

Robotic representation, reasoning and learning

Assignment for ReaRW 2014

Václav Hlaváč

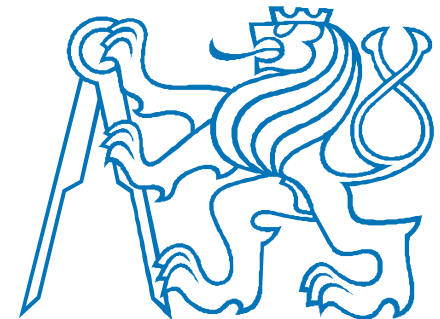
Czech Technical University in Prague

- Faculty of Electrical Engineering
- Czech Institute of Informatics, Robotics
and Cybernetics

Prague, Czech Republic

hlavac@fel.cvut.cz;

<http://cmp.felk.cvut.cz/~hlavac>

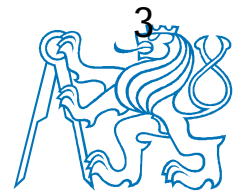


Three EC projects, our motivation



- **NIFTi**, IP, 4 years, finished 2013-12
- TRADR IP, 4 years, takes over since 2013-11
- Both projects led by DFKI Saarbrücken
- Many partners
- **CloPeMa** = Clothes perception and manipulation
- STREP, 2012-02 to 2015-01
- CERTH Thessaloniki, U of Genova, U of Glasgow, CTU Prague, Neovision (integration)

NIFTI practical success



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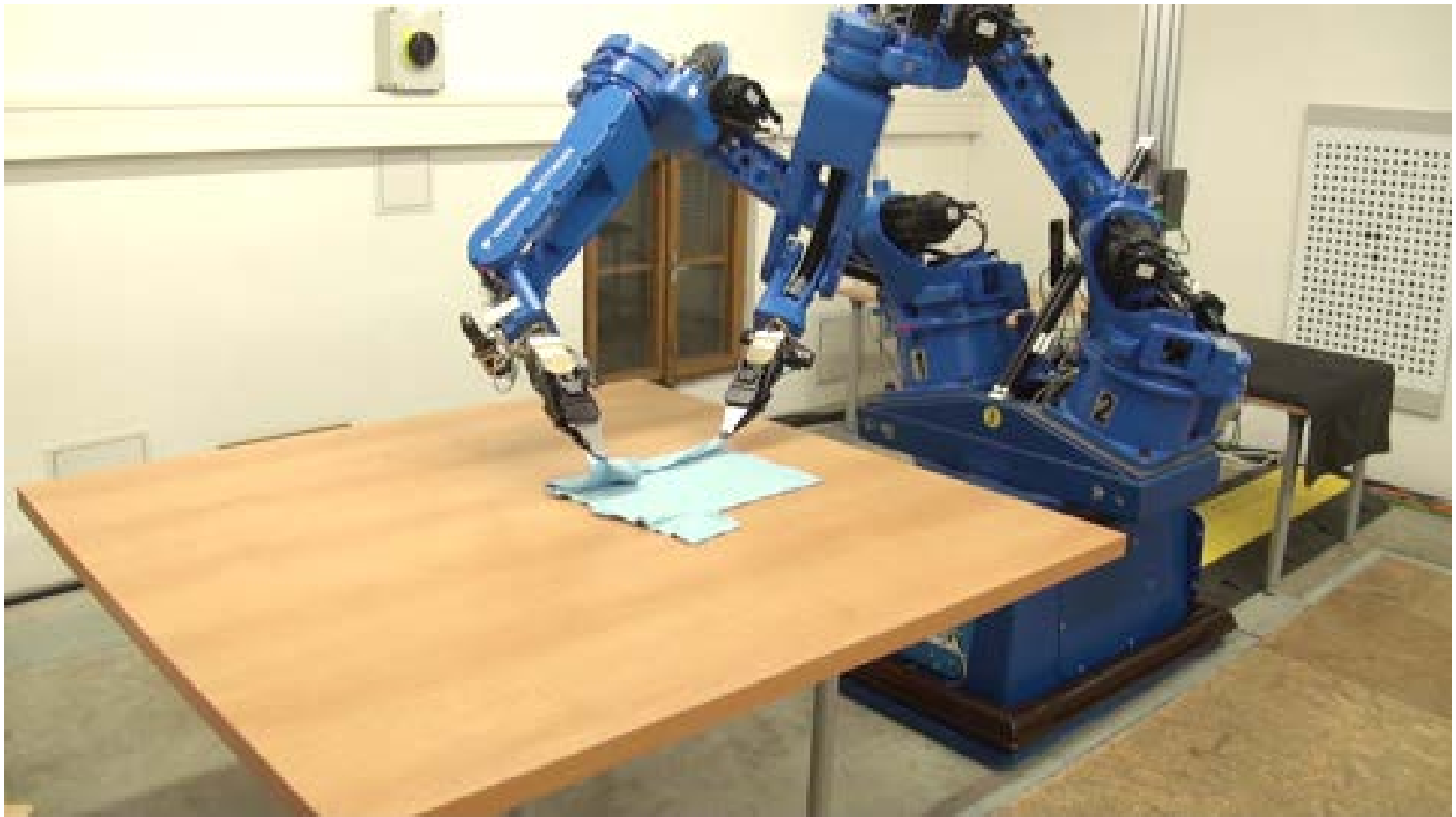
May 20 – June 18, 2012,
Mirandola, Emilia-Romagna region, Italy
246 seismic activities, 3 – 6.1 Richter scale



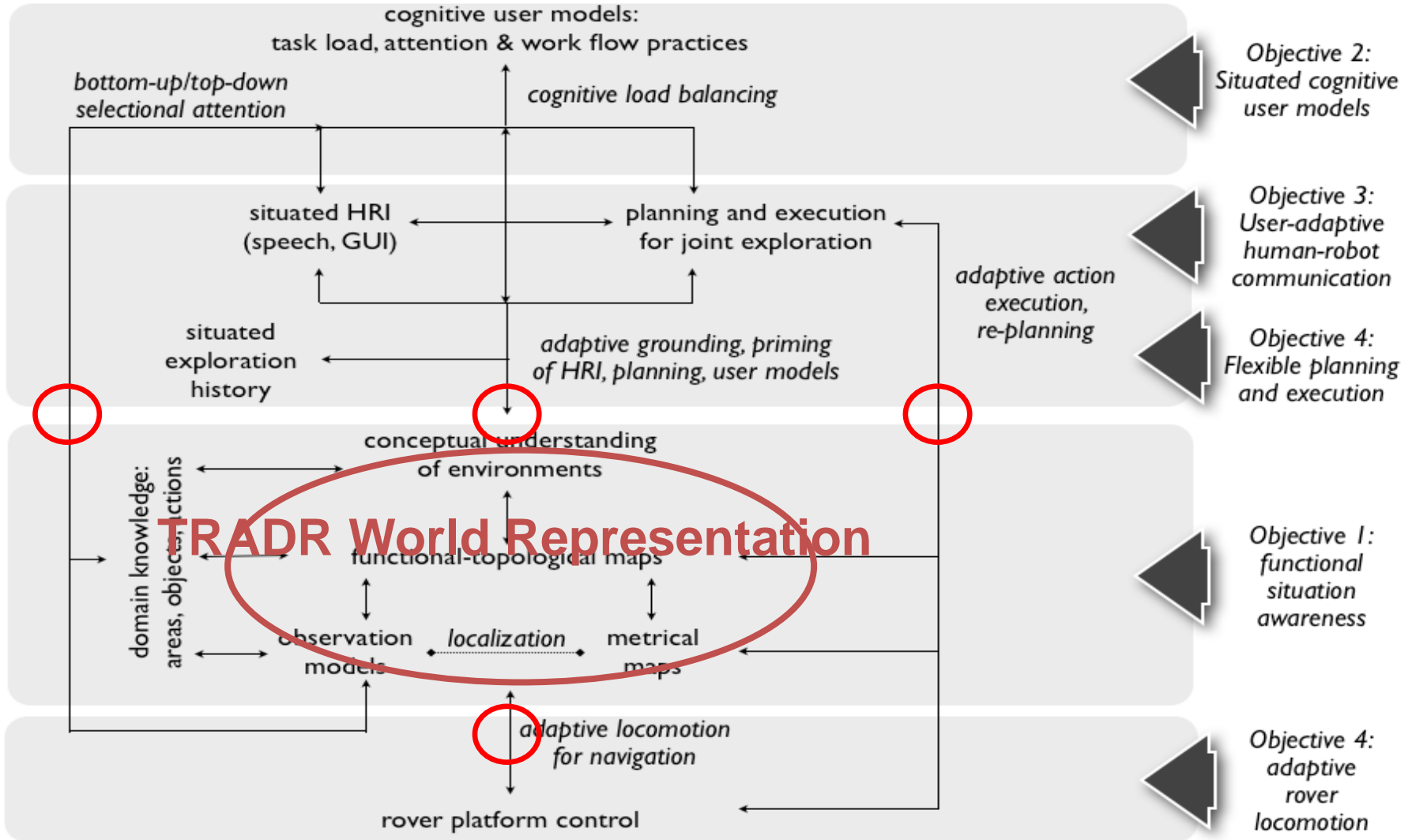
CloPeMa – current abilities



- Maria Petrou's project, the coordinator
- Maria died on Dec 15, 2012 of cancer



NIFTi knowledge architecture



Intelligence needed



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Ability to:

- Represent knowledge, including commonsense knowledge.
- Learn
- Reason, plan
- Sense / act
- Salience – the ability to recognize importance
- Metric map
- Topological map
- Functional map
- Detected object (\approx concepts, primitives, function of objects)
- Graph having objects as graph nodes and their relations as graph edges.
- Action representation

Some philosophy



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Rationalism

- “the criterion of the truth is not sensory but intellectual and deductive”.
- Intelligence stems from (logical) reasoning.
- Many rationalists believe that some part of human knowledge is innate.
- *René Descartes (1596–1650), Baruch Spinoza (1632–1677), Gottfried Leibniz (1646–1716).*

Empiricism

- “An empiricist holds that experience is the source of all human knowledge”
- E.g., all knowledge must be grounded or based in the sensory world.
- *Aristotle (384 BC–322 BC), William of Ockham (1288–1348), Francis Bacon (1561–1626), John Locke (1632–1704), George Berkeley (1685–1753), David Hume (1711–1776), Hermann von Helmholtz (1821–1894), Karl Popper (1902–1994).*

A physical symbol system hypothesis



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Harnad, S. (1990) The Symbol Grounding Problem. Physica D 42: 335-346.

- The rule-governed symbol-token manipulation is based purely on the shape of the symbol tokens (not their “meaning”), i.e., it is purely syntactic.
- There are primitive atomic symbol tokens and composite symbol-token strings.
- The syntax can be systematically assigned a meaning e.g., as standing for objects, as describing states of affairs.
- The symbols in an autonomous hybrid symbolic+sensorimotor system would be grounded. (Importance of the perception action cycle.)

AI issues in robotics



- A state space – a set of possible configurations of a robot, usually a discrete one, e.g. a position on a occupancy grid.
- Representation of a robot environment (a practical implementation of the state space), e.g. the robot world model.
- A reasoning engine – usually some type of symbol manipulation mechanism used for search/planning in a state space.
- Ontology (next slide)

Ontology in computer science



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- *Definition:*
Ontology formally represents knowledge as a set of concepts within a domain, and the relationships between pairs of concepts.
- It can be used to model a domain and support reasoning about entities.
- Ontologies are the structural frameworks for organizing information.
- Serves as the information architecture as a form of knowledge representation about the world or some part of it.
- Used in AI, robotics, semantic web, systems engineering, software engineering, biomedical informatics, library science, enterprise bookmarking,

Czech connections



- **Golem**

Late 16th century,
Prague Rabi Loew
(Judah Loew ben
Bezalel).



- **Robot**

Word invented by
Czech playwright Karel
Čapek (1890-1938)

- **Incompleteness theorem**

Kurt Gödel (1906 in
Brno - 1978)

ReaRW 2014 – The assignment



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- A gap remains between low level percepts, robot control \leftrightarrow high level reasoning.
 - Key issue is scene/knowledge representation.
 - Learning is used only within a module to set parameters, not in the entire system to establish structure qualitatively.
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- **ReaRW aims at telling: what and how an intelligent robot can be built in practice.**