
人工智能
The ShanghAI Lectures
上海授课

The Shanghai Lectures 2022

Natural and Artificial Intelligence in Embodied Physical Agents

October 27th, 2022

From Zagreb, Croatia

Today's program (CEST)

08:30 sites begin connecting
08:55 all sites are ready
09:00 (Fabio) Welcome
09:15 Introductory Lecture I
10:00 Break
10:10 Introductory Lecture II
11:00 Wrap-up

Goals

- **Education and knowledge for anyone on the planet**
- **Latest technology for knowledge transfer and community building**
- **Spreading idea of “embodied intelligence” —> new way of thinking**
- **Research platform: studying collaboration — intercultural**
- **Strengthening ties between universities**
- **Informed opinion on media reports**

Expected results

- interactions with important universities from around the world
- new collaborations
- global exchange with renowned researchers from different backgrounds in the field of intelligence research
- new view of intelligence, ourselves, world

Natural and artificial intelligence

- suited for wide interdisciplinary audience
- no specific prior training required
- novel ideas
- broad interest in public at large

Table of contents

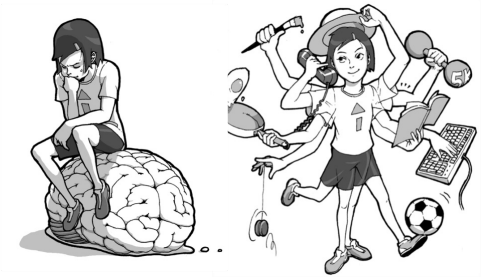
Book for class

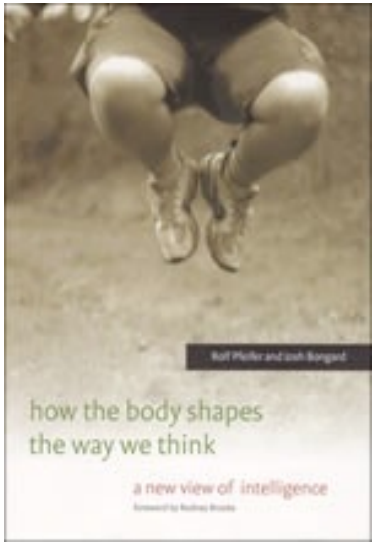
Rolf Pfeifer and Josh Bongard

How the body shapes the way we think — a new view of intelligence

MIT Press, 2007

Illustrations by Shun Iwasawa





Typical format of lectures

- 09.00 Student presentation: one of the sites
- 09.10 Lecture on embodied intelligence (Fabio)
- 09.55 Break
- 10.00 Guest speaker
- 11.00 End of lectures

Lecture 0

A New Paradigm Physical AI unifying Soft Robotics and AI

Fabio Bonsignorio
Professor, ERA CHAIR in AI for Robotics

University of Zagreb
Faculty of Electrical Engineering and Computing
Laboratory for Autonomous Systems and Mobile Robotics

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No. 952275

www.heronrobots.com

Outline of the talk

- Global Challenges
- Robotics ‘waves’
- Industry 4.0
- I4.0 impact on the Circular Economy
- Another I4.0 side effect: impact on Construction Industry
- Open issues with current ‘paradigms’ and approaches, and the road ahead
- What to do

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World population projected to reach 9.7 billion by 2050

29 July 2015, New York

The current world population of 7.3 billion is expected to reach 8.5 billion by 2030, 9.7 billion in 2050 and 11.2 billion in 2100, according to a new UN DESA report, "World Population Prospects: The 2015 Revision", launched today.

"Understanding the demographic changes that are likely to unfold over the coming years, as well as the challenges and opportunities that they present for achieving sustainable development, is key to the design and implementation of the new development agenda," said Wu Hongbo, UN Under-Secretary-General for Economic and Social Affairs.

Most of the projected increase in the world's population can be attributed to a short list of high-fertility countrie mainly in Africa, or countries with already large populations. During 2015-2050, half of the world's population growth is expected to be concentrated in nine countries: India, Nigeria, Pakistan, Democratic Republic of the Congo, Ethiopia, United Republic of Tanzania, United States of America (USA), Indonesia and Uganda, listed according to the size of their contribution to the total growth.

Shifts in the current population rankings

NATIONAL GEOGRAPHIC

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MAGAZINE | JANUARY 2016

See for Yourself: How Arctic Ice Is Disappearing

Since satellites began regularl
declined sharply in extent and thic
is thin stuff that doesn't survive t
entire Arctic ecosystem, from pla
think that, by altering the jet stre
around the N

Graphics and maps by **Lauren Ja**
Esteban,

UK world sport football opinion culture business lifestyle fashion environment tech

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Sydney Dispatch

Australia's new normal ... as city temperatures hit 47C people shelter from the deadly heat

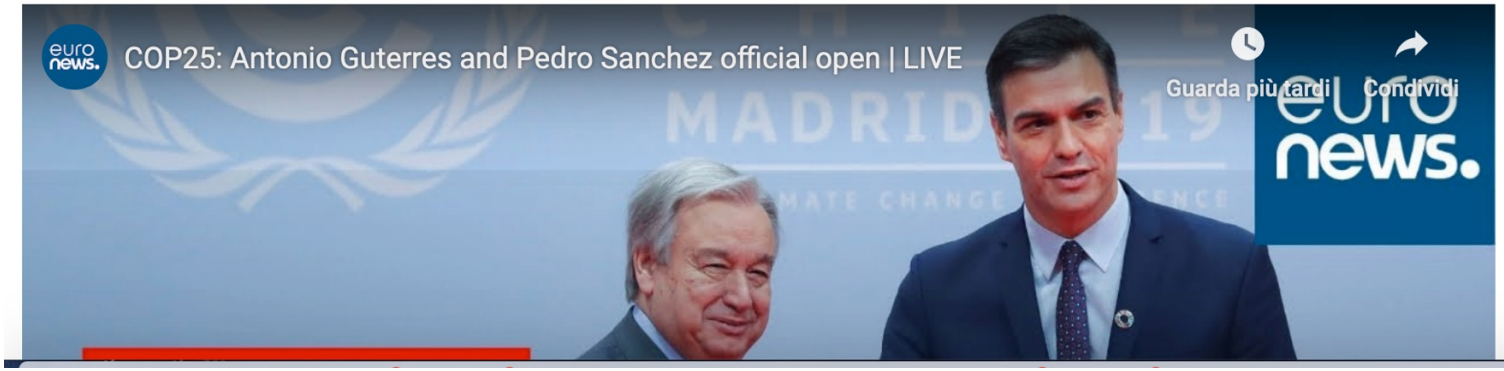
In Sydney's baking suburbs, fans have sold out – and fears about the effects of climate change are mounting

SPAIN

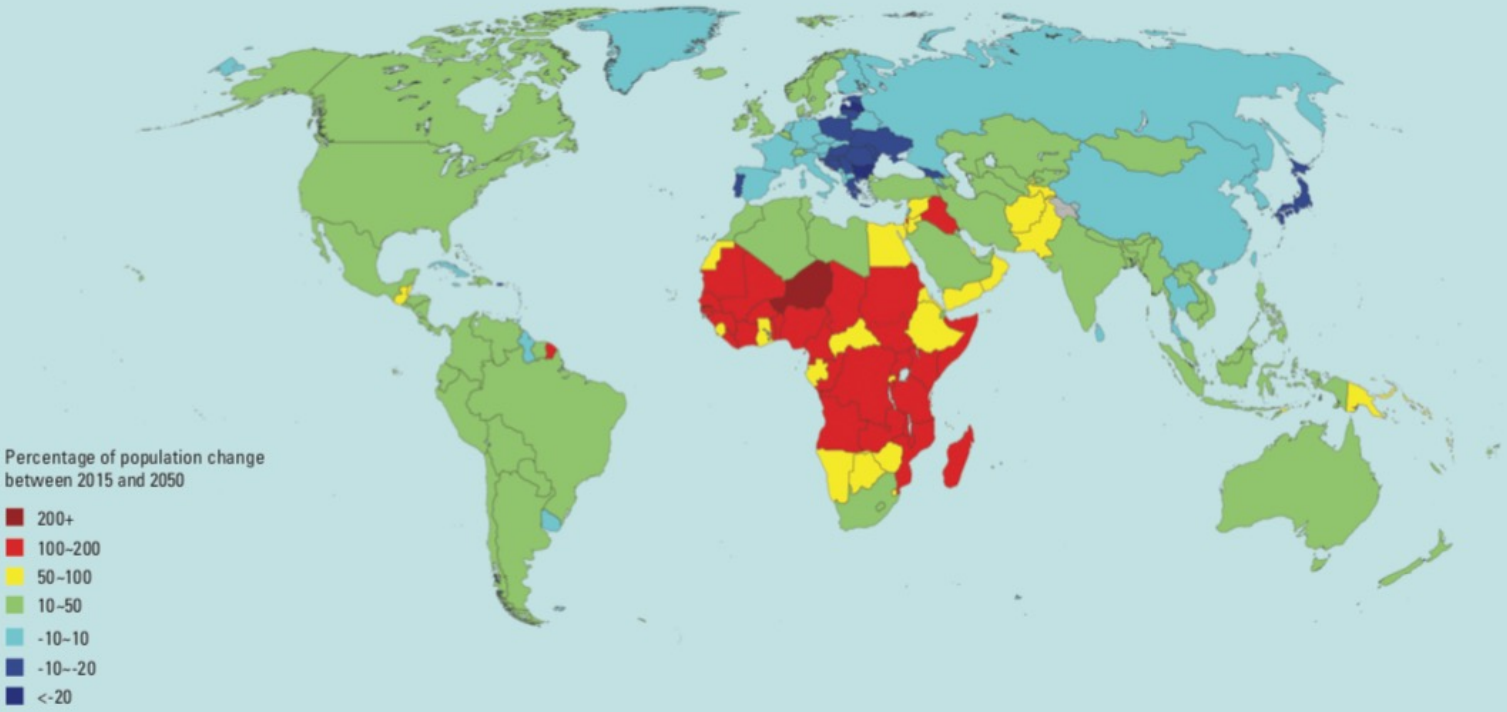
COP25 in Madrid: UN Secretary-General Guterres says planet is 'close to a point of no return'

COMMENTS

By **Sofia Sanchez Manzanaro** with **EFE** • last updated: 03/12/2019 - 10:10



Projected population growth, 2015-2050



Data source: World Population Prospects: The 2017 Revision.
The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers of boundaries. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammy and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

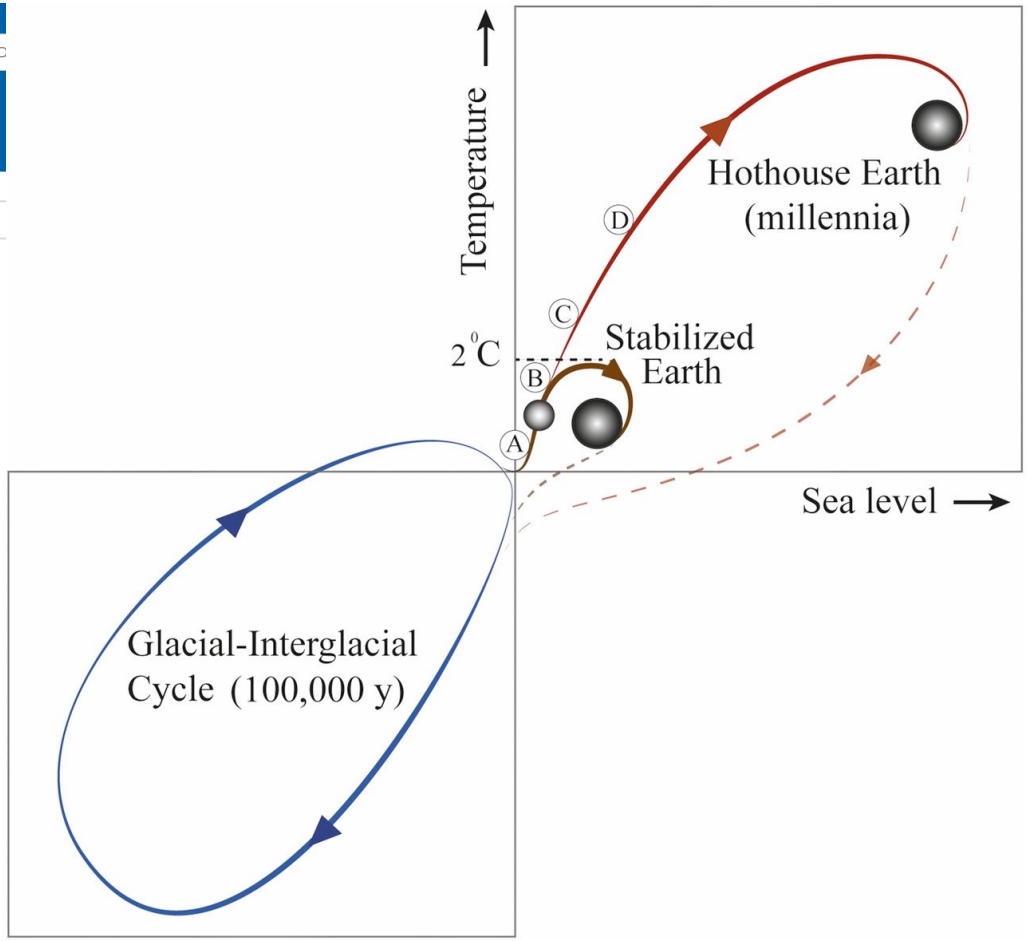
PNAS
Proceedings of the
National Academy of Sciences
of the United States of America

Trajectories of the Earth System in the Anthropocene

Will Steffen, Johan Rockström, Katherine Richardson, Timothy M. Lenton, Carl Folke, Diana Liverman, Colin P. Summerhayes, Anthony D. Barnosky, Sarah E. Cornell, Michel Crucifix, Jonathan F. Donges, Ingo Fetzer, Steven J. Lade, Marten Scheffer, Ricarda Winkelmann, and Hans Joachim Schellnhuber

PNAS August 14, 2018 115 (33) 8252-8259; published ahead of print August 6, 2018 https://doi.org/10.1073/pnas.1810141115

Edited by William C. Clark, Harvard University, Cambridge, MA, and approved July 6, 2018 (received for review June 19, 2018)



‘Collapse of Civilisation is the Most Likely Outcome’: Top Climate Scientists

By Asher Moses, originally published by Voice of Action

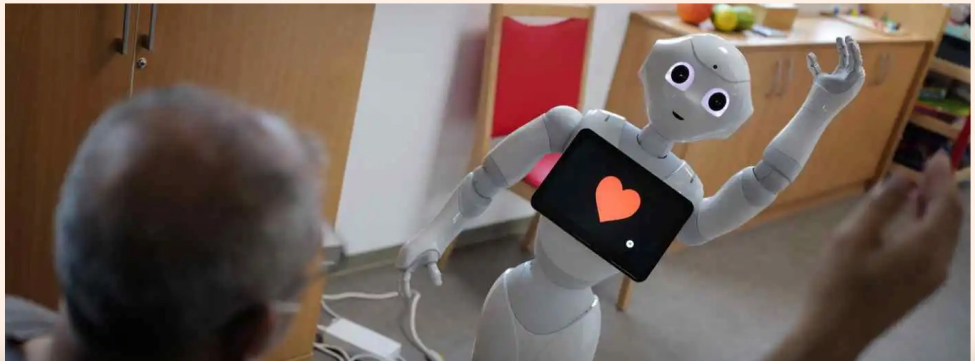
June 8, 2020

Opinion **Artificial intelligence**

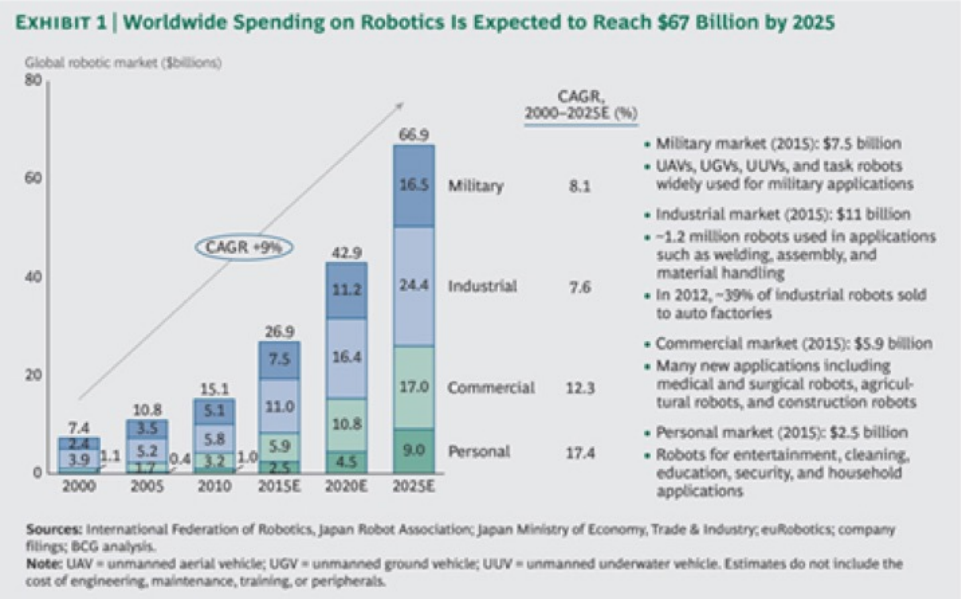
Robots need to move faster to save the world

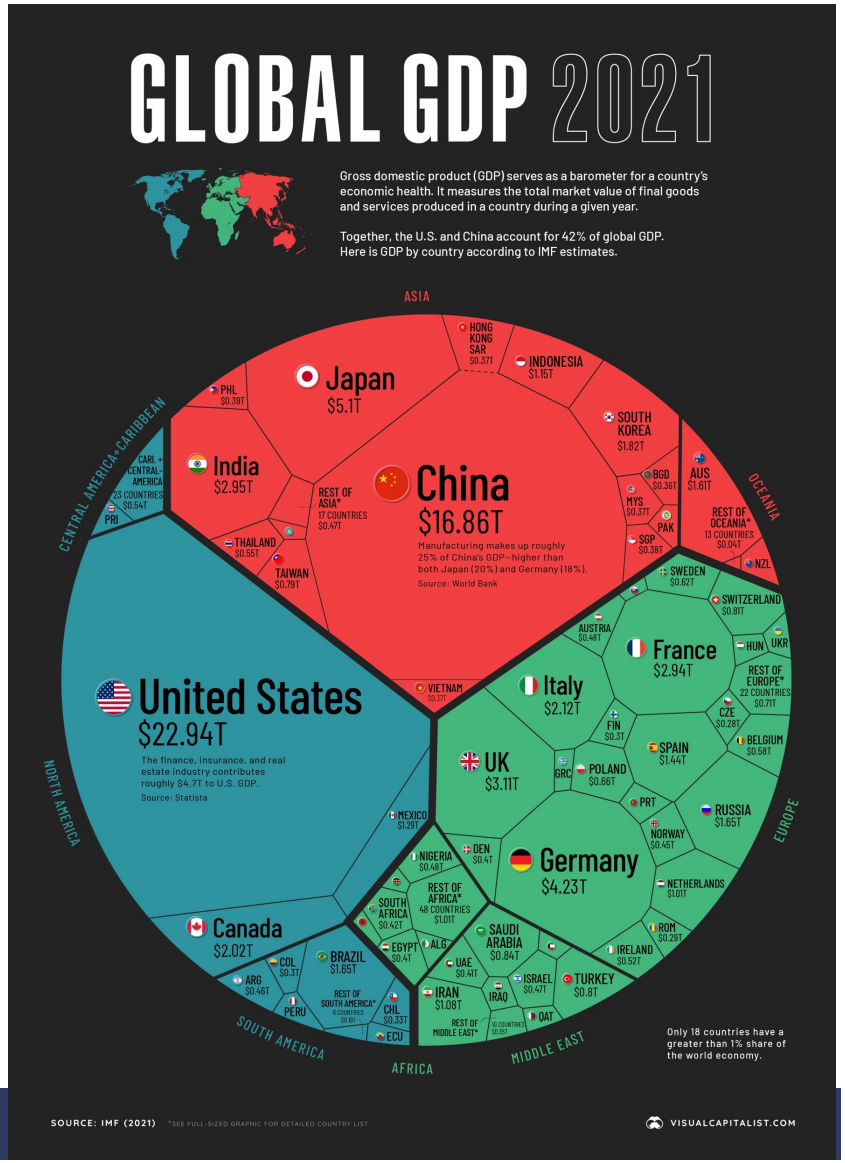
Alarmists say AI will steal jobs, but underlying demographic trends foretell continuing worker shortages

RUCHIR SHARMA + Add to myFT



Meanwhile…





1/1000!!! of Global Product

New Enabling Scientific Knowledge

+

Some General Trends

- Internet of Things
- Machine Learning/Deep Learning
- ‘some’ AI (mainly Computer vision, Object recognition and Planning)

+

- Ubiquitous Large Very Large Bandwith
- Decreasing cost of sensors, actuators
- Wright's Law*
- …

* Nagy B, Farmer JD, Bui QM, Trancik JE (2013) Statistical Basis for Predicting Technological Progress. PLoS ONE 8(2)

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Older and newer attempts

Juanelo Torriano alias Gianello della Torre, (XVI century) a craftsman from Cremona, built for Emperor Charles V a mechanical young lady who was able to walk and play music by picking the strings of a real lute.

Hiroshi Ishiguro, early XXI century

Director of the Intelligent Robotics Laboratory, part of the Department of Adaptive Machine Systems at Osaka University, Japan

Old ideas

“If every tool, when ordered, or even of its own accord, could do the work that befits it, just as the creations of Daedalus moved of themselves . . . If the weavers' shuttles were to weave of themselves, then there would be no need either of apprentices for the master workers or of slaves for the lords.”

Aristotle

(from Politics, Book 1, 1253b, 322 BC)

Old ideas

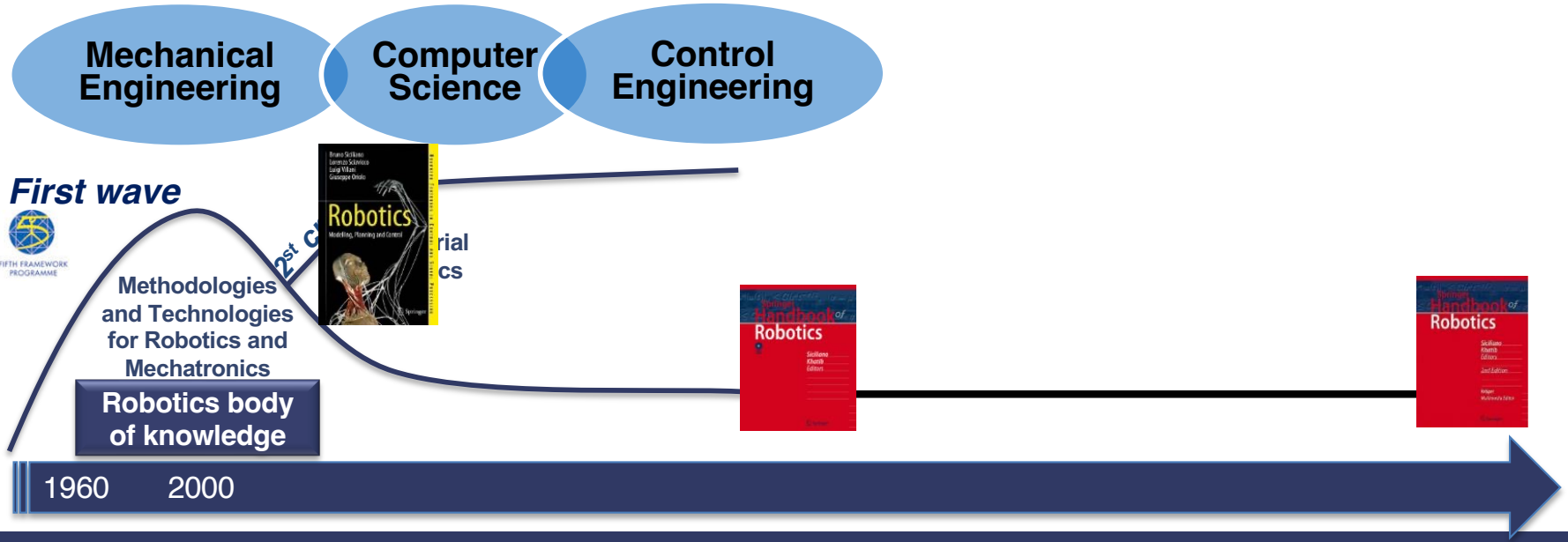
The part of the quote "or even of its own accord" is elsewhere translated as "or by seeing what to do in advance2

I think this is an important part of the quote, so it's good to go back to the original text:

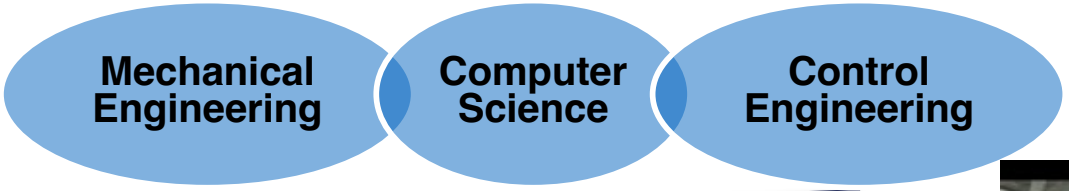
Aristotle uses the word "προαισθανόμενον" – proaisthanomenon this means literaly: pro = before, aisthanomenon = perceiving, apprehending, understanding, learning (any of these meanings in this order of frequency) in my view it is clearly a word that is attributed to intelligent, living agents....i.e. ones with cognitive abilities (!)

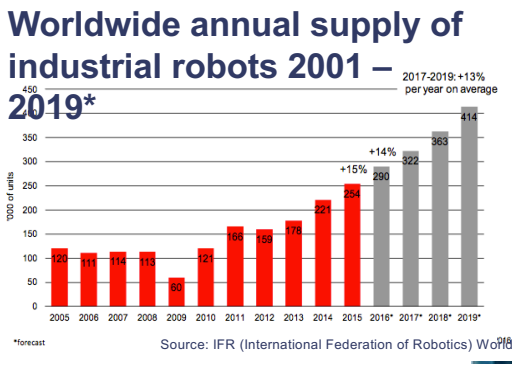
personal communication, Dr. Katerina Pastra
Research Fellow
Language Technology Group
Institute for Language and Speech Processing
Athens, Greece

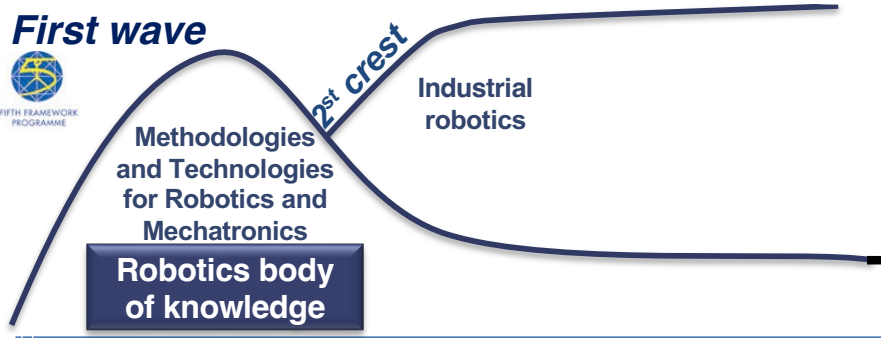
Recent successes: the first wave

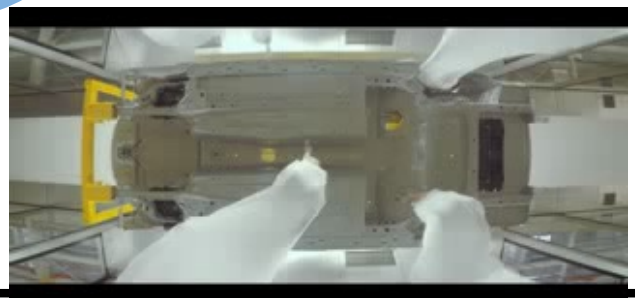


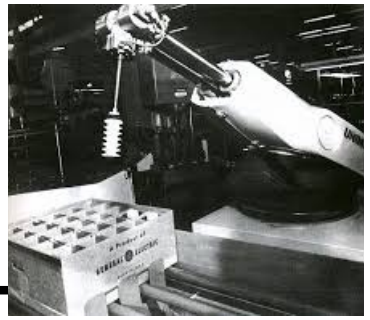
The first wave



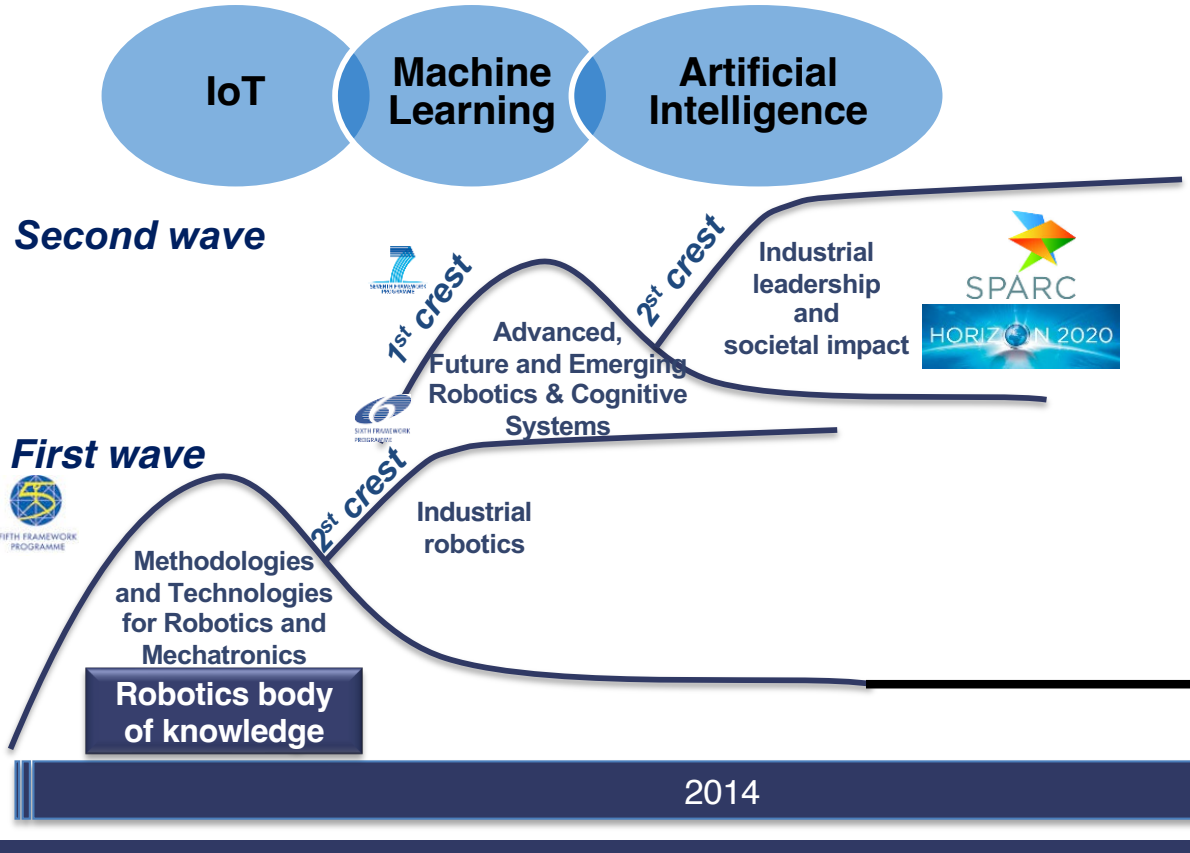








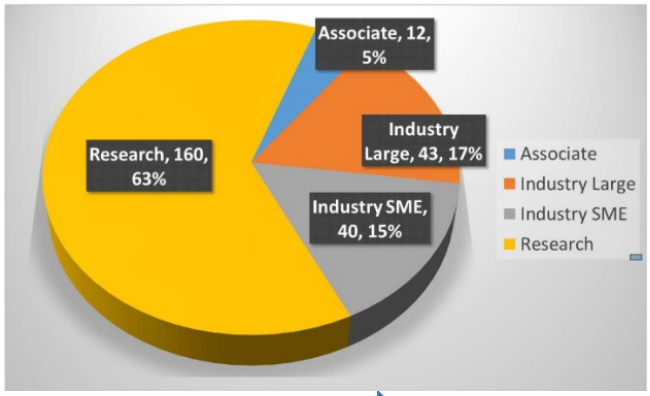
The second wave



Membership development

280 member organisations

Legend:
- Industry
- Research
- Associate
- euRobotics AISBL



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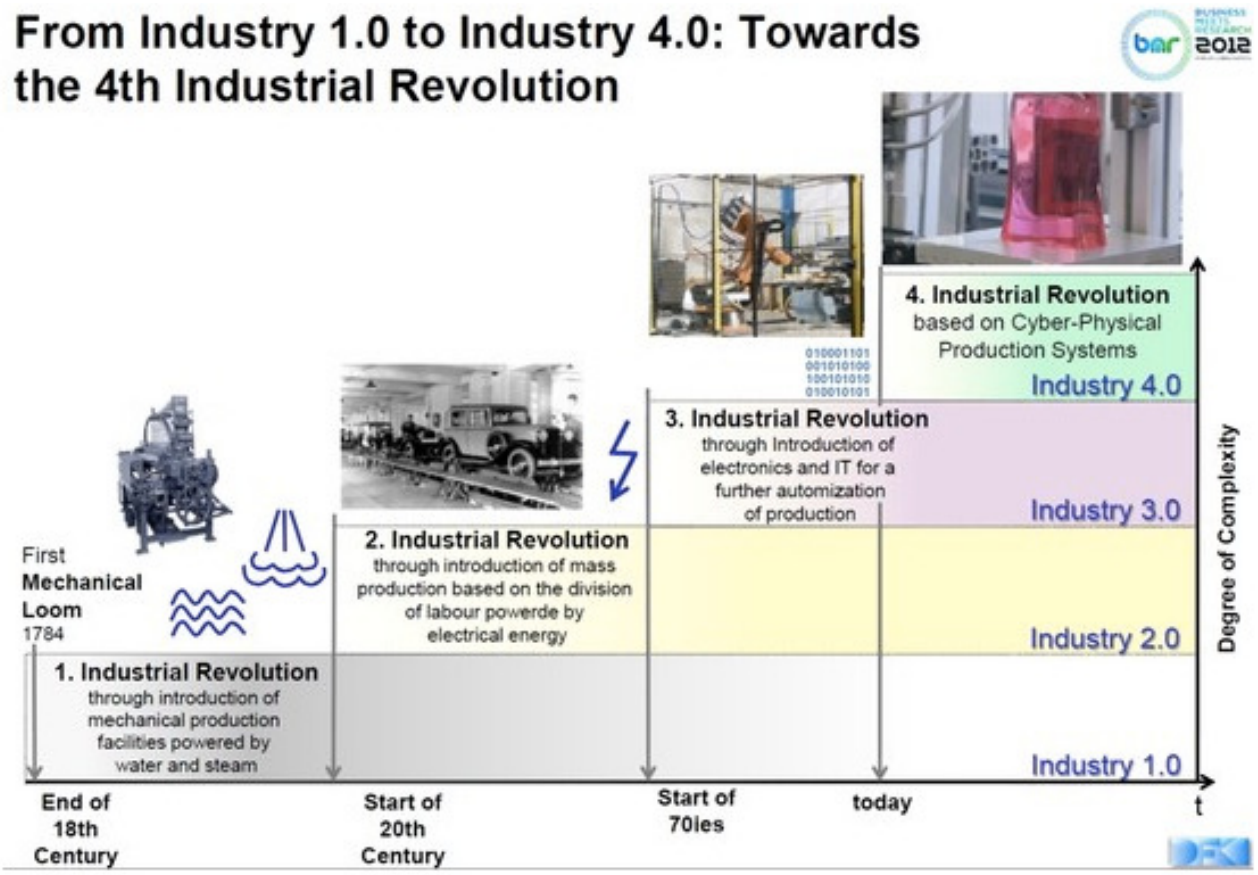
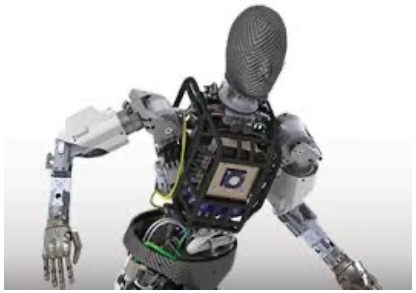
The second wave





Why we need that? Today's markets are turbulent

Many market researches since many years (Zook et al., 2001, Ghemawat HBS Blog, 2007, Qin et al., 2008) show how the markets are becoming more and more 'turbulent': *the demand of products (shifting towards service-products) becomes more and more diversified as product mix and as product quantity variation versus time*.

Digitalization of European Industry EU Strategy

a. Digitalization of Products

b. Digitalization of Services

c. Digitalizzazione of Processes

50 G€ of investments by Bruxelles should generate benefits on industry and service sectors revenue for 110 G€/year

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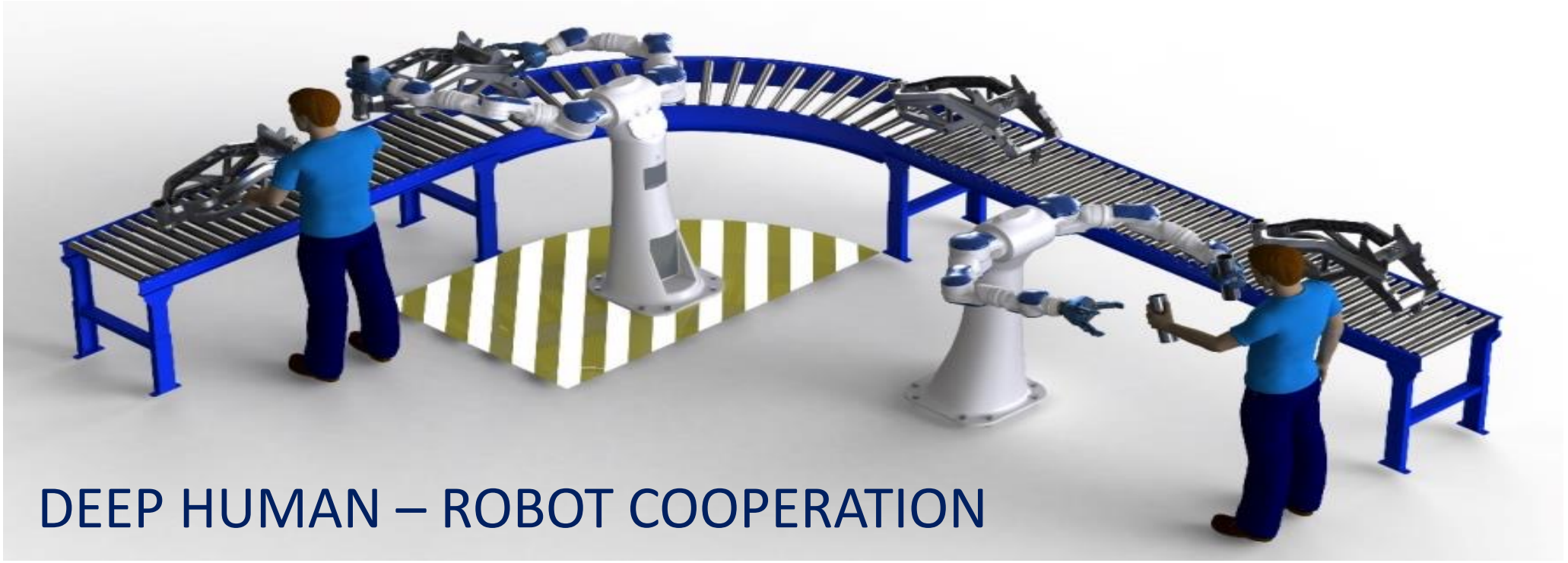
Robots on the Shop-floor

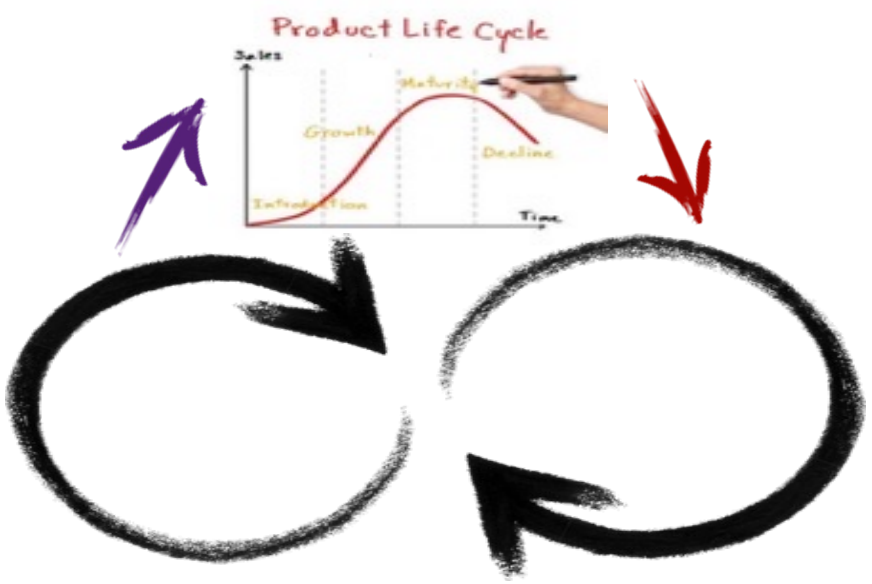
BIO-AUTOMATION: the new frontier of automation ‘eco’, bio-inspired and human centered



DEEP HUMAN – ROBOT COOPERATION

Bio-Automation: Deep Human-Robot cooperation (and workspace sharing) is needed for dismantling (and for lot of 1 artisan quality)

Assembly



Disassembly

Primary
Raw
Materials

Disposal

Disassembly Robotic Tasks for Circular Economy

Paolo Dario, Annagiulia Morachioli, Ilaria Strazzulla, Cecilia Laschi, Fabio Bonsignorio

Abu Dhabi

25th January 2016

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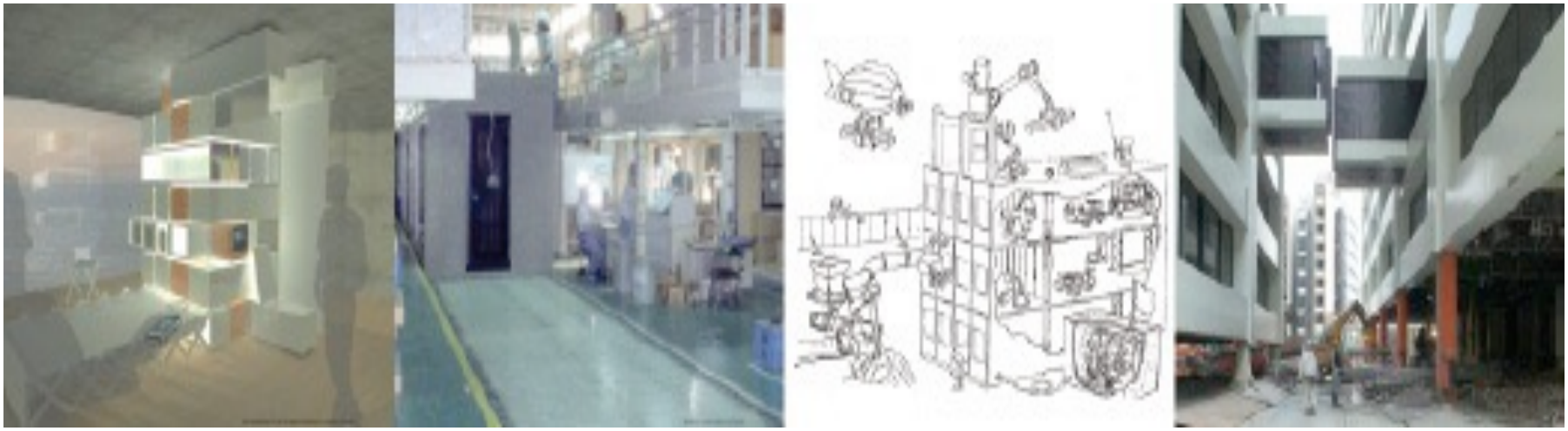
A nice side-effect of Industry 4.0 and CE: Economically and eco-sustainable refurbishment of low quality urban areas

Richard and Su Rogers. Zip-Up Enclosures No. 1 and 2, 1968-71
Model. On behalf of Rogers Stirk Harbour + Partners

KieranTimberlake Associates, Stephen Kieran and James Timberlake.
Cellophane House (Exterior)

Pictures from: K. Tadashi Oshima, R. Waern (authors), B. Bergdoll and P. Christensen (eds). Home Delivery, The Museum of Modern Art, New York, (2008)

Urban Refurbishment



a) Ambient Innovation; b) Industrialization; c) Site Automation; d) Robotic Deconstruction ('dismantling of buildings and built environments')

from T. Block. TARSA, Teaching Automation, Robotics and Services to Architects, (2010)

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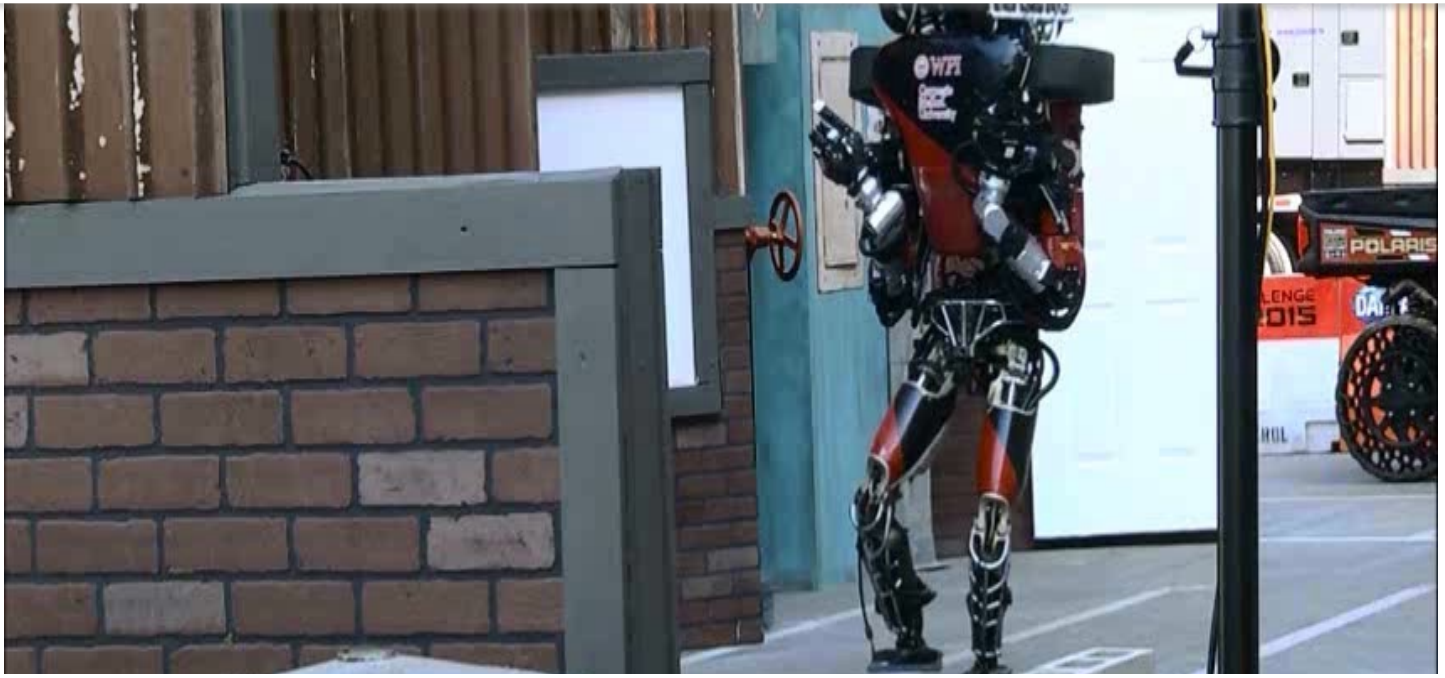
The second wave: the success stories

DARPA (American Defense Advanced Research Projects Agency) challenges have demonstrated how current robots are becoming **more accurate**, **fast** and **dexterous in structured and unstructured environments**.



Not everything worked as expected!

The second wave: the current approach shows some limitations

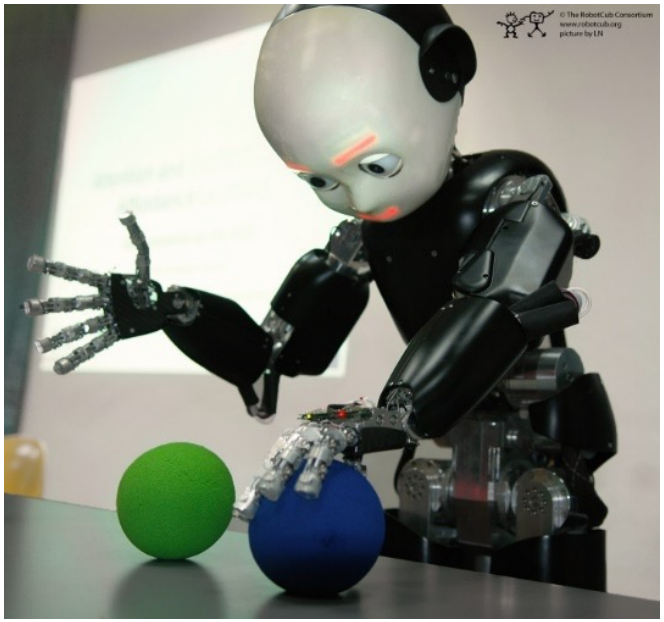
On the other hand the debriefing of DARPA DRC shows clearly that humanoid robots are **still far from the required level of capabilities in fact many metrics, such as time-to-completion, are highly application or task specific.**

According to H.Yanco a minimum of 9 people were needed to teleoperate latest DRC's robots!!!

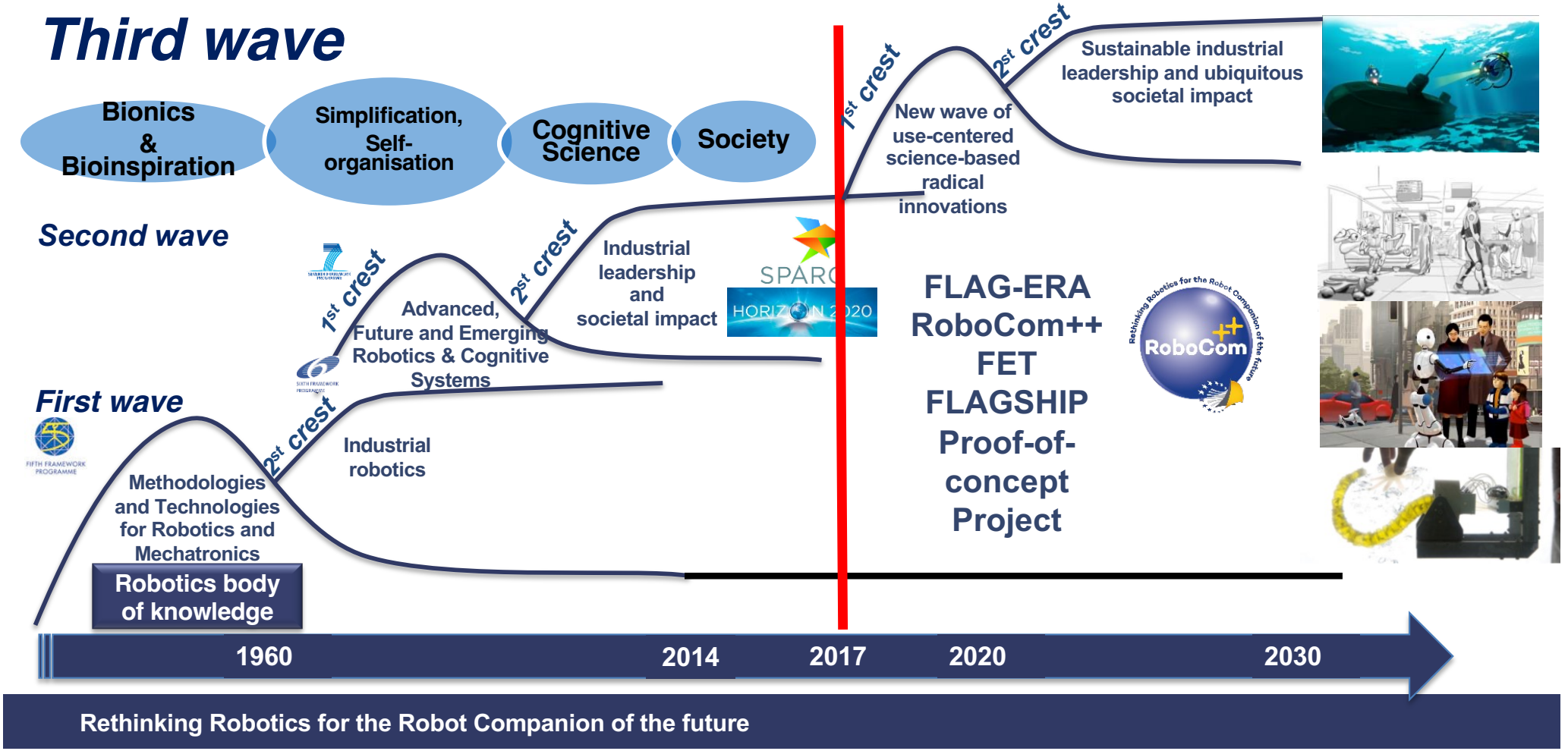
Pursuing new frontiers:
The robotics bottleneck

Today, more functionality means:

- **more** complexity, energy, computation, cost
- less controllability, efficiency, robustness, safety



The Robotics waves



BioRobotics and Bionics convergence

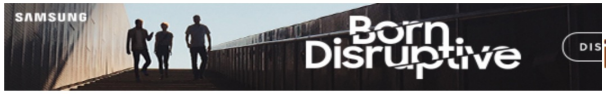
NEURALINK

Neuralink is developing ultra high bandwidth brain-machine interfaces to connect humans and computers.

CNBC

MENU MARKETS BUSINESS NEWS INVESTING TECH POLITICS CNBC TV

SIGN IN



TECH DRIVERS
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Elon Musk: I'm about to announce a 'Neuralink' product that connects your brain to computers

- Elon Musk says he will soon announce a Neuralink product that can make anyone superhuman by connecting their brains to a computer.
- He says Neuralink increases the data rate between the brain and computers and will give humans a better shot at competing with AI.
- Musk made the comments before he smoked weed and drank on Joe Rogan's podcast.

Todd Haselton | @robotodd

Published 10:26 AM ET Fri, 7 Sept 2018 | Updated 3:08 PM ET Tue, 11 Sept 2018

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Elon Musk's Neuralink brain-chip venture reportedly looks into rodent experiments

BY ALAN BOYLE on March 28, 2018 at 4:56 pm

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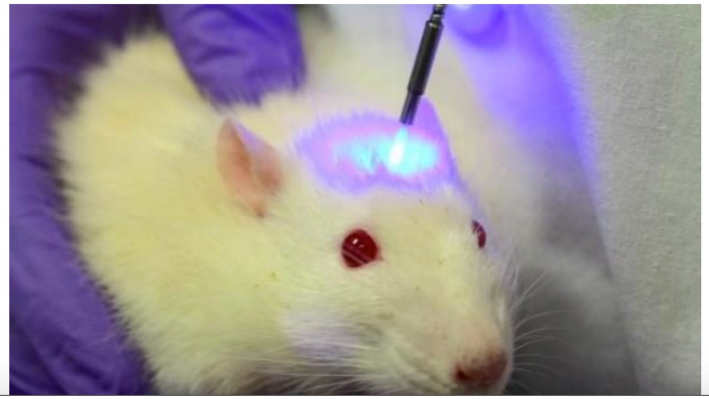
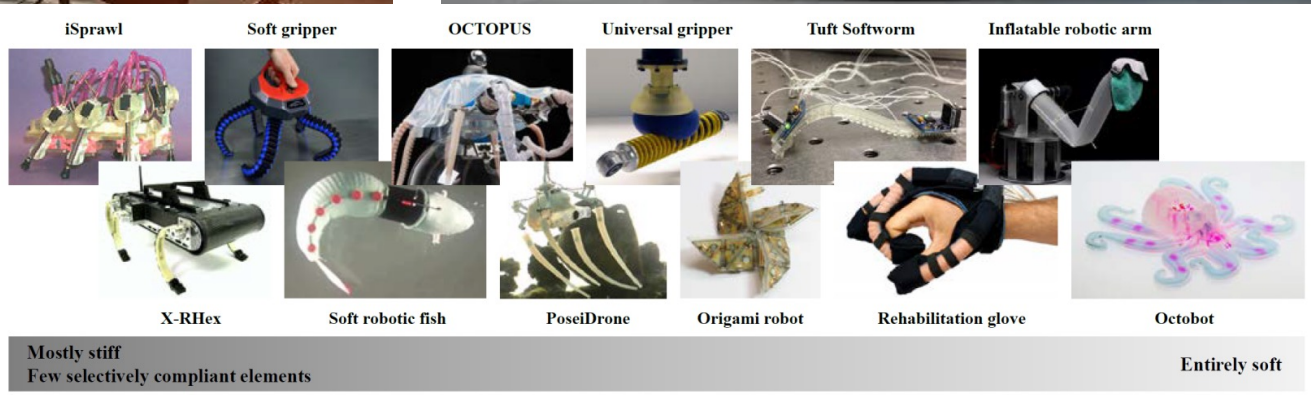
The GeekWire Gala: Join us on Dec. 6th!

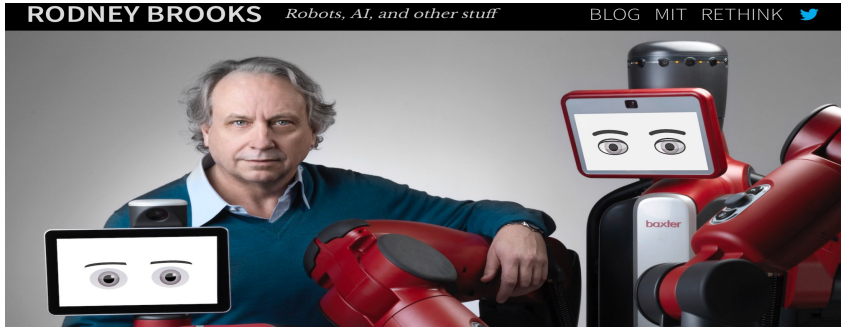


SCIENCE ROBOTICS

The marvellous progress of Robotics and AI…'Look Ma, No Hands' syndrome?



Also spracht Rodney Brooks ☺



JUNE 17, 2017 — ESSAYS

Edge Cases For Self Driving Cars

rodneybrooks.com/edge-cases-for-self-driving-cars/

“Perhaps through this essay I will get the bee out of my bonnet that fully driverless cars are a lot further off than many techies, much of the press, and even many auto executives seem to think. They will get here and human driving will probably disappear in the lifetimes of many people reading this, but it is not going to all happen in the blink of an eye as many expect. There are lots of details to be worked out.”

Also spracht Marc Raibert ☺

MATT SIMON SCIENCE 10.15.18 12:04 AM

YOU'RE EXPECTING TOO MUCH OUT OF BOSTON DYNAMICS' ROBOTS

SHARE

At the WIRED25 festival in San Francisco Sunday evening, Boston Dynamics' SpotMini robot got onstage and did what no other quadruped robot has done before: It danced the

MOST POPULAI

SECURITY
The Highly Dar
'Triton' Hacker
Probed the US
ANDY GREENBE

You might have seen the video a few days ago of Atlas doing parkour, bounding up a multi-leveled structure with ease. While the performance seemed effortless, it took over 20 attempts. After the robot gets in the groove, though, its success rate is around 90 percent.[1] "In our videos we typically show the very best behavior," Raibert said. "It's not the average behavior or the typical behavior. And we

- 'Look Ma, No Hands' syndrome?
- Replication of experiments
- Performance benchmarks, challenges and competitions to allow comparisons of results
- Needed to foster research advancement and enable practical application of research achievements

Much Needed to define ‘How good’ is a robot at performing tasks

A bit of History

Early stages 2008-2010

- 2008 Euron establishes the GEM SIG (coordinated by me, John Hallam, Angel P. del Pobil as a small fundednetworking project
- Reproducibility issues in Robotics exposed at Euron General Meeting in Prague.
- Many meetings help define the issues related to Benchmarking and Good Experimental methodology in Robotics
- 2009: The IEEE RAS TC on Performance Evaluation and Benchmarking of Robotics and Autonomous Systems (PEBRAS) is established

2010-2016

- More than 20 workshops at ICRA, IROS, RSS, ERF discuss the issues and propose solutions
- 2015: the very first Special issues made of Reproducible paper on an high profile venue on IEEE R&A Magazine
- 2015: the first IEEE RAS Summer School on Reproducible Research in Robotics

Today

- Still more workshops (the latest at ICRA 2017 in Singapore)
- New cool upcoming initiatives on IEEE RAM
- The best is yet to come!

We are not alone: the ‘reproducibility crisis’

EveryONE

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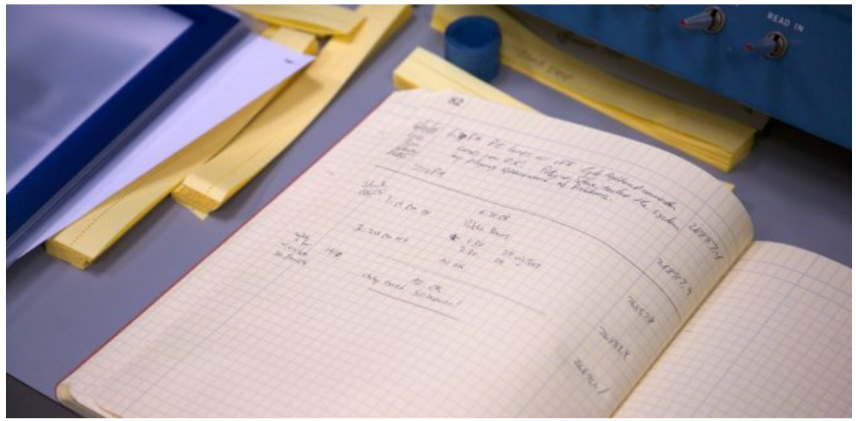

Promoting reproducibility by emphasizing reporting: PLOS ONE’s approach

nature International weekly journal of science

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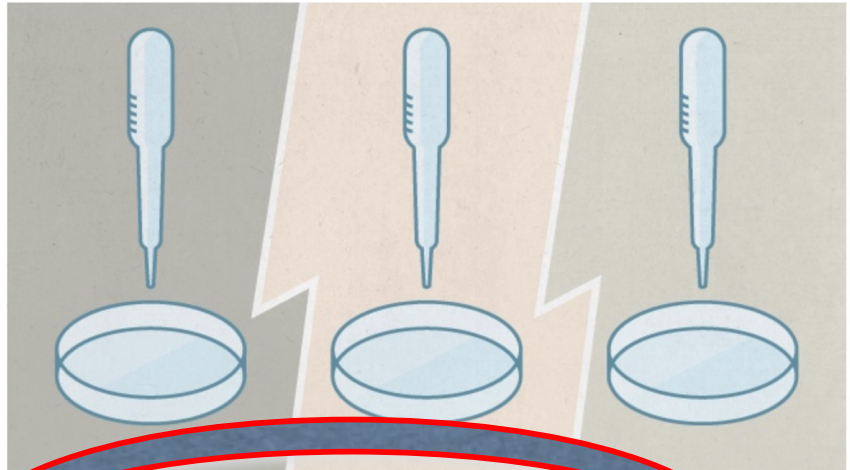
Archive › Specials and supplements archive › Challenges in irreproducible research

SPECIAL

See all specials



CHALLENGES IN IRREPRODUCIBLE RESEARCH

Science moves forward by corroboration – when researchers verify others' results. S… advances

An experiment in Robotics is a well defined (stochastically) repeatable set of (stochastically) reproducible behaviors in well defined set of (stochastically) similar set of environments (see clinical studies in Medicine, Biology, Psychology, etc.)

Performance evaluation

Dyson's robot vacuum cleaner should be considered more intelligent than the Roomba?

How to compare, classify and rank complex adaptive behaviors (Intelligent/Cognitive)?

A new kind of papers?

- ‘description’ : a journal paper text+figures+ multimedia ….according to GEM Guidelines (or similar)
- Data sets (attachments, not just ‘multimedia’
- Complete ‘code’ identifiers and or downloadable code (executables may be enough)
- ‘HW’ description or HW identifier (if it is identifiable)

…

EUROPE REGULATES ROBOTICS
JEAN MONNET MODULE

THE REGULATION OF ROBOTICS IN EUROPE: LEGAL, ETHICAL AND ECONOMIC IMPLICATIONS
INTERNATIONAL SUMMER SCHOOL | 3 - 8 JULY 2017, PISA, ITALY

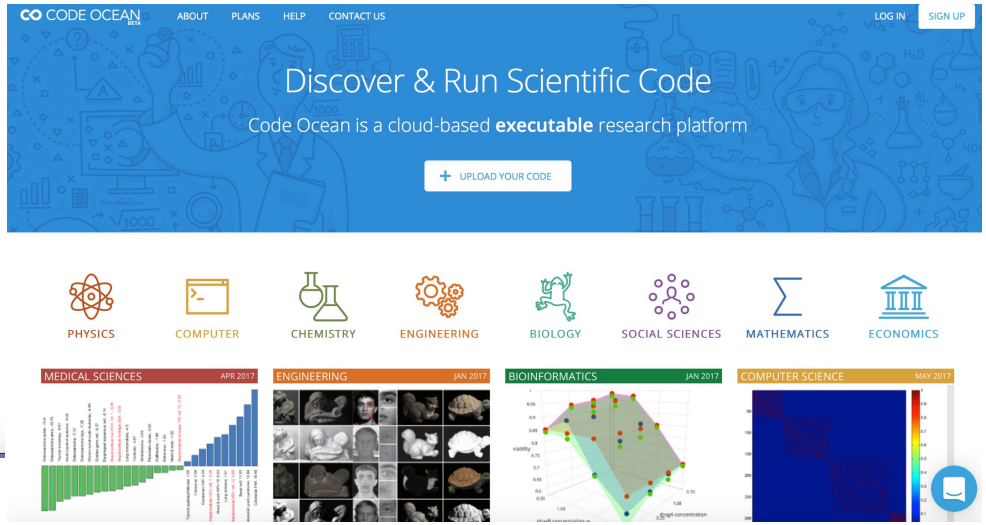
Reproducible Research now an IEEE priority

FROM THE EDITOR'S DESK

Research Reproducibility and Performance Evaluation for Dependable Robots

By Eugenio Guglielmelli

This issue of *IEEE Robotics & Automation Magazine (RAM)* focuses on reproducibility and measurability of robotics re- issue, the IEEE Robotics and Automation Society demonstrates that we are well aware of and perfectly in line with ability was introduced for computer systems in 1992 by the late Dr. Jean Claude Laprie, a senior researcher at



R(eproducible)-Articles on IEEE R&A Magazine

Medium-Long term

Prescribing criteria for statistical significance

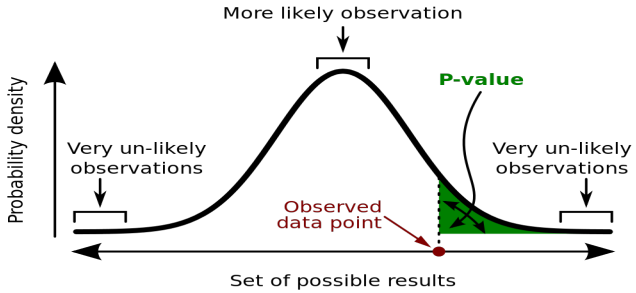
Basic

Important:

Pr (observation | hypothesis) ≠ Pr (hypothesis | observation)

The probability of observing a result given that some hypothesis is true is *not equivalent* to the probability that a hypothesis is true given that some result has been observed.

Using the p-value as a "score" is committing an egregious logical error: **the transposed conditional fallacy.**



A **p-value** (shaded green area) is the probability of an observed (or more extreme) result assuming that the null hypothesis is true.

Picture source: wikipedia

Advanced

http://www.equator-network.org/

Medium-Long term

Introducing more detailed classification of articles (see ACM ‘badging’

https://www.acm.org/publications/policies/artifact-review-badging

Editorial | Published: 11 June 2019

Robotics and the art of science

Nature Machine Intelligence **1**, 259 (2019) | Download Citation ↓

Bringing reproducibility to robotics.

It is an exciting time to work in robotics. There are plenty of interesting challenges in designing machines that intelligently interact with both humans and their environment, and a range of techniques and insights from engineering, computer science, physics, biomechanics, psychology and other fields are available to help solve them. The International Conference on Robotics and Automatio organized by the IEEE, is a lively affair: over 4,000 pa

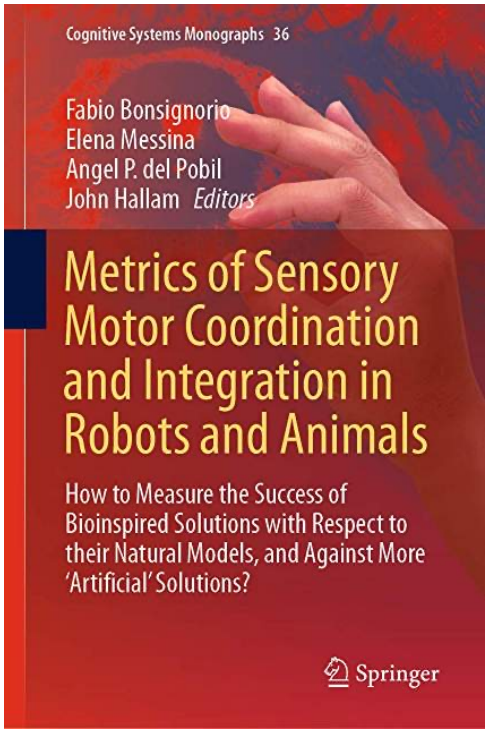
It is an exciting prospect that robotics can start growing as a scientific discipline, with clearly defined methods of evaluation and measurements in place.

References

1. Leitner, J. *Nat. Mach. Intell.* **1**, 162 (2019).
Article Google Scholar

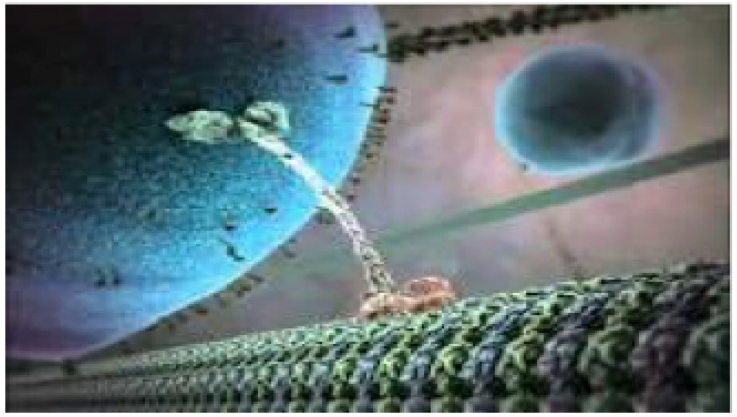
2. Bonsignorio, F. & Del Pobil, A. P. *IEEE Robot. Autom. Mag.* **22**, 32–35 (September, 2015).

3. Bonsignorio, F. A. *IEEE Robot. Autom. Mag.* **24**, 178–182 (September, 2017).



Is It Alive?

Big Questions lie in front of us!



Two views of intelligence

classical:

cognition as computation

embodiment:

cognition emerges from sensory-motor and interaction processes

PARADIGM CLASHES

www.shanghailectures.com

Soft Robotics: a working definition

Variable impedance actuators and stiffness control

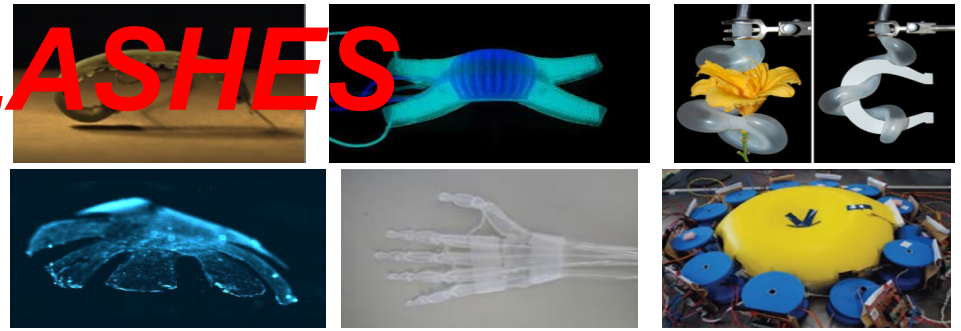
* Actuators with variable impedance
* Compliance/impedance control
* Highly flexible (hyper-redundant or continuum) robots

THE BIOROBOTICS INSTITUTE
Scuola Superiore Sant'Anna

IEEE Robotics and Automation Magazine, Special Issue on Soft Robotics, 2008
A. Albu-Schaffer et al. (Ed.s)

Use of soft materials in robotics

* Robots made of soft materials that undergo high deformations in interaction
* Soft actuators and soft components
* Control partially embedded in the robot morphology and mechanical properties



Kim S., Laschi C., and Trimmer B. (2013) Soft robotics: a bioinspired evolution in robotics, *Trends in Biotechnology*, April 2013.
Laschi C. and Cianchetti M. (2014) "Soft Robotics: new perspectives for robot bodyware and control" *Frontiers in Bioengineering and Biotechnology*, 2(3)

PARADIGM CLASHES

Outline of the talk

- Global Challenges
- Robotics ‘waves’
- Industry 4.0
- I4.0 impact on the Circular Economy
- Another I4.0 side effect: impact on Construction Industry
- Open issues with current ‘paradigms’ and approaches, and the road ahead
- What to do

Dont’ miss the next lectures ☺

Thank you!

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Faculty of Electrical Engineering and Computing
Laboratory for Autonomous Systems and Mobile Robotics

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www.heronrobots.com

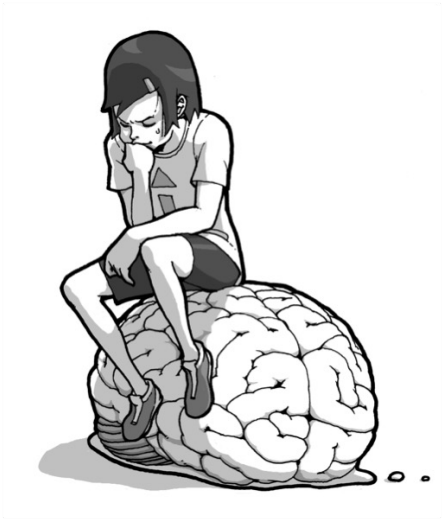
stay tuned for lecture 1!

“Intelligence — an eternal conundrum”

on November 3, 2022, 09:00-11:00 CET

(no more summer time in Europe)

www.shanghailectures.org



Short Bio

The ShanghAI Lectures 2013-

Prof. Fabio Bonsignorio is **ERA Chair in AI for Robotics** at FER, University of Zagreb, Croatia. He is **Founder and CEO of Heron Robots (advanced robotics solutions), see www.heronrobots.com**. He has been visiting professor at the **Biorobotic Institute of the Scuola Superiore Sant'Anna in Pisa from 2014 to 2019**. He has been a professor in the Department of System Enginering and Automation at the **University Carlos III of Madrid until 2014**. In 2009 he got the **Santander Chair of Excellence in Robotics** at the same university. alla stessa università. He has been working for some 20 years in the high tech industry before joining the research community.

He is a **pioneer and has introduced the topic of Reproducibility of results in Robotics and AI**. He is a **pioneer in the application of the blockchain to robotics and IA (smart cities, smart land, smart logistics, circular economy. He coordinates Topic Group of euRobotics about Experiment Replication, Benchmarking, Challenges and Competitions. He is co-chair IEEE Robotics & Automation Society (RAS) Technical Commitee, TC-PEBRAS (PErformance and Benchmarking of Robotics and Autonomous Systems)**.

He is **Distinguished Lecturer per la IEEE Robotics and Automation Society.**' Senior Member of IEEE e member of the Order of the Engineers of Genoa, Italy.

He coordinates the task force robotics, in the G2net,an EU network studying the application of **Machine Learning and Deep Learning (Apprendimento Profondo) to Gravitational wave research, la Geophysics and Robotics**.

Has given invited seminars and talks in many places: MIT Media Lab, Max Planck Institute, Imperial College, Politecnico di Milano in Shenzhen, London, Madrid, Warsaw, San Petersbourg, Seoul, Rio Grande do Sul.…