Artificial Intelligence – state of affairs and perspective

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AI – where are we now?

Programmable → Adaptive

Guided → Autonomous

194? 2020 20??

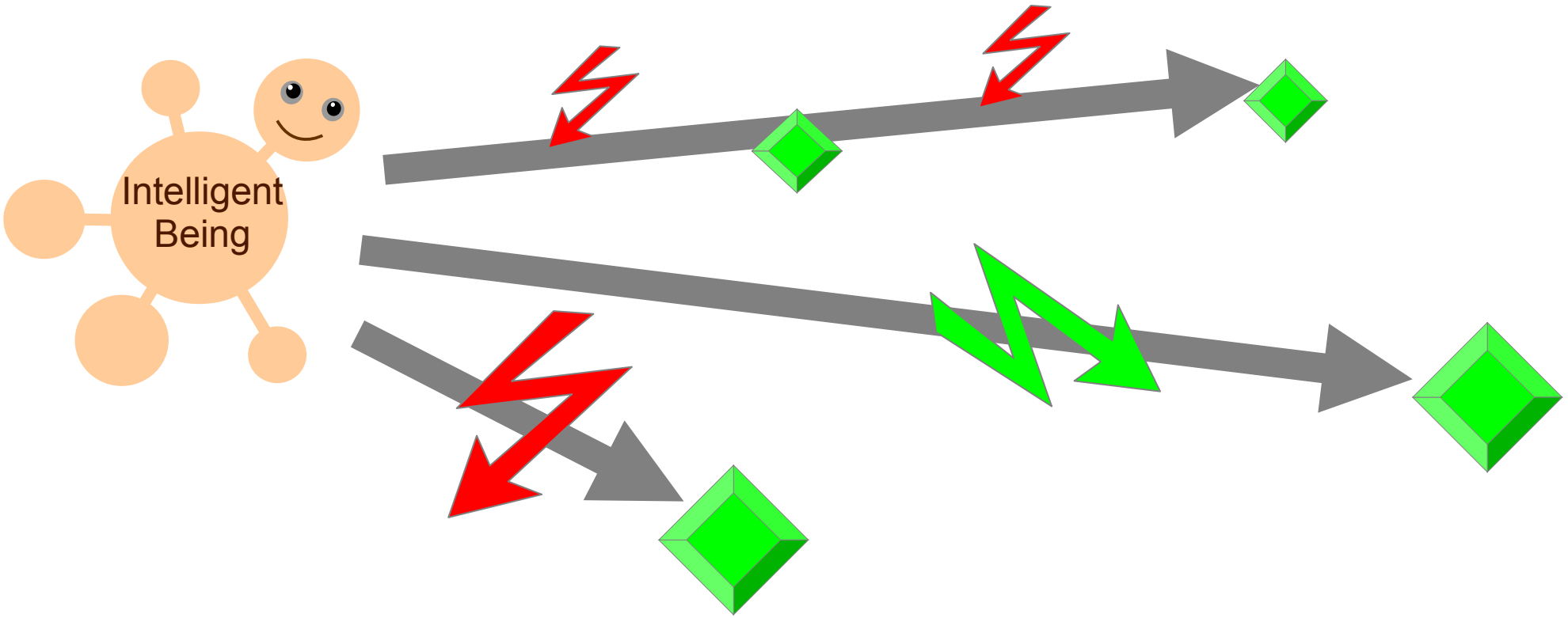
Weak → Strong

Big Data, Machine Learning, Experimental Statistics → Human-level AI (HLAI) → Super-human AI

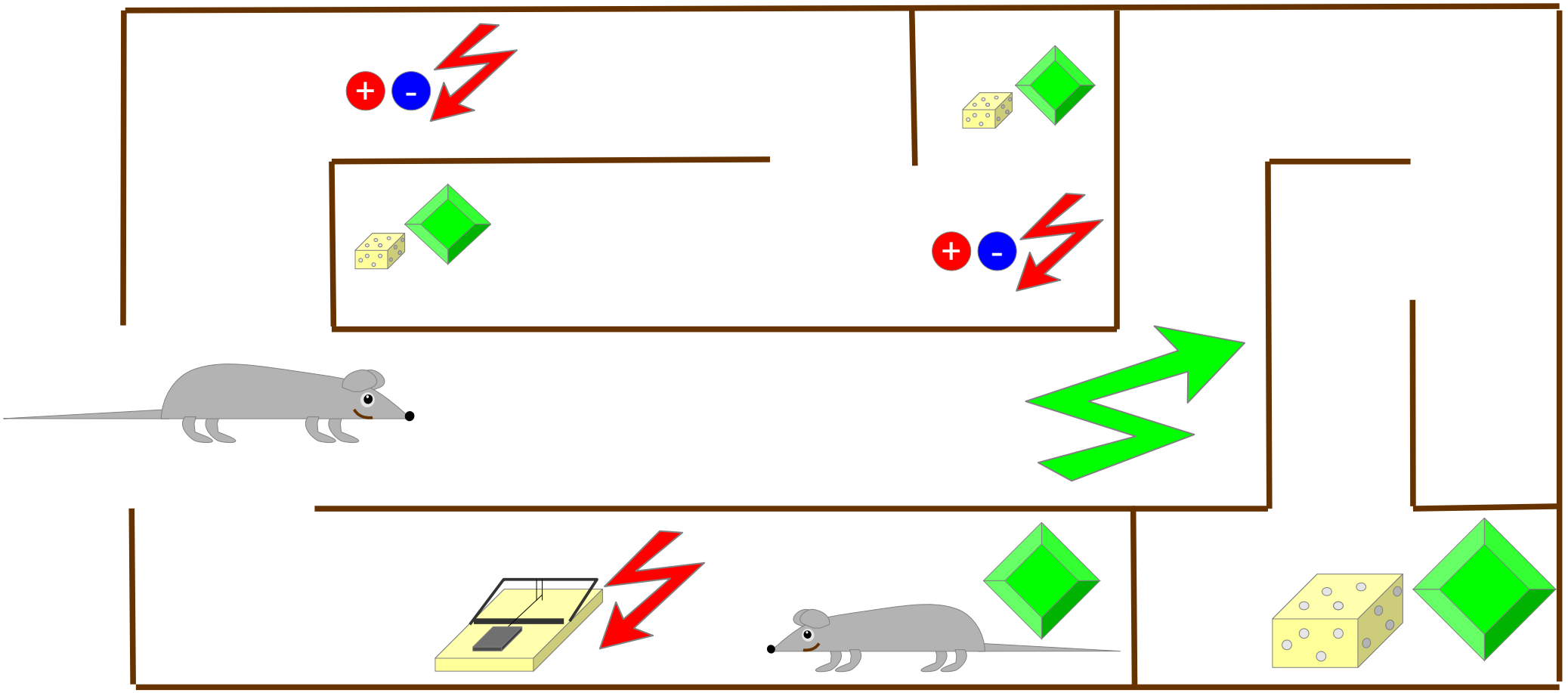
Narrow Artificial Intelligence (AI) → Artificial General Intelligence (AGI)

General Intelligence:
Reaching complex goals in different complex environments, using limited resources and minimizing risks

(Ben Goertzel + Pei Wang + Shane Legg + Marcus Hutter)



Biological Intelligence: Reaching food and parents for self-reproduction in natural environments using limited physical resources and minimizing existential risks



Personal Internet Assistant - Aigents®

Reaching information in online environments using limited CPU and RAM resources, minimizing risk of being banned

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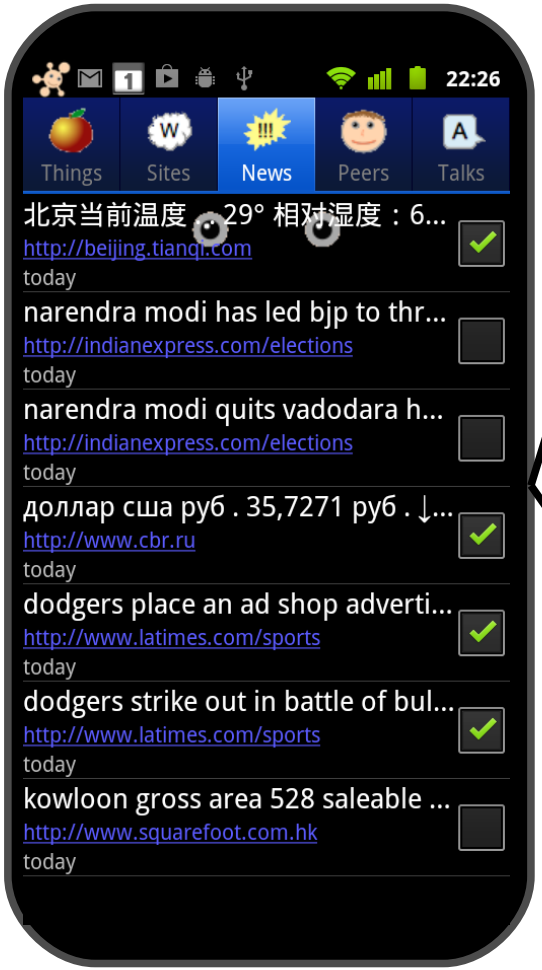
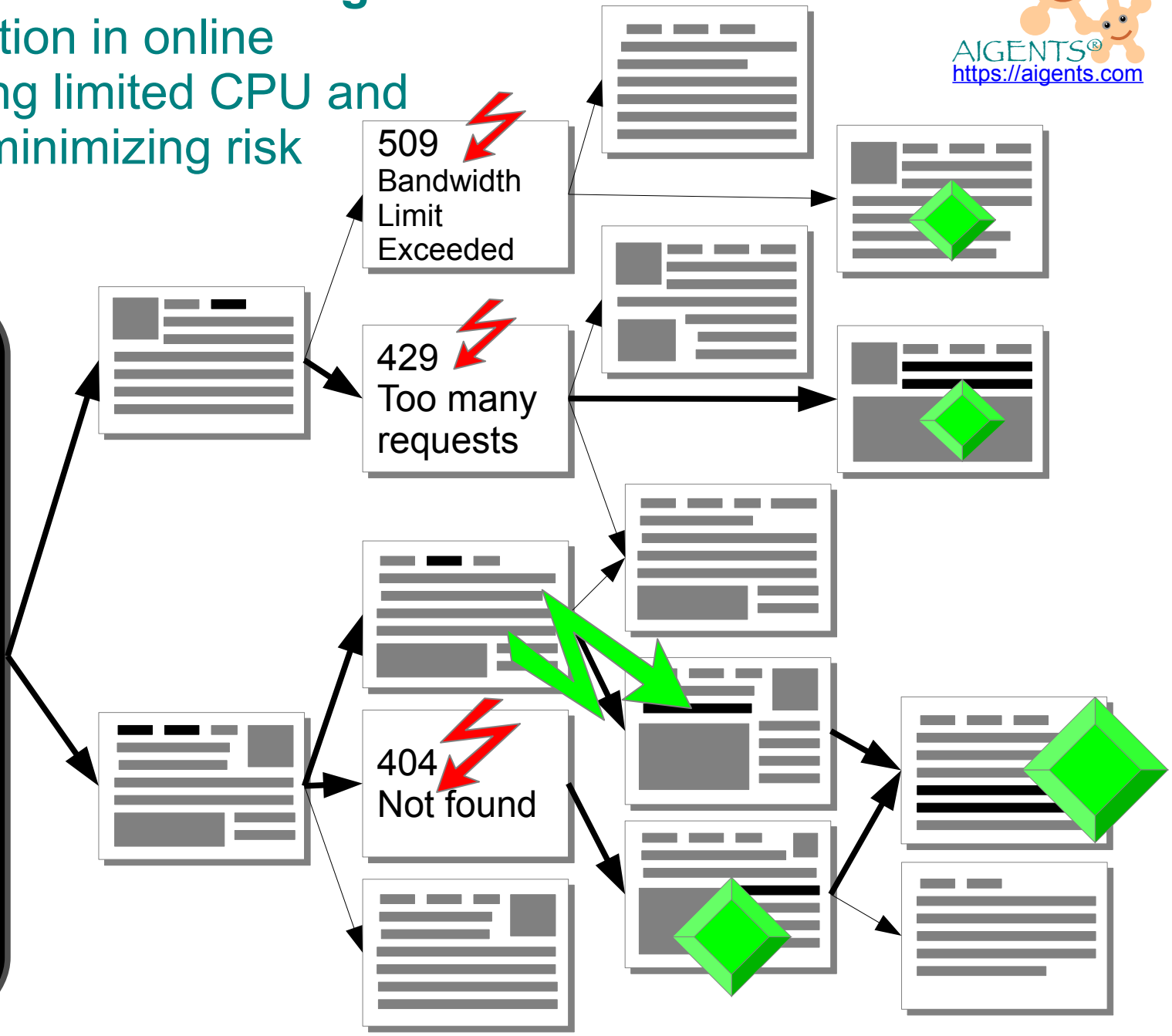




What does come next?

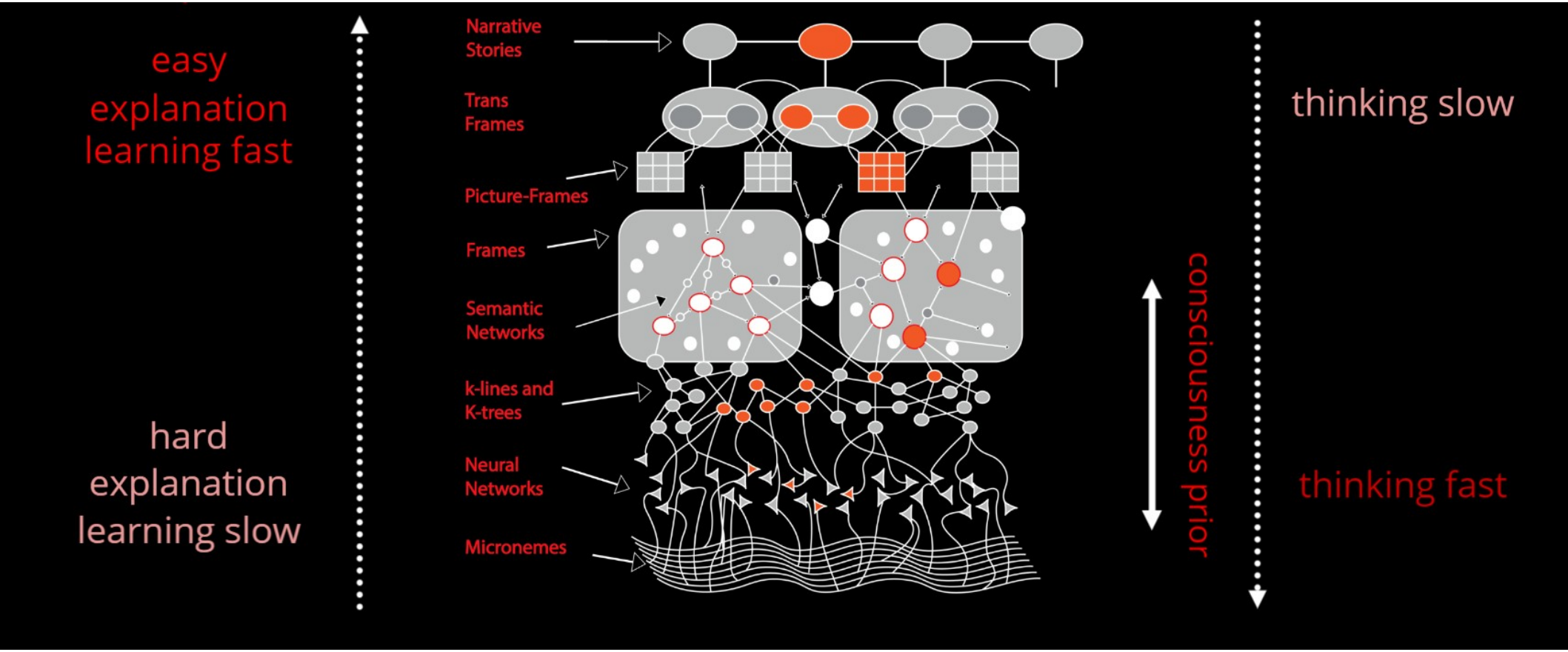
- Either - new “AI winter”, or – new breakthrough towards “technological singularity”?
- AGI will appear in large companies which own really big data to train it and great capabilities to attract talents to create it?
- Expected time of AGI arrival based on expert opinions – closest: 3-5 years, median: 80 years.
- What is important for AGI:
  - Work definition, “different environments”, “risk mitigation” (complex goals and environments and minimizing consumption of resources);
  - “Definition of done” in terms of “Baby Turing Test” - including not criteria of passing the test oly, but ability to learn approaching the criteria satisfaction following the “learning curve” incrementally.

Current AI/AGI frontiers

- Neuro-Symbolic integration
- Explainable/Interpretable AI
- Transfer learning
- One shot (few-shot) learning
- Strong generalization
- Generative models
- Structured prediction and learning
- Fighting catastrophic forgetting (and catastrophic remembering)
- Incremental learning and life-long learning
- Multi-modal learning
- New “Turing Test” (e.g., “Baby Turing Test”)
- Solving the “consciousness” problem

Hybrid Neuro-Symbolic Cognitive Architectures

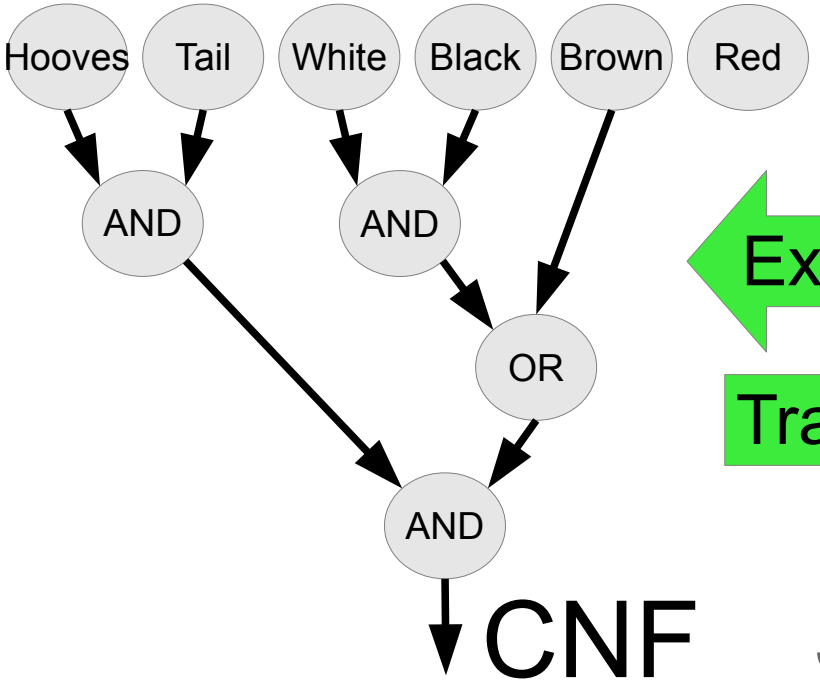
Society of Mind – Marvin Minsky
Thinking, Fast and Slow – Daniel Kahneman



https://towardsdatascience.com/explainable-ai-vs-explaining-ai-part-1-d39ea5053347

Bridging the Symbolic-Subsymbolic gap
for “explainable AI” and “transfer learning”

Labeled graph

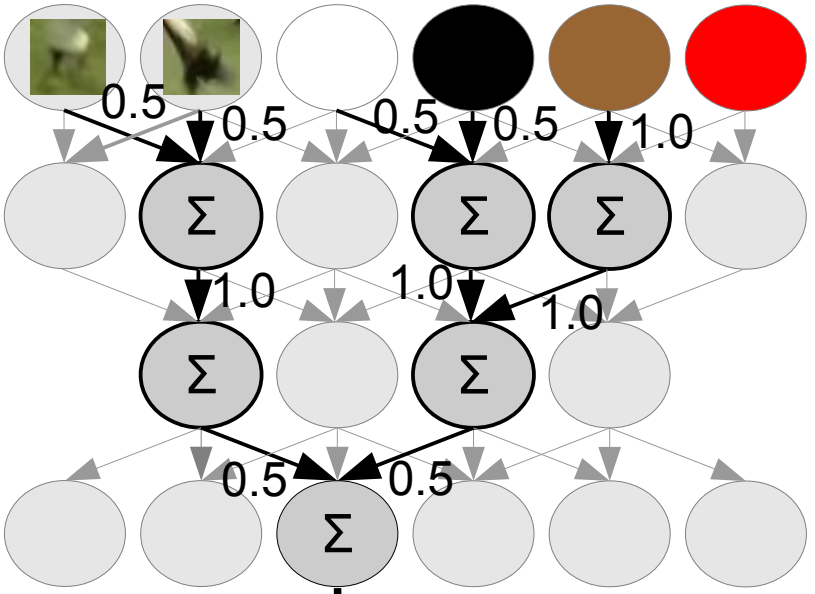


CNF

Explain

Transfer

Unlabeled graph



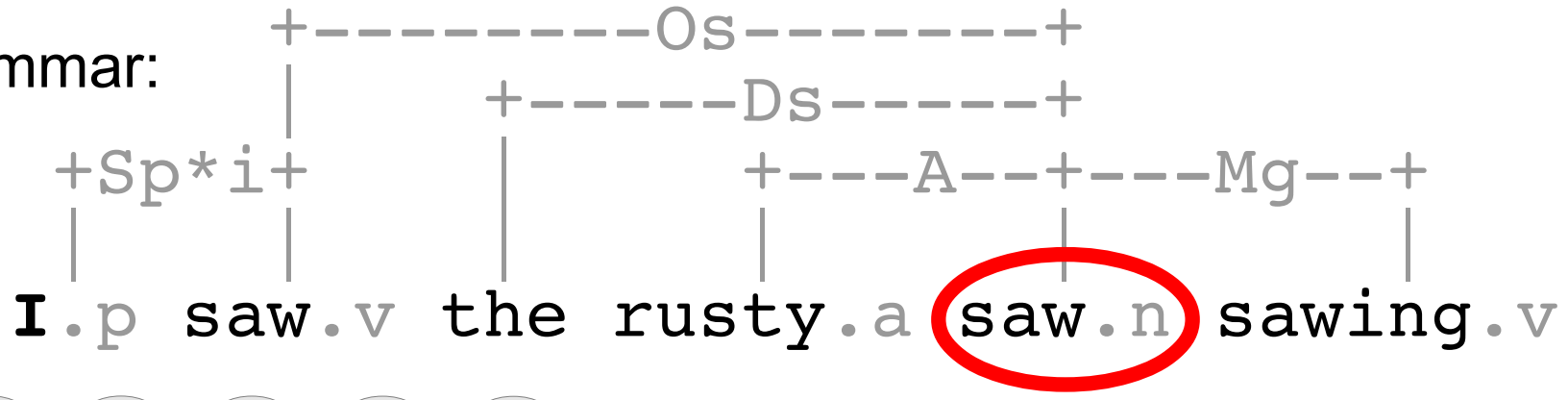
Soft-CNF

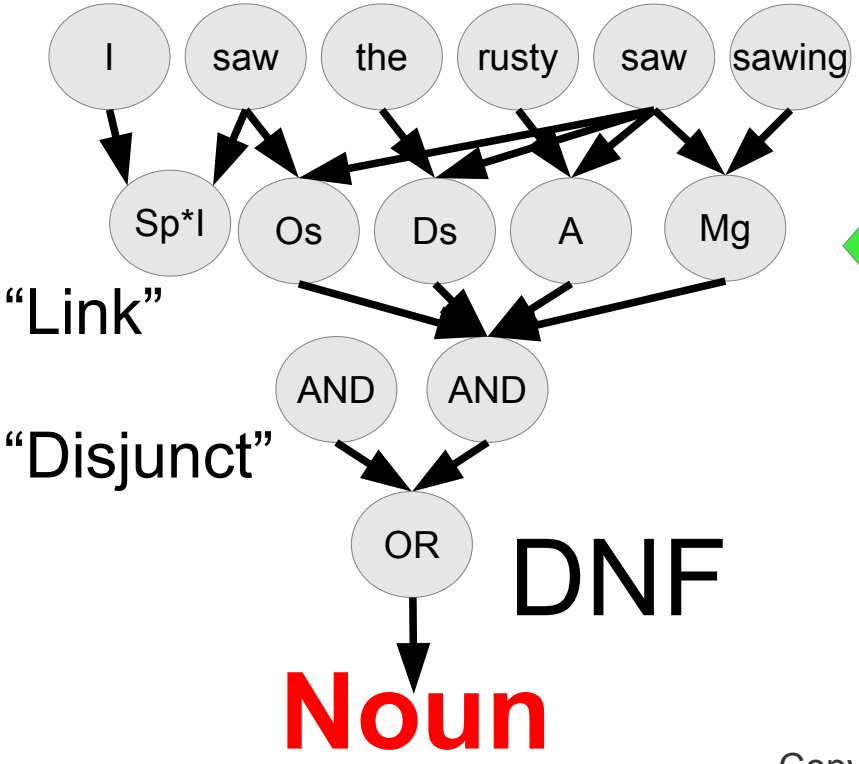
(Hooves AND Tail) AND
((White and Black) OR Brown)

=> Horse

Bridging the Symbolic-Subsymbolic gap in NLP between distributed representations and formal grammars with ontologies

Link Grammar:



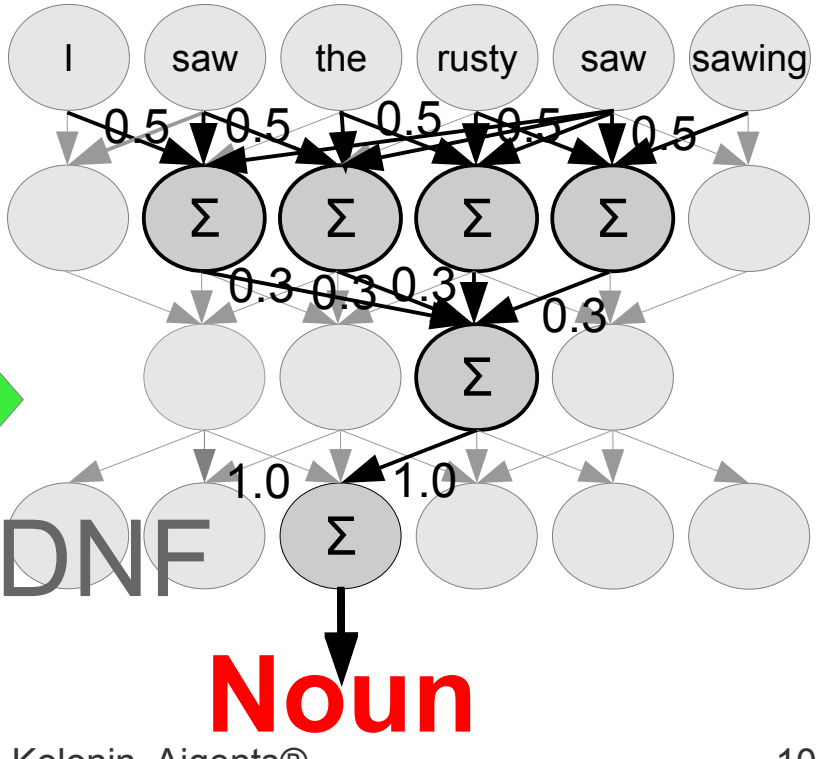


DNF

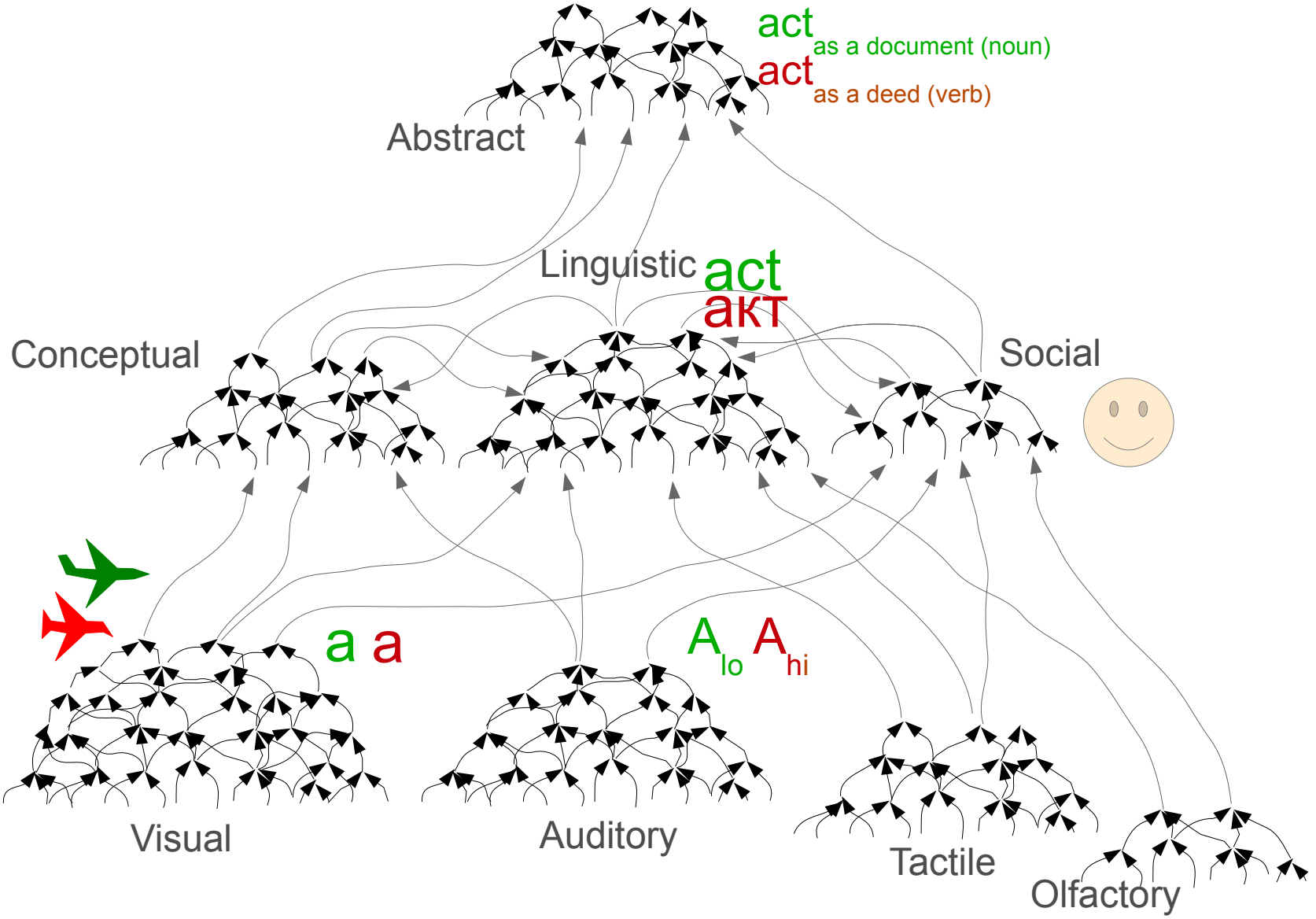
Explain

Transfer

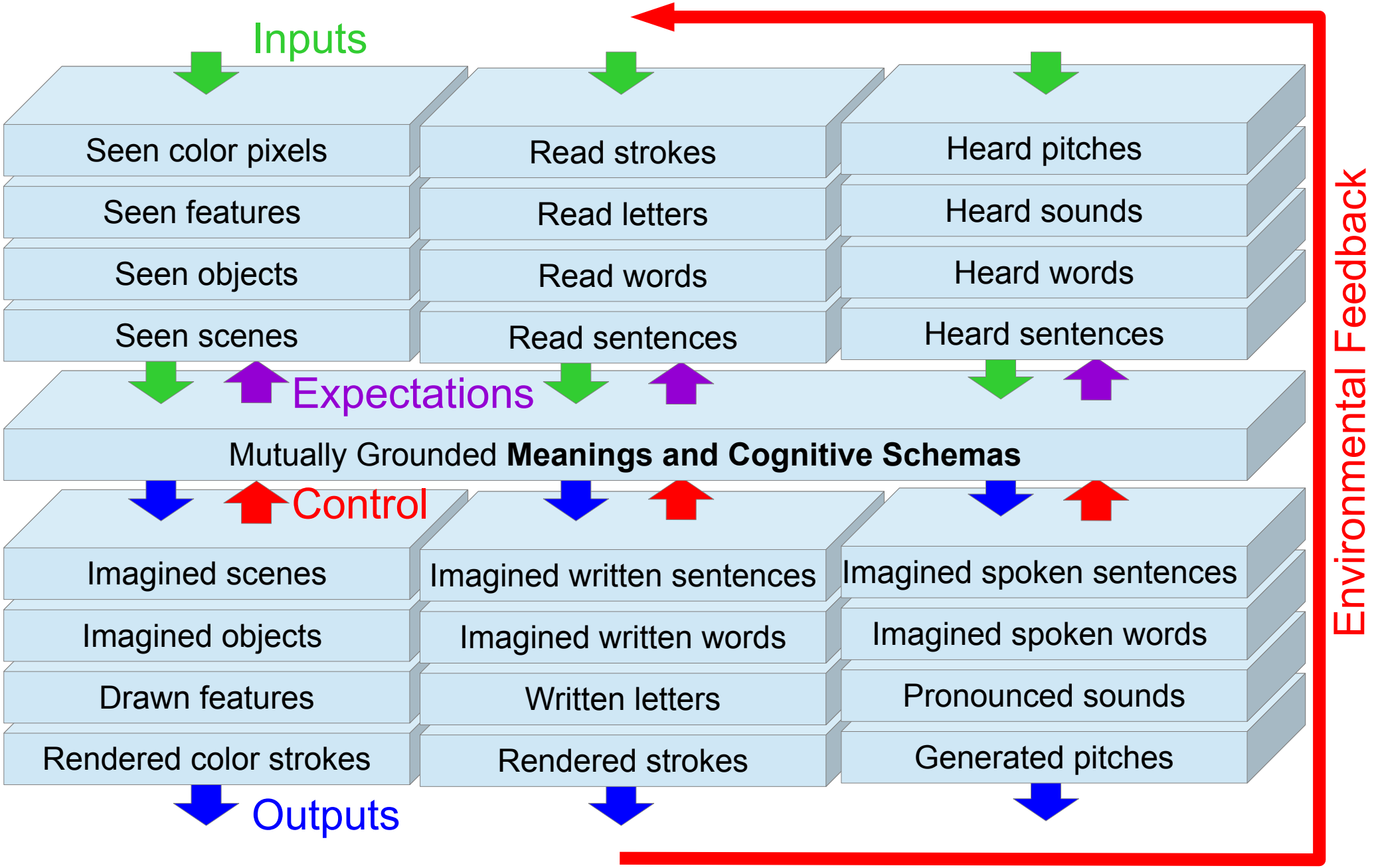
Soft-DNF



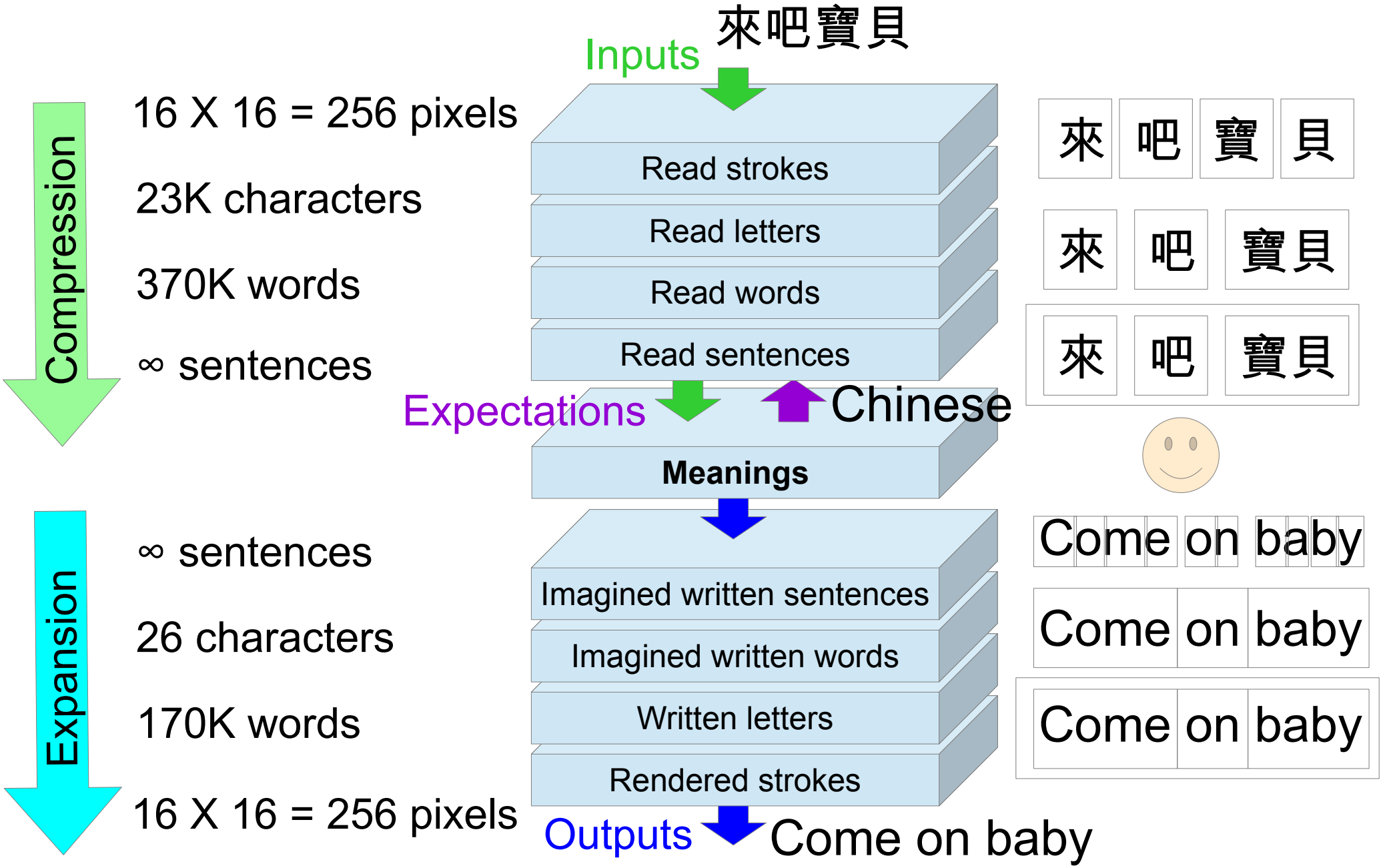
Physiological Plausibility – different segments of cortex responsible for different level of abstractions



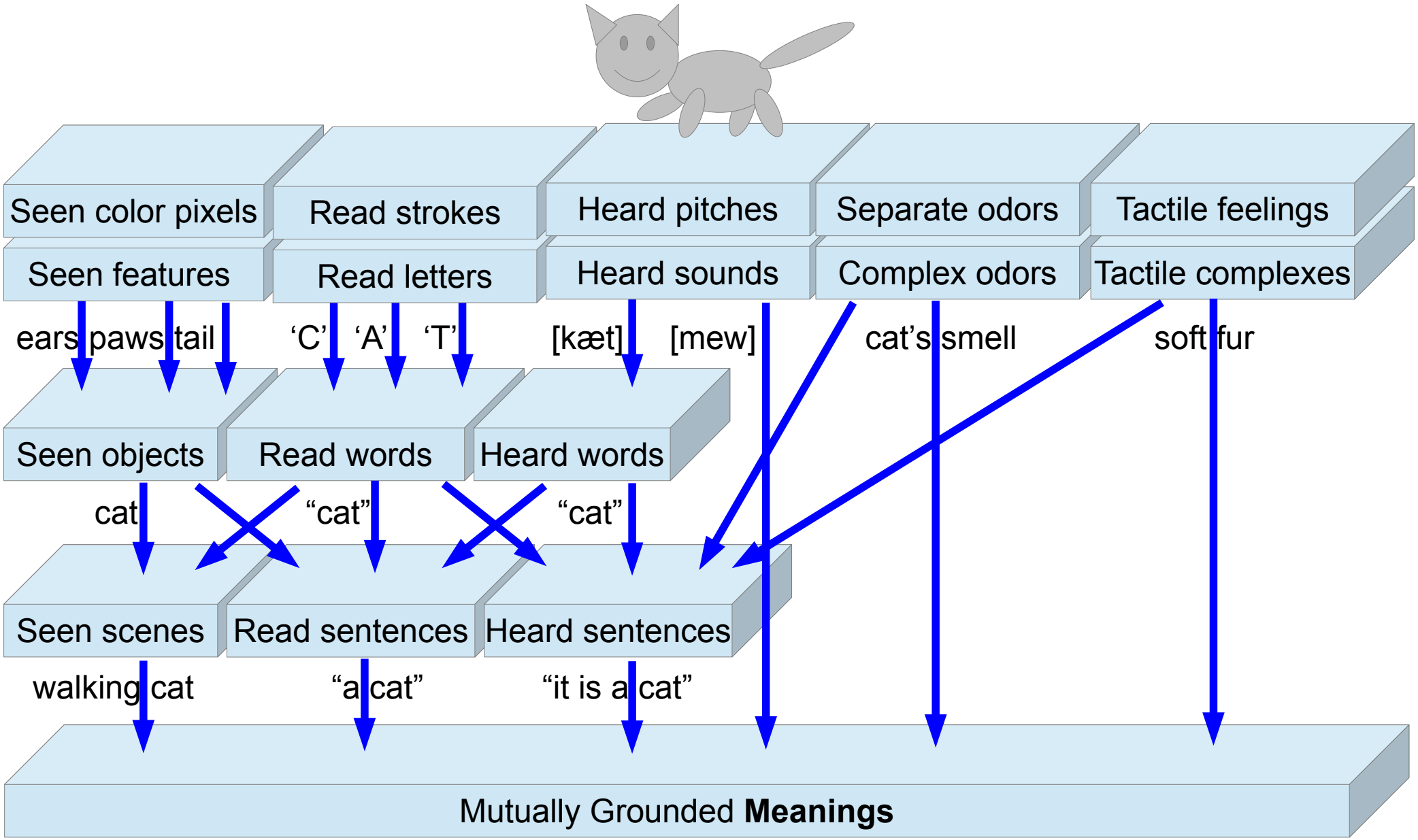
Multi-modal perception and action



Multi-layer transformation of complexity



Multi-modal perception + mutual grounding



This walking cat is mewing!

Explainable AI (XAI) vs. Interpretable AI

XAI model output explanation techniques

- "Dual" systems (like DNN + CBR)
- Transformation to "soft" CNF/DNF rules (softmax, arg max)
- XAI LIME
- XAI SHAP
- Life-long & Incremental Learning
  - (compression/forgetting–extraction–injection–extension)

Interpretable model representations

- Deep Bayes
- Deep Random Forest
- Soft Decision Trees
- Probabilistic/Fuzzy Logic
  - OpenCog/PLN
  - NARS
  - "Discovery"
- Formal Concept Analysis (FCA)

New (and forgotten old) approaches

Convergence

- Joining neural networks into cognitive architectures
  - Complex DNN Architectures
    - Attention-allocation networks
      - Contextual question answering and sentiment analysis
    - 3D CNN for spatiotemporal predictions
- Hybridization of neural networks with probabilistic programming
- Integration of neural networks with semantic networks (“knowledge graphs”)

AGI

- Narrow AGI (Ben Goertzel, SingulariytNET)
- Probabilistic programming
  - It is in the state of “neural networks” 20 years ago and may turn revolutionary
    - in just few years (Alexey Potapov, SingulariytNET)
- Agent Models
  - AIXI – universal compressor and predictor (Marcus Hutter, Arthur Franz)
  - Anokhin’s Theory of Functional Systems (TFS) extension (Evgenii Vityaev)
  - Reinforcement Learning based on "fluents" (state variables or atoms representing the states)
- Ecosystem approach
  - No one knows how to make AGI (so "let all colors bloom")
  - Brain on itself is not the same (different brain regions have totally different “architectures”)

New (and forgotten old) approaches

Deep Learning for AGI

Demis Hassabis: "transfer learning is a key ... to general intelligence"
Yan Lecun: "learn models of the world"
Cognitive Pyramid:
- Casuality
  - Reinforcement-learning
    - Transfer-learning
  - Meta-learning (Learning to Learn)
    - DL
    - GANs
    - ML
    - ...

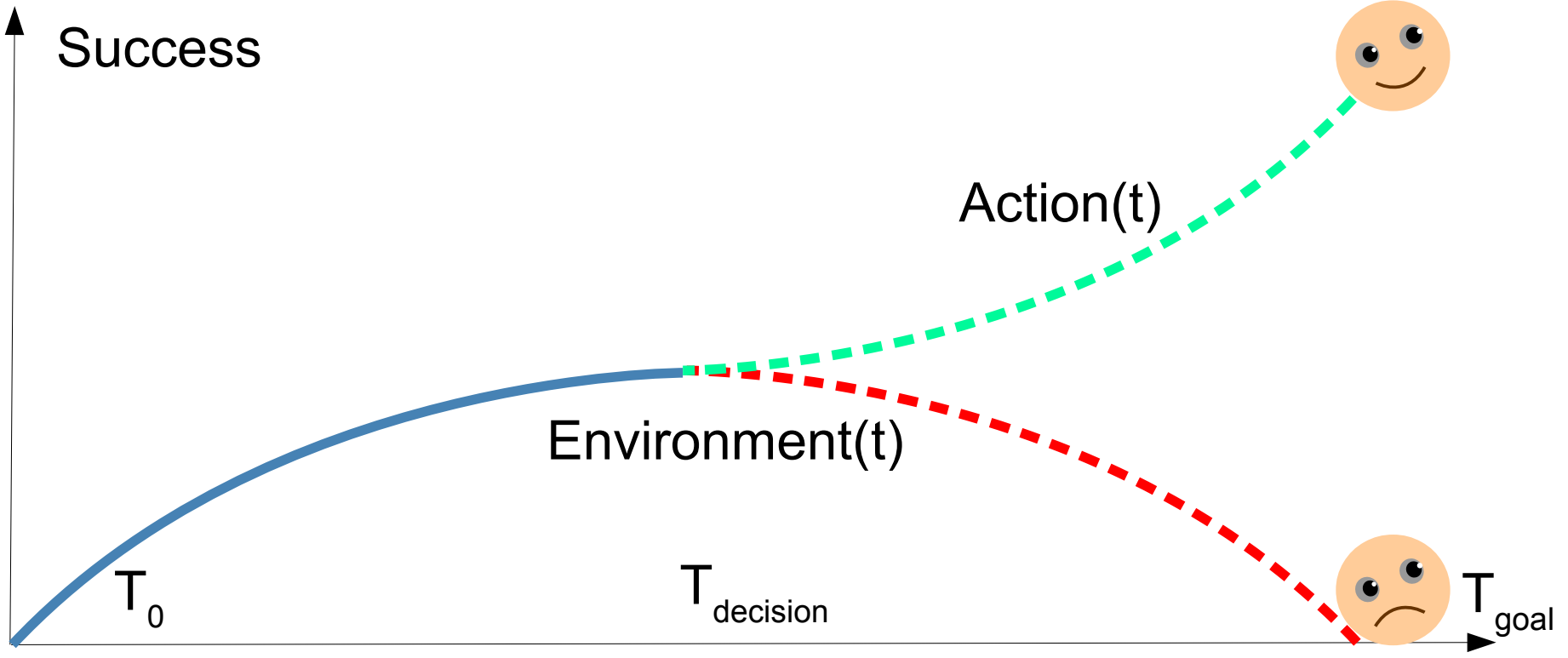
World<->ControlNetwork<->ModelNetwork *("Learn how to Learn")*

A lot to study, still

Dedrites/synapses branching
Holobionts - synergetically interacting societies
(matching studies by Jeff Hawkins,
who suggested the HTMs, preceding the DNNs)
Neuron Microtubules

Consciousness:

Ability to build models of the environment based on the past to predict the future scenarios and act “consciously” towards the desired ones



Acting consciously:
Agent being able to direct the sequence of behavioral acts (at least) to itself by any (internal or external) **language** (ontology/lexicon/grammar)

Push legs,
pull right hand

push(right_leg);
push(left_leg);
pull(right_hand).

Push left leg,
pull both hands

push(left_leg);
pull(right_hand);
pull(left_hand).

Pull left hand,
look right.

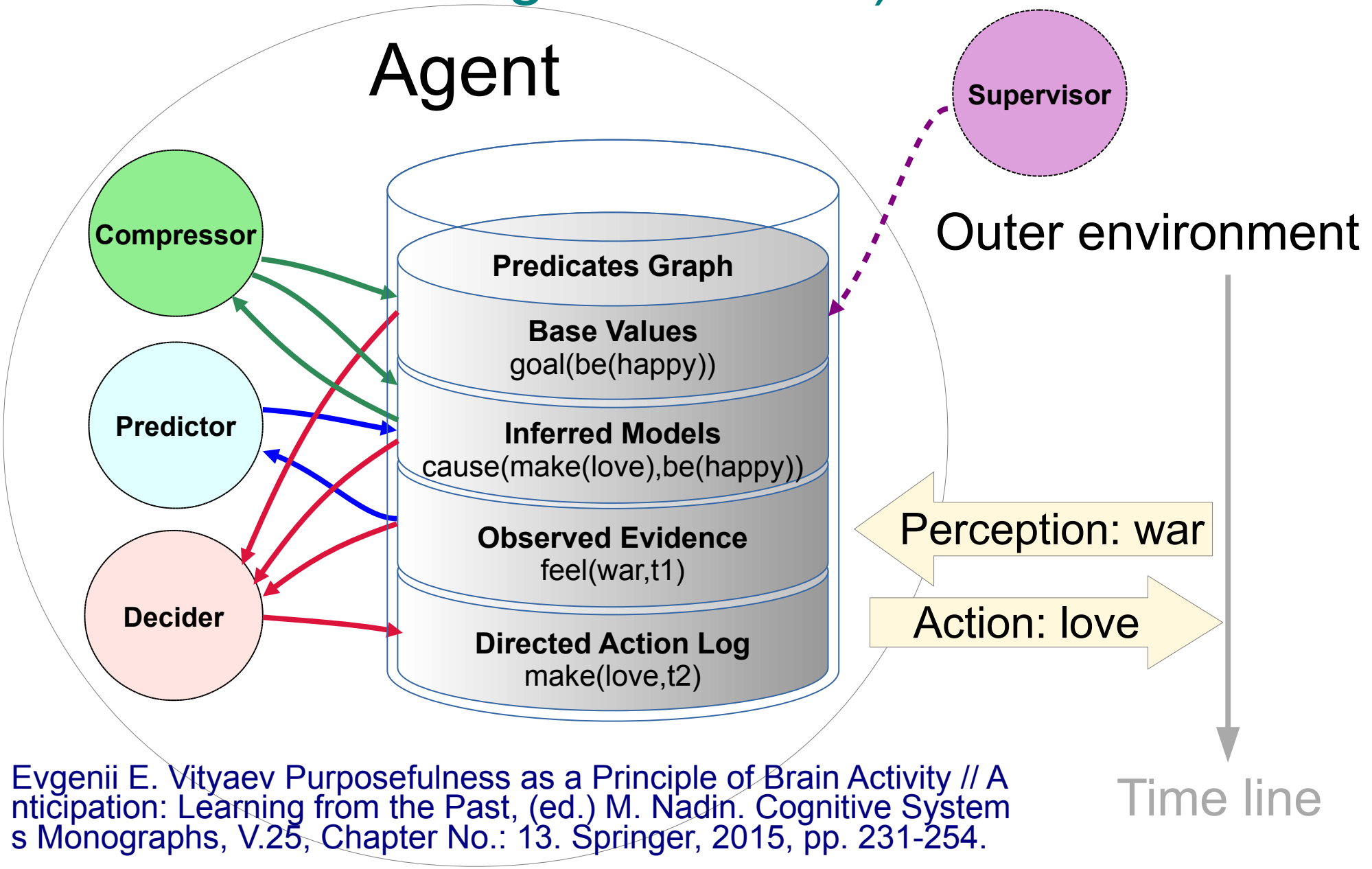
look(right);
pull(left_hand).

Pull right hand,
bend both legs.

pull(right_hand);
bend(right_leg);
bend(left_leg).

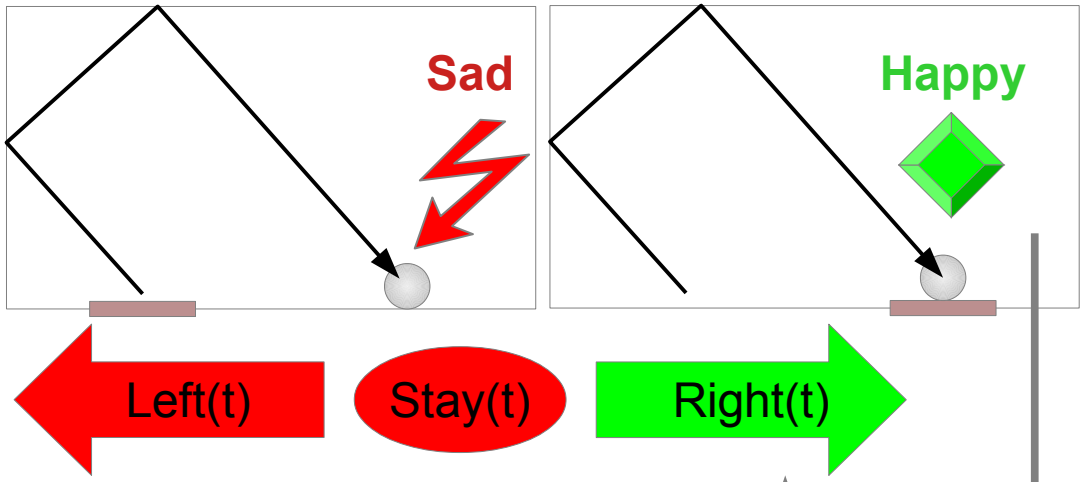
https://www.youtube.com/watch?v=oYWjqTP0AKM

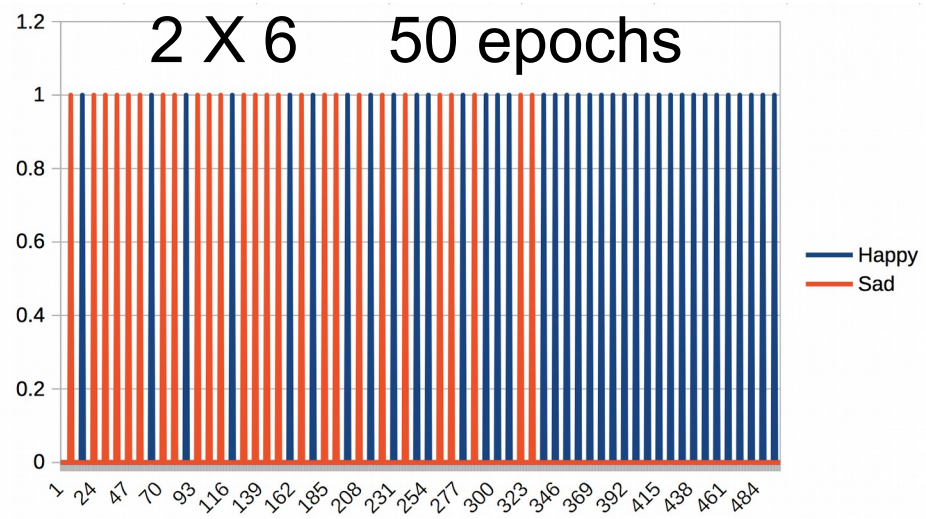
AGI Agent Cognitive Architecture (and AGI-unit testing framework) based on TFS

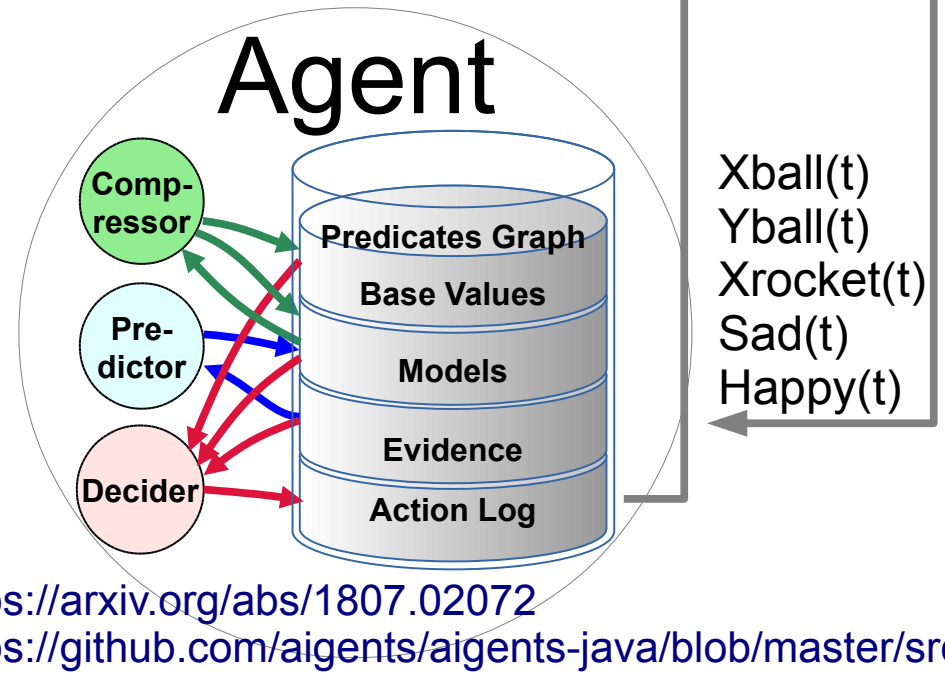


Evgenii E. Vityaev Purposefulness as a Principle of Brain Activity // Anticipation: Learning from the Past, (ed.) M. Nadin. Cognitive Systems Monographs, V.25, Chapter No.: 13. Springer, 2015, pp. 231-254.

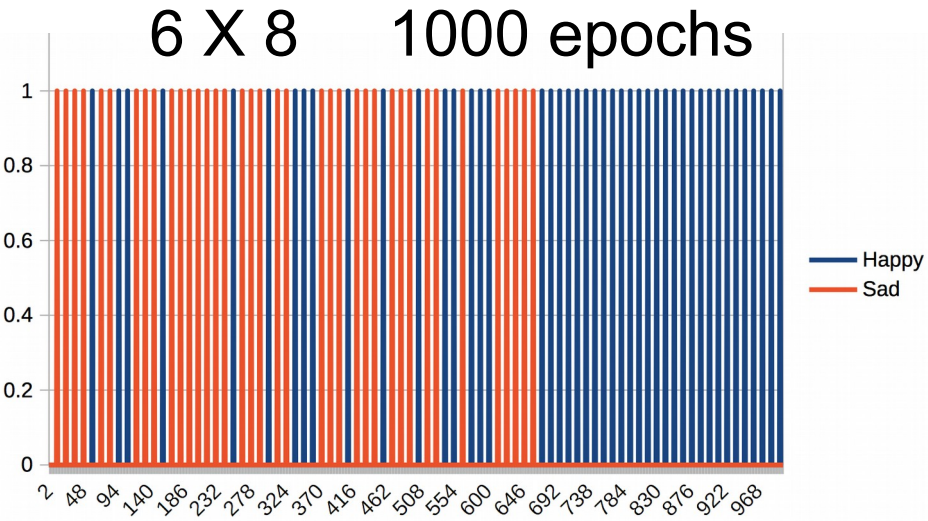
AGI Agent Cognitive Architecture
learning simplified “Atari Breakdown” game







Xball(t)
Yball(t)
Xrocket(t)
Sad(t)
Happy(t)



https://arxiv.org/abs/1807.02072
https://github.com/aigents/aigents-java/blob/master/src/main/java/net/webstructor/util/AgiTester.java

Thank you and welcome!

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