Intro to AI Workshop

July 2024

What is Artificial Intelligence (AI)?

The simulation of human intelligence in machines that are programmed to think and learn like humans.

Capabilities of AI

- **Artificial Narrow Intelligence (ANI / Weak AI)**: AI that is specialized in one area and performs specific tasks. This is the **current state** of most AI systems.

- **Artificial General Intelligence (AGI / Strong AI)**: AI that can understand, learn, and apply intelligence across a broad range of tasks at a human-like level. This is **theoretical and not yet achieved**.

- **Artificial Superintelligence (ASI)**: AI that surpasses human intelligence and capabilities across all fields. This is a **speculative future state** of AI.

AI Learning Approaches (ANI)

- **Supervised Learning**: Learning from labeled data.

- **Unsupervised Learning**: Identifying patterns in unlabeled data.

- **Semi-Supervised Learning**: Combining labeled and unlabeled data.

- **Reinforcement Learning**: Learning through rewards and penalties.

Most common applications of AI (ANI)

- **Machine Learning (ML)**: A subset of AI that focuses on the development of algorithms that allow machines to learn from and make predictions or decisions based on data.

- **Natural Language Processing (NLP)**: A field that enables machines to understand, interpret, and respond to human language.

- **Computer Vision**: The capability of machines to interpret and make decisions based on visual inputs from the world, such as images or videos.

- **Robotics**: The design and creation of robots that can perform tasks in the physical world.

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Examples of ANI / Weak AI

Example	Application	Learning Approaches
Siri & Alexa	NLP	• **Supervised Learning**: For understanding and responding to voice commands based on labeled data (e.g., training models to recognize specific phrases and their corresponding actions). • **Unsupervised Learning**: For improving user interaction and personalization by analyzing patterns in user data. • **Reinforcement Learning**: For improving dialogue management by learning from user interactions to enhance conversation flow and user satisfaction.
Google Search Algorithms	ML	• **Supervised Learning**: For ranking web pages based on user queries, using labeled data that indicates the relevance of web pages. • **Unsupervised Learning**: For clustering search results and identifying similar content across different web pages. • **Reinforcement Learning**: For optimizing the ranking algorithm by continuously learning from user click-through rates and search behavior to improve search result relevance.
Self-Driving Cars	Robotics & Computer Vision	• **Supervised Learning**: For object detection, lane detection, and recognition of traffic signs using labeled data from images and videos. • **Unsupervised Learning**: For identifying patterns in sensor data, such as clustering different driving environments or conditions. • **Reinforcement Learning**: For decision-making and control, where the system learns optimal driving policies by interacting with the environment and receiving feedback on driving performance (e.g., staying in lanes, avoiding obstacles).
IBM Watson	ML later NLP & ML	• **Supervised Learning**: For training models to diagnose diseases based on labeled medical data, including patient records, lab results, and medical images. • **Unsupervised Learning**: For discovering hidden patterns in medical data that could indicate potential health issues or correlations between different conditions. • **Reinforcement Learning**: For personalizing treatment plans by continuously learning from patient outcomes and adjusting recommendations accordingly to improve treatment effectiveness.
Video Object Detection	Computer Vision	• **Supervised Learning**: models are trained on labeled datasets where the locations and categories of objects are provided.
ChatGPT	NLP & ML (neural networks)	• **Supervised Learning**: Used during the initial training phase to predict the next word in a sequence. Later applied again during finetuning to adapt the pre-trained model to specific tasks or improve performance based on a narrower dataset. • **Unsupervised Learning**: Used during the pre-training phase to learn language patterns from vast amounts of text data without explicit labels. • **Reinforcement Learning**: Utilized in advanced versions through human feedback to enhance response quality and accuracy.

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AGI & ASI In Theory

Artificial General Intelligence (AGI / Strong AI)

- **The AI Scientist**: Imagine an AGI system that can understand and conduct scientific research across various fields. It can formulate hypotheses, design experiments, analyze data, and even make novel discoveries. For example, this AGI could work on cancer research, climate change models, and new materials for technology, all while seamlessly switching between these domains **without any additional programming**.

- **The Universal Assistant**: A highly advanced virtual assistant that can understand and respond to a wide array of tasks and questions, just like a human assistant. It can plan a complex travel itinerary, manage finances, offer psychological counseling, tutor in multiple subjects, and even engage in creative tasks like writing stories or composing music. This AGI would possess a level of common sense and reasoning comparable to humans, enabling it to **handle unexpected situations and learn continuously**.
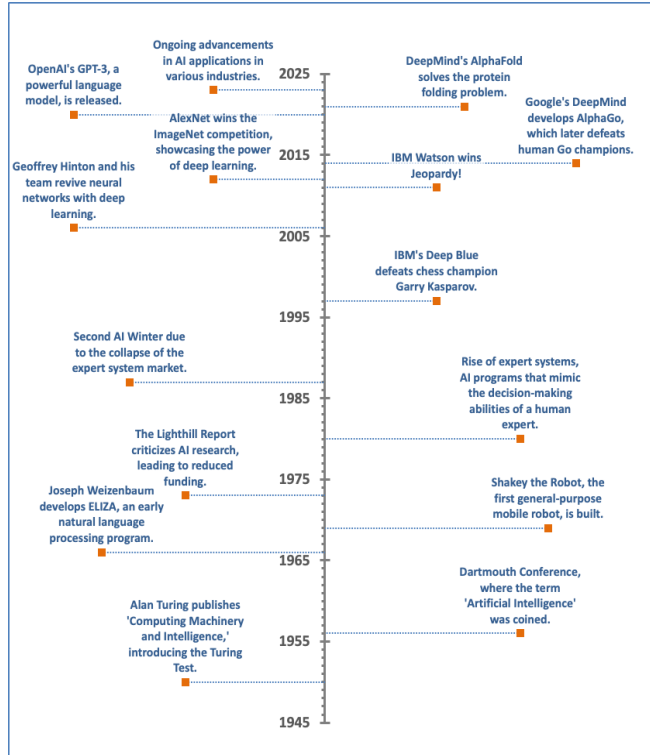
Why not now?

Artificial Superintelligence (ASI)

- **Global Problem Solver**: An ASI with unparalleled intelligence and processing power capable of solving complex global issues such as eradicating poverty, curing all diseases, reversing climate change, and optimizing resource distribution for maximum efficiency. This ASI could analyze vast amounts of data from around the world, simulate outcomes of various interventions, and **implement the most effective solutions autonomously**.

- **The Ultimate Innovator**: An ASI that continuously generates groundbreaking innovations across all domains of knowledge. It could **invent new technologies**, create advanced theories in physics, and design revolutionary medical treatments far beyond human capabilities. For instance, it might develop a form of clean energy that is limitless and environmentally friendly, or create a universal translator that instantly and perfectly translates any language, including the nuances of culture and context.

ChatGPT (Generative AI) is not AGI or ASI because…

- It cannot autonomously understand and perform any intellectual task that a human can. It lacks the ability to learn and adapt across different domains without specific programming.

- It does not surpass human intelligence. It operates within the limits of its design and training, without any capability to independently innovate or solve complex global issues beyond the scope of its programming.

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AI has been around for a while... Why all the buzz now?

Timeline (1945–2025):
- Alan Turing publishes 'Computing Machinery and Intelligence,' introducing the Turing Test.
- Dartmouth Conference, where the term 'Artificial Intelligence' was coined.
- Joseph Weizenbaum develops ELIZA, an early natural language processing program.
- Shakey the Robot, the first general-purpose mobile robot, is built.
- The Lighthill Report criticizes AI research, leading to reduced funding.
- Rise of expert systems, AI programs that mimic the decision-making abilities of a human expert.
- Second AI Winter due to the collapse of the expert system market.
- IBM's Deep Blue defeats chess champion Garry Kasparov.
- Geoffrey Hinton and his team revive neural networks with deep learning.
- IBM Watson wins Jeopardy!
- Google's DeepMind develops AlphaGo, which later defeats human Go champions.
- AlexNet wins the ImageNet competition, showcasing the power of deep learning.
- OpenAI's GPT-3, a powerful language model, is released.
- DeepMind's AlphaFold solves the protein folding problem.
- Ongoing advancements in AI applications in various industries.

We've reached a tipping point...

- **Technological Advances**: Improved machine learning algorithms and deep learning techniques have enhanced AI capabilities.

- **Increased Computing Power**: Availability of powerful GPUs and cloud computing supports complex model training.

- **Big Data**: The abundance of data from various digital sources improves AI training and performance.

- **Investment and Research**: Significant investments from tech companies and academic institutions drive rapid AI advancements.

- **Practical Applications**: AI's success in industries like healthcare, finance, and transportation showcases its benefits.

- **Public Awareness**: Media coverage and popular culture have increased public interest in AI.

- **Open-Source Tools**: Accessible AI tools and frameworks encourage innovation and collaboration.

Generative AI

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What is Generative AI (Gen AI)?

A subset of AI that focuses on creating new content or data that resembles human-created content. This can include text, images, music, and even code.

The core idea behind generative AI is to produce outputs that are not directly copied from existing data but are instead generated based on patterns and structures learned from large datasets.

Gen AI Model Types

- **Generative Adversarial Networks (GANs):** GANs consist of two neural networks, a generator and a discriminator, which are trained together. The generator **creates new data** instances, while the discriminator evaluates them. The generator aims to produce data that the discriminator cannot distinguish from real data.

- **Variational Autoencoders (VAEs):** VAEs encode input data into a lower-dimensional space and then decode it back to the original form. This process helps the model learn to **generate new data** that is similar to the original input.

- **Transformers:** Models like GPT (Generative Pre-trained Transformer) use transformer architecture, which is particularly effective for sequential data like text. They are pre-trained on vast amounts of data and then fine-tuned for specific tasks.

  - Large Language Models (LLMs): Generalized and vast
  - Small Language Models (SLMs): Specialized and more efficient

Examples of Gen AI

GANs

- **DeepFake Videos:** Using GANs, realistic videos of people can be generated, where their faces are swapped, or their actions are manipulated. This technology gained widespread attention for its potential misuse in creating fake videos of celebrities and politicians.

- **AI Art Generators:** Platforms like Artbreeder use GANs to allow users to create and modify artwork by blending images and adjusting various parameters.
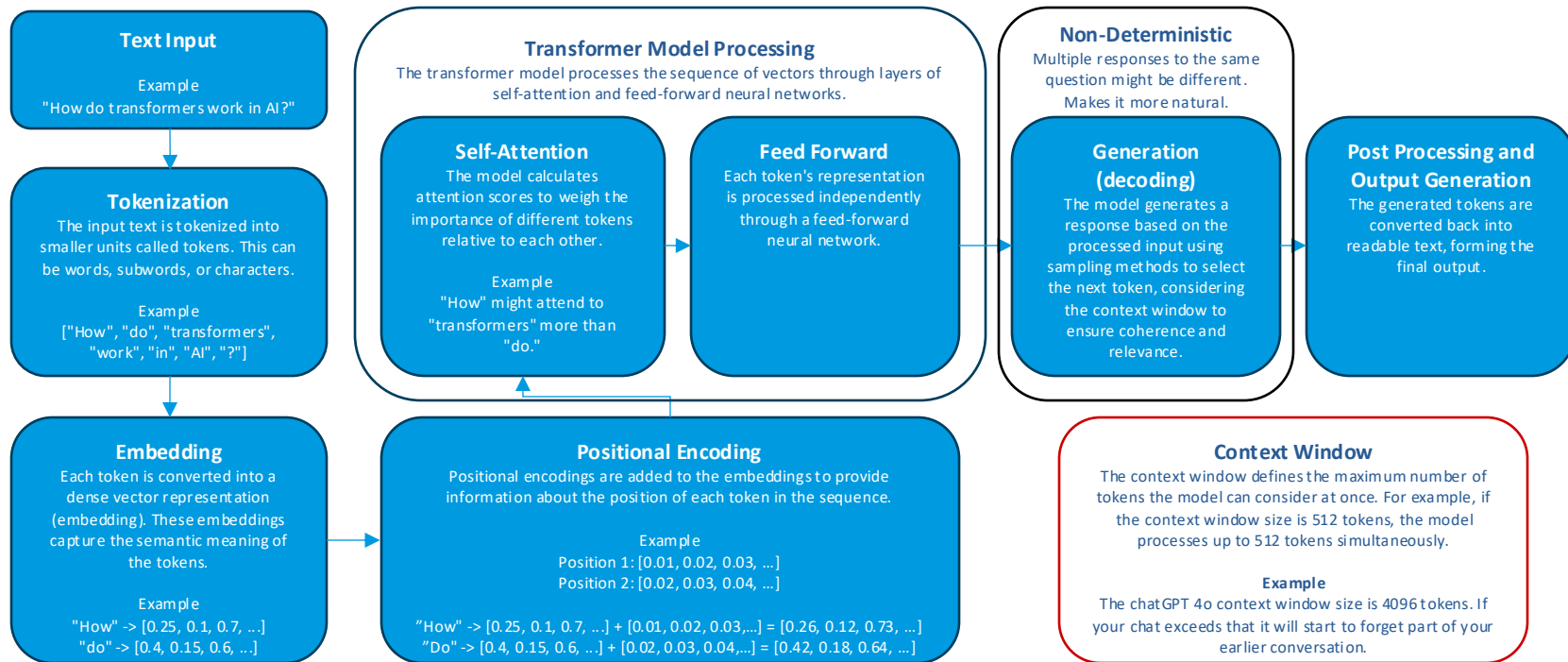
VAEs

- **Medical Imaging Anomaly Detection:** VAEs are used in medical imaging to detect anomalies in scans, such as identifying tumors in MRI images by learning the normal patterns and flagging deviations.

Transformers

- **ChatGPT:** OpenAI's conversational AI which can generate coherent and contextually relevant responses in a conversation.

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How Transformers work (specifically ChatGPT)

Text Input

Example
"How do transformers work in AI?"

Tokenization

The input text is tokenized into smaller units called tokens. This can be words, subwords, or characters.

Example
["How", "do", "transformers", "work", "in", "AI", "?"]

Embedding

Each token is converted into a dense vector representation (embedding). These embeddings capture the semantic meaning of the tokens.

Example
"How" -> [0.25, 0.1, 0.7, …]
"do" -> [0.4, 0.15, 0.6, …]

Positional Encoding

Positional encodings are added to the embeddings to provide information about the position of each token in the sequence.

Example
Position 1: [0.01, 0.02, 0.03, …]
Position 2: [0.02, 0.03, 0.04, …]

"How" -> [0.25, 0.1, 0.7, …] + [0.01, 0.02, 0.03,…] = [0.26, 0.12, 0.73, …]
"Do" -> [0.4, 0.15, 0.6, …] + [0.02, 0.03, 0.04,…] = [0.42, 0.18, 0.64, …]

Transformer Model Processing
The transformer model processes the sequence of vectors through layers of self-attention and feed-forward neural networks.

Self-Attention
The model calculates attention scores to weigh the importance of different tokens relative to each other.

Example
"How" might attend to "transformers" more than "do."

Feed Forward
Each token's representation is processed independently through a feed-forward neural network.

Non-Deterministic
Multiple responses to the same question might be different. Makes it more natural.

Generation (decoding)
The model generates a response based on the processed input using sampling methods to select the next token, considering the context window to ensure coherence and relevance.

Post Processing and Output Generation
The generated tokens are converted back into readable text, forming the final output.

Context Window
The context window defines the maximum number of tokens the model can consider at once. For example, if the context window size is 512 tokens, the model processes up to 512 tokens simultaneously.

Example
The chatGPT 4o context window size is 4096 tokens. If your chat exceeds that it will start to forget part of your earlier conversation.

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Gen AI Transformer Comparisons

https://artificialanalysis.ai/models

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Building AI Applications

Problem Definition

Problems and user stories should be written no different than how we do it for non-ai features/products. From there we ask questions to determine if AI should be used, like:

- Can AI reduce development time for this?

- Can an AI solution inform future product feature ideas?

- Can AI eliminate the need for future development or product features?

- Can AI provide a better outcome for the customer?

- What would an AI feature/product look like compared to a traditional feature/product?

Pre-Build

Model Selection

Choose an appropriate model architecture based on the problem (e.g., neural networks for image recognition, decision trees for classification, Gen AI for NLP).

Data Prep

- **Data Cleaning**: Remove or correct errors and inconsistencies in the data.

- **Data Transformation**: Convert data into a format suitable for model training (e.g., normalization, encoding categorical variables).

- **Splitting Data**: Divide data into training, validation, and test sets.

Training & Tuning (High Cost & Effort)

- **Training:** Teaching the model to understand patterns and relationships in the data so that it can make accurate predictions or decisions.
  - Focus: learning from data
  - Parameters: adjusts model parameters (weights and biases)
  - Data Usage: uses the training data
  - Iteration: multiple passes over the training data

- **Tuning:** Optimizing the model's performance by adjusting hyperparameters and ensuring it generalizes well to new, unseen data.
  - Focus: optimizing the learning process
  - Parameters: adjusts hyperparameters (settings that control the training process)
  - Data Usage: uses both training and validation data
  - Iteration: multiple evaluations of different hyperparameter combinations

ChatGPT → $544.5M in 2022 to build and train → $700k/day to run

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How Gen AI understands our data (post model training)

Retrieval Augmented Generation (RAG)

A technique in generative AI that combines retrieval-based and generation-based methods to improve the performance of natural language processing tasks.
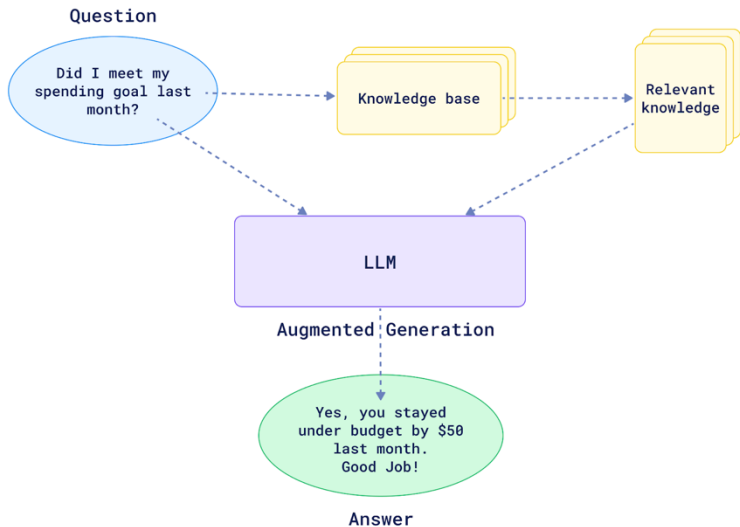
Semantic Layers

A framework that bridges the gap between raw data and meaningful, context-rich information. It is designed to provide a more intuitive and accessible way for users to interact with data by organizing and representing it in a way that aligns with human understanding and business contexts.

Just like it helps humans understand raw data, it helps AI in the same way.

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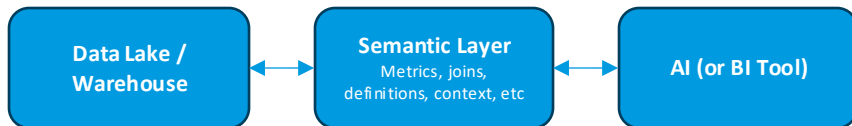
Gen AI Governance, Accuracy, & Usage Considerations

- **Bias & Fairness:** Conduct regular bias audits using techniques such as disparate impact analysis and counterfactual fairness testing

- **Ethics:** Follow frameworks like the Ethical AI Framework by the World Economic Forum and incorporate ethical checklists in the development process to ensure ethical considerations are integrated at every stage.

- **Compliance & Auditing:** Use automated tools for compliance checks, such as privacy impact assessment tools and regulatory compliance software and maintain detailed logs and audit trails of AI system activities to ensure accountability and facilitate audits.

- **Traditional Governance Methods** (little to no changes to current practices as they can be applied similarly to AI)
  - Data Quality
  - Data Security
  - System Security
  - Monitoring & Incident Response
  - Privacy
  - Testing
  - Model Management

- **Handling Hallucinations:** Hallucinations in Generative AI refer to instances where the AI produces incorrect, nonsensical, or misleading outputs that do not align with the input data or reality. They happen because of the non-deterministic (human-like) nature of Gen AI. They can be reduced by:
  - Following governance and usage considerations above
  - Additional training and tuning
  - Response validation through user testing and multiple model testing
  - Prompt engineering

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This presentation:
50% ChatGPT / 50% Human

Cox 2M AI in Action

ThoughtSpot
Gen AI – NLP
AI for Business Intelligence

Zenlytic
Gen AI – Full Chat
AI for Business Intelligence

Kayo Trips Assistant
Gen AI - Full Chat

Internal ChatGPT
Gen AI – Full Chat

People & Vehicle Detection
Computer Vision

Kayo CS Assistant
Semantic/Embeddings Search

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Try it out