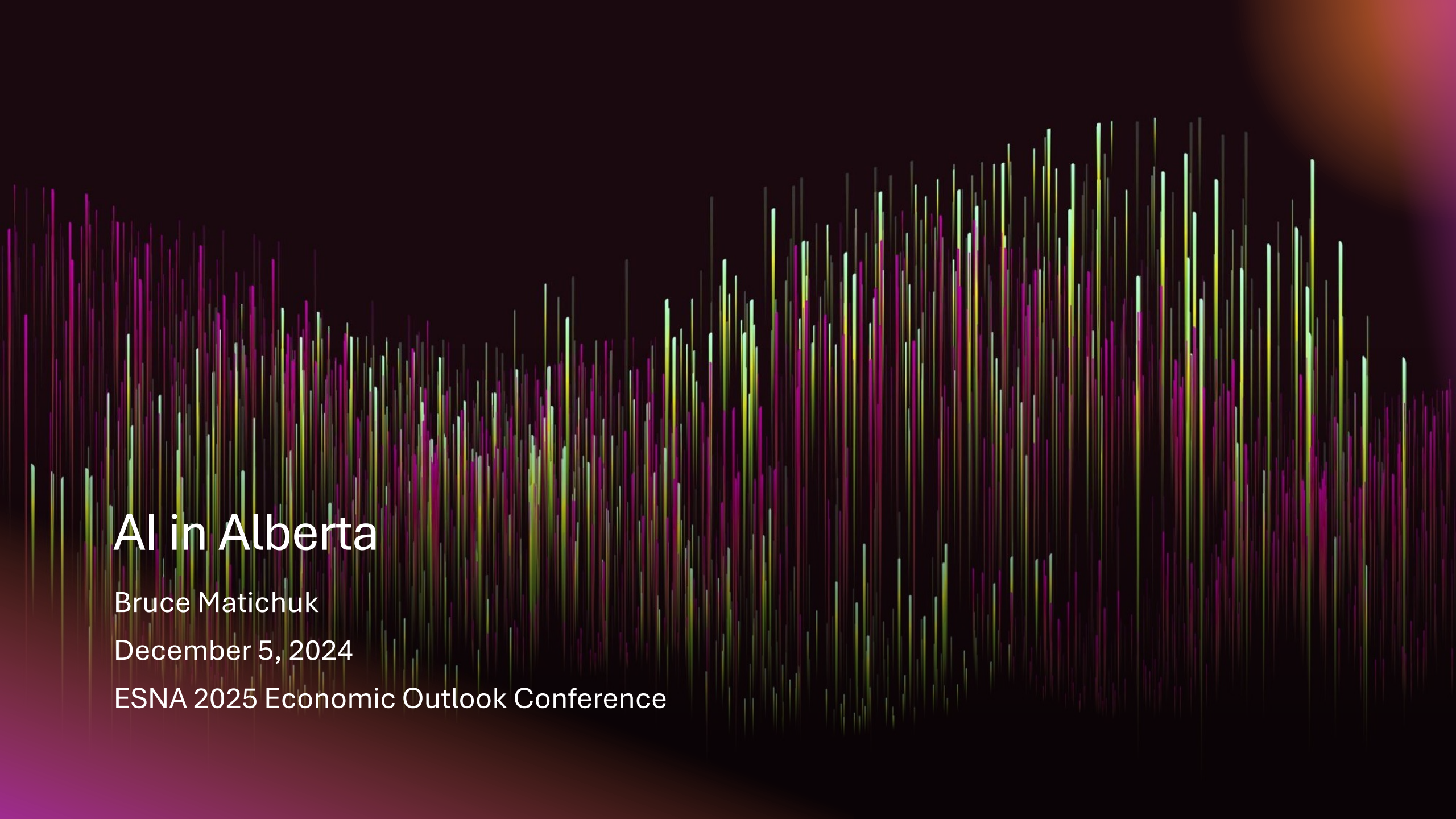


AI in Alberta

Bruce Matichuk

December 5, 2024

ESNA 2025 Economic Outlook Conference

Overview

1. AI Concepts
2. Application
3. AI Basics
4. Agentic Systems
5. Trends

About me

- MSc/PhDc in AI – University of Alberta
- 30+ years in industry applying AI
- Founder
  - Celcorp – Intelligent Integration
  - Poynt – Local Search and Directions (Before Siri)
  - Clinitrust - Secure Medical Communications Platform
  - Aidant Intelligent Technology – Intelligent Recognition System
  - Health Gauge – Intelligent Health Monitoring and Management Platform
  - MedWatch – Non-invasive Blood Glucose Monitoring

Artificial Intelligence at the U of A

Ranked 2nd

in North America for AI

$100 million

in AI funding since 2017

24

Canada CIFAR AI Chairs

WE ARE

the 1st Computing Science department in Canada

OUR GLOBAL MISSION & PILLARS

Empower individuals to live longer, healthier lives.

Our innovative platform will help people to proactively manage their glucose to avoid progression of diabetes and reduce the risk of other chronic conditions.

Featuring

NEEDLE-FREE

CONTINUOUS GLUCOSE MONITORING

- Non-invasive ease and comfort
- Long-lasting for convenience
- Less waste, less cost
- Expandable platform for monitoring vitals

- **The CGM that people not only prefer, but LOVE**

MEDWATCH™ TECHNOLOGIES

*Not FDA Cleared. FDA submission in process

MEDWATCH INNOVATIVE ROADMAP: AN INTELLIGENT AI-BASED HEALTH PLATFORM

Empower individuals to live longer, healthier lives.

Flagship Product
Non-Invasive Continuous Glucose Monitor

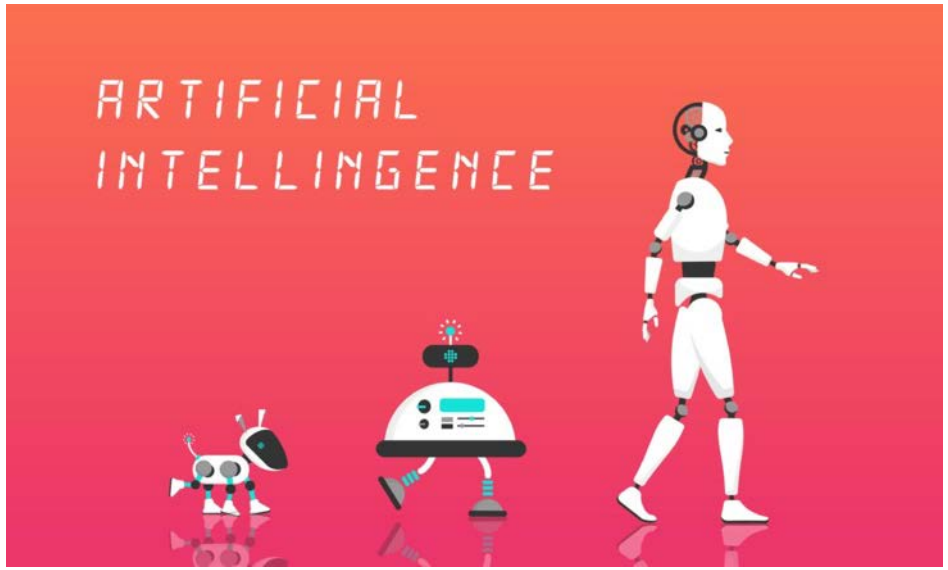
Additional Non-Invasive Functionalities as FDA Medical Device

Band format option

MEDWATCH™ TECHNOLOGIES

What is AI?

- The study of systems that have human-like intelligence
- AI is mankind's most important creation
  - The power to change the world
  - The power to destroy
- AI is a mirror into ourselves
  - What is a person?
  - What does it mean to think and reason?
  - Can machines be conscious?
- Artificial Intelligence vs Machine Learning

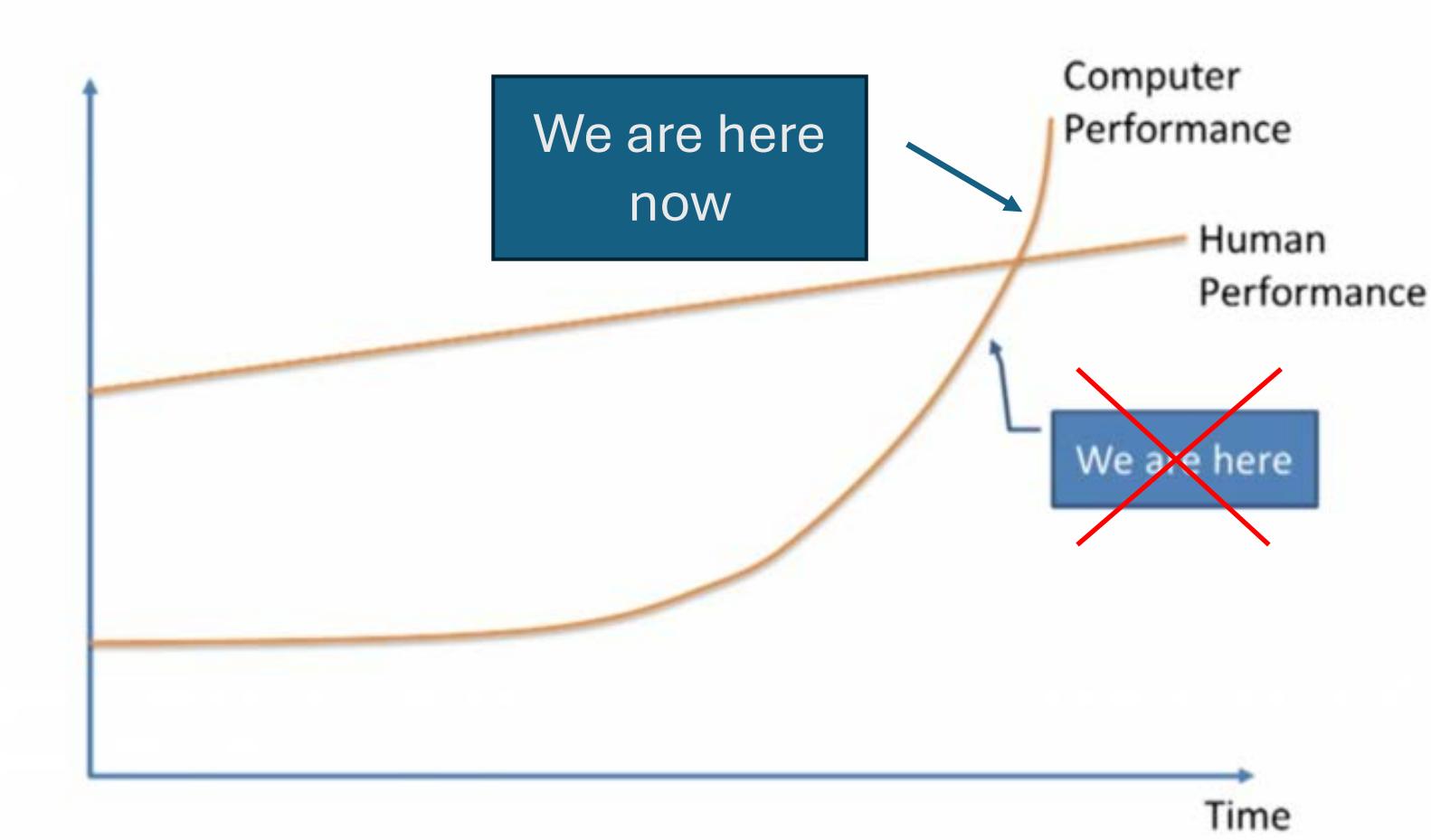


Demystifying AI: From Thought to Consciousness

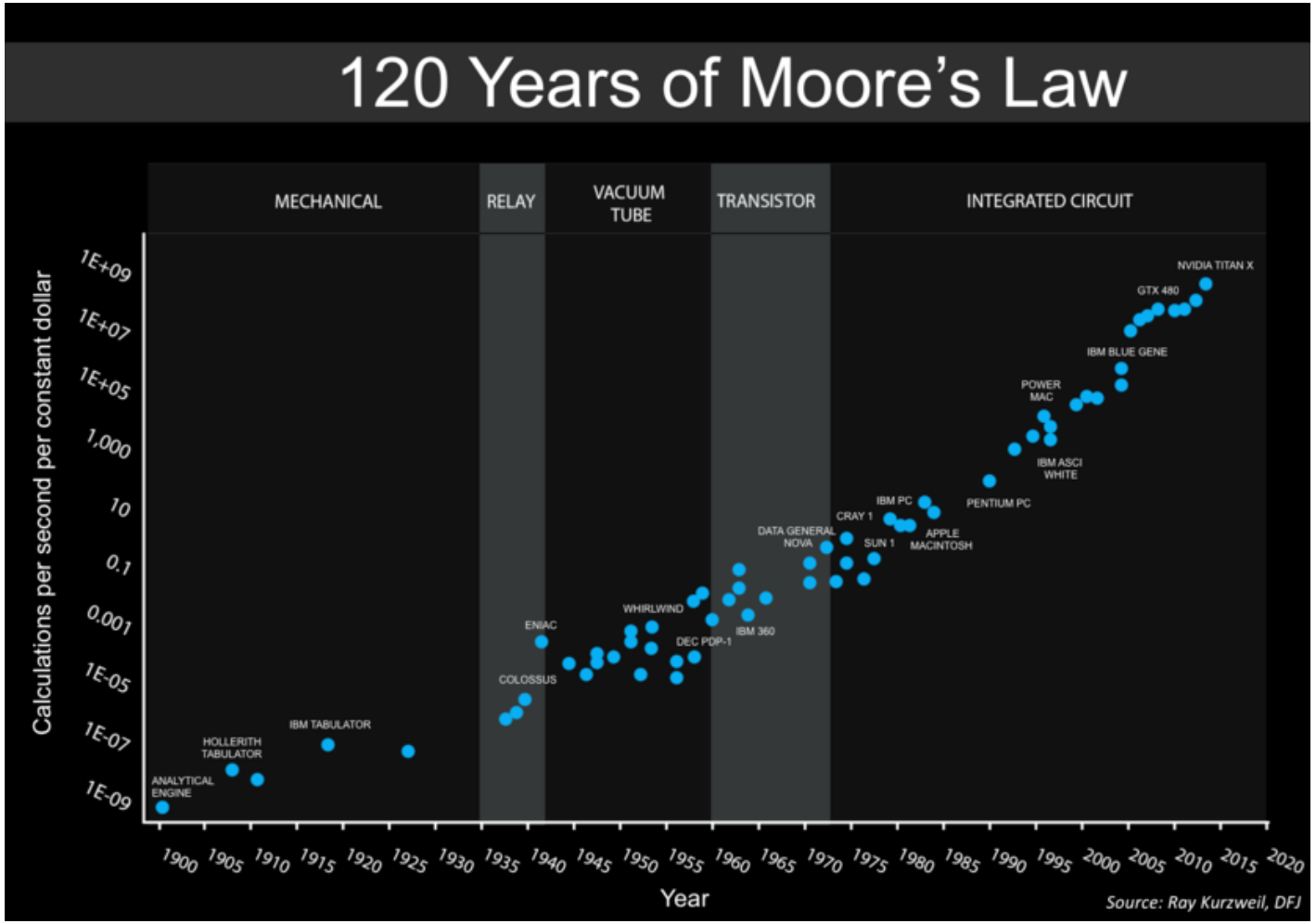
- Turing Test
  - Can machines think?
- Strong-AI
  - An AI system can think and have mind.
- Weak-AI
  - An AI system can only act like it thinks and has a mind.
- General AI vs Narrow AI
  - AGI – Artificial General Intelligence
- The AI Singularity – Are we there yet?

Alan Turing

The Singularity Curve



Moore’s Law Curve



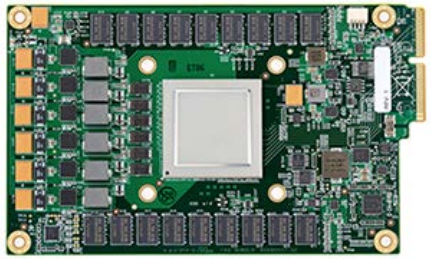
Frontier

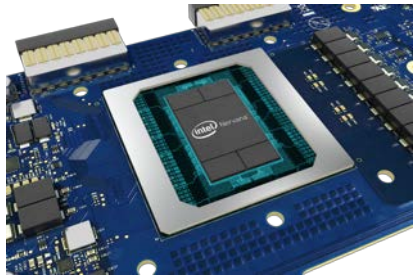
Currently US made Frontier runs at a peak 1.2 petaFLOPS

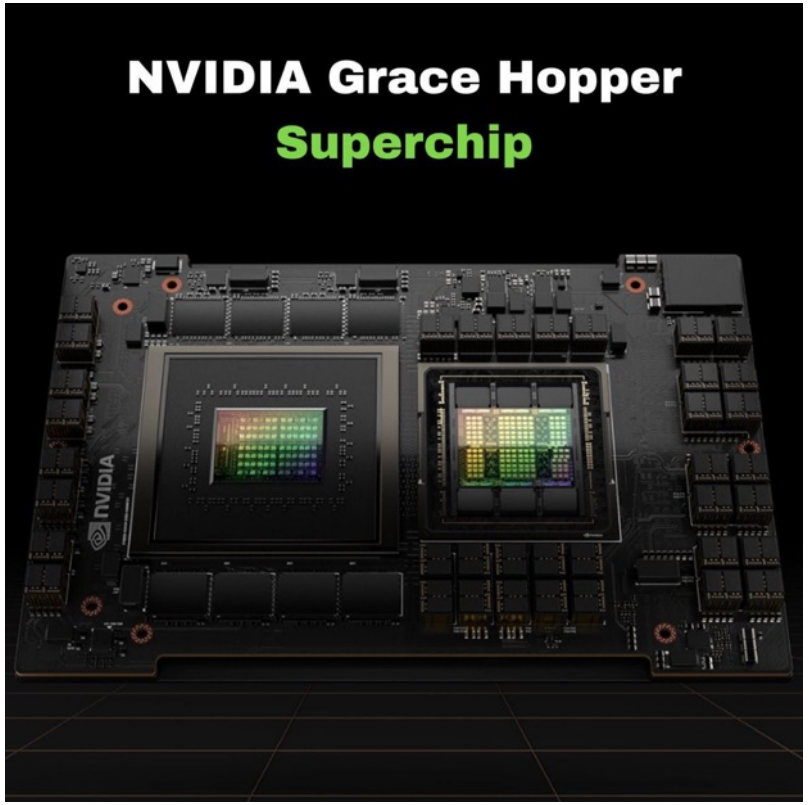
Note: Oracle is building a new supercomputer that will run at 2.4 zettaFLOPS

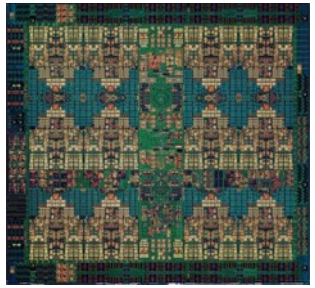
Hardware Based AI

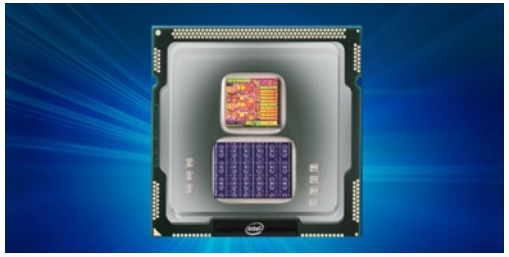
- NVIDIA GPU
- Google TPU
- Intel
- IBM AI chip
- Neuromorphic Computing







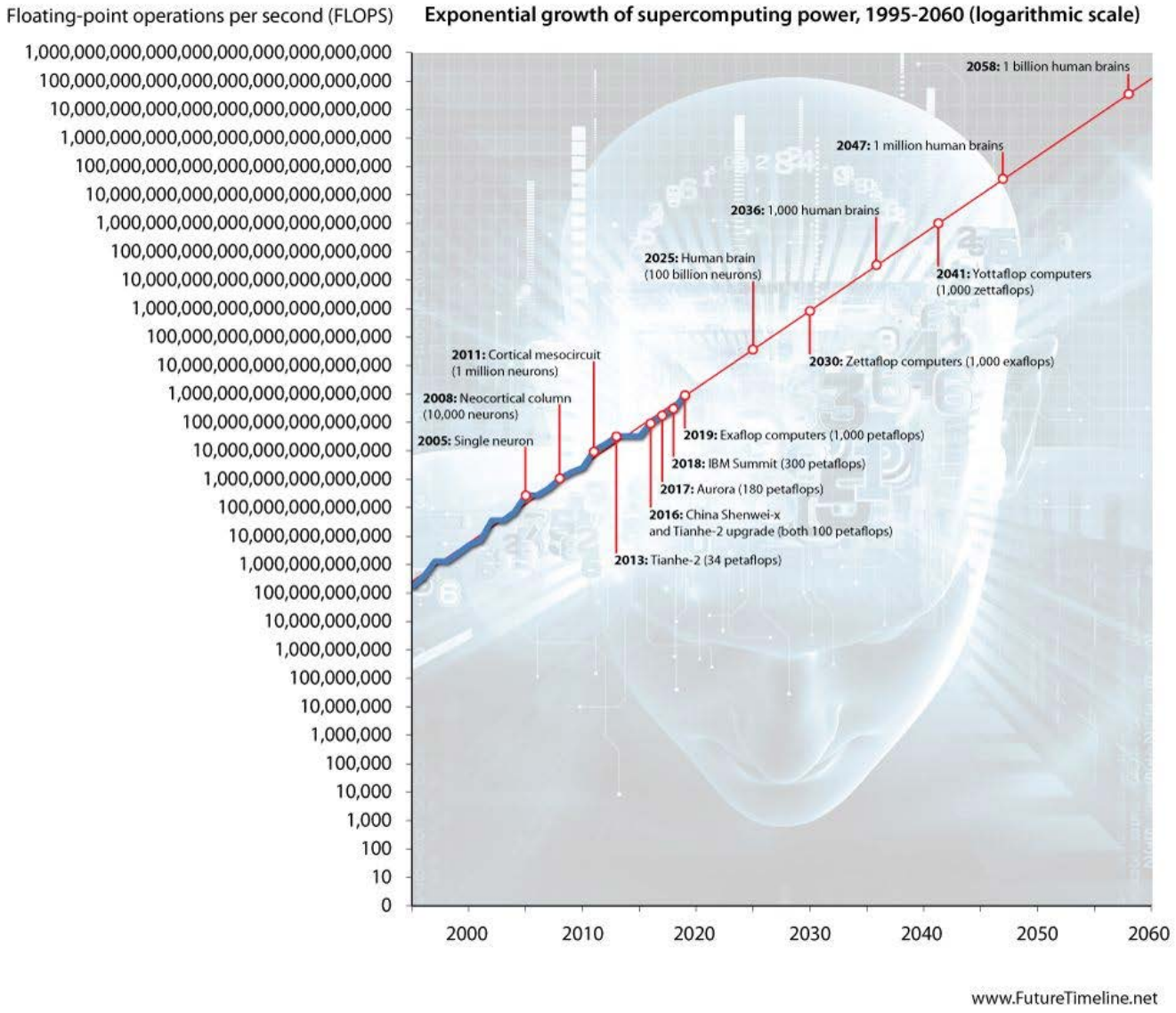




Cerebras Wafer Scale Engine (WSE-3)

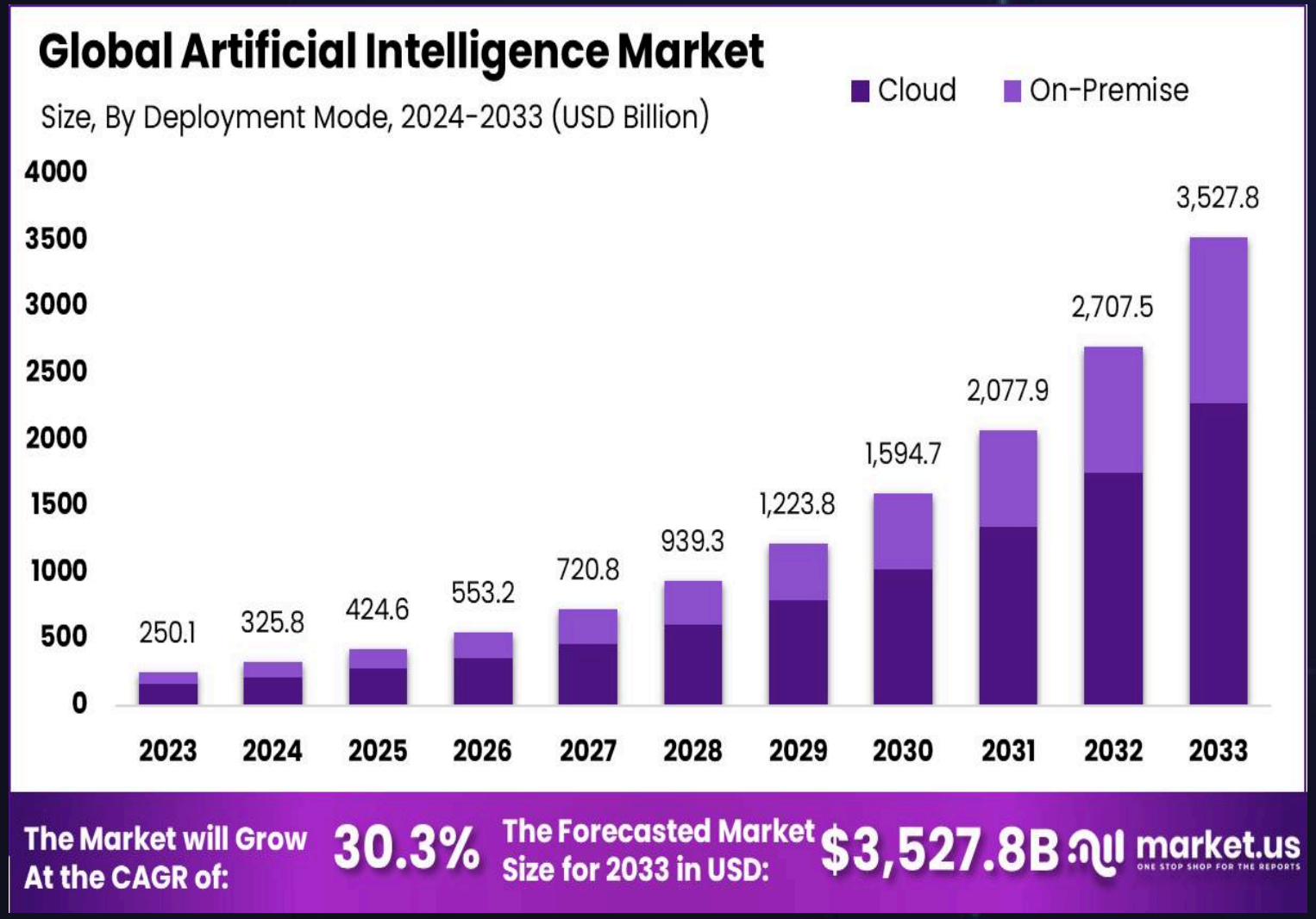
- The largest chip ever built
- 4 Trillion transistors
- 900,000 AI optimized compute cores.
- 44 GB on-chip memory
- 125 Petaflops
- External memory: 1.5TB, 12TB, or 1.2PB
- Trains AI models up to 24 trillion parameters

The AI Singularity Curve



- 2025 – Human brain
  - 100 billion neurons
- 2036 – 1000 Brains
- 2047 – 1 million brains
-

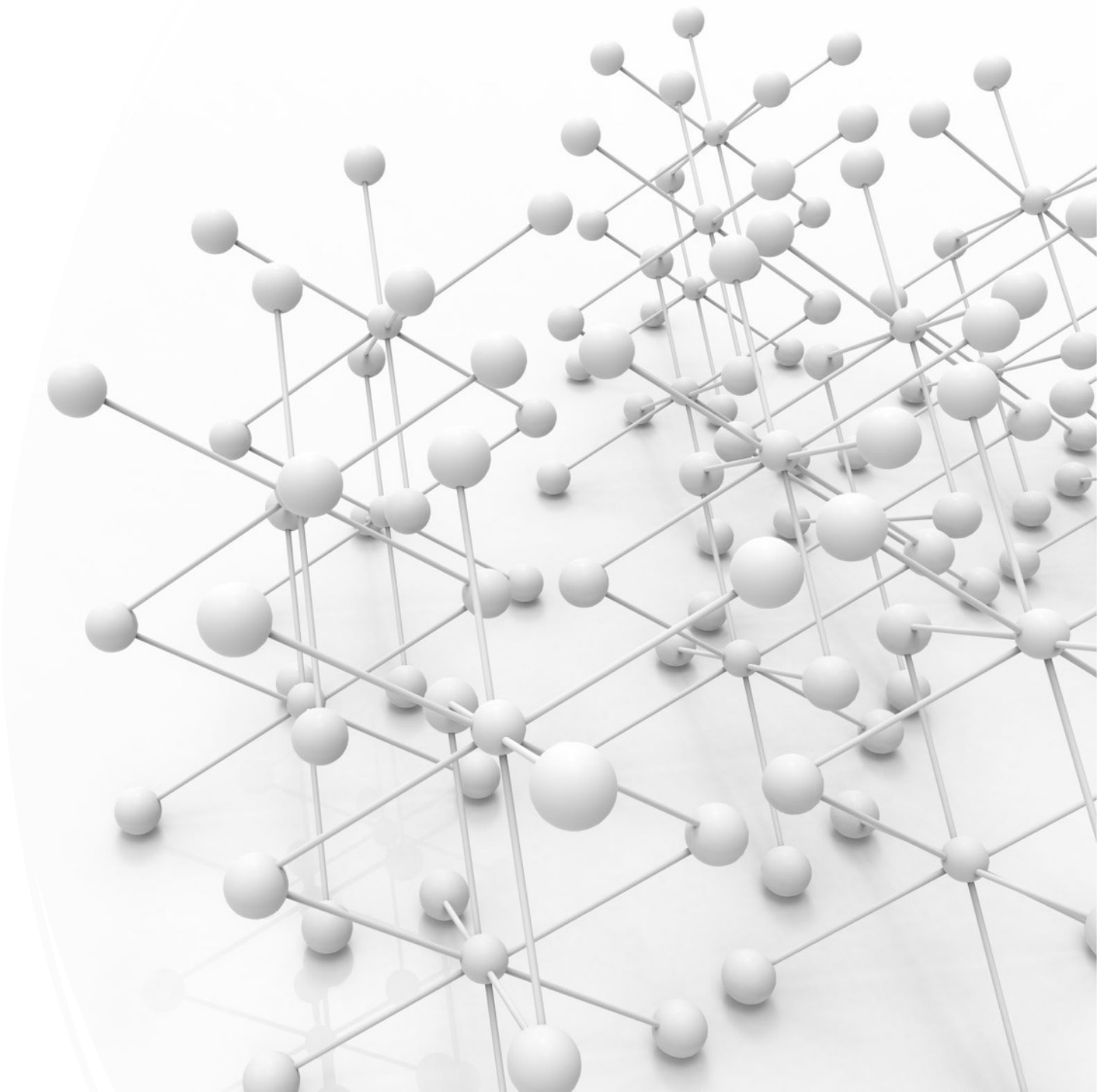
Artificial Intelligence Market Size



https://www.statista.com/outlook/tmo/artificial-intelligence/worldwi

AI Topics

- Symbolic Processing
- Machine Learning
  - Neural Nets
  - Deep Learning
  - Reinforcement Learning
- Search/Games
- Generative AI
- Attention/Transformer Architecture
- Large Language Models – ChatGPT4o
- Diffusion – DALLE 2
- Intelligent System Orchestration



Symbolic Reasoning

Brothers are siblings

$$\forall x, y \;\; Brother(x, y) \;\Rightarrow\; Sibling(x, y).$$

"Sibling" is symmetric

$$\forall x, y \;\; Sibling(x, y) \;\Leftrightarrow\; Sibling(y, x).$$

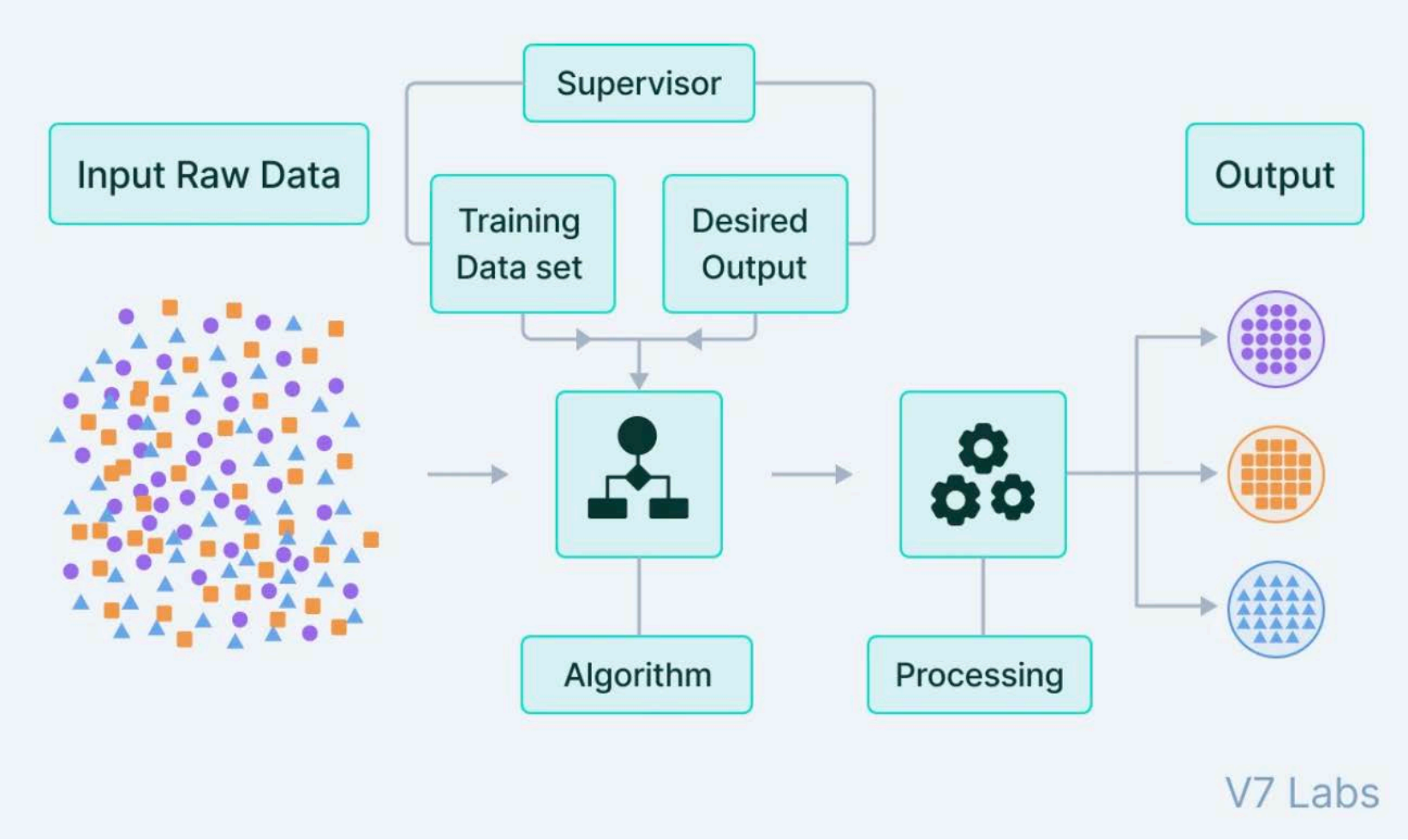
One's mother is one's female parent

$$\forall x, y \;\; Mother(x, y) \;\Leftrightarrow\; (Female(x) \wedge Parent(x, y)).$$

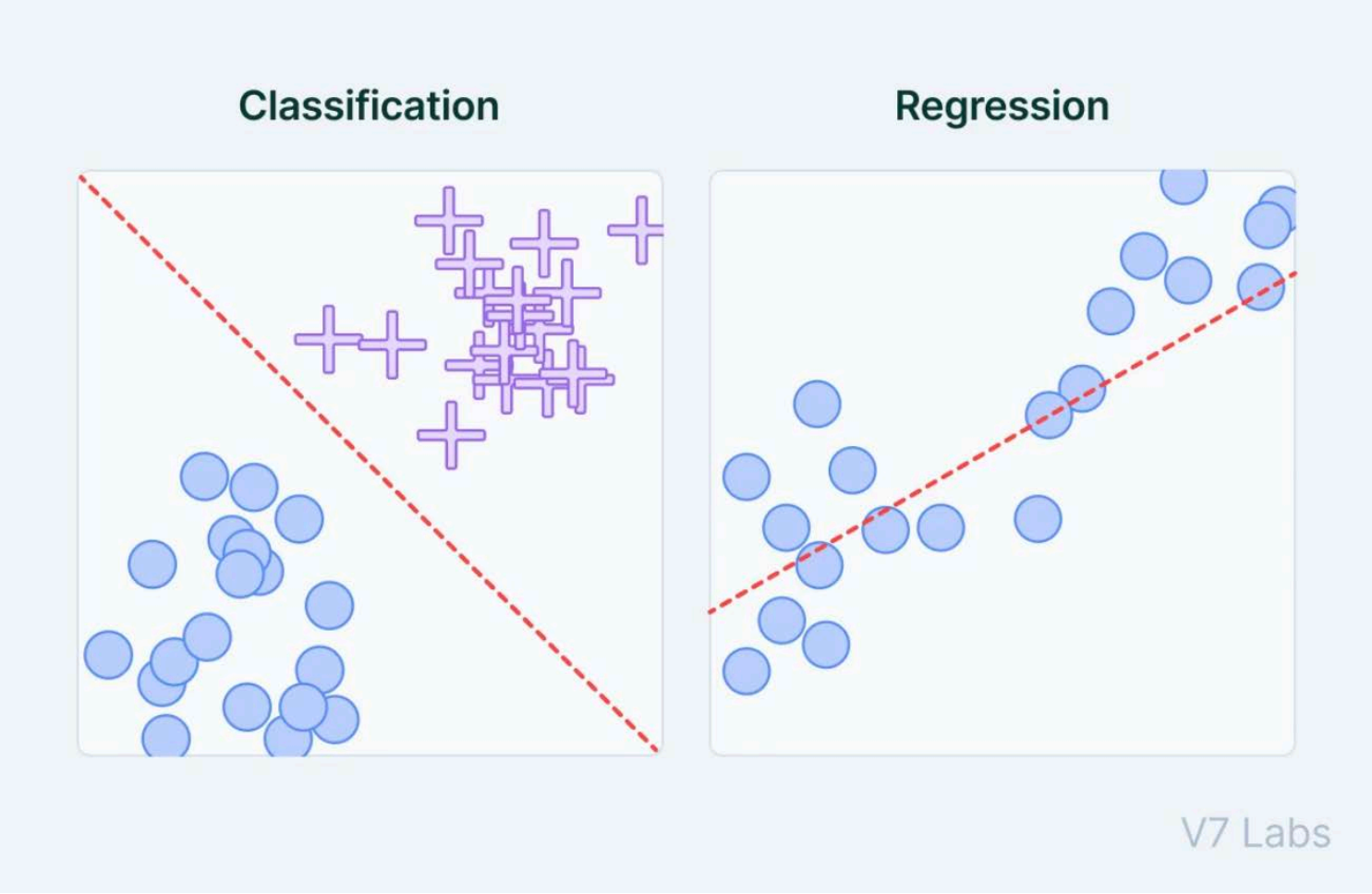
A first cousin is a child of a parent's sibling

$$\forall x, y \;\; FirstCousin(x, y) \;\Leftrightarrow\; \exists p, ps \;\; Parent(p, x) \wedge Sibling(ps, p) \wedge Parent(ps, y)$$

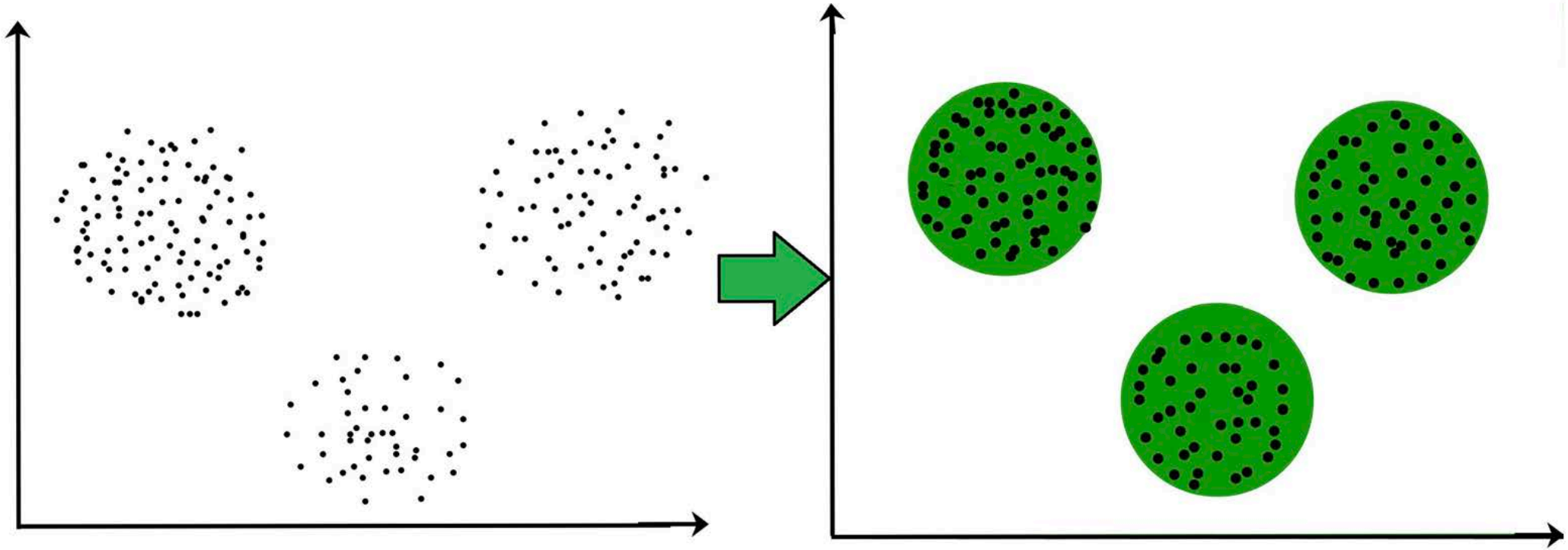
Supervised Learning



Classification vs Regression



Clustering



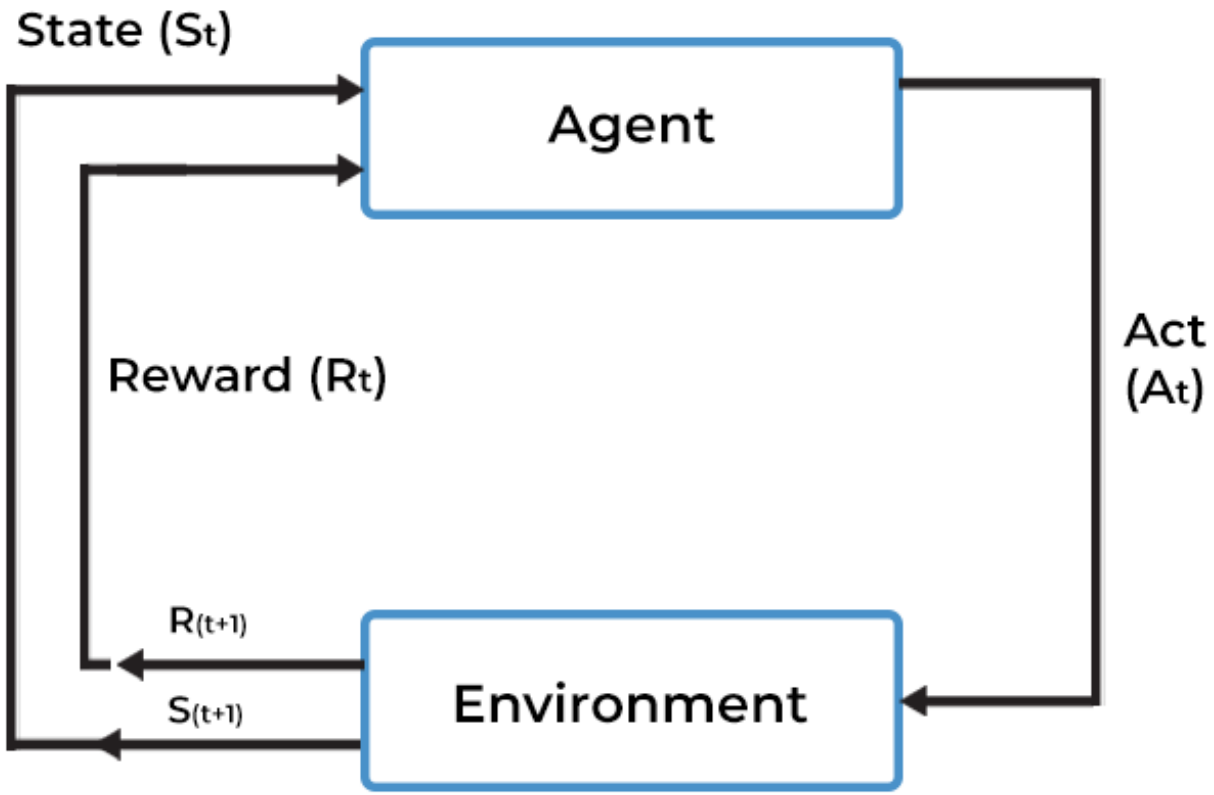
Examples of symbolic reasoning

- Database queries
- Constraint Systems
- Planners and Schedulers
- Formal Verification Tools
- Temporal Reasoning
- Description Logics

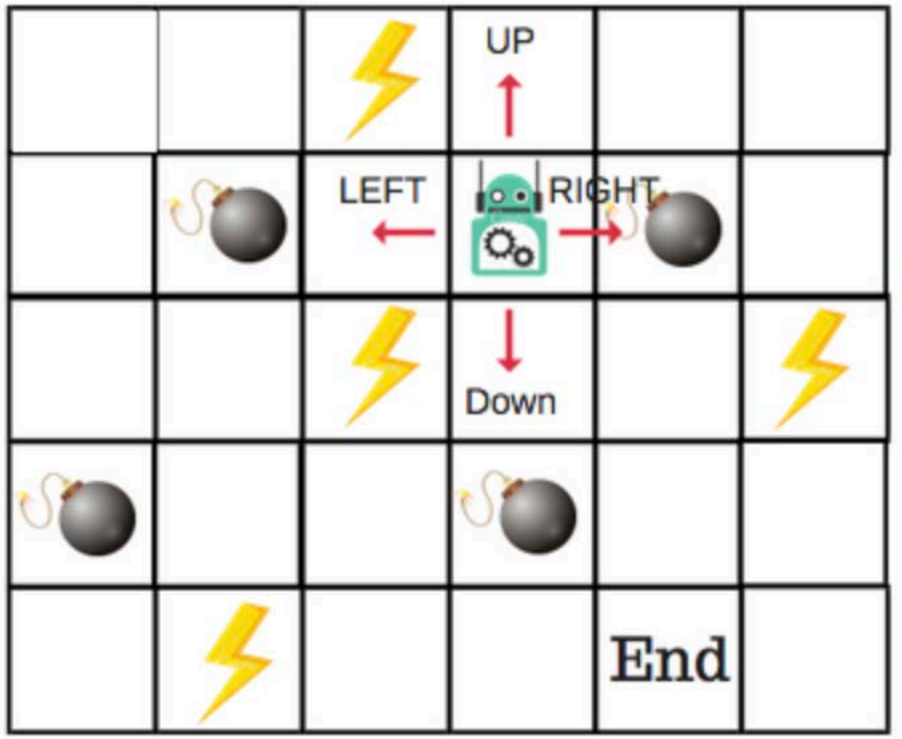
Machine Learning

- Supervised Learning
  - Classification
  - Regression
- Unsupervised Learning
  - Clustering
  - Dimensionality Reduction
  - Embeddings
  - Feature learning
- Reinforcement Learning (RL)

Reinforcement Learning



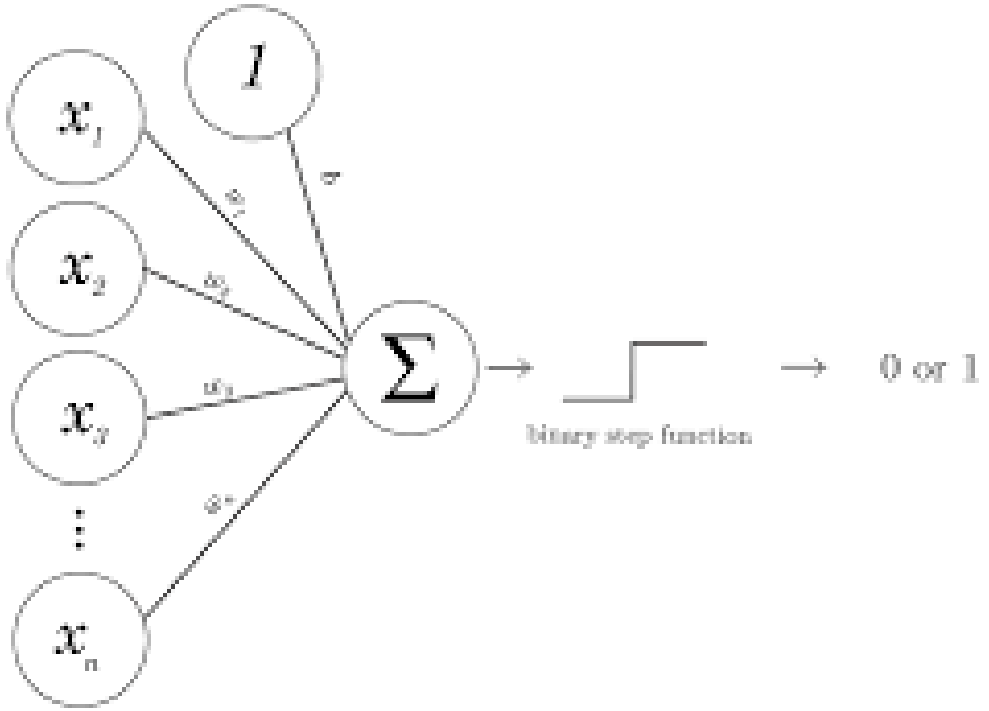
Q-Learning

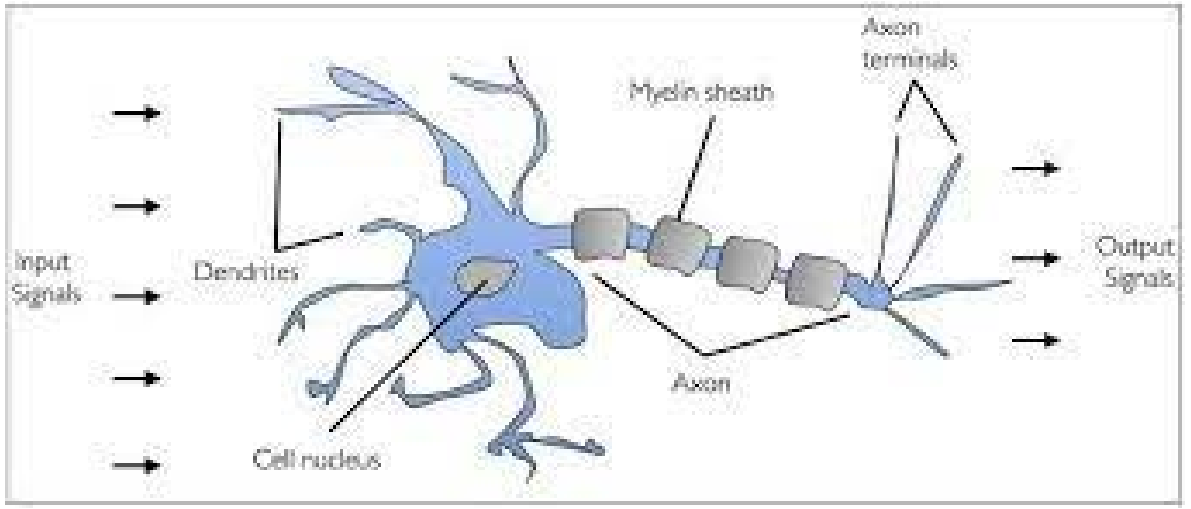


Reinforcement Learning

- Value-Based Methods
  - Q-learning
- Policy-Based Methods
  - Policy gradients
- Model-Based Methods
  - Example: model of the environment
- Applications
  - Robotics
  - Game playing (e.g., AlphaGo)
  - Autonomous driving.

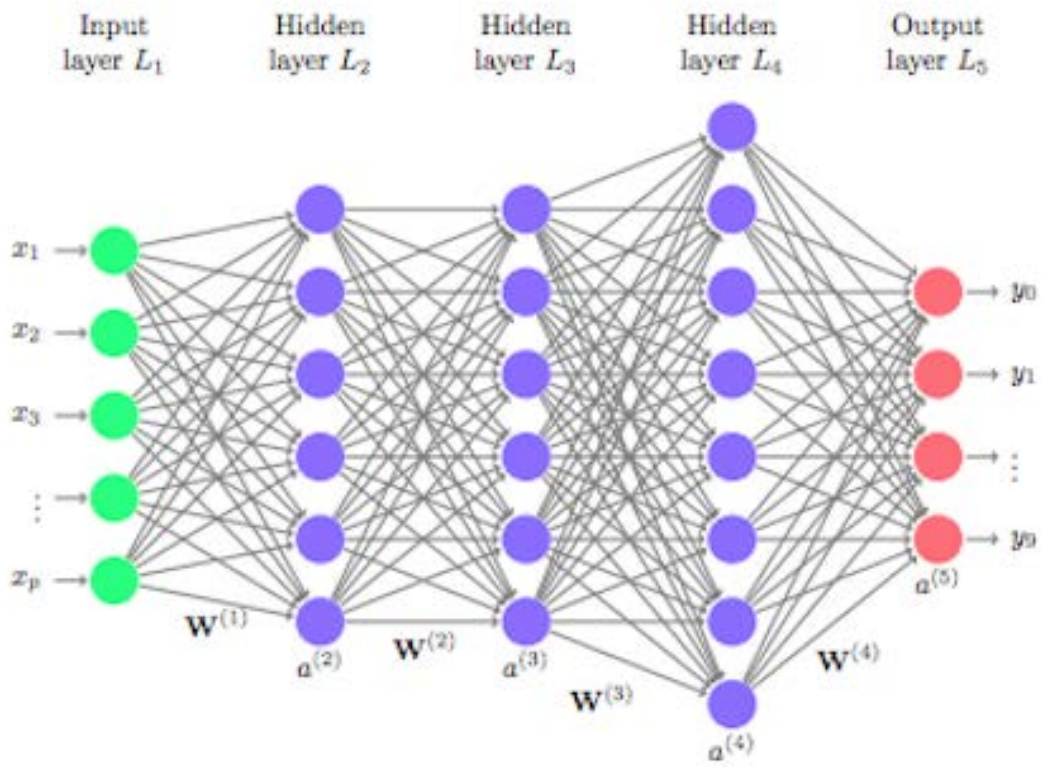
Artificial Neural Nets



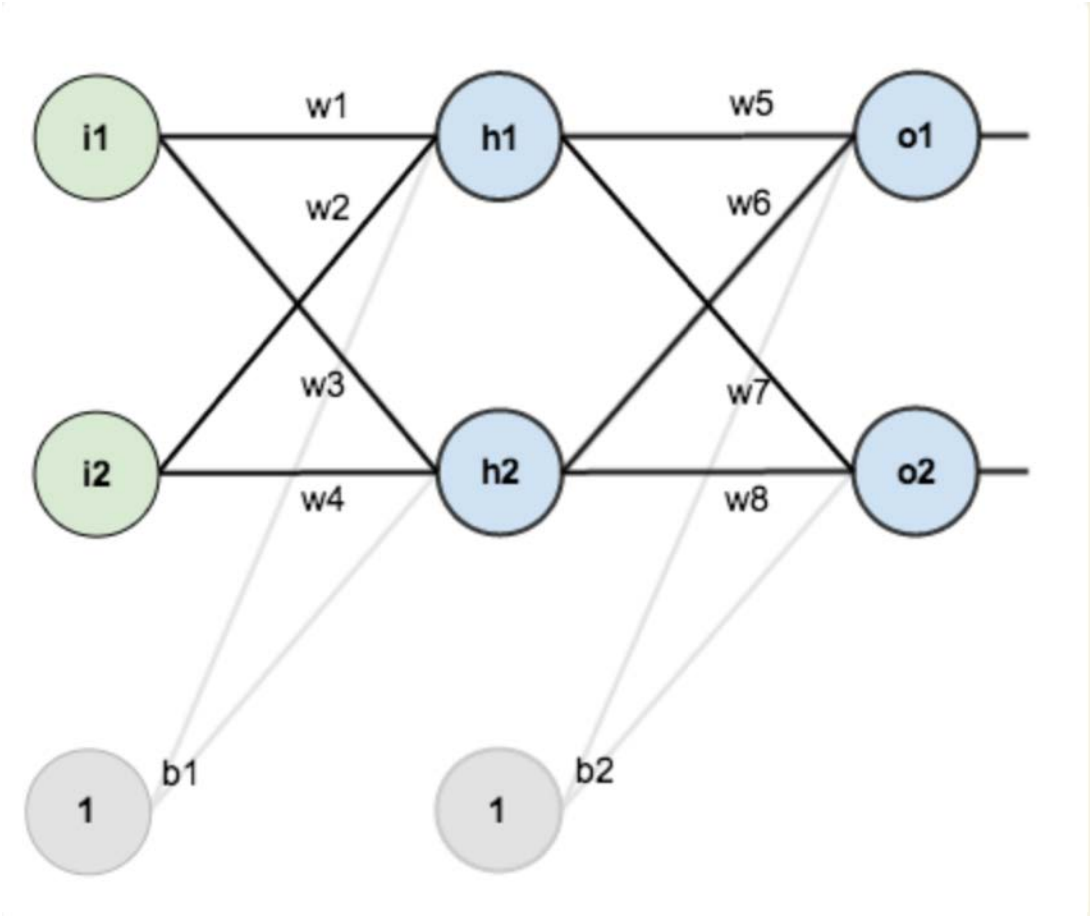


Deep Learning

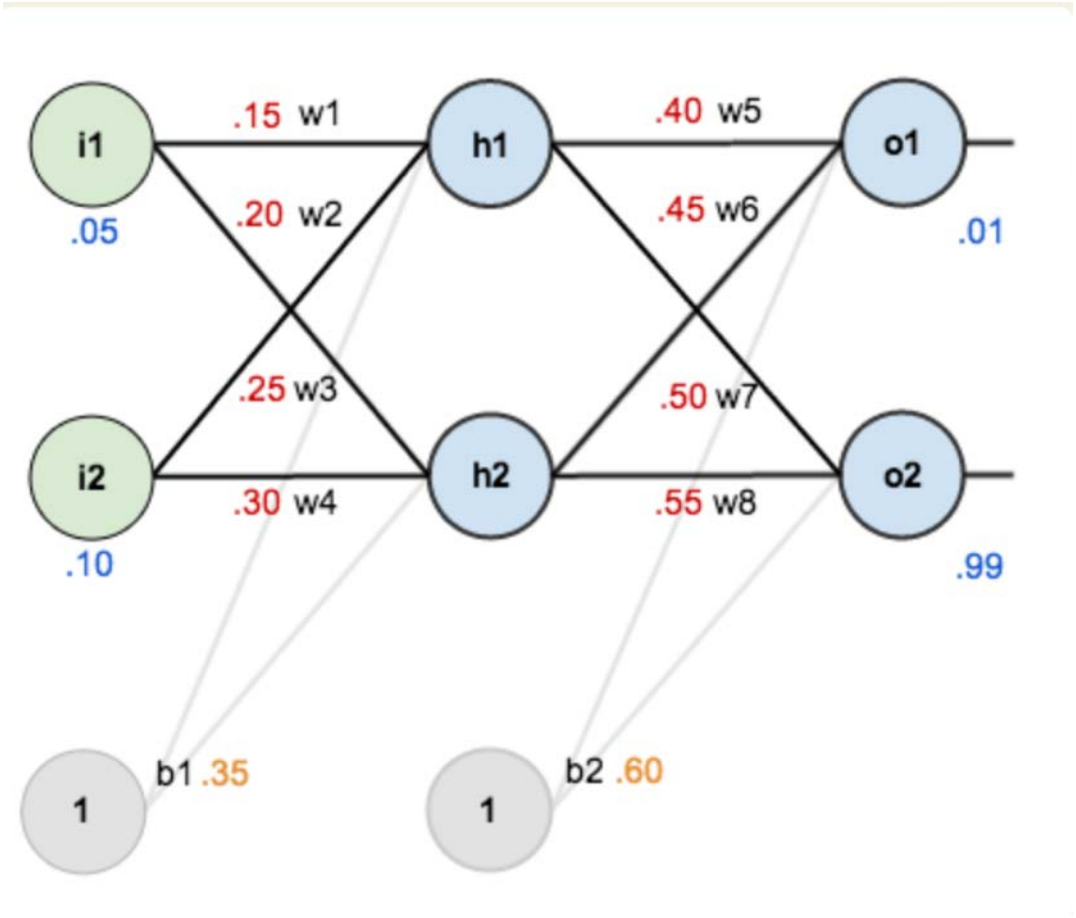
- Size matters
- 100s of layers



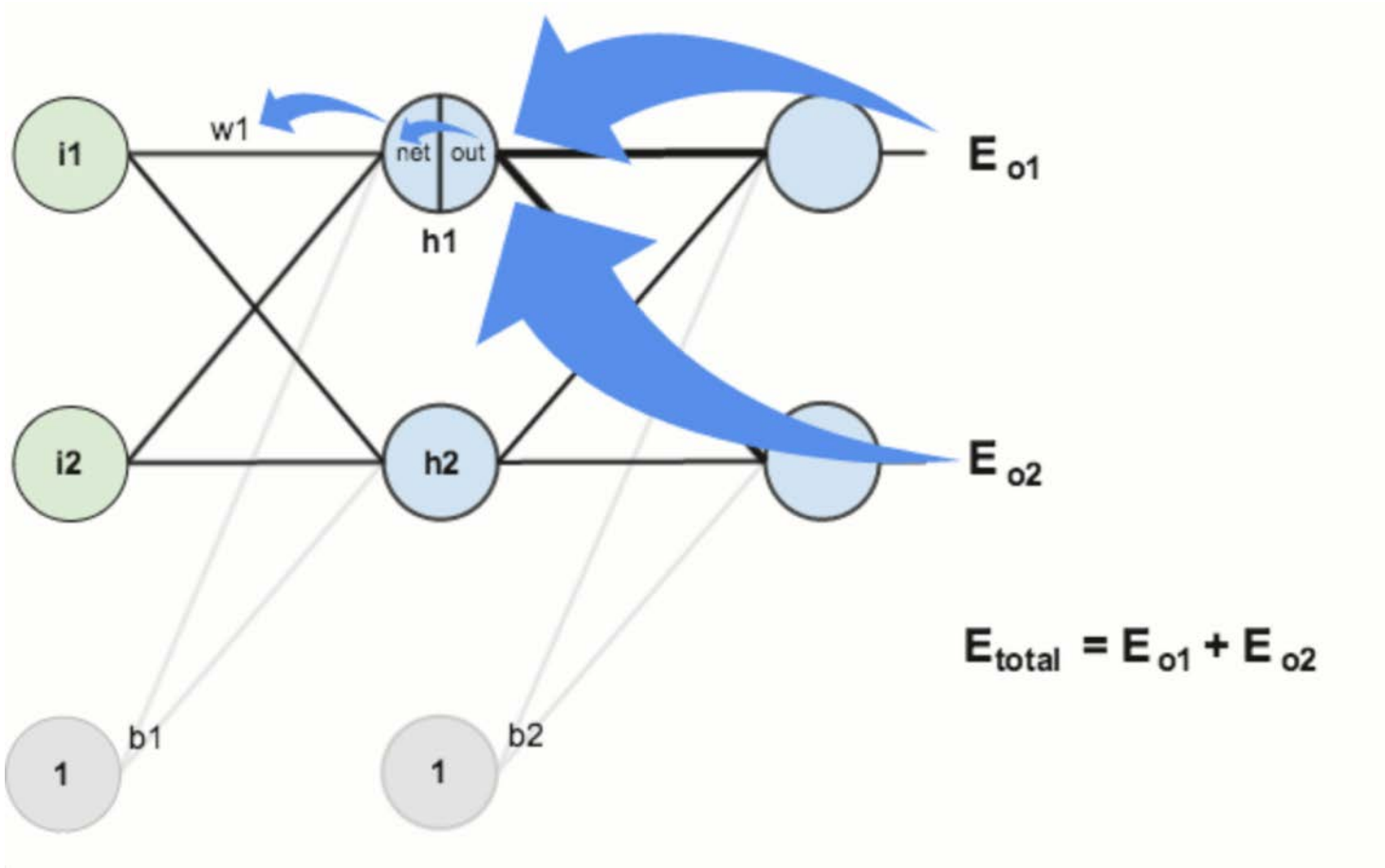
Backpropagation



Backpropagation



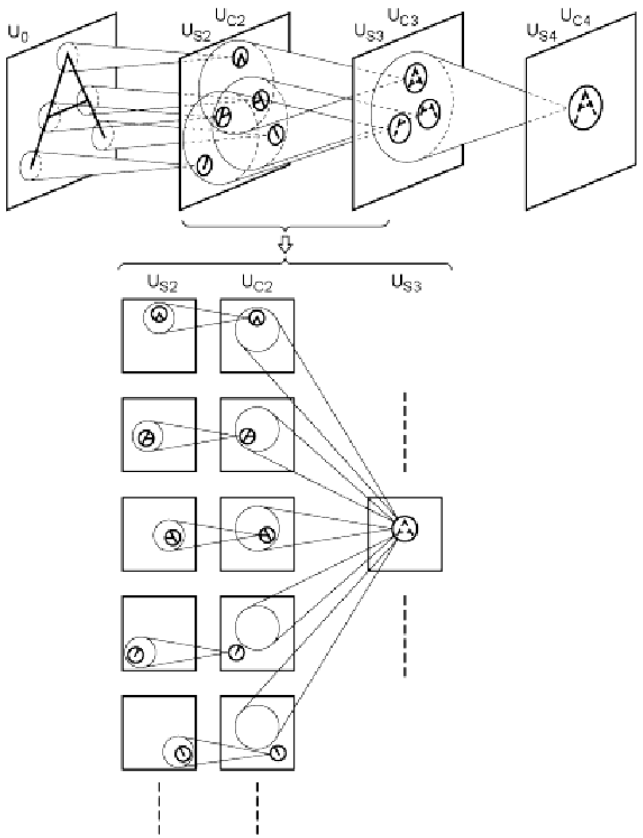
Backpropagation

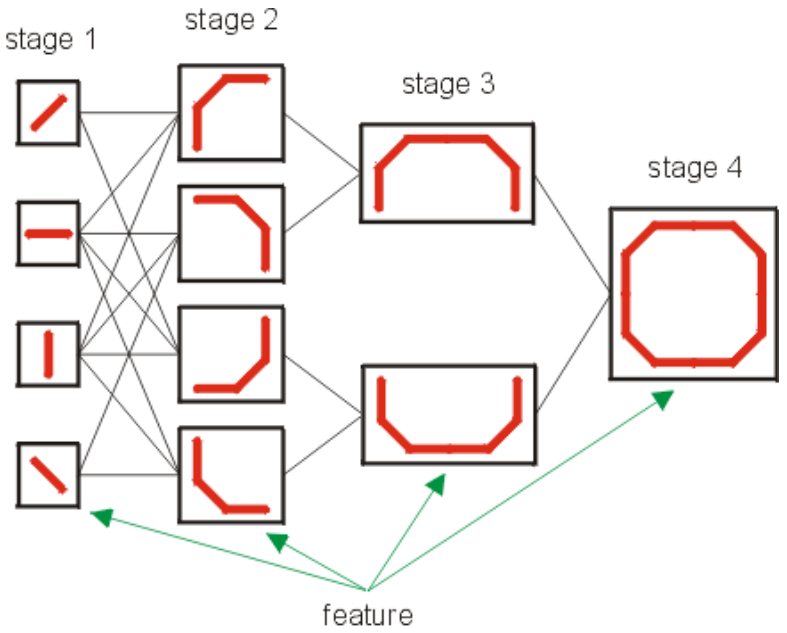


Deep Learning

- Regular Neural Networks have 1 or 2 hidden layers
- Each layer allows more complexity in the decision making
- Deep Neural Networks use many layers
  - AlphaGo uses 13 layers for each decision (value and policy)
  - Combined with tree search
    - Effective layers = thousands
  - Note: AlphaGo in 1 year advanced automated Go by 20 years
- Microsoft Deep Learning net for images
  - 152 layers
- ChatGPT – 500 + layers

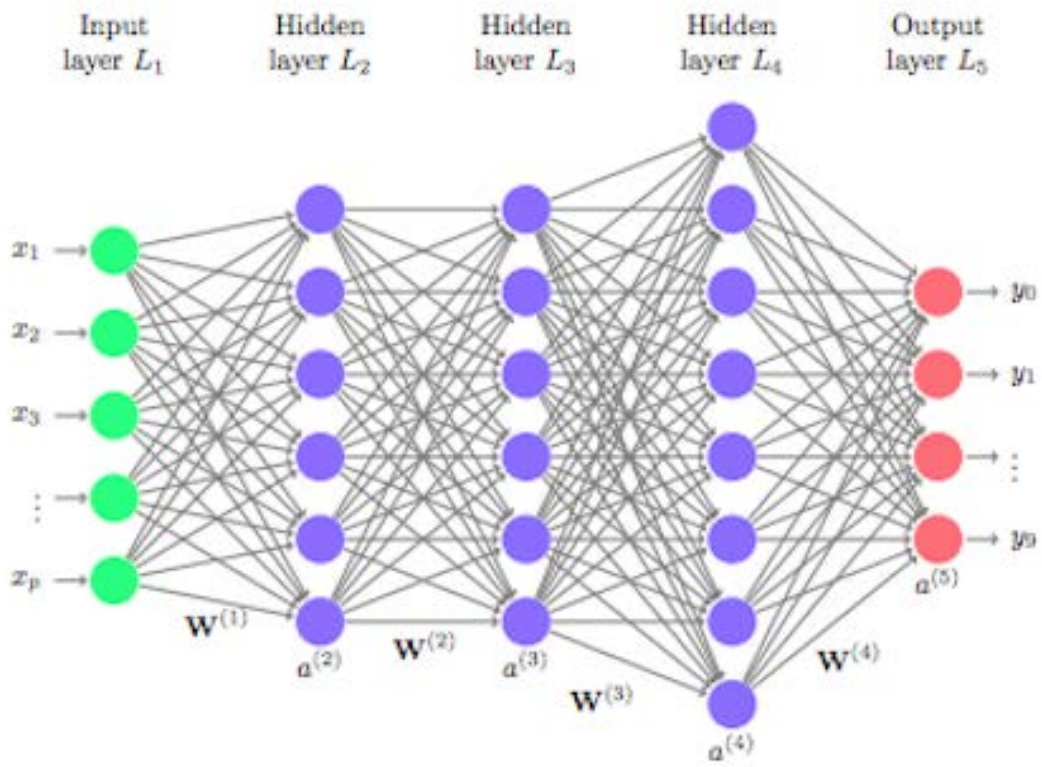
Hierarchical Processing





Deep Learning

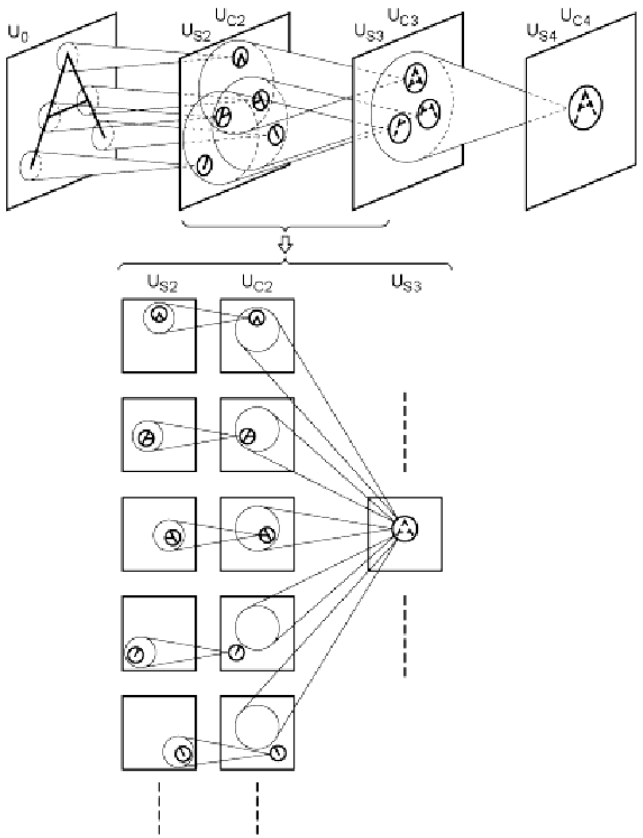
- Size matters
- 100s of layers

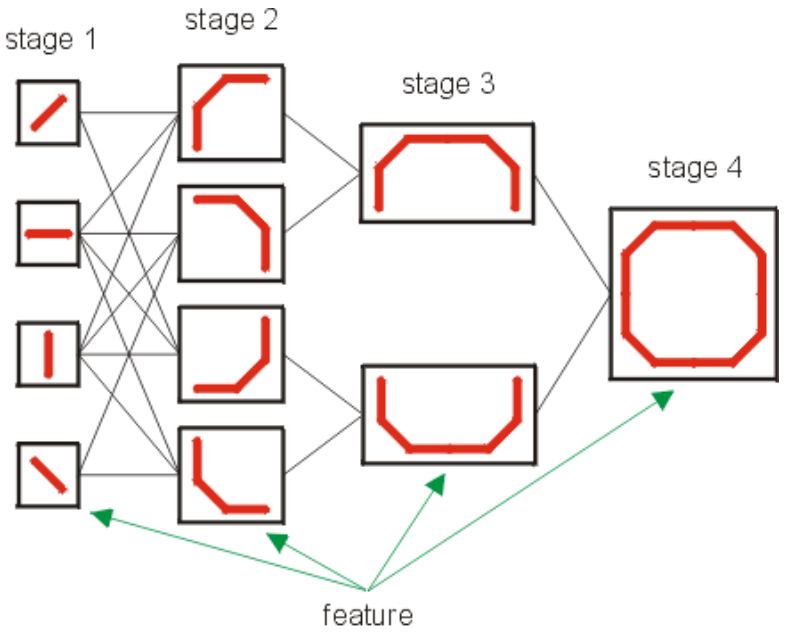


Deep Learning

- Regular Neural Networks have 1 or 2 hidden layers
- Each layer allows more complexity in the decision making
- Deep Neural Networks use many layers
  - AlphaGo uses 13 layers for each decision (value and policy)
  - Combined with tree search
    - Effective layers = thousands
  - Note: AlphaGo in 1 year advanced automated Go by 20 years
- Microsoft Deep Learning net for images
  - 152 layers
- ChatGPT – 500 + layers

Hierarchical Processing



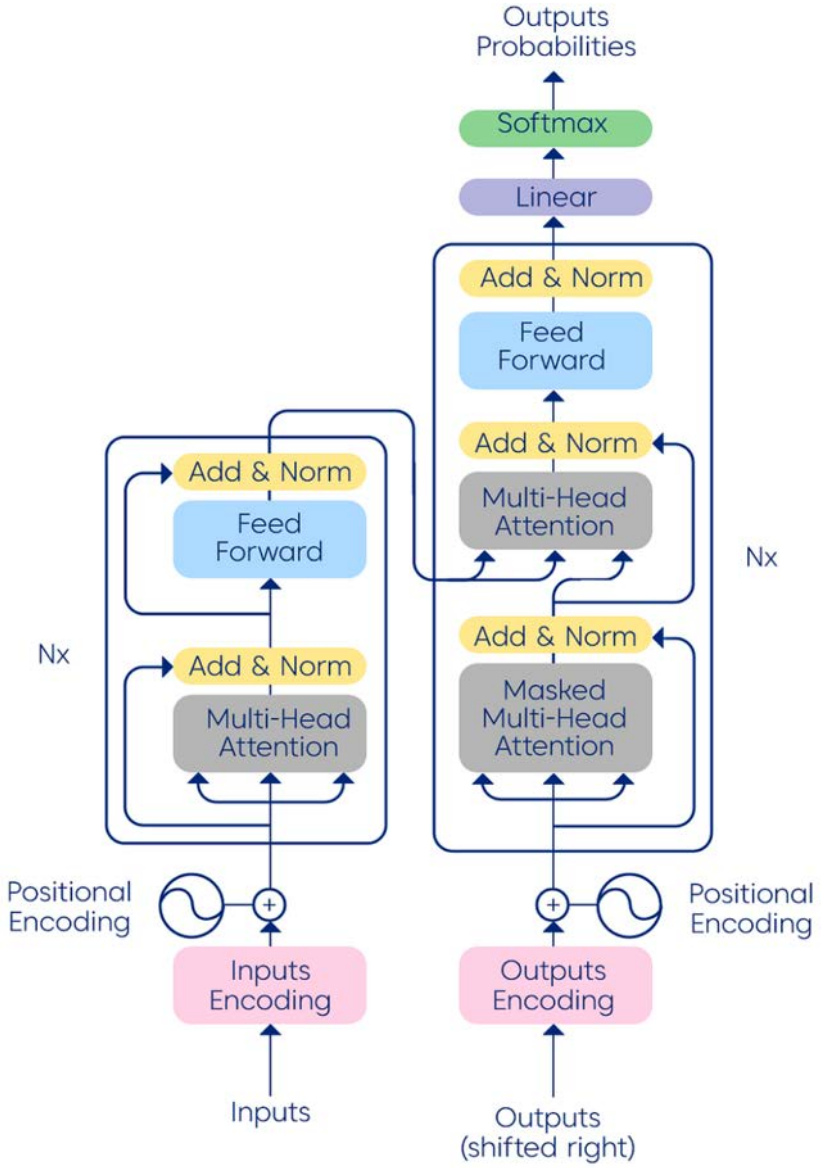


Transformers and ChatGPT

- Based on Attention
- Large Language Model
- Super Intelligent
- 1.2 Billion users
- Fastest growing application
- More progress than predicted
- Emergent Behavior
- Feared
- Surprisingly useful for many tasks
- Rapidly changing field
- API Available from various vendors
- Plugins
- Fine-tuning

The Transformer System

- The DNA of Super-Intelligence
  - Small code footprint
  - Massive Parameter Size
  - Trained on all of mankind's knowledge
  - Black Box
- Generative AI



Generative Text – Anything you can do…

- GPT (Generative Pre-trained Transformer)
  - Models like GPT-3 and GPT-4, developed by OpenAI, can generate human-like text based on prompts, create articles, answer questions, and even write code.
- Chatbots
  - Advanced conversational agents like ChatGPT use generative AI to engage in natural, human-like conversations.
- Text Summarization
  - Tools that condense long pieces of text into shorter summaries while preserving key information.
- Creative Writing
  - AI systems that can write stories, poems, and other forms of creative literature.

Generative AI - Images

- DALLE
- MidJourney
- Stable Diffusion

Generative AI Images

Diffusion Networks

- AI models that can generate arbitrary images from textual descriptions.
- DALL-E, Midjourney, Stable Diffusion

GANs (Generative Adversarial Networks)

- Used to create realistic images, art, and even deepfakes by pitting two neural networks against each other.

Style Transfer

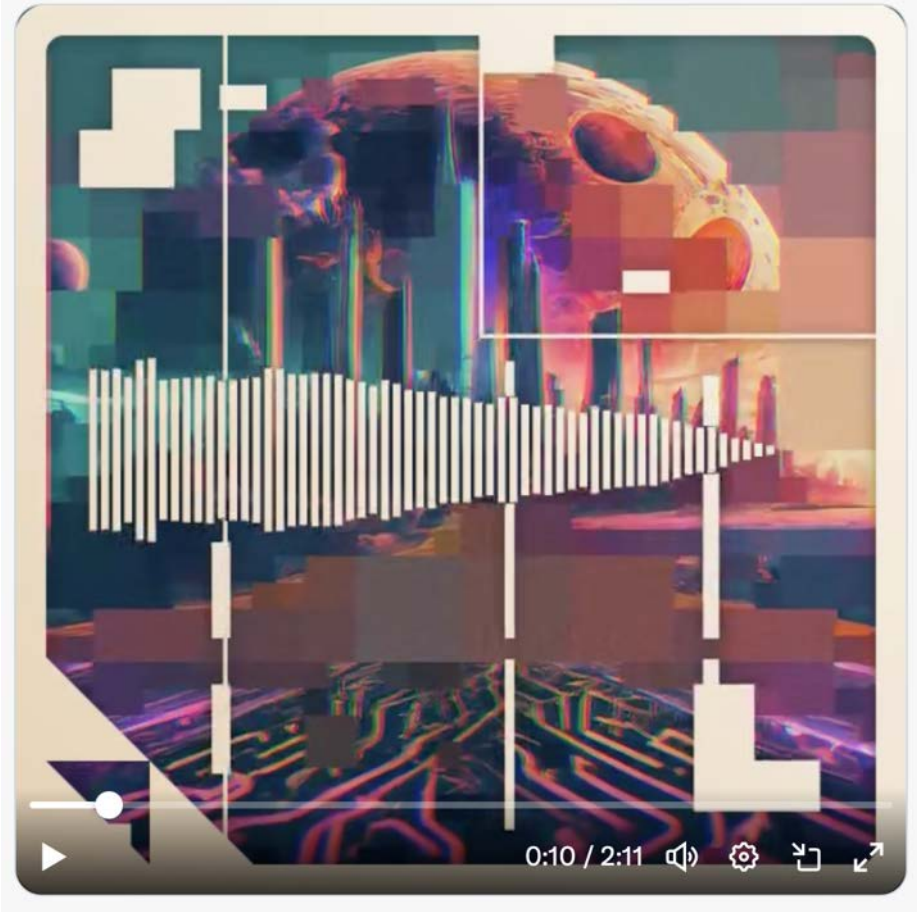
- AI can transform the style of an image, such as making a photo look like a painting by a famous artist.

DALLE

an armchair in the shape of an avocado”

DALLE art

Generative AI Music and Sound

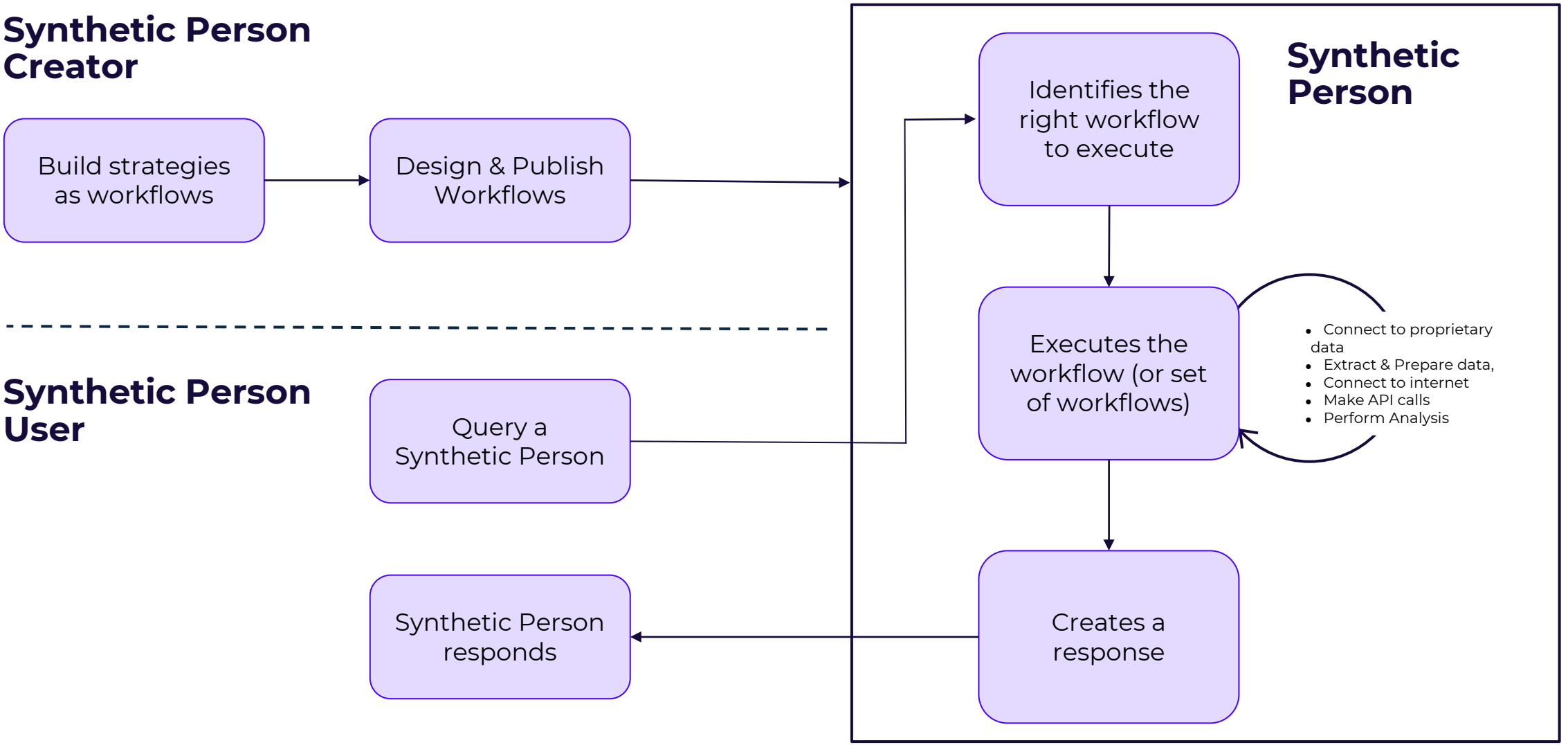



Generative AI Video

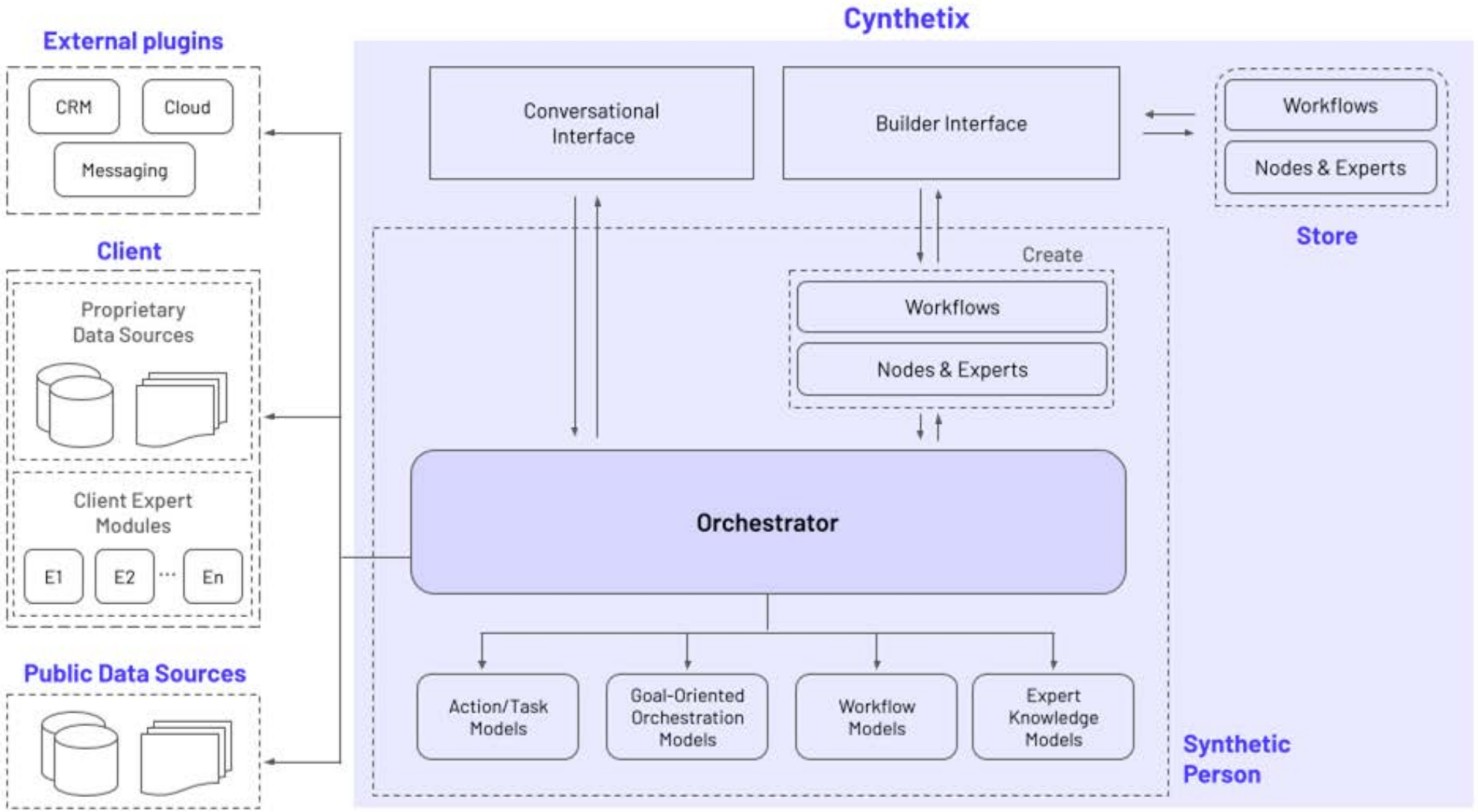
Conversational System

- Based on LLMs
- Require an Orchestration System
  - Determine topic
  - Map conversation to workflow
  - Specialized pre-defined connections to many systems
- Managed Prompting
- Can manage context for long term memory

How does the solution work?



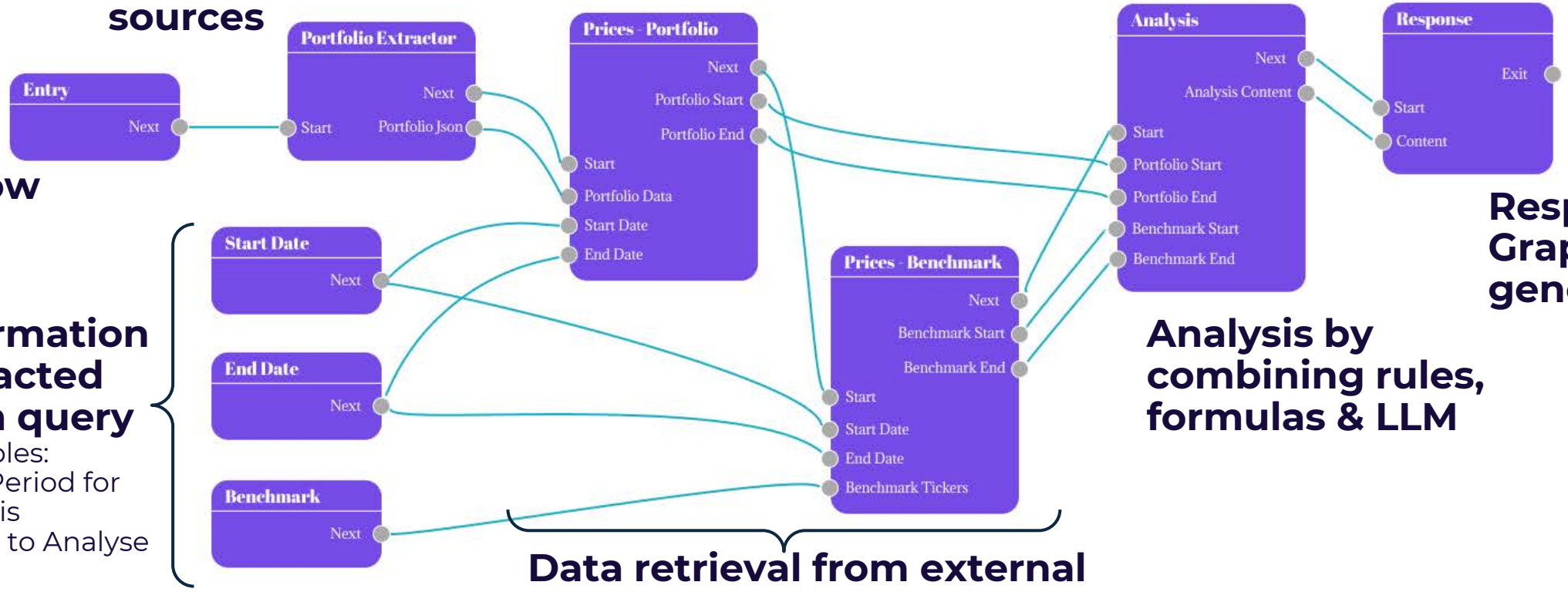
Conceptual Diagram



Example Execution of a Workflow

Query: How did my portfolio compare against S&P and Russell 2000 in the last 3 years?

Extraction from internal data sources



Start of Workflow

Information extracted from query

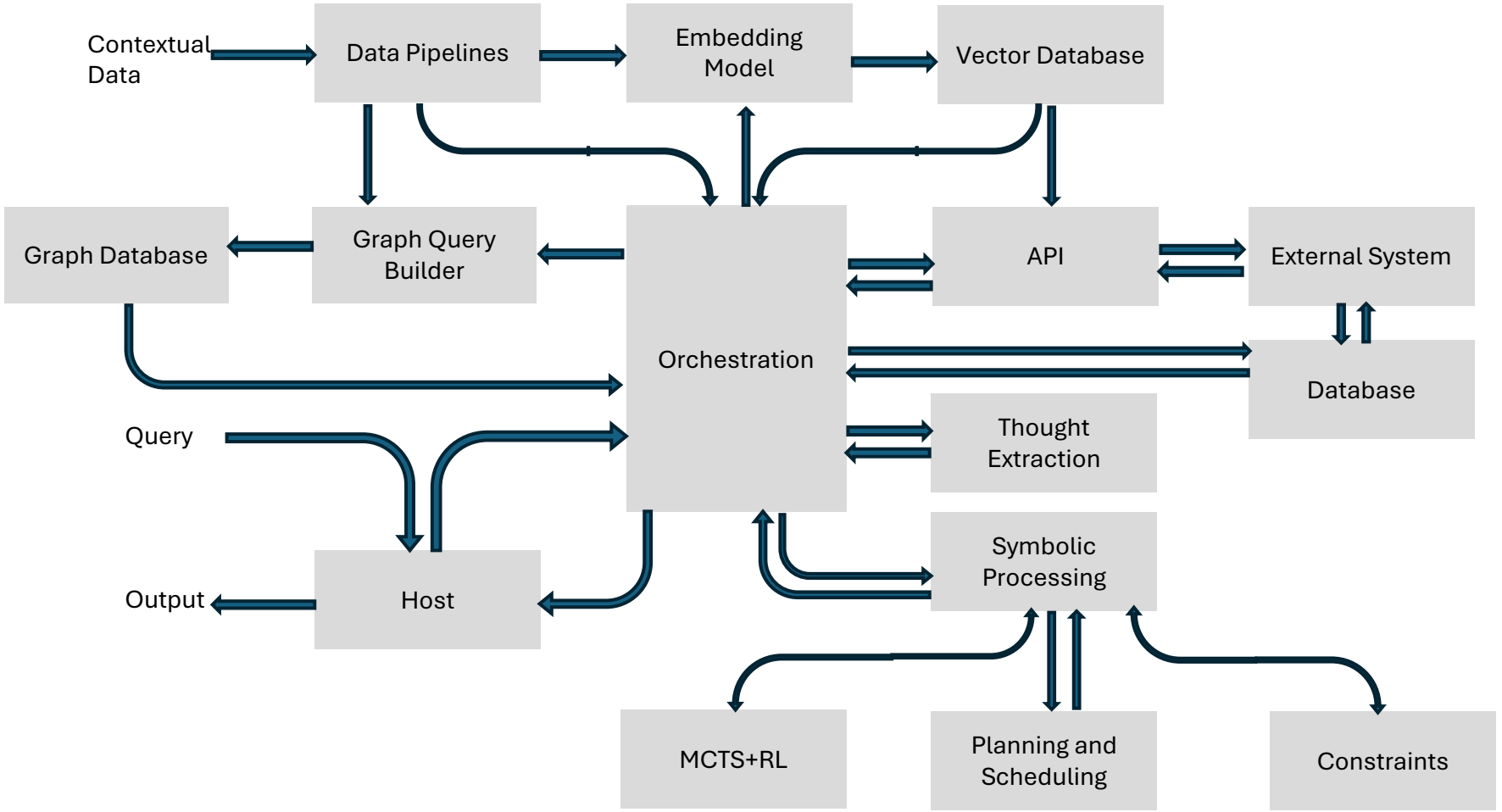
Examples:
Time Period for Analysis
Stocks to Analyse

Response & Graphics generator

Analysis by combining rules, formulas & LLM

Data retrieval from external sources (internet, APIs)

Intelligent Process with Orchestration



Modern AI Miracles

- Natural Language Understanding & Generation
- Image Generation & Style Transfer
- Autonomous Vehicles
- Protein Structure Prediction
- Personalized Healthcare
- Real-Time Language Translation
- Deep Reinforcement Learning
  - AlphaGo, AlphaFold
- Hyper-Realistic Digital Assistants
  - Alexa, Siri
- Content Creation
- Video Creation
- Game Creation
- Neural Artistry
  - Dalle, MidJourney
- Emotion Recognition
- Voice Cloning & Speech Synthesis
  - Deep Fake
- AI Companions
- AI-Powered Drug Discovery
- Autonomous Industrial Robotics
- Advanced Human-Machine Interfaces
- Personalized Education
- Synthetic Biology and DNA Design
- Automatic Programming

Modern AI Applications: Financial Industry

- Algorithmic Trading
- Fraud Detection and Prevention
- Credit Risk Assessment
- Personalized Financial Services
- Chatbots and Virtual Assistants
- Sentiment Analysis for Market Prediction
- AI-Powered Investment Advisors (Robo-Advisors)
- Customer Behavior Analytics
- Regulatory Technology (RegTech)
- Predictive Analytics for Loan Default
- Automated Underwriting
- Natural Language Processing for News Impact Analysis
- Portfolio Optimization
- Credit Scoring for Underbanked Populations
- Market Anomaly Detection
- Know Your Customer (KYC) Automation
- Risk Management through Deep Learning
- Fraud Detection in Real-Time Payment Systems
- Anti-Money Laundering (AML) Compliance Monitoring
- Insurance Claims Processing Automation

Trends

- New models with superhuman abilities
  - OpenAI, Google, AWS
- Multimodal Models
- Real Time Simulated Worlds
- Agentic Systems
  - Mixture of Agents
- Goal Directed Behavior