Maschinen statt Menschen?

Chancen und Grenzen Künstlicher Intelligenz aus Sicht der Wissenschaft ... die Perspektive einer Informatikerin

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Aus der Ankündigung der Veranstaltung

Lernende Systeme, sog. Künstliche Intelligenz (KI), entwickeln sich rasant mit immer weiteren Einsatzmöglichkeiten.

*Eine Technik, die dem Menschen im Denken ebenbürtig oder gar überlegen ist, rückt beständig näher.*

The Beginnings of Artificial Intelligence

Alan Turing
Can Machines Think?

A. M. Turing (1950)
Computing Machinery and Intelligence
Mind 49: 433-460

Can Machines Think?

Computers Try to Fool Humans at the
First Annual Loebner Prize Competition
Held at The Computer Museum, Boston

My Working Definition
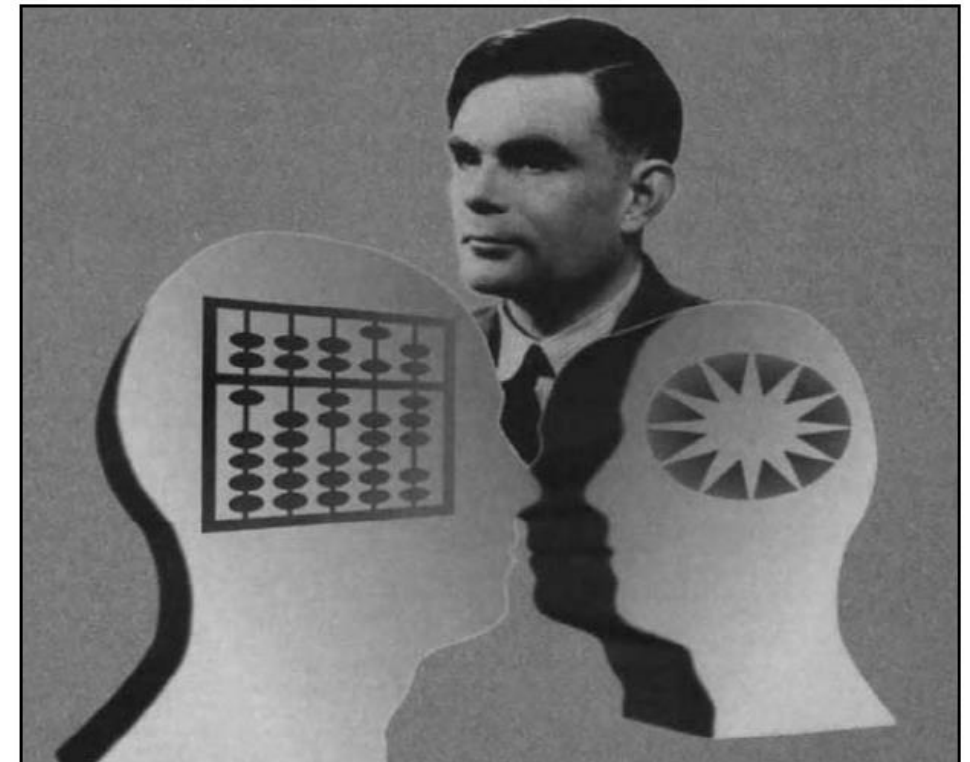
Intelligence

… is the ability to define and set goals and to develop behavior to achieve these goals …

Build Intelligent Agents	Understand Human Intelligence

Artificial Intelligence

Cognitive Science

Selected Definitions

Thinking Humanly	Thinking Rationally
"The exciting new effort to make computers think ... machines with minds, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998) "AI ... is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Models and Algorithms – 3 Types of Systems

Training
Generalization of annotated examples
via statistical pattern recognition
Machine Learning

Exploration
Experience generated from active
experimentation and environmental
feedback
Reinforcement Learning

Engineering
Human knowledge and expertise
captured in formal models
Solver

+

ALGORITHMS

=

*intelligent
behavior in
modeled
situations and
applications
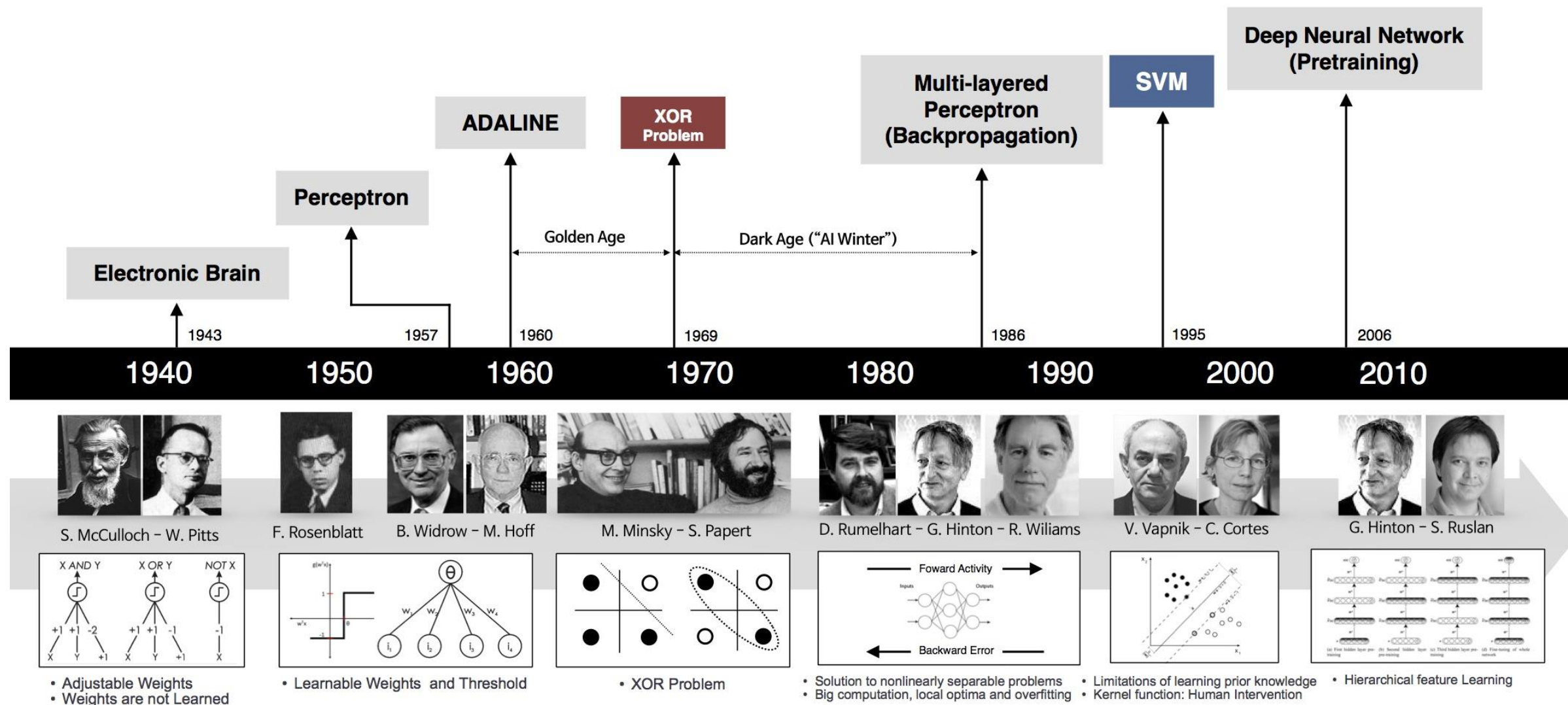(and only there!)*

See also Hector Geffner, IJCAI 2018
http://www.tecn.upf.es/~hgeffner/
https://www.youtube.com/watch?v=e8H7mAnJZ5g

Major Technologies & Application Areas

Natural Language Understanding

Intelligent Agents

Knowledge Representation & Reasoning

Search Algorithms

Image/ Video Analysis

Understanding Human Behavior

Game & Decision Theory

Planning & Reasoning about Action

Machine Learning

Decision Making

Assistants & Robots

Adaption & Flexibility

Prediction

Optimization

Automatic Translation

Search & Information Retrieval

Insights & Discovery

Continuous Progress in Key AI Fields

Deep Neural Network (Pretraining)

SVM

Multi-layered Perceptron (Backpropagation)

XOR Problem

ADALINE

Perceptron

Electronic Brain

Golden Age

Dark Age ("AI Winter")

1943 · 1957 · 1960 · 1969 · 1986 · 1995 · 2006

1940 · 1950 · 1960 · 1970 · 1980 · 1990 · 2000 · 2010

S. McCulloch – W. Pitts

F. Rosenblatt

B. Widrow – M. Hoff

M. Minsky – S. Papert

D. Rumelhart – G. Hinton – R. Wiliams

V. Vapnik – C. Cortes

G. Hinton – S. Ruslan

- Adjustable Weights
- Weights are not Learned

- Learnable Weights and Threshold

- XOR Problem

- Solution to nonlinearly separable problems
- Big computation, local optima and overfitting

- Limitations of learning prior knowledge
- Kernel function: Human Intervention

- Hierarchical feature Learning

https://beamandrew.github.io/deeplearning/2017/02/23/deep_learning_101_part1.html

IBM Watson Triggers Renewed Interest in AI

AI 2019: Artificial Intelligence - What is it about?

Current Limitations of Language-based Interaction

- «Understanding» questions that require context
- Conducting dialogues for clarification
- Recognizing arbitrary names
- Differentiating between concrete and abstract terms

5€ geschenkt: Jetzt Amazon-Konto aufladen

› Hier teilnehmen

Einkaufswagen

	Preis		Menge
"buch" 🔊		Hinzugefügt über Alexa vor 12 Stunden	

Nicht bereit für Kasse Welche "buch" wollten Sie?

[buch auswählen]   Löschen

Summe (0 Artikel): EUR 0,00

Systematic
Search

Alpha Beta
Pruning

Temporal
Difference
Learning

Heuristic Search
and Knowledge

Conflict
Learning

Monte-
Carlo Tree
Search

Reinforcement
Learning

Deep
Learning

Population-based/
Multi-Agent RL

Discounted
Regret
Minimization

Policy
Distillation

Long-/Shortterm
Planning

$$10^5/10^{31} \qquad 10^{144} \qquad 10^{123} \qquad 10^{360}$$ Imperfect Information Games

| 1940s-1970s | 1992 | 1996/97 | 2012 | 2016 | 2017 | 2019 |

TD-Gammon

Deep Blue

Watson

AlphaGo

Libratus

AlphaStar

> 20 People

> 40 People

IBM

IBM

IBM Watson

Google

Carnegie Mellon University
Computer Science Department

DeepMind

TicTacToe/Checkers   **Backgammon**   **Chess**   **Jeopardy**   **Go**   **Poker**   **Starcraft II**

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Algorithmic Business and Production @ DFKI
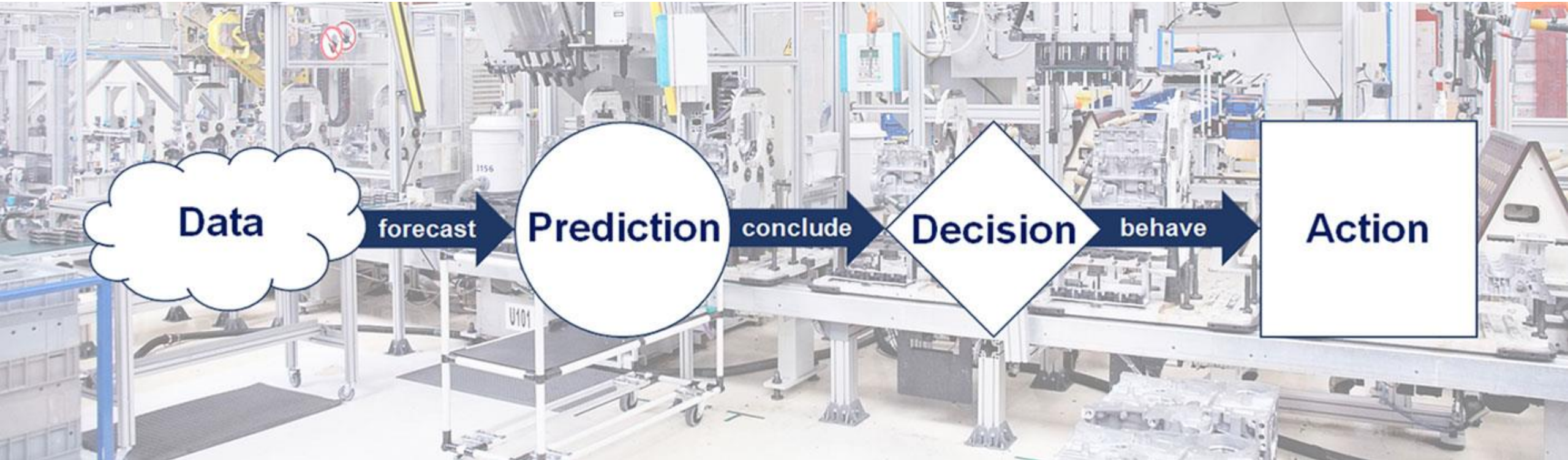
"Big data" is high-volume, -velocity and -variety information assets that demand

- *cost-effective, innovative forms of information processing*

- *for enhanced insight and decision making*

"Algorithmic business is pivotal to competitive advantage … causing the disruption of entire industries."

Gartner 2011,2016

© DFKI

Challenges in Deep Learning

Sports	94%
Tennis	93%
Tennis Player	89%
Football Player	88%
Ball Game	86%
Racquet Sport	82%

Roger Federer	8.248
2015 US Open	2.87768
Tennis	2.03366
2016 US Open	1.72056
2014 US Open	1.49444
2012 US Open	1.48128
2011 US Open	1.44896
2013 US Open	1.40856
USTA Billie Jean King National T...	1.31064
Tennis player	0.52656
Forehand	0.33282
Roberta Vinci	0.07663

- Hidden dependency on training data

- Non-calibrated confidence values

- Intransparancy of learned model

From Prediction to Decision to Action

Innovations

A new fleet of autonomous robots is now making one of the world's oldest foods

Can a robot become a master baker? The owner of the BreadBot thinks the answer is yes.

https://www.washingtonpost.com/technology/2019/01/07/new-fleet-autonomous-robots-is-now-making-one-mankinds-oldest-foods/?noredirect=on&utm_term=.cb3567de07c0
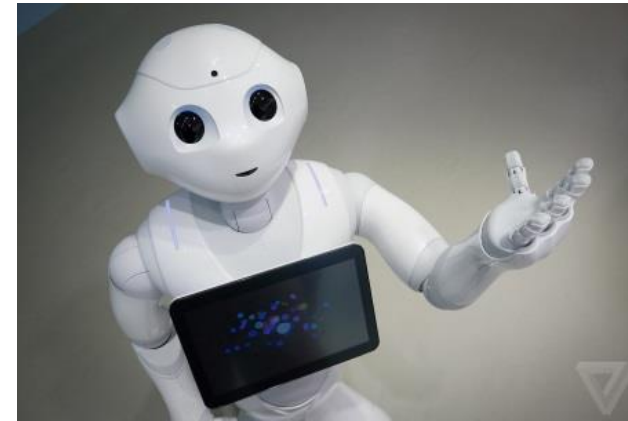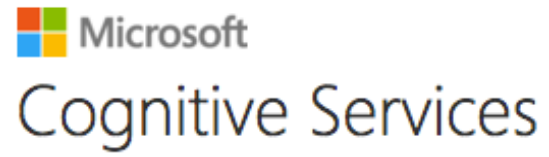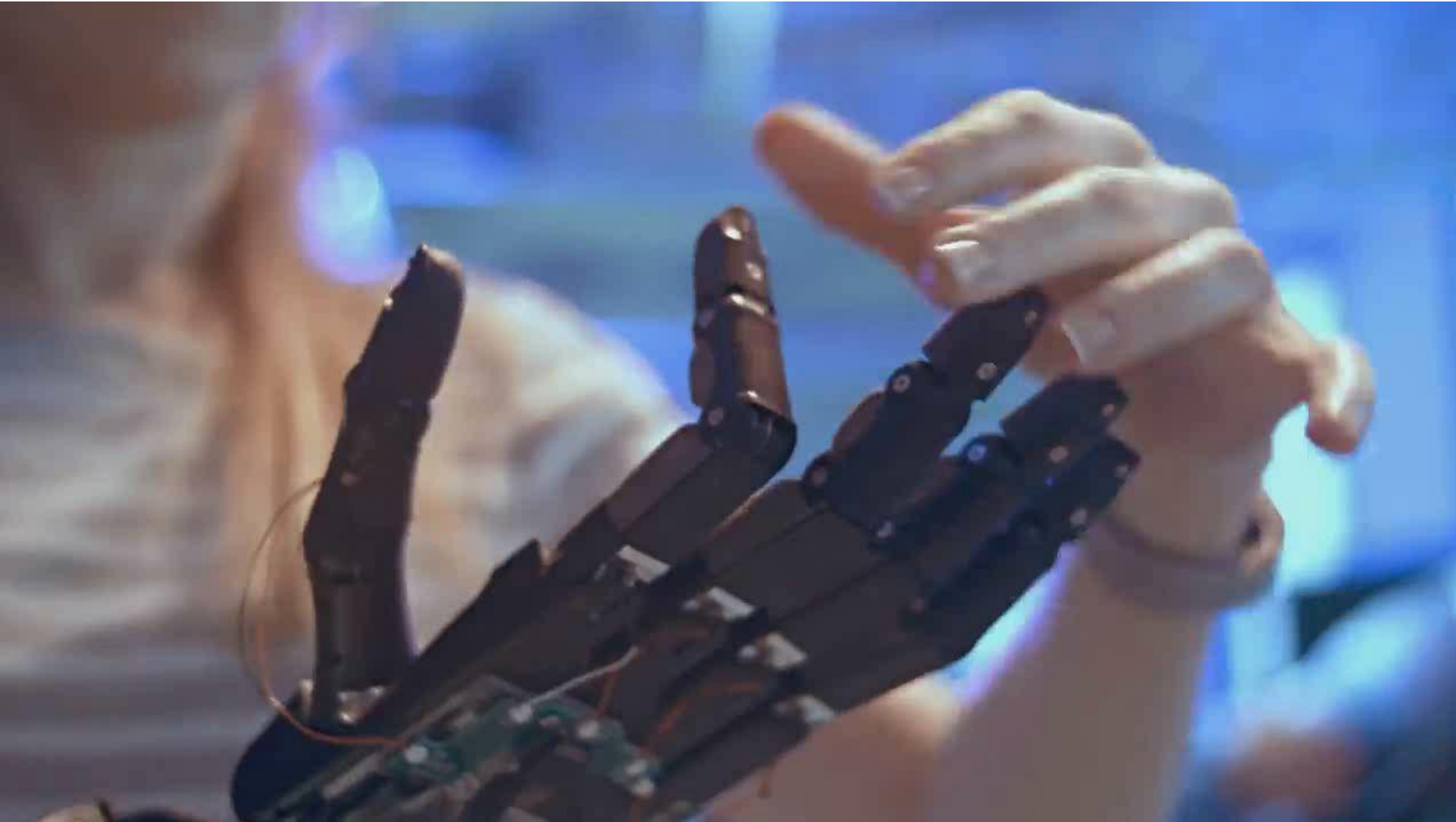
What It Really Is…

Embodiment

Open AI - Automatic Domain Randomization (ADR)

- 20 % success rate for arbitrary cube

- 60 % success rate for 15 moves problem

- 80 % dropped cubes

Transfer Learning

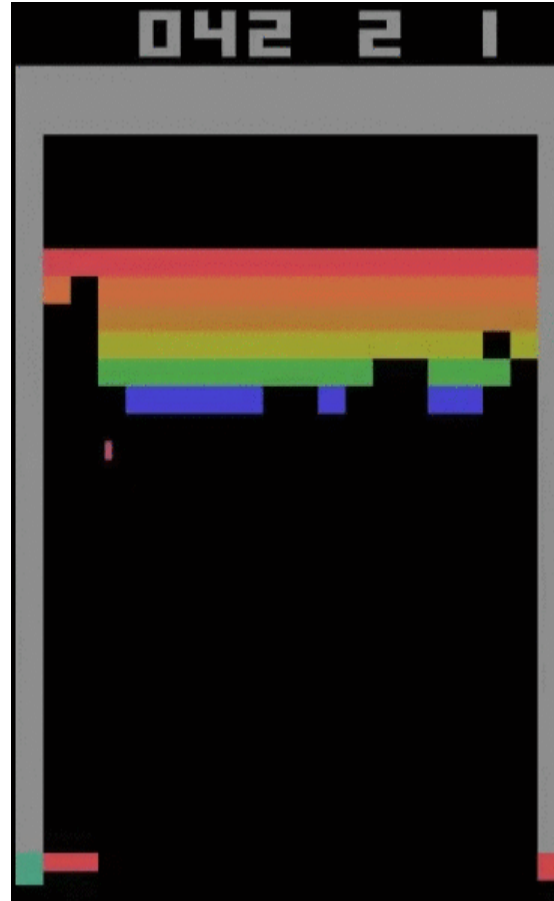https://www.youtube.com/watch?v=iaF43Ze1oeI

Safe Exploration?

Finding Unusual Strategies

Atari Breakout   after 600 training episodes

Robocup Soccer World Champion in 2009 vs. 2019

Five Key Success Factors for a Digital Nation

- Infrastructure

- Social Stability and Equity

- Life-Accompagnying Education and Learning

- High-Quality Affordable Health Care

- Business- and citizen-friendly public processes
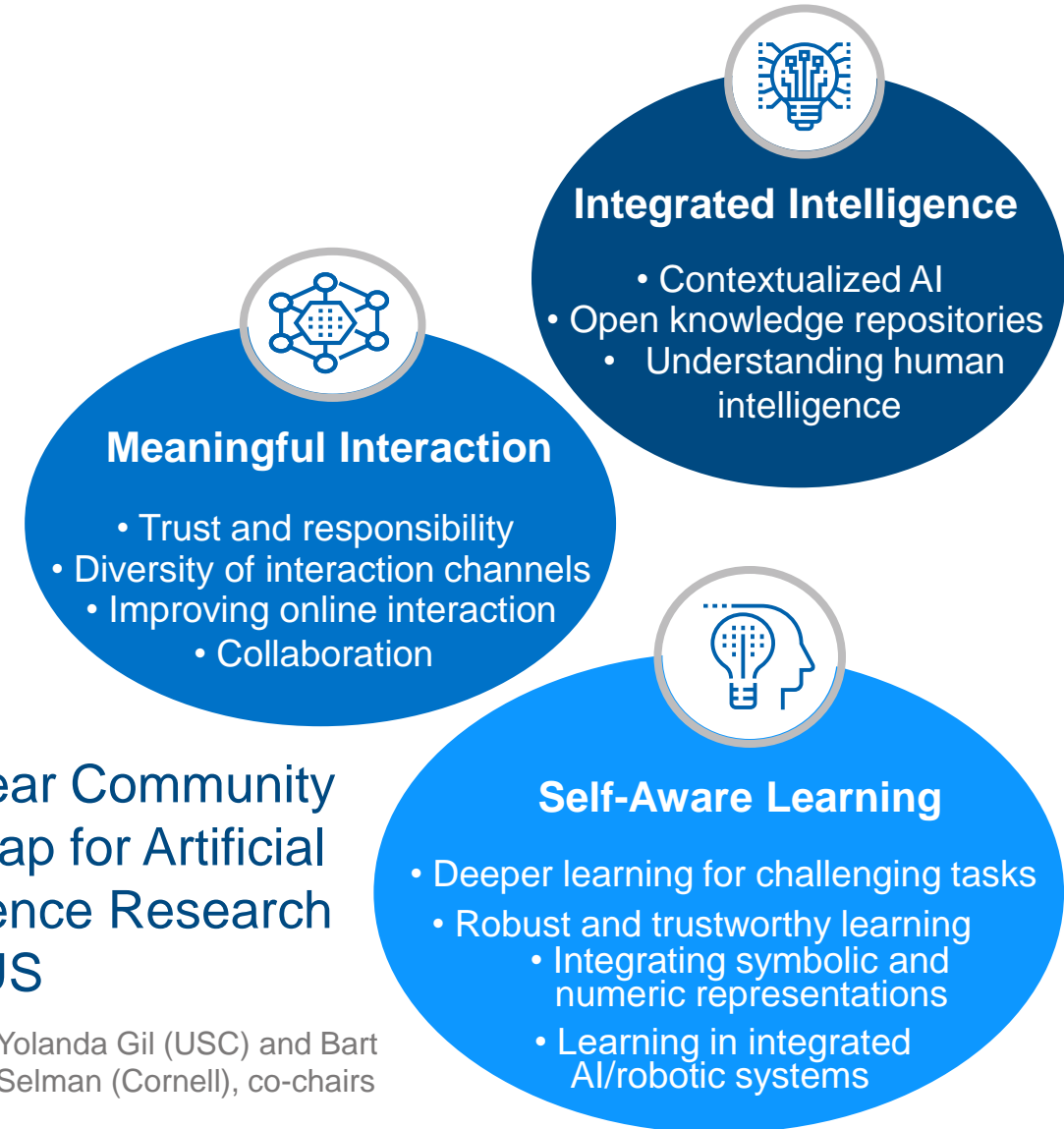
AI and IT Technology Create New Professions

- **Online world**: data scientist, influencer, online markting specialist, …

- **Industry 4.0**: AI-supported designer, AI mechatronics, robot trainer, expert technicians, …

- **Environment and agriculture**: drone pilot, agrarrobotics specialist, animal wellbeing advocate, biodiversity manager, lawn mower robot mechanics

- **Health care**: health care manager, diabetes care nurse, …

Current Research Trends

- Multi-AI Architectures

- Mastering Context

- Embodiment

- Scientific Discovery with AI

A 20-Year Community Roadmap for Artificial Intelligence Research in the US

Yolanda Gil (USC) and Bart Selman (Cornell), co-chairs

Integrated Intelligence
- Contextualized AI
- Open knowledge repositories
- Understanding human intelligence

Meaningful Interaction
- Trust and responsibility
- Diversity of interaction channels
- Improving online interaction
- Collaboration

Self-Aware Learning
- Deeper learning for challenging tasks
- Robust and trustworthy learning
- Integrating symbolic and numeric representations
- Learning in integrated AI/robotic systems

The next Decade of AI: The 4 BIG A

- **A**bstraction

- **A**nalogy

- **A**rgumentation

- **A**rbitrary Common Sense

Artificial General Intelligence (AGI)

Thank you very much for your attention.

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