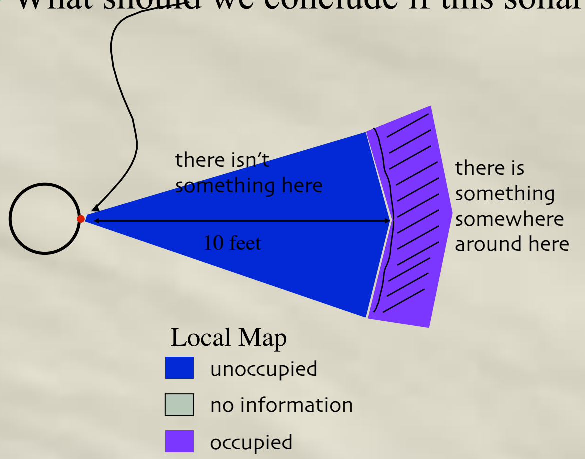
Robotica – Robot Industriali e di Servizio

Lezione 26: La localizzazione markoviana

23 maggio 2012

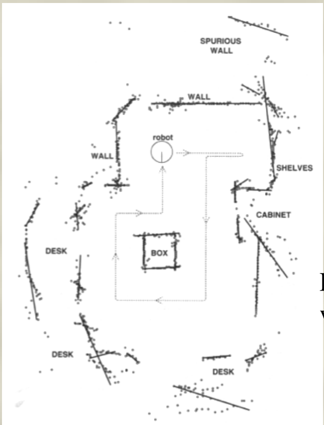
Review: Use Sonar to Create Map

- What should we conclude if this sonar reads 10 feet?



What is it a map of?

- Several answers to this question have been tried:



What information **should** this map contain, given that it is created with sonar ?

Each cell is either occupied or unoccupied -- this was the approach taken by the Stanford Cart.

What is it a map of ?

Several answers to this question have been tried:

pre '83 It's a map of occupied cells. o_{xy} cell (x,y) is occupied; $\overline{o}_{xy}$ cell (x,y) is unoccupied

'83 - '88 It's a map of probabilities: $p(\, o \mid S_{1..i}\,)$ The certainty that a cell is **occupied**, given the sensor readings $S_1, S_2, \ldots, S_i$

$p(\, \overline{o} \mid S_{1..i}\,)$ The certainty that a cell is **unoccupied**, given the sensor readings $S_1, S_2, \ldots, S_i$

☆ It's a map of *odds*. The odds of an event are expressed *relative to the complement* of that event.

evidence = $\log_2$(odds)

The odds that a cell is **occupied**, given the sensor readings $S_1, S_2, \ldots, S_i$

$$odds(\, o \mid S_{1..i}\,) = \frac{p(\, o \mid S_{1..i}\,)}{p(\, \overline{o} \mid S_{1..i}\,)}$$

probabilities

Localization: Relative

- If you know your speed and direction, you can calculate where you are relative to where you were (integrate).
- Speed and direction might, themselves, be absolute (compass, speedometer), or integrated (gyroscope, Accelerometer)
- Relative measurements are usually more accurate in the short term -- but suffer from accumulated error in the long term
- Most robotics work seems to focus on this.

Localization Methods

- Markov Localization:
  - Represent the robot’s belief by a probability distribution over possible positions and uses Bayes’ rule and convolution to update the belief whenever the robot senses or moves
- Monte-Carlo methods
- Kalman Filtering
- SLAM (simultaneous localization and mapping)
- ….

Markov Localization

- What is Markov Localization ?
  - Special case of probabilistic state estimation applied to mobile robot localization
  - Initial Hypothesis:
    - Static Environment
      - Markov assumption
      - The robot's location is the only state in the environment which systematically affects sensor readings
  - Further Hypothesis
    - Dynamic Environment

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Markov assumption (or static world assumption)

If one knows the robot's location ℓ, future measurements are independent of past ones (and vice-versa)

$$P(d_{t+1}, d_{t+2}, \cdots \mid L_T = \ell, d_0, d_1, \cdots, d_t) = P(d_{t+1}, d_{t+2}, \cdots \mid L_T = \ell)$$

- The robot's location is the only state in the environment
- Knowing the robot state is all one needs to know about the past to predict future data.

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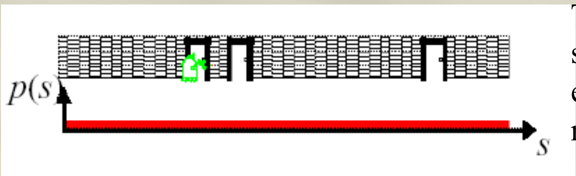
Markov Localization

- Instead of maintaining a single hypothesis as to where the robot is, Markov localization maintains a probability distribution over the space of all such hypothesis
- Uses a fine-grained and metric discretization of the state space

Example

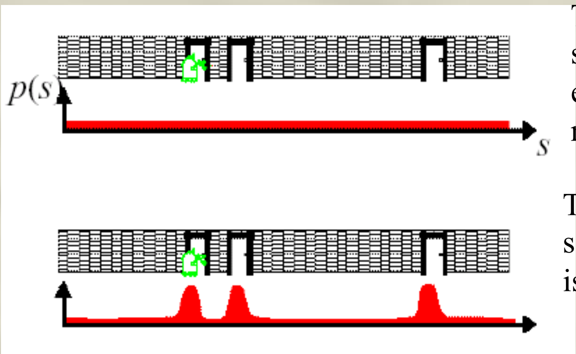
➾ Assume the robot position is one- dimensional



The robot is placed somewhere in the environment but it is not told its location

Example

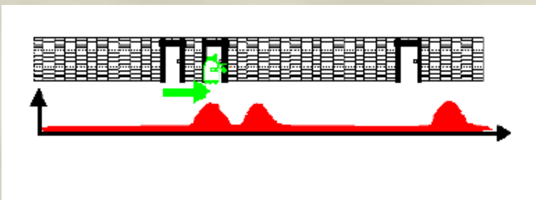
- Assume the robot position is one- dimensional



The robot is placed somewhere in the environment but it is not told its location

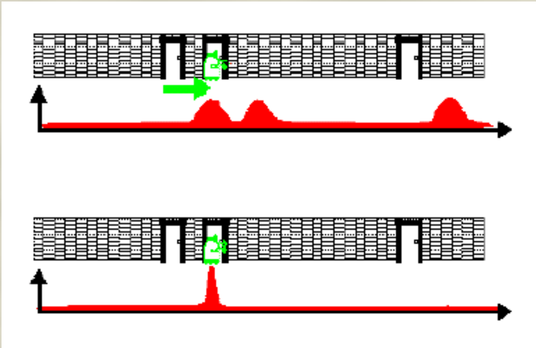
The robot queries its sensors and finds out it is next to a door

Example



The robot moves one meter forward. To account for inherent noise in robot motion the new belief is smoother

Example

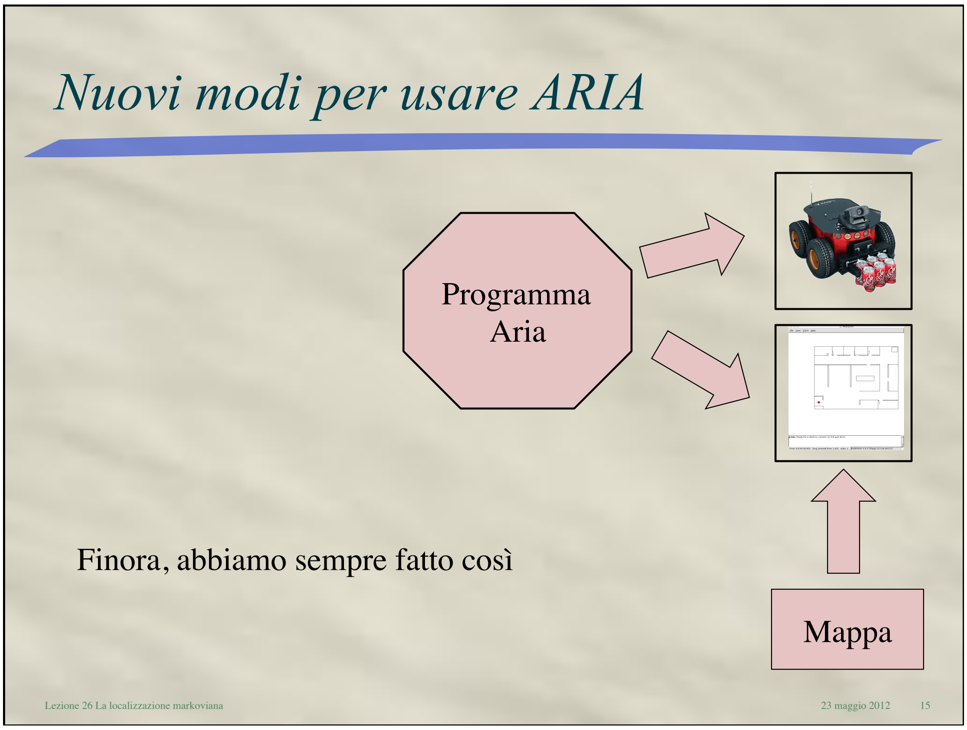


The robot moves one meter forward. To account for inherent noise in robot motion the new belief is smoother

The robot queries its sensors and again it finds itself next to a door

Per approfondire:

- http://plymouth.tinigrifi.eu/aint509.php
- http://www.cs.cmu.edu/afs/cs/project/jair/pub/volume11/fox99a-html/node2.html
- http://moodle.epfl.ch/course/view.php?id=261
- http://lis.epfl.ch/resources/podcast/2006/12/raja-chatila-robot-navigation.html


Nuovi modi per usare ARIA
Programma
Aria
Finora, abbiamo sempre fatto così
Mappa
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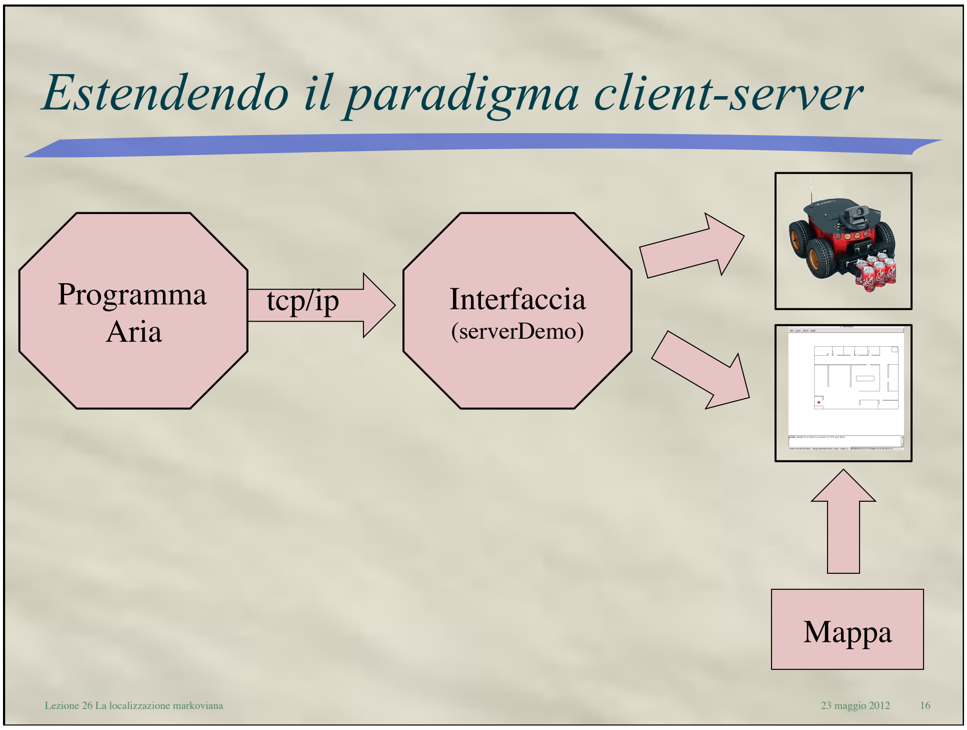
Estendendo il paradigma client-server
Programma
Aria
tcp/ip
Interfaccia
(serverDemo)
Mappa
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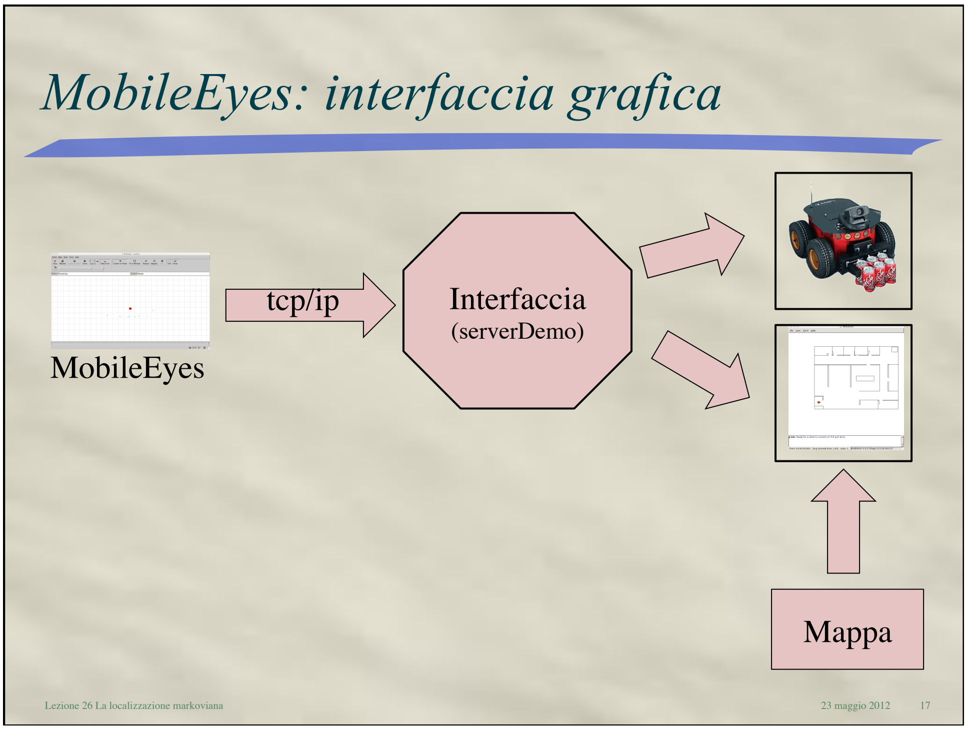
MobileEyes: interfaccia grafica
tcp/ip
Interfaccia
(serverDemo)
MobileEyes
Mappa
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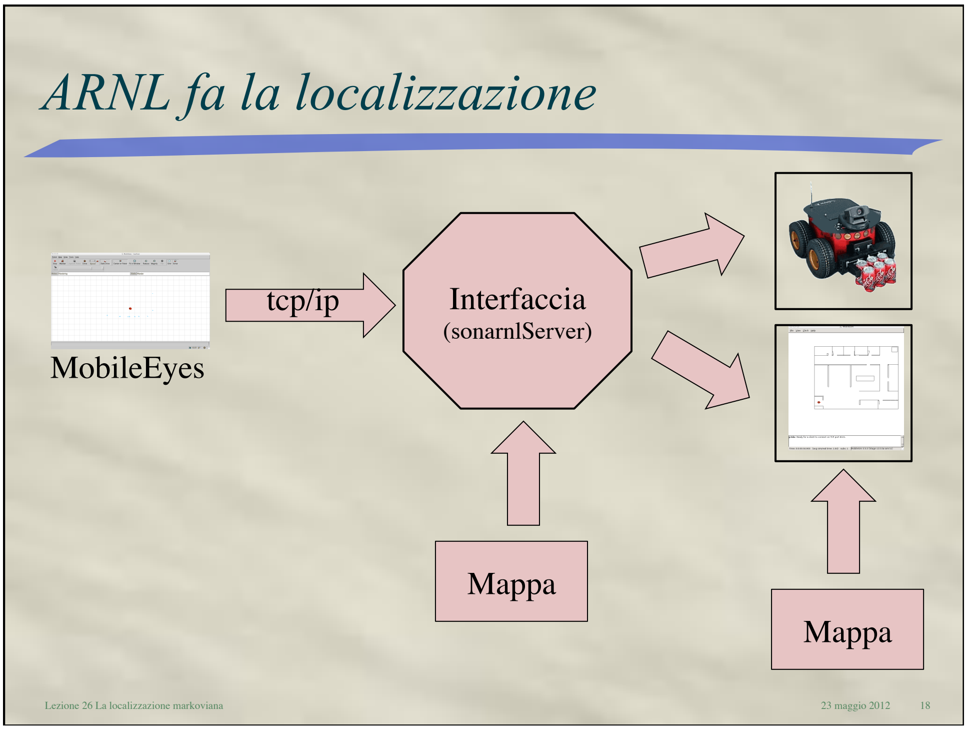
ARNL fa la localizzazione
tcp/ip
Interfaccia
(sonarnlServer)
MobileEyes
Mappa
Mappa
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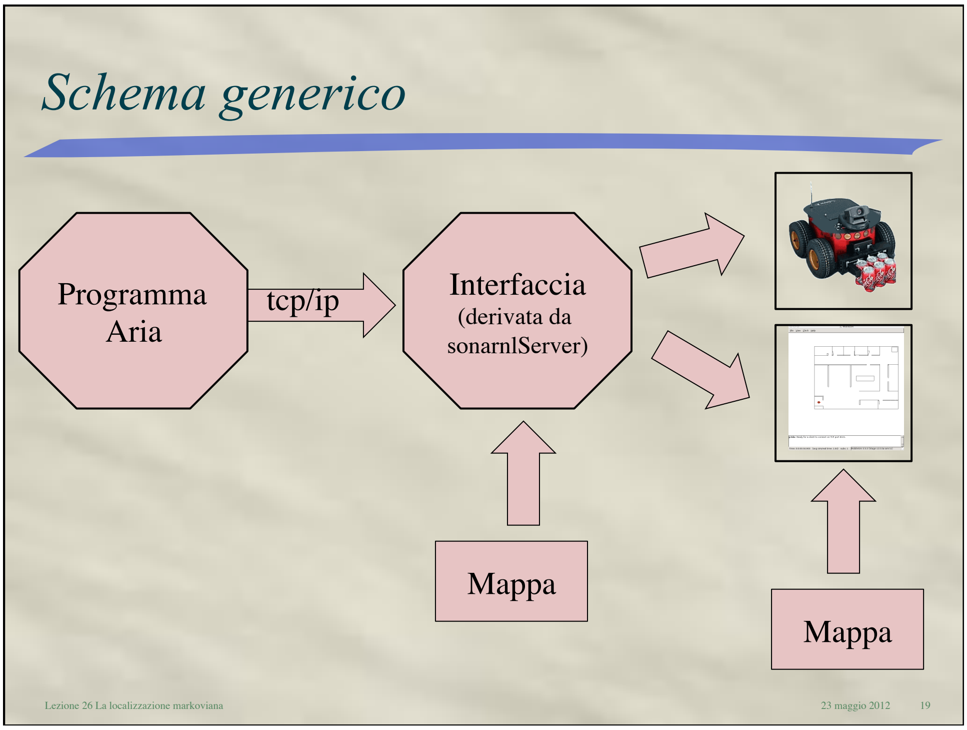
Schema generico
Programma
Aria
tcp/ip
Interfaccia
(derivata da
sonarnlServer)
Mappa
Mappa
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