

# Artificial Cognitive Systems

## Module 1: The Nature of Cognition

### Lecture 1: Motivation for studying cognitive systems

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[www.vernon.eu](http://www.vernon.eu)

# Industrial Robots



# Cognitive Robots

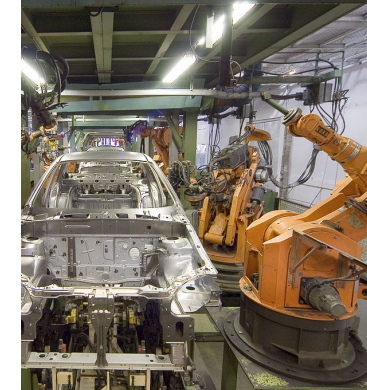


c.f. Maria Petrou's Ironing challenge; see <http://www.commsp.ee.ic.ac.uk/~mcpetrou/iron.html>

# Motivation

- Controlled environment

We know what to expect,  
and can program the robot to  
do what we want



- Complex environment

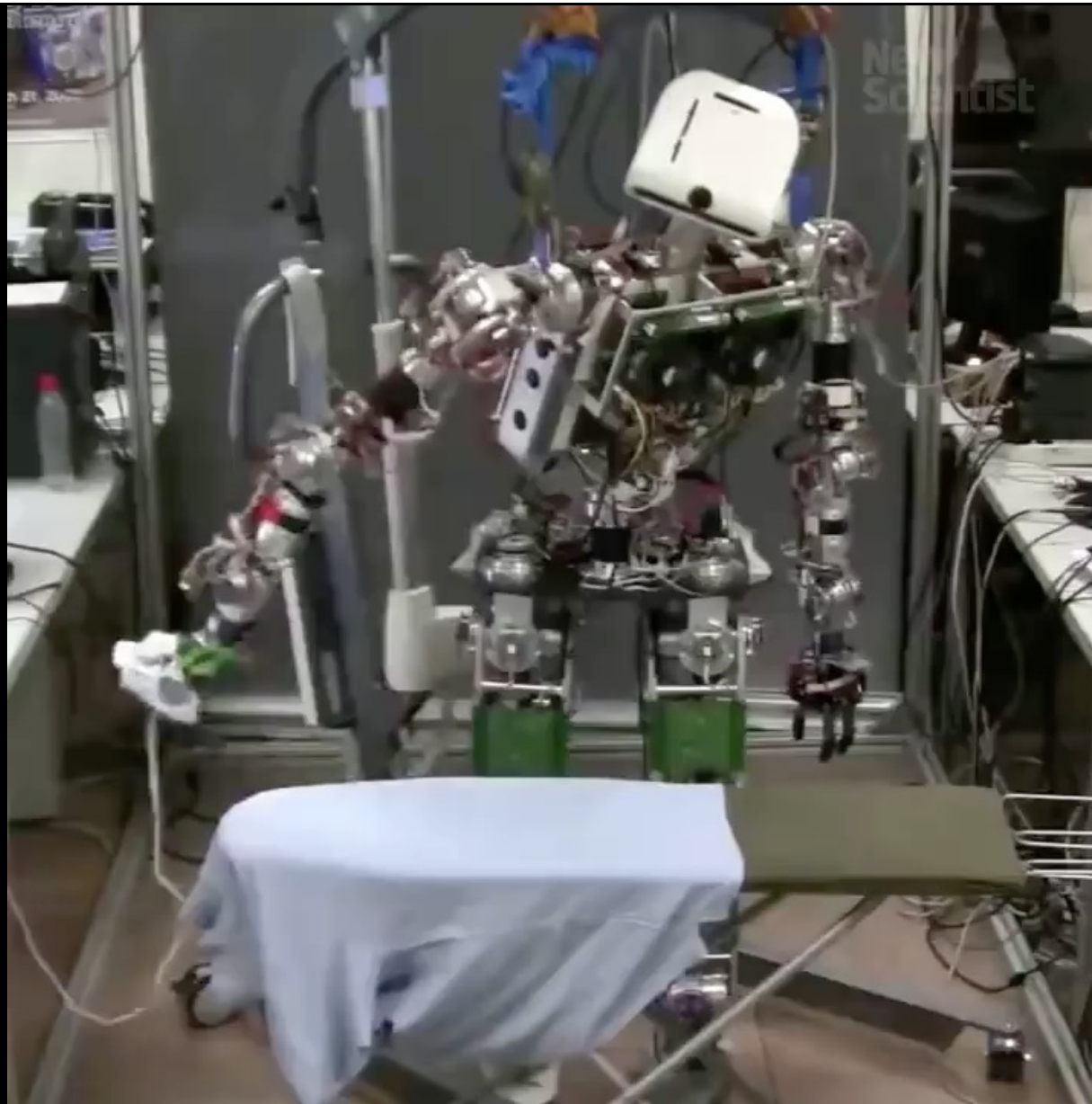
We don't know what to expect,  
and the robot has to be  
flexible and adaptable

Uncertainty, incomplete knowledge, change



c.f. Maria Petrou's Ironing challenge; see <http://www.commsp.ee.ic.ac.uk/~mcpetrou/iron.html>





<https://www.newscientist.com/article/2138264-this-handy-robot-will-iron-your-clothes-so-you-dont-have-to/>



<https://www.theguardian.com/us-news/2018/oct/08/robot-farm-iron-ox-california>



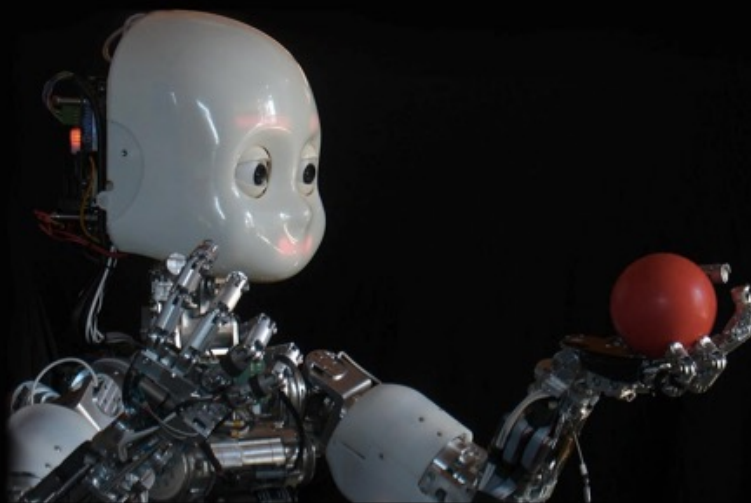




Assisting in Psychotherapy with ASD Children  
(Simple Perspective Taking in Interaction Tasks)

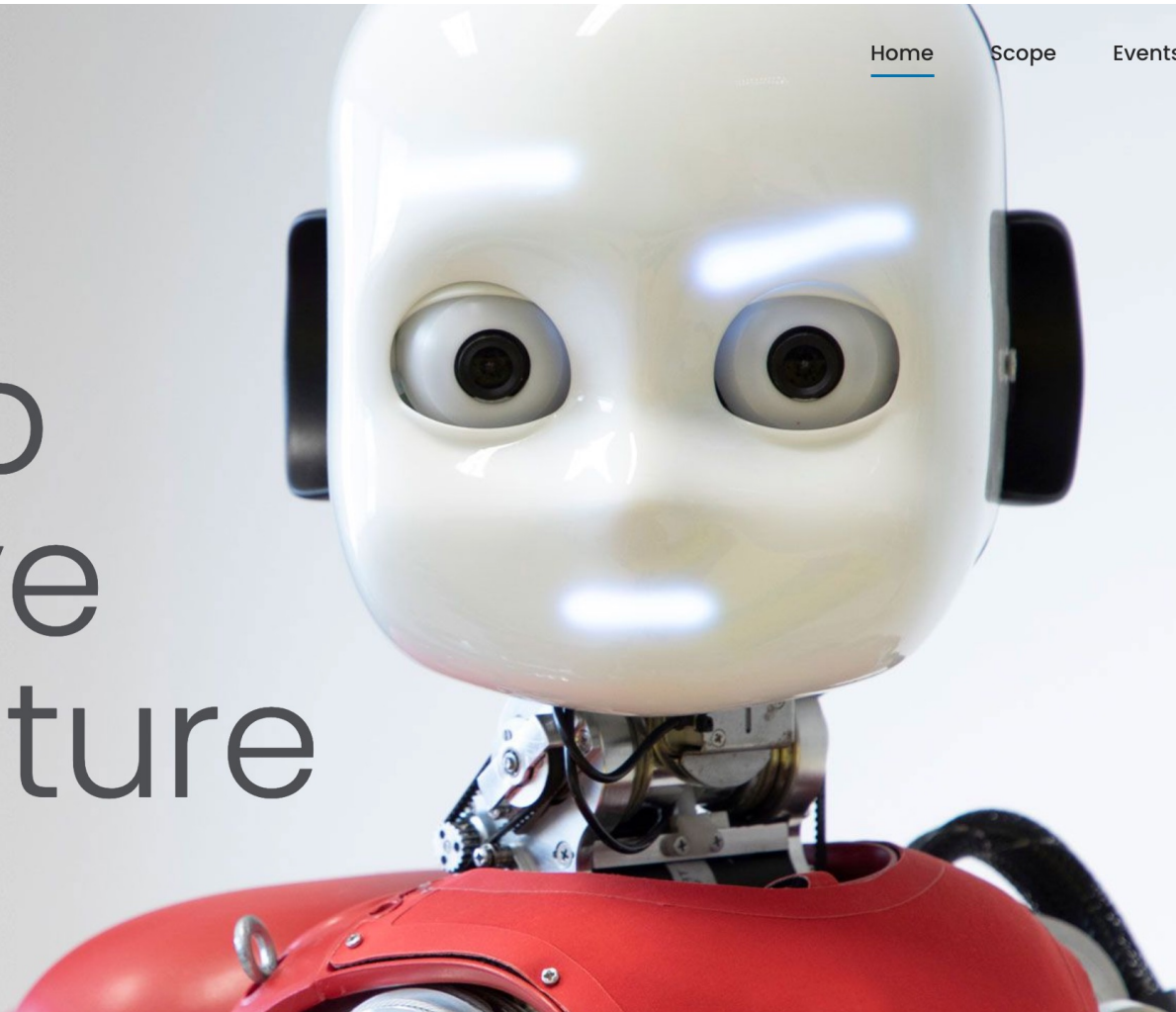


THE  
living  
a humanoid robot



Funded by The European Commission, Project IST-004370, RobotCub, Strategic Objective 2.3.2.4: Cognitive Systems  
[www.icub.eu](http://www.icub.eu)

# iCog. The iCub Cognitive Architecture



iCog is an open source initiative started at IIT with the goal of advancing our knowledge of human cognition by designing, building, and sharing a common cognitive architecture for an embodied artificial system such as the iCub humanoid robot.



OpenEASE CeBIT 2016

<http://www.open-ease.org/>





LEA (Lean Empowering Assistant)  
Robot Care Systems

<https://hittech.com/en/lea-from-robot-care-systems-in-production>

# Motivation

Two complementary reasons for **wanting a cognitive system**

1. Cognition allows the ~~robot~~ system to

- **Work independently** in challenging environments
- **Adapt** to changes
- **Anticipate** events in preparing its actions

# Motivation

Two complementary reasons for **wanting a cognitive system**

2. Cognition facilitates interaction with **people**

Works two ways:

1. It facilitates interaction **by** the human
2. It provides the robot with the ability to infer the goals and intentions of the human  
(and thereby interact with the human in a safe and helpful manner)



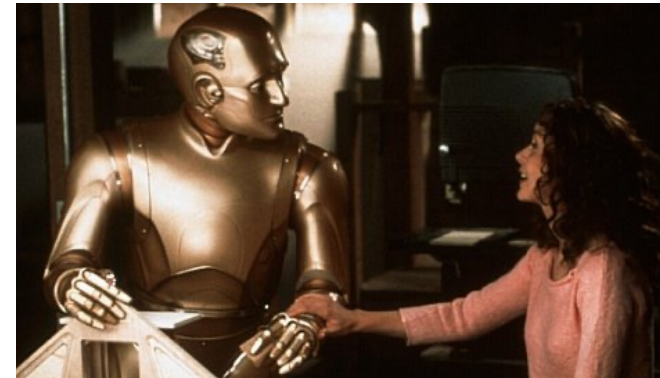
# Industrial Priorities for Cognitive Robotics

Survey of industrial developers to determine what they and their customers require from a cognitive robot

Cast as a series of eleven functional abilities

D. Vernon and M. Vincze, "Industrial Priorities for Cognitive Robotics", Proceedings of the European Society for Cognitive Systems Meeting, EUCognition 2016, Vienna, 8-9 December 2016.

**Safe, reliable, and  
transparent operation**

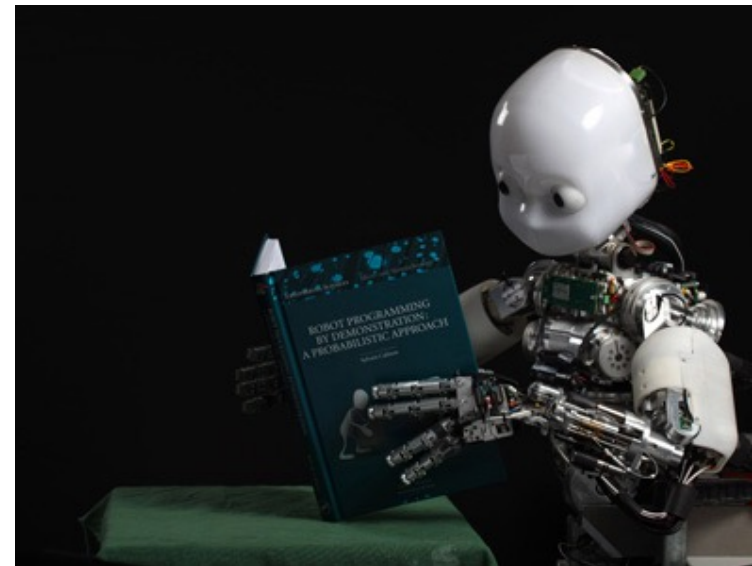


## High-level instruction and context-aware task execution





## Knowledge Acquisition and Generalization



## Adaptive Planning

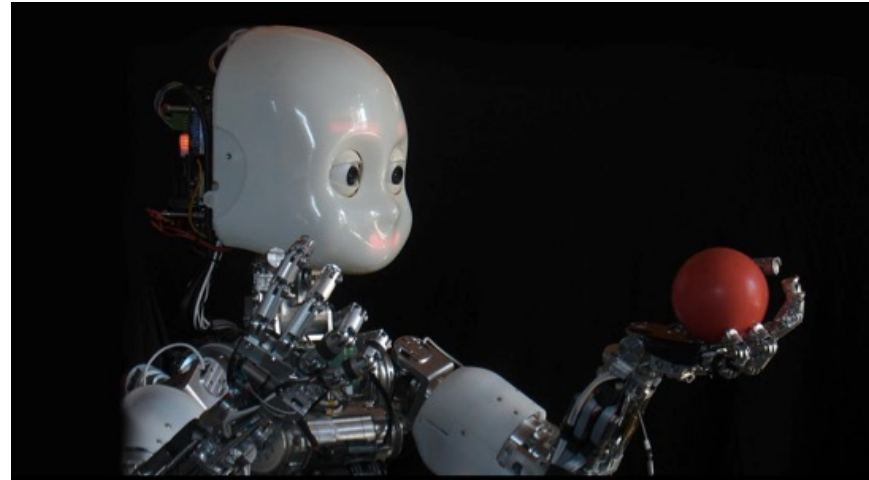


## Personalized interaction





## Self-Assessment



## Learning from Demonstration



<https://sketchucation.com/forums/viewtopic.php?f=15&t=58587>



<https://www.istockphoto.com/de/fotos/man-vacuuming?sort=mostpopular&mediatype=photography&phrase=man%20vacuuming>

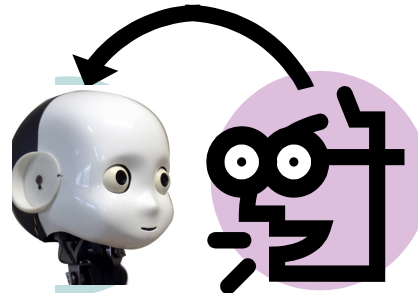
## Evaluating the Safety of Actions



## Development and Self-Optimization



## Knowledge Transfer





## Communicating Intentions and Collaborative Action



Industry 4.0 requires automation solutions to be  
**highly cognitive and highly autonomous**

It requires **enhanced collaboration between humans and machines,**  
including **next generation robots that work hand-in-hand and safely with humans**

[Deloitte 2014]



<https://www.accenture.com/us-en/digital-industry-index>

# Robotics and Artificial Intelligence in Africa

By David Vernon

Artificial intelligence (AI) provides many opportunities for social and economic empowerment in developing countries. However, when one thinks of Africa, robotics does not spring immediately to mind as the most relevant application of AI, considering that the continent typically has high unemployment and fast-growing populations. Nevertheless, some countries in Africa have embraced robotics on the basis that it has an important role to play in their economic development. In this article, we explore this role and the ways in which Africa can best exploit the opportunities afforded by intelligent automation and robotics. It also highlights strategies to offset the threats posed by global factors, such as premature deindustrialization.

## The Growing Impact of AI in Africa

There is an increasing awareness of the positive impact that AI will have on developing countries, including sub-Saharan Africa, in sectors such as agriculture, health care, and public and financial services [1]. AI has the potential to drive economic growth, development, and democratization, thereby reducing poverty, increasing education, supporting health-care delivery, increasing food production, expanding the capacity of the existing road infrastructure by increasing traffic flows, improving public services, and bettering the

quality of life for people with disabilities [2]. AI can empower workers at all skill levels to be more competitive [3], [4]. Specifically, it can be used to augment and enhance human skills—not to replace or displace humans—and to do so at all levels, enabling average and low-skill workers to fit better in high-performance environments and take on more complex responsibilities.

Africa's biggest economic challenge is to equip large sections of its economy with average workers who are primed to perform tasks far better than most employees are currently managing to do. In South Africa, approximately 31% of employers cannot fill their vacancies [4]. AI will make technology easier to adopt and harness [1], [4]. In the health-care sector, AI helps address the shortage of doctors through telemedicine and access to medical supplies through drone deliveries [5]. In agriculture, AI (including machine learning, remote sensing, and data analytics) has the potential to improve productivity and efficiency at all stages of the value chain, enabling small-holder farmers to increase their income through higher crop yields and greater price control, detect and precisely treat pests and diseases, monitor soil conditions and target fertilizer applications, create virtual cooperatives to aggregate crop yields, broker better prices, and exploit economies of scale. Internet of Things (IoT) platforms may offer cost-effective ways to achieve those benefits [6]. For example, Microsoft is applying its Farmbeats platform [7] in developing countries by lowering the cost associated with

densely deploying sensors, exploiting sparsely distributed sensors and aerial imagery to generate precision maps, and replacing expensive drones with smartphones attached to hand-carried, low-cost, tethered helium balloons [8].

## Premature Deindustrialization

On the downside, factory and call-center work will slow as tasks are replaced by AI-enabled automation, including robots, which will add pressure to unemployment rates that are already high in developing countries, including those in Africa [5]. This will be exacerbated by growing populations, reducing opportunities still further. Africa's population is large and expanding fast: most of its people are young and urban with a median age of 19.5 years, compared to Germany (47.1), the United States (38.1), and China (37.7), and the youth population is set to reach 225 million by 2055 [5]. Kenya, Nigeria, and South Africa, for example, are projected to have approximately 5.5%, 8.5%, and 12.5%, respectively, of their workforce displaced by automation [9]. A report by the Oxford Martin School at the University of Oxford, United Kingdom, and Citigroup, New York, summarizes the situation in Africa in stark terms [10]:

In most of sub-Saharan Africa, the manufacturing share of output has persistently declined over the past 25 years. The share of jobs in manufacturing is even smaller: just over 6% of all jobs. This figure barely changed over the course of the three decades

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# Reading

D. Vernon, Artificial Cognitive Systems, MIT Press, 2014; Chapter 1.

D. Vernon and M. Vincze, "Industrial Priorities for Cognitive Robotics", Proceedings of the European Society for Cognitive Systems Meeting, EUCognition 2016, Vienna, 8-9 December, R. Chrisley. V. C. Müller, Y. Sandamirskaya. M. Vincze (eds.), CEUR-WS Vol-1855, ISSN 1613-0073, pp. 42-43. 2016.