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 ?

Real world

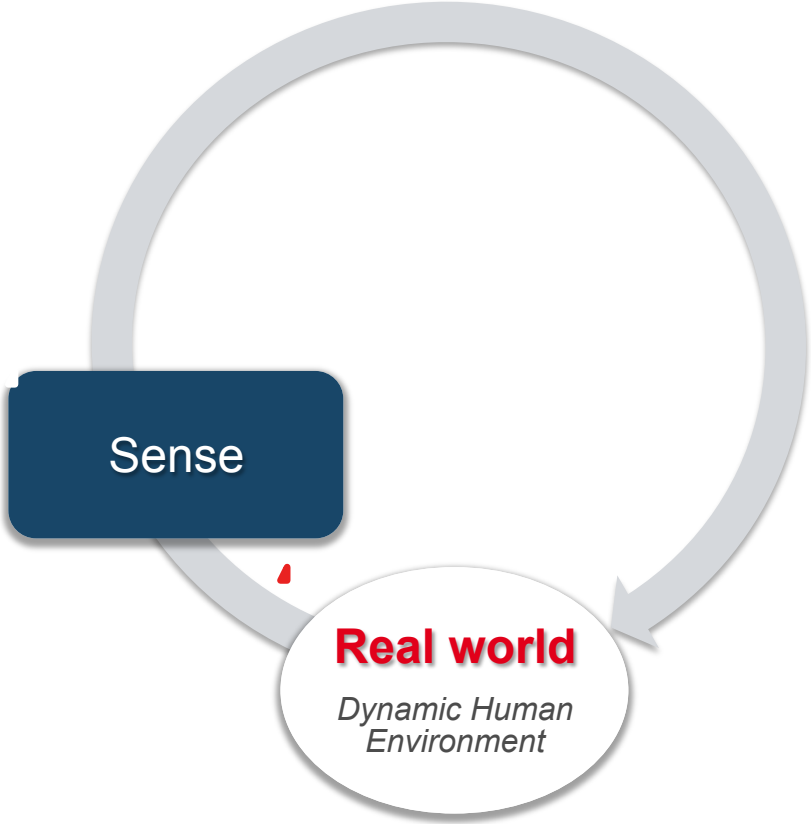
Dynamic Human Environment

Appropriate Decisional & Control Architecture

➔ *Combining & Adapting four interdependent functions*

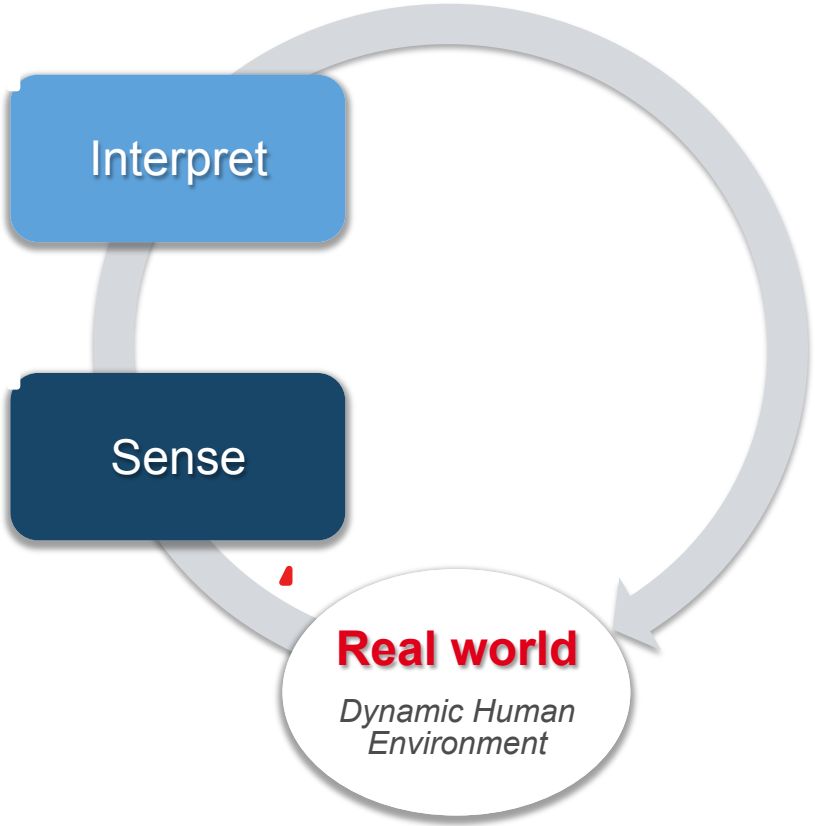
(Sensing , Interpreting, Deciding, Acting)

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



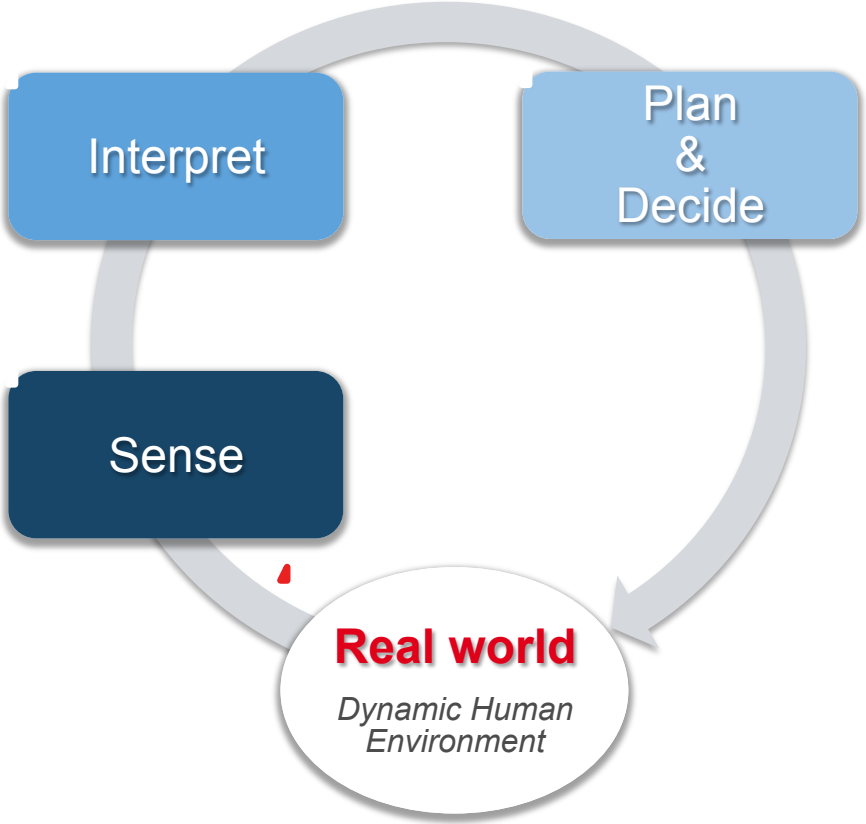
Sensing the environment using various sensors

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



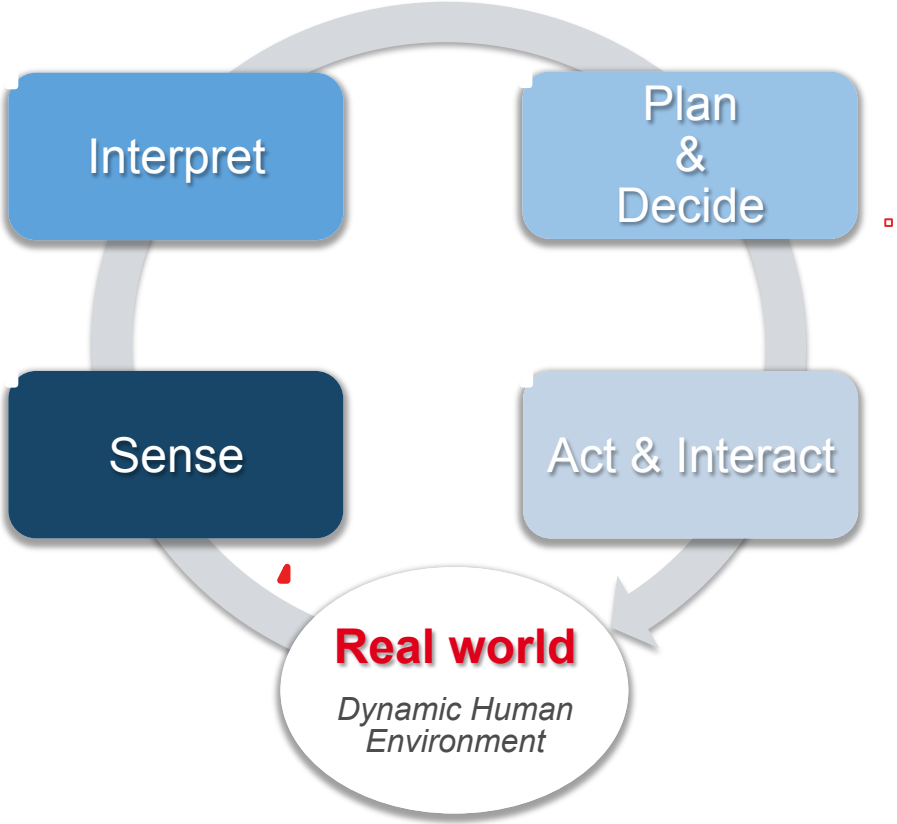
Interpreting the dynamic scene using context & semantics

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)

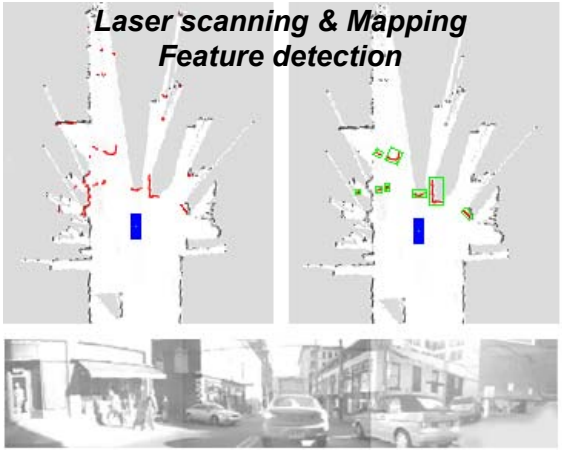
How to control Robot actions in a Dynamic world populated by Human Beings ?

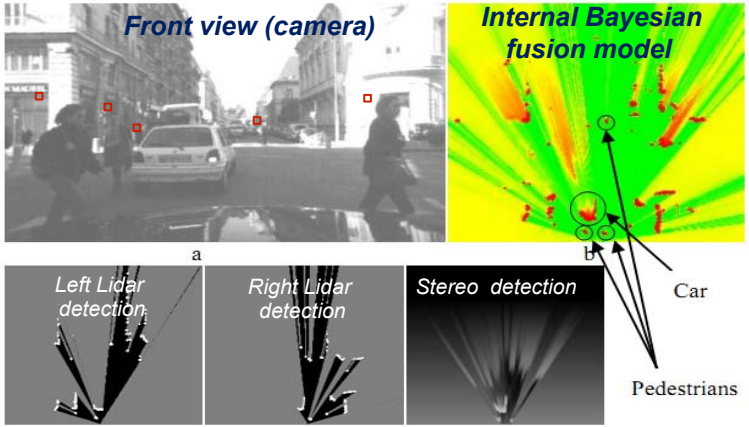


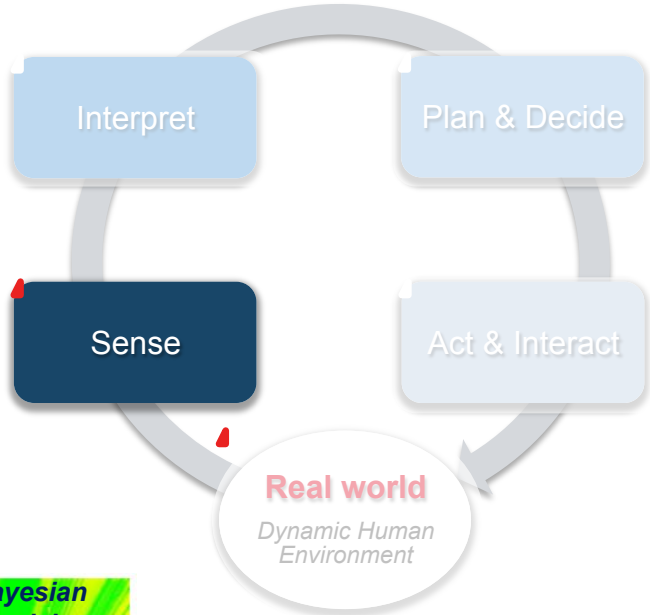
Acting & Interacting
in the Real world
(Safety & Acceptability)

Sense

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

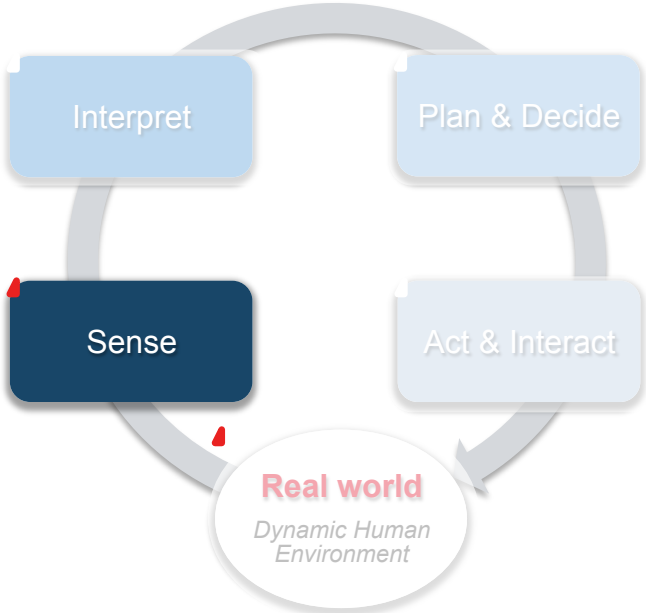






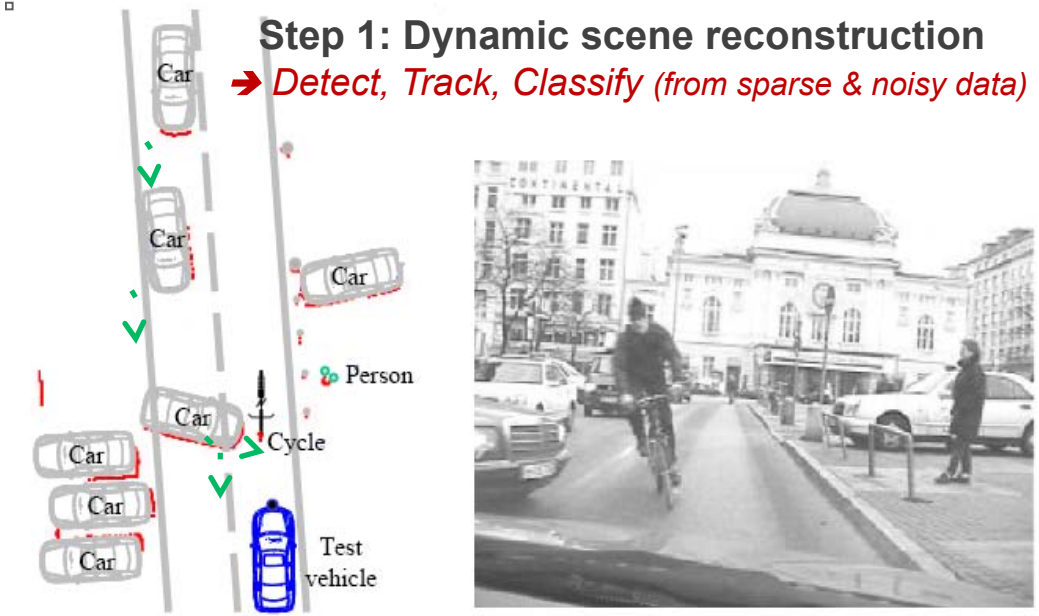
Sense

- **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*



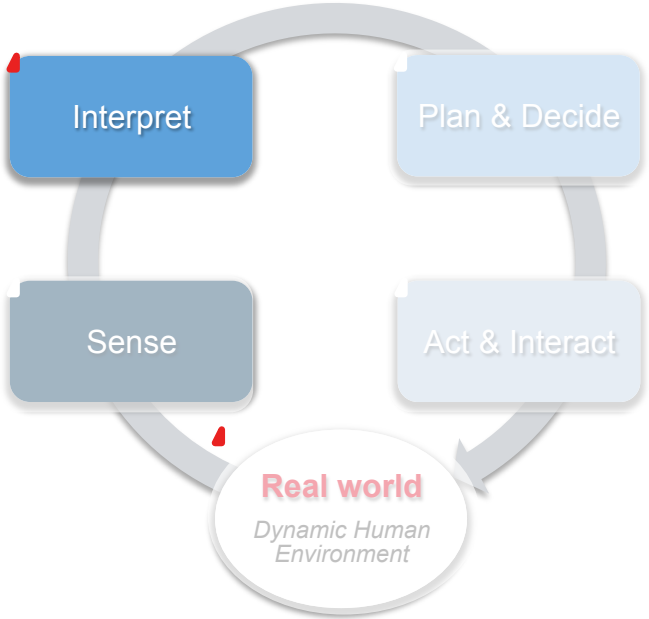
Interpret

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



Step 1: Dynamic scene reconstruction

➔ *Detect, Track, Classify (from sparse & noisy data)*



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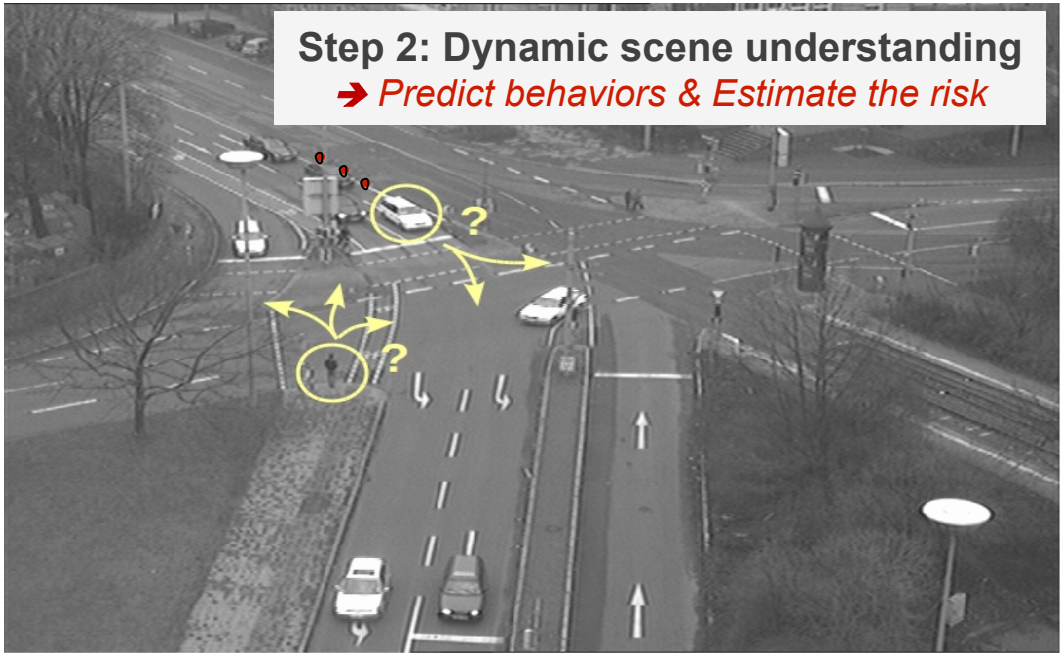
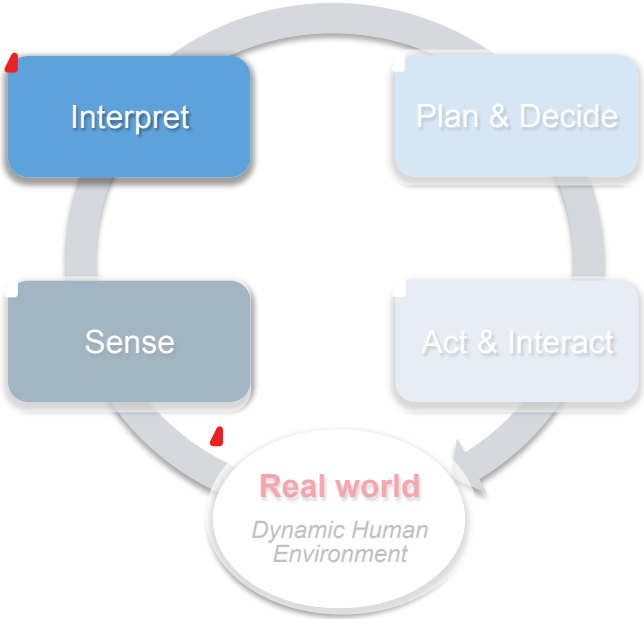
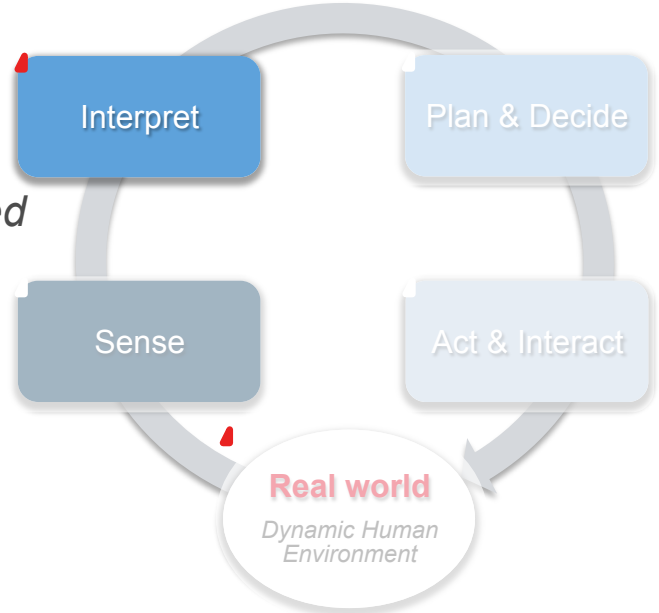




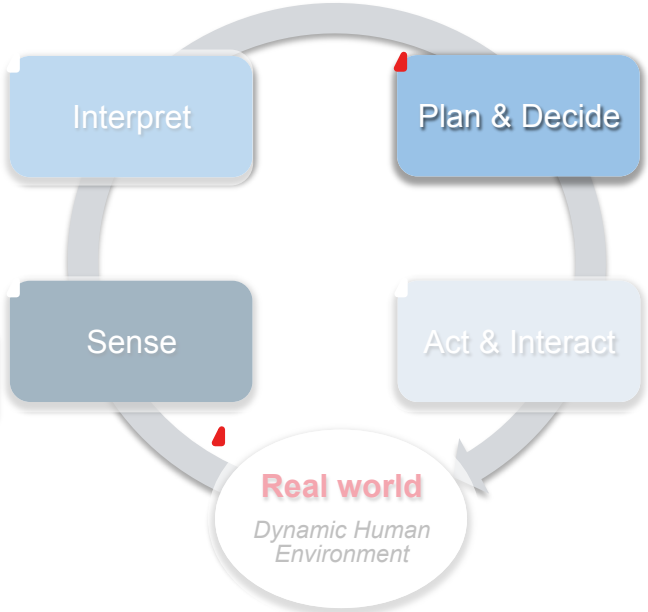
Interpret

- **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*

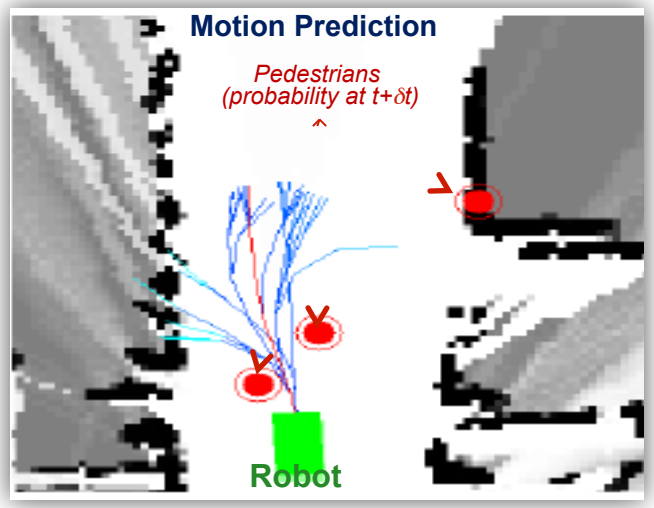


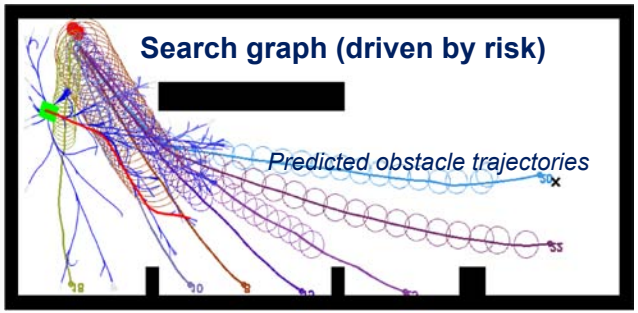
Plan & Decide

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





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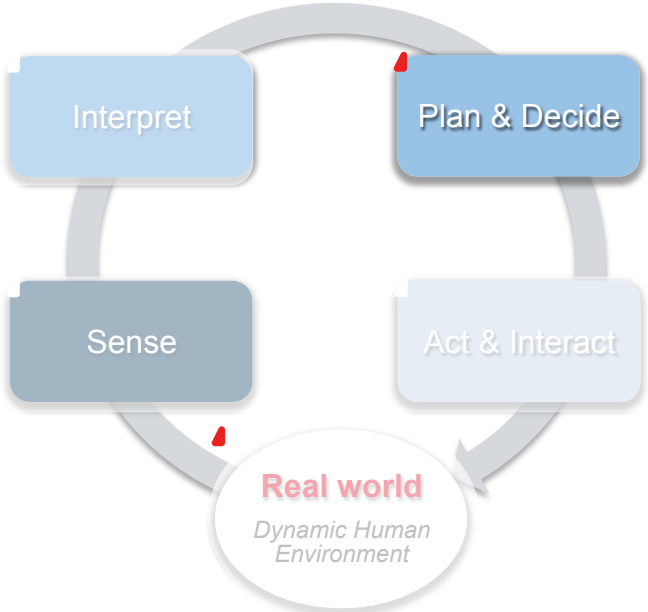
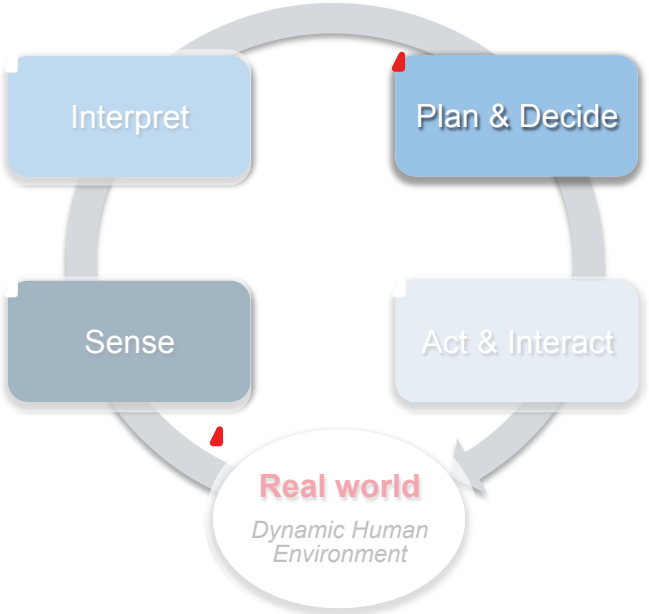


Step 2
Decision making driven by Context & Collision Risk

Plan & Decide

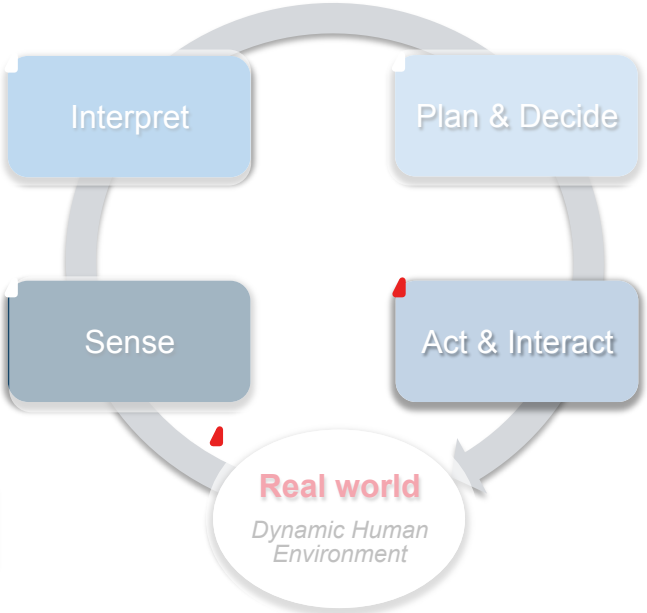
- **Main Difficulty & Functions**
  - ✓ *On-line Motion Planning under various constraints: time, kinematic, dynamic, uncertainty, collision risk, social*
  - ✓ *Decision making under uncertainty using contextual data: history, semantics, prediction*

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



Act & Interact

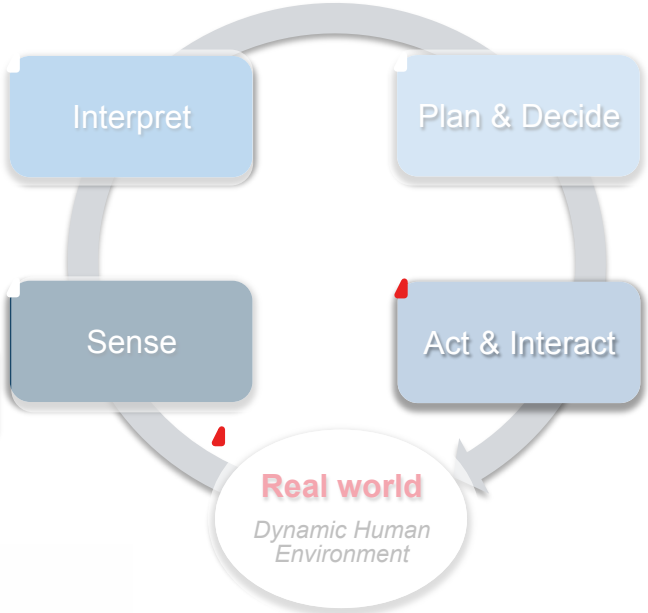
Objective: *Controlling the robot for executing **Safe & Socially Acceptable** robot actions, while taking into account the related **Human – Robot Interactions***



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***



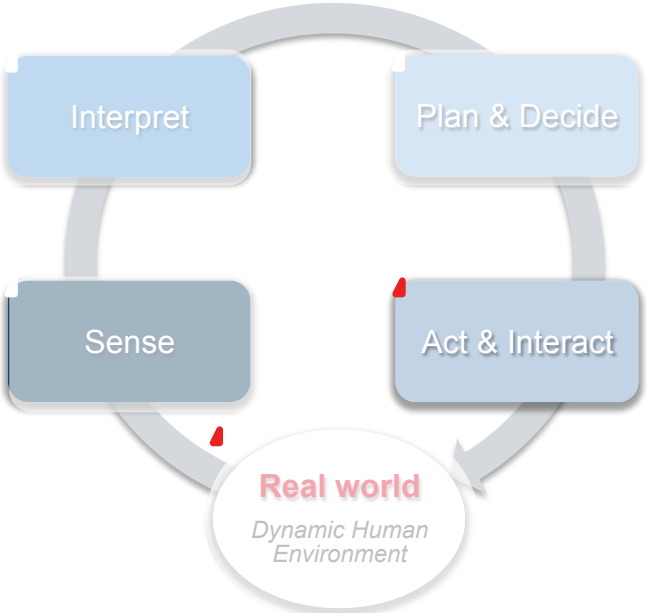
Step 2
Autonomous Navigation under Safety & Social constraints

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

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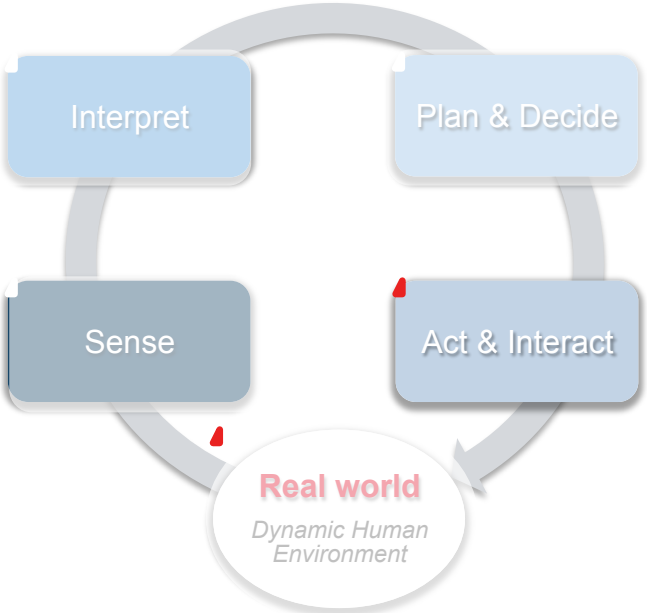

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