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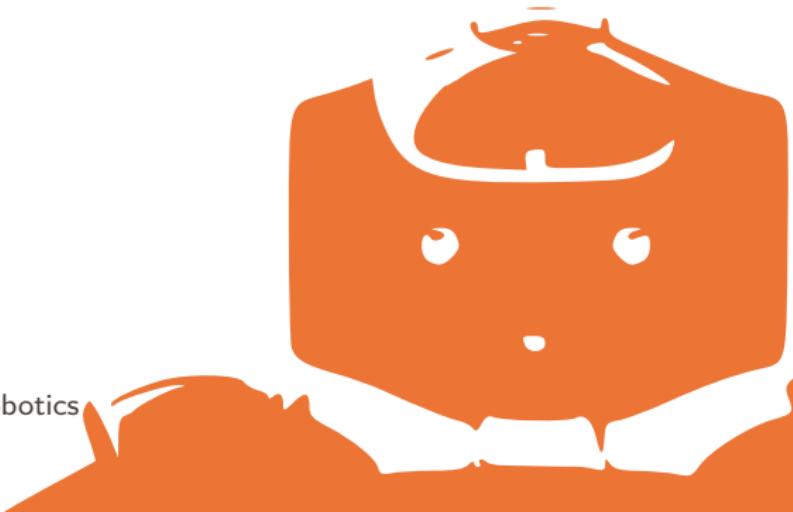
You can download the sources of this presentation here:  
[github.com/severin-lemaignan/module-mobile-and-humanoid-robots](https://github.com/severin-lemaignan/module-mobile-and-humanoid-robots)

# **ROBOTICS WITH PLYMOUTH UNIVERSITY**

ROCO318  
Mobile and Humanoid Robots  
Part 1 – Introduction

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Centre for Neural Systems and Robotics  
Plymouth University





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Lecture slides for Plymouth University's ROCO318 – Mobile and Humanoid Robots – Edit

20 commits

1 branch

0 releases

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severin-lemaignan Added a README

Latest commit 00d21e4 38 seconds ago

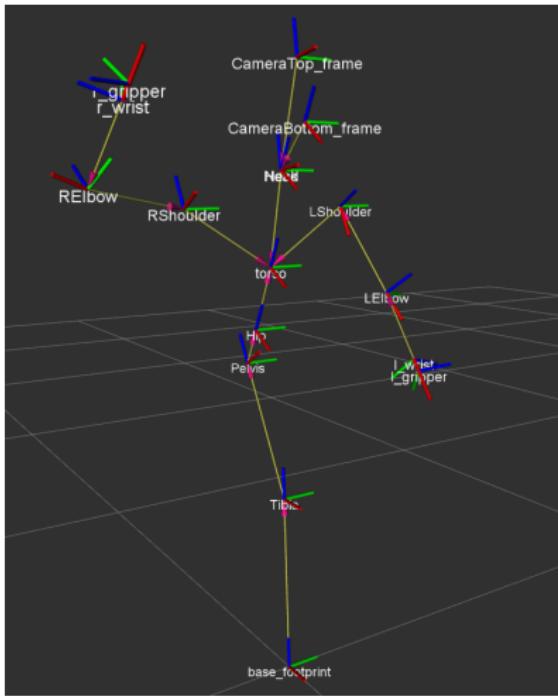
doc	Added a README	32 seconds ago
figs	[intro] Updated slides with pepper demo 'results'	7 minutes ago
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2-sensors-and-perception.tex	[chap2] Structure	5 days ago
Makefile	Update compilation infrastructure	5 days ago
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README.md

ROCO 318 -- Mobile and Humanoid Robots

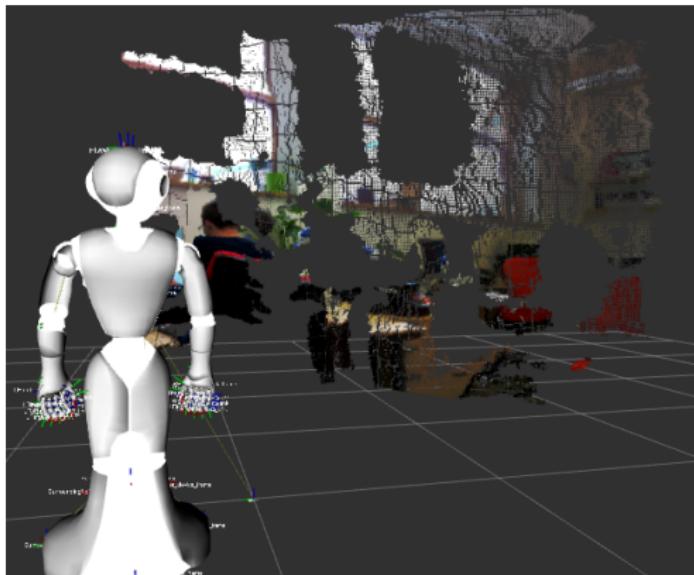


WHAT HAVE WE SEEN SO FAR?

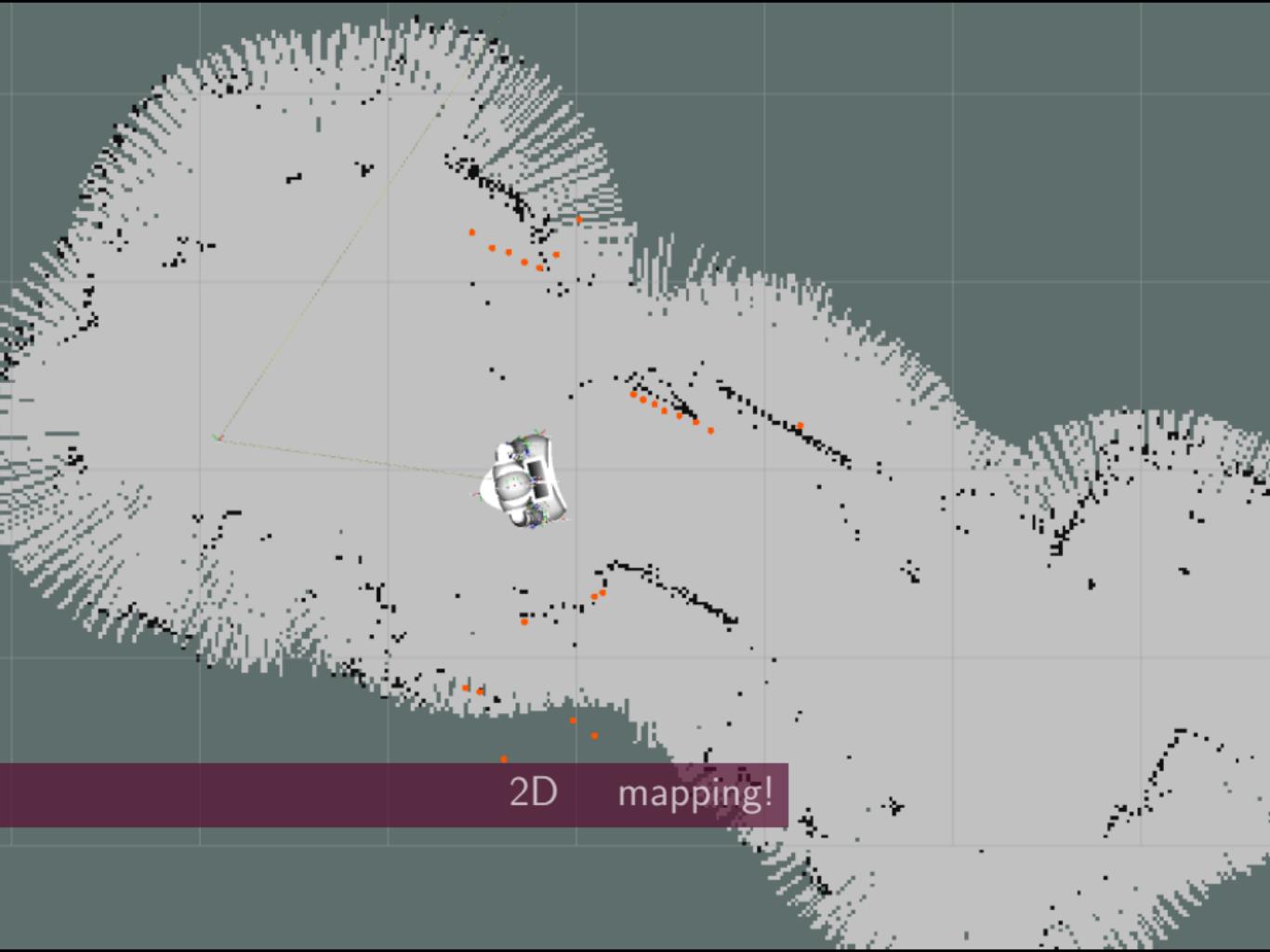


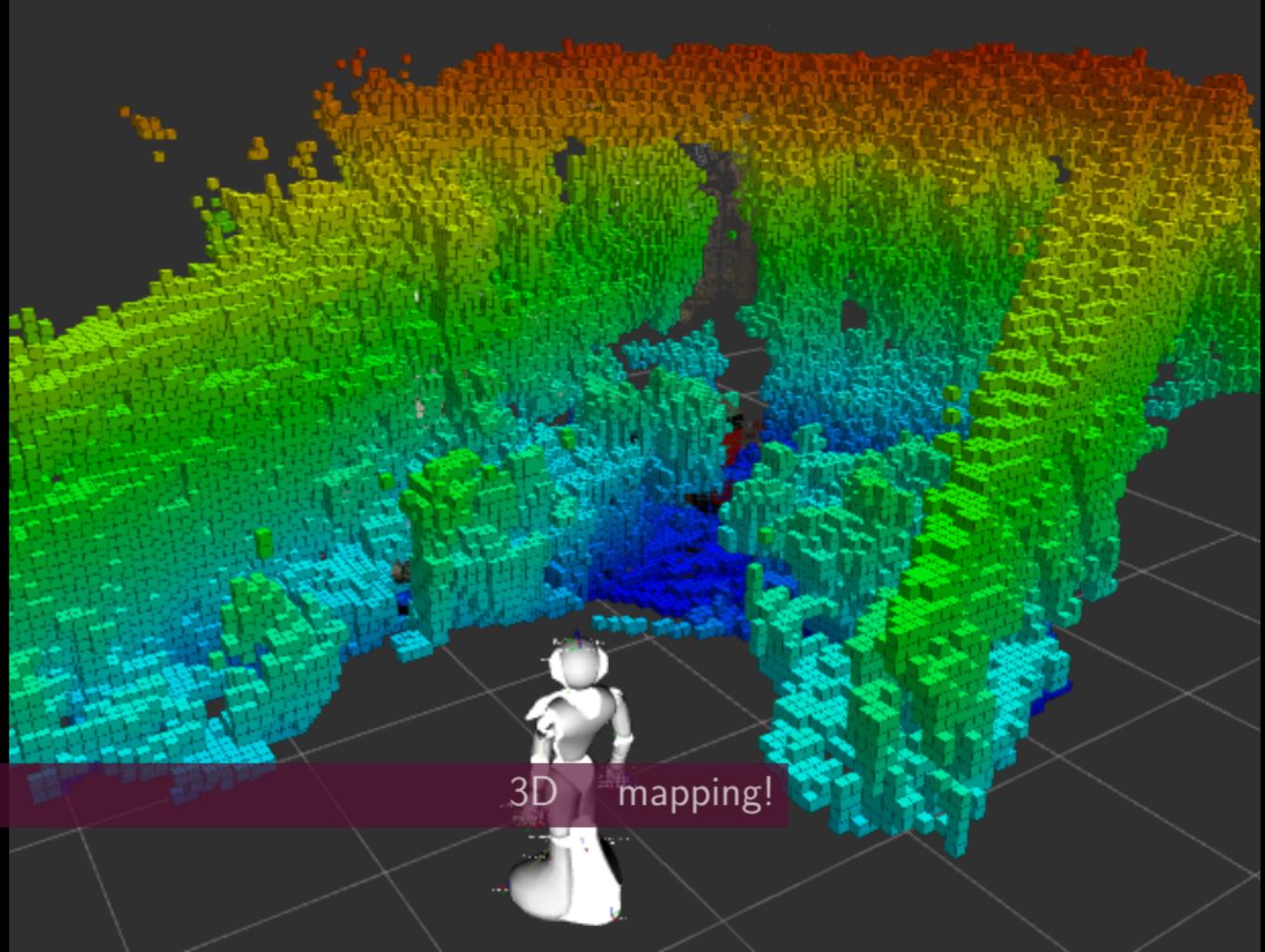
- **frames**
- **forward kinematics**
- **inverse kinematics**

## Lots of sensors!



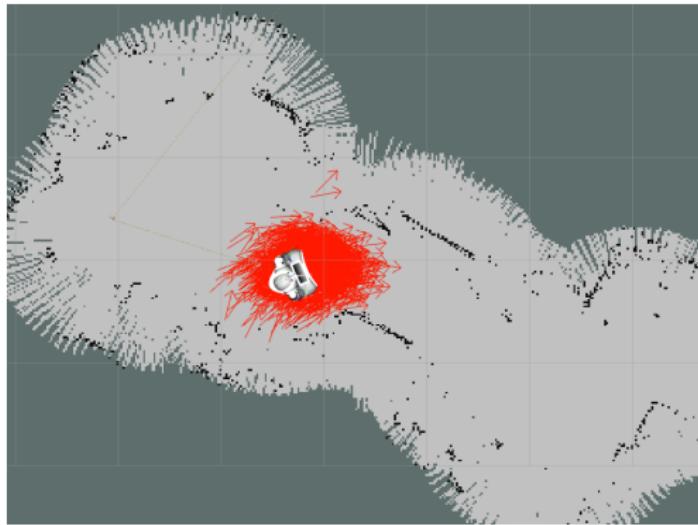
- **RGB-D cameras**, color + depth registration
- **Laserscans**
- **Sonars**,...



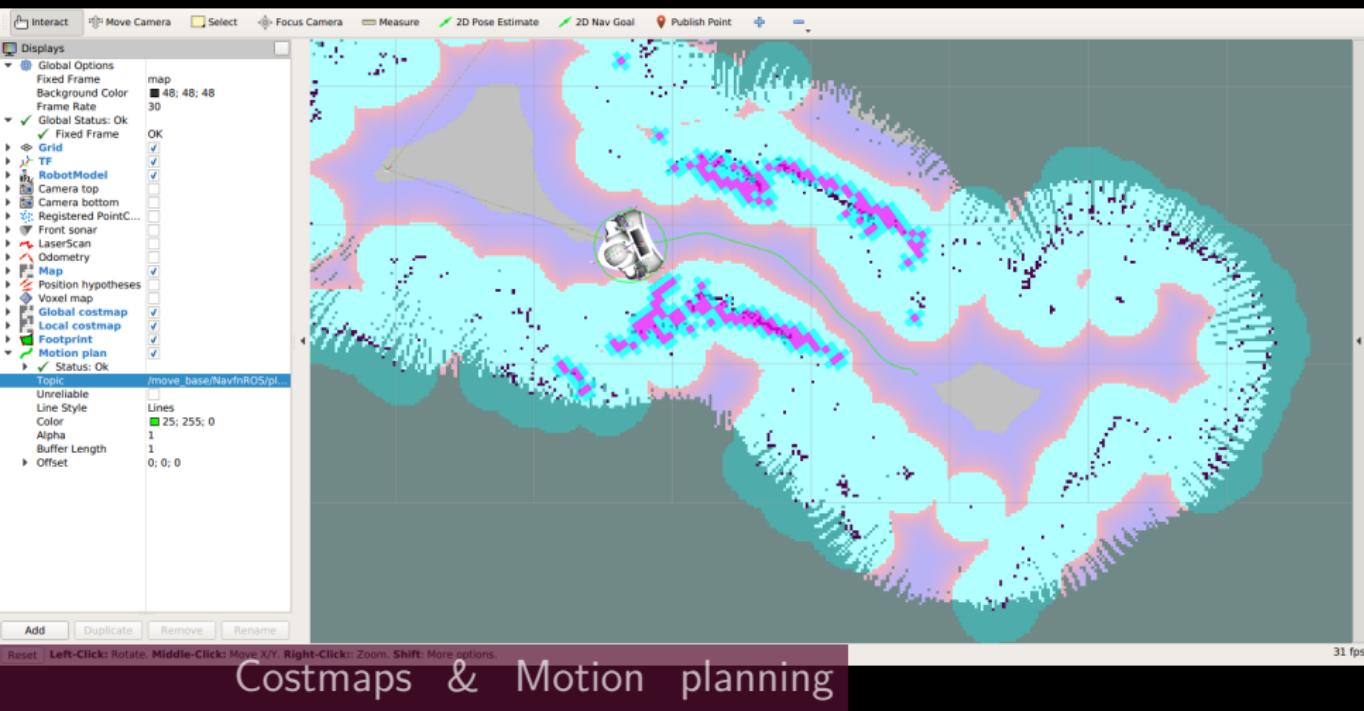


3D mapping!

## Odometry is not good enough



- **SLAM** (Simultaneous Localization and Mapping)
- using **probabilistic reasoning** (Monte-Carlo localisation)



Costmaps & Motion planning

Well, ROCO318 is over...

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(oh no, I forgot about the autonomous chairs...)



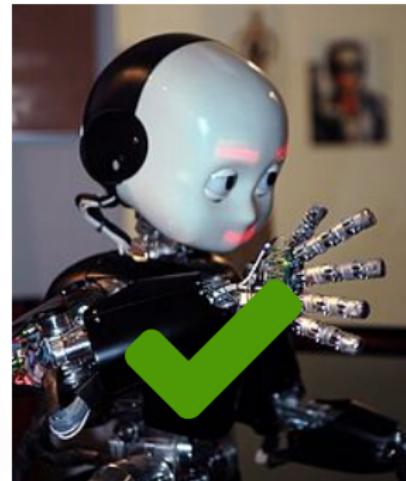
# MODULE OVERVIEW

# THIS MODULE

- Sensors for mobile and humanoid robots
- Computer vision
- Localisation
- Robot control
- Planning and navigation
- Bipedal robots

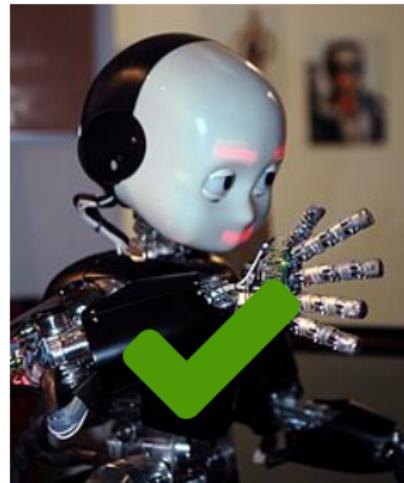
# THIS MODULE

How to build intelligent mobile/humanoid robots?  
≠ industrial automation!



# THIS MODULE

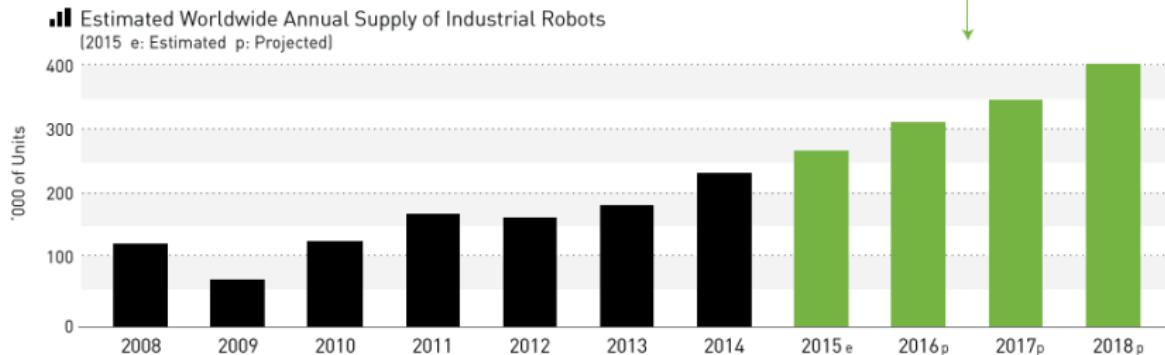
How to build intelligent mobile/humanoid robots?  
≠ industrial automation!



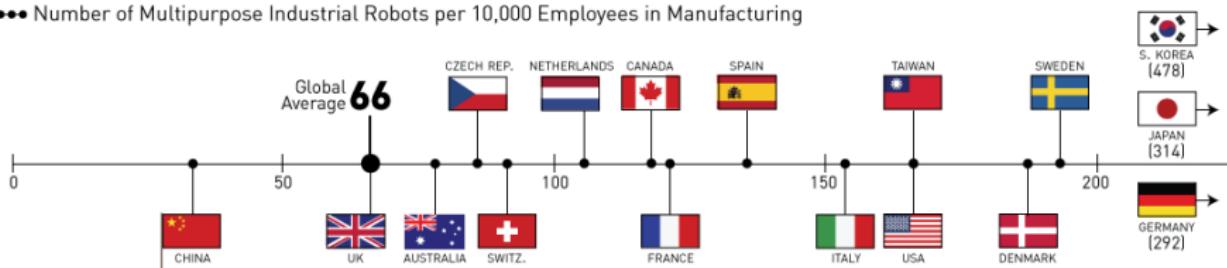
- **Hardware issues:** sensors, actuators, drive mechanisms, ...
- **Software issues:** robot control, computer vision, learning robots, ...

HOW WIDESPREAD?

The market for robot systems is growing at 15% pace, with 1.3 million new units installed by 2018



Number of Multipurpose Industrial Robots per 10,000 Employees in Manufacturing



China's robot density is just half of the global average.

Sales are rising fast. China will be home to one-third of the world's robots by 2018.

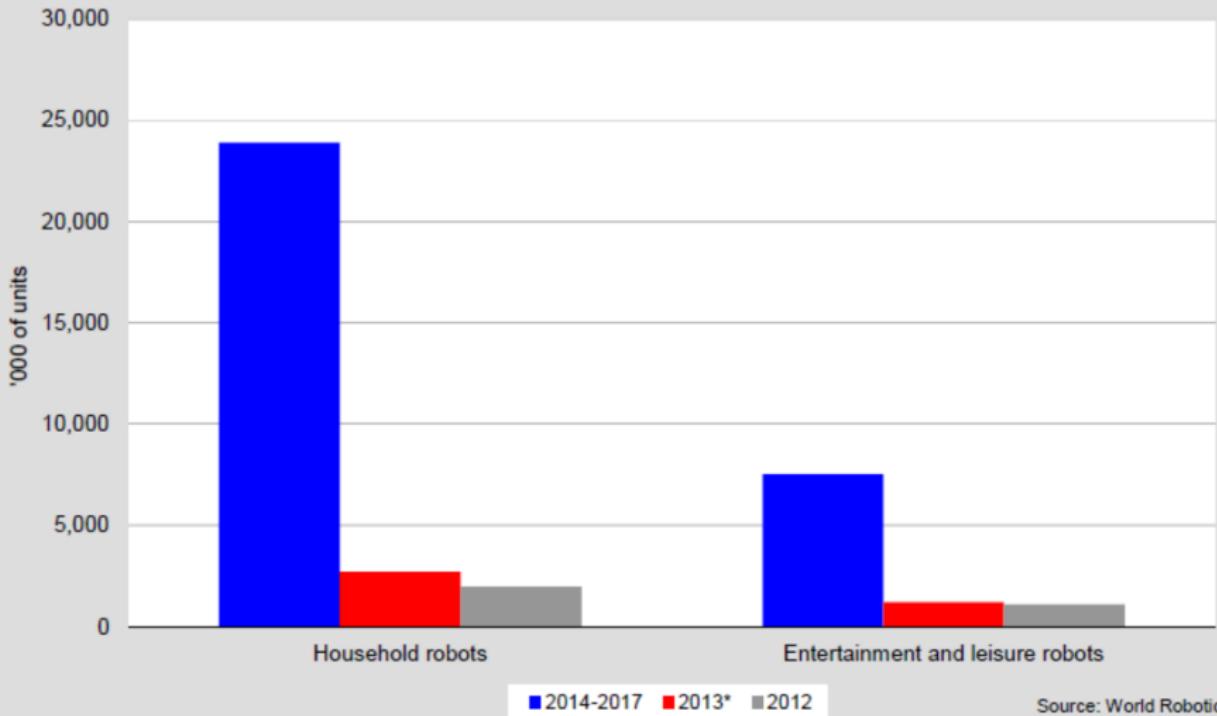
Source: World Robotics 2015

visualcapitalist.com



But...

**Service robots for personnel/domestic use.  
Units sales Forecast 2014-2017, 2013 and 2012**



Source: World Robotics 2014

# DOMAINS OF ROBOTICS

# SERVICE/DOMESTIC ROBOTS

## Service robots

- iRobot Roomba, 12M units sold.
- Samsung, LG, Dyson



## Edutainment robots

- e.g. KeepOn,
- Lego Mindstorms (original, NXT, EV3),
- RoboSapiens



# FLYING ROBOTS

Very popular research field and tremendous interest from the military, some civilian uses (e.g. aerial videoing).

Challenges: autonomy (control of flight parameters), localisation, energy autonomy, robustness.



- Raffaello D'Andrea's drone acrobatics
- U. Pennsylvania, Vijay Kumar's nano quadrotors (see also TED talk)
- EPFL's flying wing robot.

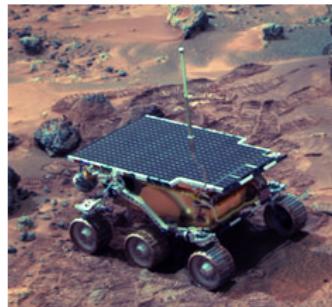
# SPACE EXPLORATION

Three Mars rovers:

- **Sojourner** touched down in summer 1997
- **Spirit** and **Opportunity** landed in January 2004
- **Curiosity** touched down 5 August 2012

All are fully teleoperated from earth. However, the sensors and software allow for autonomous obstacle detection and navigation.

Have survived 30x longer than planned: [marsrovers.nasa.gov](http://marsrovers.nasa.gov)



# MILITARY ROBOTS

Best selling “professional service” robot: 6500 units in 2011, 6100 in 2012, 9500 in 2013.



Modular Advanced Armed Robotic System (MAARS)

Video: iRobot packbot

# AUTONOMOUS CARS

**2005:** Darpa Grand Challenge; >200km race in Mojave/Nevada desert



*Source: Wikipedia*

# AUTONOMOUS CARS

**2007:** Darpa Urban Challenge; 100km in urban environment, must obey all traffic regulations



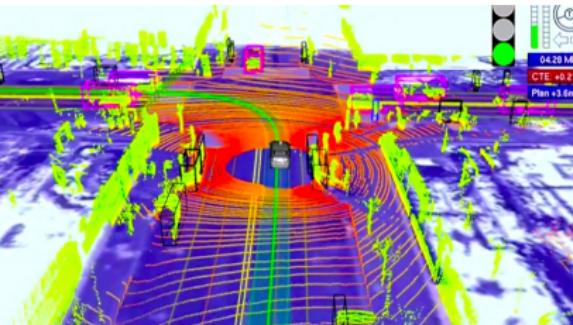
*Source: Wikipedia*



*Source: Wikipedia*

# AUTONOMOUS CARS

## Google Driverless cars



Source: *Engadget*

Source: *IEEE Spectrum*

24 Lexus + 34 'Google Cars'; between 2009 and August 2016,  
autonomously driven  $\approx$  2 000 000 miles

# AUTONOMOUS CARS

## Uber autonomous taxis



*Source: Bloomberg*

100 Volvo cars ...already driving in Pittsburg's streets! (with human supervision)

# HUMANOIDS

Human-like robots.

Tremendously challenging:

- Power,
- actuations,
- artificial intelligence,
- perception,
- control,
- walking, ...
  
- Honda Asimo latest version
- Boston Dynamics Petman prototype and obstacle negotiation.
- DARPA Robotics challenge 2015 outtakes



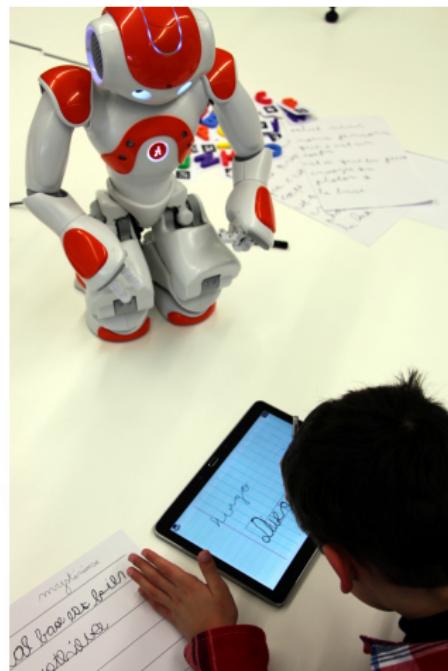
# AND WHAT DO I DO?

## Cognitive robotics

Building robots and their artificial intelligence inspired on natural systems, such as developing children

## Human-Robot Interaction

Building robots that can work alongside people, using social cues that people use to communicate



# That's all, folks!

See you on Friday, 13:00, for the first lab

Questions:

Portland Square A216 or **severin.lemaignan@plymouth.ac.uk**

Slides:

[github.com/severin-lemaignan/module-mobile-and-humanoid-robots](https://github.com/severin-lemaignan/module-mobile-and-humanoid-robots)