

Robotics Training - Day 1

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Introduction

Name: Mirka Leino

University: Satakunta University of Applied Sciences, Finland

Education: PhD (Tech), MSc (Tech)

Duties: Project lead and education in automation

Research focus: Intelligent machine vision systems and future robotics for smart manufacturing



Learning outcomes of the training

- Absorb a holistic view to smart industrial robotics
- Get to know the principal features that enable the advanced robots



Content of the Training

Definition of Smart manufacturing from the robots' point of view

Holistic view to smart industrial robotics

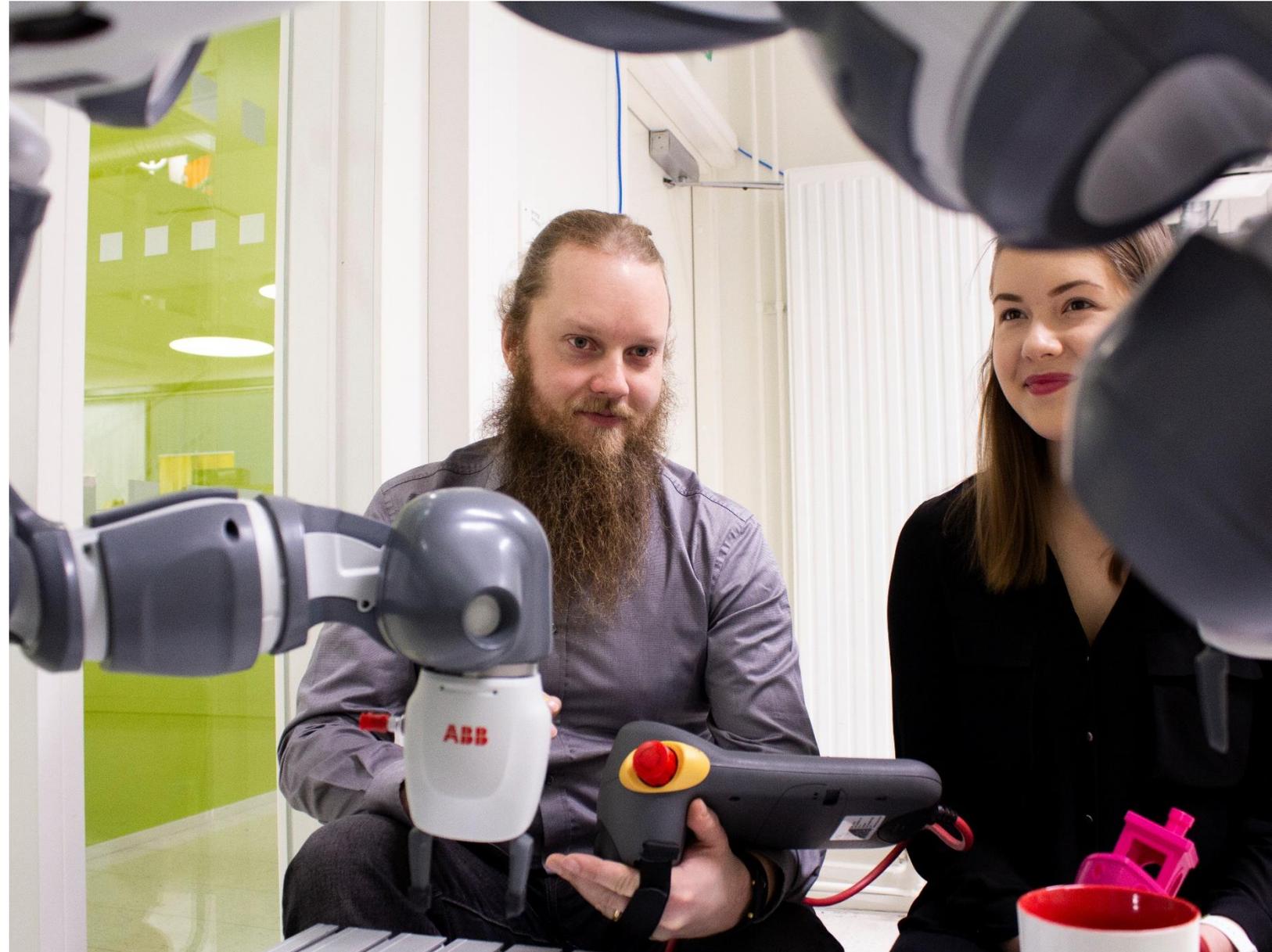
Smart Robots are coming – What does it mean?

Examples of smart industrial robots driving manufacturing growth

Collaborative robots

QA-oriented robots

Sensor integration in smart manufacturing robots



Schedule of the robotics training

Mon 25.1.2021	Tue 26.1.2021	Wed 27.1.2021	Thu 28.1.2021	Fri 29.1.2021
Webinar: Smart Robots in Smart Manufacturing + briefing for assignment 1	Assignment 1 <i>(Inquiry-Based Learning at your own time)</i>	Webinar: Collaborative robots and QA-oriented robots + briefing for assignment 2	Assignment 2 <i>(Inquiry-Based Learning at your own time)</i>	Webinar: Sensor integration and smart tools in smart manufacturing robots + training conclusion
Webinar schedule (CET): 14.00-14.55 Part 1 14.55-15.05 Break 15.05-16.00 Part 2	Independent work	Webinar schedule (CET): 14.00-14.55 Part 1 14.55-15.05 Break 15.05-16.00 Part 2	Independent work	Webinar schedule (CET): 14.00-14.55 Part 1 14.55-15.05 Break 15.05-16.00 Part 2

Employees in the factory of the future

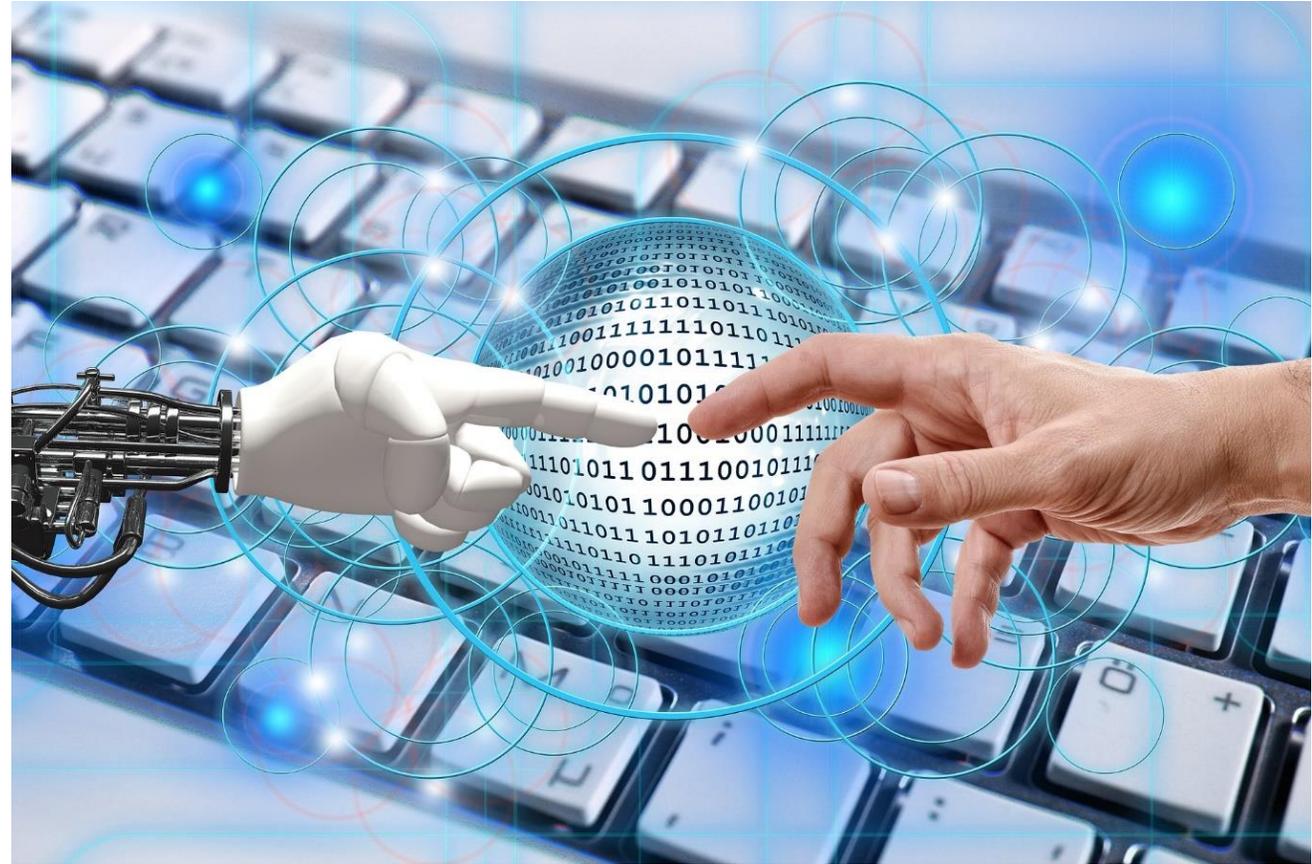
“The factory of the future will have two employees: a human and a dog. The task of the human will be to feed the dog. The dog will have the task to dissuade the human to touch the automated systems.” (Warren G. Bennis)

2011: Industry 4.0

Big investments in the development of intelligent production.

The balance between people and automation is challenging to achieve.

The importance of technologies is usually overestimated in the short term but underestimated in the long term.



Smart manufacturing

- Using intelligent manufacturing processes connected to their digital twins with a real-time connection
- Digital twin predicting and analyzing the processes all the time
- Real-time expert knowledge based support to the processes through digital twin
- Expert knowledge utilizes AI, IoT, Big data analysis and cloud computing in decision making
- Solving the challenges with the help of AI and deep learning

(Evjemo et. al. 2020; Wan 2019)



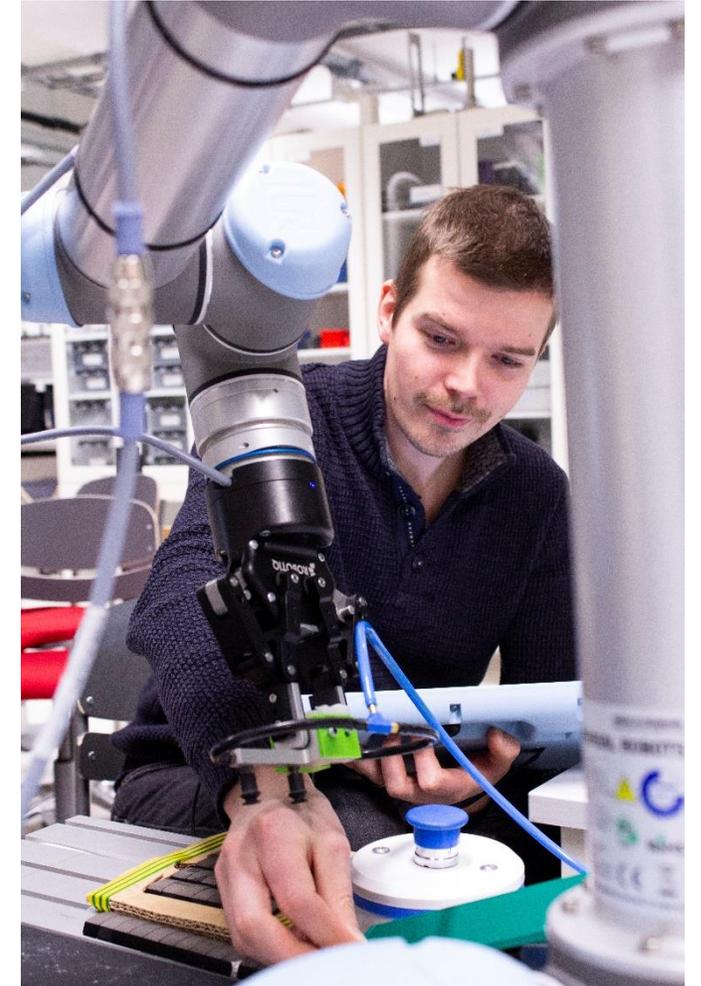
Humans ja robots in smart manufacturing

Past in factories: Traditional Industrial Robots work separately from humans.

Today: People have improved access to the robots works areas.

Future: Real-time and close human-robot collaboration (HRC).

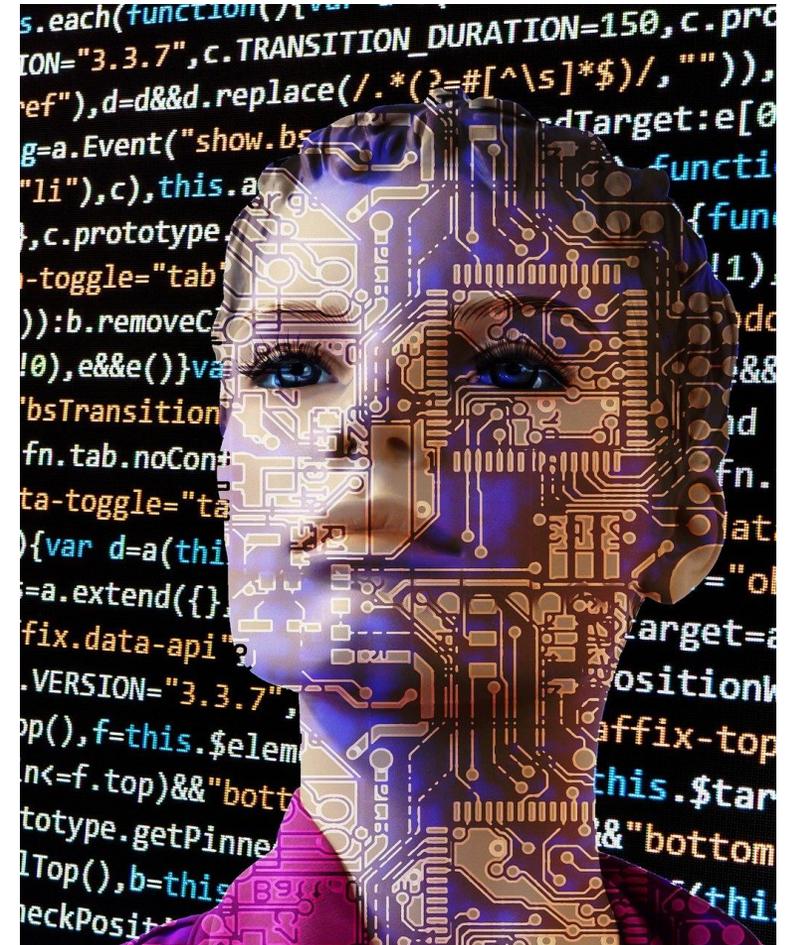
Collaborative robots + humans = combination of robots' precision and tirelessness as well as human cognitive and sensorimotor skills



Holistic view to smart industrial robotics

Robotics will change the world! It will unleash the same if not an even more disruptive and transformational power within the next 50 years as mainstream IT-technology and the Internet have in the last half of a century (Boesl & Liepert 2016).

1. Robot-Based Automation Solutions
2. Sensitive and Safe Robot-Based Automation
3. Mobile, Sensitive and Safe Robot-Based Automation
4. Perceptive and Cognitive, Mobile, Sensitive, Safe Robot-Based Automation



Smart industrial robots driving manufacturing growth

- The age of smart manufacturing: advances like the Industrial IoT, artificial intelligence, augmented reality and machine learning are here to change everything
- Urgent need for a new culture and processes when implementing smart manufacturing
- Robots in smart manufacturing will
 - Reduce costs
 - Improve safety
 - Increase output and quality
 - Enable flexible manufacturing

**Smart robots are
coming**

SMART ROBOTS ARE COMING!

Prediction: In the following few decades, we all must give up on some routine tasks that we have, and our co-workers will be some type of a new machine!

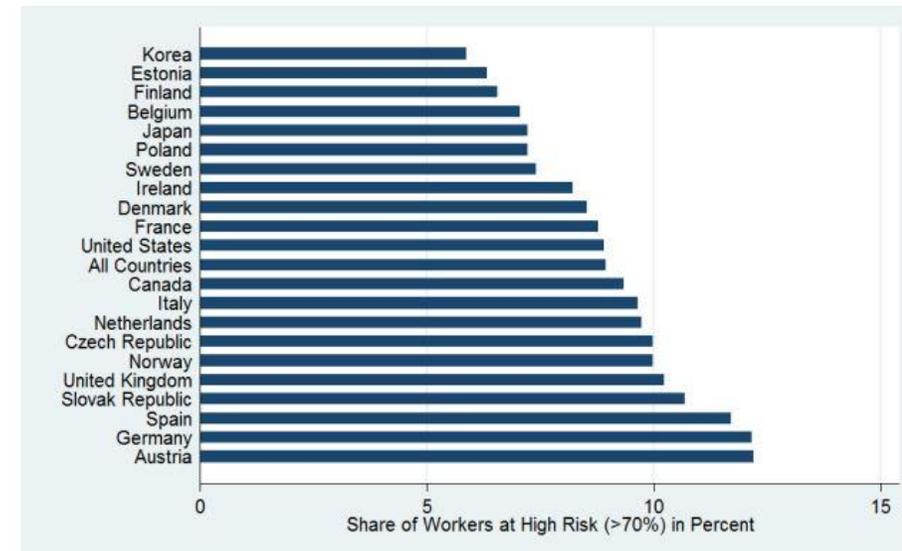
There's talk about another machine era:

Ways to produce, working life and changes in the society are compared to the changes which come with industrial revolution

Smart robots of the future

- Take over human tasks or (Replace humans in human tasks)
- Change human tasks
- Create new tasks for humans

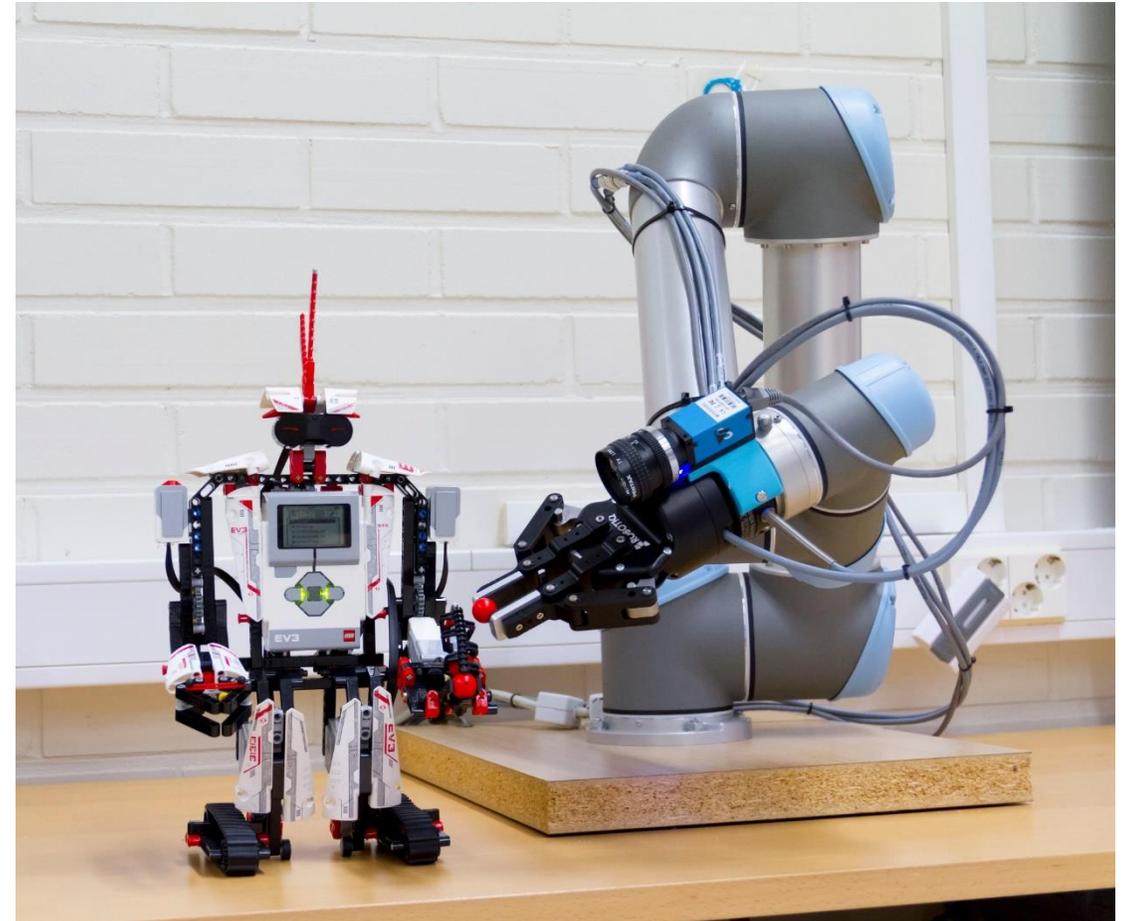
Robots are taking our jobs?



- New technologies are getting a foothold very slowly. Many issues are affecting the development, those are economical, legislation and social issues.
- Any adjusting workers will always find new tasks to do, and development in the industry keeps creating them
- History has shown that technological development has created more jobs than destroyed them.
- It has been calculated that automation e.g. in Finland will take around 7 % of the jobs in the next twenty years. 12 % of all the jobs keep disappearing every year.
- Development should not be slowed down → instead, look for new ways in which people and labour market could adapt in to the era of robots!

What type of tasks to robots? - Write in chat!

- Physically exhausting tasks
- Tasks that require precision
- Tasks that are dangerous and dirty
- Boring and long-running tasks
- **All tasks that can be defined**

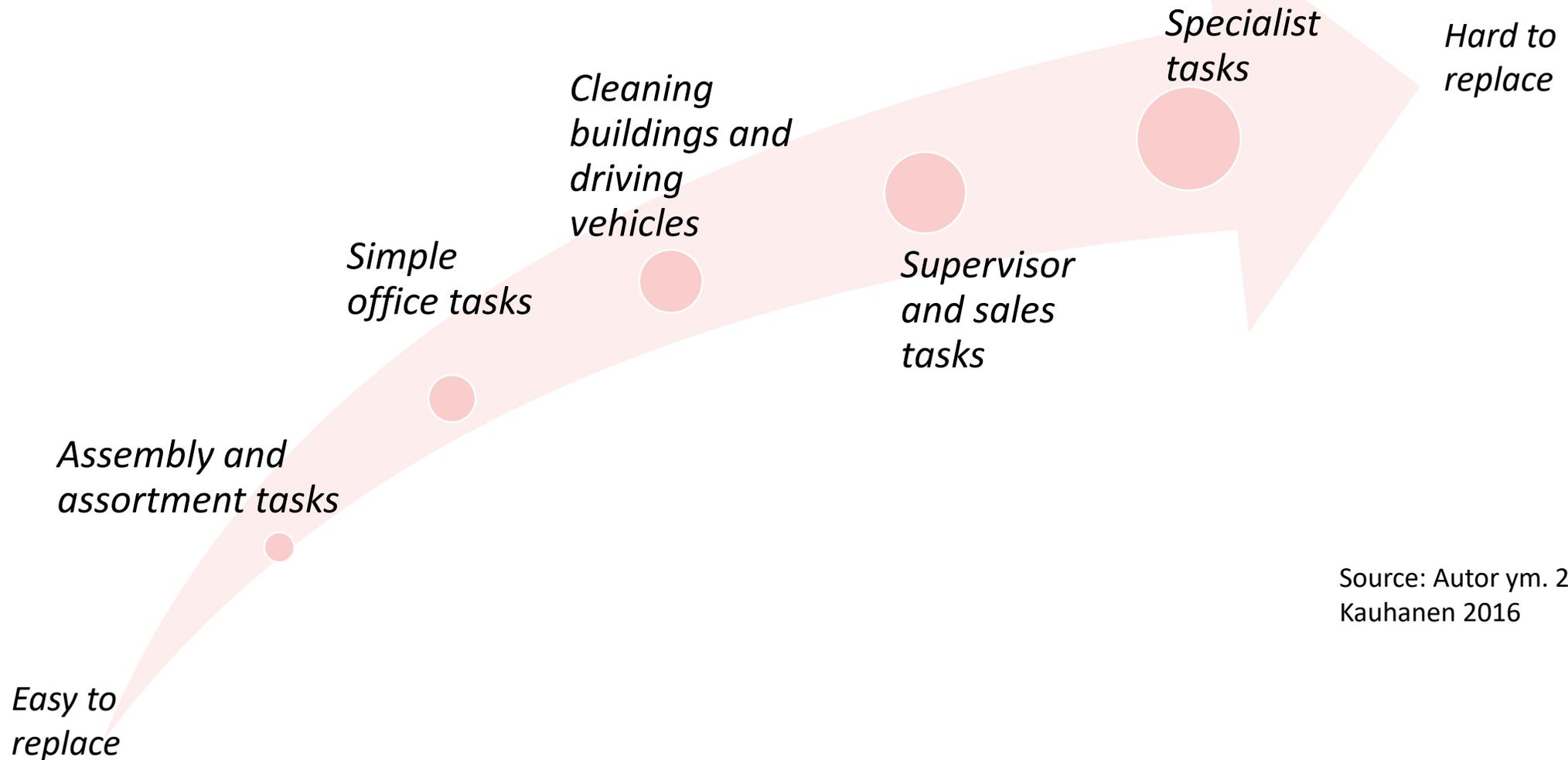


What type of tasks for humans? - Write in chat!

- Tasks that require human interaction and discretion
- Tasks, that can't be easily chopped down to small routines (= the ones that can't be defined)
- Tasks which require knowledge that's only acquired by experience
- ➔ Humans have certain advantages over robots, such as ability to solve problems on the go and handling complex communication between people



Replacing a worker with a robot



Source: Autor ym. 2003 and
Kauhanen 2016

Robots now

We're still in the situation where creating robots and the combining of technologies that they require is challenging

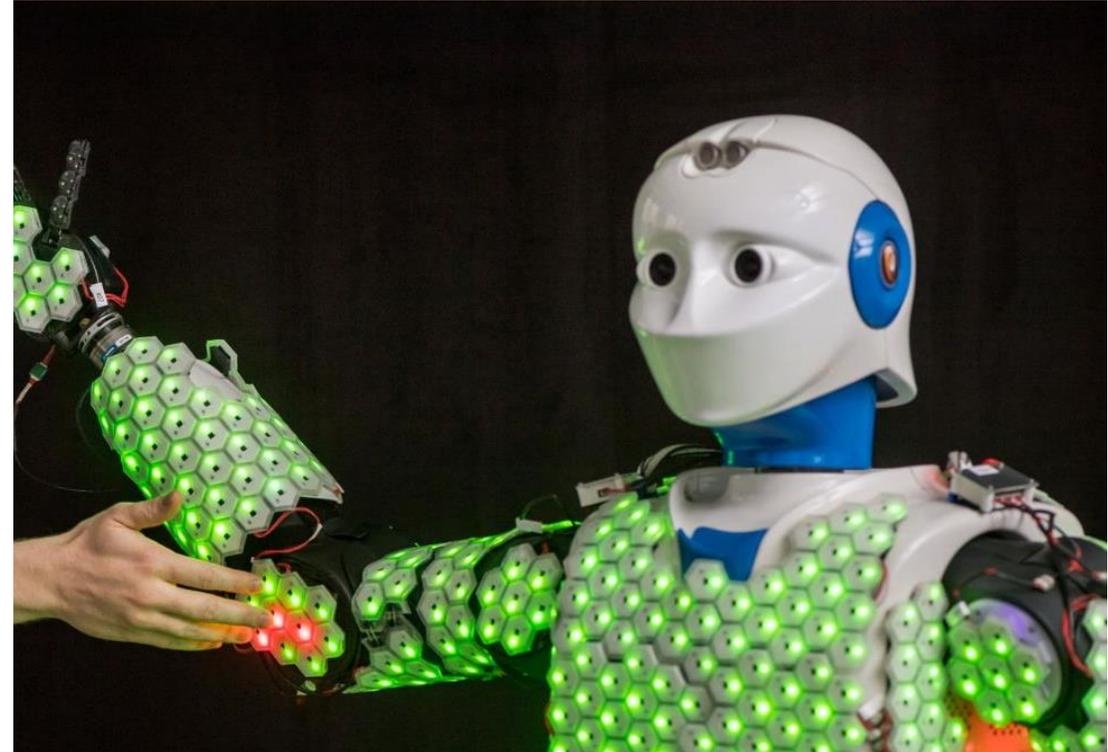
Robots work in very specific environments and in specific tasks in those environments.

→ Adaptive robots are still hard to program



Robots are evolving

- Human's ability to recognize shapes has been phenomenal so far.
- The development of artificial intelligence makes more and more work tasks routine → robots can do those in a breeze
- Machine "senses" are soon in the same starting line as human senses.
→ These kind of robots, which have humanlike vision and feeling senses can clearly do more tasks than normal industrial robots
- Innovations focus on technologies which are hoped to bring economic benefit!



Human tasks develop

Even though robots are overwhelming in several tasks, the replaced human's contribution should be utilized.

- Humans should focus on different amenities, because in those, we're least worst compared to a robot.
 - Robots manufacture products and execute simple service tasks
 - Humans should focus on developing and creating new services

The strength of man is human capital

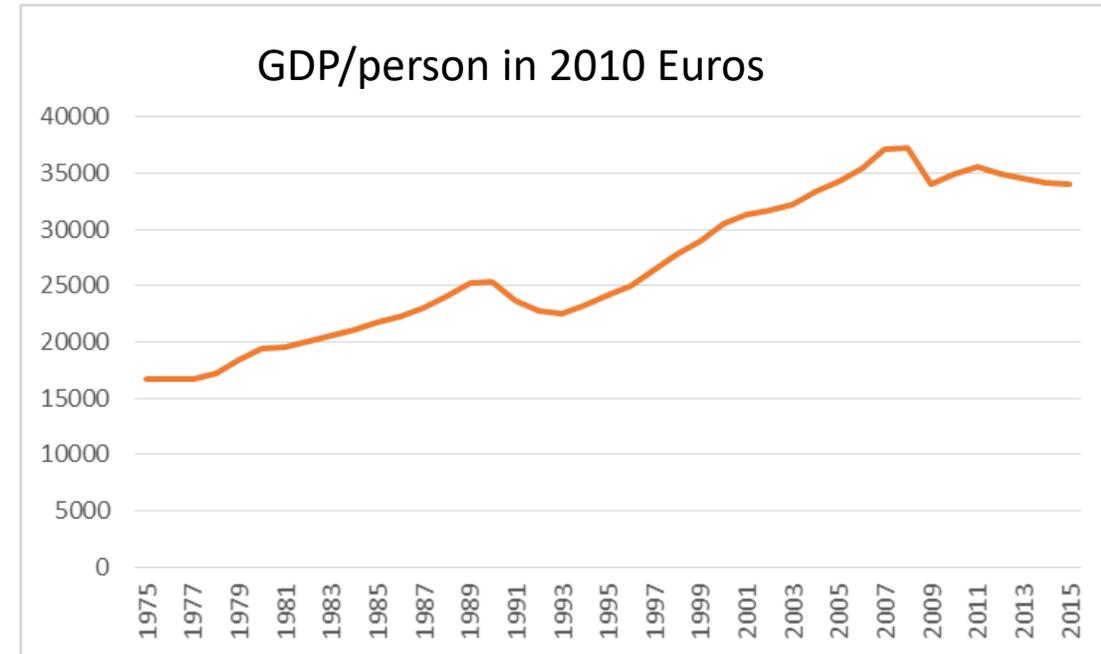
→ Skills that machines can't do very well, but which humans can do even more effectively with the help of IT

Work Productivity in human's point of view

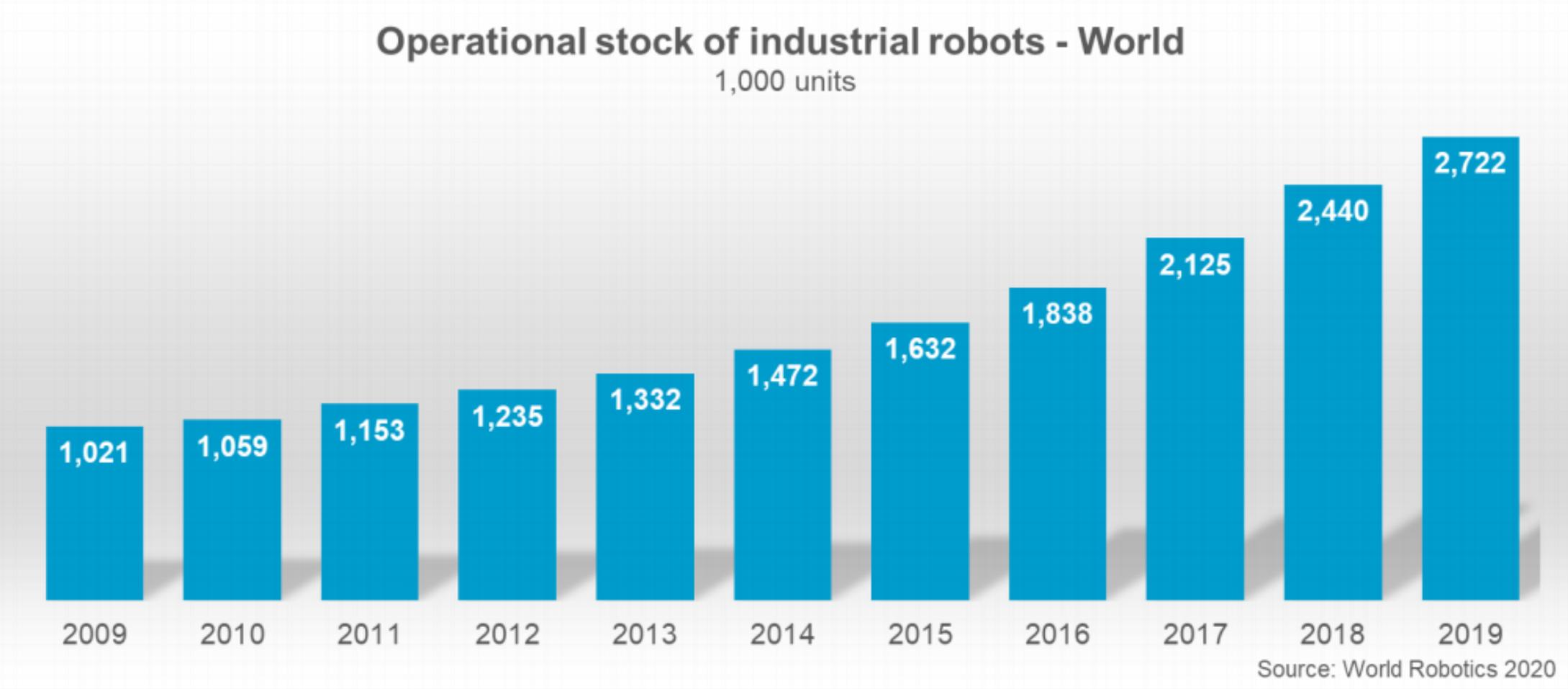
In the last 40 years, productivity has grown remarkably

- Gross Domestic Product (=GDP) has almost doubled
- Amount of work, hasn't changed

Virtuous circle: growth in productivity keeps lowering product prices which correlates by the growing demand!



Industrial robot usage in the whole world



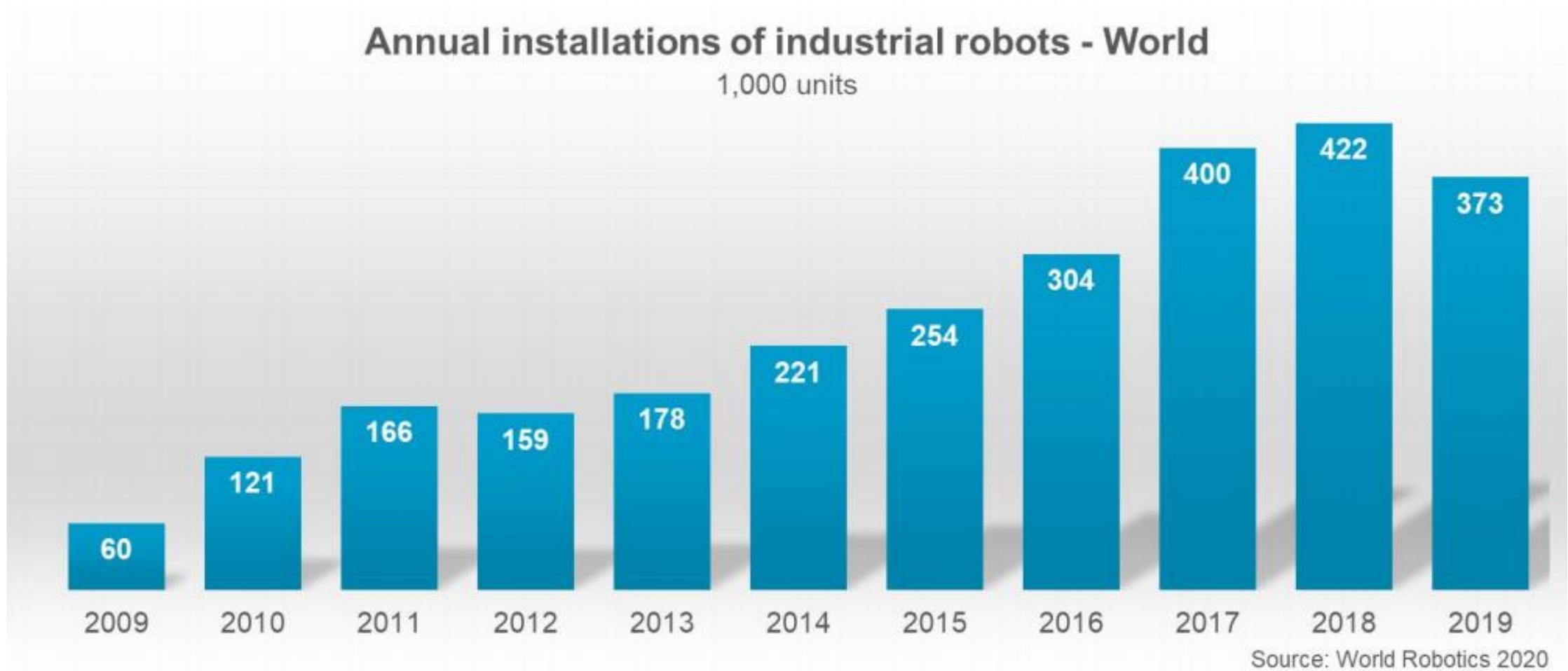
Robot usage in different continents

Operational stock of industrial robots
('000 of units)



Source: World Robotics 2020

Annual installations of industrial robots in the whole world



Industrial robot usage in the different areas of industry

Annual installations of industrial robots by customer industry - World

1,000 units

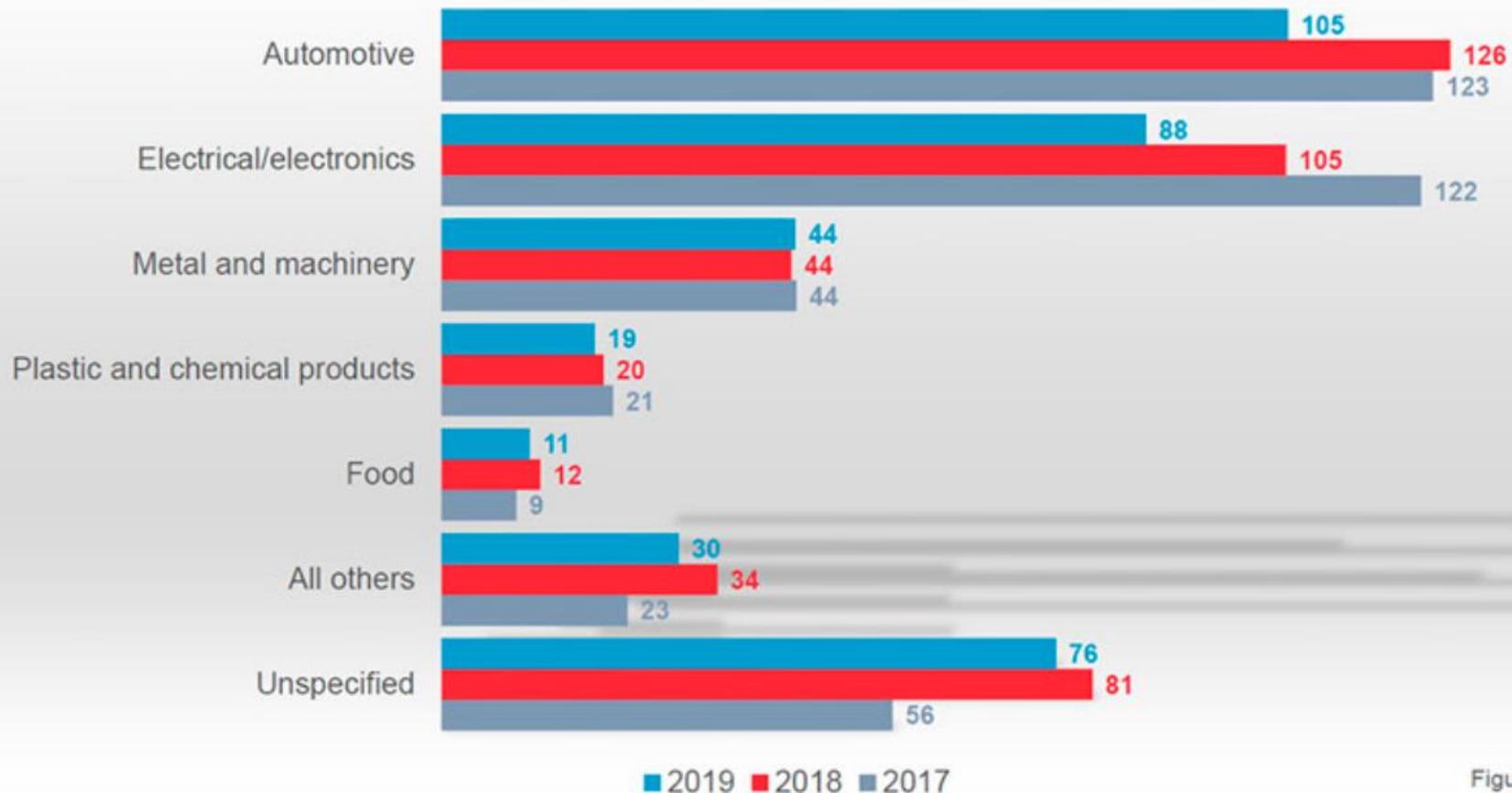


Figure 2.16



Main tasks for robots?

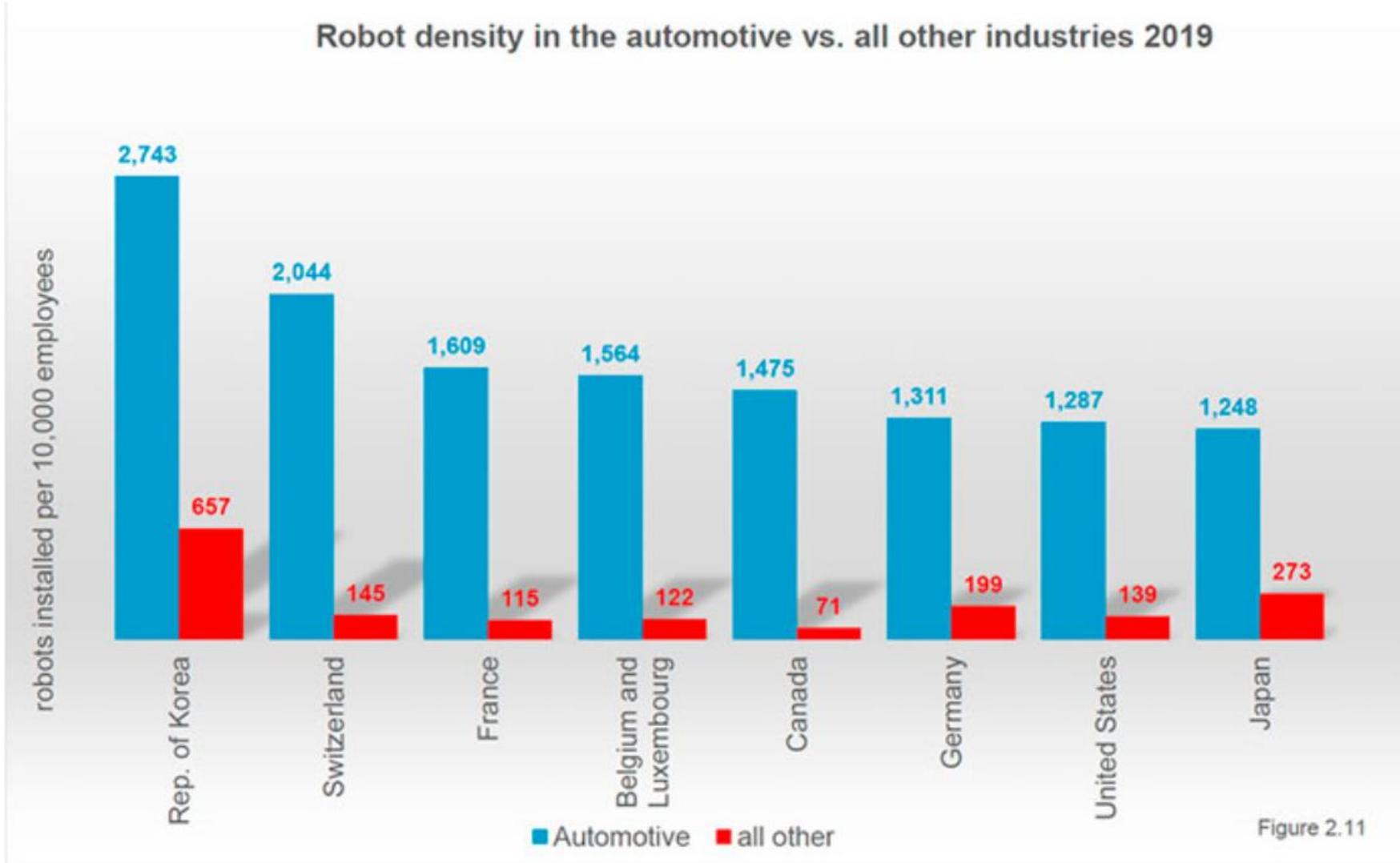
Operational stock of industrial robots by application - World

1,000 units



Source: World Robotics 2020

Automotive industry vastly ahead of others



More comparison with the automotive industry

Robot density in the automotive vs. all other industries 2019

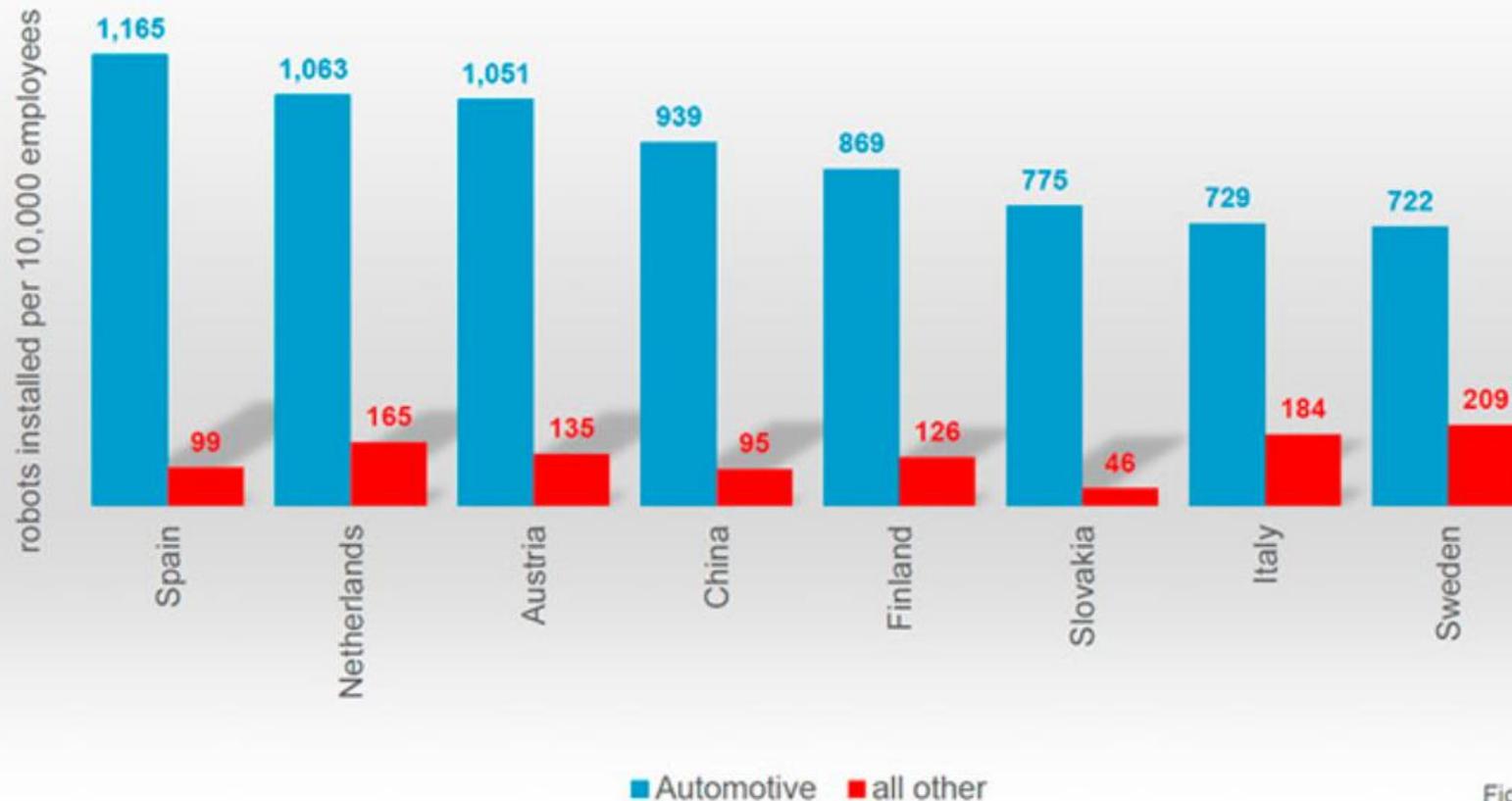
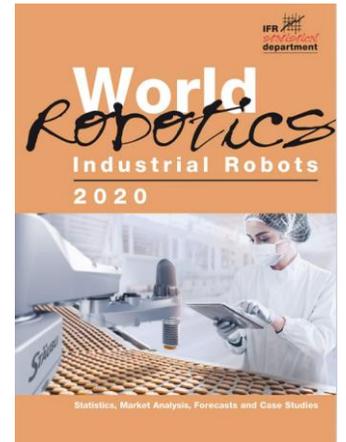
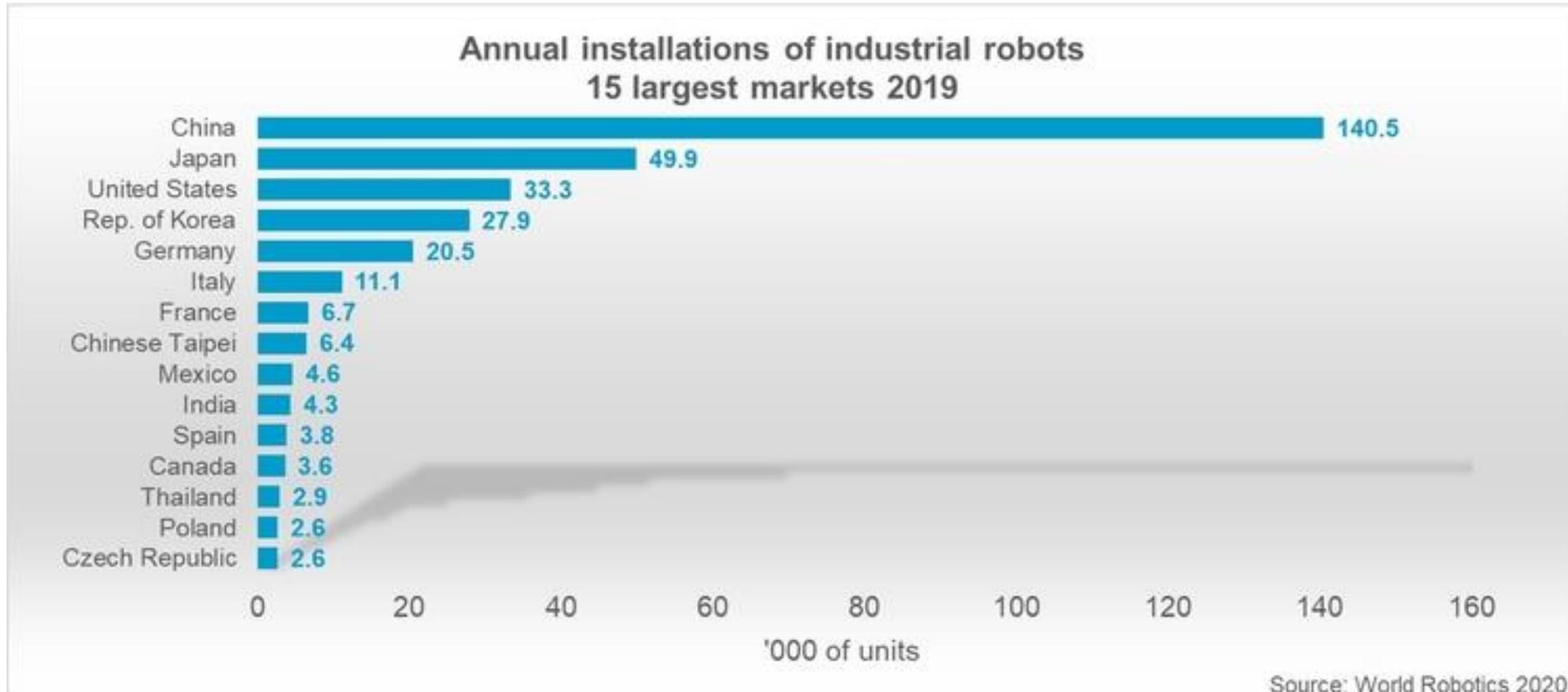


Figure 2.12

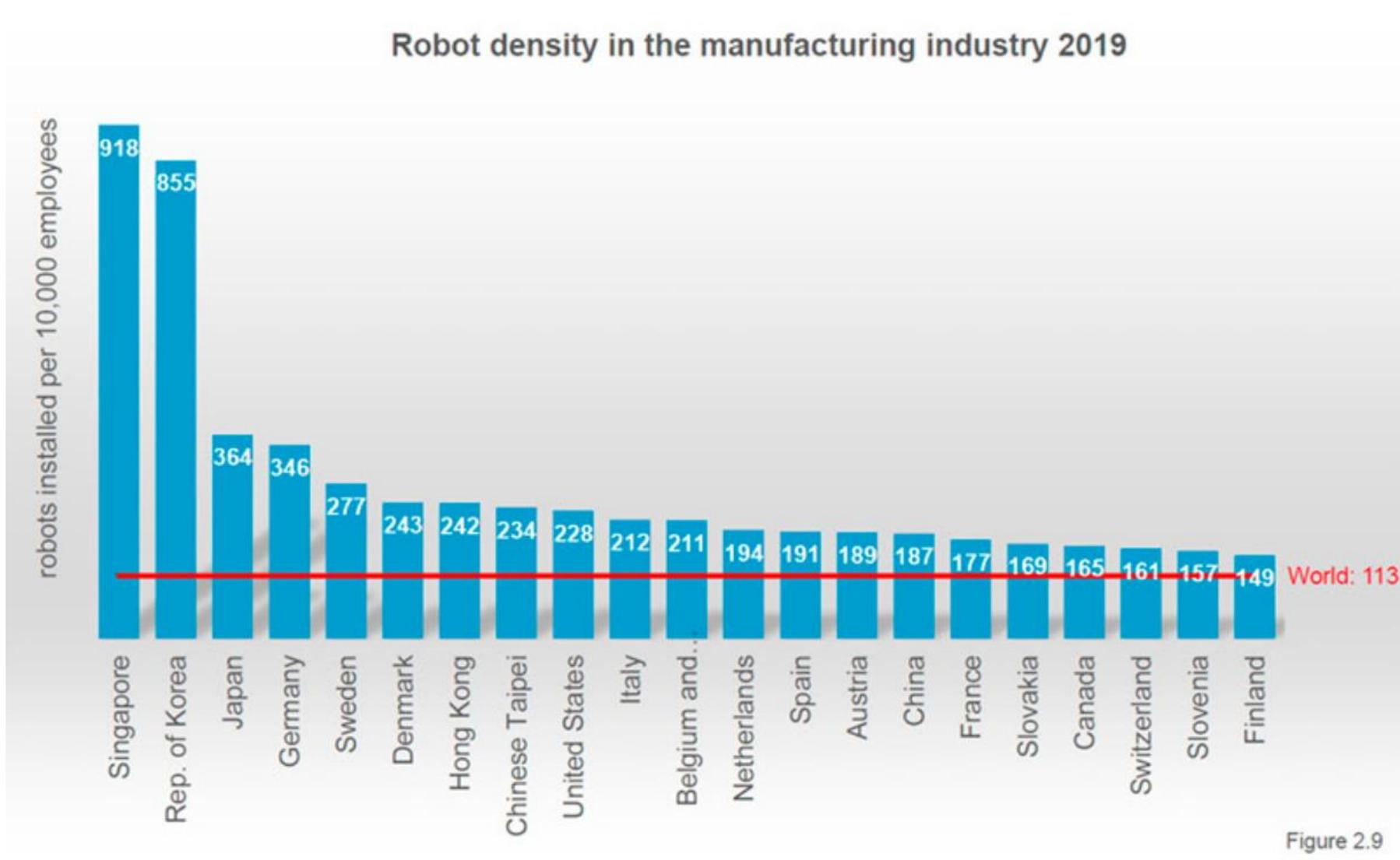


World countries using industrial robots

- In 2019, a total of 373,000 new industrial robots, the 3rd largest total ever
- China accounts for 38 % of the total



Robots installed per 10000 employees



Forecast for COVID-19 survival

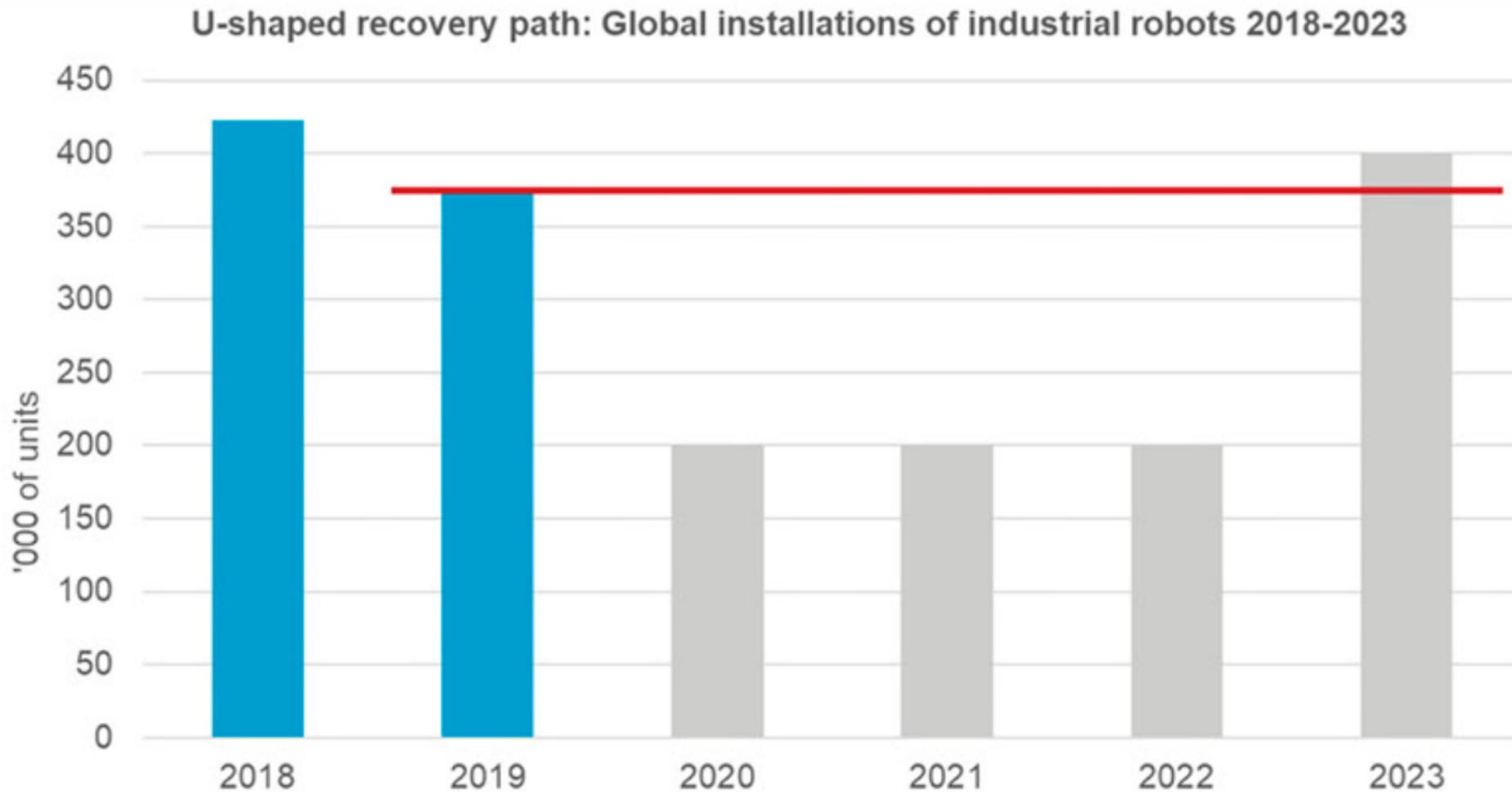


Figure 4.4



Industrial robots are becoming everyday things

- Industrial robots are cheaper, and easier to get than ever before.
- Traditional industrial robots are mass products, and on the same time they fulfil all the requirements required by legislation
- Prices of new robots are slowly coming down.
- Robot and components today, can do so much more and are more durable than what they used to be → robots are more versatile and durable
- The market of cheap used robots enable the development and testing of various low-cost models and applications

Ease of initialization



Initialization of robots, has become a lot easier and more straightforward than what it was few years ago. → Maybe even Plug and Play in the future?

Different kind of robots, their peripheral devices and controllers have been designed so, that there's no problems implementing communication between them

→ Building a robotics cell is easier, systems are more reliable and more flexible

The number of robots is multiplying

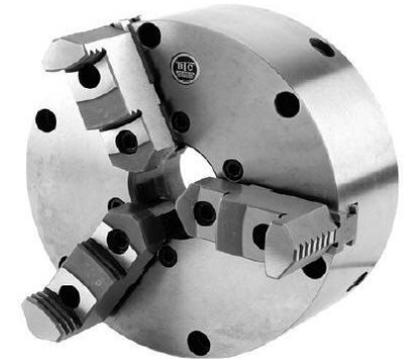
- The prices of industrial robots have fallen
- Usability improved
- Sharing and security
- New types of robots
- Development of peripherals such as servo grippers
- Decreased price of machine vision and improved usability
- Workforce aging and labor productivity
- For example, six axis industrial robots have become more unified
- Different manufacturers have same type basic models and the usability is pretty much the same between them
- Competition in the robotic market has led to the point that one manufacturer's robot is easy to replace with a competitor's robot



The importance of robot's tools grows

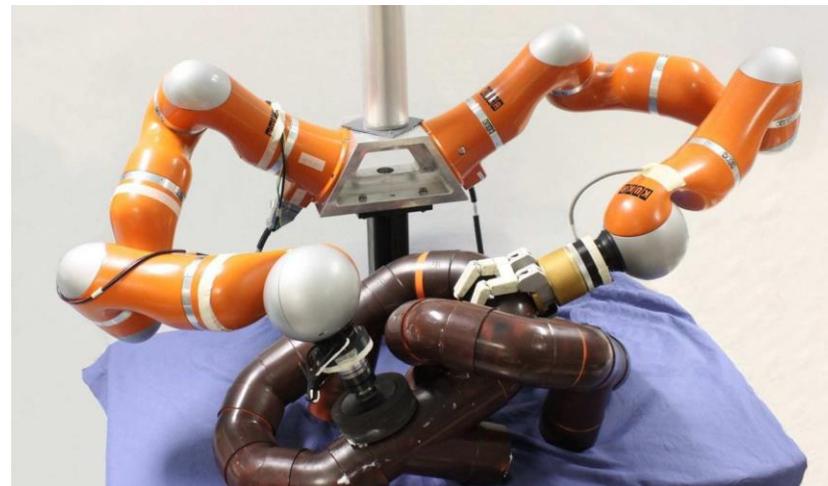
The ability to quickly change grippers or tools, enables even more complex tasks and thus creating more savings

EOAT = End Of Arm Tooling



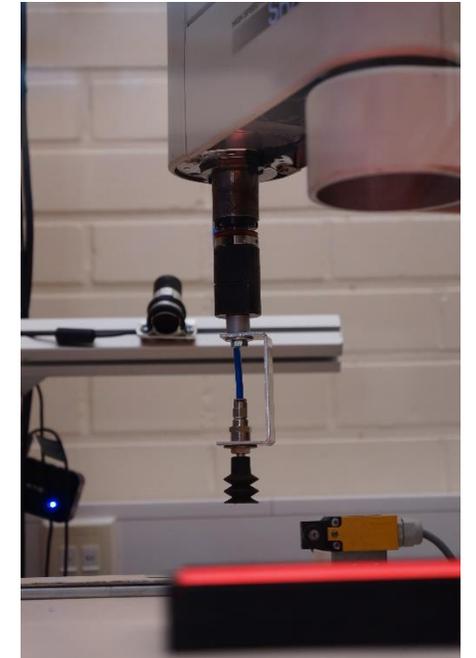
DUAL-arm robots

- Dual-arm robots have made it possible to use robots in tasks that require more precision and agility
- Dual-arm robots can be programmed to work so that the arms are individual or they work together
- → This gives the possibility to do many types of assembly, picking and loading tasks



Machine vision guidance

- Possibility to do pick and place tasks with several different positions to pick & place the objects
- Eliminates the need to feed objects in certain angle or location.
- Robot can handle different type of objects without change in the software → no mechanical changes are needed



Machine vision systems controlling a traditional Scara Robot



Collaborative robots

The biggest thing that has happened in industrial robotics in many years!



Sources of information

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- Wan L. From intelligence science to intelligent manufacturing. *Engineering*. 2019;5(4):615–8.
<https://doi.org/10.1016/j.eng.2019.04.011>.
- International Federation of Robotics. <https://ifr.org/>

Kahoot Quiz of today's topics

- Go to www.kahoot.it
- Give the Game PIN - sent to chat
- Give your Nickname and click "OK, go!"
- When everybody are in the game, let's start!

The Kahoot! logo consists of the word "Kahoot!" in a white, bold, sans-serif font, centered within a solid purple rectangular background.

Assignment 1 for the day 2

- Find in the Internet and introduce a smart robotics solution for smart manufacturing
- Prepare a short introduction to the chat of this training
 - Import a link to the application you are presenting in the chat
 - Describe why and how the manufacturing cell is smart
 - Which are the components and solutions that make the cell smart?
 - Why did you choose this exact cell?
 - If possible, read and comment on application examples brought by others
- Deadline: Next training session on Wed 27th January

Thank you!

Questions?

