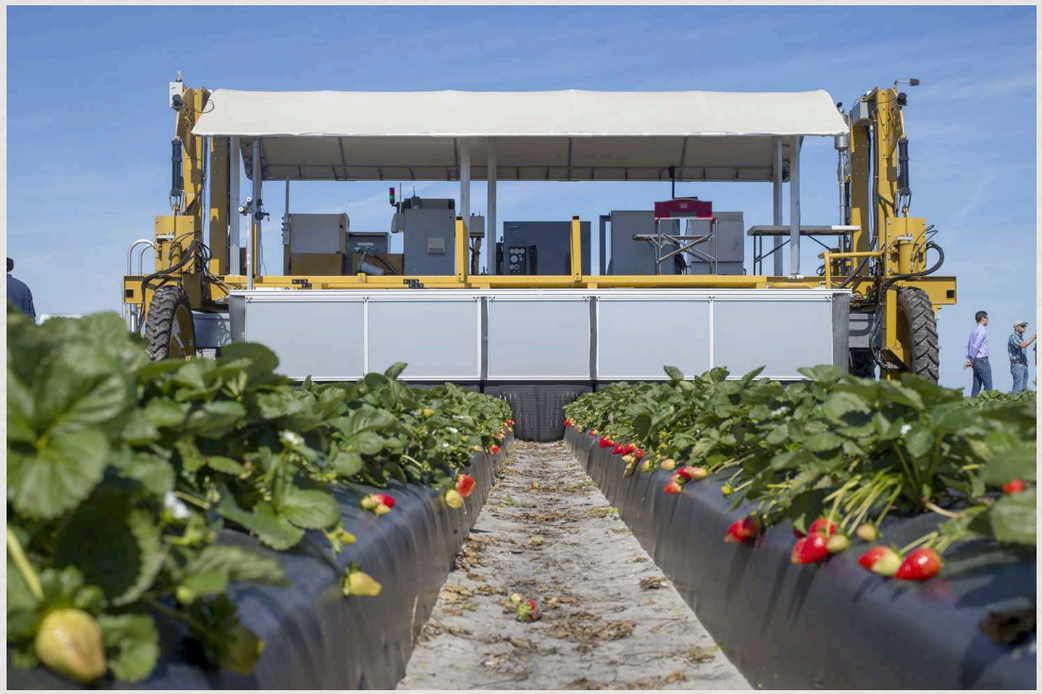
Forms of (AI) planning: perception planning

Self-driving car

Perception planning is concerned with plans **involving sensing actions** for gathering information. It arises in tasks such as modelling environments or objects, identifying objects, localising through sensing a mobile system, or more generally identifying the current state of the environment. An example of these tasks is the design of a precise virtual model of an urban scene from a set of images.

Forms of (AI) planning: navigation planning

Navigation planning combines the two previous problems of motion and perception planning in order to reach a goal or to explore an area. The purpose of navigation planning is to synthesize a policy that combines localization primitives and sensor-based motion primitives, e.g., visually following a road until reaching some landmark, moving along some heading while avoiding obstacles, and so forth.



Forms of (AI) planning: manipulation planning

Manipulation planning is concerned with **handling objects, e.g., to build assemblies**. The actions include sensory-motor primitives that involve forces, touch, vision, range, and other sensory information. A plan might involve picking up an object from its marked sides, returning it if needed, inserting it into an assembly, and pushing lightly till it clips mechanically into position.

Forms of (AI) planning: communication planning

Communication planning arises in **dialog** and in **cooperation** problems between several agents, human or artificial. It addresses issues such as when and how to query needed information and which feedback should be provided.

Relating AI Planning and Problem Solving

Domain-depend planning

One develops predictive models for the type of actions to be planned for and for the states of the system in which they take place. Computational tools for running these models, in order to predict and assess the effects of alternate actions and plans in various situations, exploit the specifics of the domain.

Domain-independent planning

Domain-independent planning relies on abstract, general models of actions. These models range from very simple ones that allow only for limited forms of reasoning to models with richer prediction capabilities. There are in particular the following forms of models and planning capabilities.

Type of modelling in planning

Project Planning

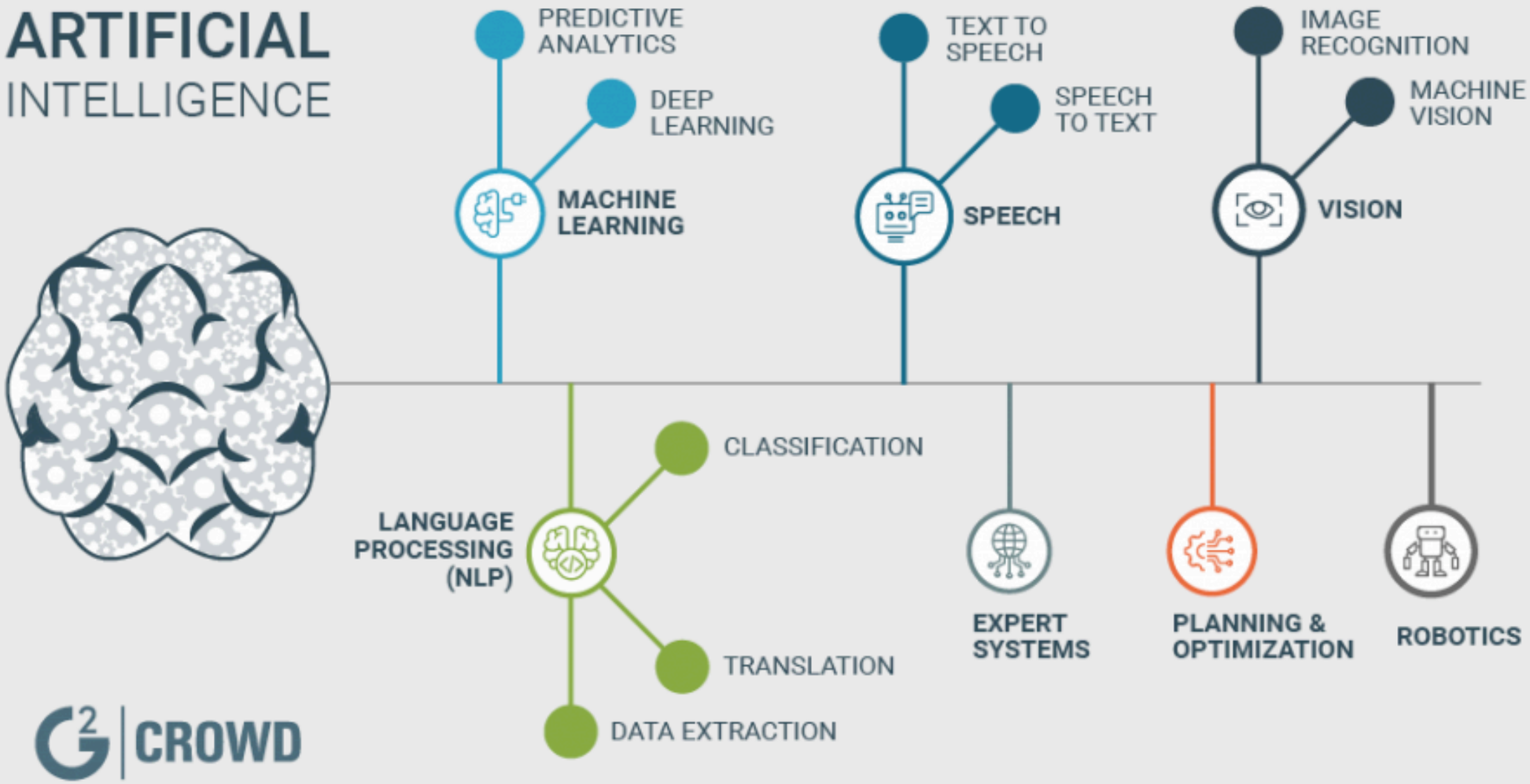
in which models of actions are reduced mainly to temporal and precedence constraints, e.g., the earliest and latest start times of an action or its latency with respect to another action.

Scheduling and resource allocation

in which the action models include the above types of constraints plus constraints on the resources to be used by each action.or its latency with respect to another action.

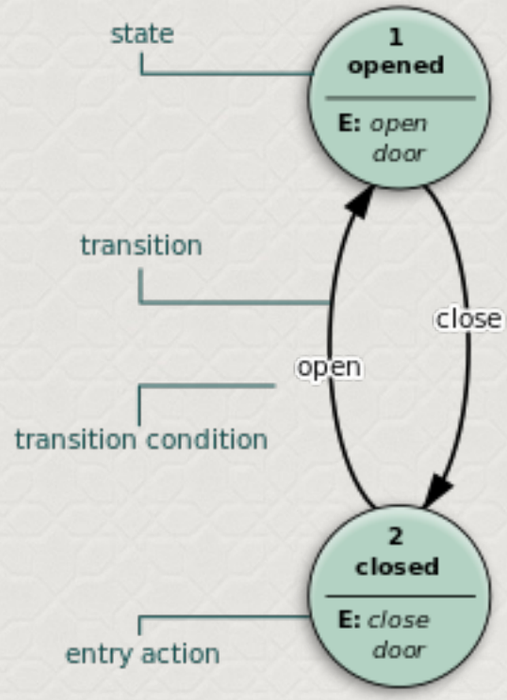
Plan Synthesis

in which the action models enrich the precedent models with the conditions needed for the applicability of an action and the effects of the action on the state of the world.


ARTIFICIAL
INTELLIGENCE
MACHINE LEARNING
PREDICTIVE ANALYTICS
DEEP LEARNING
SPEECH
TEXT TO SPEECH
SPEECH TO TEXT
VISION
IMAGE RECOGNITION
MACHINE VISION
LANGUAGE PROCESSING (NLP)
CLASSIFICATION
TRANSLATION
DATA EXTRACTION
EXPERT SYSTEMS
PLANNING & OPTIMIZATION
ROBOTICS
G2 CROWD

Summarising planning concepts

The most important point is that automatic planning was created as an **inspired problem solving methods**, and therefore had to be adherent to a problem solving method and basic formalism. This formalism is based on **Transition Systems**.



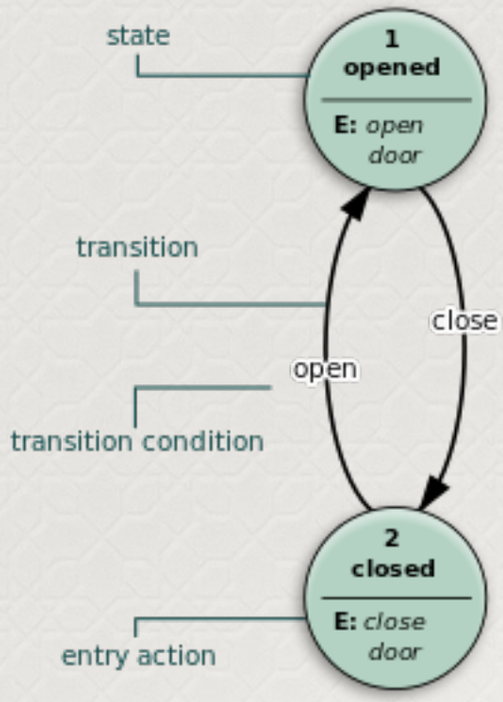
A conceptual modelling for planning

Transition Systems are also known as State-Transition Systems and are in the basis of the discrete systems approach.

Formally, a state-transition system is a 4-tuple E = (S, A, E, y), where:

- S = {Sl, S2 . . . . } is a finite or recursively enumerable set of states;
- A = {al, a2,...} is a finite or recursively enumerable set of actions;
- E = {el, e2,...} is a finite or recursively enumerable set of events; and
- $\gamma : S \times A \times E \rightarrow 2^S$ is a state-transition function.

A state-transition system may be represented by a directed graph whose nodes are the states in S. If $s' \in \gamma(s, u)$, where u is a pair (a, e), $a \in A$ and $e \in E$, then the graph contains an arc from s to s' that is labeled with u. Each such arc is called a state transition.



Programação Lógica

ProLog

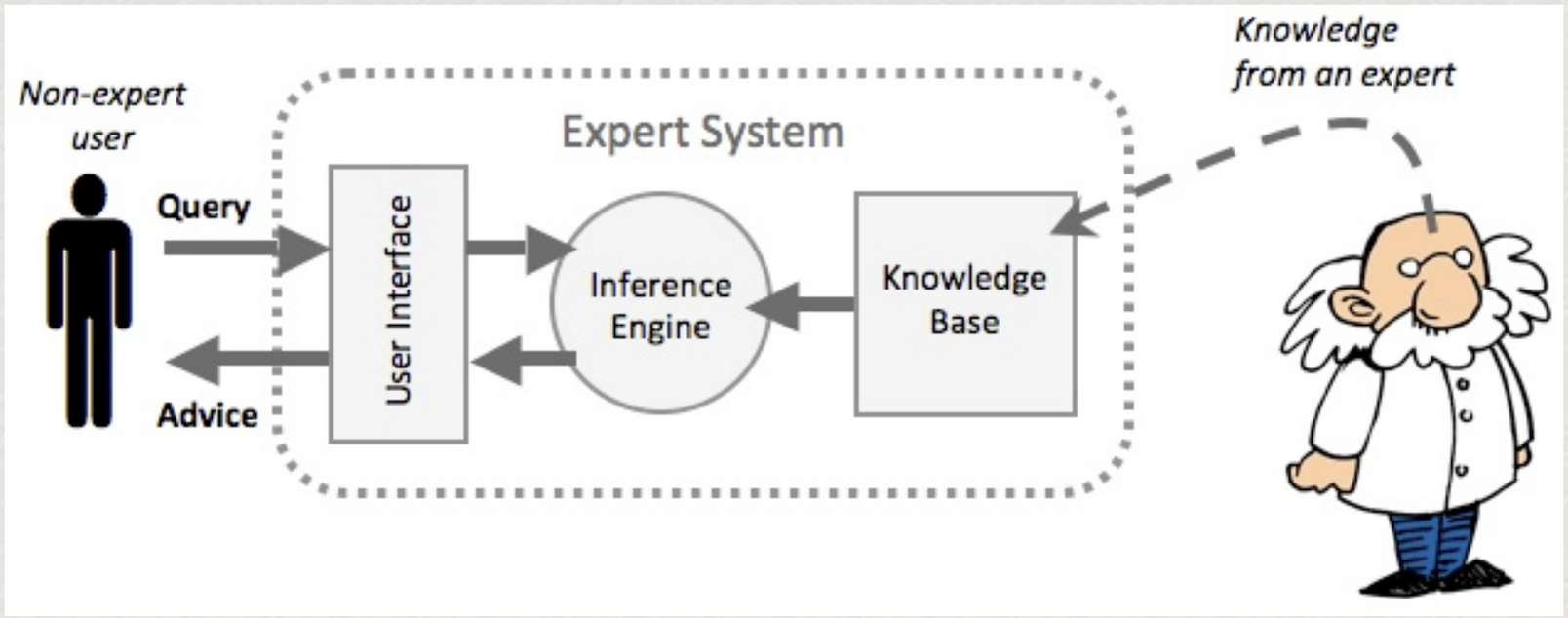
The imperative approach:

1. Enter the coffee shop
2. Queue in the line and wait for the barista asking you for your order
3. Order
4. Yes, for takeaway, please
5. Pay
6. Present your loyalty card to collect points
7. Take your order and walk out

The declarative approach:

1. A large latte for takeaway, please

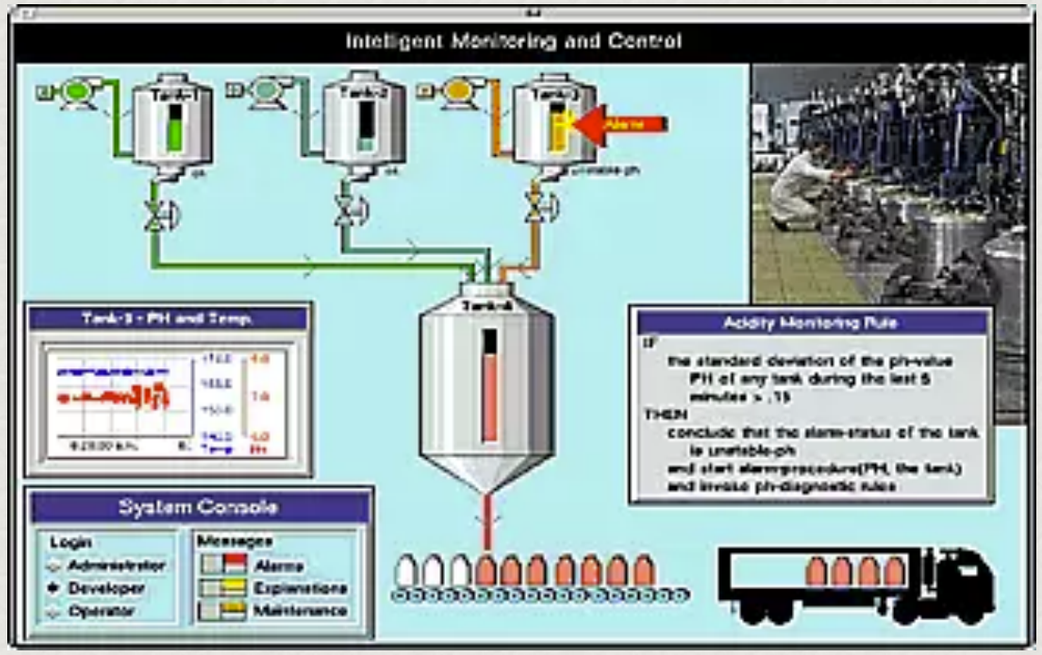
Aplicações



sistemas de diagnóstico (médico, mecânico, etc.), operações náuticas, análise de crédito bancário, perfil de clientes, etc.

Academic X Commercial applications of AI


Ignite Technologies
Information Technology Solutions
Gensym G2
The World's Leading Software Platform for Real-Time Expert System Applications


Intelligent Monitoring and Control
Tank-1
Tank-2
Tank-3
Alarm
Tank-3 - PH and Temp.
Acidity Monitoring Rule
IF
the standard deviation of the ph-value
PH of any tank during the last 5
minutes > .15
THEN
conclude that the alarm-status of the tank
is unstable-ph
and start alarm-procedure(PH, the tank)
and invoke ph-diagnostic rules
System Console
Login
Administrator
Developer
Operator
Messages
Alarms
Explanations
Maintenance


LAFARGE

Forms of (AI) planning: perception planning

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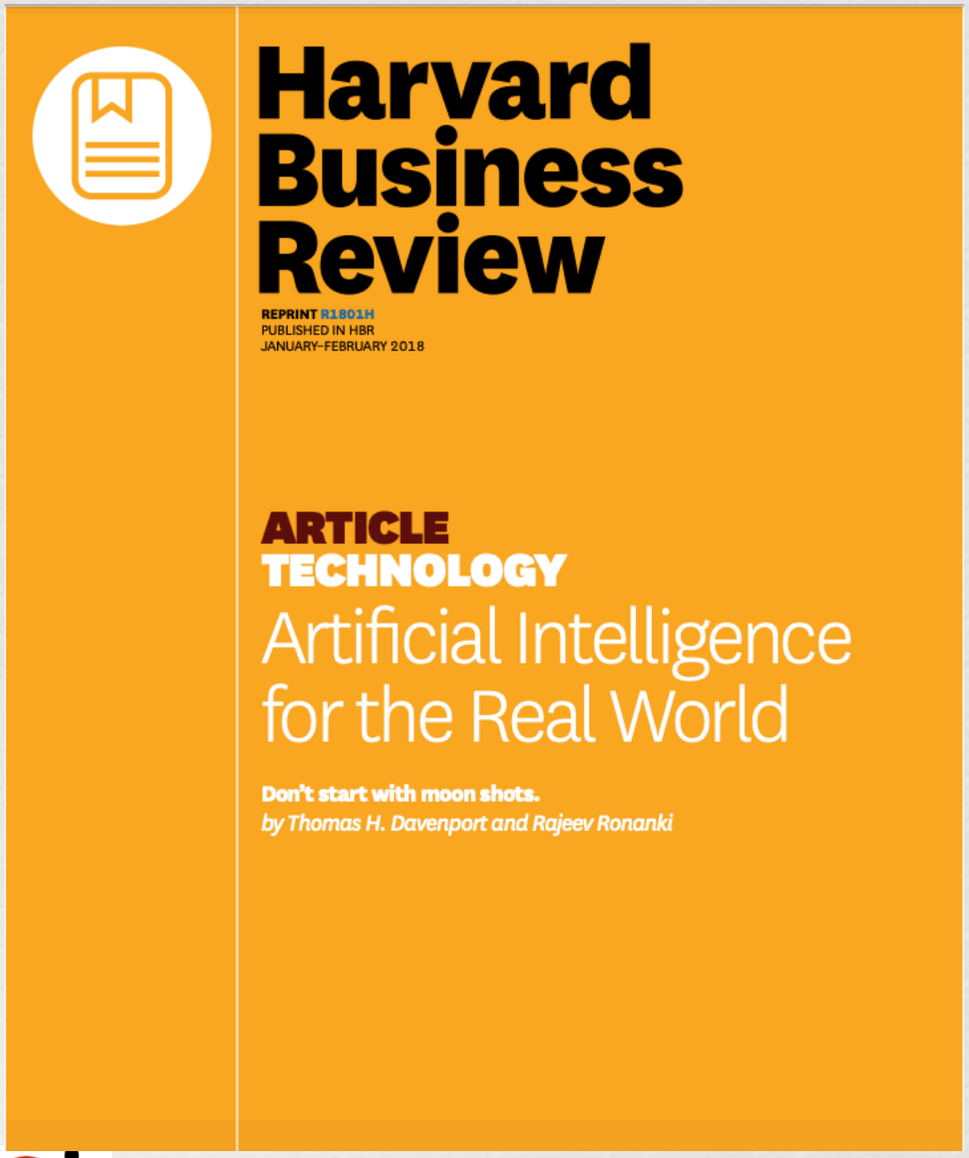
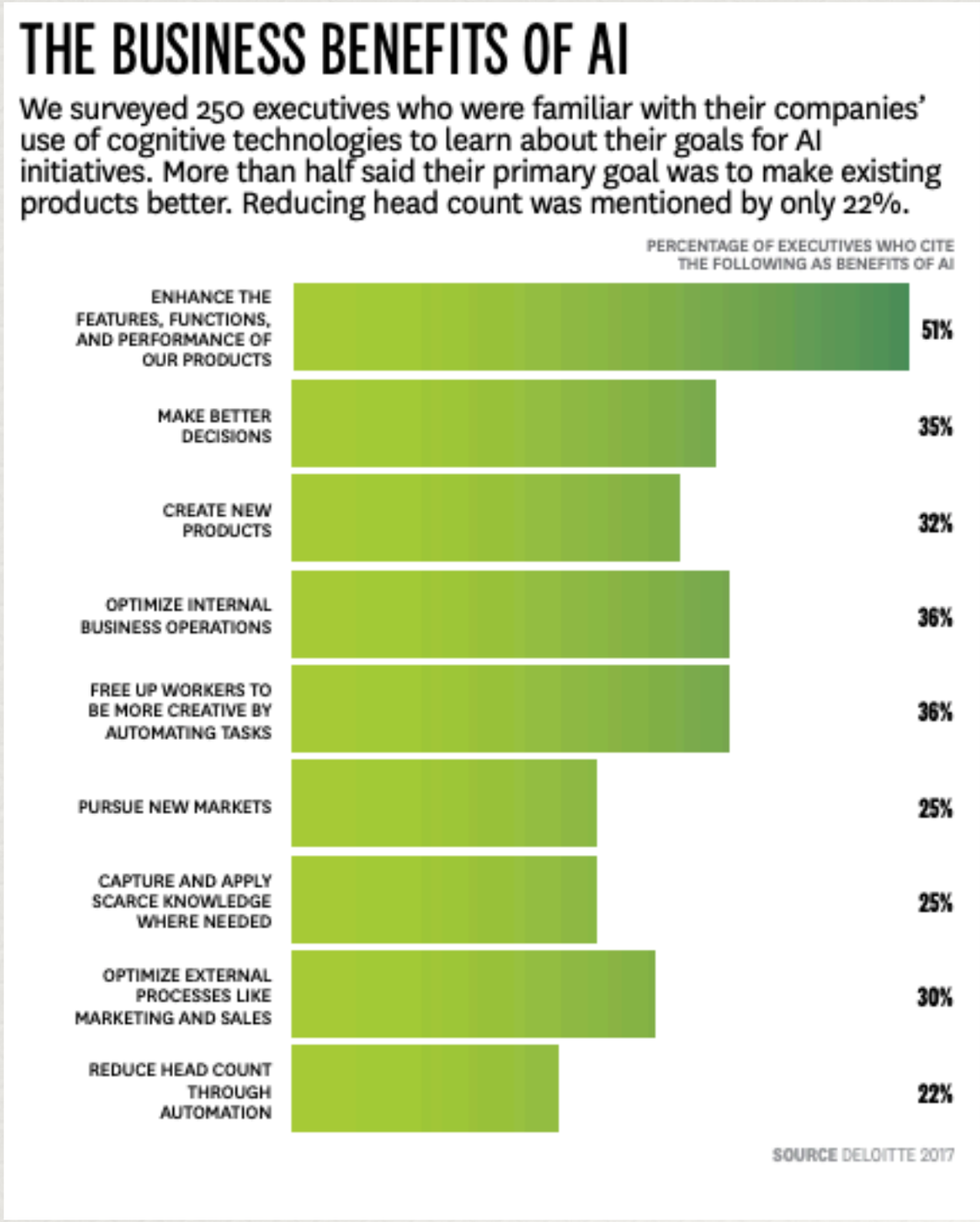
AI Applications to Health Care

Stakeholder expectations

https://www.kungfu.ai/wp-content/uploads/2019/01/R1801H-PDF-ENG.pdf

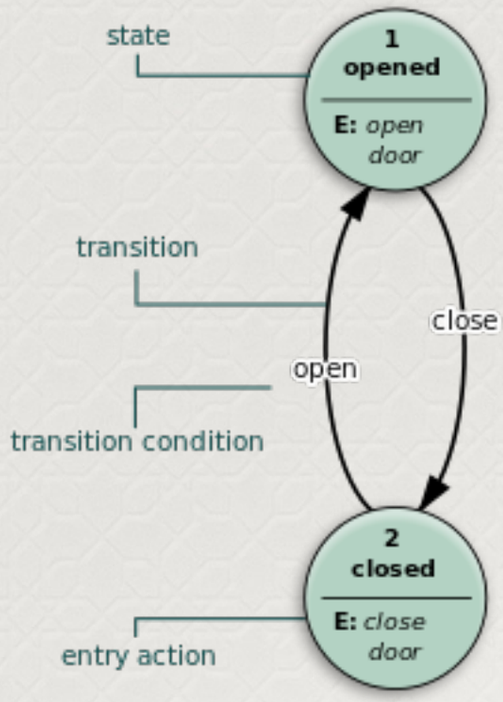




Quais das técnicas da IA clássica podem (ou devem) ser usadas para chegar nestas aplicações do mundo real.

O que mais falta?

A **state-transition system** may be represented by a directed graph whose nodes are the states in S. If $s' \in \gamma(s, u)$, where u is a pair (a, e), $a \in A$ and $e \in E$, then the graph contains an arc from s to s' that is labeled with u. Each such arc is called a state transition.



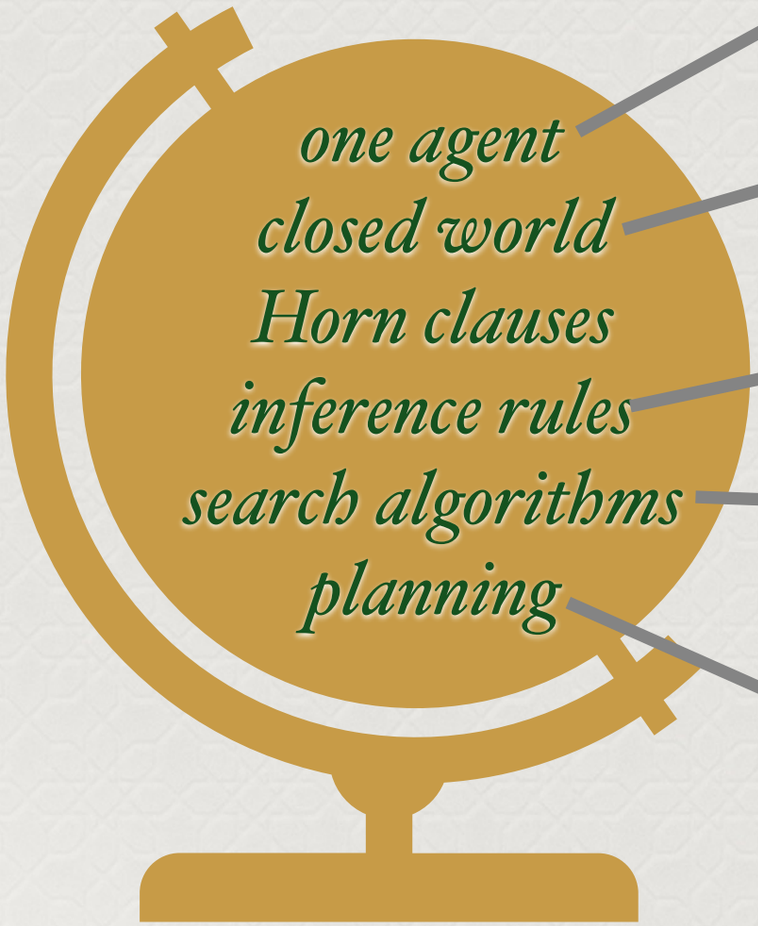
Let us consider the following conceptual elements :

1. A **state-transition system** Z evolves as specified by its state-transition function γ, according to the events and actions that it receives.
2. A **controller**, given as input the state s of the system, provides as output an action a according to some plan.
3. A **planner**, given as input a description of the system Z, an initial situation, and some objective, synthesizes a plan for the controller in order to achieve the objective.

Classic planning (STRIPS)

X

Non-classic planning + Expert Systems



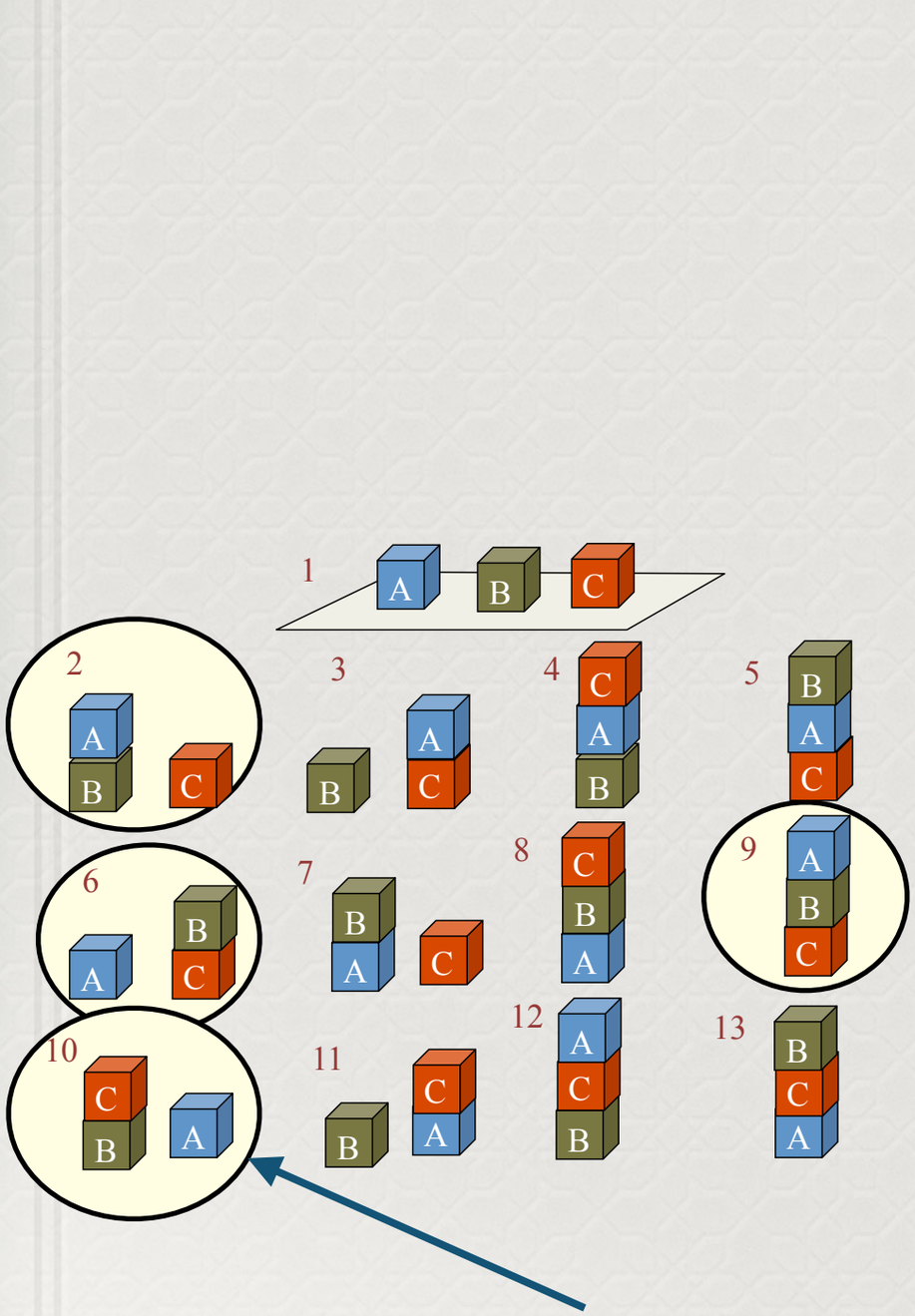
multiple agents

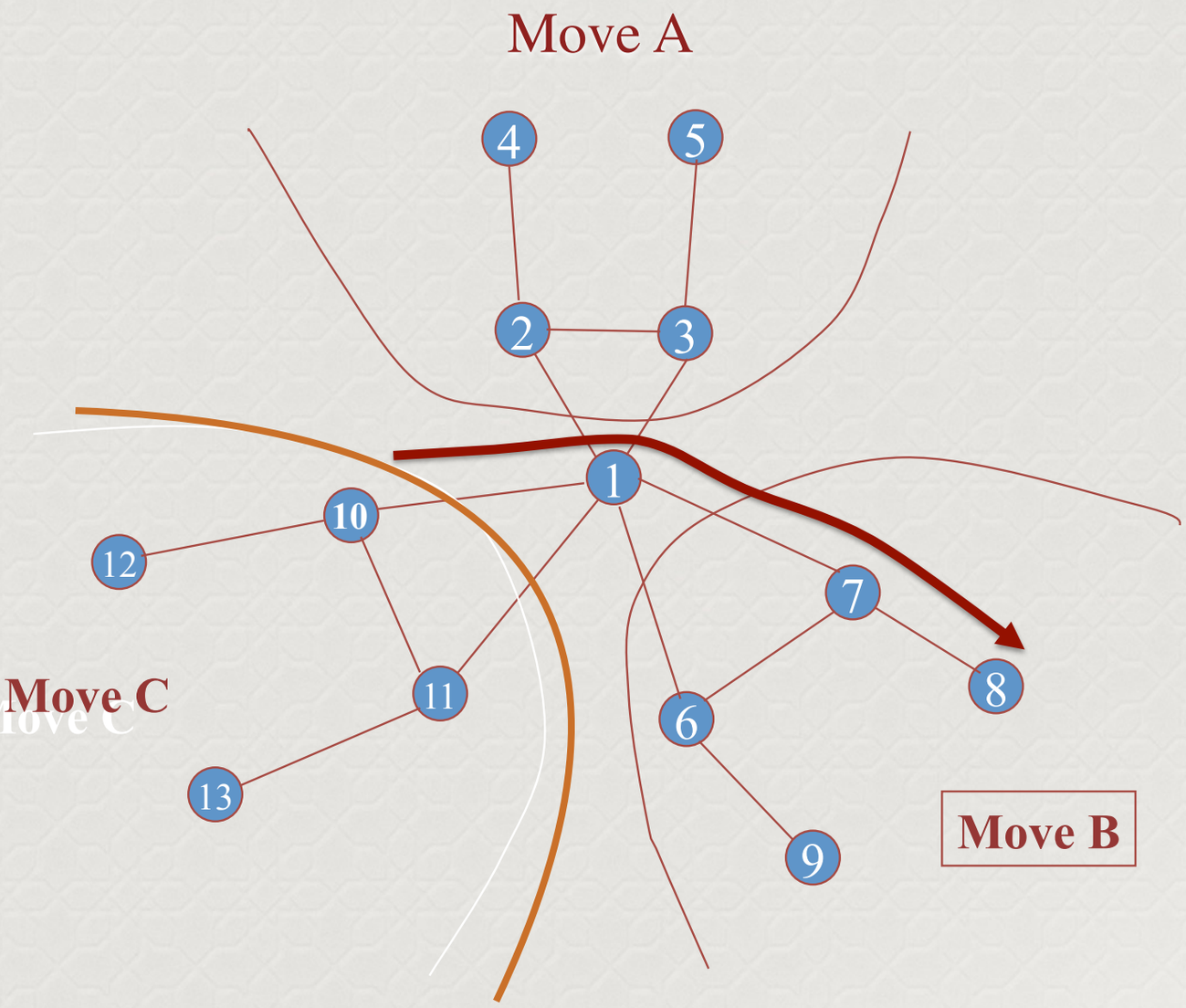
Kripke structures

dif. equation constraints

cognitive methods

machine intelligence


1
2
3
4
5
6
7
8
9
10
11
12
13
A
B
C


Move A
Move C
Move B
1
2
3
4
5
6
7
8
9
10
11
12
13

Forward search

```
Forward-search(O, s_0, g)
    s ← s_0
    π ← the empty plan
    loop
        if s satisfies g then return π
        applicable ← {a | a is a ground instance of an operator in O,
                          and precond(a) is true in s}
        if applicable = ∅ then return failure
        nondeterministically choose an action a ∈ applicable
        s ← γ(s, a)
        π ← π . a
```

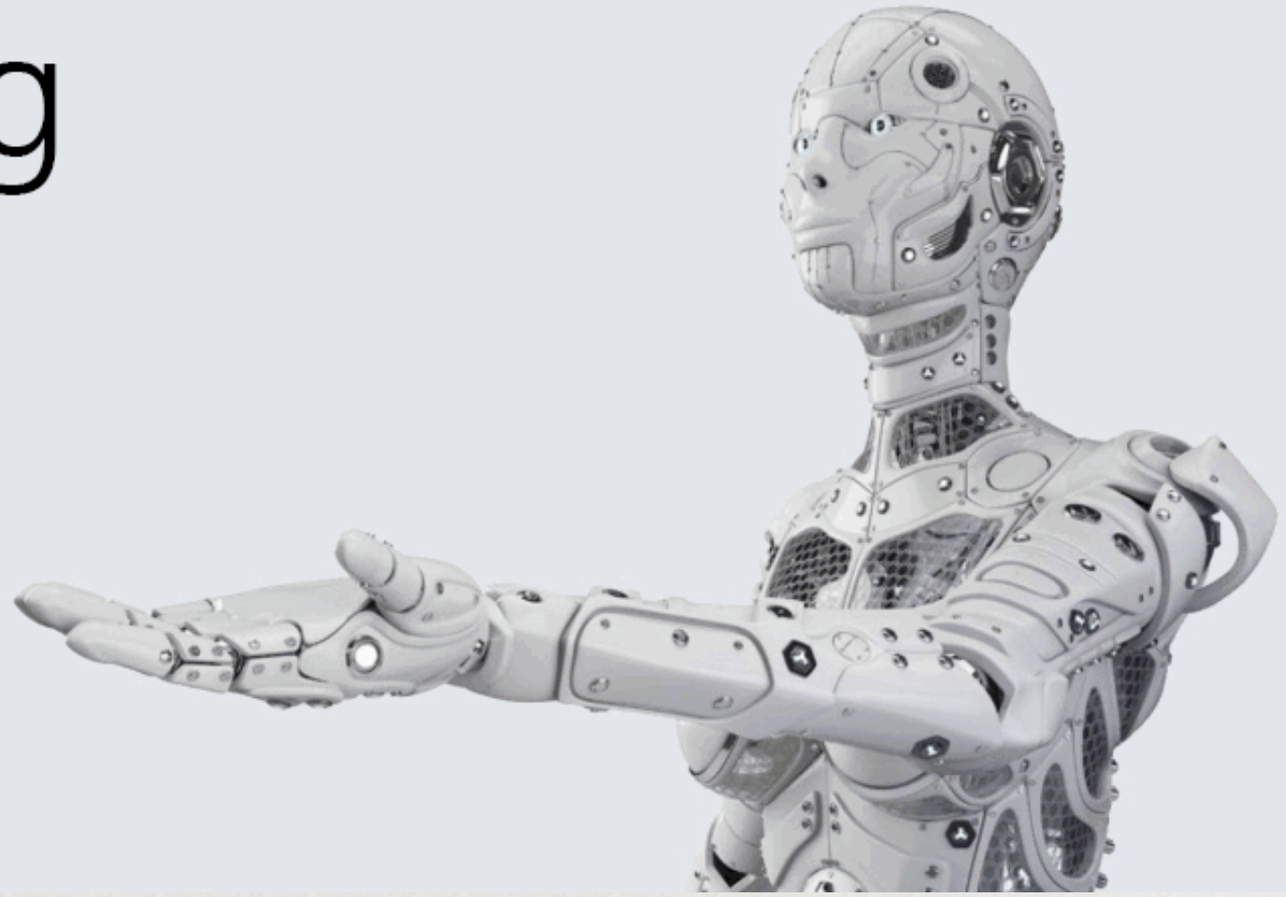
Backward search

```
Backward-search(O, s_0, g)
    π ← the empty plan
    loop
        if s_0 satisfies g then return π
        relevant ← {a | a is a ground instance of an operator in O
                        that is relevant for g}
        if relevant = ∅ then return failure
        nondeterministically choose an action a ∈ applicable
        π ← a.π
        g ← γ^{-1}(g, a)
```

Outra possibilidade seria combinar seja os métodos chamados clássicos (busca, planejamento tipo STRIPS, sistemas especialistas) com métodos como Forward Search, Backward Search, métodos estatísticos, ou ainda métodos cognitivos.

AI's coming of age

The progress into the AGI phase and the beginning of true autonomy.



Até a próxima aula!