ETH zürich

„Robotik, Drohnen und autonome Systeme“

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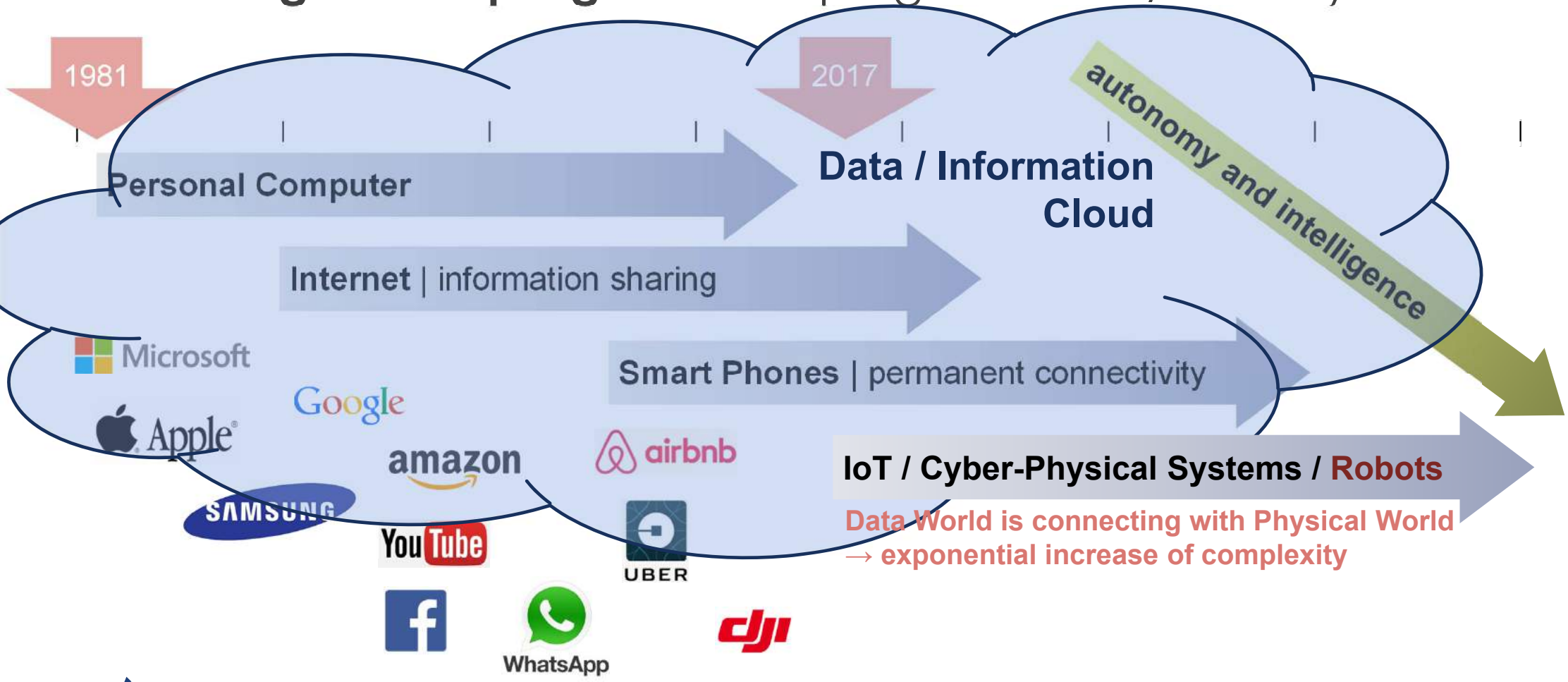
Mittwochgesellschaft Zug:
11. April 2018

Technologies disrupting services | digitalization / industry 4.0



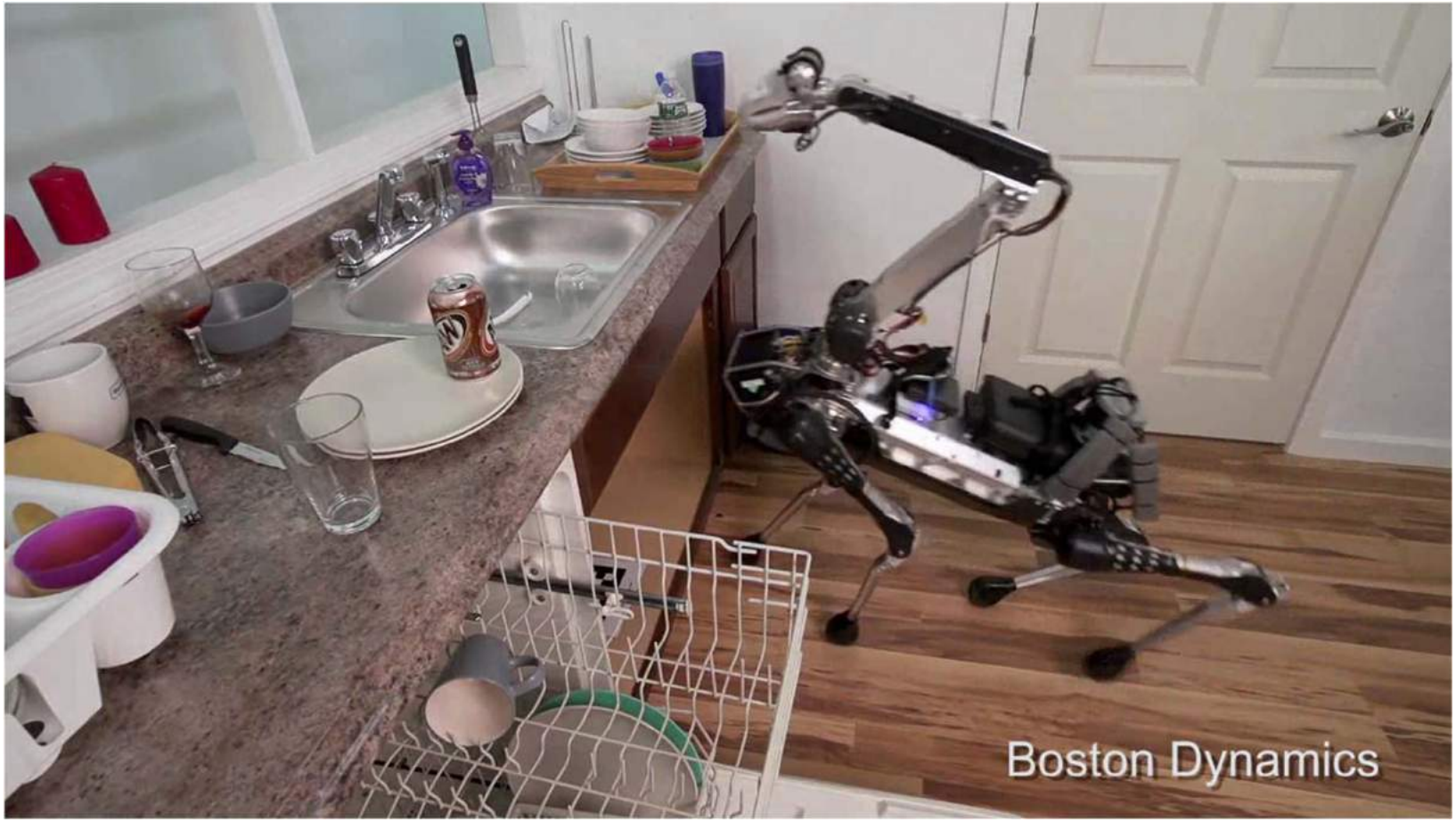
Data World is connecting with Physical World
→ exponential increase of complexity

Robotik heute (Changan-Ford China)

248'000 Industrieroboter wurden 2015 verkauft, 68'000 davon in China

https://www.youtube.com/watch?v=SeloQy0oXjI

Robotik morgen – in unserem täglichen Umfeld?



SpotMini | electic quadruped, Boston Dynamics

https://www.youtube.com/watch?v=tf7IEVTDjng

Serviceroboter | die Herausforderungen

50x speed
https://www.youtube.com/watch?v=gy5g33S0Gzo

- Roboter müssen mit ***unsicherer*** und nur ***teilweise verfügbarer multimodaler Information*** umgehen können.
- Roboter müssen ***sehen***, ***spüren*** und ***verstehen*** können.
- Roboter müssen ***taktil*** mit der Umgebung interagieren können
  → («soft robots» mit Kraftreglung)
- Roboter müssen ***intuitiv programmierbar*** sein
- Roboter müssen ***lern-*** und ***anpassungsfähig*** sein

→ Um das zu erfüllen, braucht es Künstliche Intelligenz, aber auch neue Sensoren, Aktoren und Roboterkonzepte

Service Robots
– wheeled and walking robots for challenging tasks

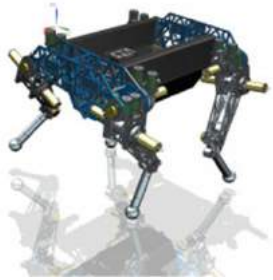
BeachBot (with Disney) – developed by students
| the beach artist
https://www.youtube.com/watch?v=eBRrQBPtdak

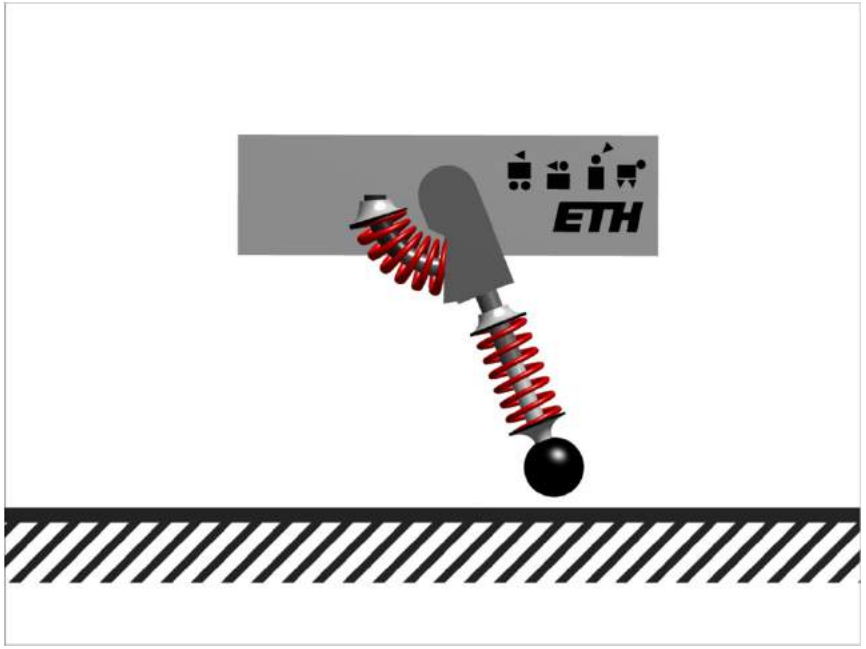
Vertigo – developed by students
| the ultimate wall climber
https://www.youtube.com/watch?v=KRYT2kYbgo4

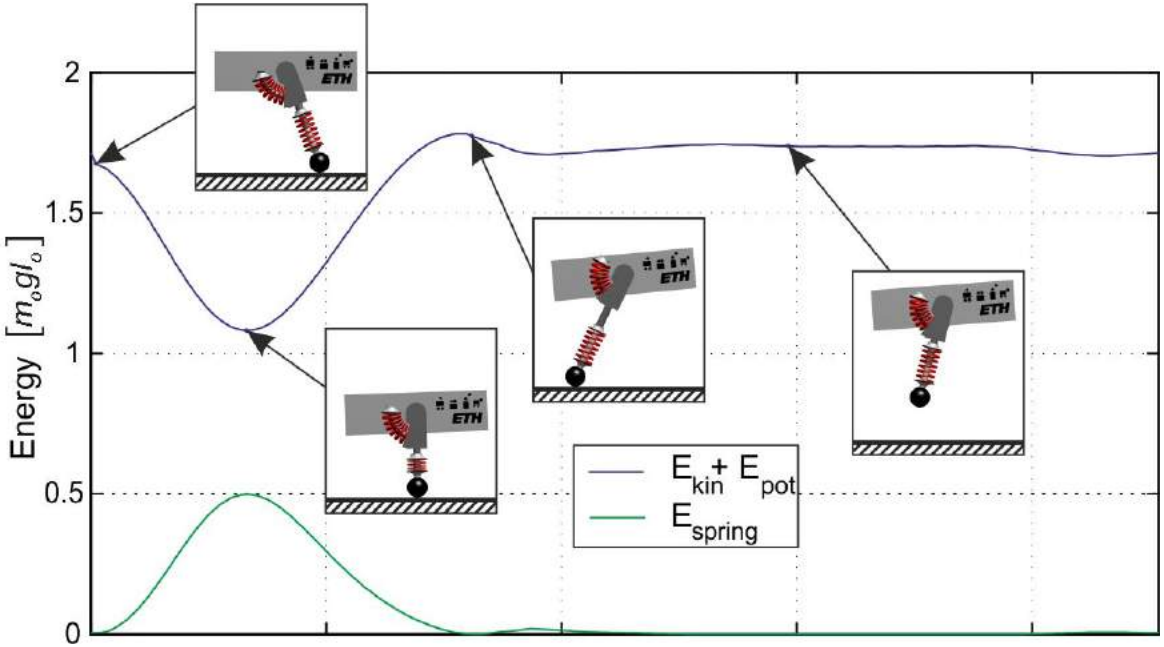
Efficient Walking and Running |
what nature evolved (Extreme Jumpy Dog)

- http://www.youtube.com/watch?v=Jql6TSyudFE

Efficient Walking and Running | serial elastic actuation



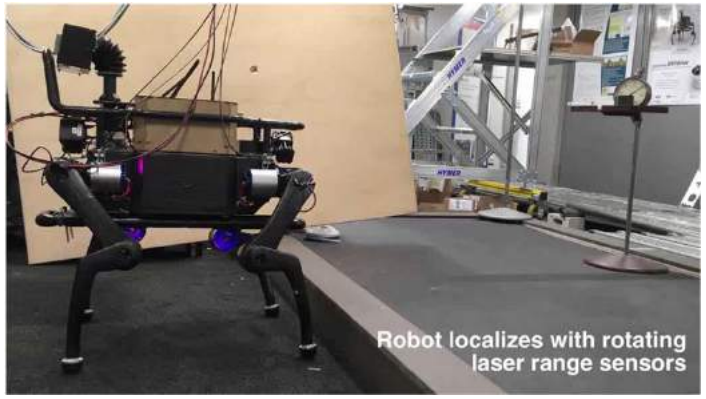


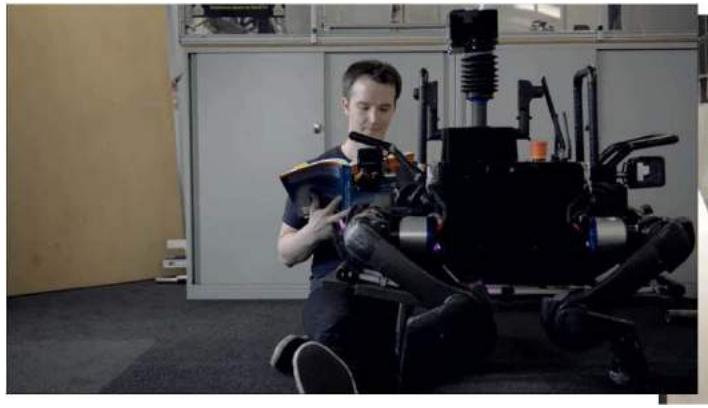


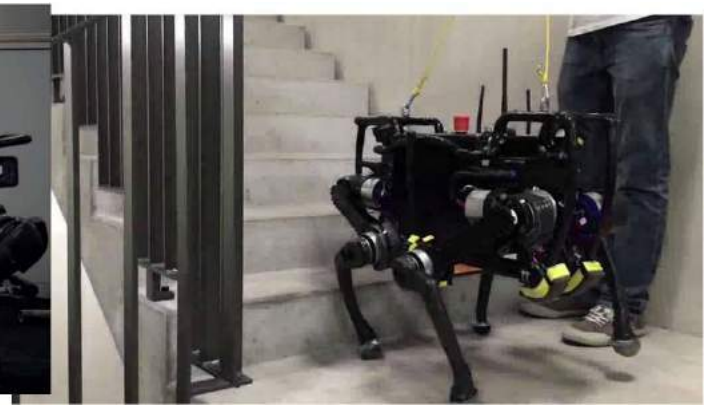
https://www.youtube.com/watch?v=6igNZiVtbxU

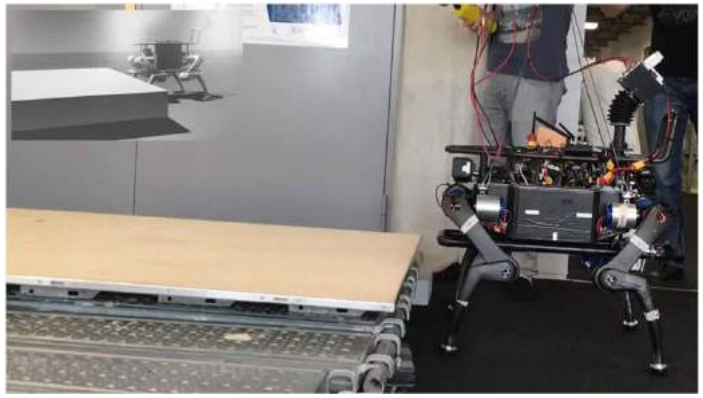
ANYmal
Combining dynamic motion skills with large mobility

Prof. Marco Hutter









Service Robots – flying robots for challenging tasks

wingtra

wingtra – developed by students

| the VTOL UAV

https://www.youtube.com/watch?v=QADvPDWtgFU

Atlantik Solar

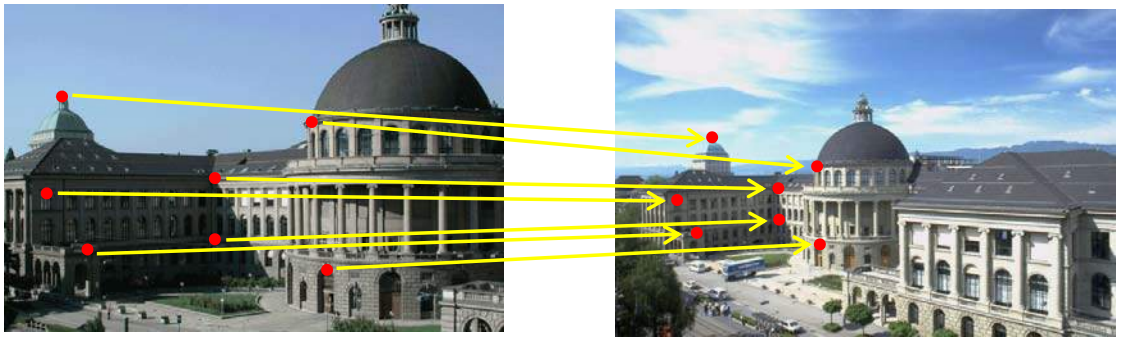
| 81 hours non-stop in summer 2015

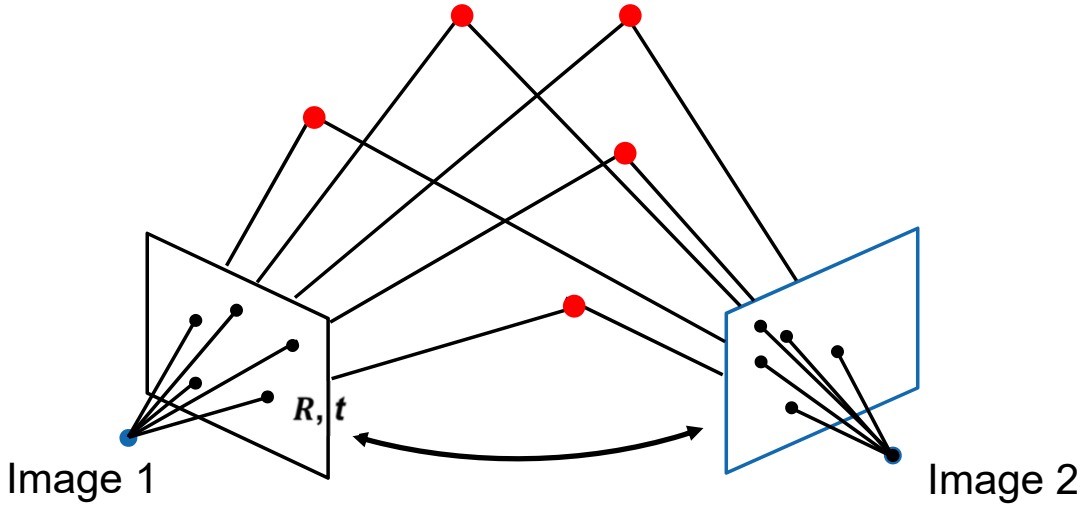
| 5.64 m, 6.2 kg

https://www.youtube.com/watch?v=8m4_NpTQn0E

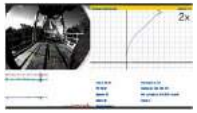
https://www.youtube.com/watch?v=wyS6W1t_ryQ

"Sehen" | Bewegungsschätzung mit Kamera und Inertialsensor (IMU)



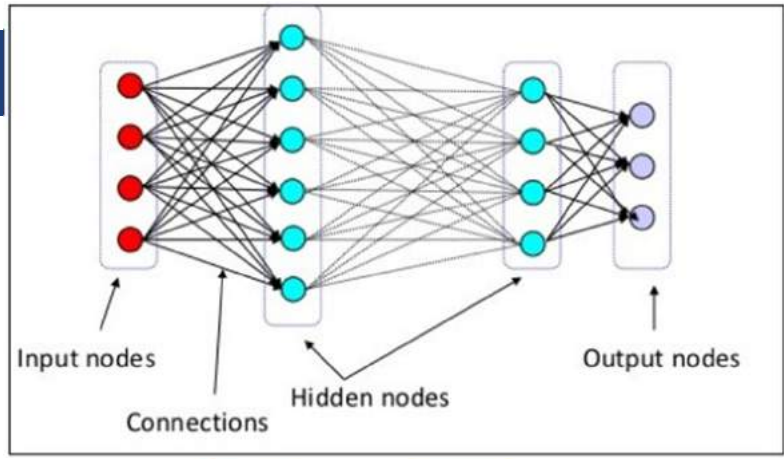


Google
Project Tango

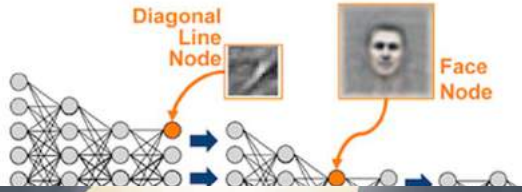


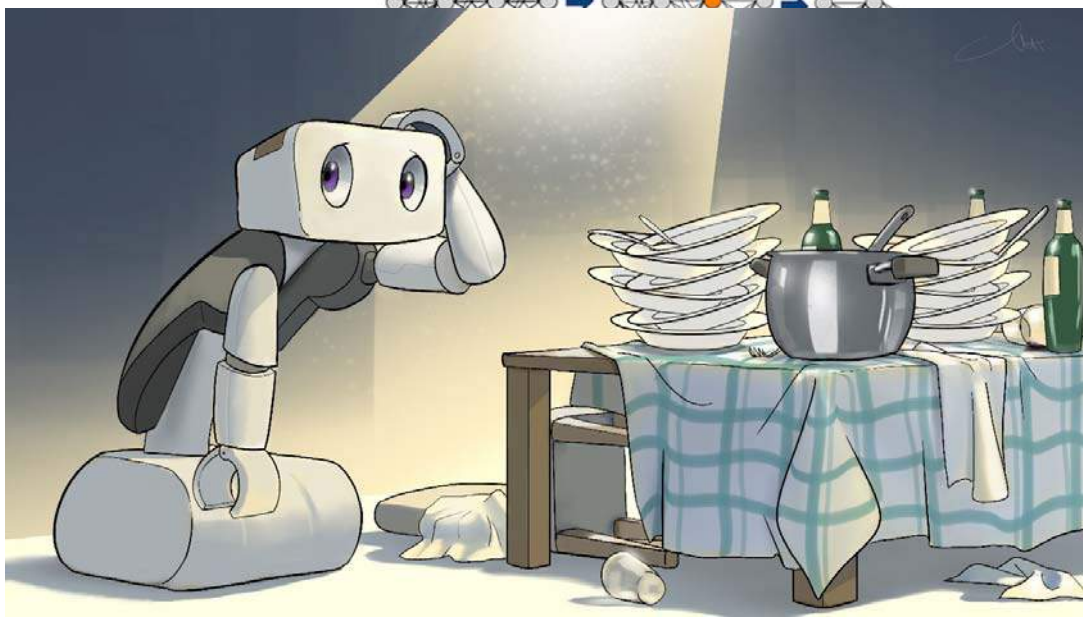
https://www.youtube.com/watch?v=yvgPrZNp4So

AI-Example: Deep Learning for Robotics



- Key Idea: mimic behavior of neurons in a human brain in a very simplified way.
- Deep learning methods learn an unknown function from observing numerous exemplary input/output pairs.
- Examples
  - Recognizing object types in images.
  - Recognizing words in a voice recording.
  - Recommending products based on past purchases.
- Challenges involve the generation of a big amount of training data and tackling high computational burden.
  → how to generalize from low amount of data ?
  → how to learn from real world interactions?
  → how to learn from multimodal data?
  → how to learn semantics and to understand?
- **Narrow AI ↔ General AI**





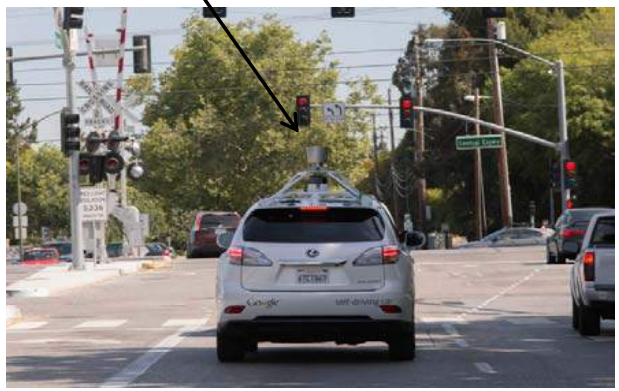
Autonomous Cars Today | cameras (lane tracking, …) → no map

- Detection and tracking of …
  - Lanes,
  - street signs,
  - other cars,
  - …

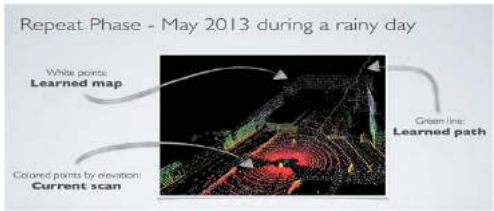
https://www.youtube.com/watch?v=aGW4nRzx8Iw

Today | 3D laser sensors → map based

Expensive, complex and cumbersome



- Google Self-Driving Car Project (status summer 2015)
  - > 20 vehicles in use
  - > 2,7 mio km, 1.5 mio km in autonomous mode
  - > 11 accidents
    - No people insured
    - Non of them caused by car control algorithm



https://www.youtube.com/watch?v=eJCR2TaeSFc

Autonomous Cars | roadmap

Fully autonomous Car
(you can sleep)

Autonomous car freeway

Interaction / negotiation between traffic participants

increasing complexity /understanding

learning and adaptation

Autonomous car urban

V-CHARGE

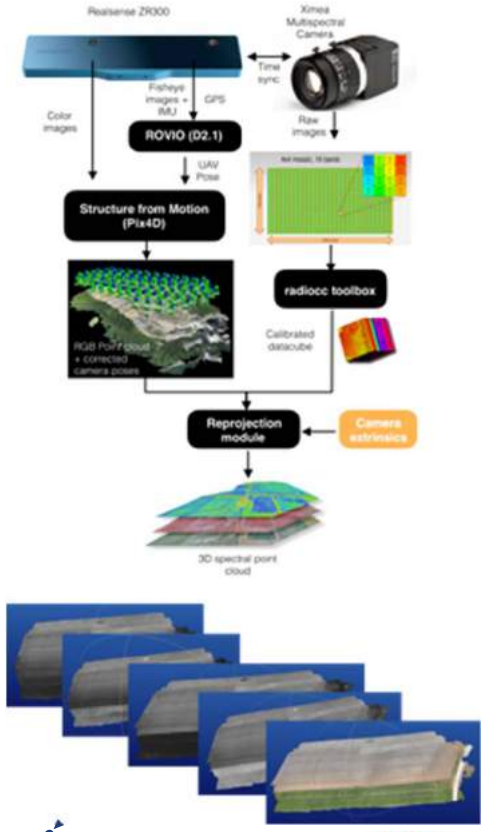
Driving Speed

Complexity of Environment → Perception and Interaction

Autonomous Cars | a bright future without traffic jams

Flourish – Aerial Data Collection and Analysis, and Automated Ground Intervention for Precision Farming

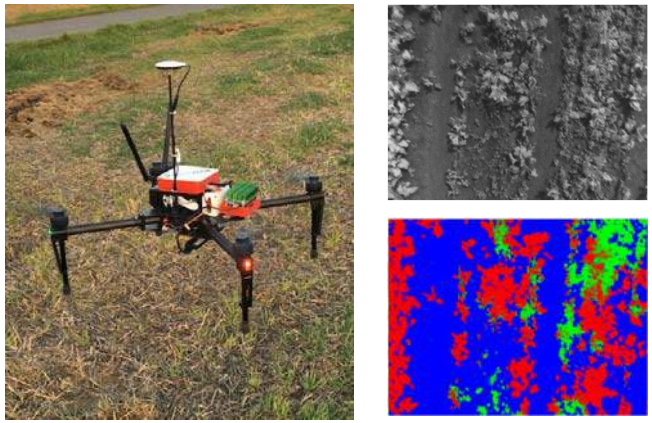
Spatio-Temporal Spectral Environment Modeling



https://youtu.be/5f1EtfW76Qc

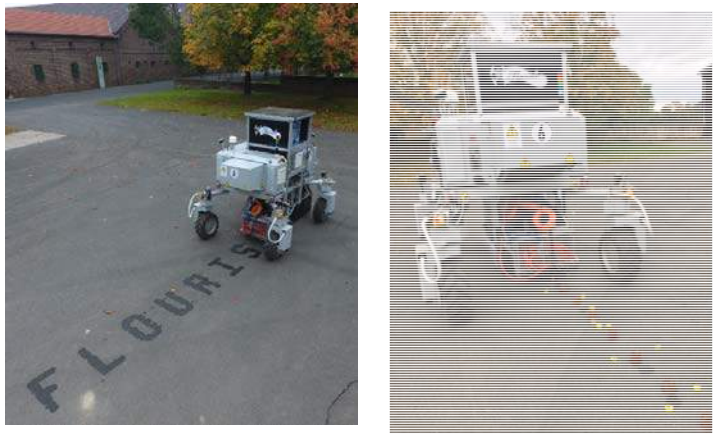
Autonomous UAV landing

UAV onboard weed detection



Weed classification on UGV (Sunflower ~95% acc.)

Automated spraying and stamping



Collaborative Visual-Inertial Navigation | teach and repeat

Google Project Tango

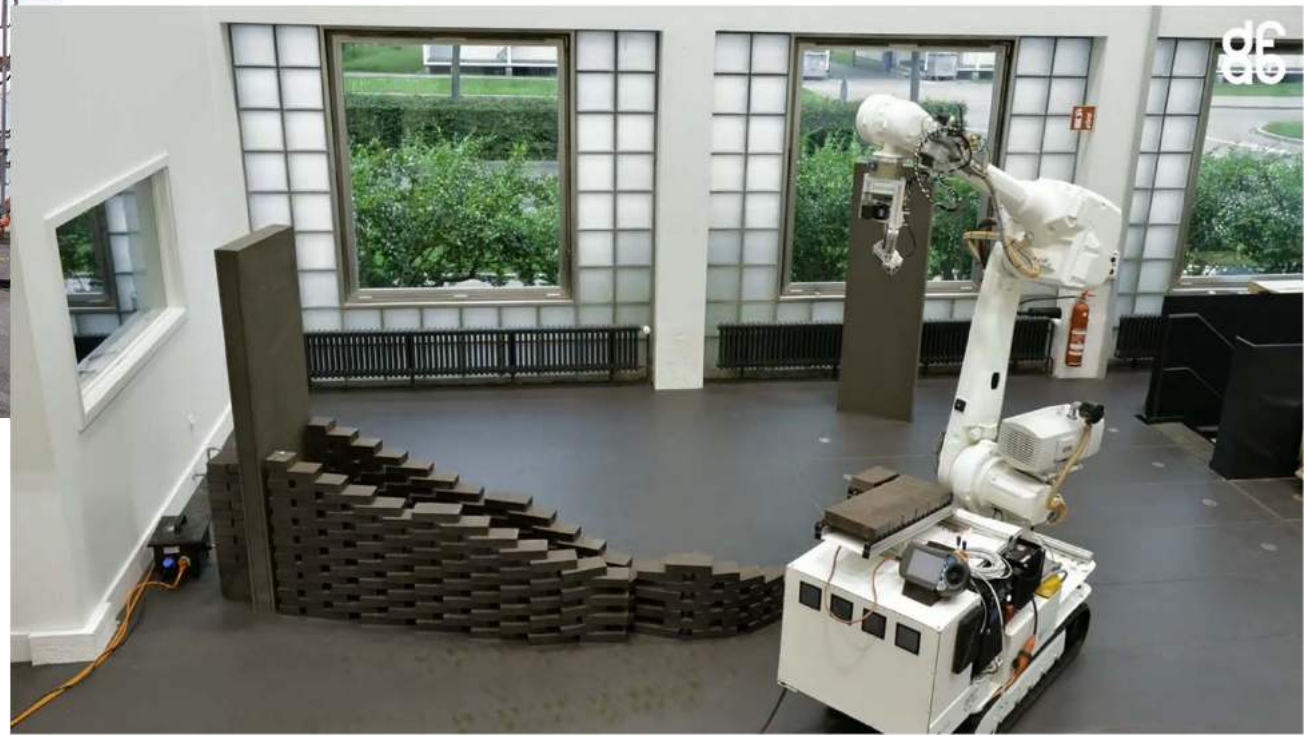
https://www.youtube.com/watch?v=pDIQXsOrgI4

Navigation & Planning in Cluttered Environments

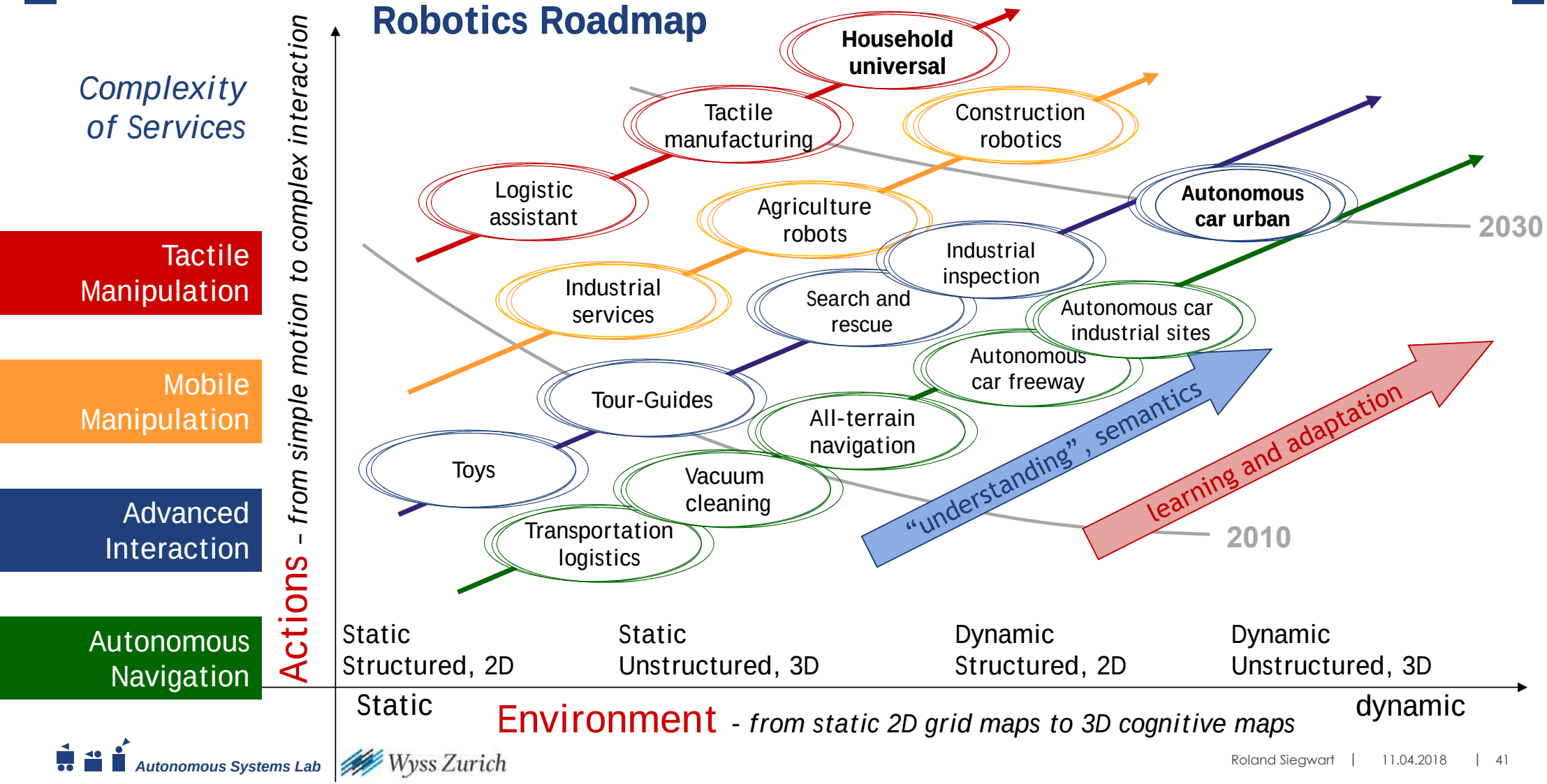
https://www.youtube.com/watch?v=rAJwD2kr7c0

Roboter auf der Baustelle – NCCR Digital Fabrication

National Centre of Competence in Research Digital Fabrication



Robotics Roadmap



Switzerland | a melting pot for robotics technology

Initiatives

robotics – Swiss National Centre of Competence in Research

National Centre of Competence in Research Digital Fabrication

Max-Planck-Gesellschaft

ETH zürich – Center for Learning Systems

Wyss Zurich – Translational Center

ieLab

Spin-offs (*ASL)

ANYbotics *

senseFly

VERITY studios

ONESKY – Safer Smarter Sky for All

PIX4D – simply powerful

GoPro

Skybotix *

wingtra *

force dimension

aeon scientific

YouRehab – inspire motivate achieve

noonee – because its wearable

FEMTO TOOLS

Dacuda – Scanning redefined

Ophthorobotics AG

MagnebotiX

Fotokite

DISTRAN Switzerland *

FLYABILITY

AEROTAIN *

BLUEBOTICS * – Mobile Robots at Your Service

Rapyuta Robotics

Hocoma

F&P Personal Robotics

Inspection Robotics *

Industrial Collaborations (ASL)

Google

Disney Research, Zurich

Project Tango

GoPro – Be a HERO.

ABB

menzi muck

arma suisse

SIEMENS

TOTAL

HEXAGON

Leica Geosystems

BOSCH

esa

RUAG

MANOR

Schindler

ASCENDING TECHNOLOGIES

intel

Take Home Message

- Ja, Robotik boomte
  - … es braucht aber noch viel F&E um diese komplexen Systeme auf den Markt zu bringen.
- Ja, Europa und speziell die Schweiz hat das Potential diesen wichtigen Markt zu erobern und somit nachhaltig Arbeitsplätze zu schaffen. Es geht um:
  - Hervorragende Forschung und grossartige Talente
  - Präzisionsmechanik und Künstliche Intelligenz
  - Innovation und Unternehmertum
- Für die Skalierung von Robotik-Technologie und Startups brauchen wir Talente, mehr Risikobereitschaft und langfristig ausgerichtetes Risikokapital (> 10 Jahre)