HUMAN-ROBOT INTERACTION

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ABOUT ME

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http://www.dibris.unige.it/en/bruno-barbara

PhD in Robotics in 2015 from the University of Genoa
Background in Robotics Engineering and Computer Engineering
Post-doc researcher at the University of Genoa, dept. DIBRIS with teaching and research responsibilities.

Passionate fan of many sports, including football, so please please please do not mention the World Cup Qualifiers.

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GENOA & THE UNIVERSITY

3

EMARO+ & ROBOTICS ENGINEERING

European Master on Advanced RObotics

Double Master Degree action within the EU Educational Project ERASMUS+

4 European Institutions

7 associated academic and industrial partners in Japan, China, France, Spain and Italy

http://emaro.irccyn.ec-nantes.fr/

4

HUMANS AND ROBOTS (ONE END)

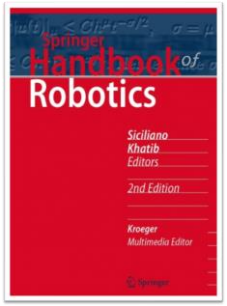
Recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL))

Published in 2016

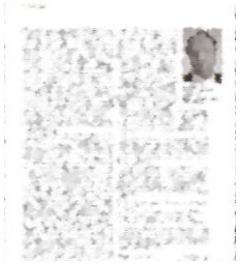
HUMANS AND ROBOTS (THE OTHER END)

SICILIANO, Bruno; KHATIB, Oussama (ed.). *Springer handbook of robotics*. Springer, 2016.

Published in 2016



HUMANS AND ROBOTS (THE OTHER END)



As you study this volume and look for places to contribute to research through your own talents and hard work I want to alert you to capabilities or aspirations that I believe will make robots even more useful, more productive, and more accepted. I describe these capabilities in terms of the age at which a child has equivalent capabilities:

- The object-recognition capabilities of a child
- The language capabilities of a
- The manual dexterity of a
- The social understanding of a

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- The object-recognition capabilities of a 2-year-old child
- The language capabilities of a 4-year-old child
- The manual dexterity of a 6-year-old child
- The social understanding of an 8-year-old child.

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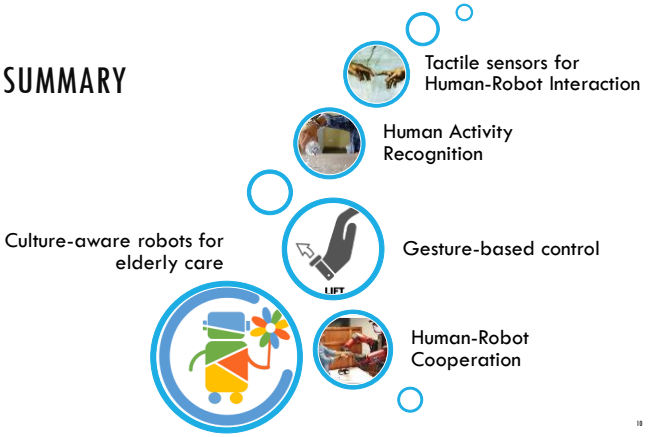
SUMMARY



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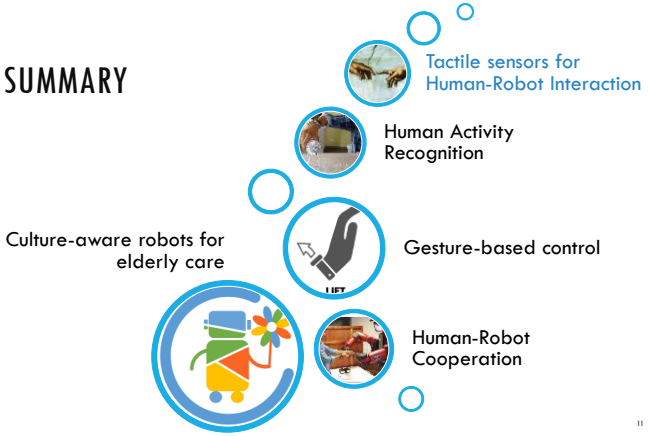

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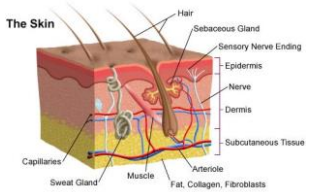
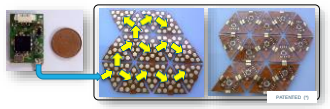
TACTILE SENSORS





Large area tactile sensors

- embedded electronics
- deformable/conformable
- "simple"/cheap to build
- "simple"/cheap to repair/replace
- modular/scalable

12

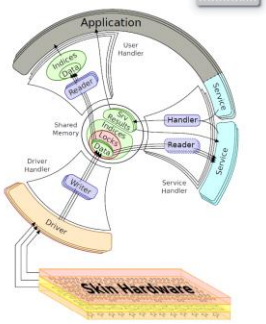
REAL-TIME MIDDLEWARE FOR TACTILE DATA PROCESSING

Skinware works in R/T (RTAI OS)

Locks used for data coherency and synchronization

Data indexes are used (as in databases) to organize (e.g. in abstract groups) and access data

Drivers available for different busses (CAN, EtherCAT, Ethernet)



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ROBOSKIN & BEYOND

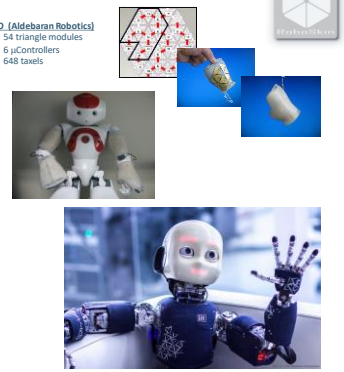
http://www.cyskin.com/

CySkin:
Demo on a Schunk Manipulator

MACLAB - University of Genoa - Italy

CySkin

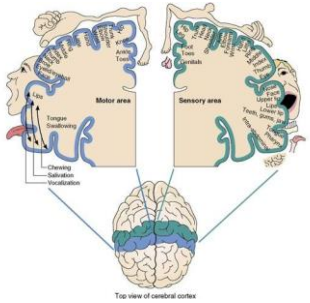
NAO (Aldebaran Robotics)
- 54 triangle modules
- 6 µControllers
- 648 taxels



14

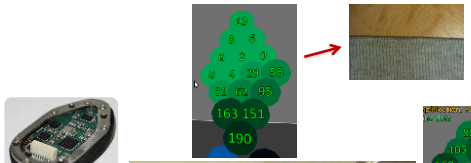
TOUCH-BASED SENSING

Dynamic Distributed Synchronization of Neural Oscillators for Tactile Perception



15

EXAMPLES: TACTILE BASED COGNITIVE TASKS



98%+ classification accuracy
(30+ fabric types)

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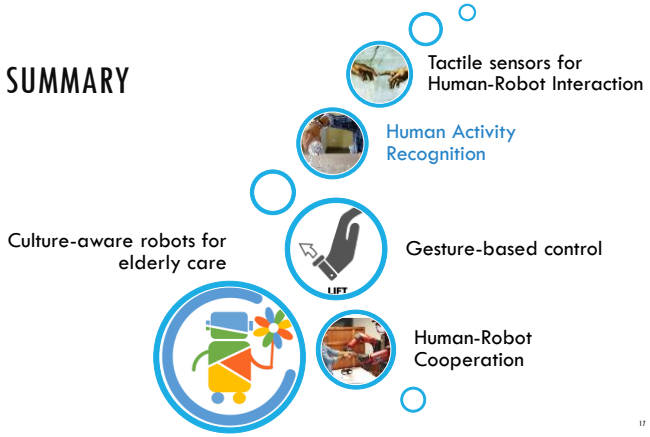
SUMMARY



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HUMAN ACTIVITY RECOGNITION

Human Activity Recognition with Wearable Devices

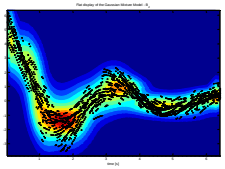
Using Fuzzy Logic to Enhance Classification of Human Motion Primitives

Human Activity Recognition with Vision

Robots for activity recognition through Cloud-based services for semantic tagging of images.

clarifai

Microsoft Cognitive Services



Modelling acceleration patterns based on wearable sensors for the real-time recognition of motion primitives.

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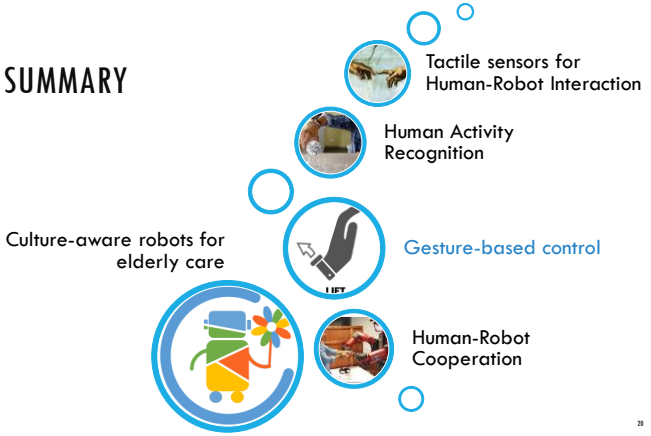
SUMMARY



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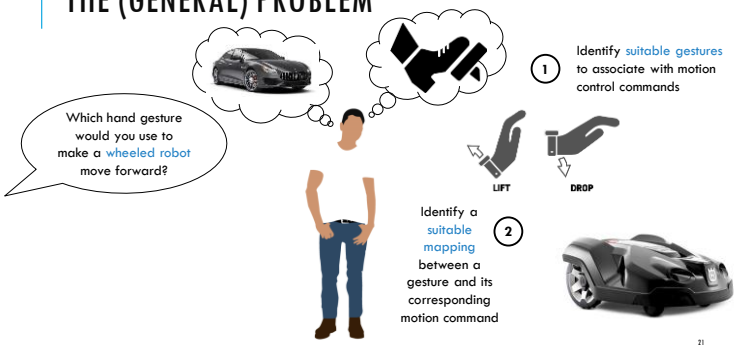
THE (GENERAL) PROBLEM



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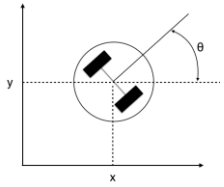
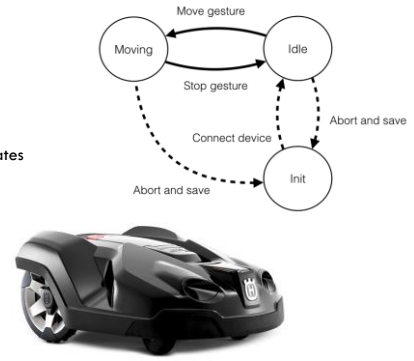
THE (ACTUAL) PROBLEM

R1 Full control of HRP robot motions

R2 Full control of HRP robot functional states





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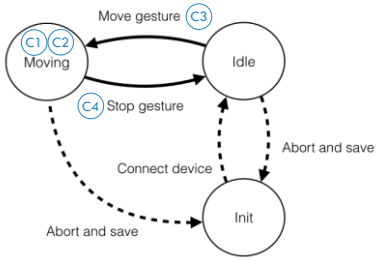
GESTURES IDENTIFICATION

C1 Driving velocity

C2 Angular velocity

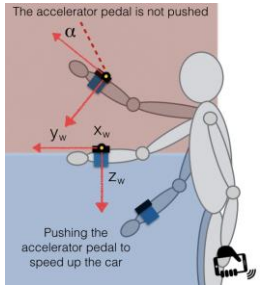
C3 Transition from idle to moving

C4 Transition from moving to idle



23

DRIVING VELOCITY GESTURE



$$v_1 = \begin{cases} 0, & \text{if} \quad \omega_x - \alpha \leq 0 \\ (\omega_x - \alpha)/s_x, & \text{if} \quad \omega_x - \alpha > 0 \end{cases}$$

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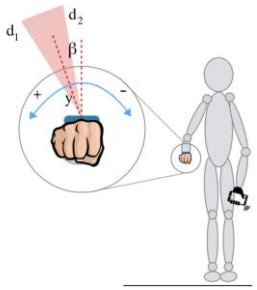
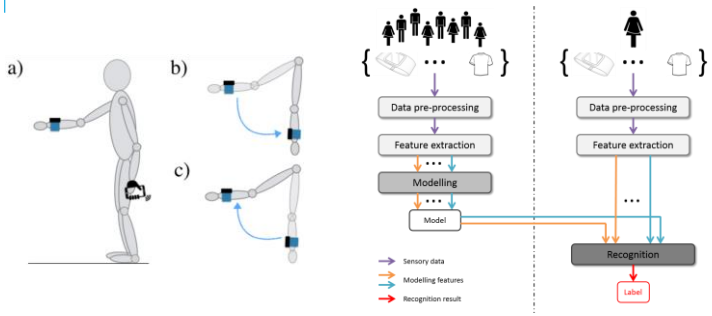
ANGULAR VELOCITY GESTURE



$$v_2 = \begin{cases} 0 & \text{if} \quad d_1 \geq \omega_y - \beta \geq d_2 \\ (\omega_y - \beta)/s_y & \text{if} \quad d_1 \leq \omega_y - \beta \leq d_2 \end{cases}$$

25

IDLE-TO-MOVE TRANSITION



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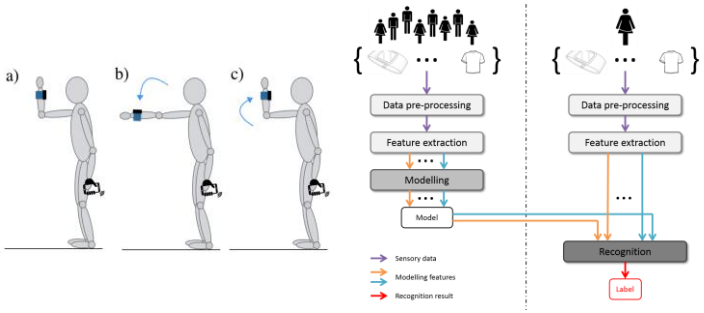
MOVE-TO-IDLE TRANSITION



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EXPERIMENTAL EVALUATION

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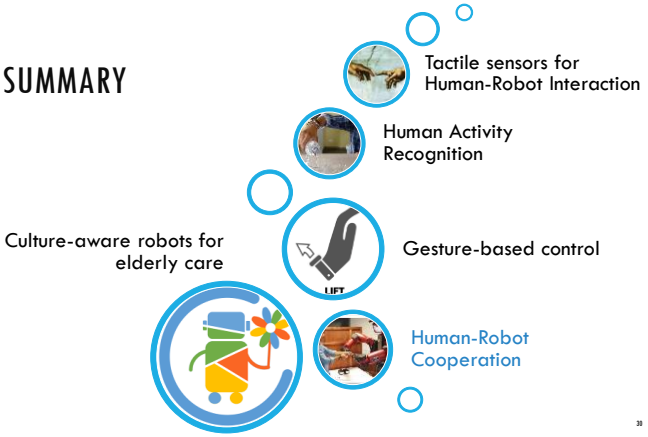
Gesture-based control of the Husqvarna HRP

1) fixed point of view

SUMMARY



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GESTURE-BASED INTERACTION

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AND-OR GRAPHS FOR HUMAN-ROBOT COOPERATION

Motivations

HRC assumes a well-defined task to carry out, with (predictable) variations

A robot must adapt to a human co-worker activities but assure that the cooperation goal is achieved

Research objectives

The robot should recognize human motions/gestures in real-time

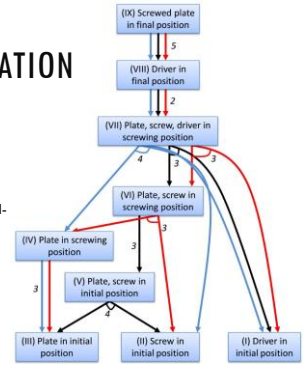
The robot should be equipped with a hybrid reactive/deliberative robot sensing and control framework

Methodology

Wearable sensors and GMM+GMR for human motion modeling and classification

AND/OR graphs for HRC modeling

Task priority control for robot motions



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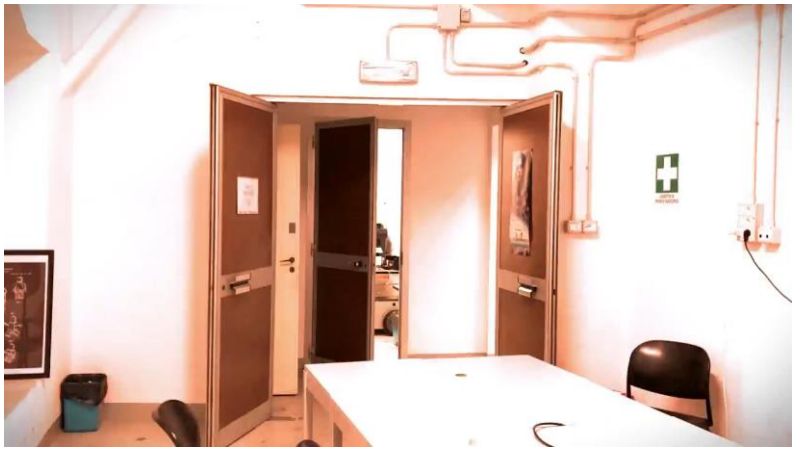

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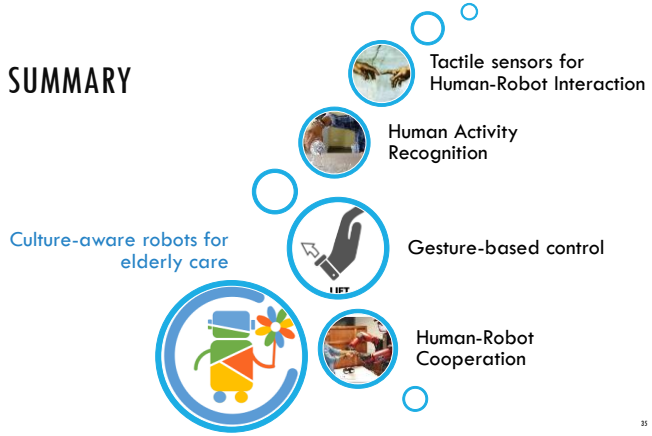

35

THE IDEA

We consider **personal robots** that are physically identical, but we make them **act and communicate** in different ways **to match the culture, customs, and etiquette** of the person they are assisting.

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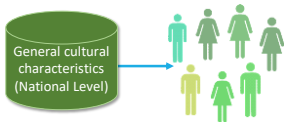

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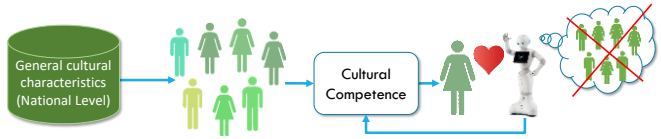

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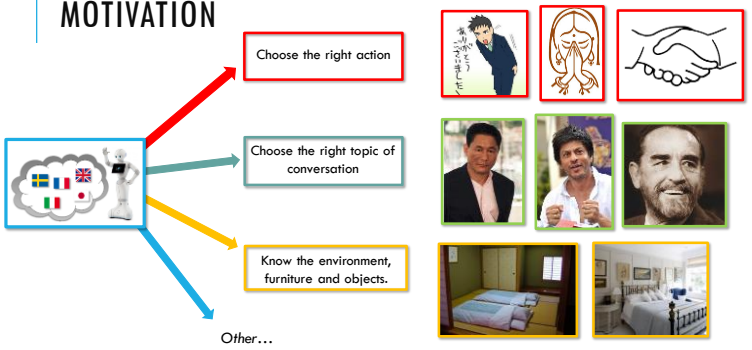
MOTIVATION



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CULTURE AWARENESS

Culture aware Human Activity Recognition

Culture-dependent initialization of interaction parameters

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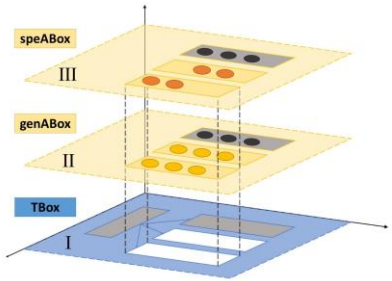
CULTURAL KNOWLEDGE REPRESENTATION



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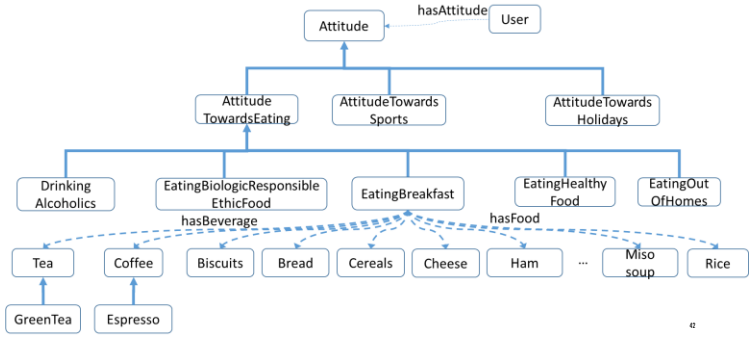

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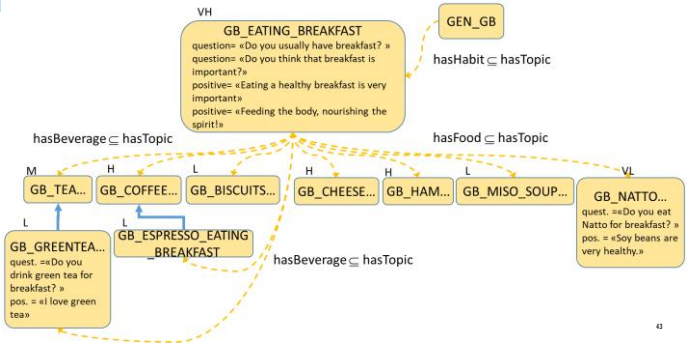
CULTURAL KNOWLEDGE REPRESENTATION



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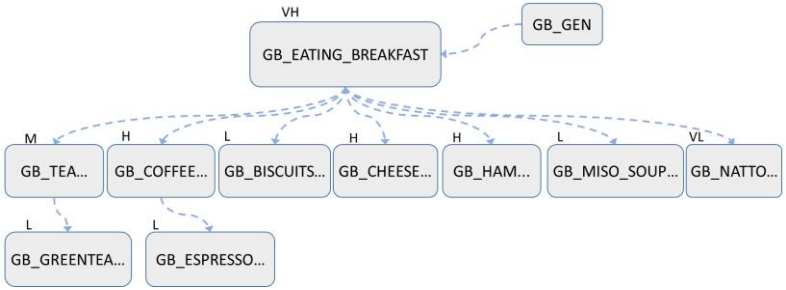
CULTURAL KNOWLEDGE REPRESENTATION



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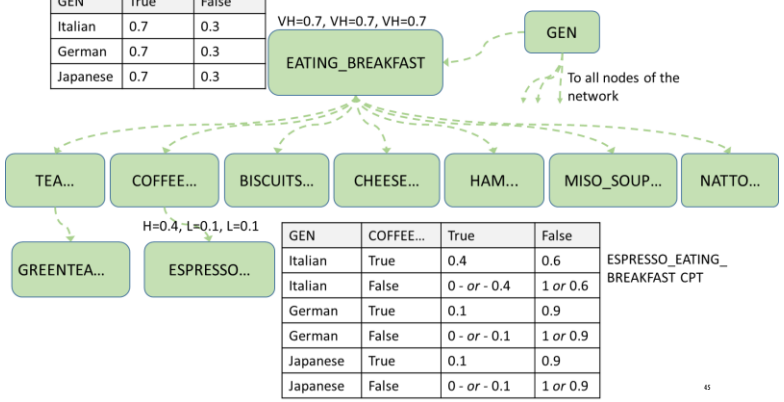
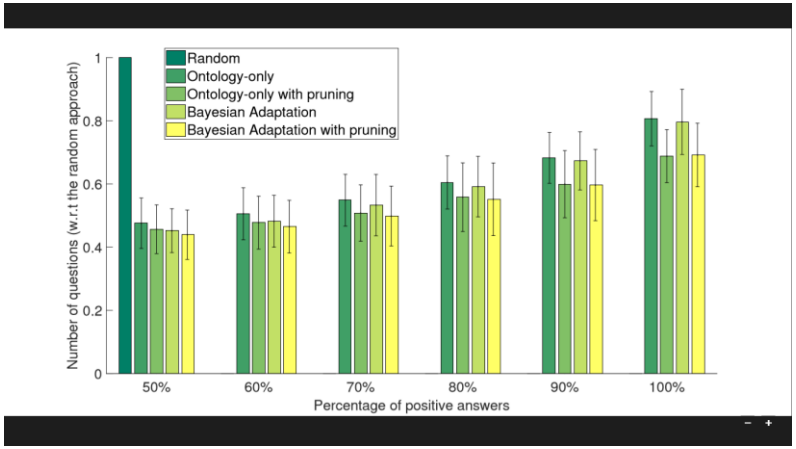
EATING_BREAKFAST CPT

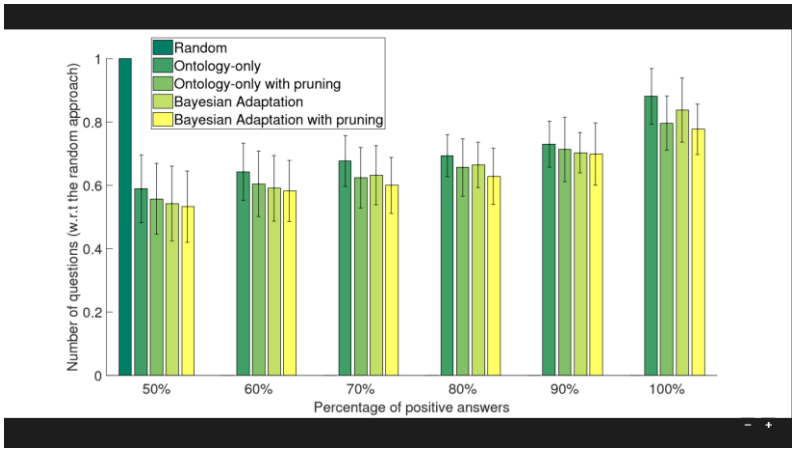
GEN	True	False
Italian	0.7	0.3
German	0.7	0.3
Japanese	0.7	0.3

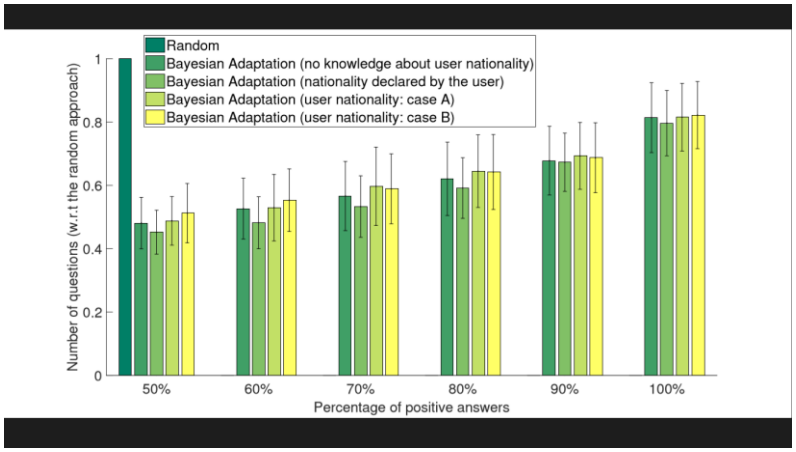


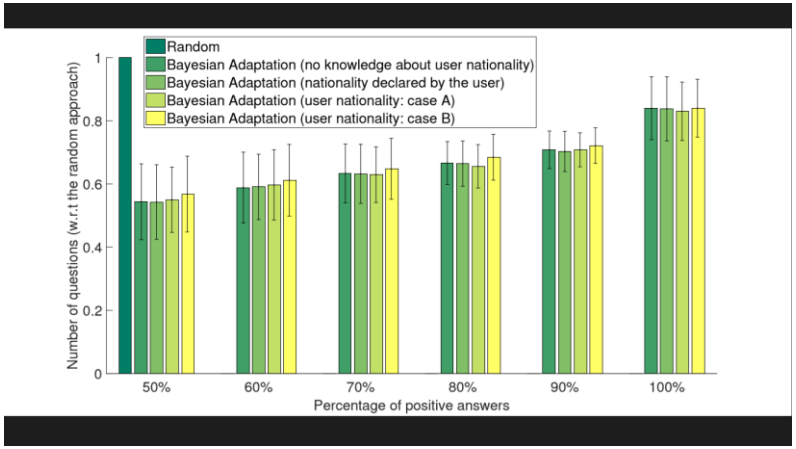
GEN	COFFEE...	True	False
Italian	True	0.4	0.6
Italian	False	0 - *or* - 0.4	1 *or* 0.6
German	True	0.1	0.9
German	False	0 - *or* - 0.1	1 *or* 0.9
Japanese	True	0.1	0.9
Japanese	False	0 - *or* - 0.1	1 *or* 0.9

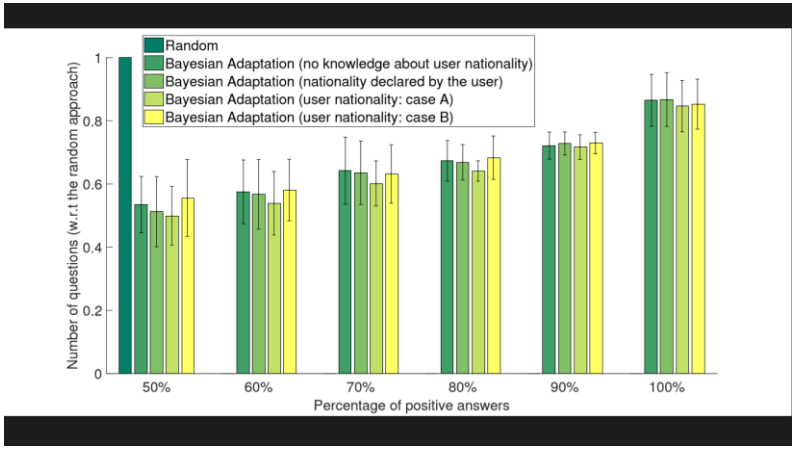
ESPRESSO_EATING_BREAKFAST CPT











THANK YOU!

barbara.bruno@unige.it

… and also thanks to the students and colleagues of the University of Genoa whose work is the reason why I could give this presentation today :-)