

# DALI for Cognitive Robotics: Principles and Prototype Implementation

*Giovanni De Gasperis*

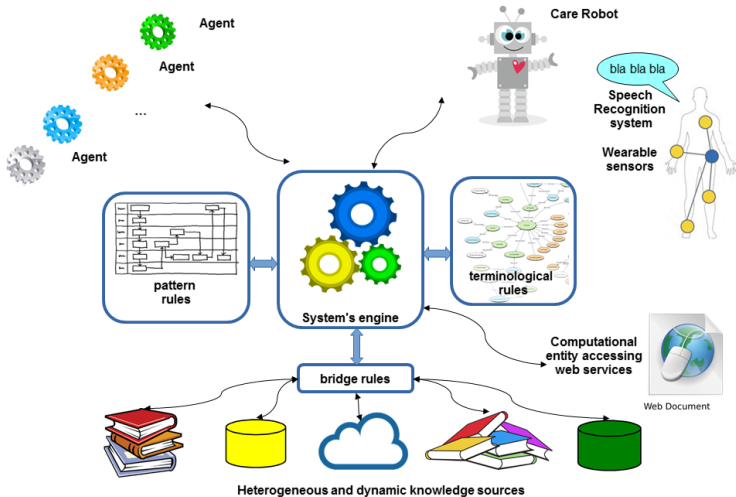
University of L'Aquila, Italy

RuleML Webinar, 24 February 2017



# Big Picture: Smart Cyber-Physical Systems

## Envisaged Smart Healthcare Architecture



# Cognitive Robotics

Quoting from <http://www.ieee-ras.org/cognitive-robotics>

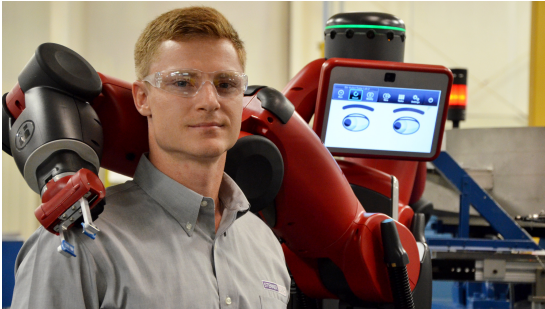
## Definition

*" There is growing need for robots that can **interact safely with people** in everyday situations. These robots have to be able to **anticipate the effects of their own actions** as well as the actions and needs of the people around them. To achieve this, two streams of research need to merge, one concerned with physical systems specifically designed to **interact with unconstrained environments** and another focusing on control architectures that explicitly take into account the need to **acquire and use experience.** "*



# Co-Bots: collaborative robots

a robot intended to physically interact with humans in a shared workspace.

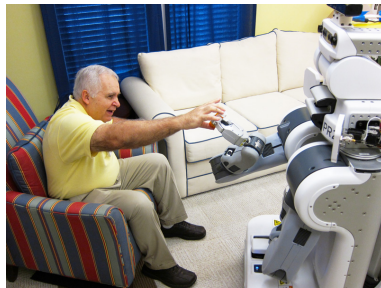


*Courtesy of respective photo authors*



# Care Robots

robots specialized to assist humans at home



*Courtesy of respective photo authors*



# Big Picture: Care Robots

- ▶ Interesting ongoing work, e.g., by the group of Prof. Johan Hoorn at Vrije Universiteit Amsterdam about social robotics.
- ▶ Concerns not only Artificial Intelligence aspects, but also the impact of robots on the user from the point of view of ethics, interaction with the disabled and even acceptable robot appearance.
- ▶ Robots still not fully autonomous, work to do for AI.
- ▶ Some of this work is reported in a famous documentary “Alice cares”: [▶ View](#)



# Robot's Brain: Intelligent Software Agents

- ▶ Advantageous to define a robot's cognitive part as an agent or Multi-Agent System (MAS) defined via declarative agent-oriented languages.
- ▶ Robot's tasks: user observation, monitoring and training.
  - ▶ the robot should be equipped with a basic user profile defining the user's needs, habits, and preferences;
  - ▶ the robot should reactively cope with situations;
  - ▶ the robot should proactively take care of the user.
- ▶ Some candidate logic-based languages and frameworks: MetateM, 3APL, GOAL, AgentSpeak, Impact, KGP and DALI.

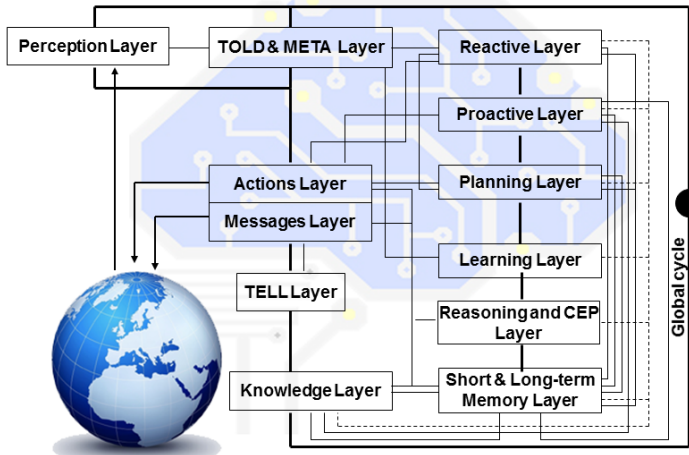


# DALI

Invented and Developed at the University of L'Aquila, available on [GitHub](#)

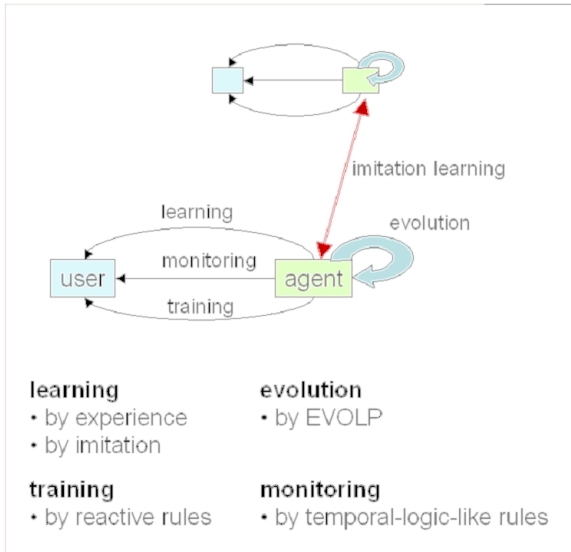
## A Layered Model of DALI

DALI prolog-based agent-oriented language and architecture





# DALI for Care Robots



# DALI for Care Robots: Examples

User Profile Available and Updated

Constraint: warning user and/or alerting caregivers

*NEVER drink\_alchool AND take\_medicine.*

Care module: reaction, (ranked) preferences

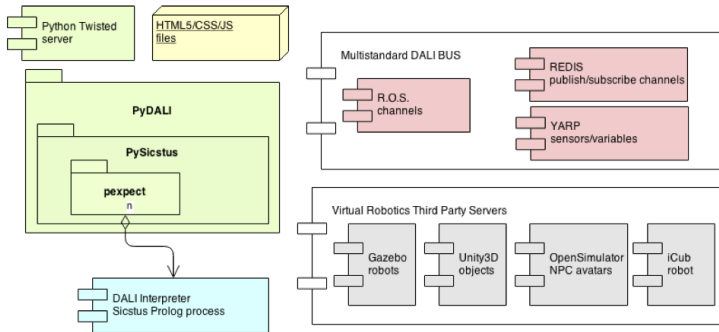
*hungry\_userE :>*

*{provide\_foodA(F) : food(F), available\_food(F) :  
best\_preferred, healthier}.*



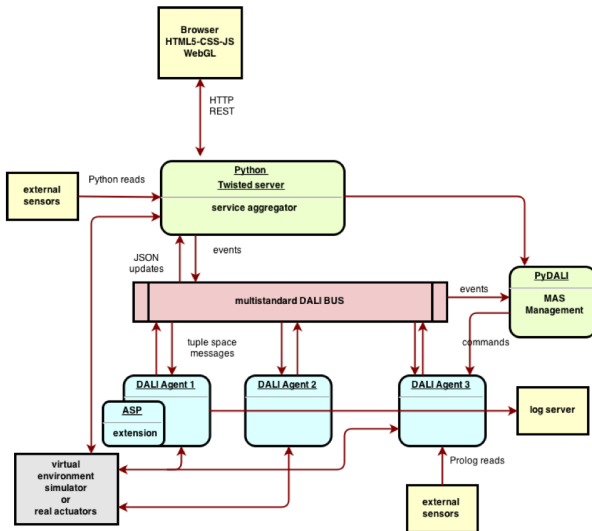
# Improving the DALI Implementation

## Software components of the extended DALI



# Improving the DALI Implementation

## Runtime deployment of the extended DALI architecture



# Improving the DALI Implementation

## Robotic plugin

We consider (New with respect to the paper) both

- ▶ Virtual Robotic platforms and
- ▶ Real Robots



# DALI on top of a virtual robot

## Robotic plugin

In a virtual robotic simulator (V-REP) the robot is guided by subsumption architecture of behaviors:

- ▶ low level reaction behavior for collision avoidance (V-REP LUA)
- ▶ middle layer computer vision behavior for target searching (V-REP-LUA)
- ▶ top layer cognitive reasoner and commander (Prolog)
- ▶ glue code for messaging and integration (Python)



# DALI on top of a REAL robot

## Robotic plugin

In a real robotic setup with ROS (Robotic Operative System) the robot is guided by subsumption architecture of behaviors:

- ▶ low level reaction behavior for collision avoidance (C)
- ▶ middle layer computer vision behavior for target searching (Python+OpenCV)
- ▶ top layer cognitive reasoner and commander (DALI with LINDA tuple space)
- ▶ glue code for messaging and integration (Python with ROS)



# DALI on top of a REAL robot

Robotic hardware setup - work in progress

Robotic platform: Turtle Bot 2



- ▶ Kobuki motorized platform
- ▶ RaspberryPI 3 with WiFi
- ▶ Asus depth stereo camera

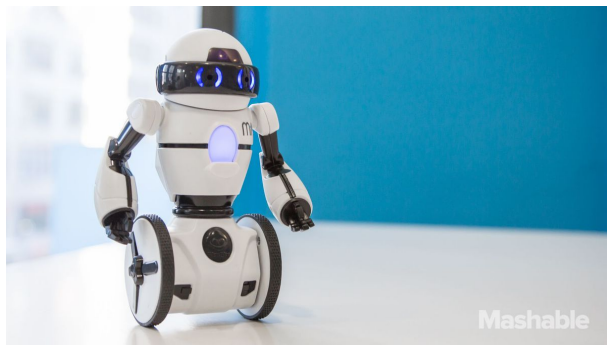




# Movie time!

student's robotics projects

- ▶ learn how to deal with stochastic sensors and actuators
- ▶ introduce computer vision in the loop



# Cheers from "Intelligent Systems and Robotics Laboratory"

@DISIM-UnivAQ



THANK YOU!

<mailto:giovanni.degasperis@univaq.it>

