AI systems in Trading: Is AI a ‘game changer’?

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AI systems in Trading: Is AI a ‘game changer’?

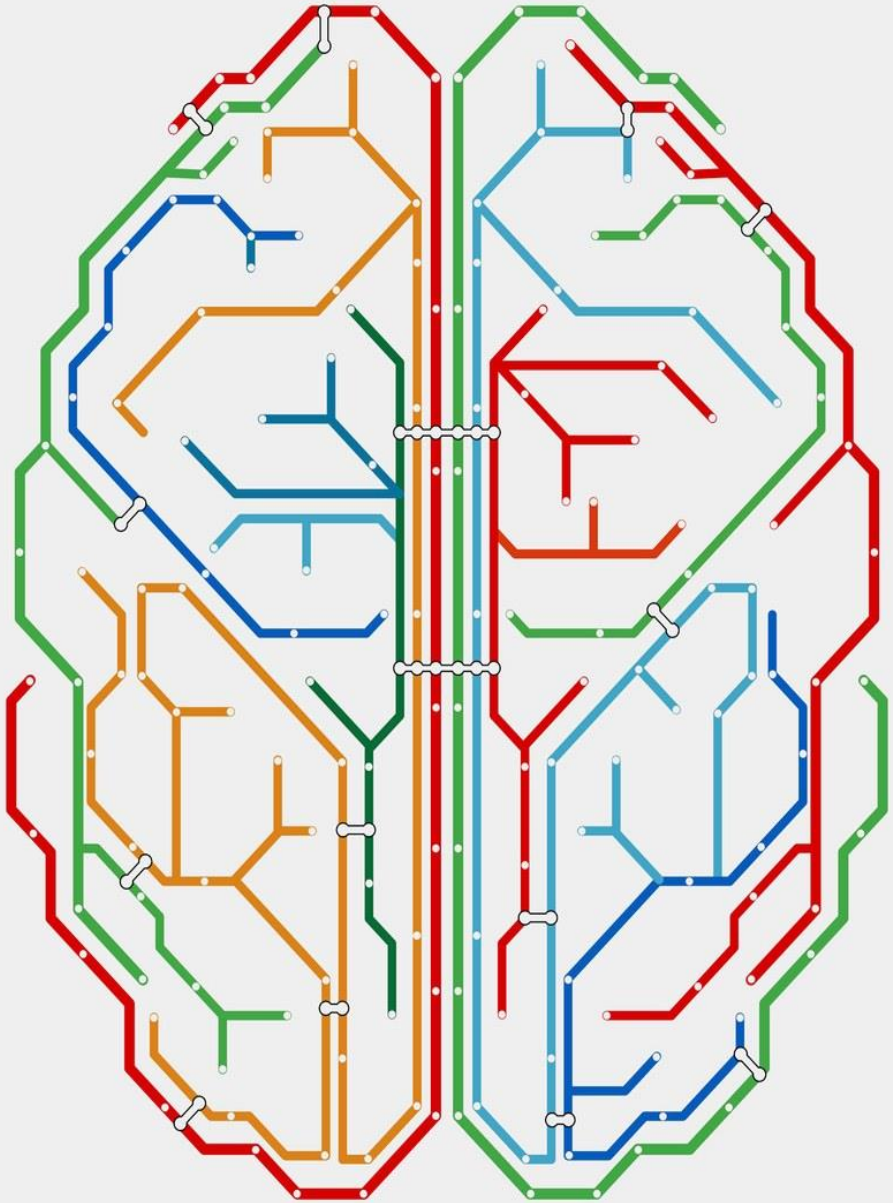
What you should <u>not</u> expect in the next 45 min?

- An *‘apocalyptic’* view of the AI destroying our jobs, and later, the world
- A *‘bombastic’* view of AI as the solution for everything
- A *‘techy’* view of AI
- And obviously…. *do not expect all the answers*

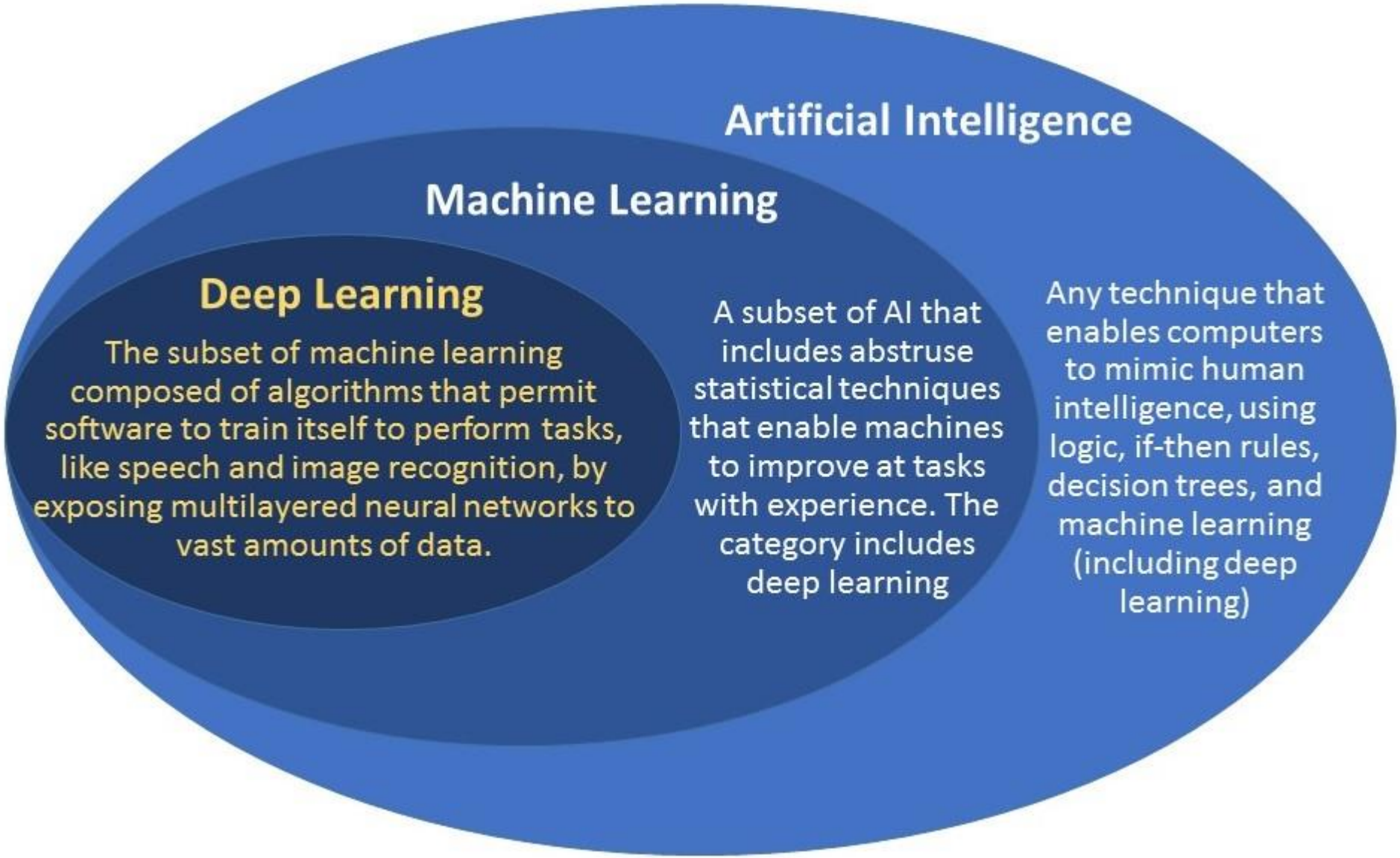
What can you expect in the next 45 min?

- *Some interesting questions* about **AI and our jobs**, hopefully the right ones…
- *Some honest opinions*, hopefully unbiased…
- *Some simple ideas* about the **what’s next**, hopefully well-founded…
- And some ‘*possible*’ clues about how to **make money** of all of that

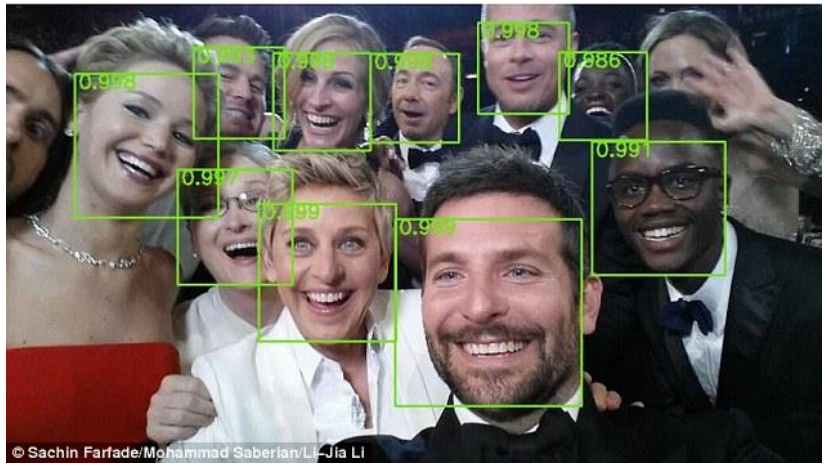
1. Introduction
2. How traders think?
3. How a system. trading think?
4. How AI trading system think?

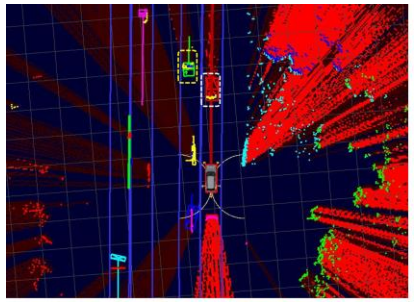


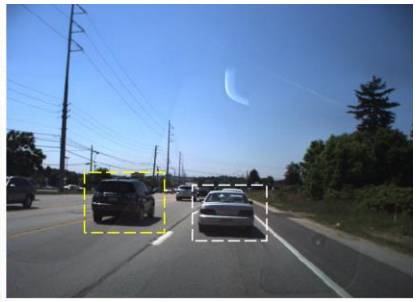
Introduction

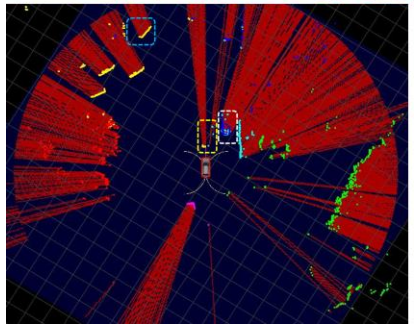


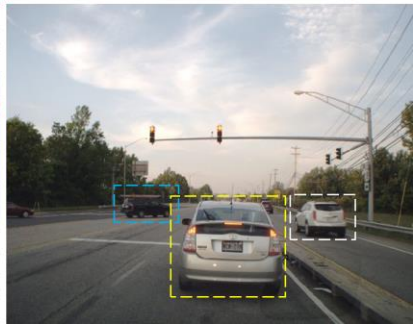
Introduction

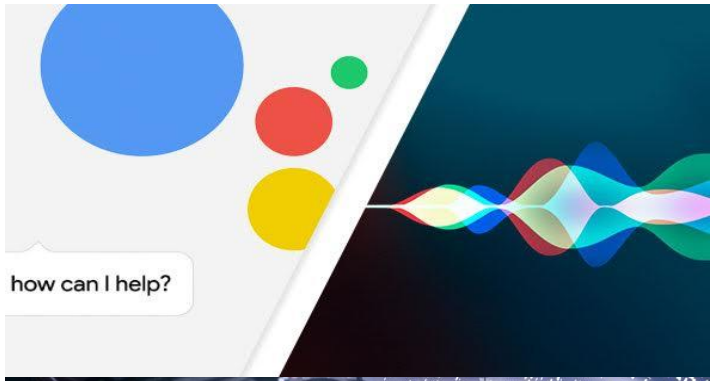












Introduction

- **Some AI technologies**, for very specific uses, are mature enough for 'prime-time' deployment at Google, Facebook, IBM, Tesla, Salesforce, Baidu… But true is that, we are decades away from AI that can build models of the world as flexibly and as deeply as humans do.

- There is **some experimental AI in finance**: Two-Sigma, Numer.ai, Quantopian… but are they new? Will they be a "AI game changers" in trading/financial markets?

But the true is that we are just **starting** to understand some of the **fundamental principles of intelligence, intuition and learning** behind **trading.** Two examples:

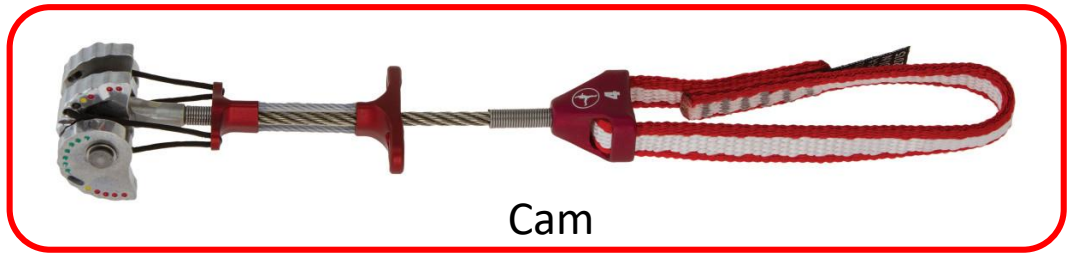
  - **One shot-learning:** How can we connect such rich concepts in an complex environment that rarely repeat twice?

  - **Commonsense understanding:** How can we see a whole market, agent's interactions and our own possibilities to take advantage – not simply find patterns or follow trends? How do traders learn such abstract, rich, and flexible representations of the market with incomplete information?

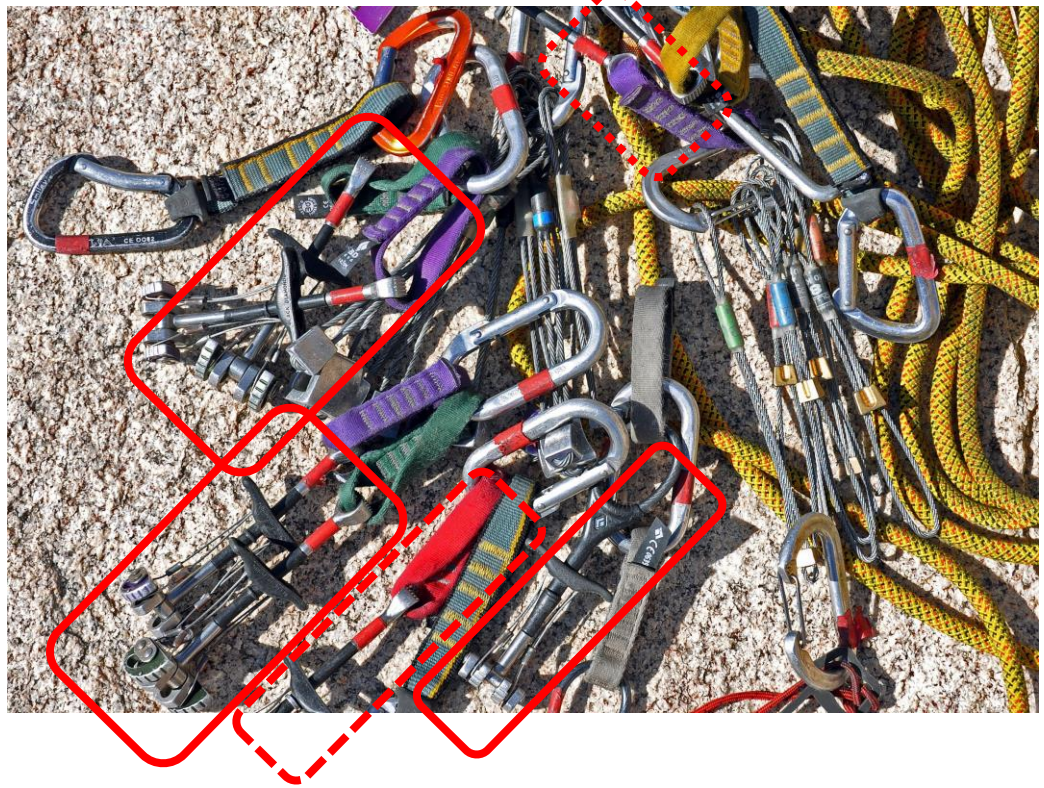
Introduction

One shot-learning examples

Segway



Cam

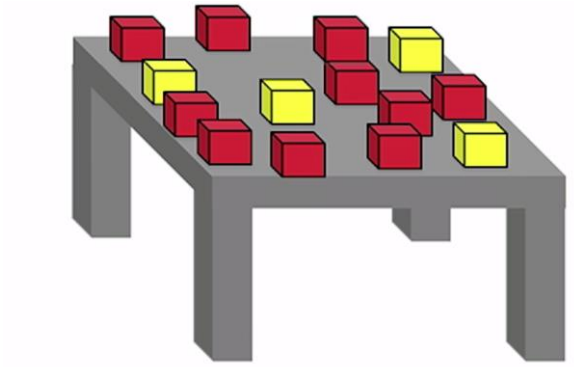


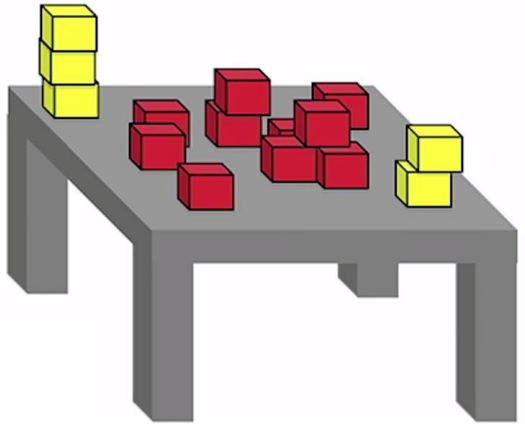
Examples adapted from Lake, Salakhutdinov, and Tenenbaum (2015)

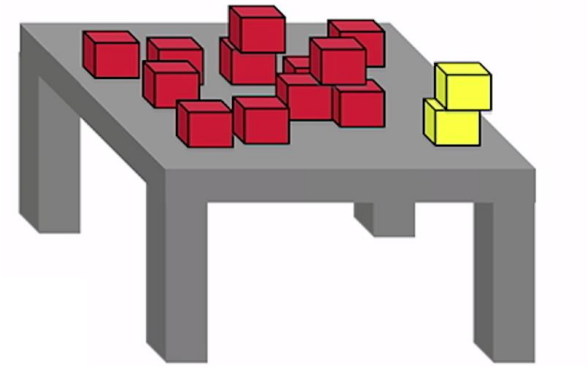
Introduction

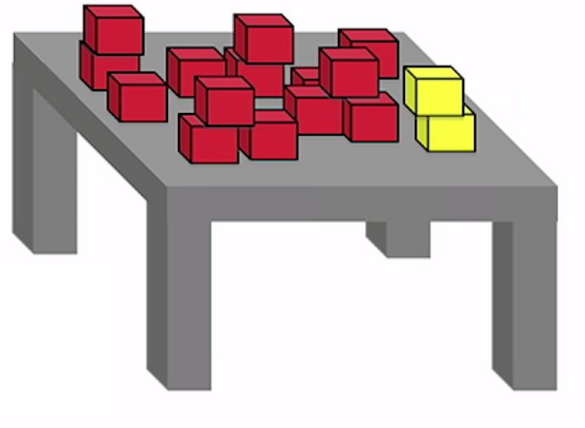
Commonsense understanding

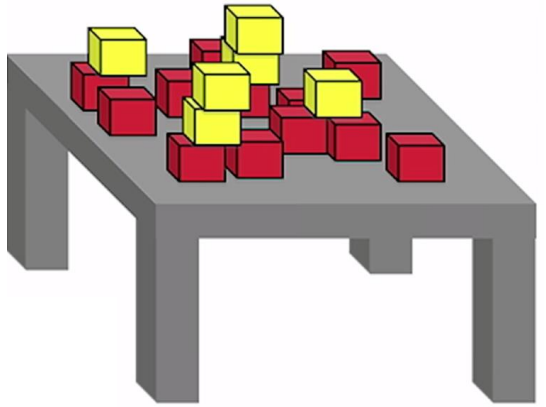
What if a table is bumped hard enough to knock some of the blocks onto the floor? Is it more likely to be red blocks or yellow block?







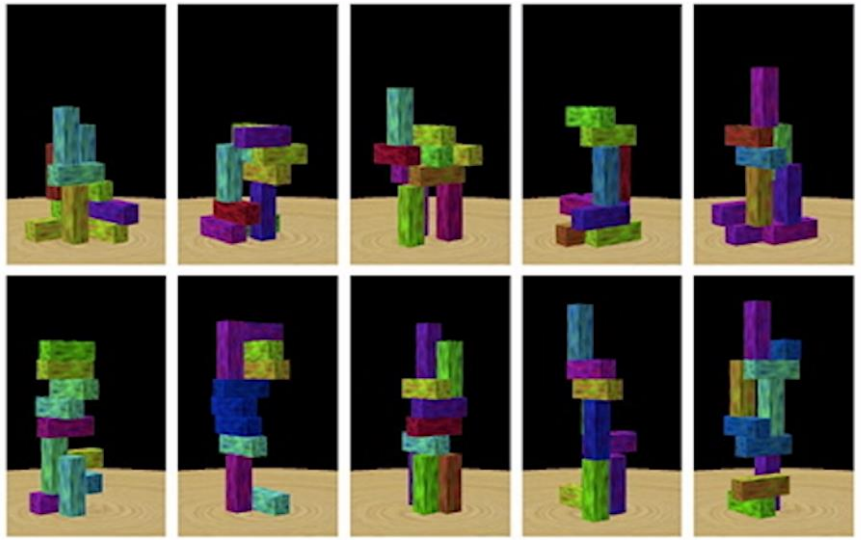




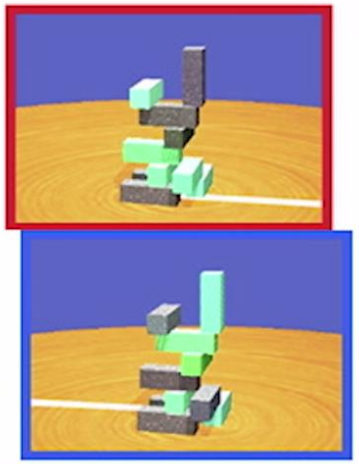
Introduction

Commonsense understanding

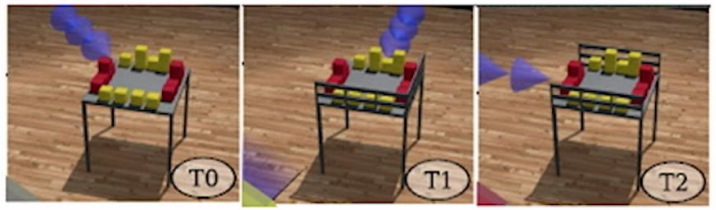
Will this stack of blocks fall?



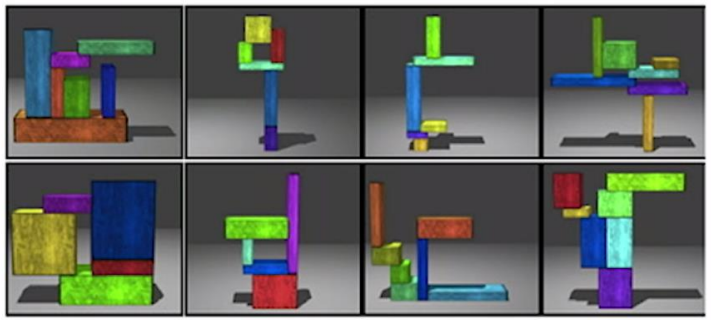
What if grey is much heavier than green?



What will happen if you bump the table …?



How to glue blocks together to make them stable?



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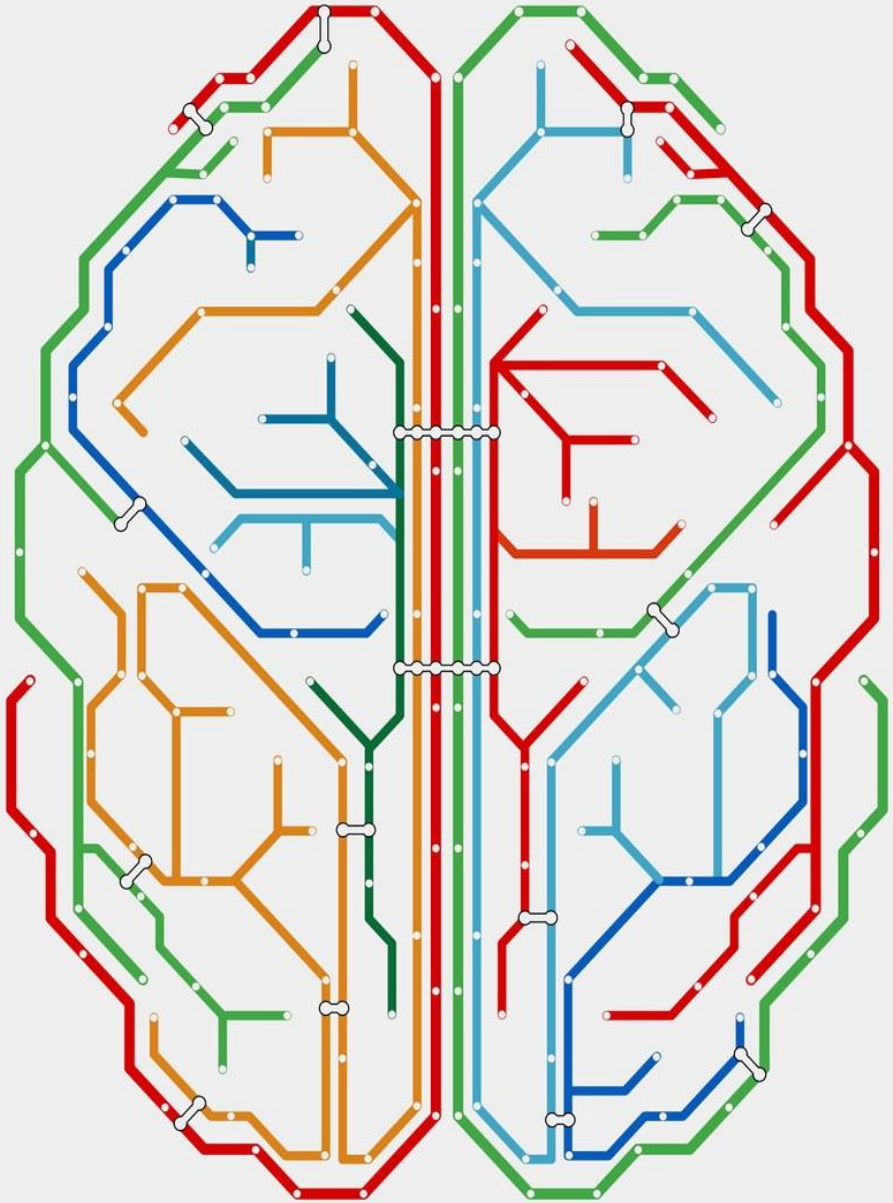

How a trader thinks?

- In the physical world, we can see model-building at work in all the ways that even a young child is more intelligent than any current robot or AI system. We have seen two examples:
    - **One-shot learning**
    - **Commonsense understanding**

- But **Trading** is not about 'physical' objects under a physical 'laws': *Market moves under 'human' laws* (fear and greed)

- **AI in Trading** is about a 'human' modelling of 'human' behaviors (condensed in numbers = a price dynamics).

- Good **Human Traders** are *very good* in:

Causal explanation:	→	**Explaining** and **understanding** they we see in the screens
Imagination:	→	**Imagining** market movements we could see but haven't yet happen
Planning:	→	**Problem solving** and **planning actions** with an **expected probabilistic outcome**
Thinking:	→	And **building new models as we learn** more about the markets

How AI trading system think?

Trading is about …		Human Trader	Systematic Trader	AI System
Causal explanation:	**Explaining** and **understanding** what we see 'in the screens'	✓✓		
Imagination:	**Imagining** market movements we could see, but haven't yet happen	✓✓		
Planning:	**Problem solving** and **planning actions** with a **expected probabilistic outcome**	✓✓		
Thinking:	And **building new models as we learn** more about the markets	✓✓		

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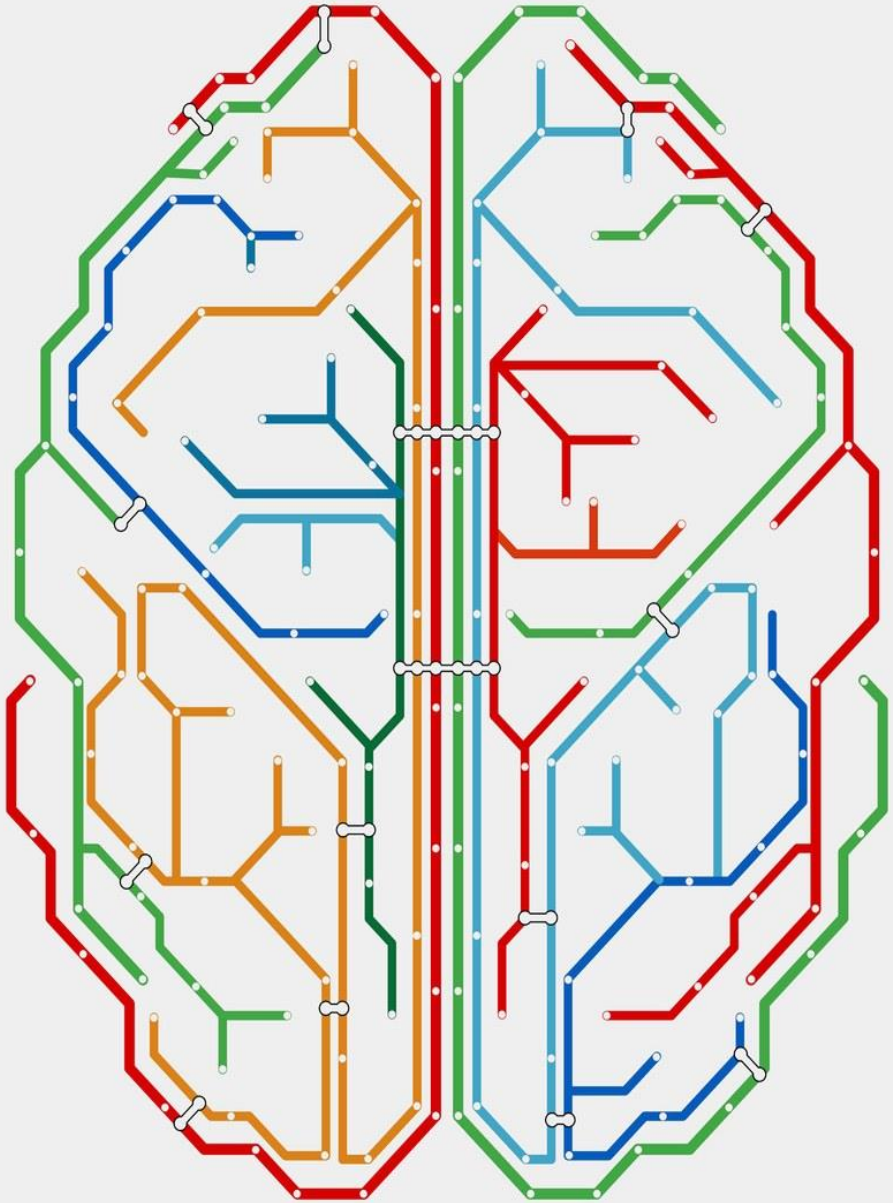
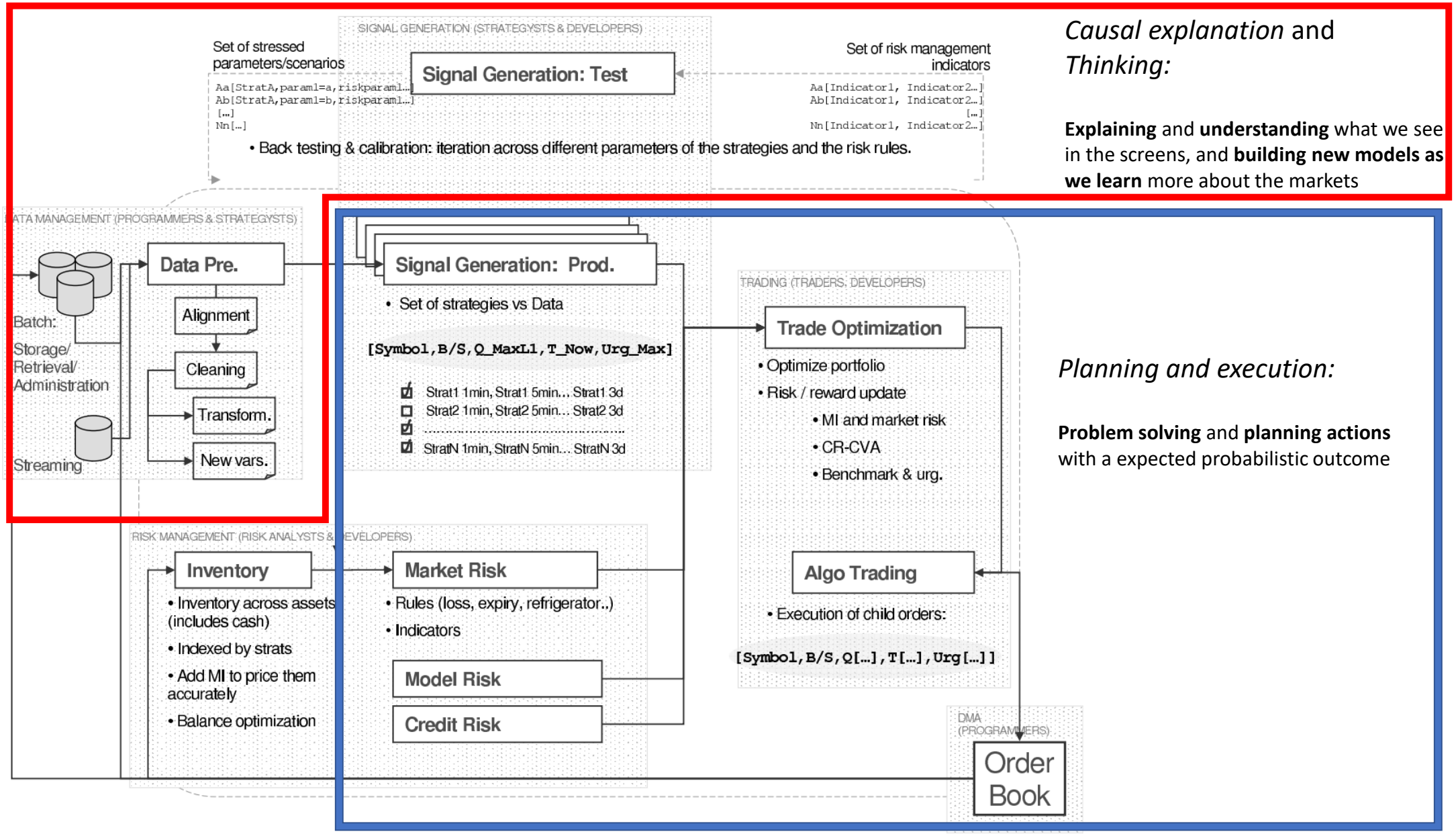


How systematic trading think?



Causal explanation and *Thinking:*

Explaining and **understanding** what we see in the screens, and **building new models as we learn** more about the markets

Planning and execution:

Problem solving and **planning actions** with a expected probabilistic outcome

How AI trading system think?

Trading is about …		Human Trader	Systematic Trader	AI System
Causal explanation:	**Explaining** and **understanding** what we see 'in the screens'	✓✓	✓	
Imagination:	**Imagining** market movements we could see, but haven't yet happen	✓✓		
Planning:	**Problem solving** and **planning actions** with a **expected probabilistic outcome**	✓✓	✓	
Thinking:	And **building new models as we learn** more about the markets	✓✓	✓	

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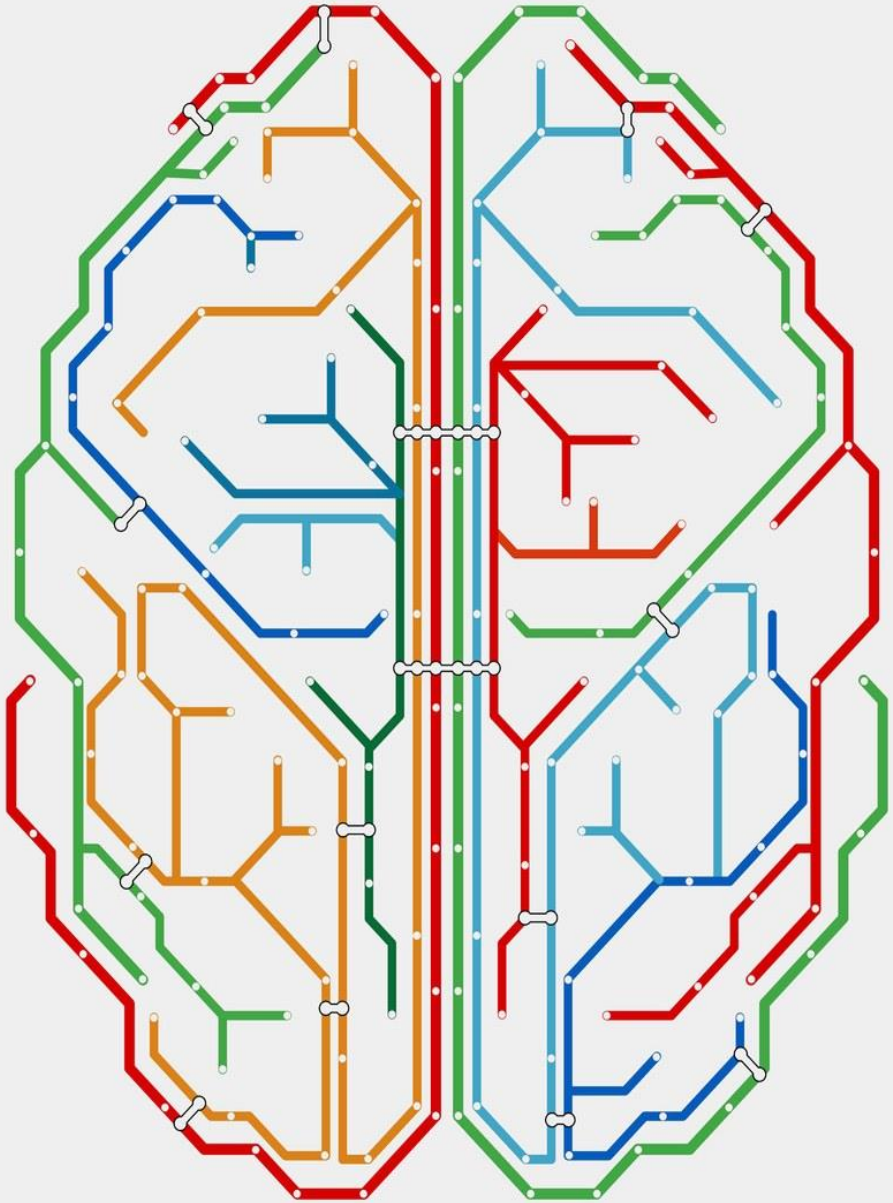
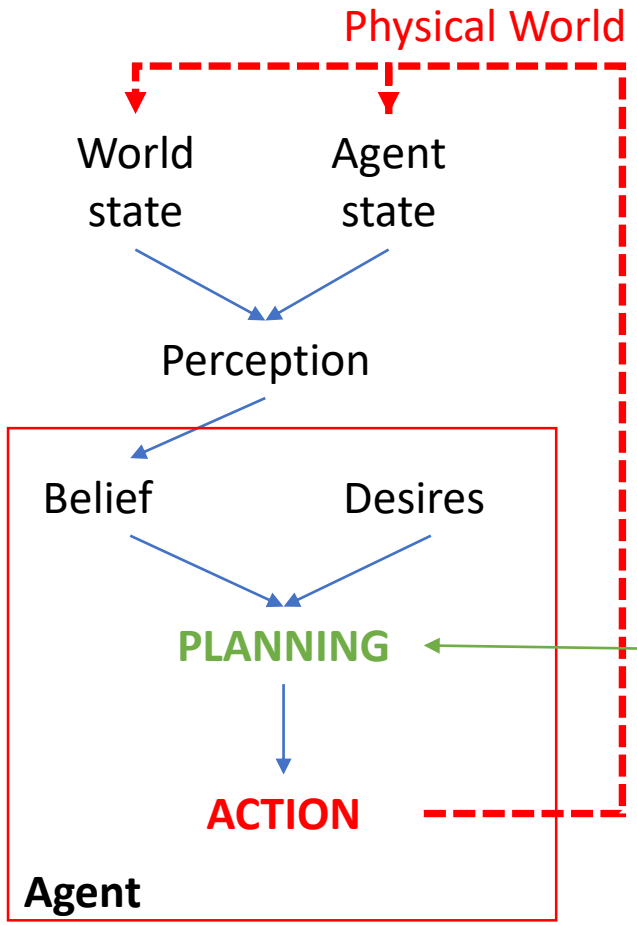


How AI trading system think?

From the Max Planck Institute for Evolutionary Anthropology.
https://youtu.be/Z-eU5xZW7cU

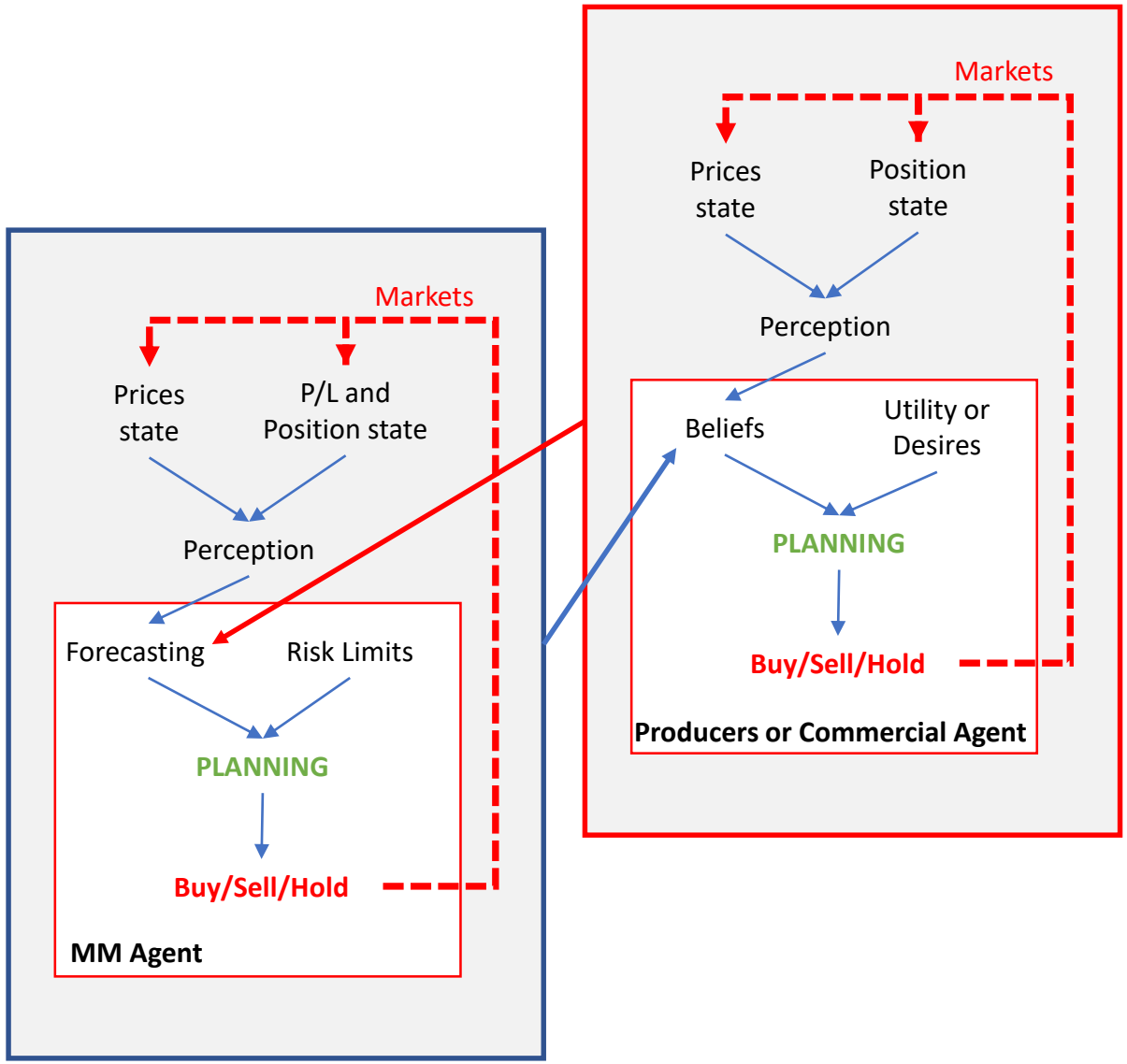


Planning efficient actions:

Find the action(a) that **maximize** the utility of the agent (in terms of max. **rewards** at the min. **cost**) given my current state (s)

$$\underset{a}{\text{argmax}}\ \mathbf{U}(a,s) = \mathbf{R}(s') - \mathbf{C}(a)$$

How AI trading system think?



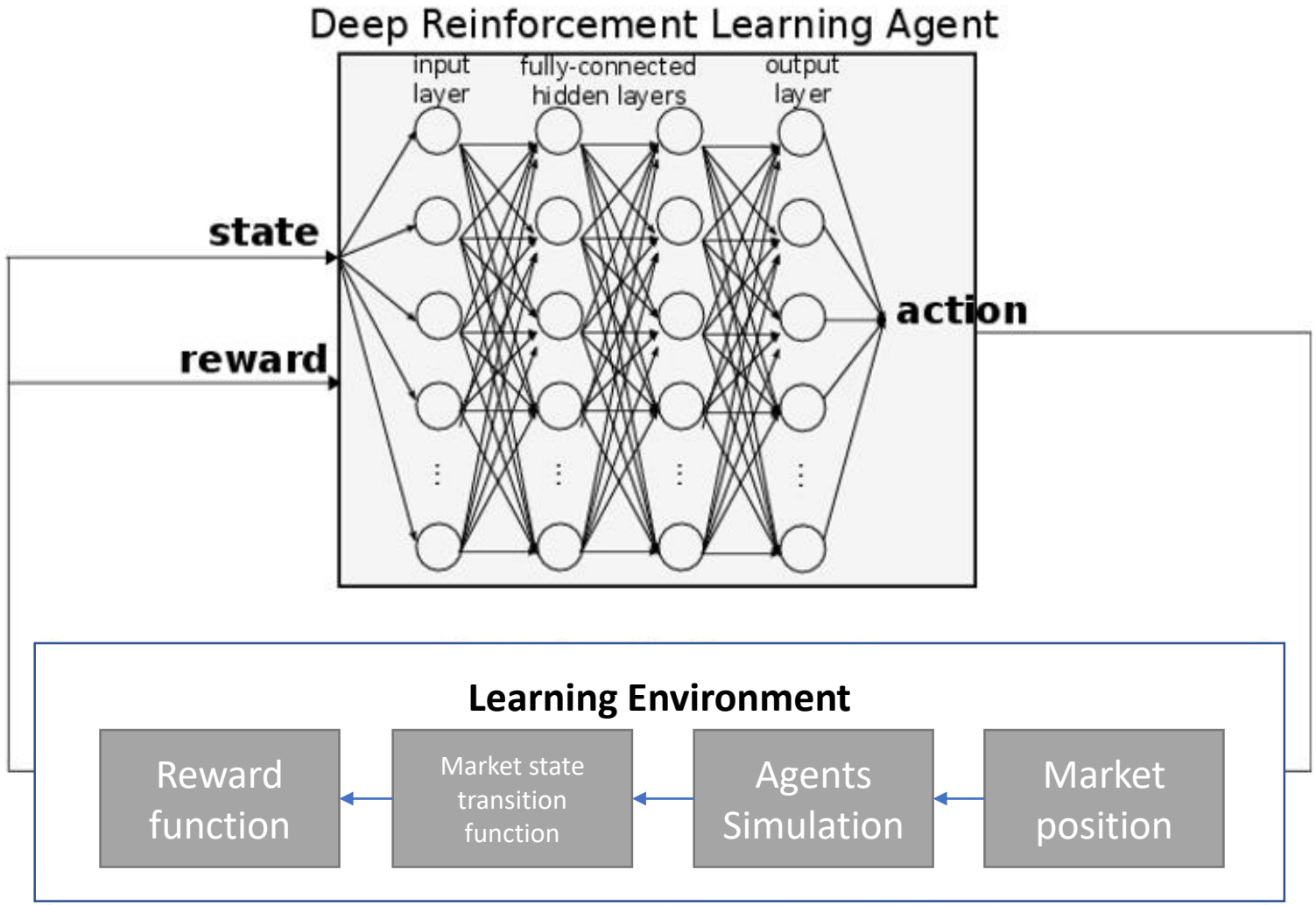
- **To understand the market** is about **to understand human behavior**. It is not just about equations. If we understand the human decisions, we will understand the markets

- The ability of a machine to understand (replicate) human behavior, is based in the simulation of the **interaction of multiple agents utilities dependent on another's** (allied or opponents)

- **Commodities markets** are populated by **market agents** (producers/merchants, hedge-funds…) with different **utilities functions** (min. risk of losses, max. sharpe ratio…) and **trading decisions systems** (quantitative, technical, discretionary…)

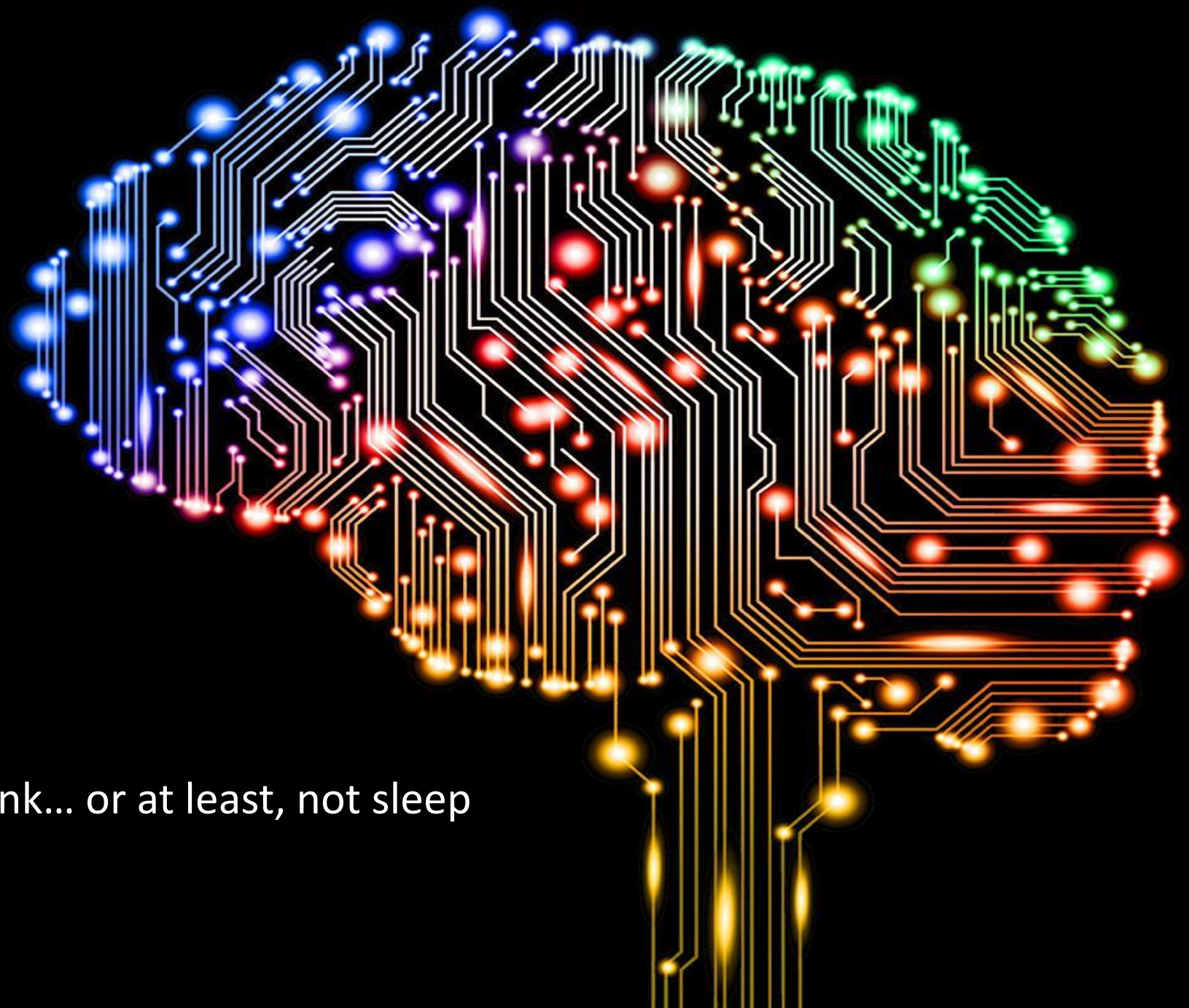
- **Markets can be replicated through the interaction of multi-agents** with different but dependent utilities functions and learning mechanisms.

How AI trading system think?



How AI trading system think?

Trading is about …		Human Trader	Systematic Trader	AI System
Causal explanation:	**Explaining** and **understanding** what we see 'in the screens'	✓✓	✓	✓✓✓
Imagination:	**Imagining** market movements we could see, but haven't yet happen	✓✓		✓
Planning:	**Problem solving** and **planning actions** with a **expected probabilistic outcome**	✓✓	✓	✓✓✓
Thinking:	And **building new models as we learn** more about the markets	✓✓	✓	✓



Hope it make you think… or at least, not sleep

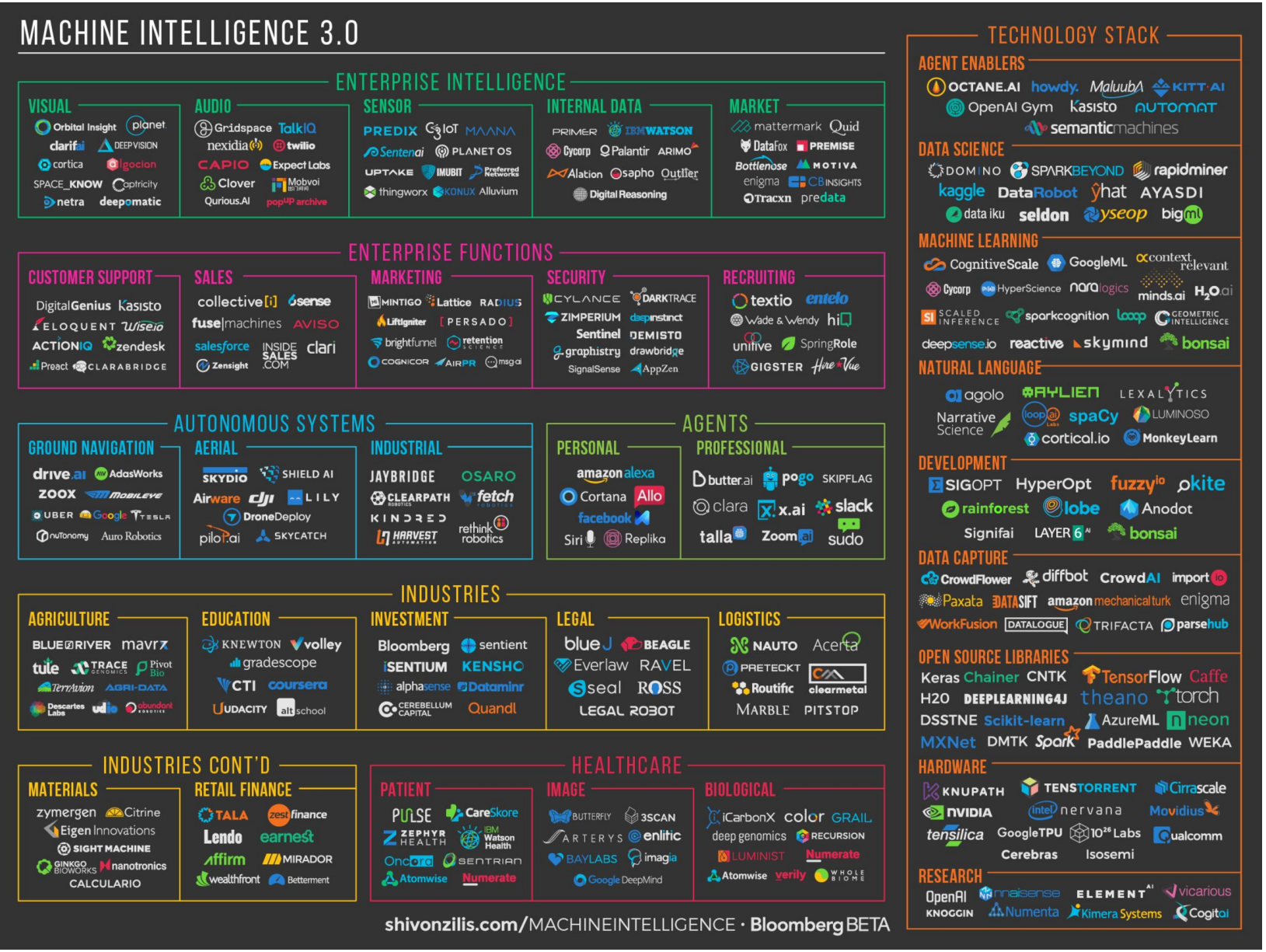
Thank you!

Add-ons

Glossary

- **Neural network:** A network of simple neuron-like processing units that collectively perform complex computations. Neural networks are often organized into layers, including an input layer that presents the data (e.g, an image), hidden layers that transform the data into intermediate representations, and an output layer that produces a response (e.g., a label or an action). Recurrent connections are also popular when processing sequential data.
- **Deep learning**: A neural network with at least one hidden layer (some networks have dozens). Most state-of-the-art deep networks are trained using the backpropagation algorithm to gradually adjust their connection strengths.
- **Backpropagation:** Gradient descent applied to training a deep neural network. The gradient of the objective function (e.g., classification error or log-likelihood) with respect to the model parameters (e.g., connection weights) is used to make a series of small adjustments to the parameters in a direction that improves the objective function.
- **Convolutional network** (convnet): A neural network that uses trainable filters instead of (or in addition to) fully-connected layers with independent weights. The same filter is applied at many locations across an image (or across a time series), leading to neural networks that are effectively larger but with local connectivity and fewer free parameters.
- **Model-free and model-based reinforcement learning:** Model-free algorithms directly learn a control policy without explicitly building a model of the environment (reward and state transition distributions). Model-based algorithms learn a model of the environment and use it to select actions by planning.
- **Deep Q-learning:** A model-free reinforcement learning algorithm used to train deep neural networks on control tasks such as playing Atari games. A network is trained to approximate the optimal action-value function Q(s, a), which is the expected long-term cumulative reward of taking action a in state s and then optimally selecting future actions.
- **Generative model:** A model that specifies a probability distribution over the data. For instance, in a classification task with examples X and class labels y, a generative model specifies the distribution of data given labels P(X|y), as well as a prior on labels P(y), which can be used for sampling new examples or for classification by using Bayes' rule to compute P(y|X). A discriminative model specifies P(y|X) directly, possibly by using a neural network to predict the label for a given data point, and cannot directly be used to sample new examples or to compute other queries regarding the data. We will generally be concerned with directed generative models (such as Bayesian networks or probabilistic programs) which can be given a causal interpretation, although undirected (non-causal) generative models (such as Boltzmann machines) are also possible.
- **Program induction:** Constructing a program that computes some desired function, where that function is typically specified by training data consisting of example input/output pairs. In the case of probabilistic programs, which specify candidate generative models for data, an abstract description language is used to define a set of allowable programs and learning is a search for the programs likely to have generated the data.

Some AI companies to closely follow…



- **ABEJA** – Tokyo-based startup focused on AI-powered retail analytics systems
- **Datalogue** – New York AI data-mining platform developed out of Cornell University
- **ElementAI** – Montreal-based startup helps companies quickly integrate AI capabilities
- **Elemental Cognitio** – NYC startup founder for the former chief engineer of IBM Watson
- **Fastdata.io** – California and Washington-based startup offers software for big data processing
- **Optimus Ride** – MIT spinoff developing fully autonomous vehicles
- **SoundHound** – Silicon Valley startup building voice-enabled AI solutions
- **TempoQuest** —Colorado-based startup doing GPU-accelerated weather forecasting
- **Zebra Medical** – Israel-based startup using AI to read medical images

AI pitfalls

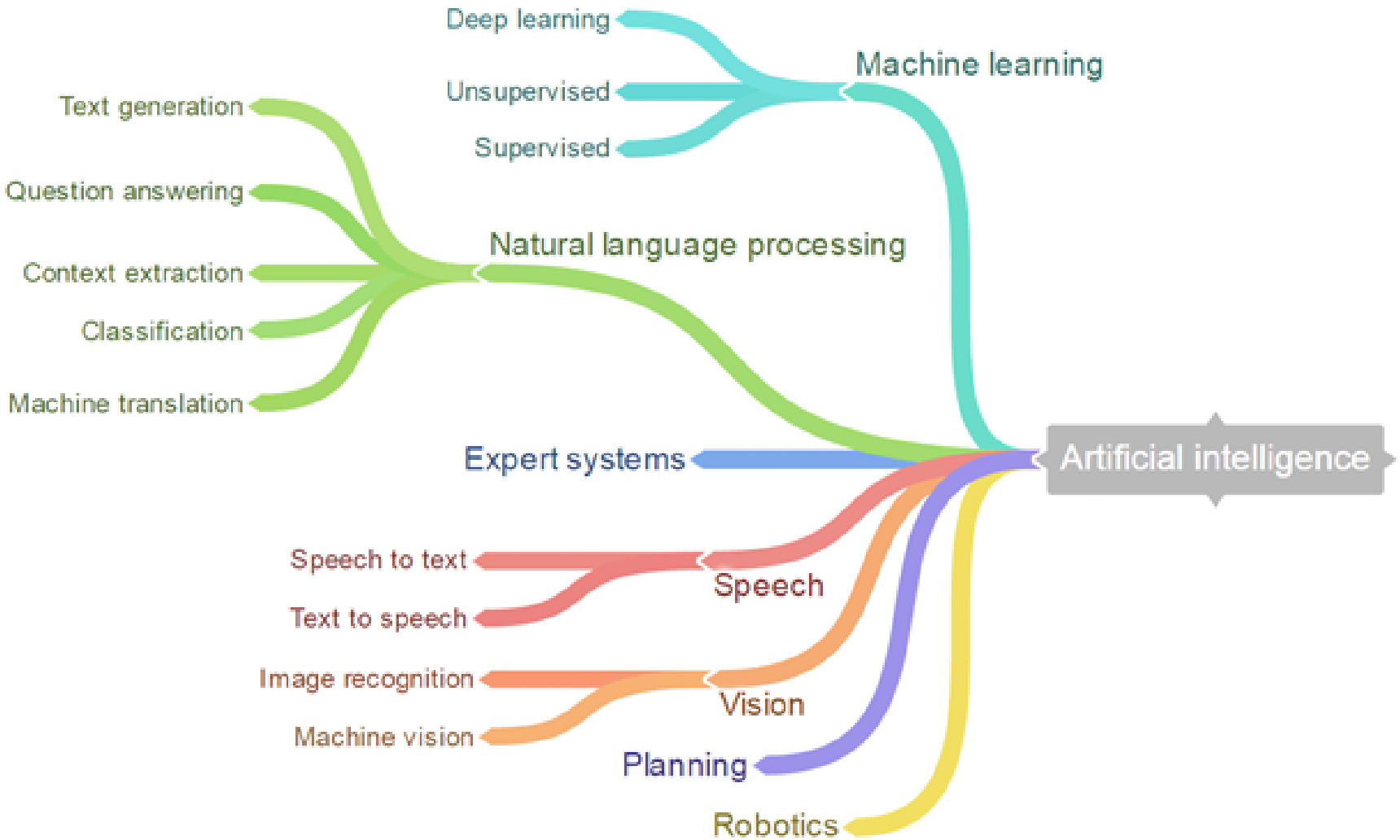
a woman riding a horse on a dirt road

an airplane is parked on the tarmac at an airport

a group of people standing on top of a beach

Perceiving scenes without intuitive physics, intuitive psychology or causality. Image captions are generated by a deep neural network (Karpathy & Fei-Fei, 2015) using code from github.com/karpathy/neuraltalk2. Image credits: Gabriel Villena Fernandez (left), TVBS Taiwan / Agence France-Presse (middle) and AP Photo / Dave Martin (right).

AI branches


Deep learning
Unsupervised
Supervised
Machine learning
Text generation
Question answering
Context extraction
Classification
Machine translation
Natural language processing
Expert systems
Artificial intelligence
Speech to text
Text to speech
Speech
Image recognition
Machine vision
Vision
Planning
Robotics