

W1. Objectives, Challenges, State of the Art, Technologies

- Socio-economic context
- Technological evolution of Robotics & State of the Art
- New challenges for Robotics in Human Environments
- **Decisional & Control Architecture for Autonomous Mobile Robots & IV**
- Sensing technologies: Object Detection
- Sensing technologies: Robot Control & HRI
- Basic technologies for Navigation in Dynamic Human Environments
- Intelligent Vehicles: Context & State of the Art
- Intelligent Vehicles: Technical Challenges & Driving Skills

How to control Robot actions in a Dynamic world populated by Human Beings ?



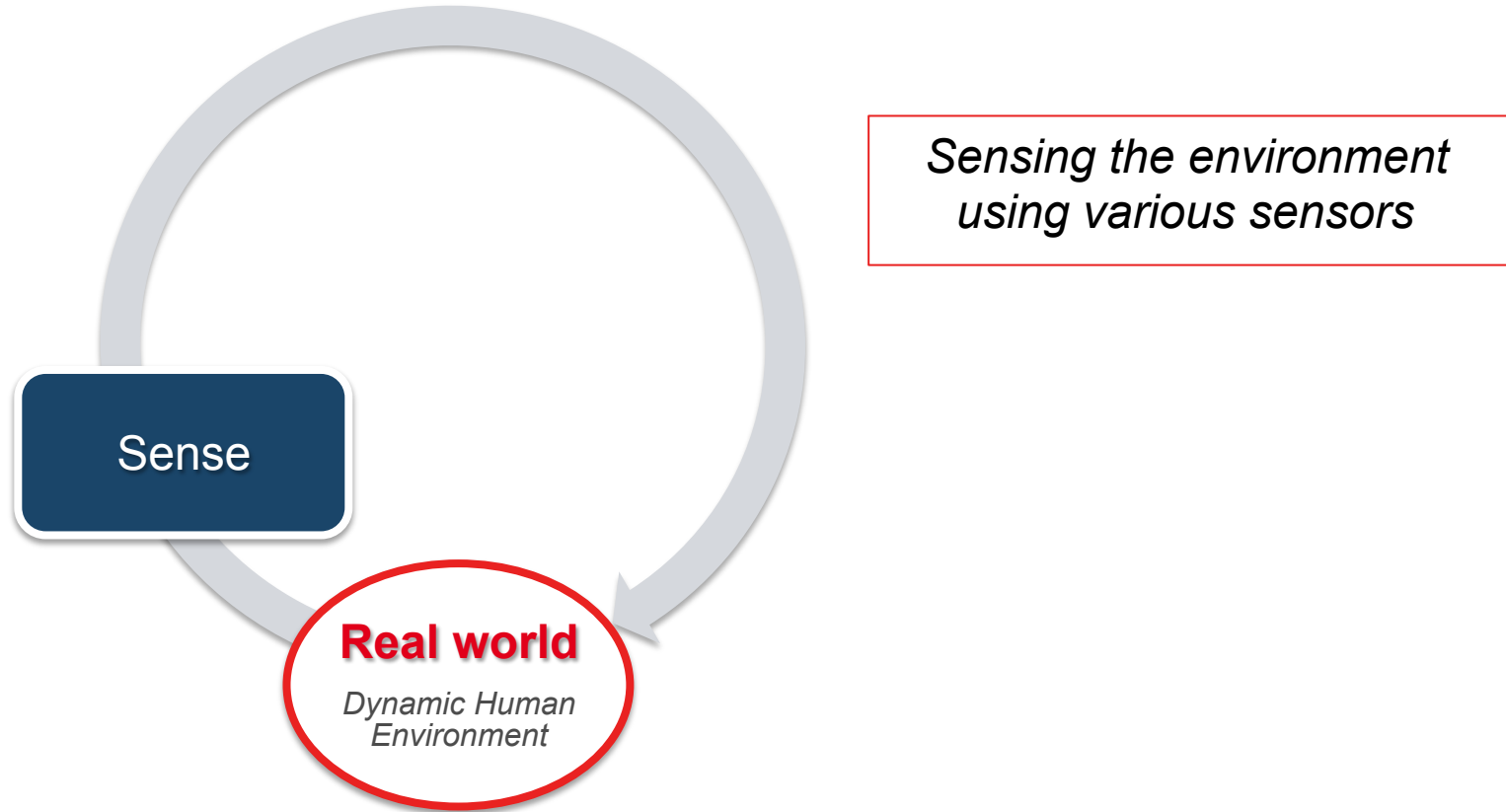
Appropriate Decisinal & Control Architecture

→ *Combining & Adapting four interdependent functions*
(Sensing , Interpreting, Deciding, Acting)

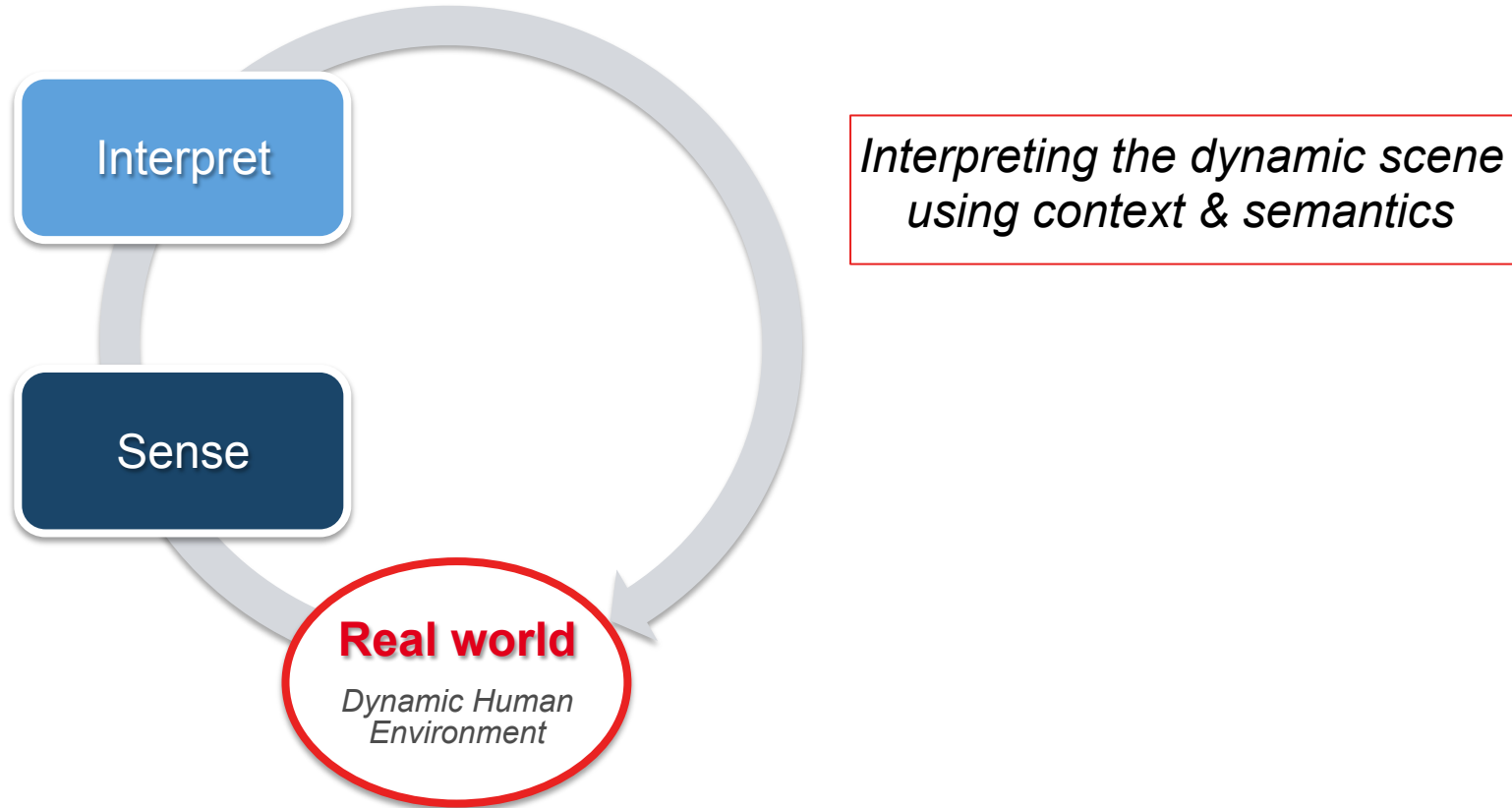
Real world

*Dynamic Human
Environment*

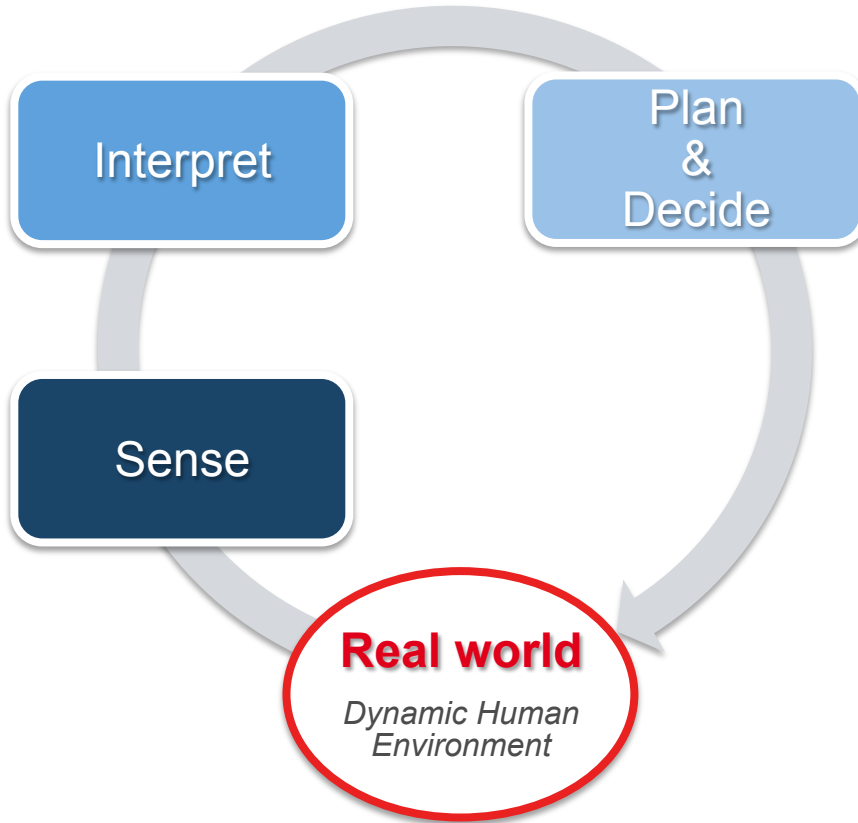
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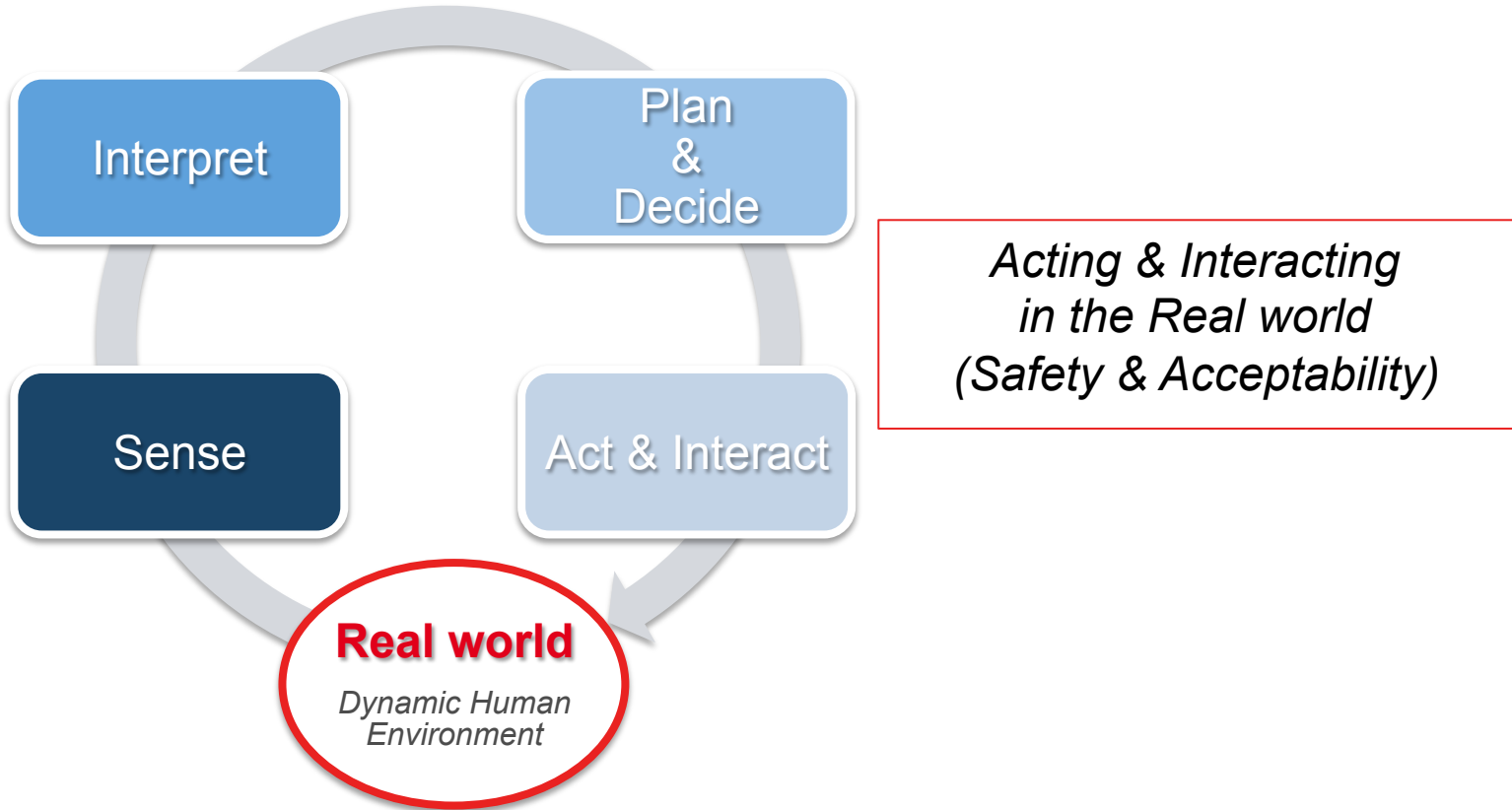


How to control Robot actions in a Dynamic world populated by Human Beings ?



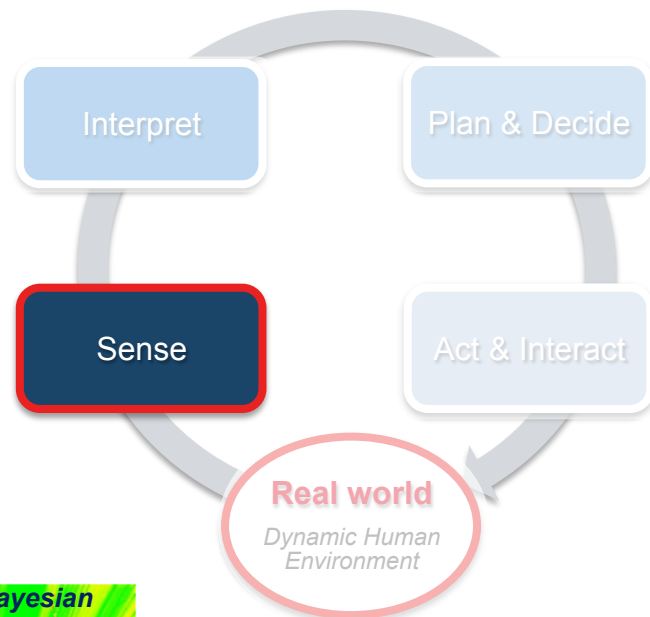
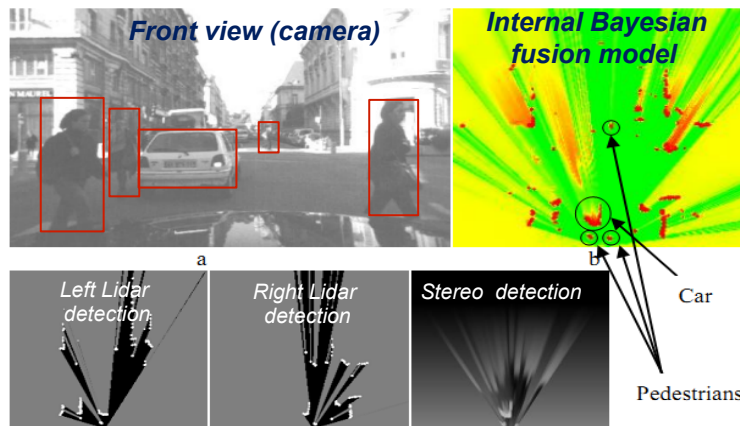
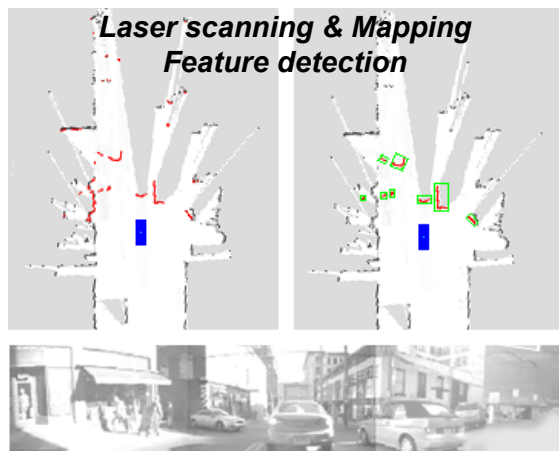
*Planning robot motions
+
Deciding of the most
appropriate
action to be executed
(with a Goal in mind)*

How to control Robot actions in a Dynamic world populated by Human Beings ?



Sense

Objective: *Perceive what is happening in the Dynamic Scene using various sensors*



Sense

- **Main Difficulty**

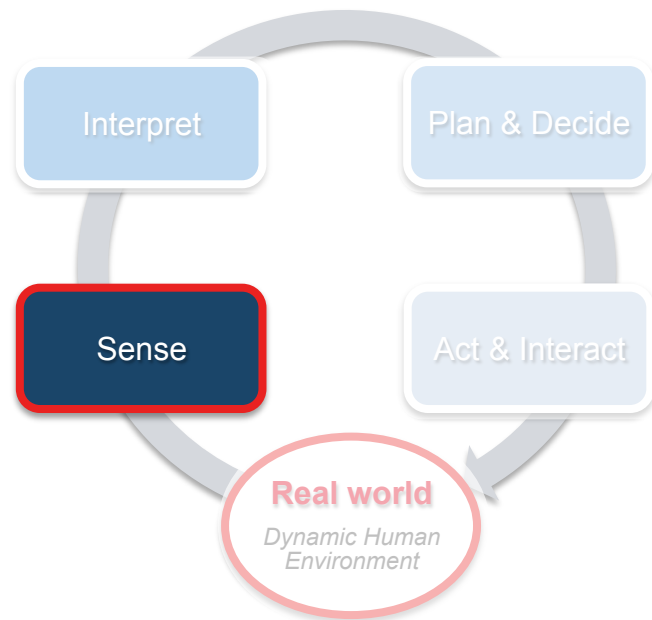
- ✓ *Huge heterogeneous sensory data*
- ✓ *Sensing errors & Uncertainty*
- ✓ *Real-time processing*

- **Main Functions**

- ✓ *Localization & Mapping (SLAM)*
- ✓ *Static & Mobile Objects Detection*

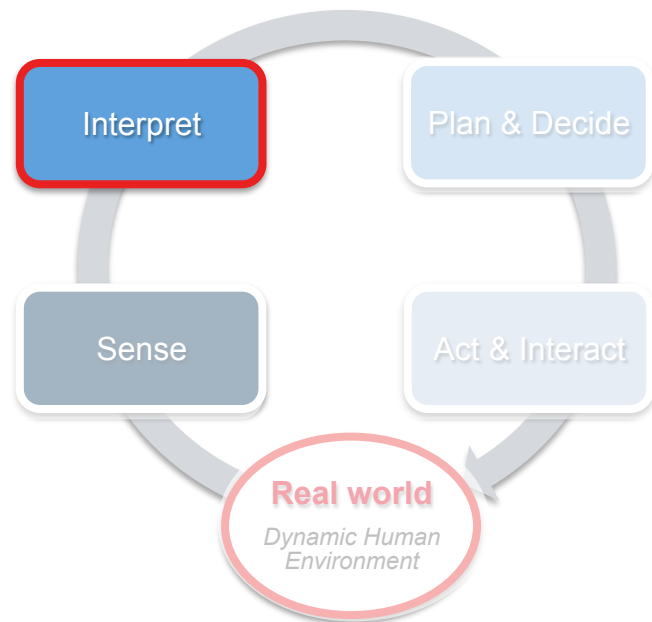
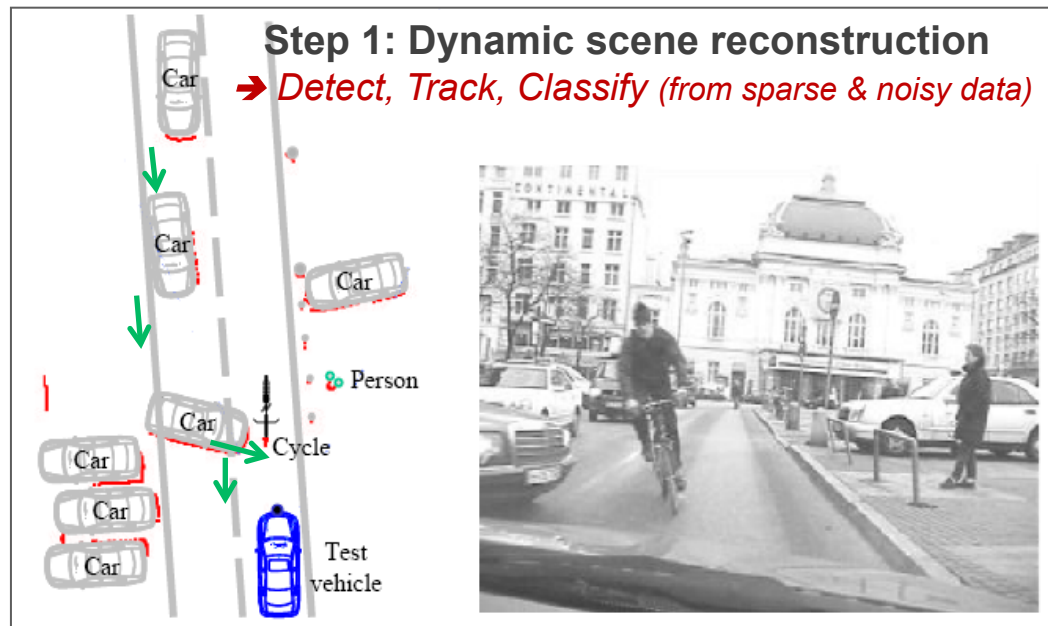
- **Main Models & Algorithms**

- ✓ *Bayesian Filtering*
- ✓ *Feature based & Grid based approaches*



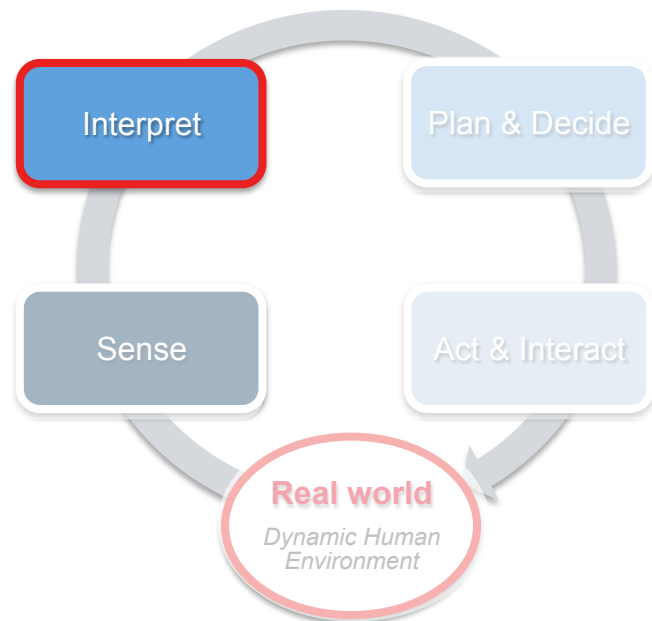
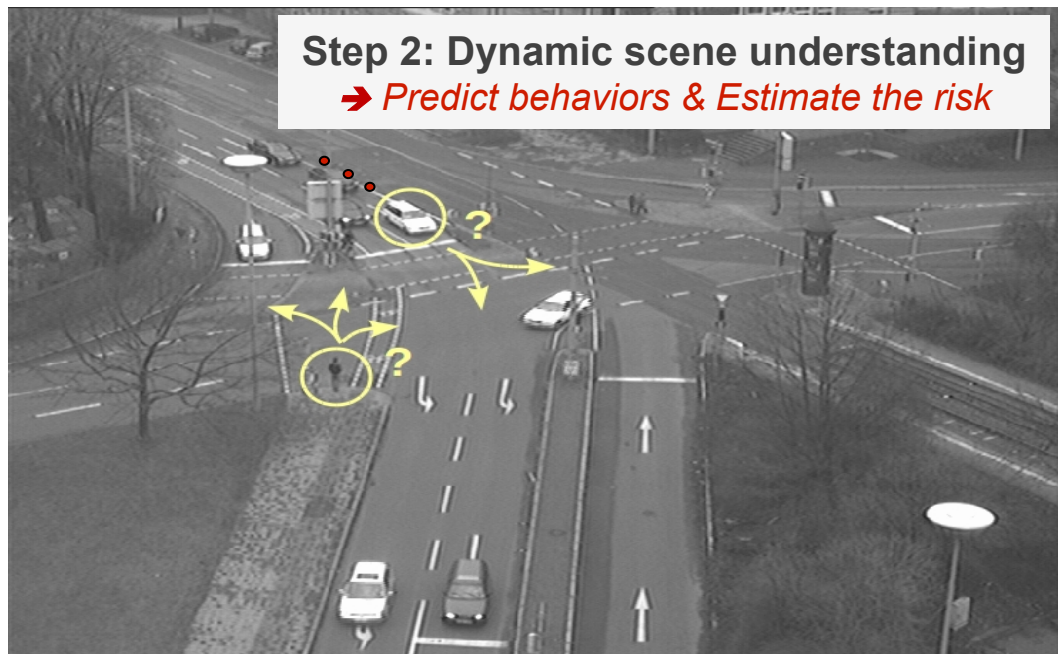
Interpret

Objective: *Understand the content of the Dynamic Scene using Contextual & Semantic knowledge*



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Interpret

- **Main Difficulty**

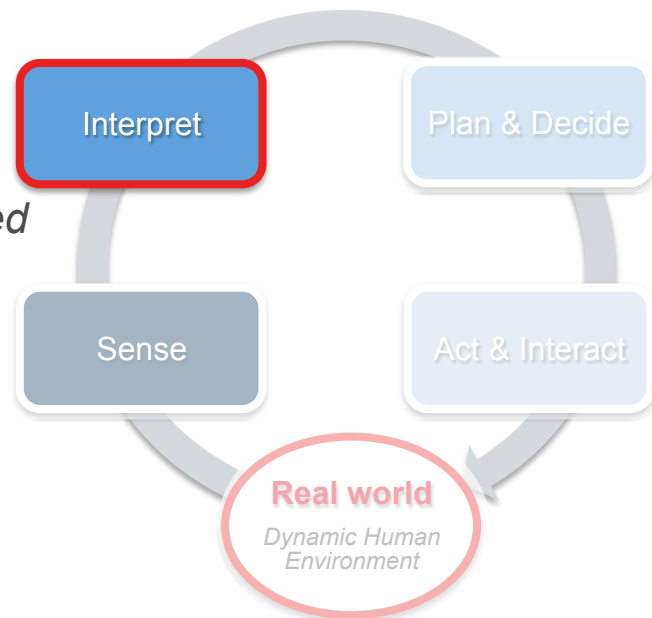
- ✓ *Uncertainty & Huge volume of sensory data to be processed*
- ✓ *Real-time processing*
- ✓ *Reasoning about various knowledge: **history, context, semantics, prediction models***

- **Main Functions**

- ✓ *Detection & Tracking of Mobile Objects (DATMO)*
- ✓ *Objects classification (recognition)*
- ✓ *Prediction & Risk Assessment: **avoiding future collisions***

- **Main Models & Algorithms**

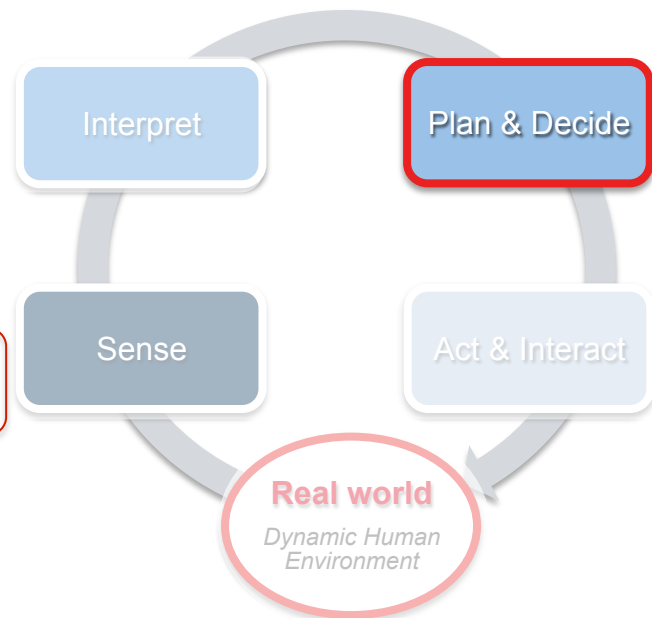
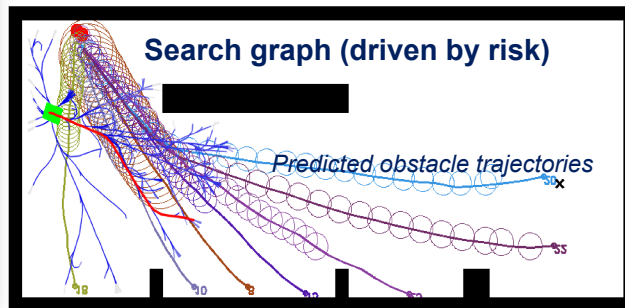
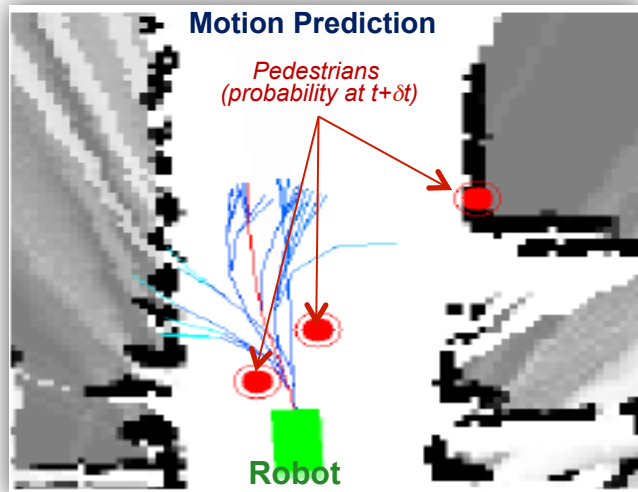
- ✓ *Bayesian Perception Paradigm*
- ✓ *Behaviors modeling & learning*
- ✓ *Bayesian approaches for Prediction & Risk Assessment*



Plan & Decide

Objective: *Planning robot motions & Deciding of the most appropriate action to be executed by the robot (Goal & Context & Risk)*

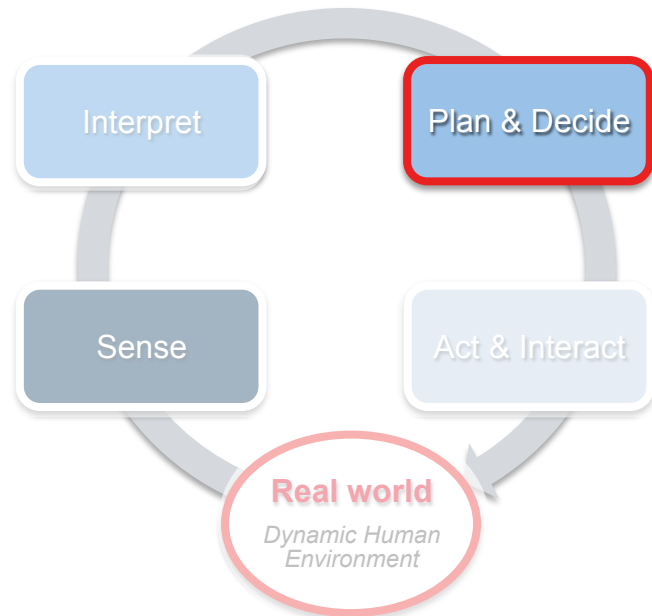
Step1
Iterative Motion Planning under Time & Risk constraints



Plan & Decide

Objective: *Planning robot motions & Deciding of the most appropriate action to be executed by the robot (Goal & Context & Risk)*

Step 2
Decision making driven by Context & Collision Risk



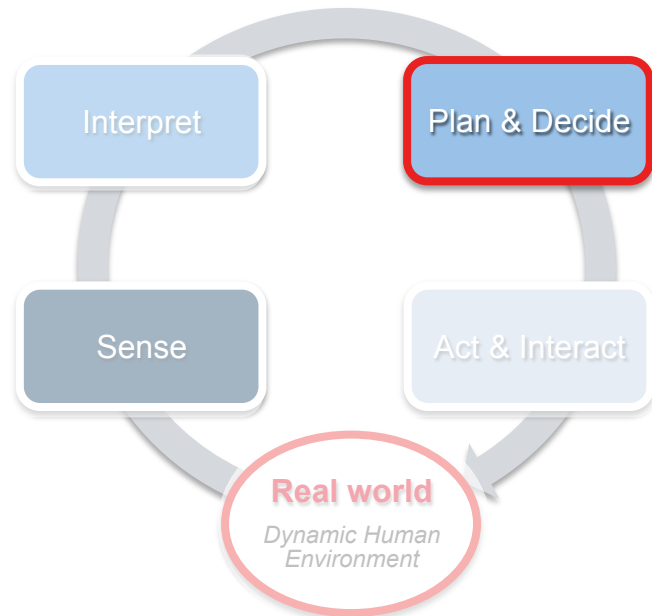
Plan & Decide

- **Main Difficulty & Functions**

- ✓ *On-line Motion Planning under various constraints: time, kinematic, dynamic, uncertainty, collision risk, social*
- ✓ *Decision making under uncertainty using contextual data: history, semantics, prediction*

- **Main Models & Algorithms**

- ✓ *Iterative Risk-based Motion Planning: e.g. Risk-RRT*
- ✓ *Decision making using Contextual data & Bayesian networks*

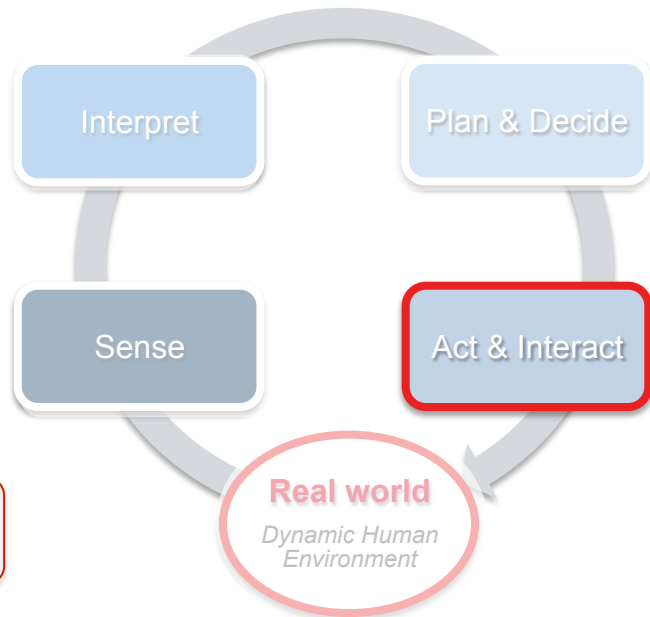


Act & Interact

Objective: *Controlling the robot for executing **Safe & Socially Acceptable** robot actions, while taking into account the related **Human – Robot Interactions***

Step 1

Autonomous Safe Navigation (adapted to Task & Context)



Act & Interact

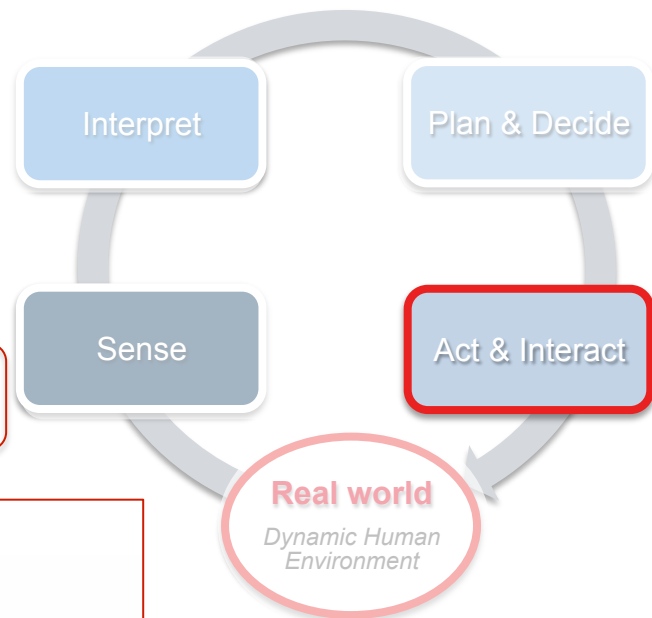
Objective: *Controlling the robot for executing **Safe & Socially Acceptable** robot actions, while taking into account the related **Human – Robot Interactions***

Step 2

Autonomous Navigation under Safety & Social constraints



**Navigation autonome en
environnement humain**



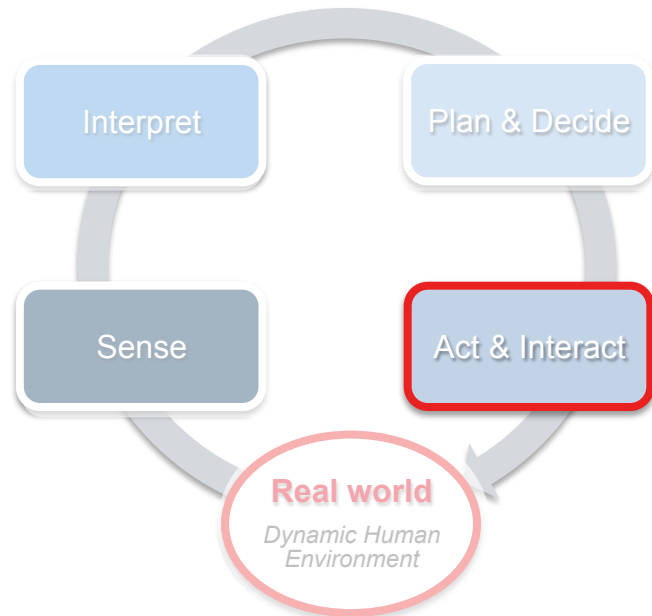
Act & Interact

- **Main Difficulty & Functions**

- ✓ *Robot navigation while taking into account both Safety & Social constraints*
- ✓ *Human in the loop !*

- **Main Models & Algorithms**

- ✓ *Human-Aware Navigation paradigm: **safety & social filters***
- ✓ *Intuitive Human-Robot Interaction*



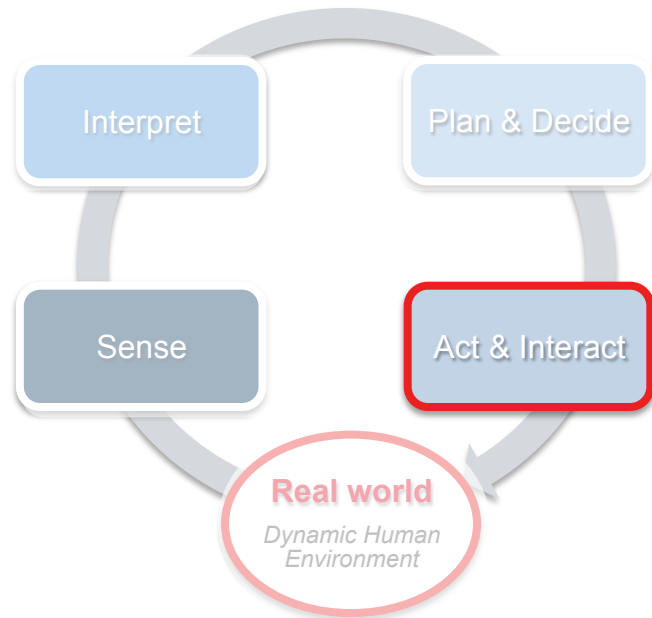
Act & Interact

- **Main Difficulty & Functions**

- ✓ *Robot navigation while taking into account both Safety & Social constraints*
- ✓ *Human in the loop !*

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- ✓ *Human-Aware Navigation paradigm: **safety & social filters***
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Pictures & Movies

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