Introduction to Computer Vision and Robotics

Henrik Trommer, henrik.trommmer@uni-goettingen.de

This course in a nutshell:

Lecture

- Henrik Trommer, Matthias Nuske
- Theoretical Exam

Practical

- Sebastian Ruiz, Lennart Jahn, and Julian Kerl
- Practical Exam, Milestones

9 ETC ☺

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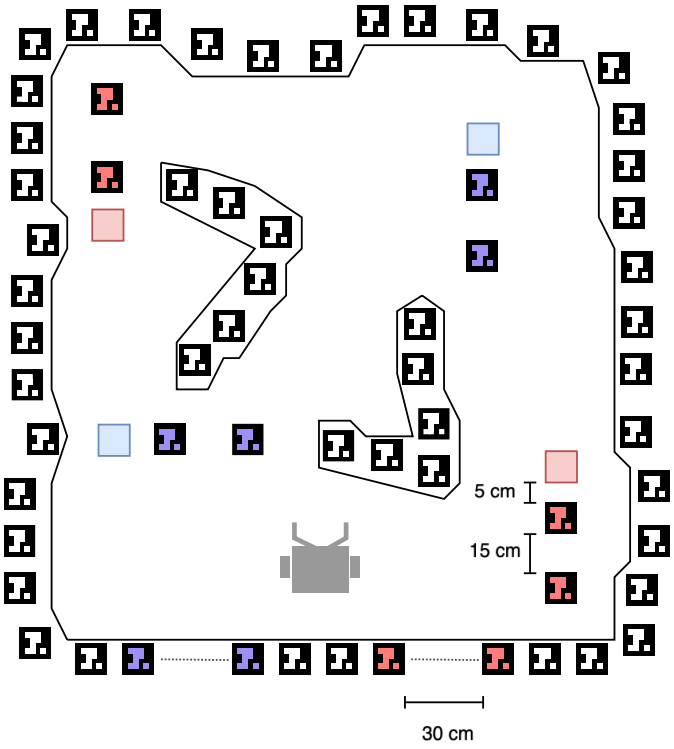
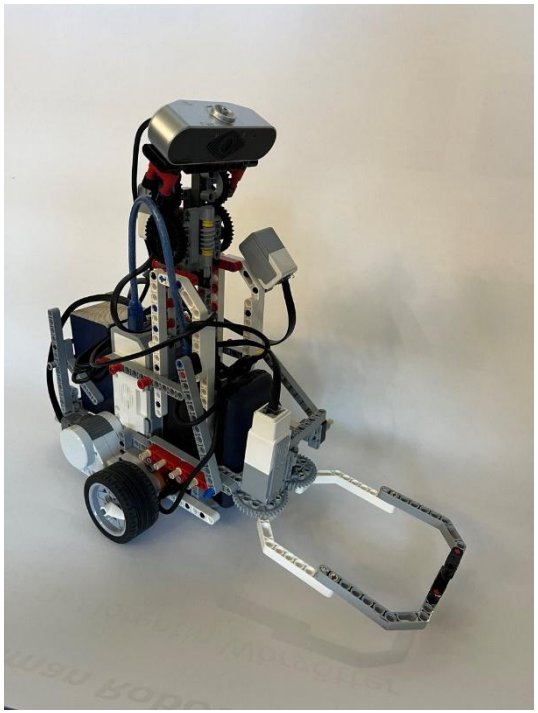
Task

- Build a robot
- Map and navigate though a maze
- Archive all milestones





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Milestones

14th November 2024

Familiarize with SSH, VScode, Robot
Notebook: Aruco detection , Image (2D) to global coordinate transform (3D)

21st November 2024

Notebook: ImplementBasic motor control, PID controller

5th December 2024

Notebook: SLAM, Driving to a point and driving to an Aruco marker

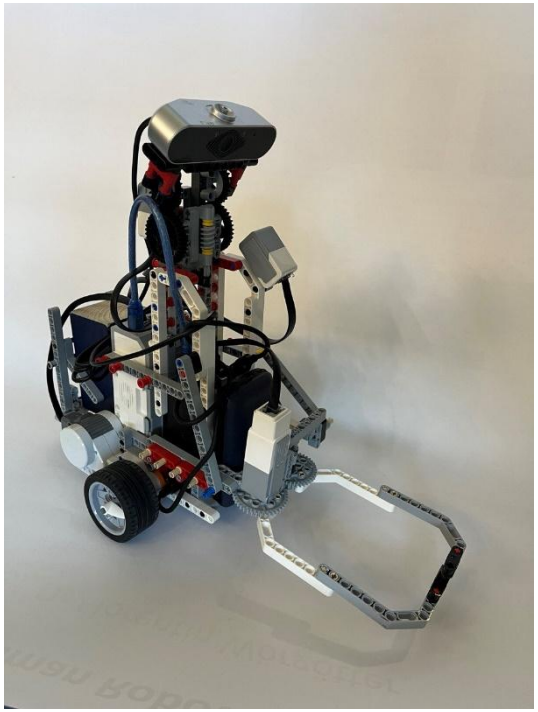
9th January 2025

Notebook: Map discretization and optimal paths, Planning

30 Jan 2025

Apply all these solutions to the task

Exam



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Any Questions?

Lecture

- Henrik Trommer, Matthias Nuske
- Theoretical exam

Practical

- Sebastian Ruiz, Lennart Jahn, and Julian Kerl
- Practical exam, milestones

9 ETC ☺

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Group Forming, KIT Handout

- 5 Minutes, form groups of 3
  - ➢ One Person is responsible for the KIT (KIT-Master)!
- Do the paperwork and get your kits (right after lecture)

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Any Questions?

last chance ☺

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Introduction to Robtics

(History, robot mindset, digital twins, signal processing)

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Lecture Overview

1. Introduction (Henrik)
2. Computer-Vision (Julian)
3. Stereo Vision, Coordinate Transformations (Henrik)
4. Control Theory (Henrik)
5. Point Cloud Matching, SLAM, Kabsch (Henrik)
6. Kernels-Morphological Operations (Simon)
7. Path Planning (Henrik)
8. Edge-Detection (Julian)
9. Features & Transforms 1 (Simon)
10. Features & Transforms 2 (Simon)
11. Manipulators, ROS(2) (Henrik)
12. Segmentation (Julian)

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Lets Play – We need 3 volunteers ☺

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Task: Pick up an object from the table

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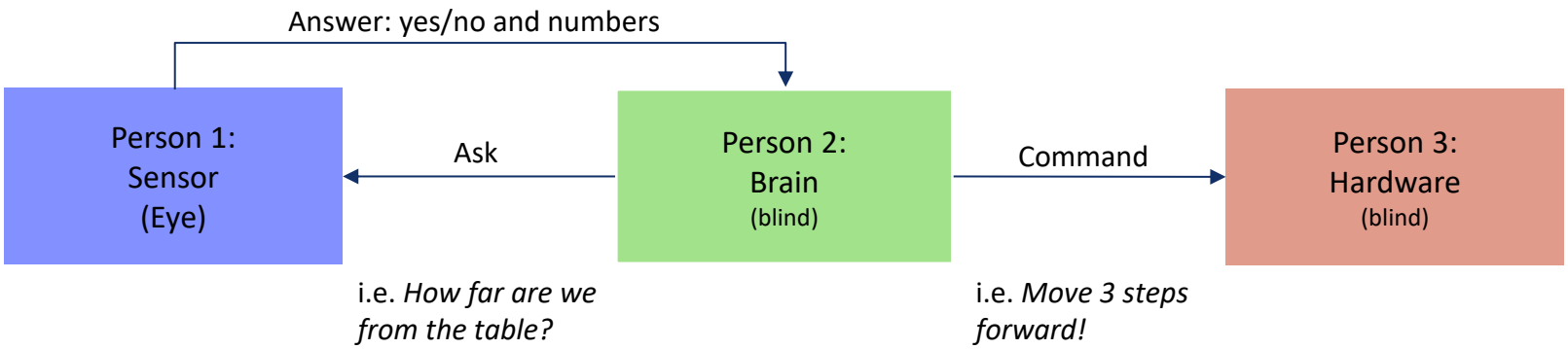

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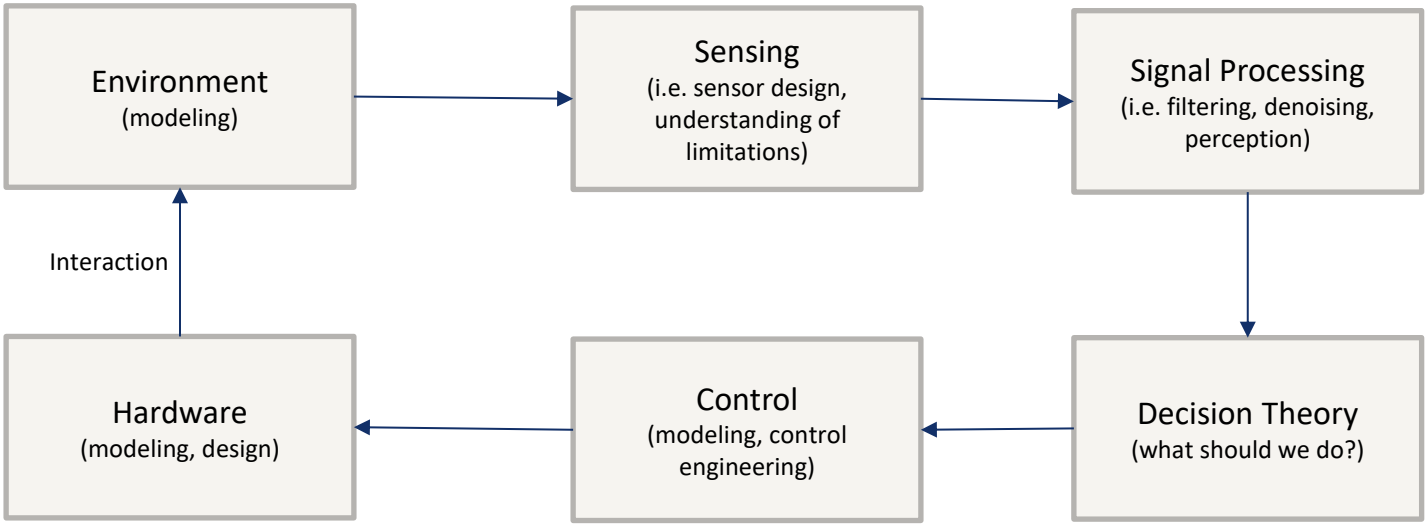
Limitations – Development – Complexity

Litterally every robot:



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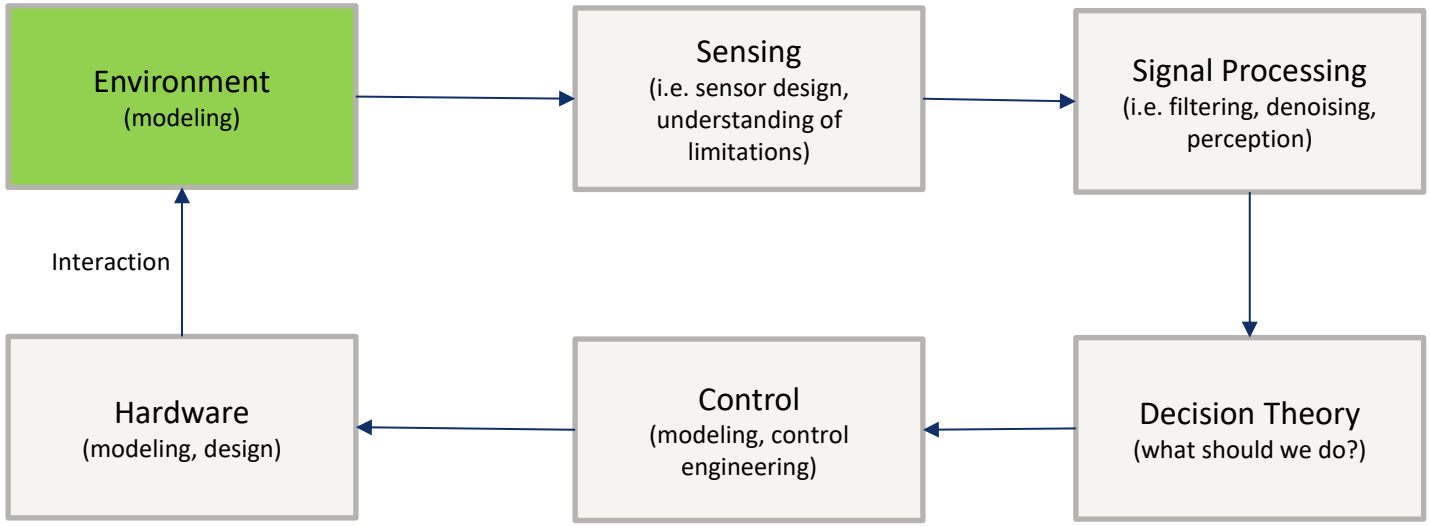

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Examples

Antenna Calibration (QuatSat)

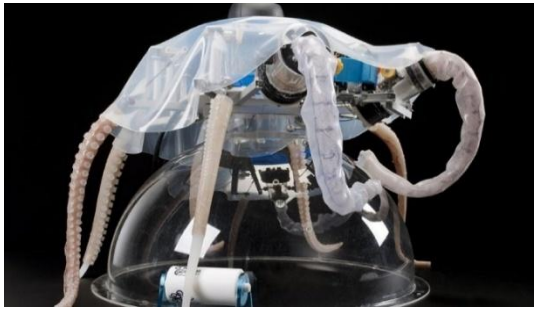
Production (UR Cobots)

Mobile Platforms (MIR)

Fruit Picking

Production (KUKA @ VW)

Soft Robotics



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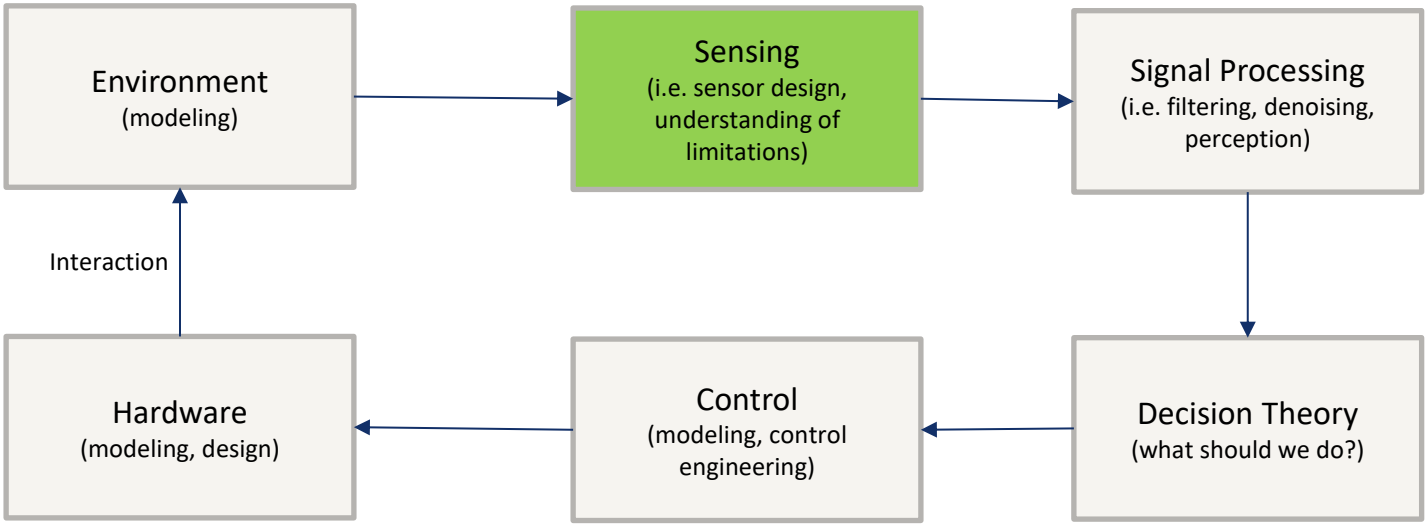

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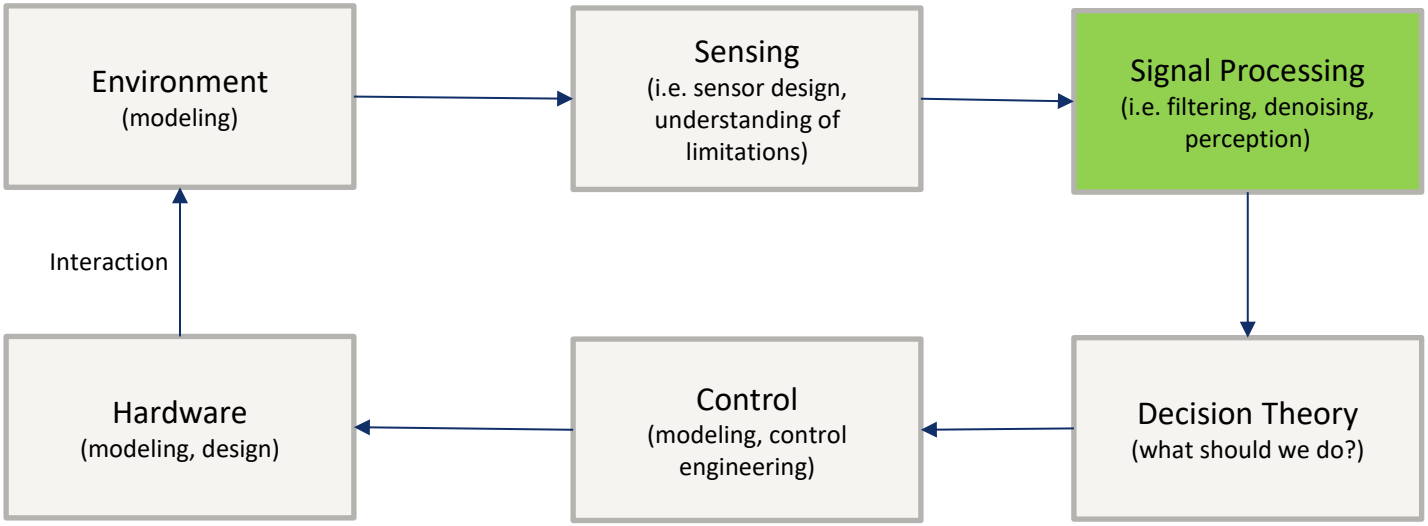

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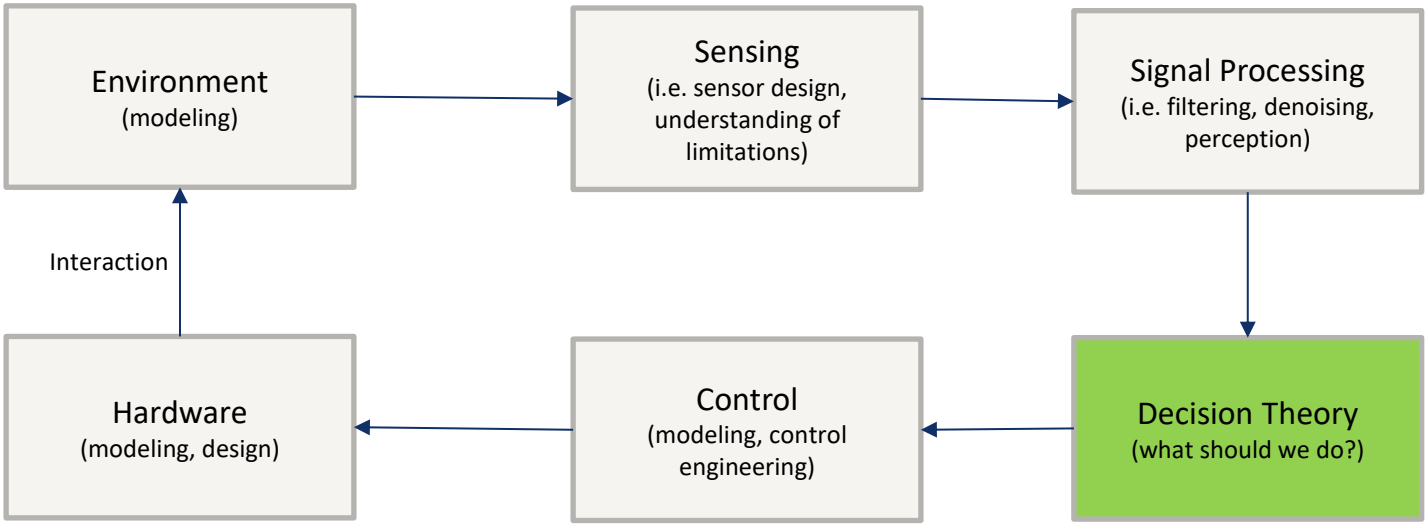

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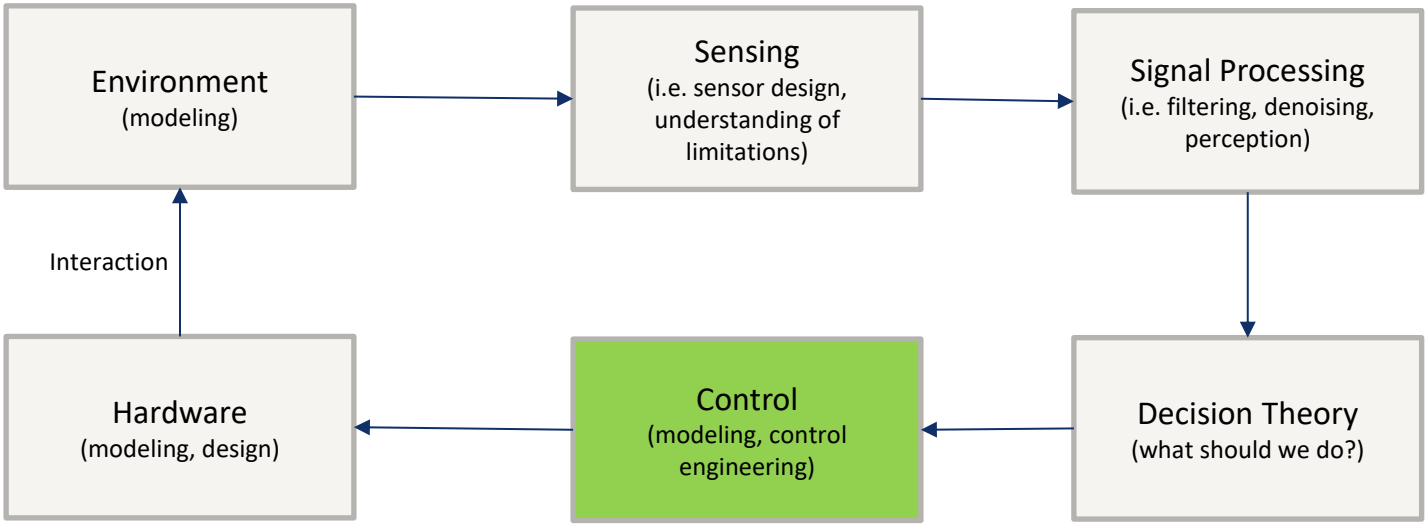

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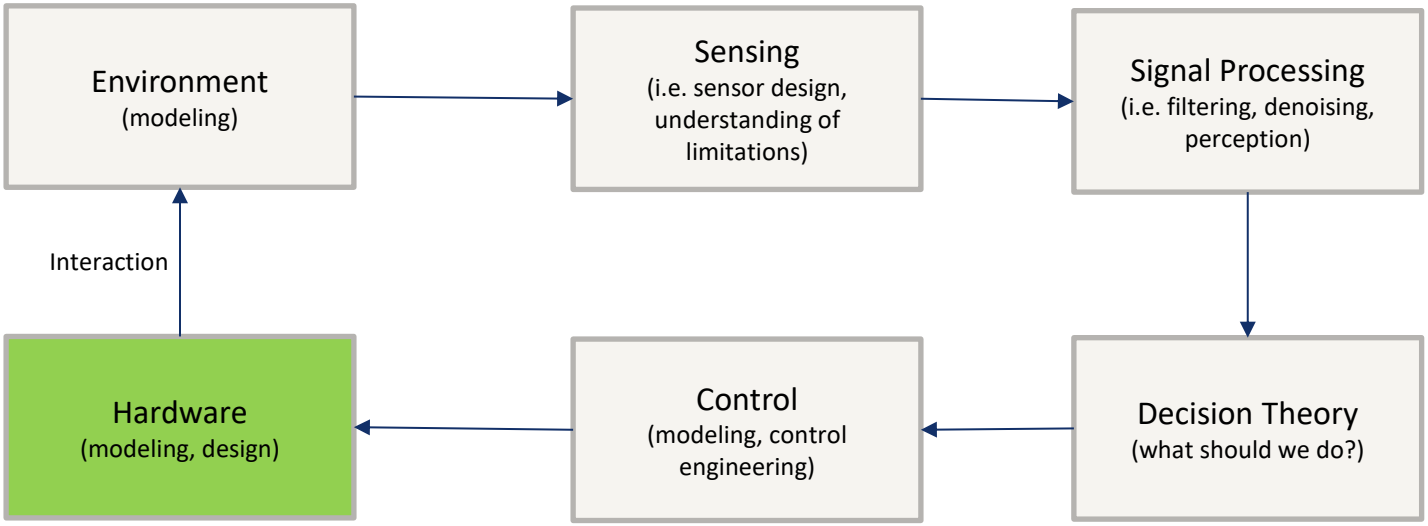

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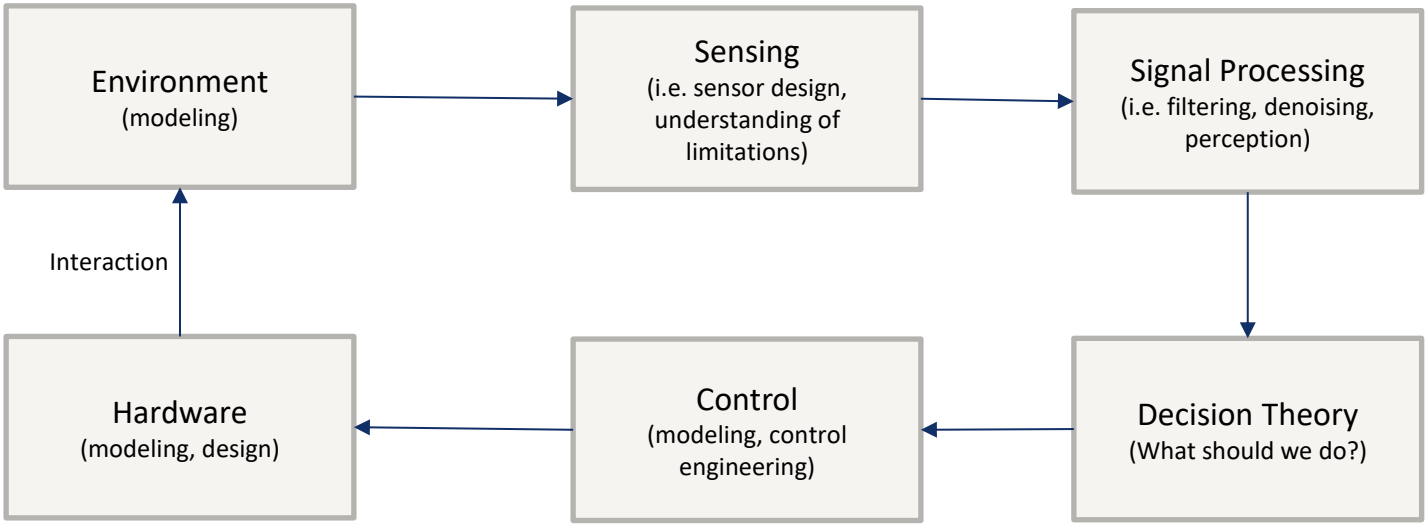
Limitations – Development - Costs



Each topic is a field of scientific research!

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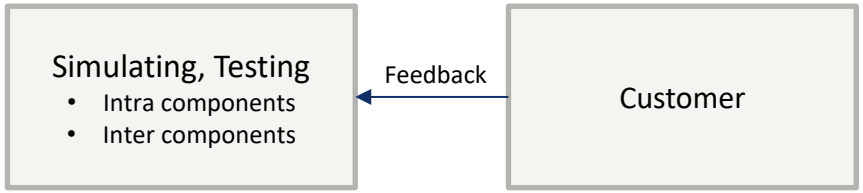
Limitations – Development - Costs



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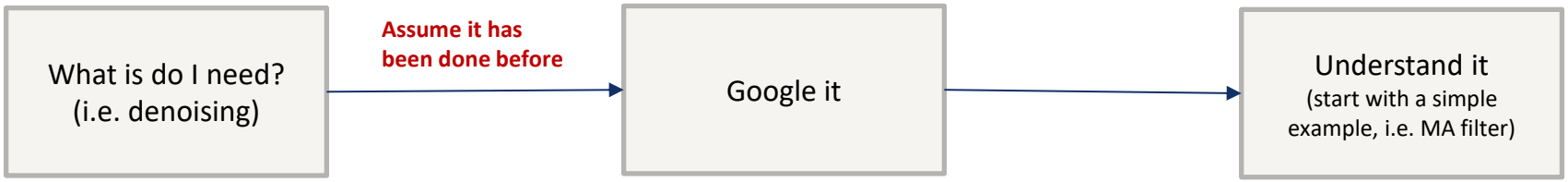
Do not re-invent the wheel – *The engineering mindset*

Step 1: Research



Step 2. Engineering

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Do not re-invent the wheel – *The engineering mindset*

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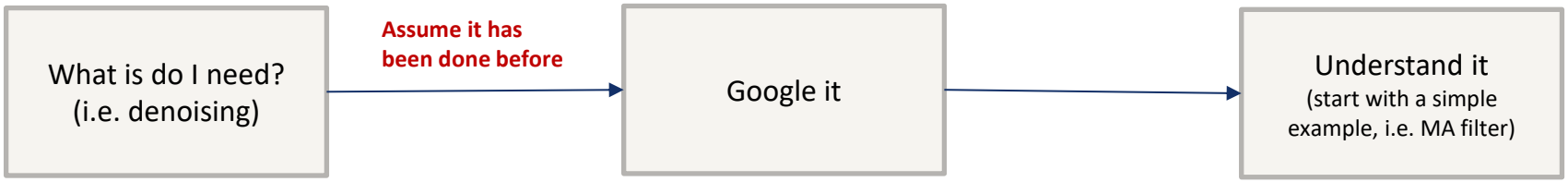

Step 2. Engineering

Time = Money
Do not waste it with inventing things other people have done before

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About testing

- Robotics is complex – Visualize your data as much as you can
- Use simple tools (i.e. matplotlib, camera images, provided tools)
- **Understand whats going on!**

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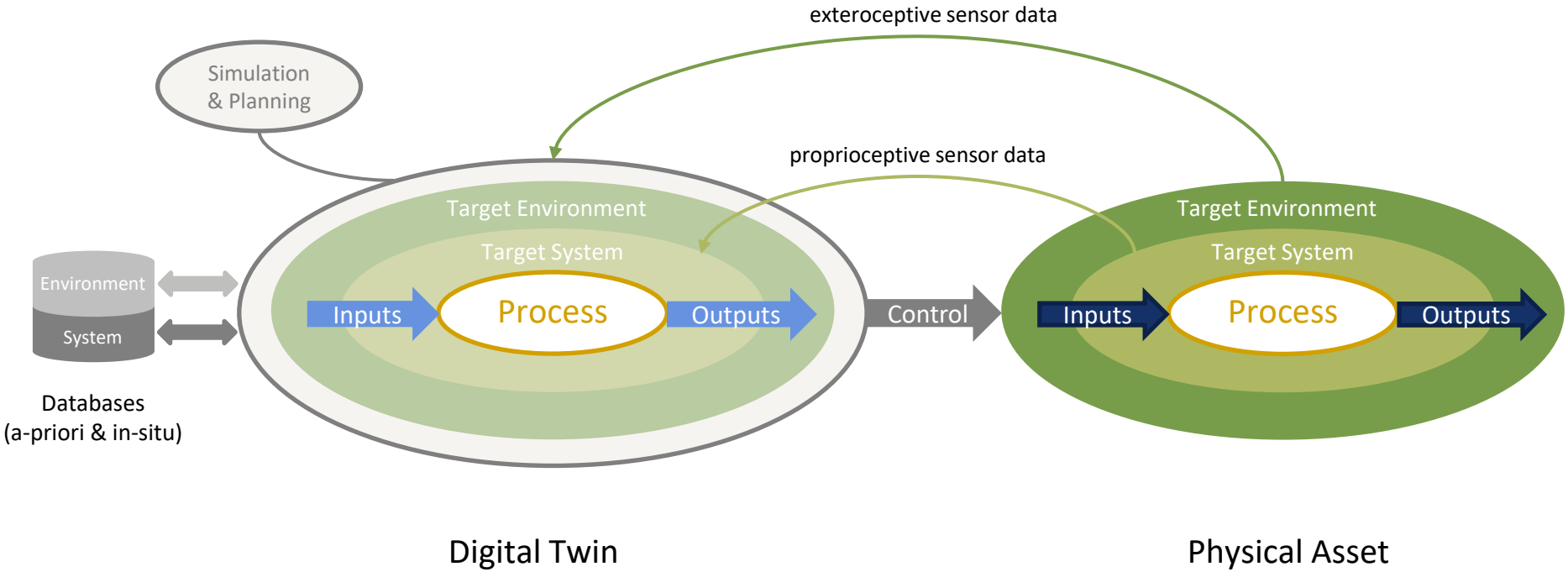
Digital Twins

System-oriented view in robotics



(Inspired by an amazing lecture of Prof. Dr. Christian Schlette)

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Historical Background

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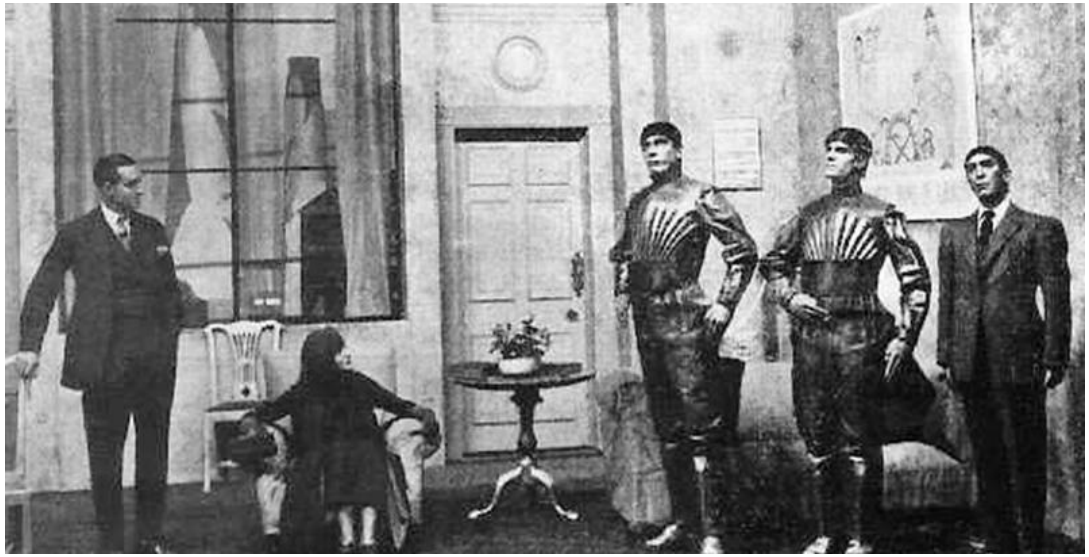

Karel and Joseph Capek:

- Rossum‘s Universal Robots (1920)

- Robot = *Worker*

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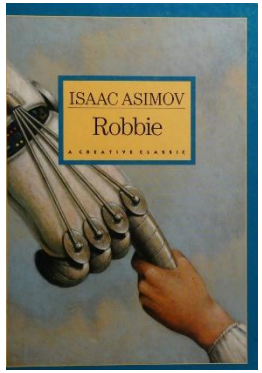
Historical Background

Science Fiction, Isaac Asimov, Laws of Robotics:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.



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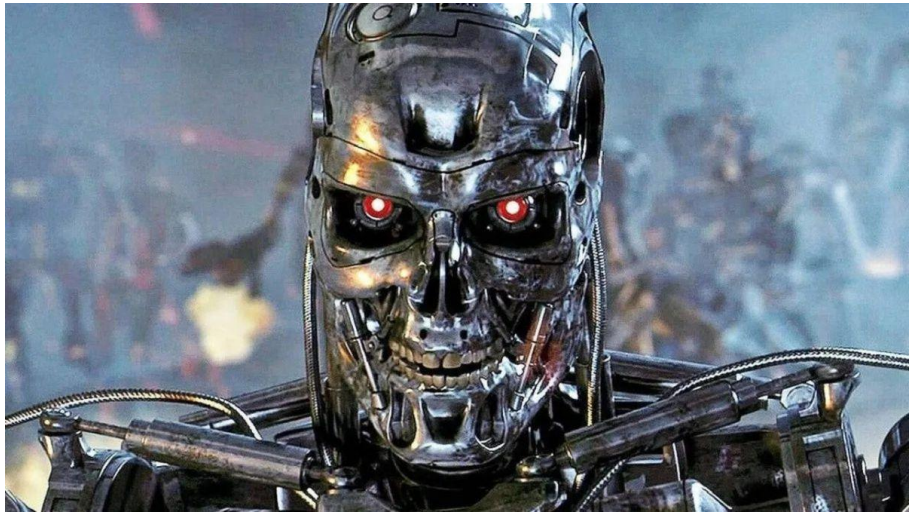
Historical Background

Robots in Hollywood:



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Historical Background

Robots of Reality

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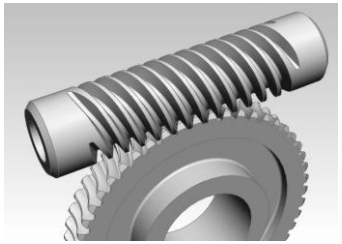
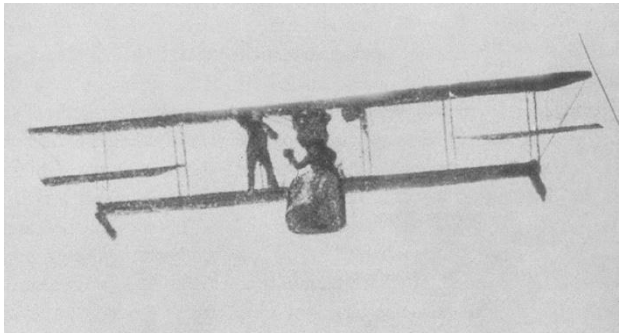
Historical Background



Technological advances:

- Power loom (1733)
- Steam engine (1760-)
- Worm gear (1774)
- Mass Production (1908) Henry Ford's car factory
- Computer (Turing, John von Neumann)
- Autopilot in Planes (Curtiss Biplane by Lawrence &Sperry 1912)
- Artificial Intelligence, i.e. Perceptron (Rosenblatt 1957)



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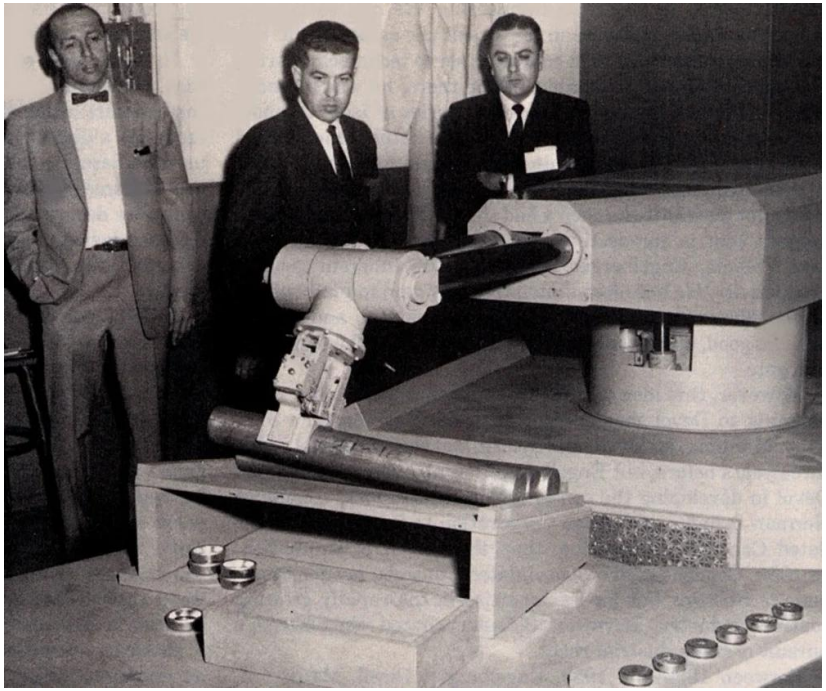
Motivation? Automation!

Robots introduced at General Motors in 1961 (Unimate from George Devol)



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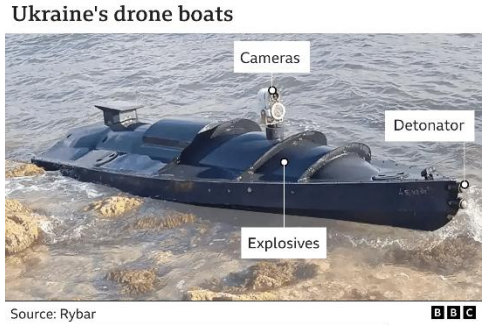
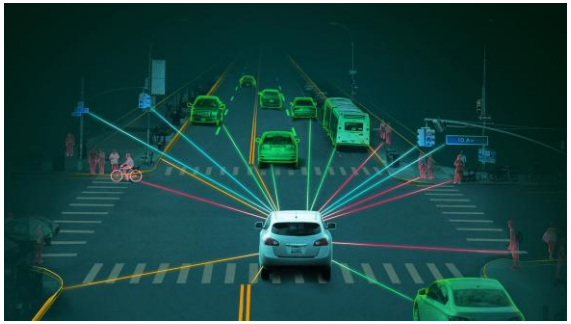
Motivation? Automation!

- Production: Manipulators, Workcells, Cobots
- Human danger: Autonomous systems, military
- Efficiency: i.e. Unmanned Aerial Vehicle (UAV) -> less weight
- Autonomy: Vacuum Cleaners, Autonomous Cars
- Form Factor: Humanoids





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Automation and Society

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(Dunning-Kruger effect)

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Do Robots actually *take our jobs*?

- Robots will take over jobs that can be **automated**
- Automation can happen because those jobs are **repetitive**
- Humans can work more in less repetitive but more creative jobs
- Hence, automation frees brain power

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Robots and Global Politics

Strategic considerations for manufacturers when building a production site:

- Produce in countries with cheap human labor
- Cheap Human labor correlates with low human rights, which correlates with autocraties
- Generates political and economical dependencies
- Prone to espionage

vs.

- Produce in coutry with high legal standards
- Use robots to stay compatible
- Less dependencies
- Example: Denmark

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Limitations of Robots

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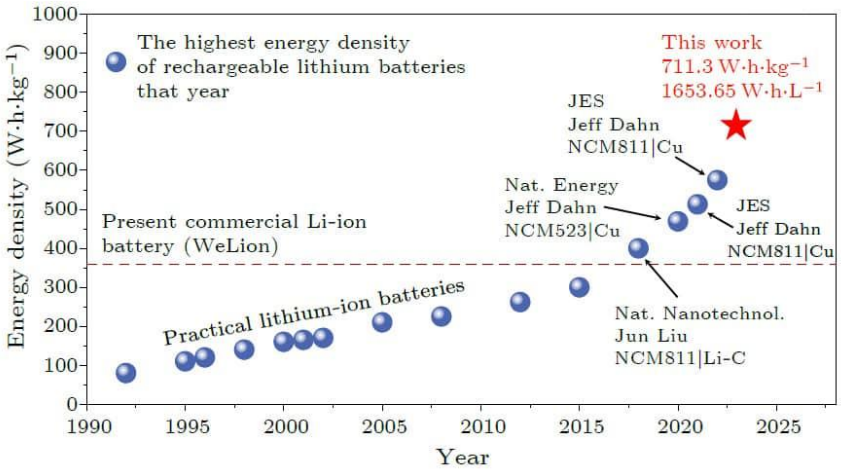
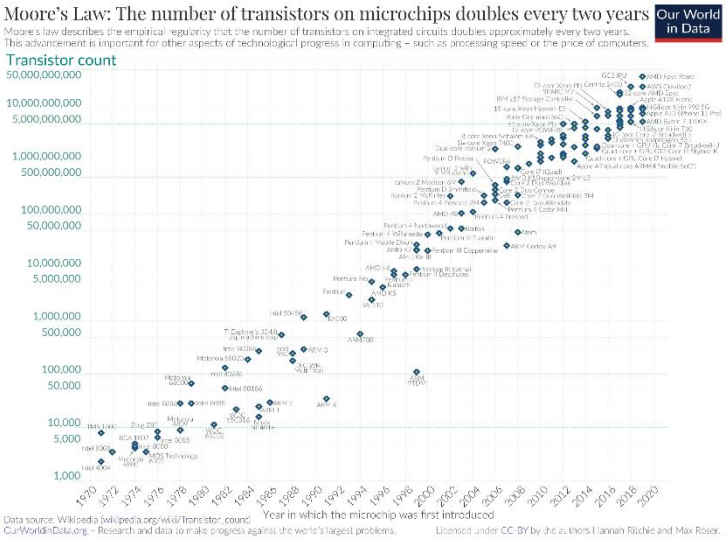
Limitations – Hardware





Final words

- You are smart people!
- **You are needed and you are smart!**
- Thank you!

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