Munich Center for Machine Learning

Current Trends in Artificial Intelligence Research, Future Prospects, and Opportunities

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LMU Munich

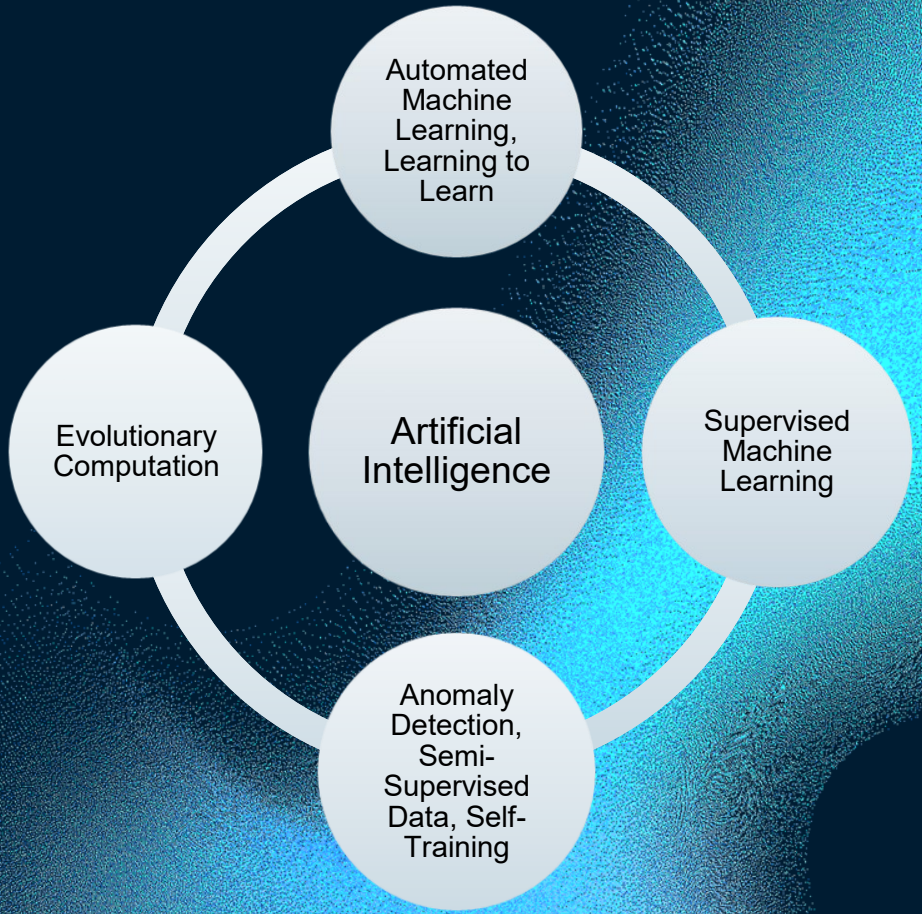
Seminar „International patent law: Recent trends in Artificial Intelligence“, Kraus & Weisert Munich, September 12, 2023

Munich Center for Machine Learning

Dr. Marcel Wever

Transfer Coordinator Education

Dr.rer.nat. in computer science
2021, Paderborn University, Germany



What is the MCML

Joint research initiative of

Ludwig-Maximilians-Universität München and
Technische Universität München

Part of German and Bavarian government‘s AI strategy

One of six national AI competence centers in Germany
that is permanently funded since July 2022

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

TUM

HIGHTECH Agenda Bayern

Bayerisches Staatsministerium für Wissenschaft und Kunst

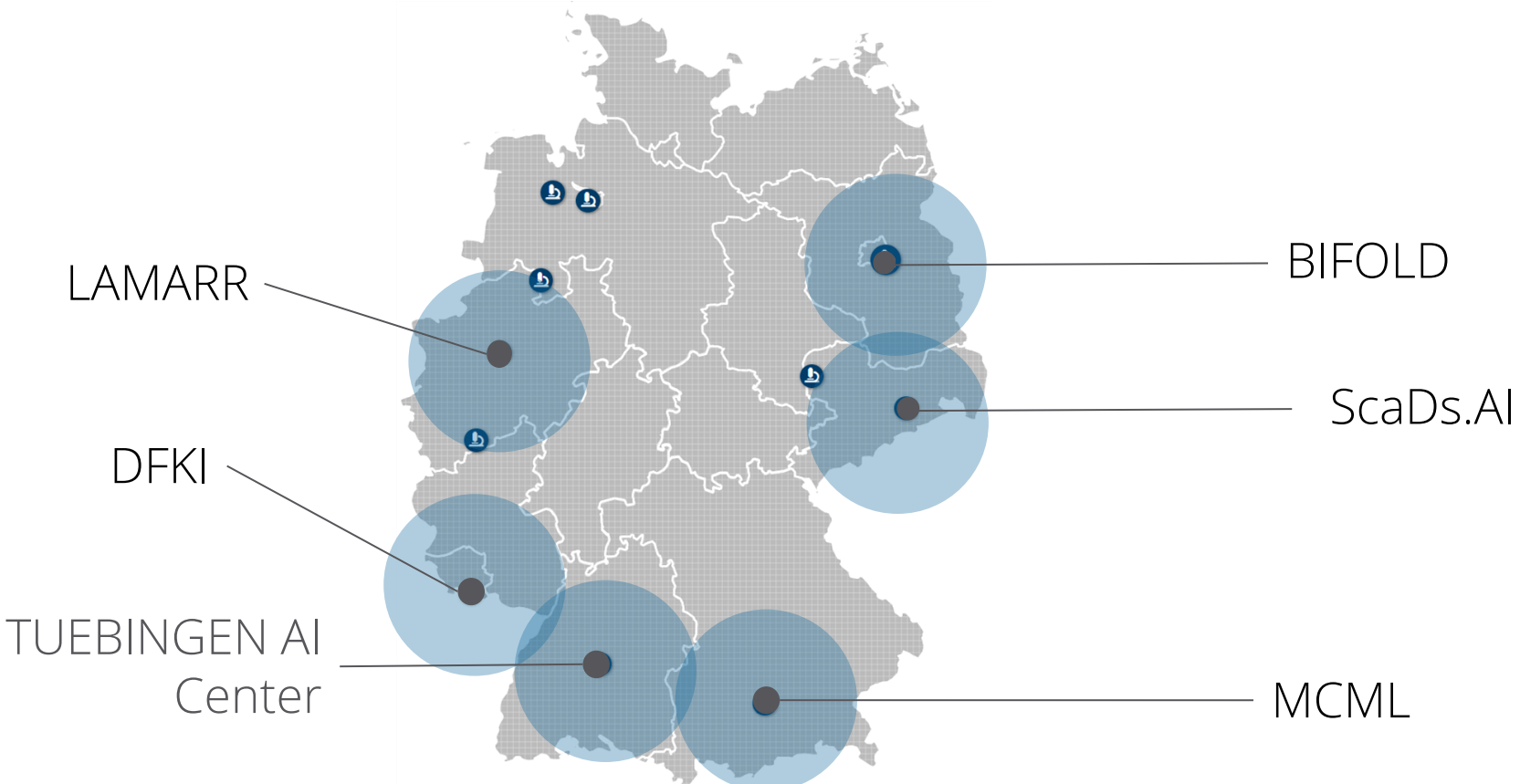
GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

Our mission

We unite leading researchers in Germany, to strengthen international, national and regional competence in the field of Machine Learning and Artificial Intelligence.

We make Machine Learning potential accessible to users from science, industry and society.

MCML is one of six AI competence centers in Germany



MCML in numbers

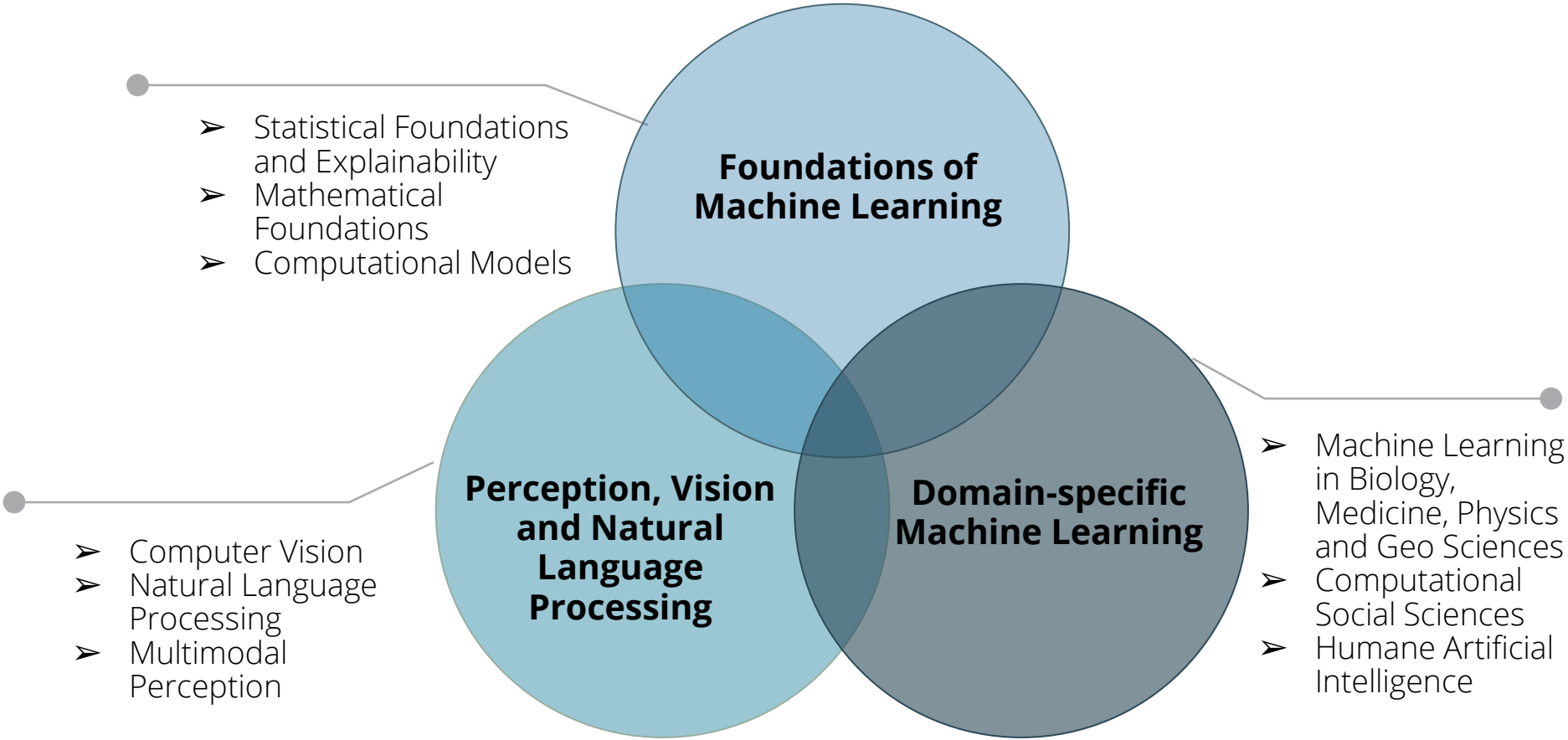
Several of world leading researchers in the field of AI/ML - our principal investigators - are part of the MCML

Top ranked publications have been achieved by MCML-researchers

Many talented and motivated PhD students are being trained and educated at the MCML

The research areas of the MCML

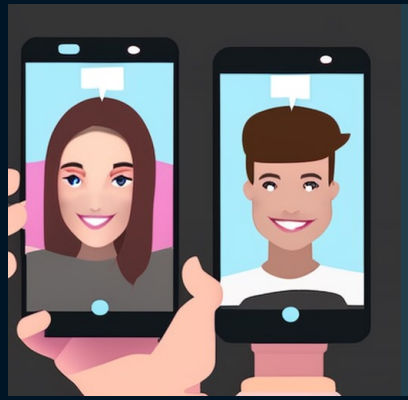
Three research areas




We transfer science in the field of AI into industry and society

Artificial intelligence and where to find It

- Profile picture for the workshop flyer
- Only low-quality picture from a website
- Insufficient quality for the flyer
- Use software tool based on AI to increase quality



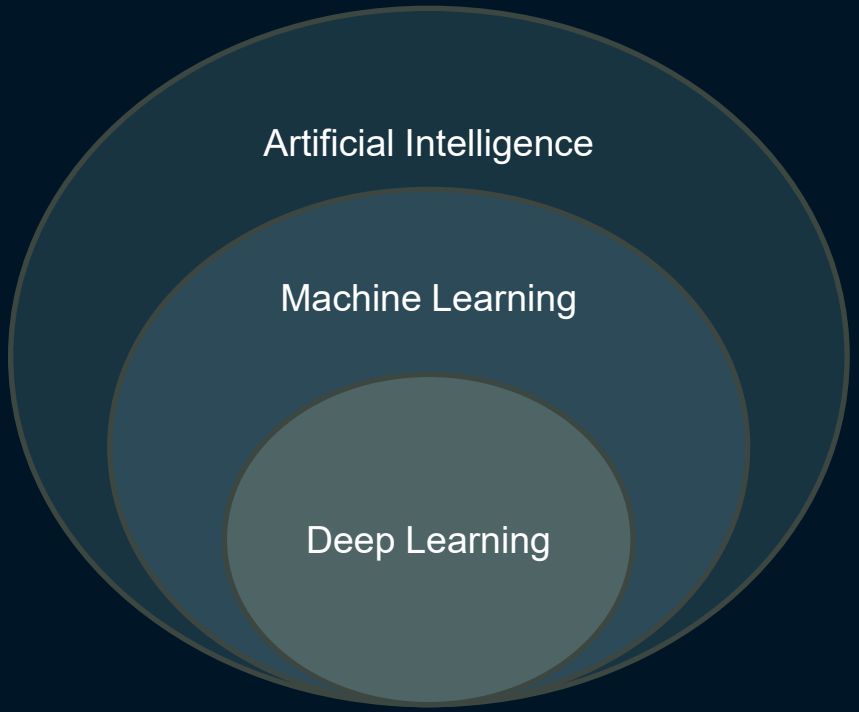
- Face recognition
- Charging behavior
- Social media
- Spell checking
- Translation
- Web search
- Digital assistants

"smartphone face social media"

- Predictive maintenance
- Autonomous driving
- Fraud detection (banking)
- Online ads
- Recommendations

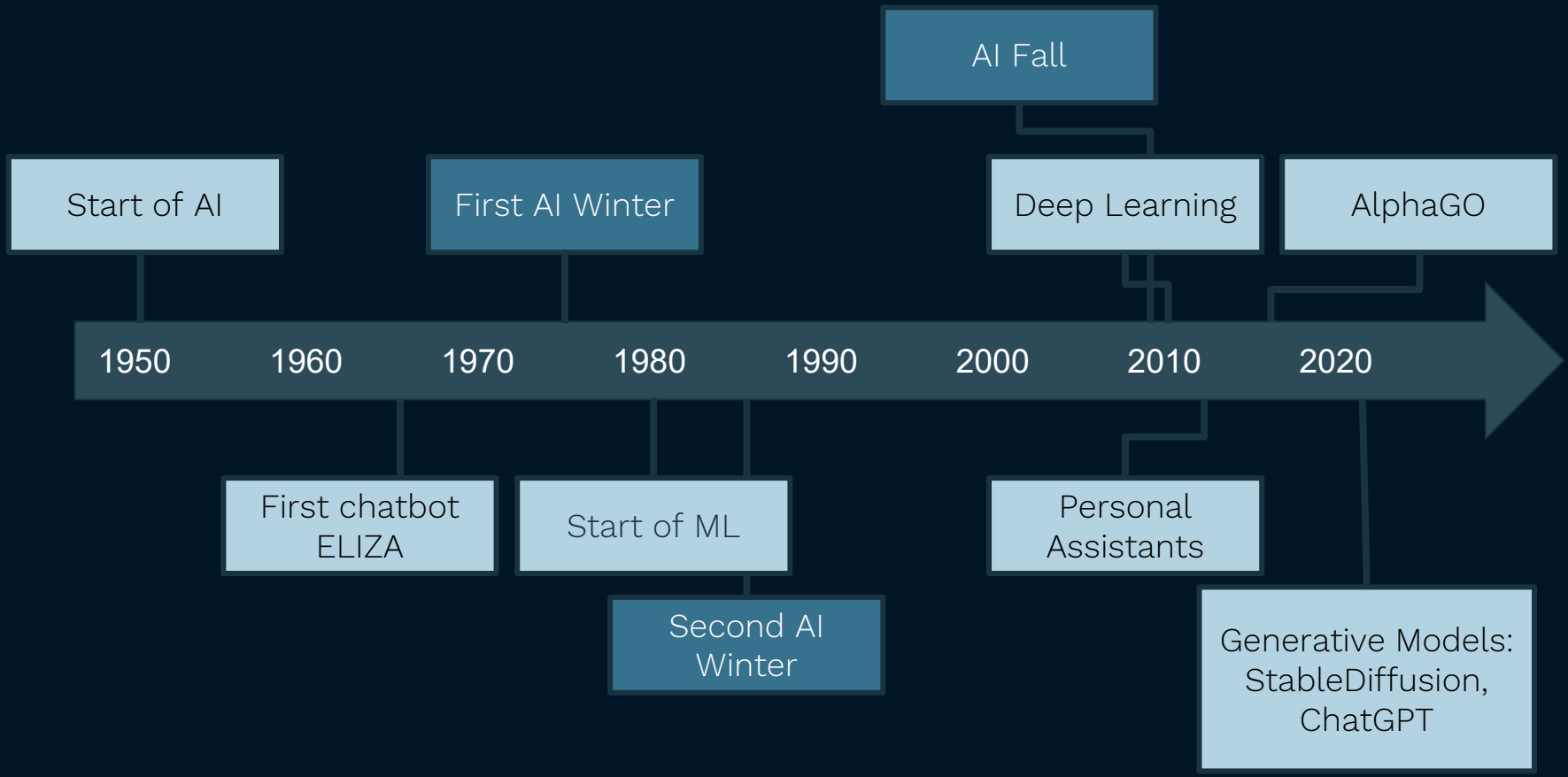
"automation industry recommendation"

What are AI, machine learning, and deep learning?



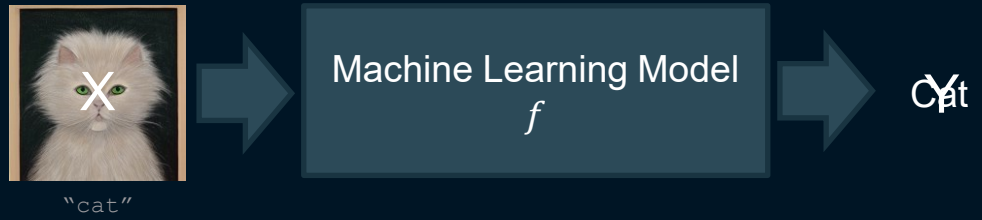
- Artificial Intelligence:
  Intelligent behavior (previously done by humans) is performed *algorithmically*
- Machine Learning:
  A parameterized (mathematical) *model* is "learned" from examples to map *inputs* to *outputs*
- Deep Learning:
  An *artificial neural network (ANN)* is learned from examples

A brief overview of the history of AI



Machine Learning and Generative Models

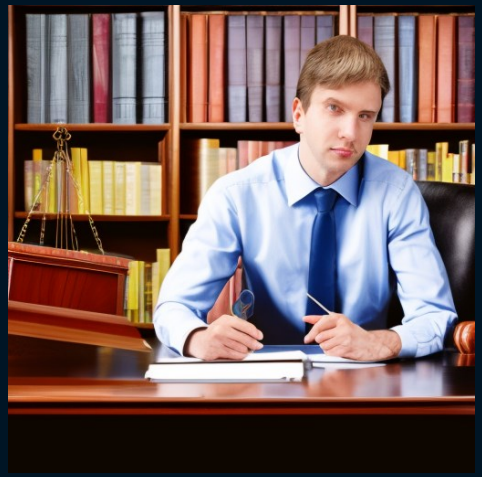
- Classical machine learning maps inputs (e.g. picture) to outputs (e.g. label)



- Generative models invert the mapping
- Given a label, generate a picture

Stable Diffusion: Generative Models for images

- Text-to-image models generate images based on a prompt
- Basic idea behind diffusion models can be transferred to text generation, traffic simulation, game design, ...



"patent attorney justice legal"

"attorney in front of Eiffel tower"

"traffic simulation"

Stable Diffusion: Editing images

- (Image+Text)-to-Image: Edit images by masking and describing the changes

- Future: More advanced image and video editing tools

Best of Stable Diffusion

Generative Models for text data

- Given a text prompt:
  Generate a text as a response
- Translation of texts, e.g., to Japanese
- Can be used to generate standard documents: letters, CV's, summaries, explanations, statements, ...

Title: Current and Future Trends in Artificial Intelligence

Slide 1: Introduction

Welcome and introduction to the presentation
Importance of Artificial Intelligence (AI) in today's world
Overview of current and future trends
Slide 2: Current Trends in AI

Discuss the current state of AI technology
Highlight recent advancements and applications
Include examples such as natural language processing, computer vision, and recommendation systems
Slide 3: Machine Learning

Explain the role of machine learning in AI
Discuss supervised, unsupervised, and reinforcement learning
Mention the importance of deep learning and neural networks
Slide 4: Big Data and AI

Explore the relationship between big data and AI
Discuss how AI is used to analyze large datasets
Emphasize the impact on decision-making and insights
Slide 5: AI in Healthcare

Present current applications of AI in healthcare
Discuss diagnosis, treatment, and drug discovery
Highlight the potential for personalized medicine
Slide 6: AI in Autonomous Systems

Describe the role of AI in autonomous vehicles and drones
Discuss safety and regulatory challenges
Explore future possibilities for autonomous AI systems

Building generative text models

- Generative models as ChatGPT are pre-trained on vast amount of data
- Varying levels of finetuning after pre-training

Step 0 Foundation Model	**Step 1** Example Responses	**Step 2** Preferences	**Step 3** Likes/Dislikes
Train on massive amount of text data	For given prompts, let humans give example answers	For a given prompt, let humans rank different responses	A user gives feedback in terms of like/dislike for generated text
Learn to predict a single masked word	Very costly, very informative	Less costly, moderate informativeness	Very cheap, weak signal

- With finetuning, domain-specific knowledge can be introduced

Handling of multi-modal data

- AI tools so far often restrict themselves to a single data format

- The world is multi-modal and so should be the data fed to AI systems
- More versatile AI systems that can handle different types of data

Generative Models for programming

- Generate program code, e.g., a program to compute the Fibonacci numbers in the programming language Python

- Prompt: „Give me a python program computing the Fibonacci numbers“

1. **Iterative Approach** (Recommended for large Fibonacci numbers):

python — Copy code

```python
def fibonacci_iterative(n):
    if n <= 0:
        return []
    elif n == 1:
        return [0]
    elif n == 2:
        return [0, 1]
    else:
        fib_sequence = [0, 1]
        for i in range(2, n):
            next_fib = fib_sequence[i - 1] + fib_sequence[i - 2]
            fib_sequence.append(next_fib)
        return fib_sequence

# Usage example:
n = 10  # Change n to the desired Fibonacci sequence length
fib_sequence = fibonacci_iterative(n)
print(f"Fibonacci sequence of length {n}: {fib_sequence}")
```

1. **Recursive Approach** (Not recommended for large Fibonacci numbers due to exponential time complexity):

python — Copy code

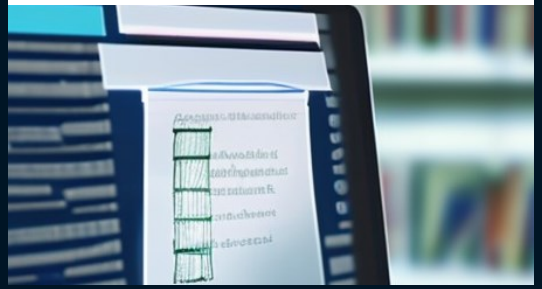
```python
def fibonacci_recursive(n):
    if n <= 0:
        return []
    elif n == 1:
        return [0]
    elif n == 2:
        return [0, 1]
    else:
        fib_sequence = fibonacci_recursive(n - 1)
        next_fib = fib_sequence[-1] + fib_sequence[-2]
        fib_sequence.append(next_fib)
        return fib_sequence

# Usage example:
n = 10  # Change n to the desired Fibonacci sequence length
fib_sequence = fibonacci_recursive(n)
print(f"Fibonacci sequence of length {n}: {fib_sequence}")
```

Generative Models for assisting human experts

- AI-based assistants for human experts

AI CHATBOT



AI-based document scanning and summarization

"document scanning artificial intelligence"

GitHub Copilot

AI-based pair programming

ML-Copilot

AI-assisted data science and machine learning

Automated Machine Learning (AutoML)

- High demand for machine learning applications
- Limited availability of experts to engineer those applications
- Solution: Automation Achieves state-of-the-art performance

AutoML and NAS

Black-box optimization for the choice of machine learning algorithms / artificial neural networks

Meta-Learning

Use machine learning to predict for a dataset which algorithms to use

Learn a generic predictor

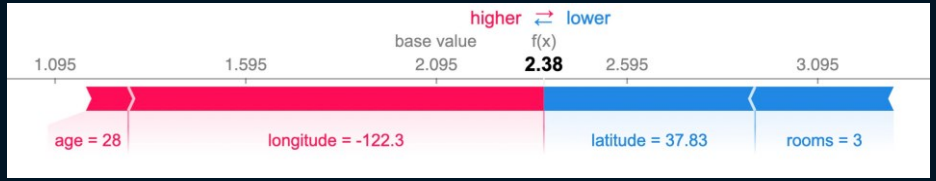
AutoML Zero

Generate machine learning algorithms from scratch

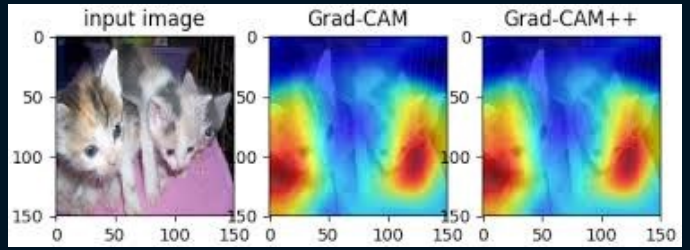
Acceptance problems: Requiring tools to be more *interactive* and *explainability*

Explainable Artificial Intelligence

- Explain predicted outcomes Y to the user
- Influence of inputs X in terms of a force plot



- Highlighting the most influential parts of an image:



Only relatively simple explanations possible so far.
In the future: Addressing other questions a user of AI might have.

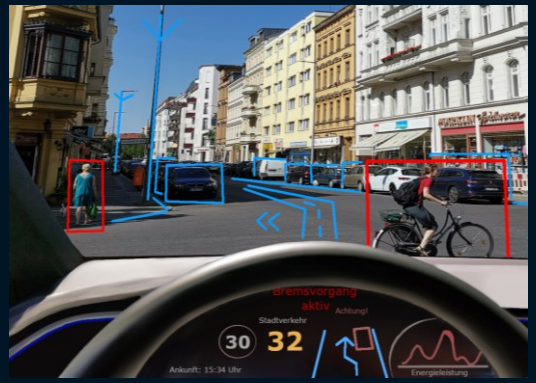
Cooperative AI tools: AI interacting with humans

- Build AI tools that can interact with humans
- Cooperatively come up with solutions
- Generative Models for text as a basis

- AI mainly developed by mathematicians, computer scientists, computerlinguists
- Future: AI developed by domain experts incorporating domain-specific knowledge

Autonomous driving: Processing images

Object Recognition



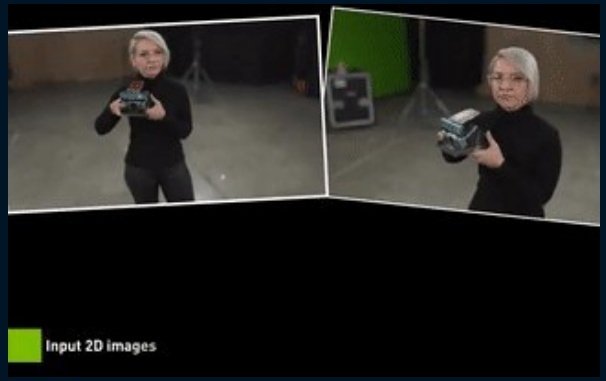
- Detect objects
- Distinguish between moving and static objects
- Estimate the depth/ distance from monocular images

Realistic Simulation

"traffic simulation"

- Simulate realistic traffic situations
- Development environment for autonomous driving
- Test case selection (testing is expensive)

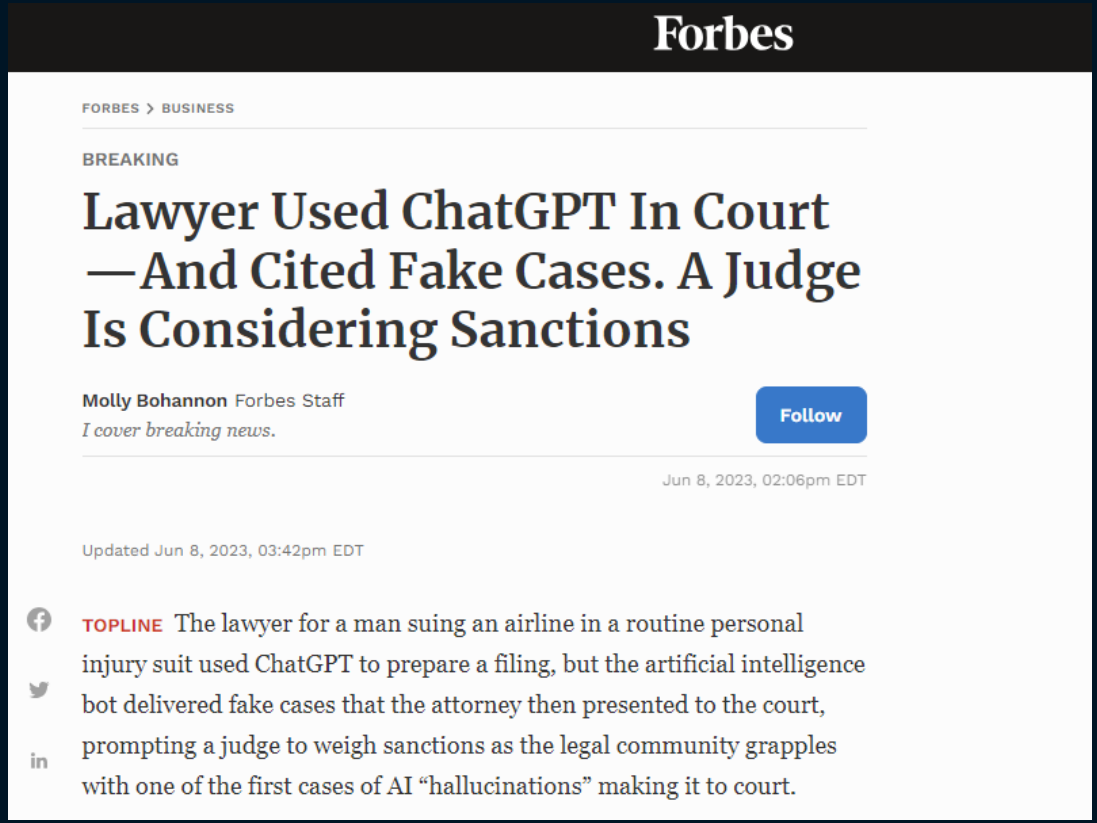
Scene Rendering



- Generate 3D models based on 2D images
- Situational awareness
- Predict information that is missing

Pitfalls: Misusage

- Responsible use of AI is crucial
- Understanding the capabilities what AI can do and more importantly cannot do (yet)
- Blind usage is dangerous
  - need proper education and explanations



Forbes

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BREAKING

Lawyer Used ChatGPT In Court —And Cited Fake Cases. A Judge Is Considering Sanctions

Molly Bohannon Forbes Staff
I cover breaking news.

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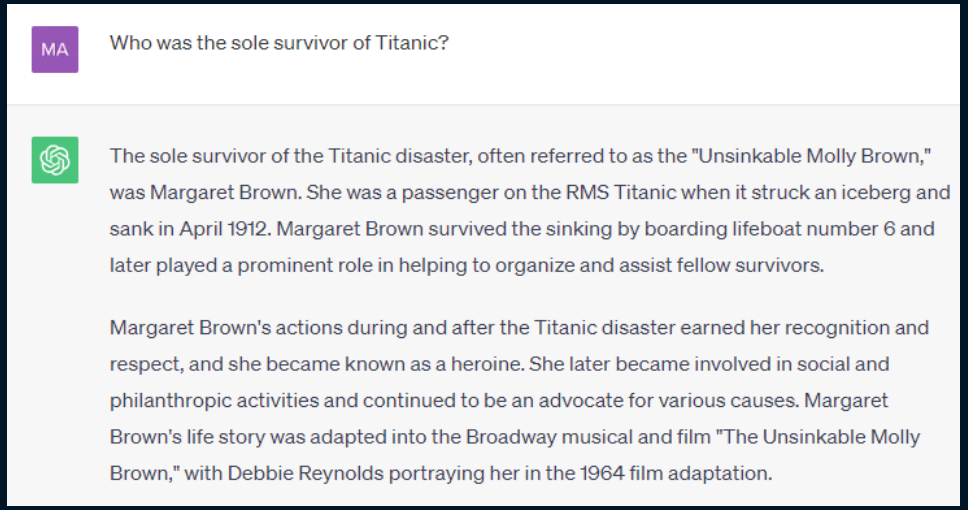
Jun 8, 2023, 02:06pm EDT

Updated Jun 8, 2023, 03:42pm EDT

TOPLINE The lawyer for a man suing an airline in a routine personal injury suit used ChatGPT to prepare a filing, but the artificial intelligence bot delivered fake cases that the attorney then presented to the court, prompting a judge to weigh sanctions as the legal community grapples with one of the first cases of AI "hallucinations" making it to court.

Pitfalls: Hallucinations of Generative Models

- Generative models for text may *hallucinate* instead of truthfully informing



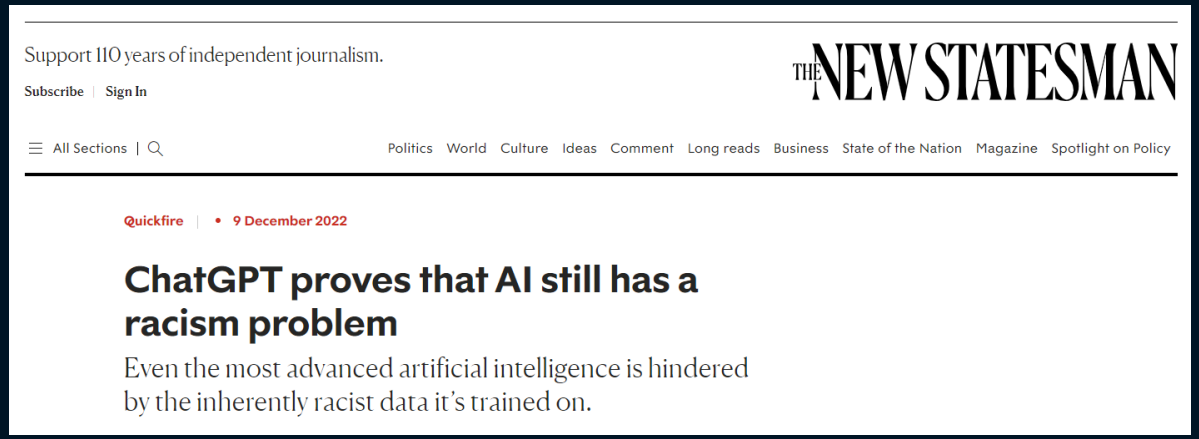
Trick question!

Actually there were 700 survivors

Avoiding hallucinations is a major challenge.
In the future: Link to knowledge bases maintaining *facts*.

Pitfalls: Biases

- AI learns from data created by humans
- Data can be biased: racism, gender-bias, ...
- AI may be used to influence people



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ChatGPT proves that AI still has a racism problem

Even the most advanced artificial intelligence is hindered by the inherently racist data it's trained on.

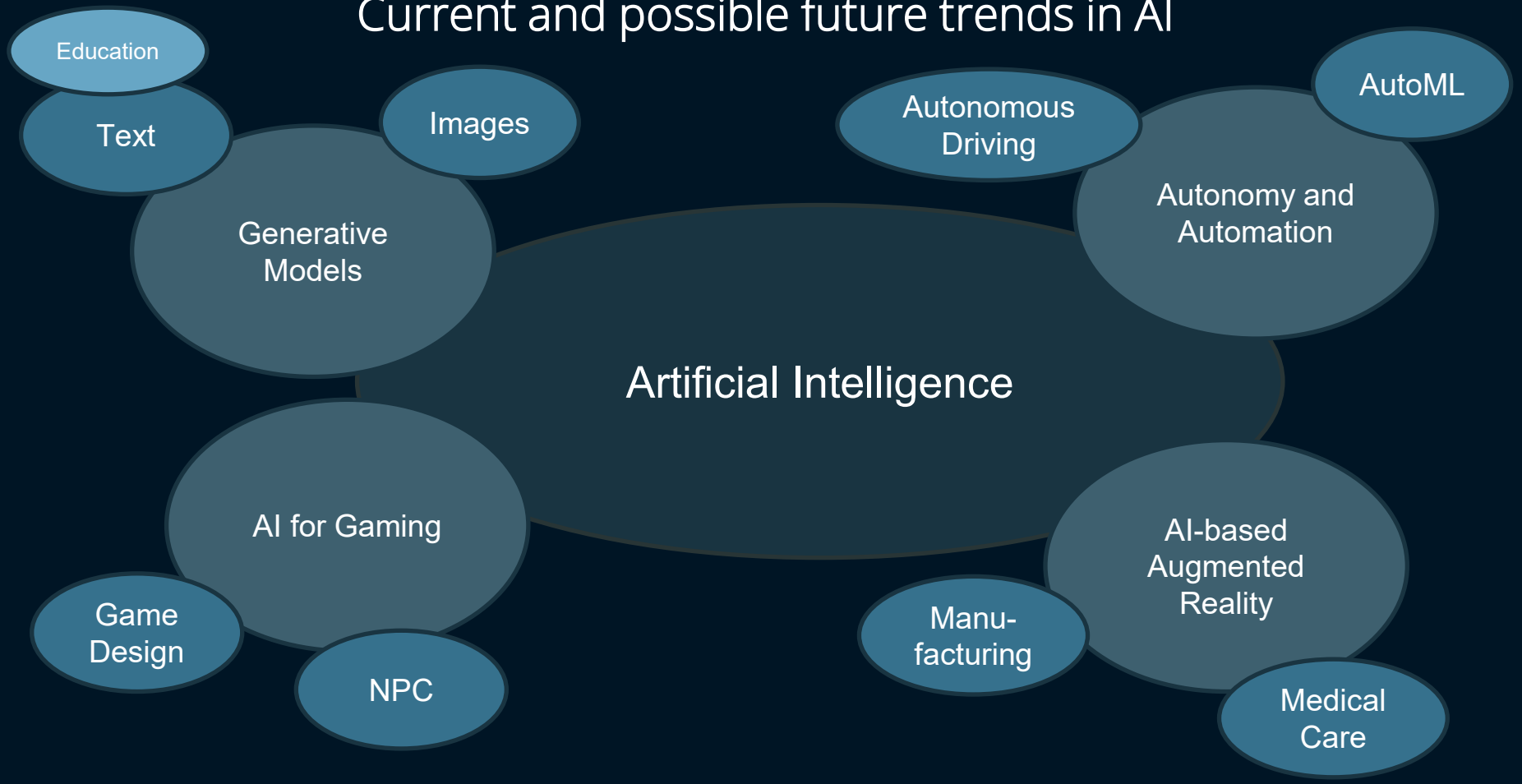
In order to obtain fair AI, additional mechanisms need to be incorporated

Pitfalls: Fake News

- Generative Models can be used to make up fake pictures

Need for AI tools that can detect whether something is generated or real

Current and possible future trends in AI



Open (Legal) Issues

EU AI Act

Liability for AI

Copyright for content generated by AI

Impact on society

International governance

Sentience of AI (Intelligence – Turing Test)

Data privacy and protection

Conclusion

- Generative Models for
  - Images
  - Text
- (Partial) automation
  - Business processes
  - Data science
  - Decision making
  - Driving
- Supportive AI
- Sophisticated media creation

@wever_marcel
@MunichCenterML

(Some) Future Prospects

- Generative Models handling
  - Multi-modal data
  - Specialized for various domains
  - Connected to
- Explainability and interactiveness
  - Explain inner workings
  - Explain data
  - Explain *concepts*
  - *Cooperative* AI
- Addressing legal and ethical concerns
- Domain-specific AI

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