

ROBOTICS

Universidad Carlos III de Madrid

AI



[plg]



Outline

1 Introduction

2 Classical architecture

3 Reactive behavior

4 Path finding

5 Task planning

6 Other issues

Robotics

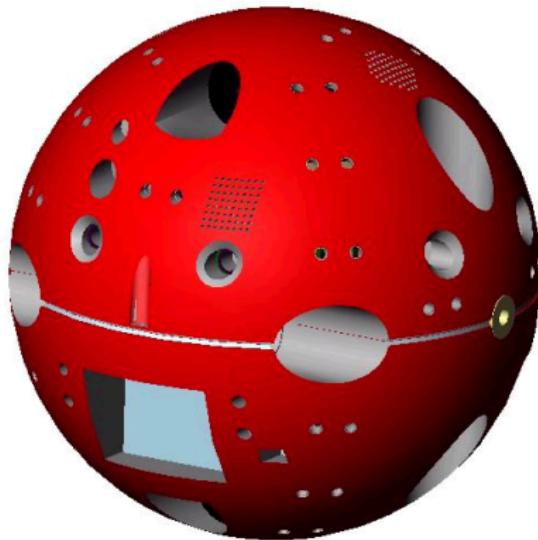


Autonomy



<http://www.youtube.com/watch?v=4Y2Cf9nRq0w>

Personal Satellite Assistant PSA



http://www.youtube.com/watch?v=trtMoeNEDtc&feature=PlayList&p=4C1AACE6A5BBCFB5&playnext_from=PL&playnext=1&index=84

Unmanned aerial vehicles (UAV)



©Mike Vines 2003

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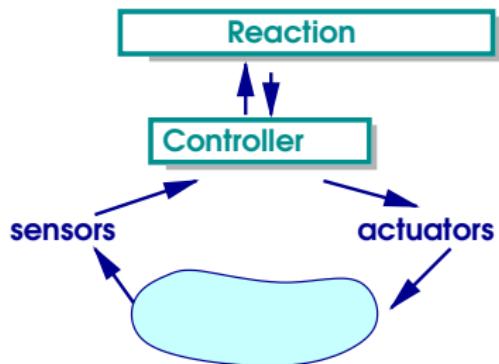
3 Reactive behavior

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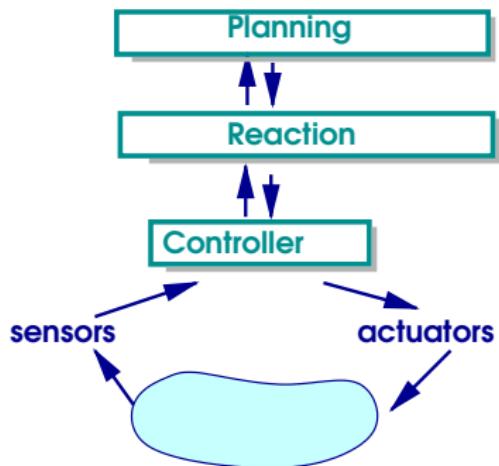
5 Task planning

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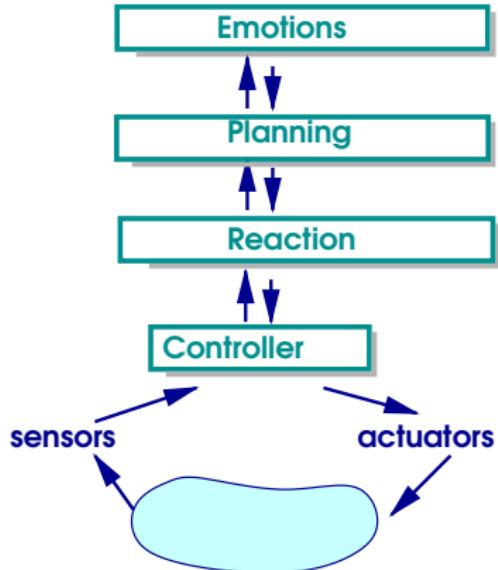
AI in robots control



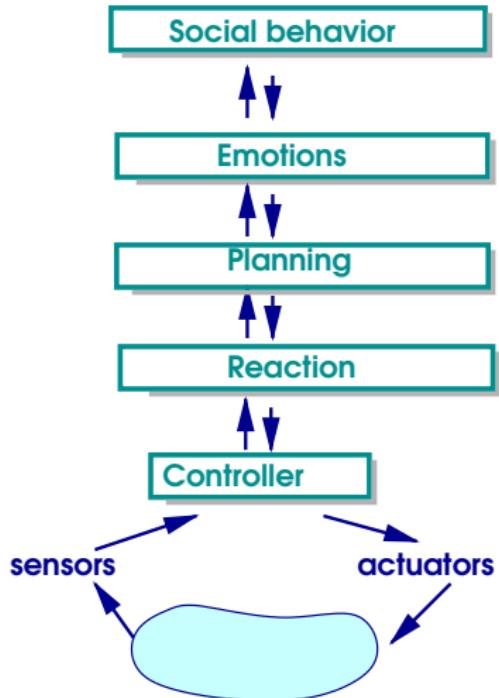
AI in robots control



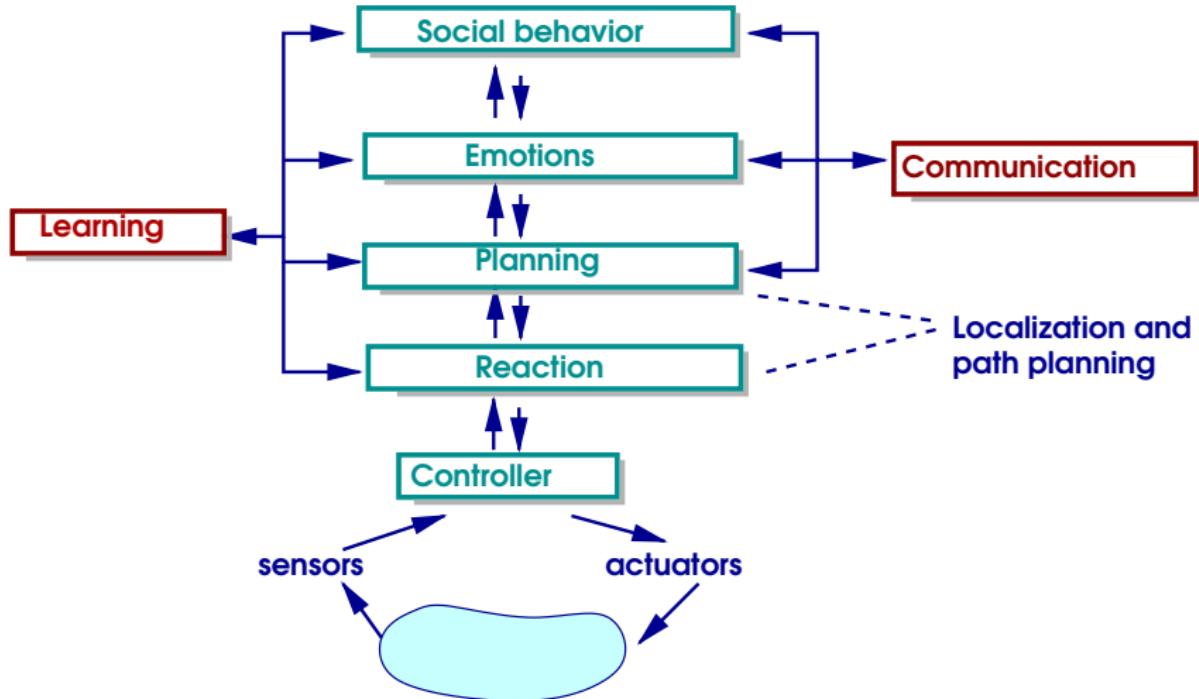
AI in robots control



AI in robots control



AI in robots control



Inputs and Outputs

Sensors

- Infrared
- Laser
- Cameras
- Bumpers
- Sounds
- Light, movement, stairs, ...

Sensors



Inputs and Outputs

Actuators

- Wheels speed
- Arms
- Sound
- Camera
- Software: email, ...

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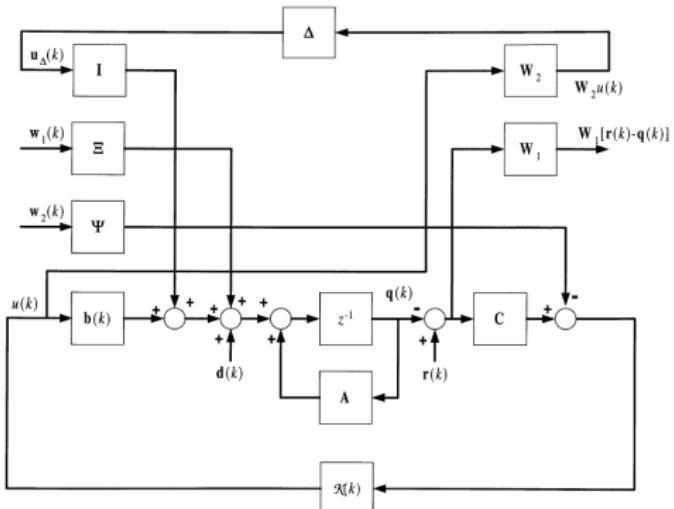
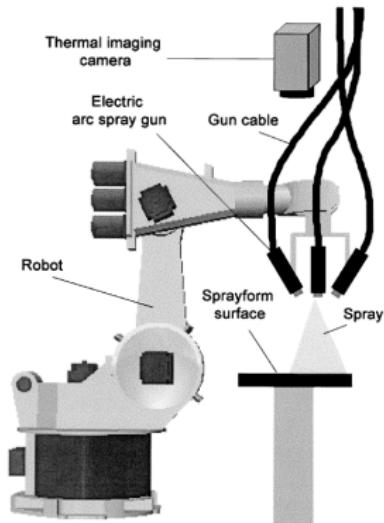
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Classic control [Jones et al., 2003]



Programming a behavior

Move right

- Classic logic (rules)

If $\text{sensor}[0] < 100$ AND

$\sum_{i=1}^8 \text{sensor}[i] > 800$

Then $\text{speed}[1] = 100$, $\text{speed}[2] = 0$

Programming a behavior

Move right

- Classic logic (rules)

If sensor[0] < 100 AND

$$\sum_{i=1}^8 \text{sensor}[i] > 800$$

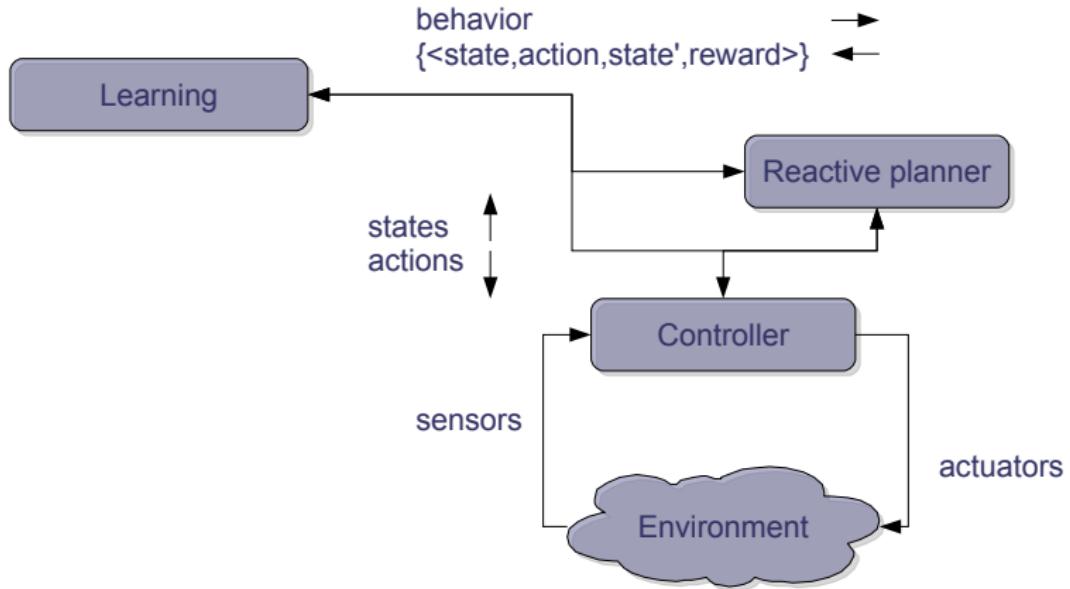
Then speed[1] = 100, speed[2] = 0

- Fuzzy logic

If left sensor is close AND
rest of sensors are far

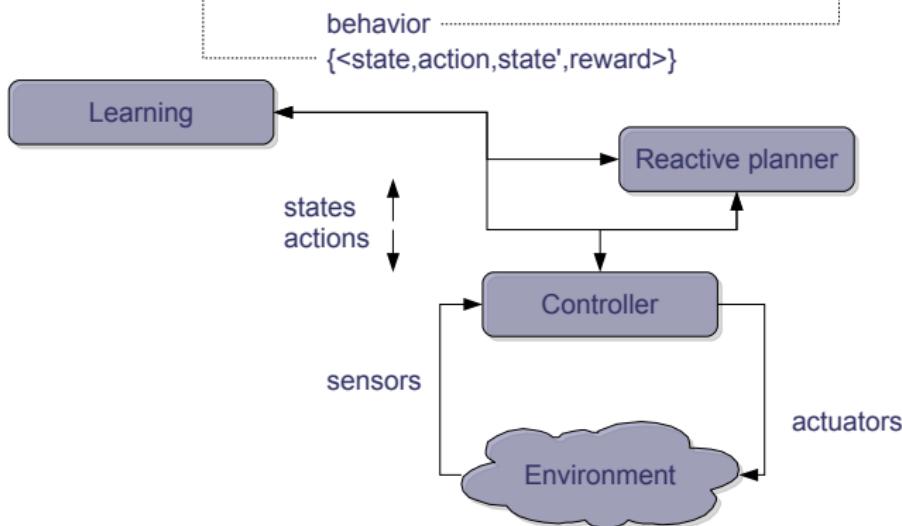
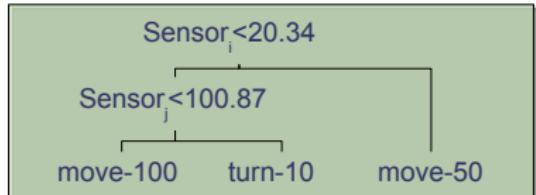
Then speed[1] = a lot,
speed[2] = very little

Learning behaviors

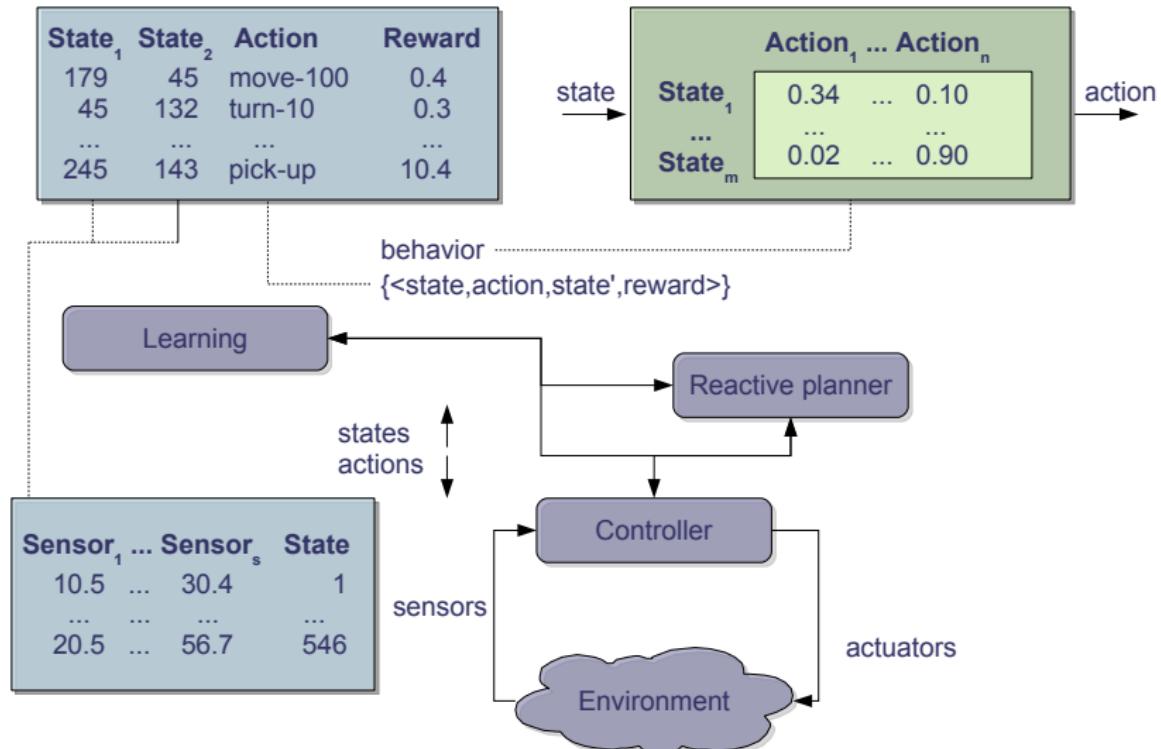


Learning from examples

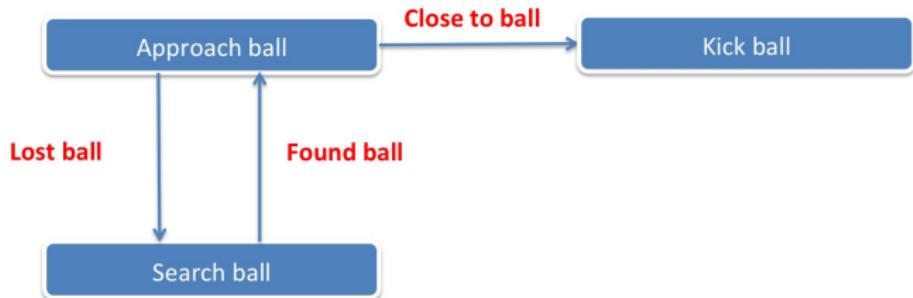
Sensor ₁	...	Sensor _n	Class
23.45	...	34.23	move-100
10.11	...	33.23	turn-10
...
30.10	...	32.54	pick-object



Learning from examples. Reinforcement learning



Combining simpler behaviors

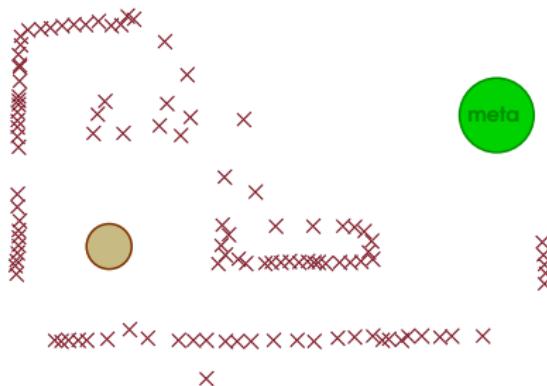


Hierarchical description



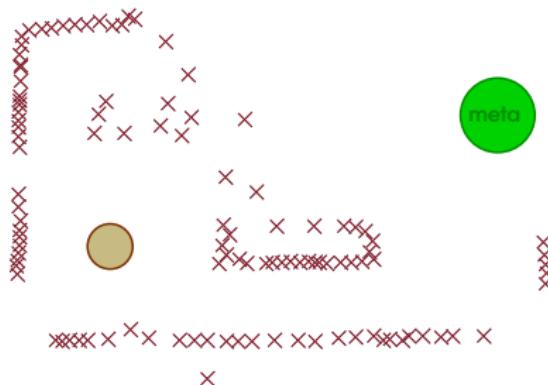
Maps

- Map generation: pre-programmed, learned



Maps

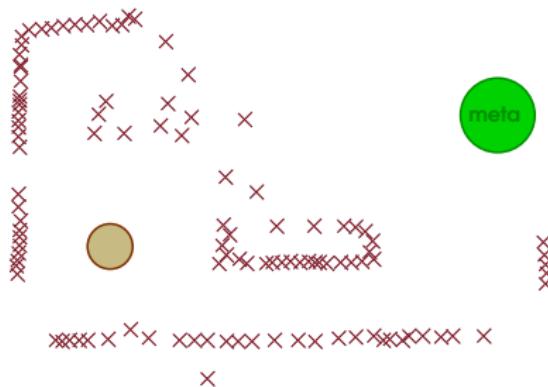
- Map generation: pre-programmed, learned



- Localization: GPS, beacons, Markov, Montecarlo, Kalman filter, ...
 $p(\text{State}=(x, y) \mid \text{Sensors} = (s[0], \dots, s[n]))$

Maps

- Map generation: pre-programmed, learned



- Localization: GPS, beacons, Markov, Montecarlo, Kalman filter, ...
 $p(\text{State}=(x, y) \mid \text{Sensors} = (s[0], \dots, s[n]))$
- Path finding

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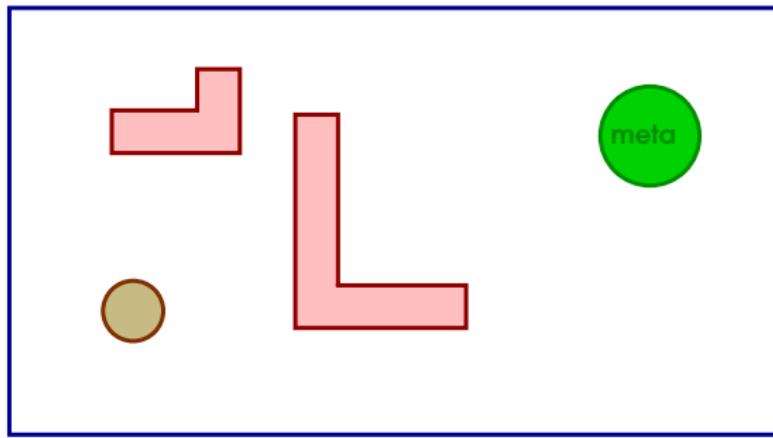
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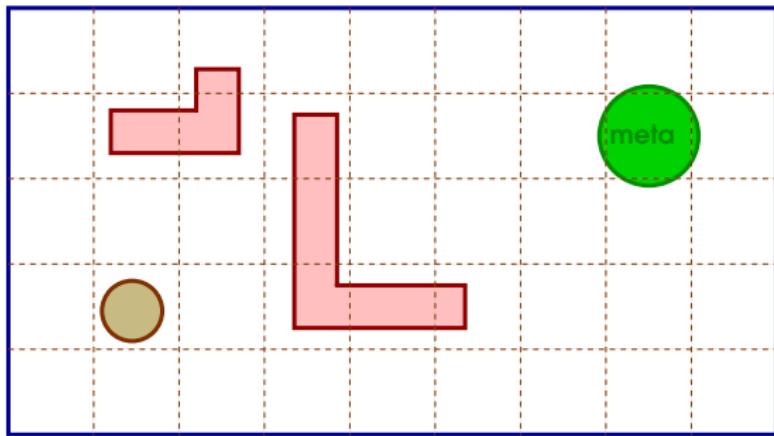
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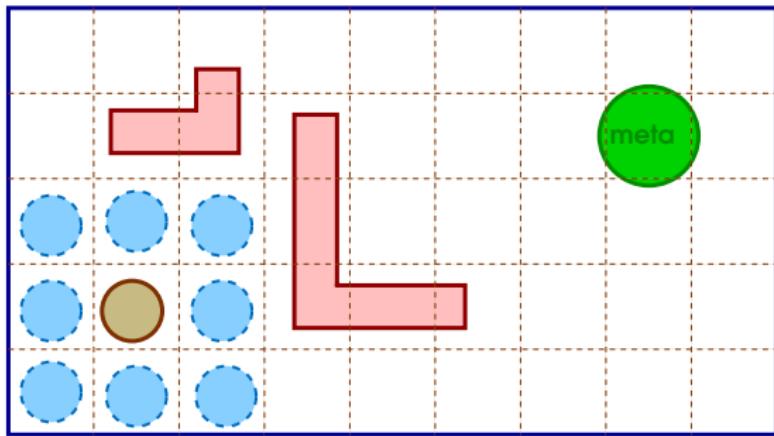
Find best path



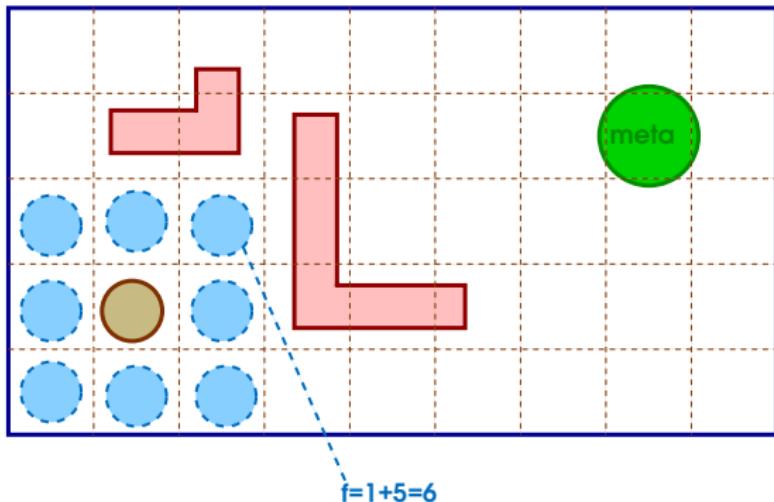
Find best path



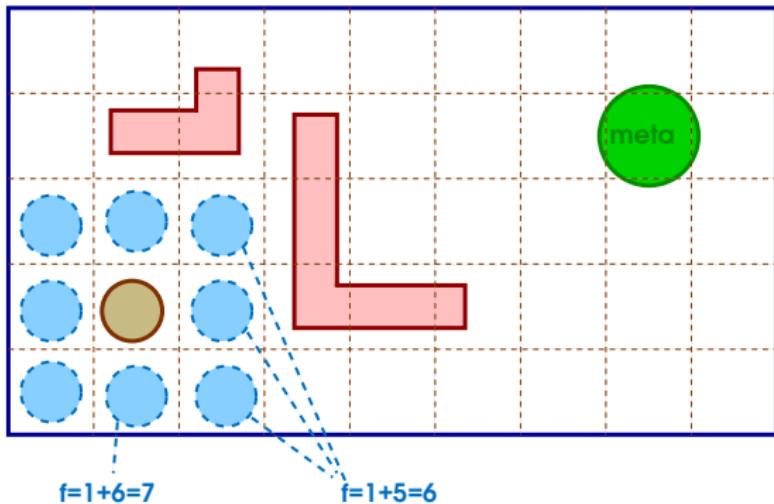
Find best path



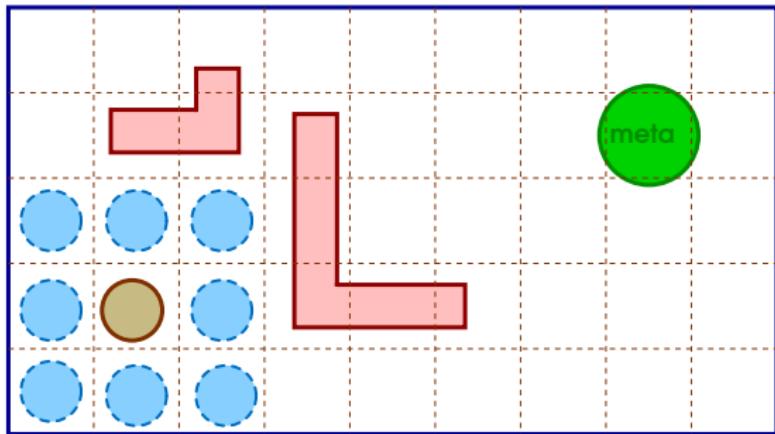
Find best path



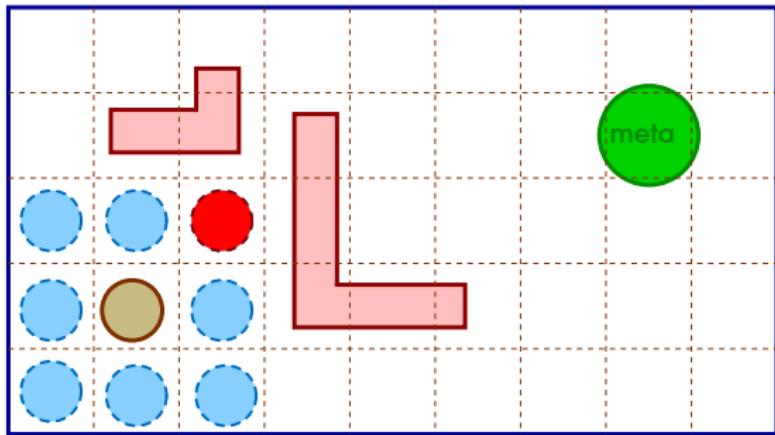
Find best path



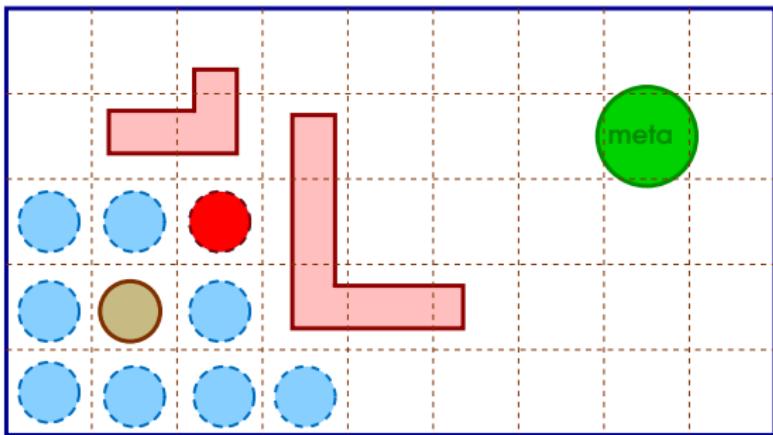
Path finding. A*



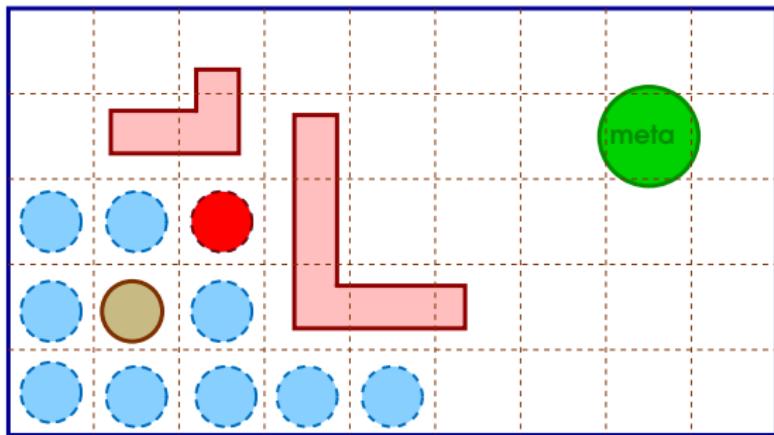
Path finding. A*



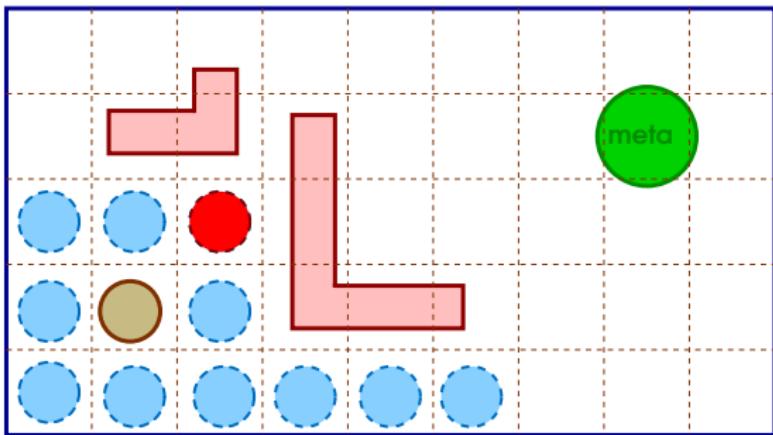
Path finding. A*



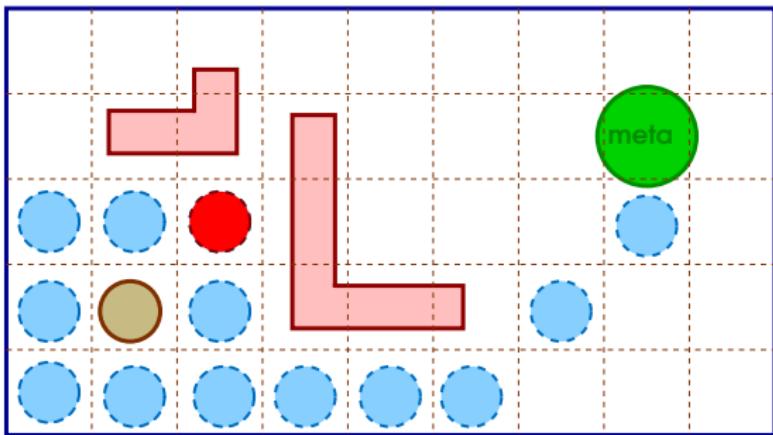
Path finding. A*



Path finding. A*



Path finding. A*



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Planning in robotics

- **State**

at(robot1, room1),
open-door(door1, room1, room2),
closed-door(door2, room1, room3), ...

- **Action**

pull, push, grasp, drop, move, turn, ...

- **Goals:** at(letters, room3)

- **Plan:** move(robot1, room1, room2, door1), ...

- **Metrics:** time, cost, ...

Example in humanoid robot



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Emotions and social behavior



http://www.youtube.com/watch?v=dKZczUDGp_I

Multi-robot environments

- Some domains are multi-robot
- Need of coordination, negotiation, cooperation, communication
- Coordination
 - centralized: if robot1 close to robot2 then move robot2
 - distributed: if too close to next robot in the right then move left
- Communication (need of language, as KQML)
 - inform X Y
 - request X Y
- Examples:
 - <http://www.youtube.com/watch?v=pJVS-9sMiVY>
 - <http://www.youtube.com/watch?v=qBUFX4le1mc>
 - <http://www.youtube.com/watch?v=M2nn1X9Xlps>

Example of social robots - theater



<https://www.youtube.com/watch?v=cJu1VweV3BQ>

Applications



Industry



Medicine



Transport



Surveillance



Exploration, science



Entertainment

More robots

- P3 (Honda):

http://www.youtube.com/watch?v=7T_O9BkkFik

- Dog:

<http://www.youtube.com/watch?v=cHJJQ0zNNOM>

- Spirit and Opportunity

http://www.youtube.com/watch?v=R1jneh_N9WI

- Boss:

<http://www.youtube.com/watch?v=lULL63ERek0>

- Nao:

<http://www.youtube.com/watch?v=2STTNYNF4lk>

- Quadropters:

http://www.youtube.com/watch?v=_sUeGC-8dyk

- More quadropters:

<http://www.youtube.com/watch?v=Qlqe1DXnJKQ>

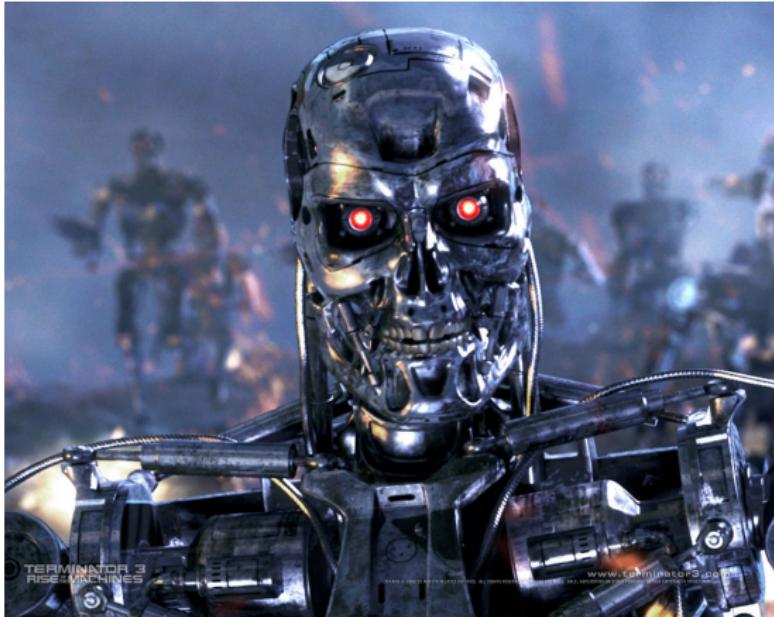
Future



<http://www.youtube.com/watch?v=hhwSbHytvuU>

<http://www.youtube.com/watch?v=g-DkoGvcEBw>

Or even...



TERMINATOR 3
RISE OF THE MACHINES

www.terminator3.com

To wrap up... some soccer games

