



# APM(Robot)

## Towards a platform for meta-reasoning in robotic applications

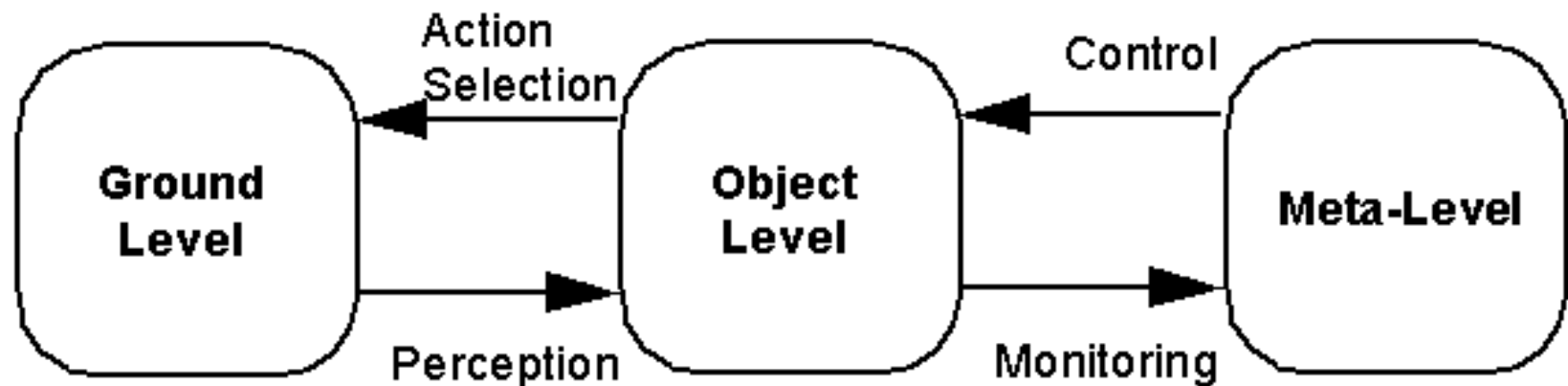
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# APM(Robot): Towards a platform for meta-reasoning in robotic applications

## Introduction:

- We want to integrate several technics in robotics
- We need a middleware between robots
- We want to manage the operations in the robots
- We need knowledge about these operations
  - We need Meta-Reasoning on robots modules (Pitrat 90)
  - One program with different behaviors depending on the robot configuration



Doing

Reasoning

Metareasoning

# APM(Robot): Towards a platform for meta-reasoning in robotic applications

## Plan:

- 1) **APM: An Agent Platform for Meta-reasoning**
- 2) APM(Robot): Instance of APM for robotic applications

## Key Points:

An agent oriented platform  
Abstract communication concepts  
Abstract memory management concepts  
Meta reasoning

# 1) An Agent Platform for Meta-reasoning

## An agent platform

### Why:

- We need a middleware
- Reuse of our platform for several applications:
  - Robots
  - ORB
  - Simulation
- We want to separate behavior and execution

### How:

- We use agent concepts:
  - Communication
  - Memory management

# 1) An Agent Platform for Meta-reasoning

## **A platform based on abstract communication concepts**

### Why:

- Communication for adaptation
- Communication autonomy for our agents
- Genericity of information exchanged between agents

### How:

- Contacts information as meta-data on system entities
- Physical Links
- Communication manager
- Communication languages

# 1) An Agent Platform for Meta-reasoning

## A platform based on abstract communication concepts

### How:

- Contacts
  - Represents an entity and the different ways to send messages to it
  - Noury Bouraqadi Agent
    - *Mail: bouraqadi@ensm-douai.fr*
    - *Tel: 06xxxxxxx*
- Physical Links
  - More general than OSI physical and data link layers
  - *Ex: IP, Socket, bus I2C, Bluetooth, Mail, HTTP*
- Duality between synchronous and asynchronous communication:
  - Synchronous: Telephone
  - Asynchronous: Mail

# 1) An Agent Platform for Meta-reasoning

## **A platform based on abstract communication concepts**

How:

- Communication manager
  - Outbox
    - Automatic selection of physical links
    - Sending strategies
  - Inbox
    - Messages storage
    - Dispatcher module

# 1) An Agent Platform for Meta-reasoning

## A platform based on abstract communication concepts

### How:

- Communication languages based on: (Ferdinand de Saussure 1916)
  - Messages:
    - Signifiant (the object)
    - Signifier (the way to represent it)
  - Marshallers:
    - Implement different ways to serialize/deserialize a message on a physical link
    - Can be chained



# 1) An Agent Platform for Meta-reasoning

**A platform based on  
abstract memory management concepts**

Why:

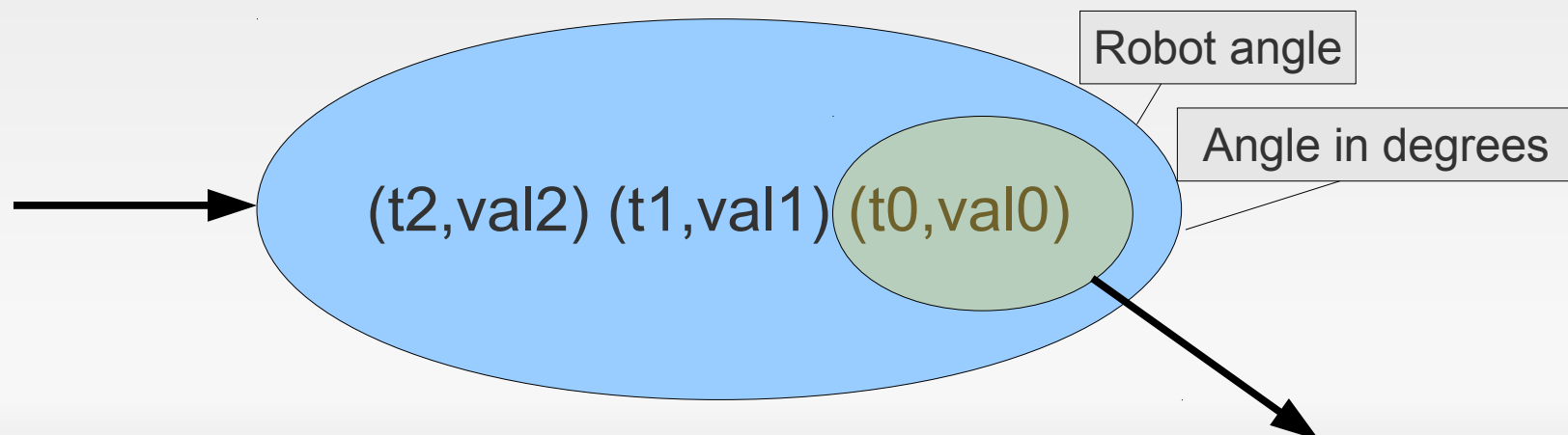
- A proactive use of knowledge
- Independence of information and their usage

# 1) An Agent Platform for Meta-reasoning

## A platform based on abstract memory management concepts

### How:

- Data history
  - Timed tagged data
  - Attached meta-data
  - Policy to delete outdated values



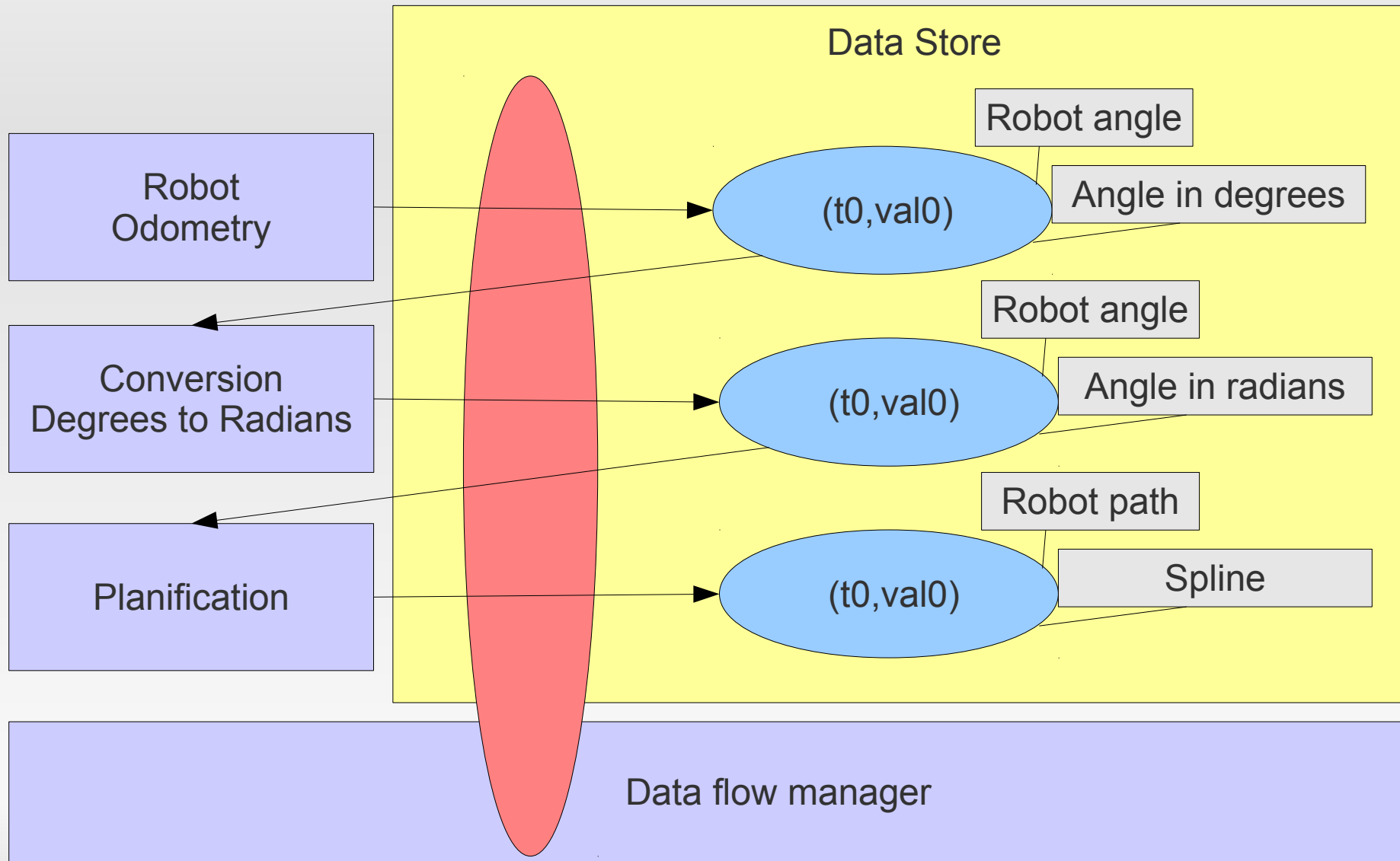
# 1) An Agent Platform for Meta-reasoning

## A platform based on abstract memory management concepts

### How:

- Data store
  - An “intelligent module” that manages data histories
  - Producer/Consumer and event based models
    - Events on data or types of data
      - value added, value deleted, meta-data added, meta-data deleted*
- Data processing modules
  - Data flow generated by events
  - Modules can manage data flows (Meta Modules)

# 1) An Agent Platform for Meta-reasoning



# 1) An Agent Platform for Meta-reasoning

## Abstract meta-reasoning capabilities

### Why:

- An entity aware of its knowledge and its skills
- An entity able to modify its functions

### How:

- Meta-data on modules
- Meta-data on information → Data histories

# 1) An Agent Platform for Meta-reasoning

## Summary:

- APM provides abstract concepts for:
  - Communication
  - Memory management
  - Meta-data and meta-reasoning
- APM is not a complete platform!
- APM is an abstract platform for the design of concrete platforms
- APM helps to create interoperability modules between platforms

# APM(Robot): Towards a platform for meta-reasoning in robotic applications

## Plan:

- 1) APM: An Agent Platform for Meta-reasoning
- 2) **APM(Robot): An APM instance for robotic applications**

## Key Points:

Why meta-reasoning in robotic applications?

Agent vs Object Oriented Platform

Basic modules: *Sensors manager, Localization, Planning*  
Environment representation

## 2) APM(Robot): An APM instance for robotic applications

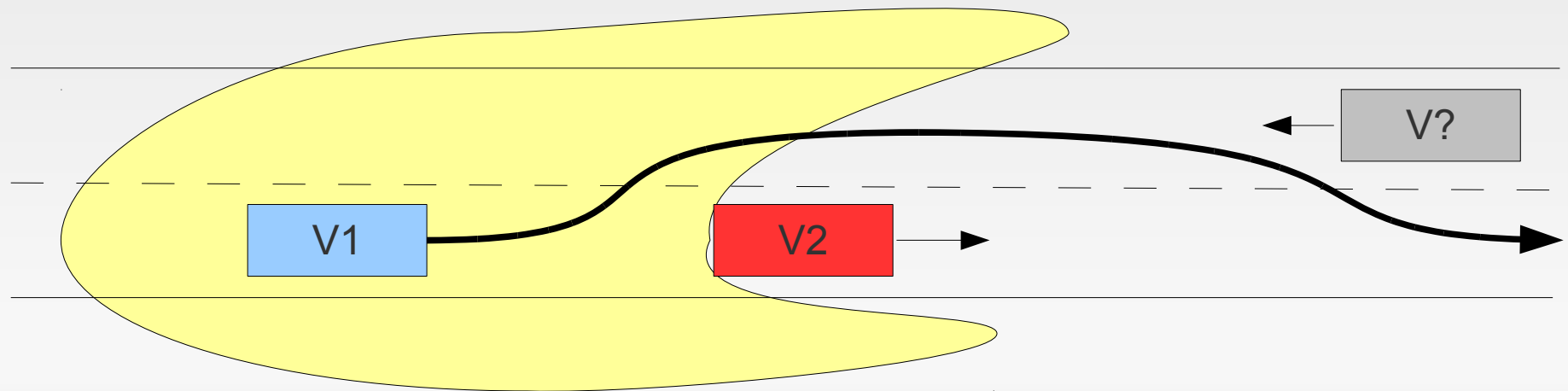
### Why meta-reasoning in robotic applications ?

We want to solve this kind of problem

- Limited perception radius
- Limited motion abilities

We want to reason on

- Sensors
- The way to plan motion



Overtaking problem



## 2) APM(Robot): An APM instance for robotic applications

### Agent vs Object Oriented Platform

- Object oriented platform: genericity for execution  
→ we mask robot operations
- Agent oriented platform: genericity for robot operations management  
→ we want to know how the robot works

Existing platforms:

- Player Stage: genericity on control and sensors
- Urbi: parallel control of sensors/controllers
- Robot Operating System: Meta on operating system, hardware abstraction and distributed execution of familiar modules in robotics

## 2) APM(Robot): An APM instance for robotic applications

### Agent vs Object Oriented Platform

- A robot application should:
  - discover its own software modules**
  - discover its own hardware**
  - weave its behavior thanks to these modules**

## 2) APM(Robot): An APM instance for robotic applications

### Sensors manager

- Description of each sensor connected to the robot
- Generated data put into data store with attached meta-data
- Events on these data for attached modules

### Localization

- Two main approaches:
  - Chained data fusion
  - Integrated data fusion (Kalman,Particles) → more Efficient
- Adaptation of sensors operations in order to improve efficiency of localization

## 2) APM(Robot): An APM instance for robotic applications

### Planning

#### Why:

- Complexity of interactions between planning levels:  
*Goal Planning, Path Planning, Motion planning*
- Heterogeneous technics and problem representations
- We want a robot able to adapt its planning strategies to the situation

#### How:

- Meta-reasoning on:
  - Inputs, outputs and inner parameters of planning algorithms  
Ex: Discrete/Continuous data shared between path and motion planning  
Meaning of a point in a discrete path  
as an input for motion planning?

## 2) APM(Robot): An APM instance for robotic applications

### Abstract concepts for environment representation

#### Why:

- Several representations for each modules
- No generic representation adapted for each needs
- Adaptation to simulation or real execution

#### How:

- Several models of the environment
  - Continuous, discrete,...
- Several views for the same entity
  - Geometrical shape, picture, ...
  - Versatile layer-based GUI
- Incoherent representations are supported

# APM(Robot) : Towards a platform for meta-reasoning in robotic applications

## Conclusion

- APM provides abstract agent concepts for meta-reasoning:
  - Communication and Memory management
- APM(Robot) instantiates APM concepts in robotics context
- APM(Robot) can be used for:
  - Design, simulation and analysis of robotic algorithms
  - Execution on real robots

## Perspectives:

- First meta-reasoning:
  - Getting unknown information on the environment...
  - ... to improve robot motion planning