



# Mobile Robots | Introduction and Lecture Overview

## *Autonomous Mobile Robots*

**Roland Siegwart**

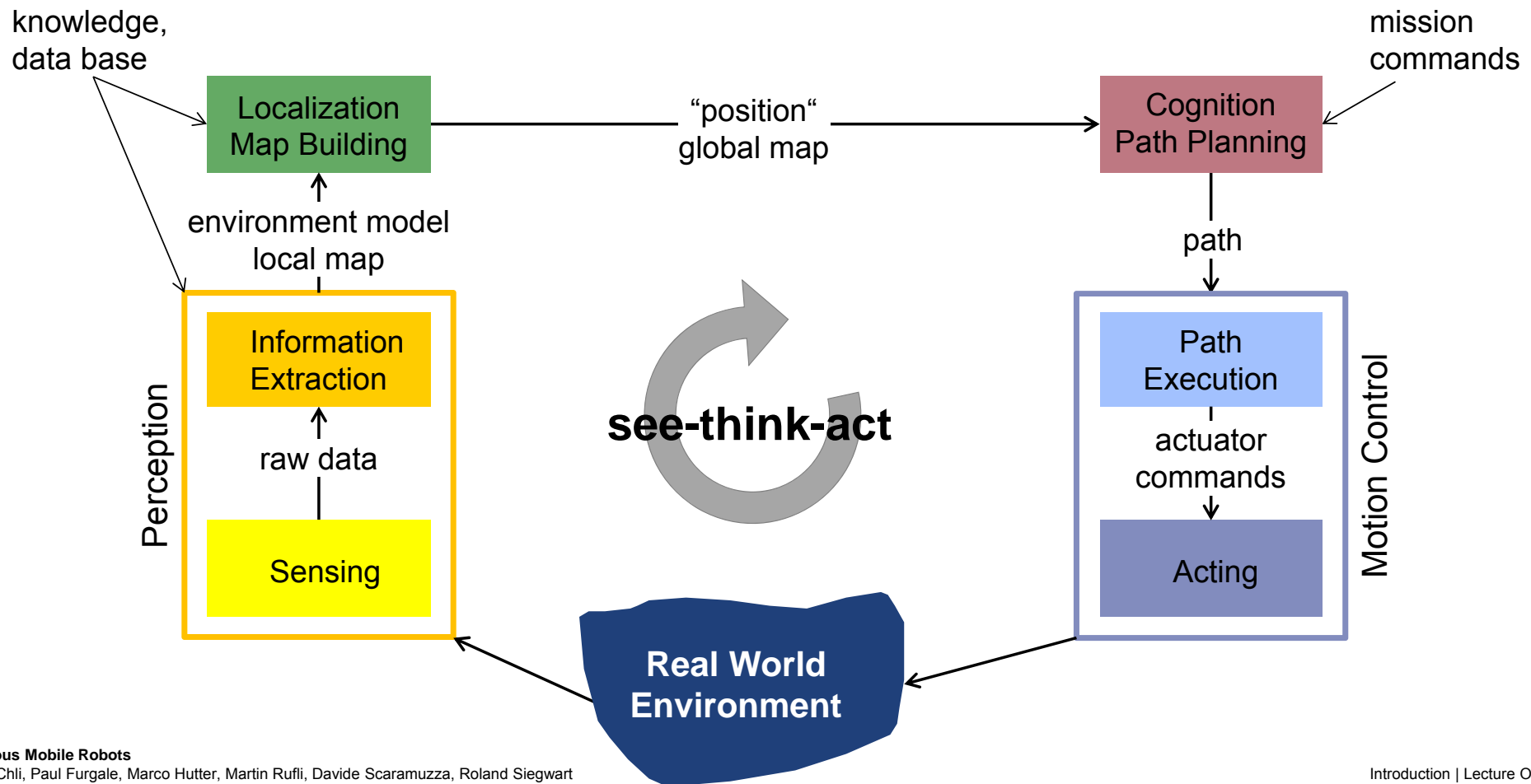
Margarita Chli, Paul Furgale, Marco Hutter, Martin Rufli, Davide Scaramuzza

# Autonomous mobile robot | the key questions

- The three key questions in Mobile Robotics
  - Where am I ?
  - Where am I going ?
  - How do I get there ?
- To answer these questions the robot has to
  - have a model of the environment (given or autonomously built)
  - perceive and analyze the environment
  - find its position/situation within the environment
  - plan and execute the movement

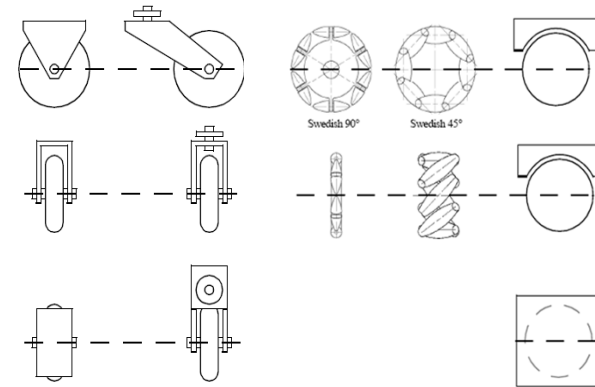


# Autonomous mobile robot | the see-think-act cycle



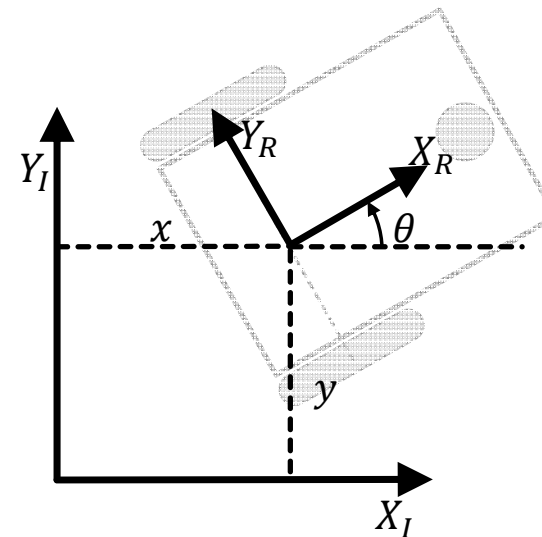
# Motion Control | kinematics and motion control

- Wheel types and its constraints
  - Rolling constraint
  - no-sliding constraint (lateral)
- Motion control

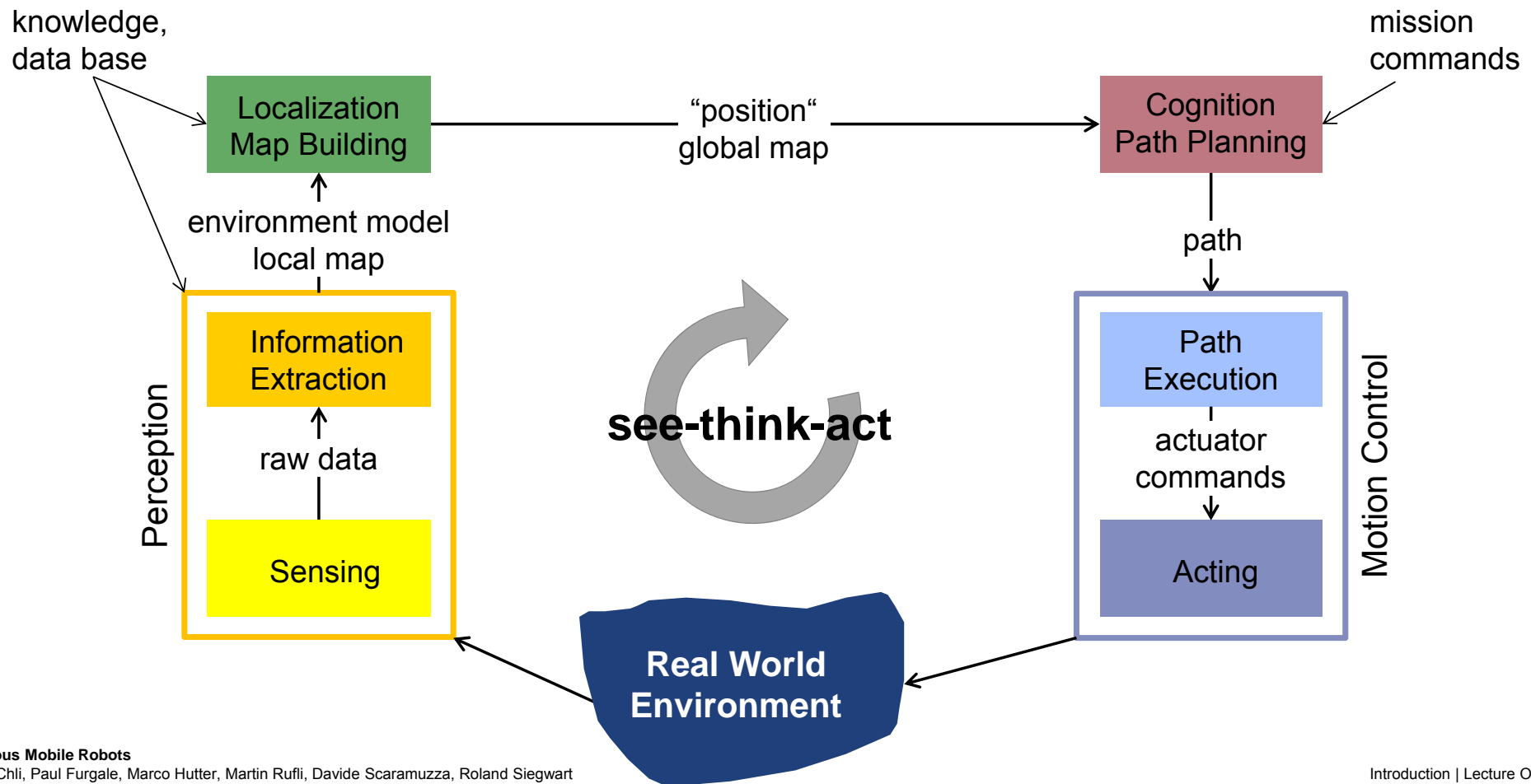


$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = f(\dot{\phi}_1 \cdots \dot{\phi}_n, \theta, geometry)$$

$$\begin{bmatrix} \dot{\phi}_1 \\ \vdots \\ \dot{\phi}_n \end{bmatrix} = f(\dot{x}, \dot{y}, \dot{\theta}) \quad ?$$

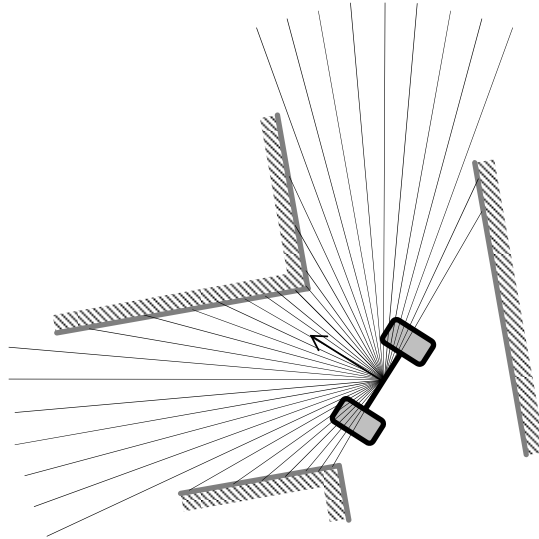


# Autonomous mobile robot | the see-think-act cycle

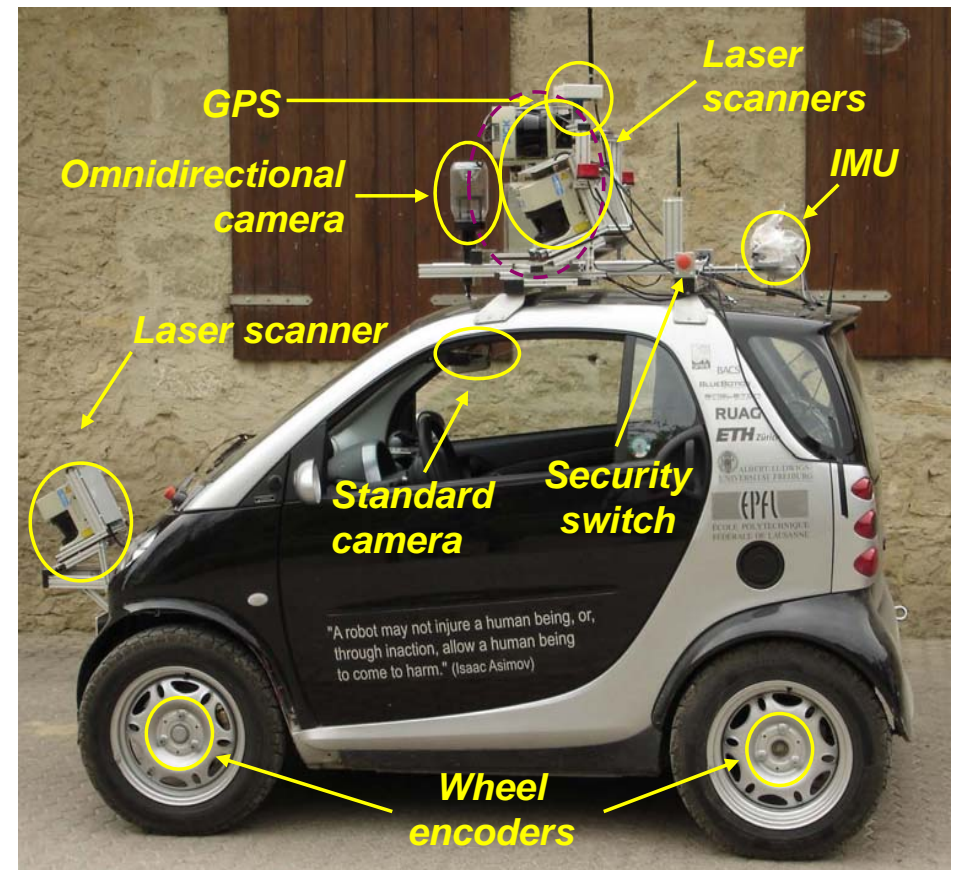
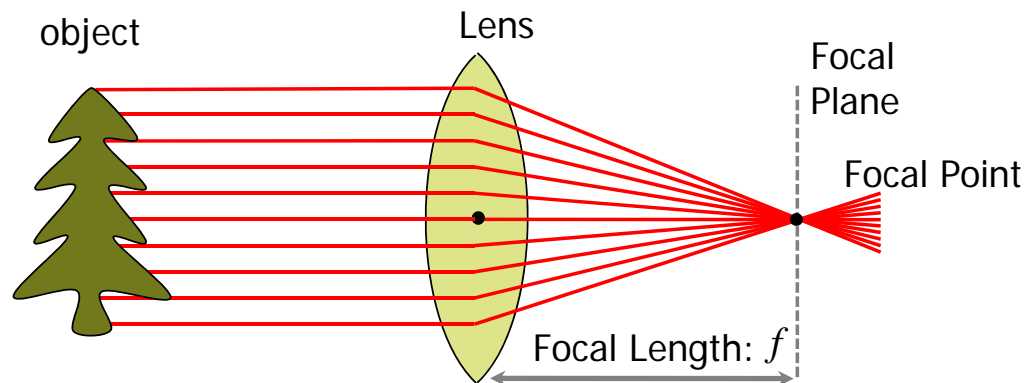


# Perception | sensing

- Laser scanner
  - time of flight

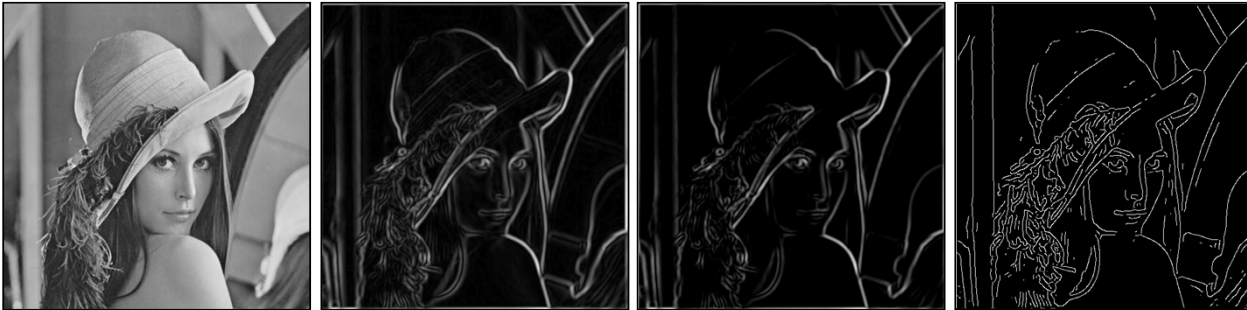


- Camers





# Perception | information extraction



- Filtering / Edge Detection

- Keypoint Features
  - features that are reasonably invariant to rotation, scaling, viewpoint, illumination
  - FAST, SURF, SIFT, BRISK, ...

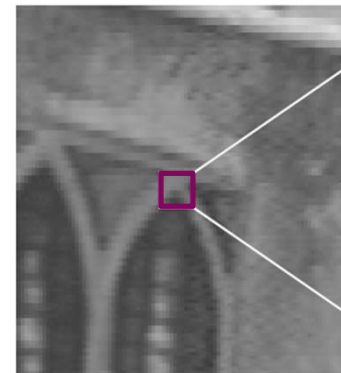
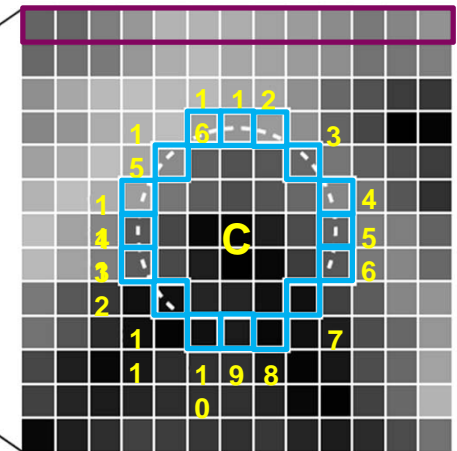


Image from [Rosten et al., PAMI 2010]



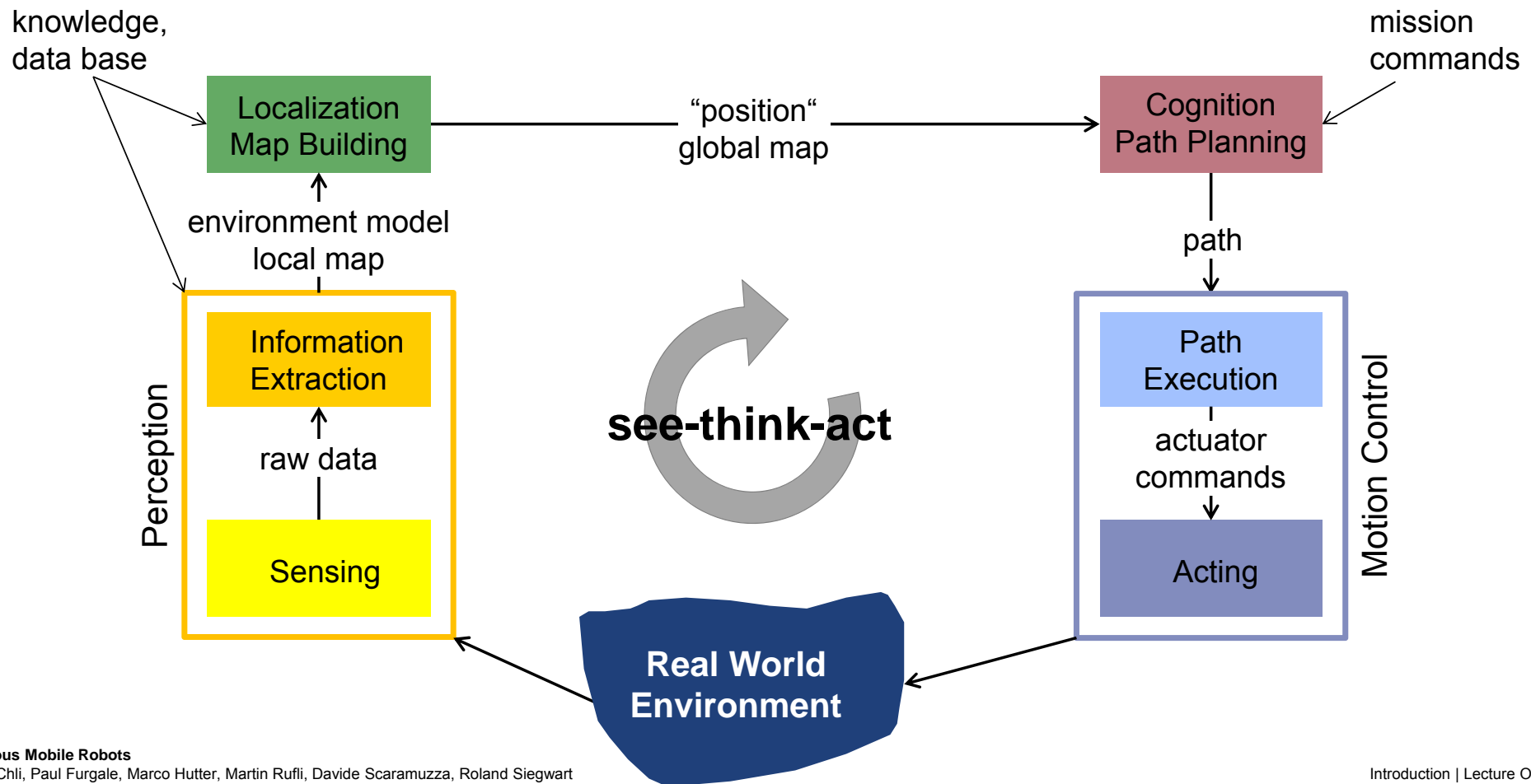
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- Keypoint matching
  - BRISK example



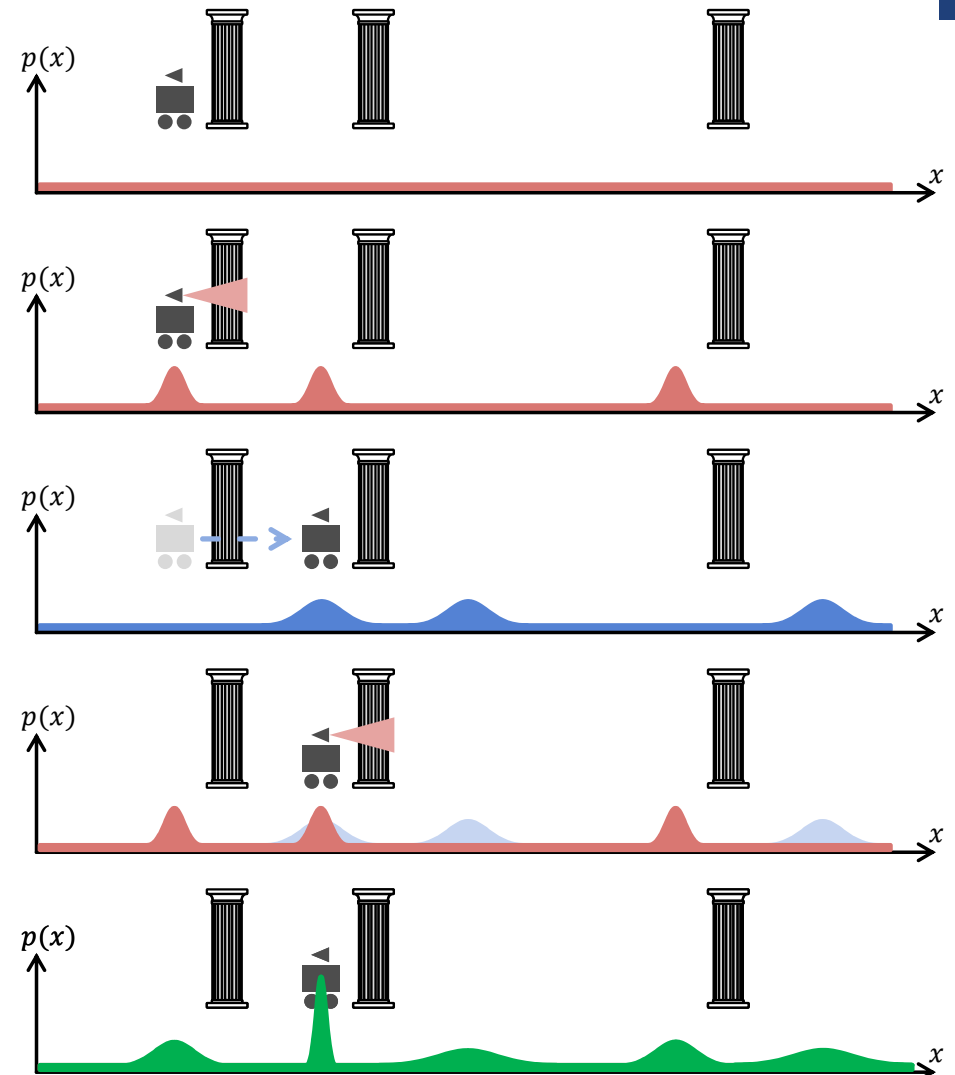
# Autonomous mobile robot | the see-think-act cycle



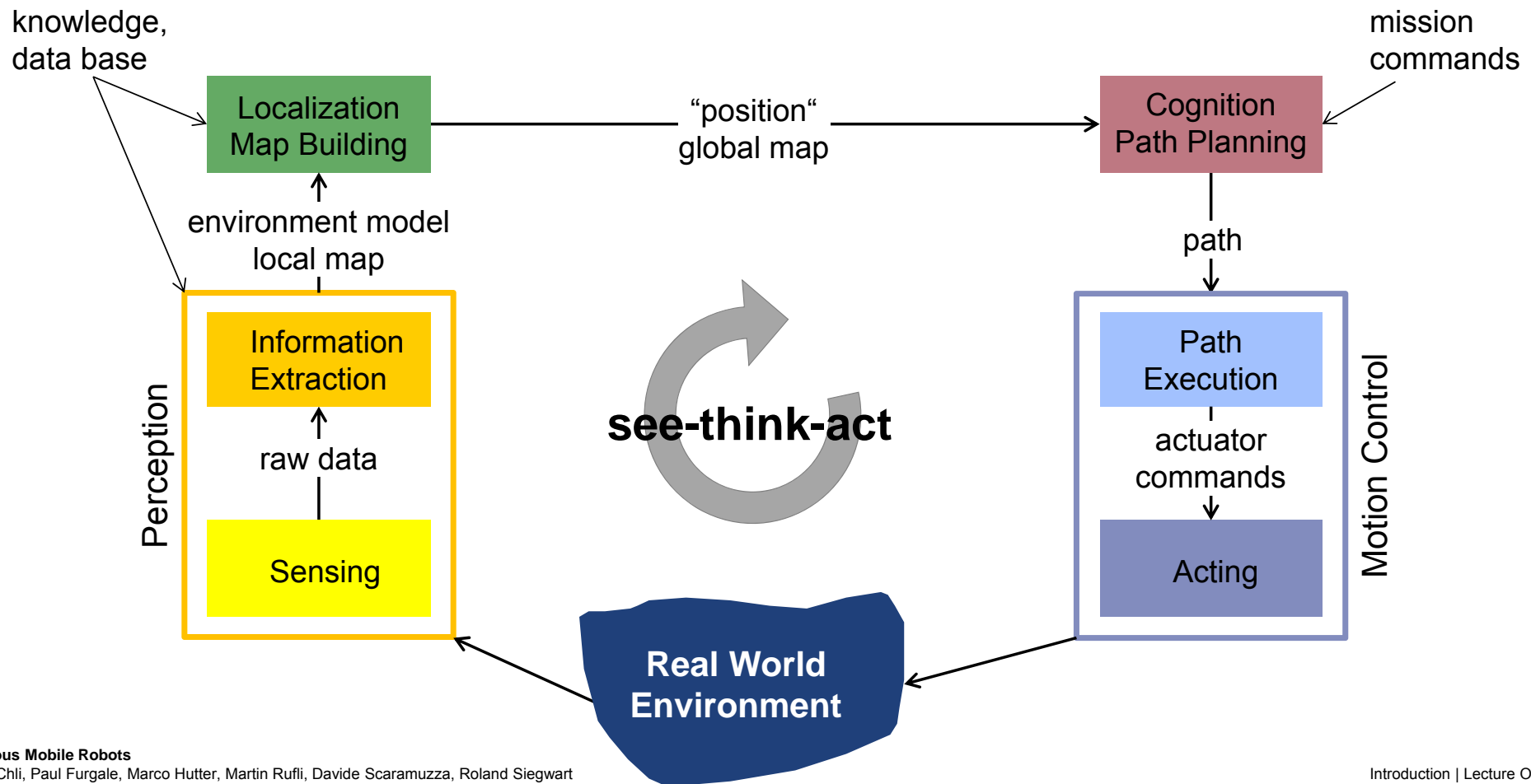


# Localization | where am I?

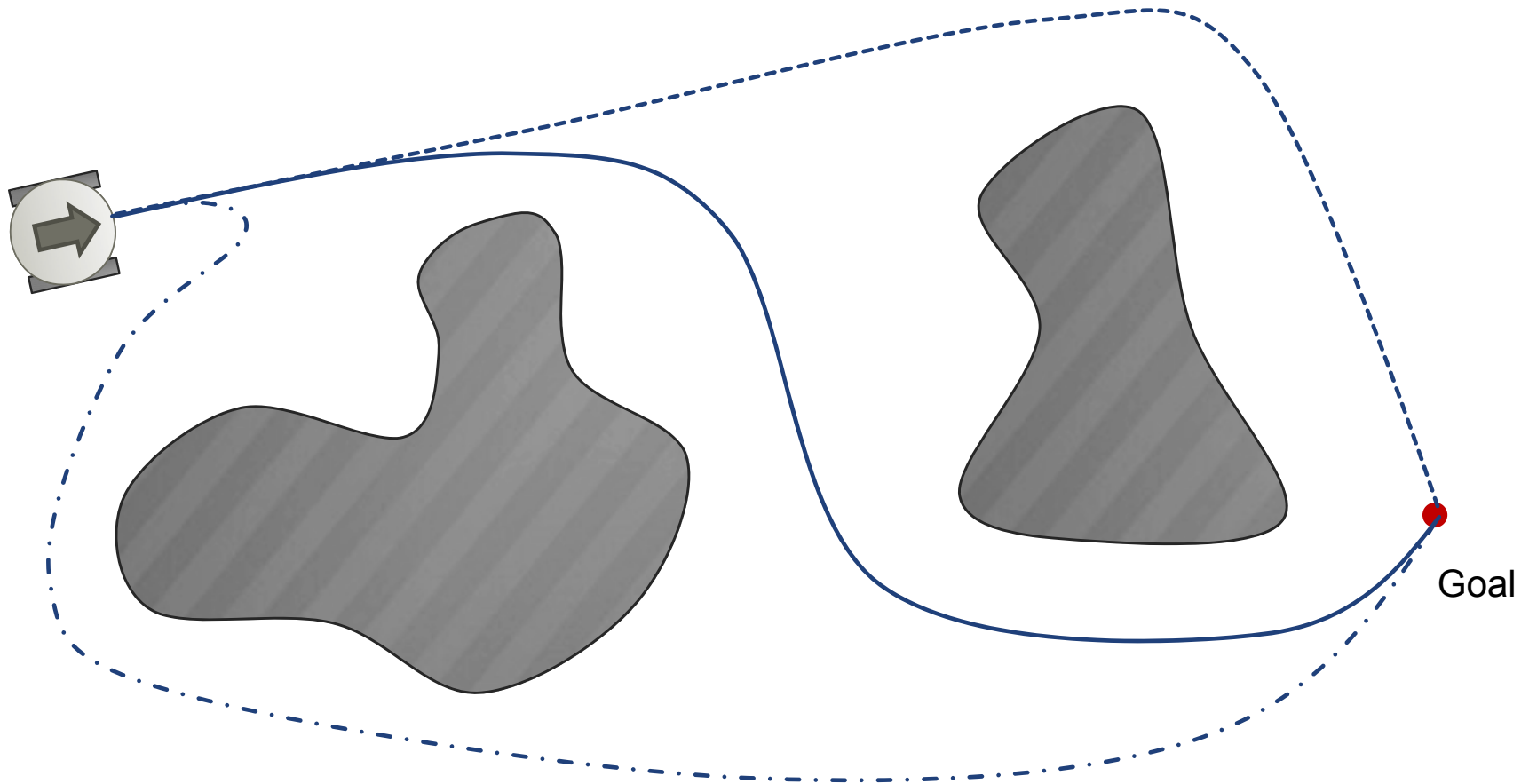
- SEE: The robot queries its sensors  
→ finds itself next to a pillar
- ACT: Robot moves one meter forward
  - motion estimated by wheel encoders
  - accumulation of uncertainty
- SEE: The robot queries its sensors  
again → finds itself next to a pillar
- Belief update (information fusion)



# Autonomous mobile robot | the see-think-act cycle

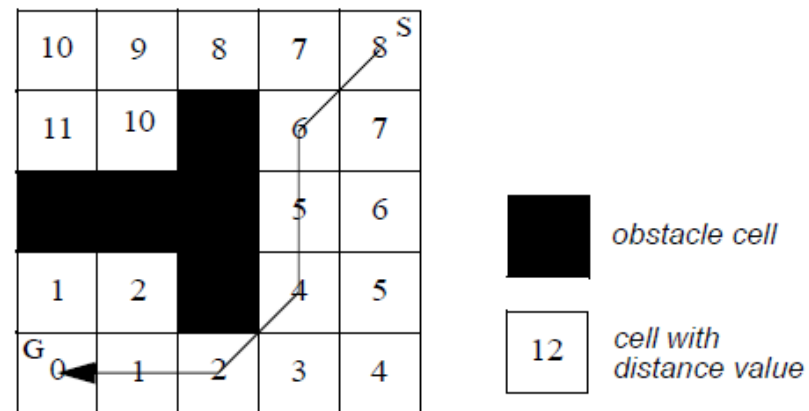


# Cognition | Where am I going ? How do I get there ?

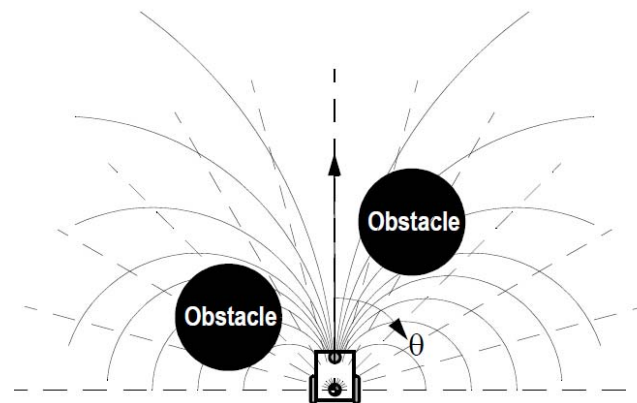


# Cognition | Where am I going ? How do I get there ?

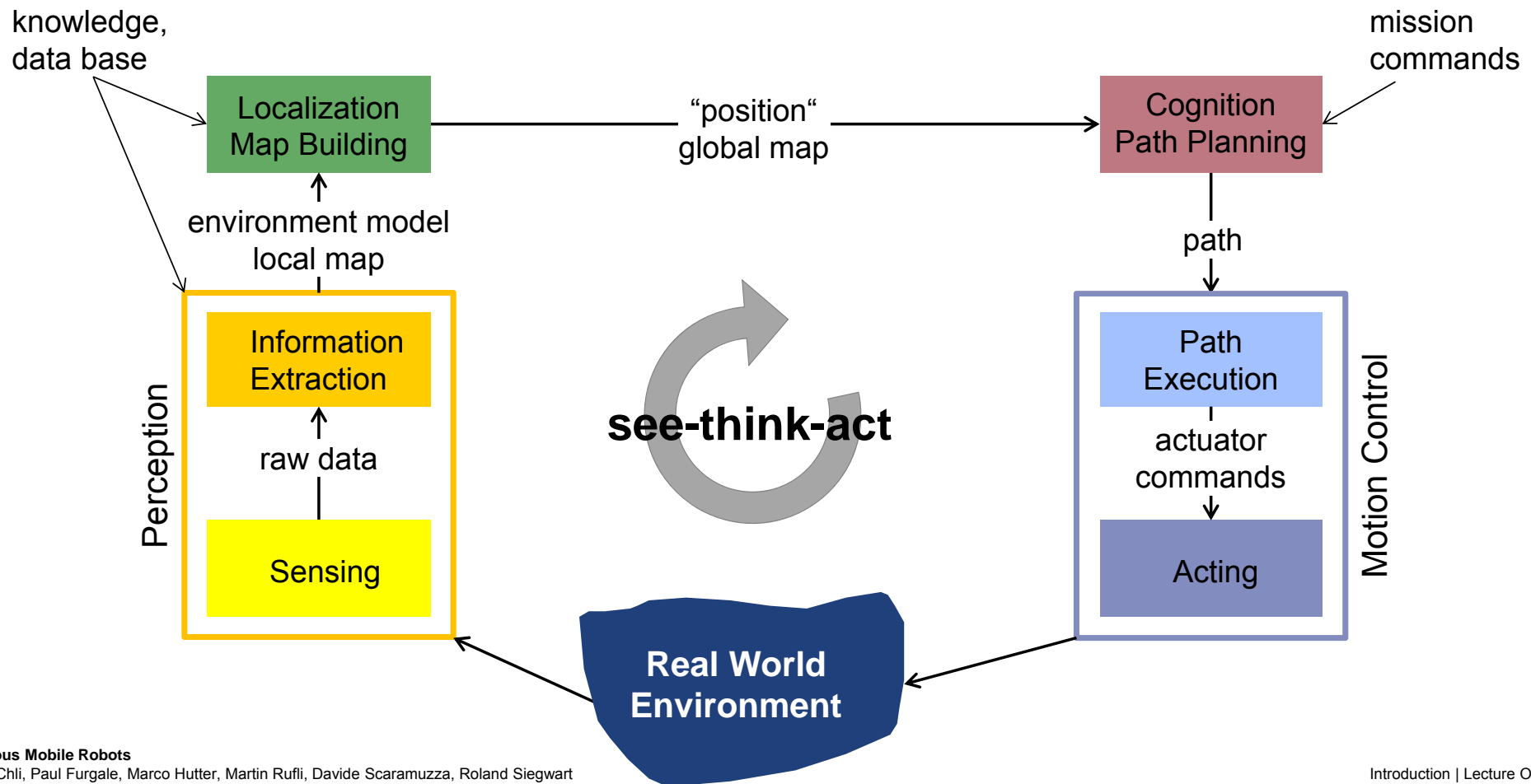
- Global path planning
  - Graph search



- Local path planning
  - Local collision avoidance

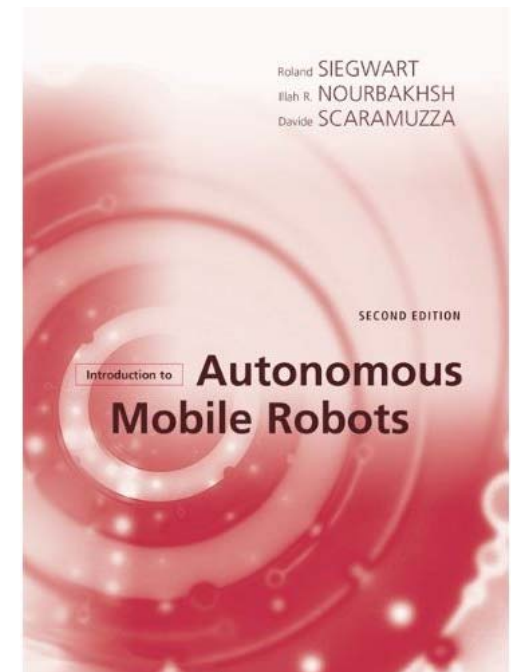


# Autonomous mobile robot | the see-think-act cycle



# Autonomous mobile robot | about the course

- Around 30 short video lectures that we call “segments”.
- The “segments” are complemented with:
  - short questions for each segment to verify your understanding and progress
  - various exercises
  - videos showing the current state-of-the-art in the field
- Based on lecture at ETH Zurich
- Textbook
  - „Introduction to Autonomous Mobile Robots“
  - Roland Siegwart, Illah Nourbakhsh, Davide Scaramuzza*
  - The MIT Press





# Autonomous mobile robot | your teachers



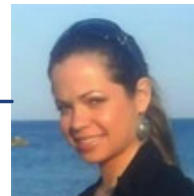
—● Roland Siegwart, ETH Zurich

Paul Furgale, ETH Zurich —●



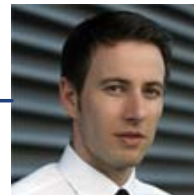
—● Marco Hutter, ETH Zurich

Margarita Chli, Univ. of Edinburgh —●



—● Davide Scaramuzza, Univ. of Zürich

Martin Rufli, IBM Research —●



# Autonomous mobile robot | we invite you to join the course



## We look forward having you as our students in this course