tec-connection

New trends in intelligent robotics in the laboratory. Towards “analytical robotics”

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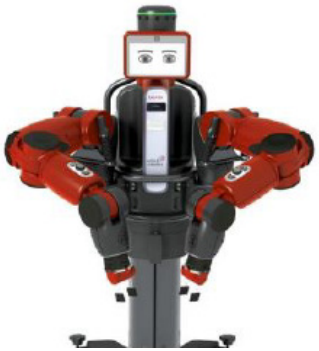
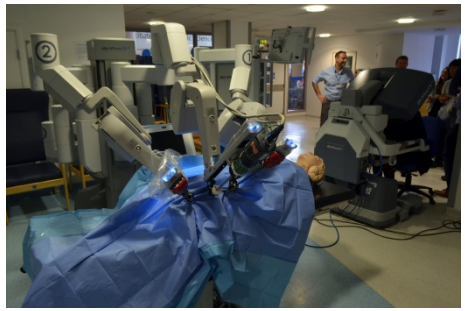
SelectBio Laboratory Automation and Robotics, Berlin November 2016

Commercial robots today

In the garden, the house, the factory, the street and the operating theatre



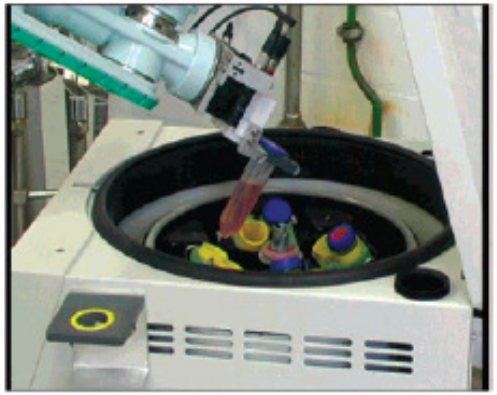


and a survivor bias

Images: wikipedia, Cmglee, iRobot, ABB, Tecan, Rethink, Google

Already 20 & 10 years ago - so why now ?

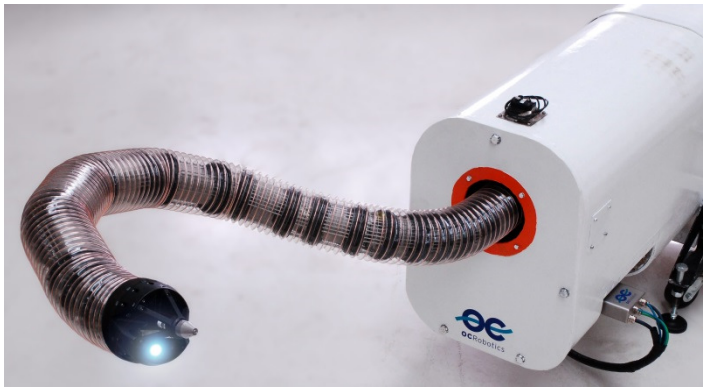
The Automation Partnership: from Cellmate to Compact SelecT



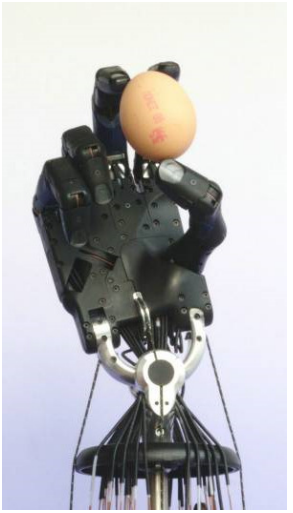
TU München, University of Bielefeld / Bayer (2004)

Technology **Science** **Political will**

EU robotics programme: 2005…2020



New application domains, new robotic forms and novel software capability



Images: CYBERLEGS, CloPeMa, VALERI, AEROARMS, Fraunhofer IFF, iCub/IIT italy, OCrobotics, Kuka/DLR, Shadow robot

What we can and can’t yet do

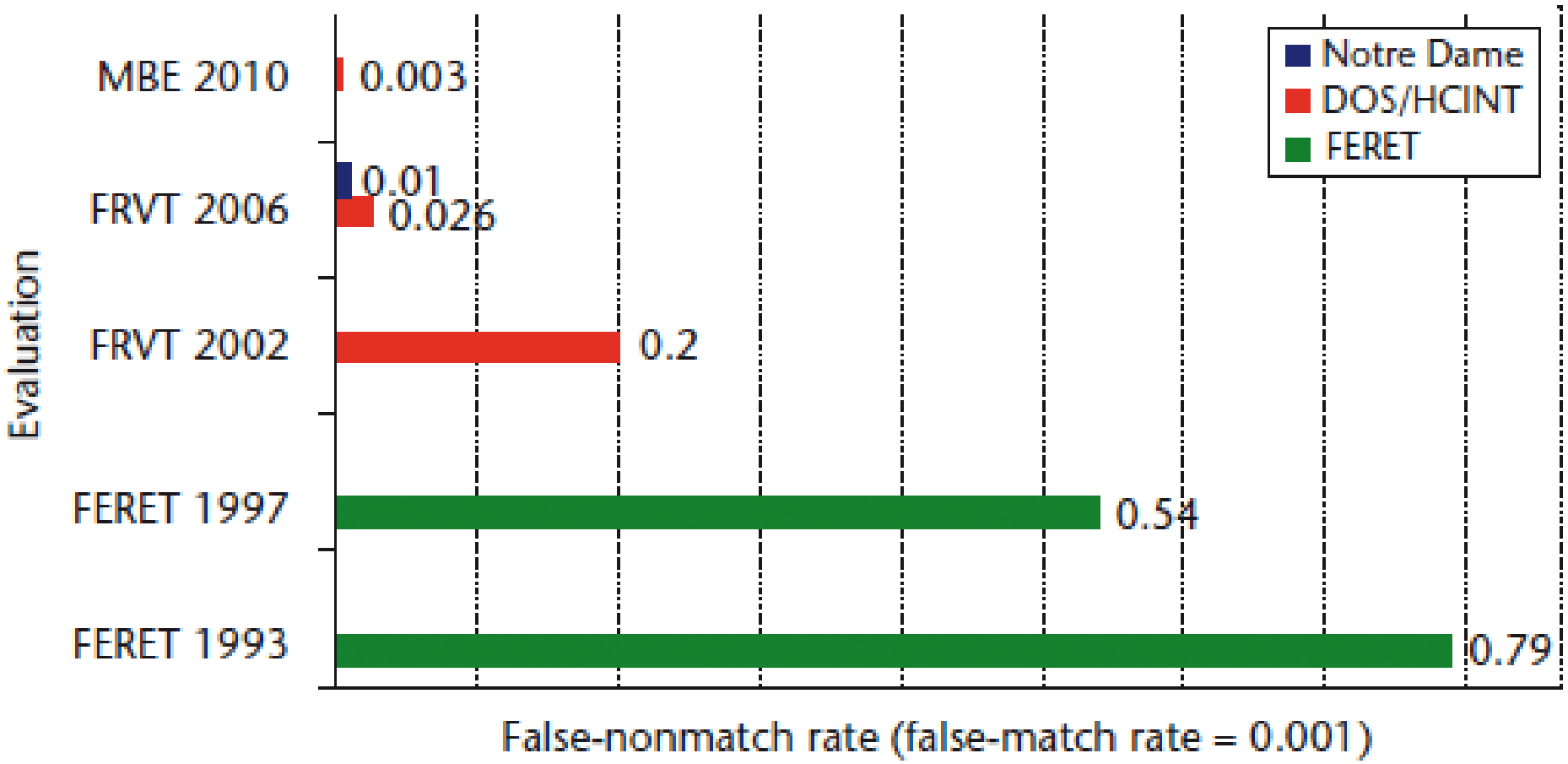
- Interaction and collaboration: new tasks & new capabilities
  - How to get the most out of my highly skilled scientists?
  - Learning on the job and from examples
- New robots for existing tasks: logistics and manipulation
  - For those hard to automate steps
- Getting smarter in the lab:
  - Why can’t I use my smartphone in the lab like I can at home?
  - Other side of the Internet of things: eye/ears – arms/legs
- Bringing it all together

Learning by example

- See video at https://youtu.be/2jYhdmk-pMg

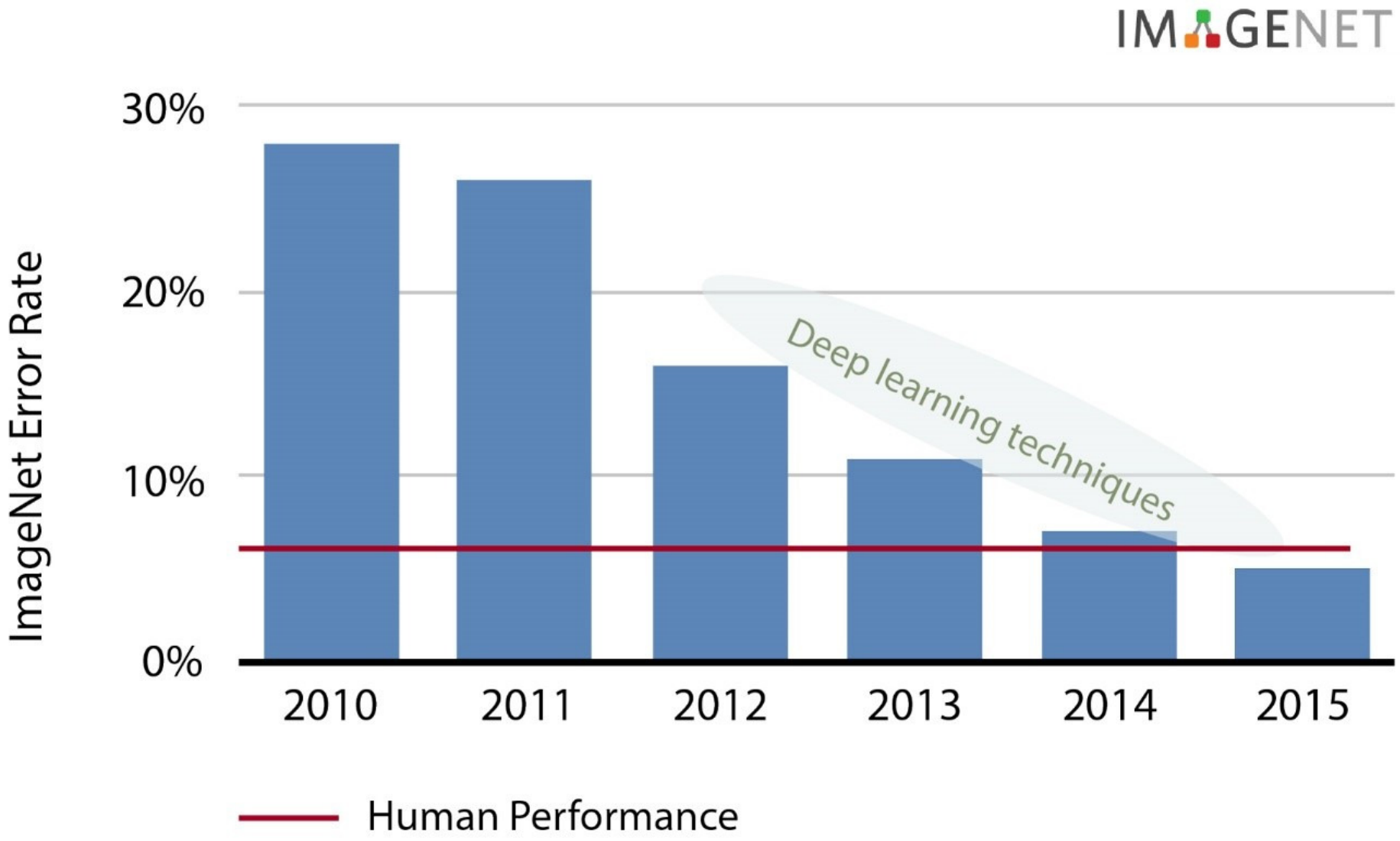
Progress in machine learning

Progress in machine learning: face recognition



Unsang Park, Brendan Klare, Anil K. Jain, "Face Matching and Retrieval in Forensics Applications", *IEEE MultiMedia*, vol. 19, no. , pp. 20, 28, January-March 2012, doi:10.1109/MMUL.2012.4

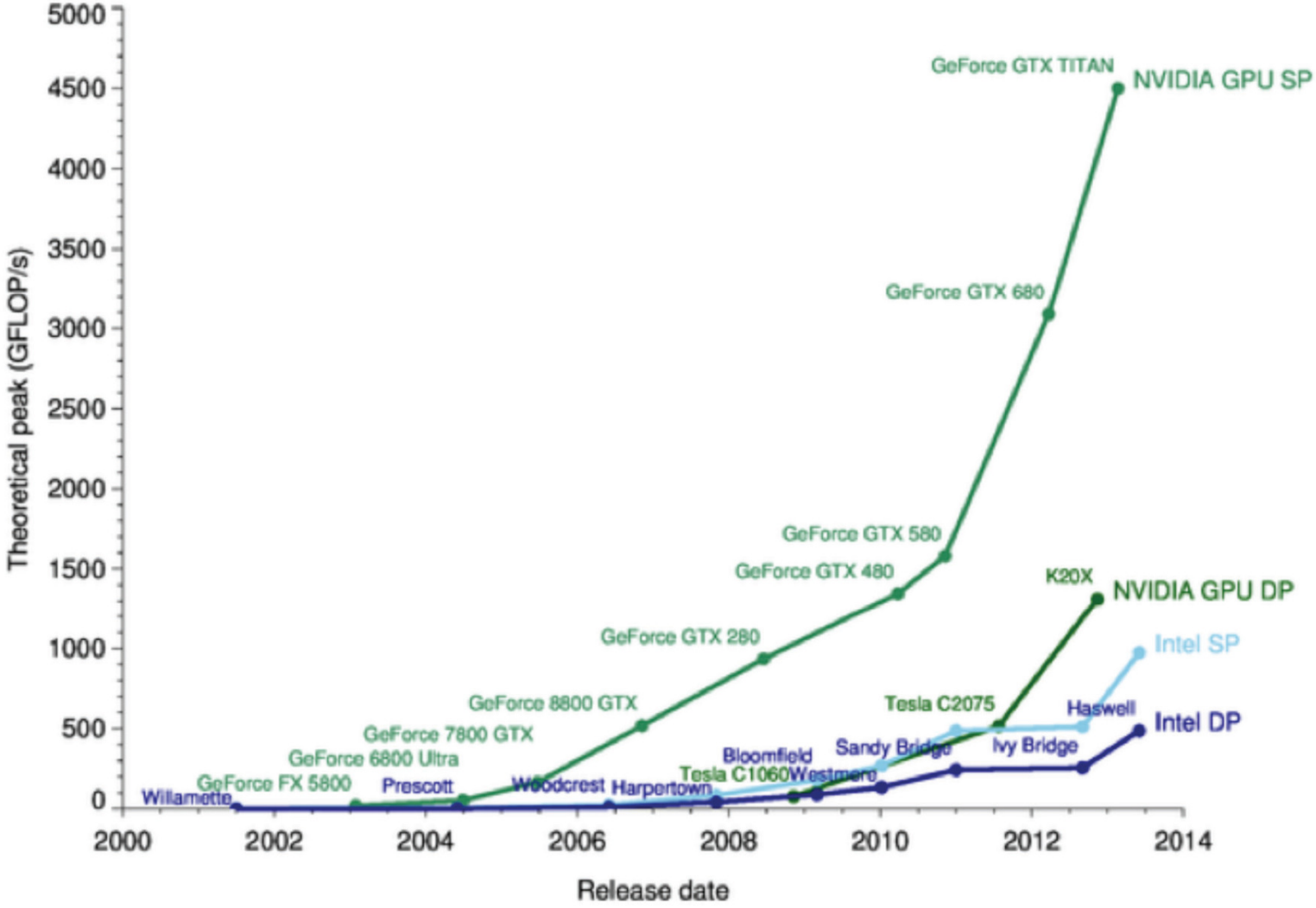
Progress in machine learning: object recognition



but the errors are not human

http://blog.ceva-dsp.com/deep-learning-frameworks-features-and-challenges/

Progress in machine learning: computing

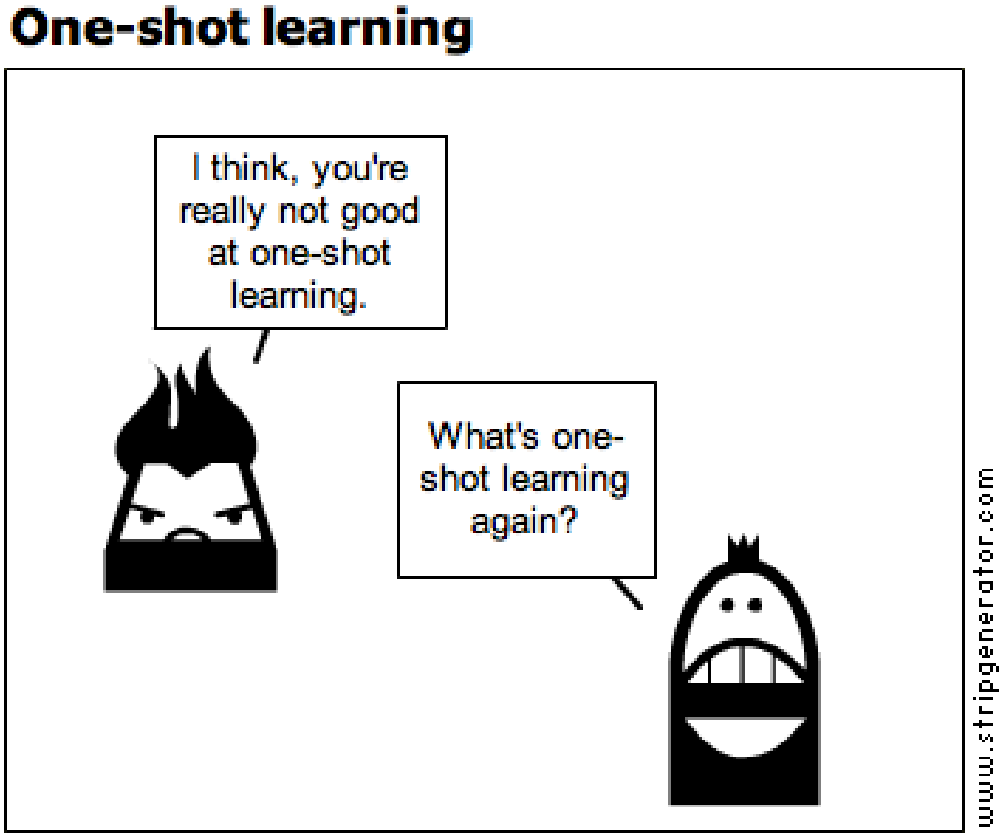


brute force for free with Moore's law

http://michaelgalloy.com/2013/06/11/cpu-vs-gpu-performance.html

But is this quite enough?

- Data needed grows exponentially
- Performance asymptote is (too) low
- This is not how we learn



- Progress with skills learning

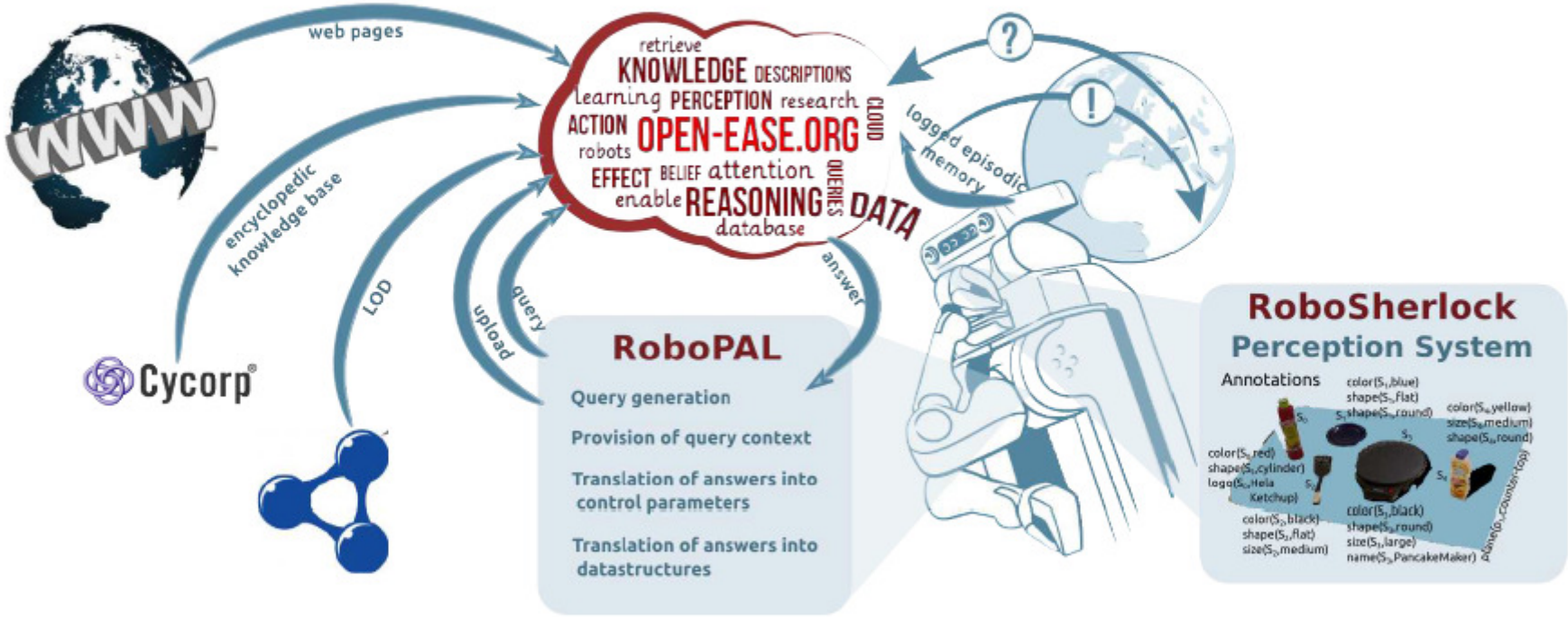
→ **SME robotics video**

→ **RoboHow video**

Performing everyday tasks

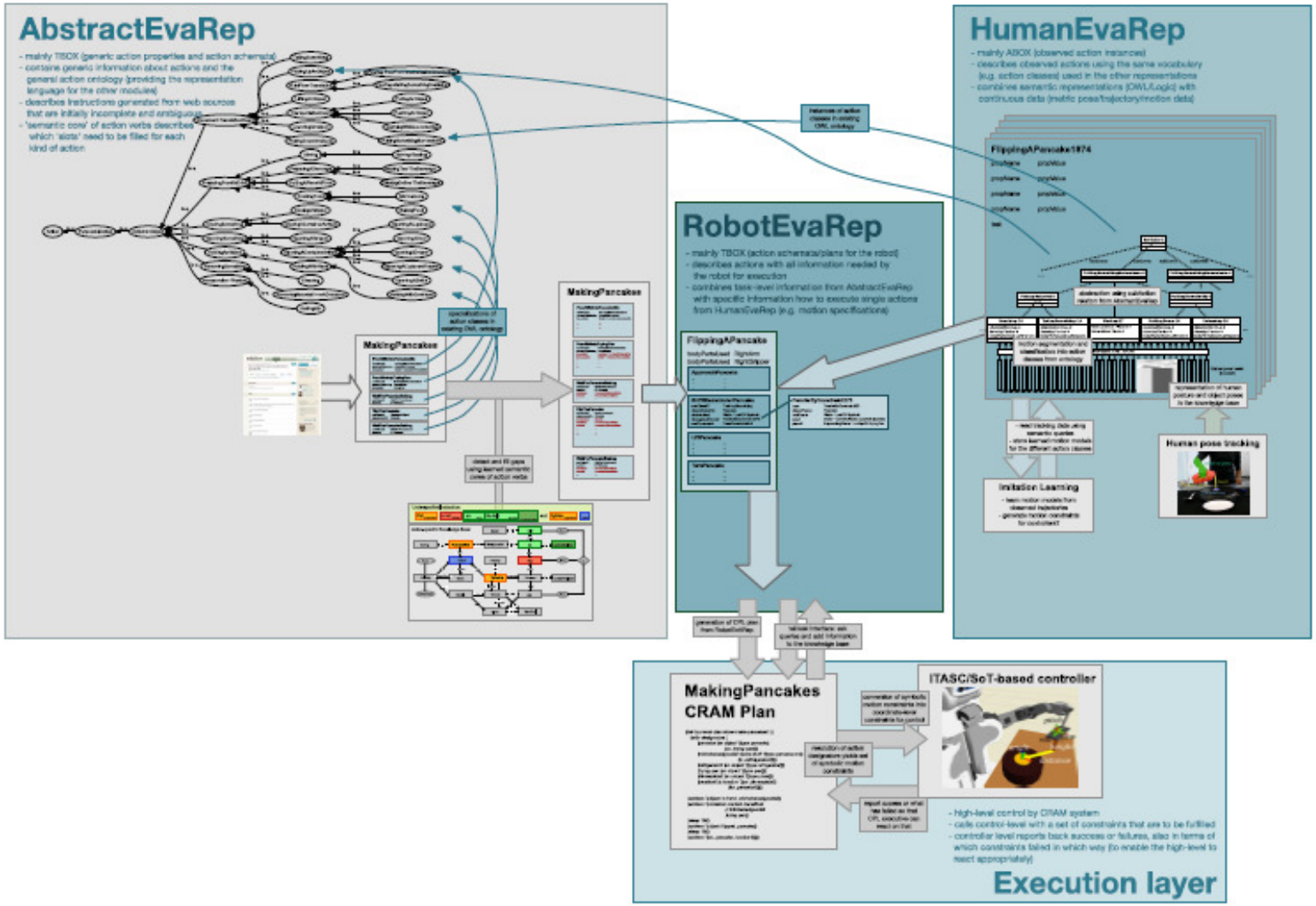
- See video at https://youtu.be/cTCJSNjTdo0

Step Change 1: Representation and Reasoning
Step Change 2: Perception
Step Change 3: Semantic Manipulation



Insights: amount, breadth & depth of knowledge needed to perform “simple” tasks

Representations in RoboHow



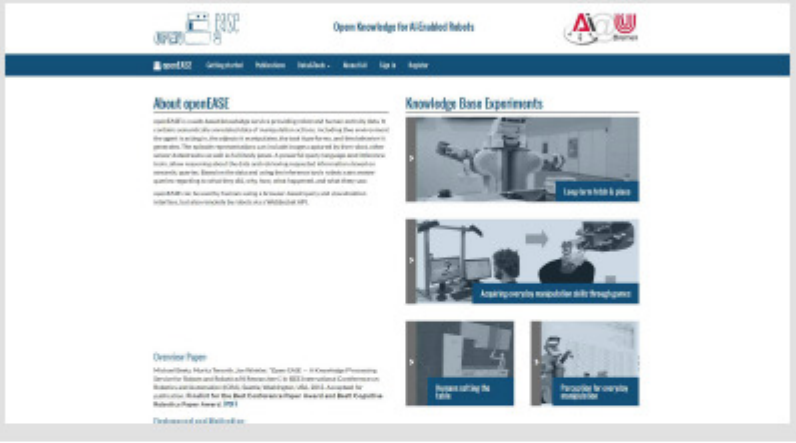
The how of RoboHow

- See video at https://youtu.be/0eIryyzlRwA

1:09

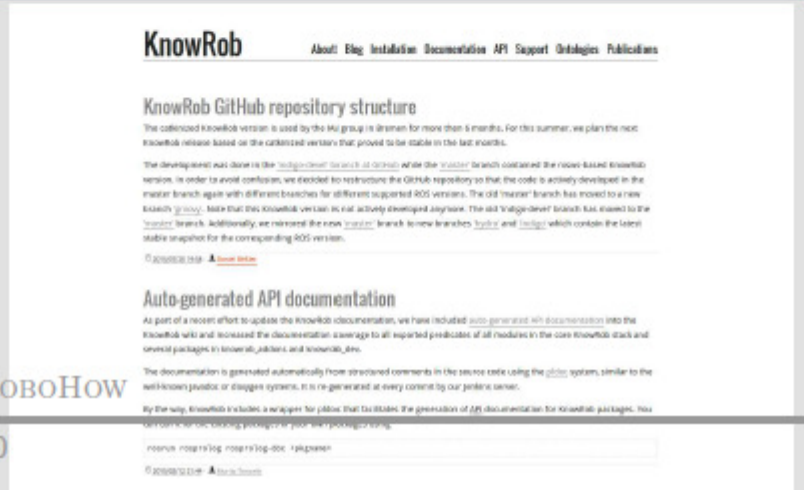
RoboHow Open Tools for . . .

open research/innovation



probabilistic reasoning

knowledge processing



perception

Collaborative robots

All major suppliers
Roots in Research
User interest

Comau

Rethink

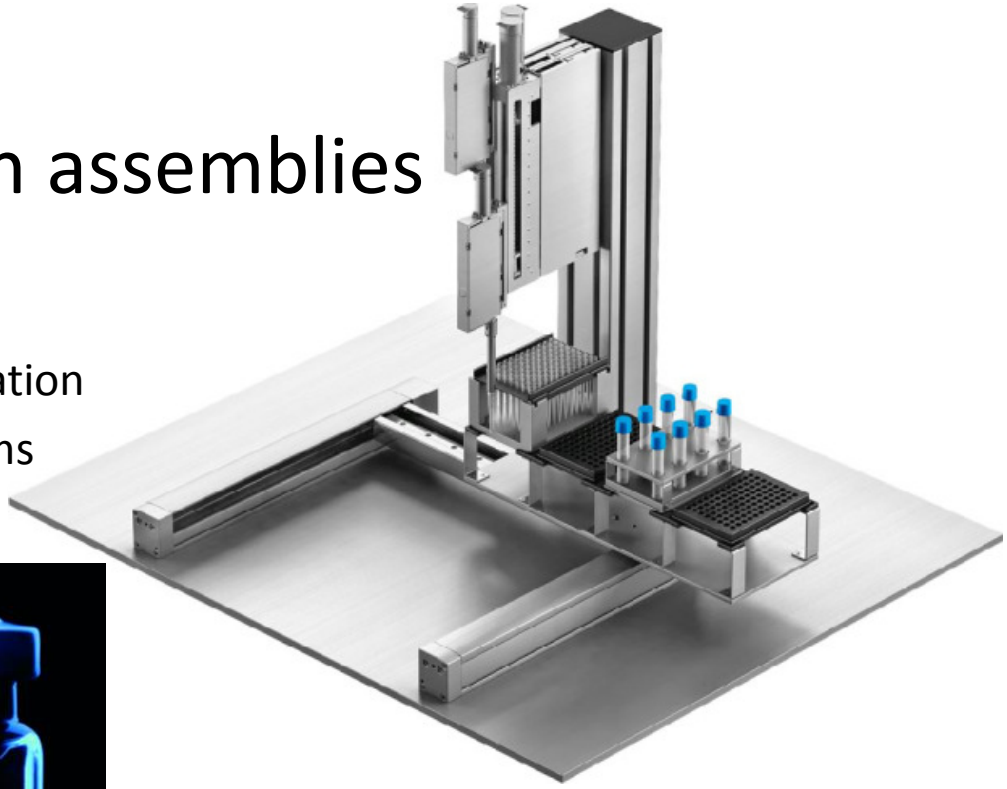
ABB YuMi

Stäubli

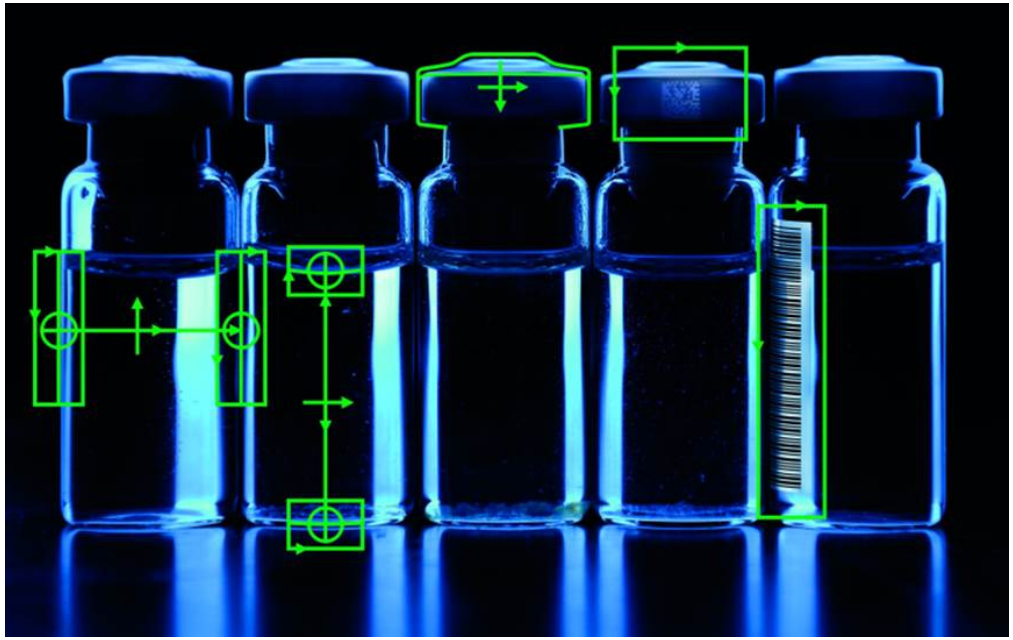
Sample logistics and manipulation

Smarter subsystems

Actuation assemblies



higher level smart subsystems for integration
to produce more capable &robust systems



Sensing assemblies

Cognex, Festo

HYFLAM - A Hyper-Flexible Work Cell for Biochemical Lab Automation

- See video at https://youtu.be/eFFJ_bG2M48

Rodbots for more delicate tasks

- See video at https://youtu.be/CFCYuYNamIc

To more freely behaving objects

- See video at https://youtu.be/gygxZRXZgWI

Reference: Thrishantha Nanayakkara, Allen Jiang, María. R. Armas Fernández, Hongbin Liu, Kaspar Althoefer, Joao Bimbo, “Stable Grip Control on Soft Objects With Time Varying Stiffness”, in press, **IEEE Transactions on Robotics,** vol. 32, no. 3, pp. 626-637, 2016

Mobile robots

- Adept Lynx platforms

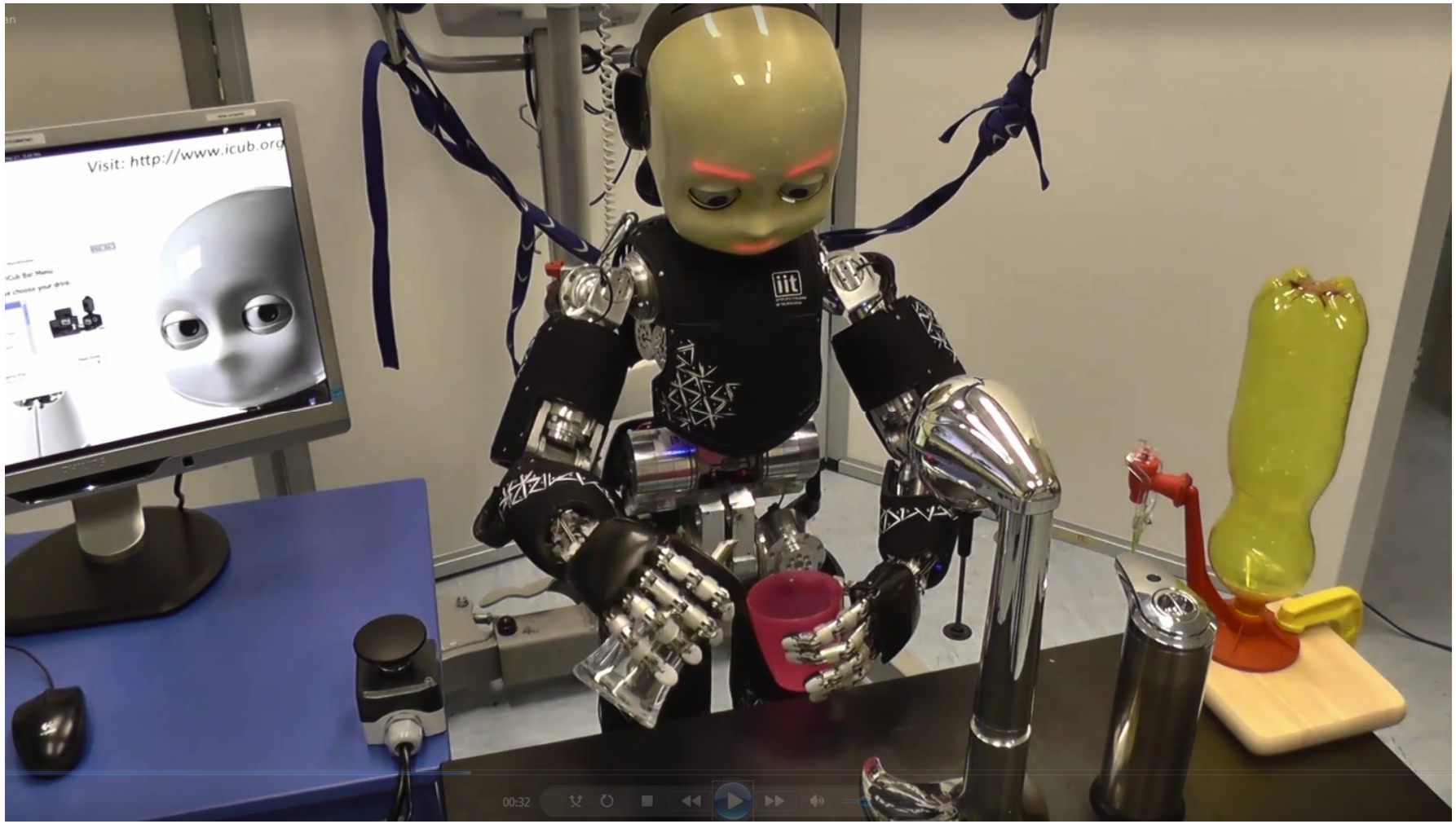
Bosch APAS

Humanoid robots

- Nextage: Hitachi

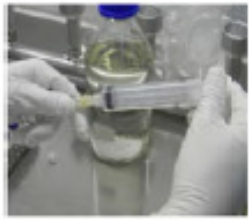
- Motoman MC10
- Yaskawa
- iCub

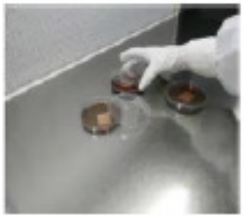
iCub as an open source platform



IIT/Telerobot GSK case study

Sterility batch sample test – in line maintenance





Cooking robot works from a recipe

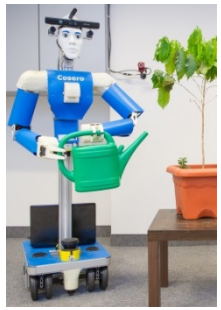
- See video at https://youtu.be/SNy6fEuPWbc

Bringing it all together:
The Healthcare Lighthouse vision



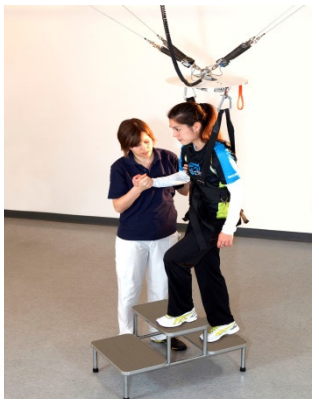
Laboratory

Care

Surgery



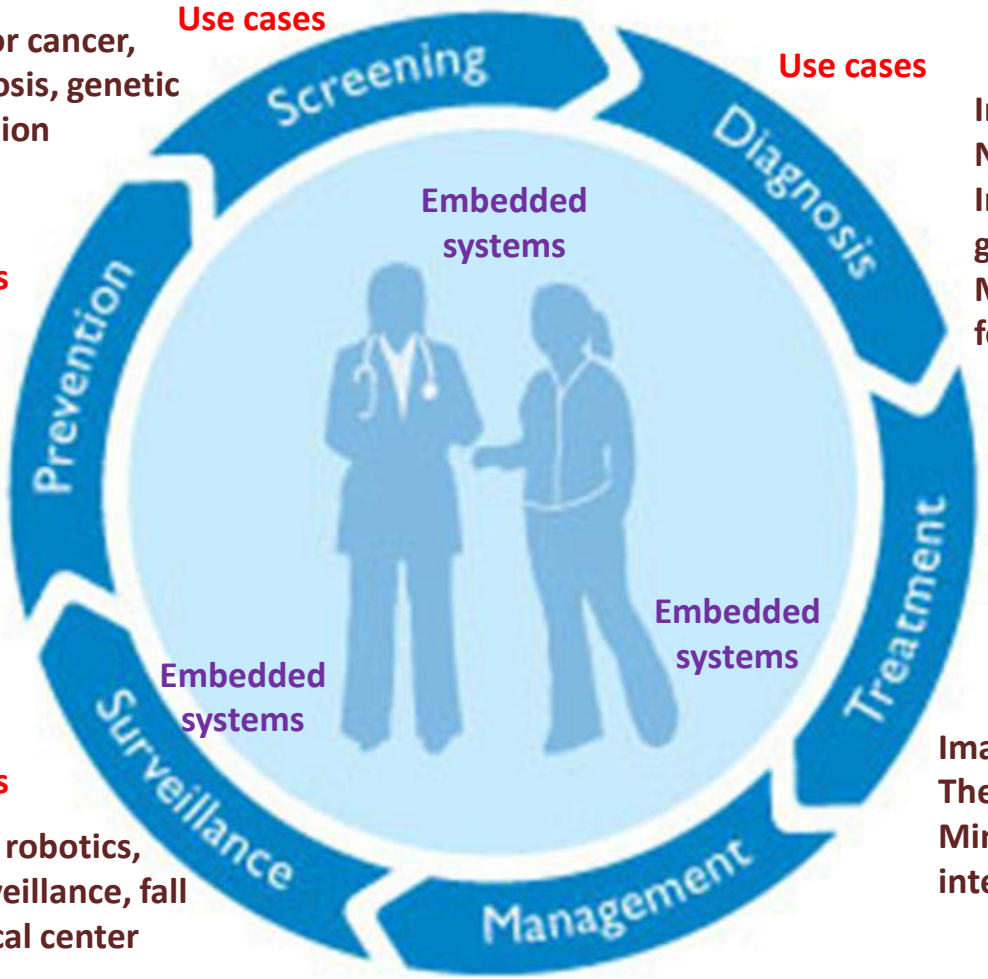



Rehabilitation

Robotics in healthcare as Patient-centred

Care Pathways

- **Cardiology**: prevention & early detection, miniinvasive treatment, chronic disease management
- **Neurology**: early diagnosis,effective treatmen, chronic disease management
- **Oncology**; early diagnosis, effective treatment, chronic disease management
- **Infection**: surveillence, diagnosis, vaccine / drug development, trials, treatment, management
- **Degenerative diseases**: stem cell collection, manufacturing, treatment, management



Use cases

Screening for cancer, atherosclerosis, genetic pre-disposition

Use cases

In vivo diagnosis: ECG, US, NM, CT, MR
In vitro: biomarkers, genetics
Minimal invasive robotics for diagnosis

Use cases

Life style management, assistance, cognitive and physical stimulation

Use cases

Image Guided Interventional Therapy (X-Ray, US, MR)
Minimal invasive robotics for interventions

Use cases

Assitive & rehabilitation robotics, activity monitoring, surveillance, fall detection, alert to medical center

Emeryville, CA, USA

Emerald Cloud Lab

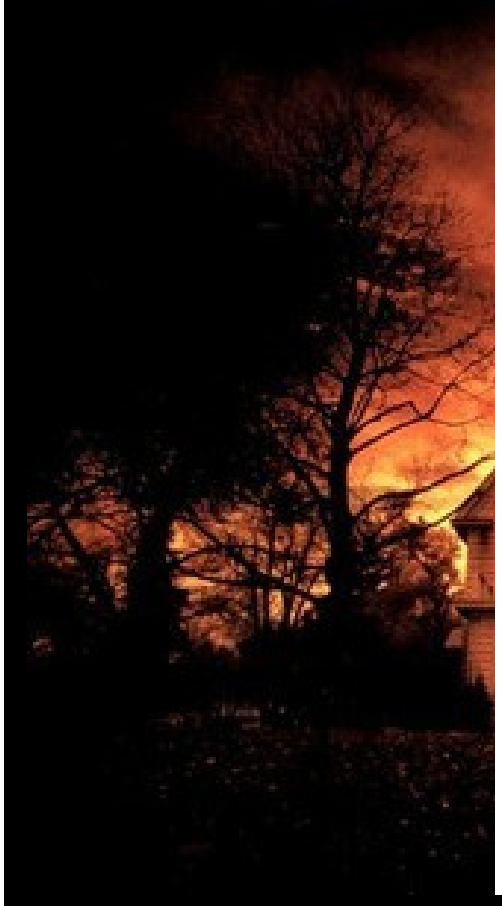
“big data + robots = all problems solved”

THE EMERYVILLE HORROR

5 NOVEMBER 2015 | VOL 527 | NATURE

Tech investors bet on synthetic biology

Once hesitant, Silicon Valley venture capitalists are warming to the idea of engineered cells.



MONEY FOR MICROBES

Investments in synthetic-biology start-ups have increased dramatically in the past three years. Much of the funding comes from prominent technology investors.

COMPANY	YEAR FOUNDED	BUSINESS	TOTAL FUNDS (US$)	NOTABLE INVESTORS
Twist Bioscience	2013	DNA synthesis	$82.11 million	Yuri Milner (Internet-company investor)
Zymergen	2013	Microbial-strain optimization	~~$44 million~~ $133M	Obvious Ventures; Eric Schmidt (Alphabet executive chairman)
Ginkgo Bioworks	2008	Microbial engineering	$54.12 million	Matt Ocko (Facebook and Zynga investor)
Bolt Threads	2009	High-performance fibres	$40 million	Peter Thiel and Max Levchin (PayPal co-founders)
Transcriptic	2012	Robotics for biology labs	$14.37 million	Jerry Yang (Yahoo co-founder)
Riffyn	2014	Software	$1.8 million	O'Reilly AlphaTech Ventures
Emerald Therapeutics	2010	Technology platforms	$34 million	Peter Thiel and Max Levchin

More details and information about European Robotics Forum 2017 at

www.erf2017.eu

Contact us at
info@erf2017.eu

8th EUROPEAN ROBOTICS FORUM

22 – 24 March 2017
Edinburgh, Scotland
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Edinburgh International Conference Centre
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Thanks to 80+ organisations

- Associations: ELRIG, SiLA
- 19 End users: GSK, AstraZeneca, Böhringer, Curie Inst, QUT, Actelion, Novartis, Synthace, Sellafield, Unilever, Johnson Matthey, Milan University hospital, Lonza, Cell therapy Catapult, UCB, MIB, EMBL, Pasteur, NHM
- 42 Suppliers: Roche, Agilent, TTP Labtech, Hamilton, Cytomate, Cognex, Bosch, SMC, Tecan, BEE robotics, Shadow Robot, Festo, TAP/Sartorius, Waco automation, LGC, BioMérieux, Titian Software, Telerobot, Renishaw, Chemspeed, Labman, Analytik Jena, ABB, Kuka, Brechbuehler, Liconic, HiRes, Eppendorf, Qiagen, Bionic Robotics, Bertin, Singer Inst., Mitsubishi, Precise, Universal, Schunk, Aseptium, Adept, PAA, Integra, Helbling
- 5 RTOs: Fraunhofer IFF/IPA, CSEM, VTT, IIT
- 20 Academics: University of Manchester, University of Bielefeld, Brunel, Birmingham, Bristol, Bremen, TCI Hannover, Dresden, Rostock, Liverpool, TU München, FH Buchs, Rapperswil, Imperial, Kings college, Copenhagen, Strathclyde, Aachen, TUT, TUWien

- Thank you for listening