

Computational Concept and Architecture of Artificial Psyche

Anton Kolonin

akolonin@aigents.com

Telegram: akolonin

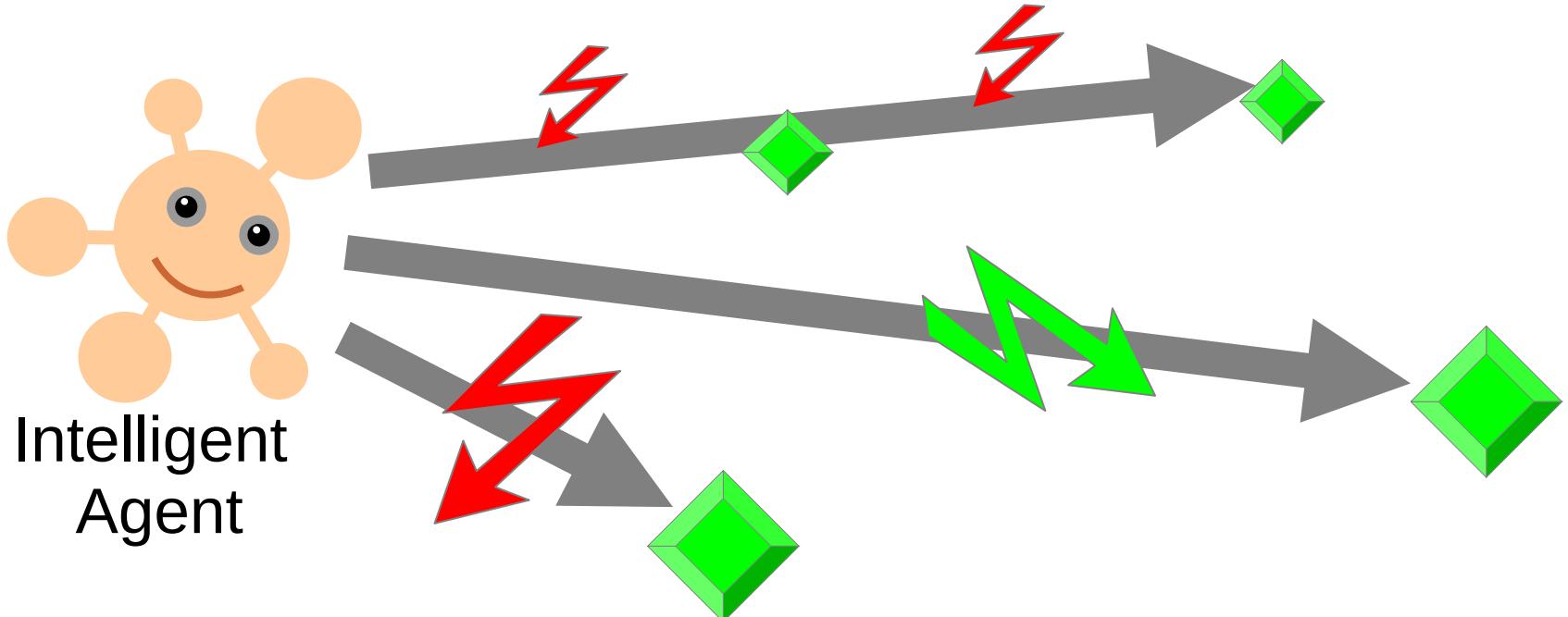


<https://agirussia.org>

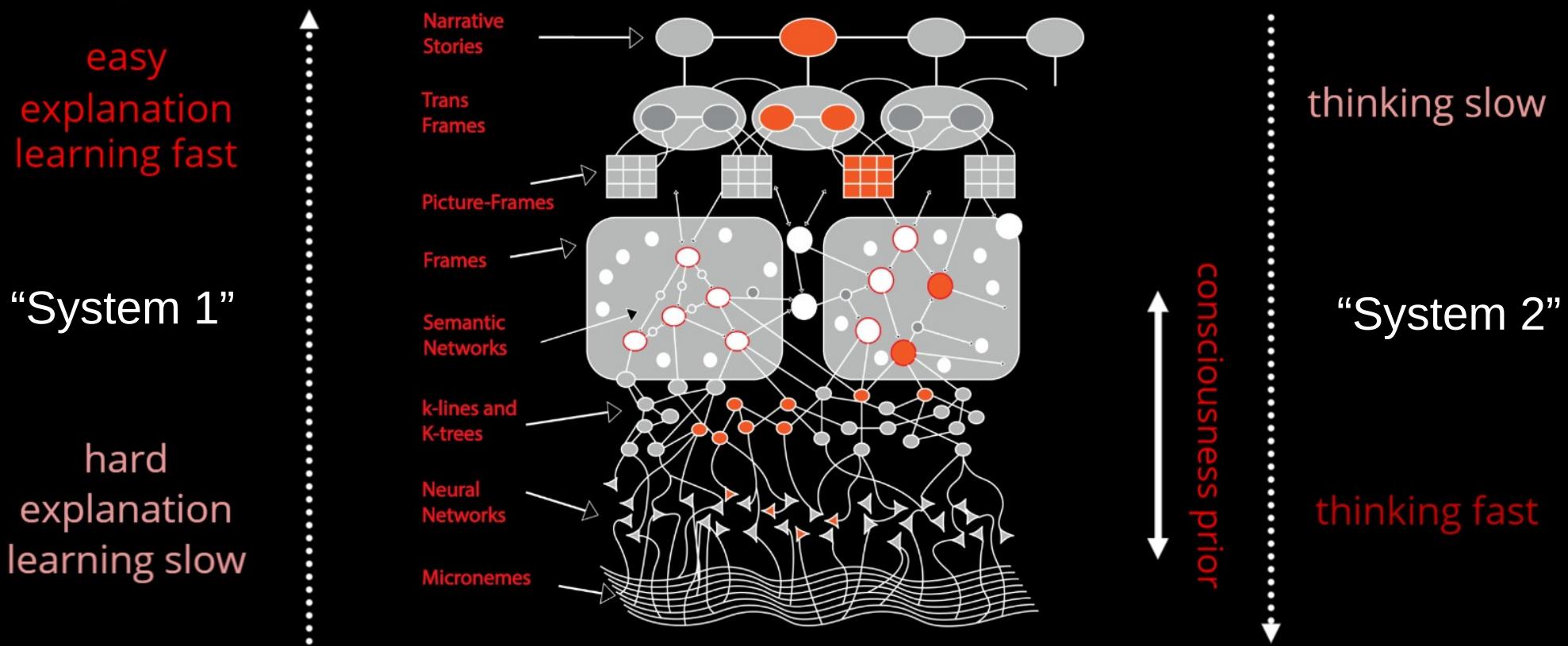
General Intelligence:

Reaching complex goals in different complex environments, using limited resources under uncertainty

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

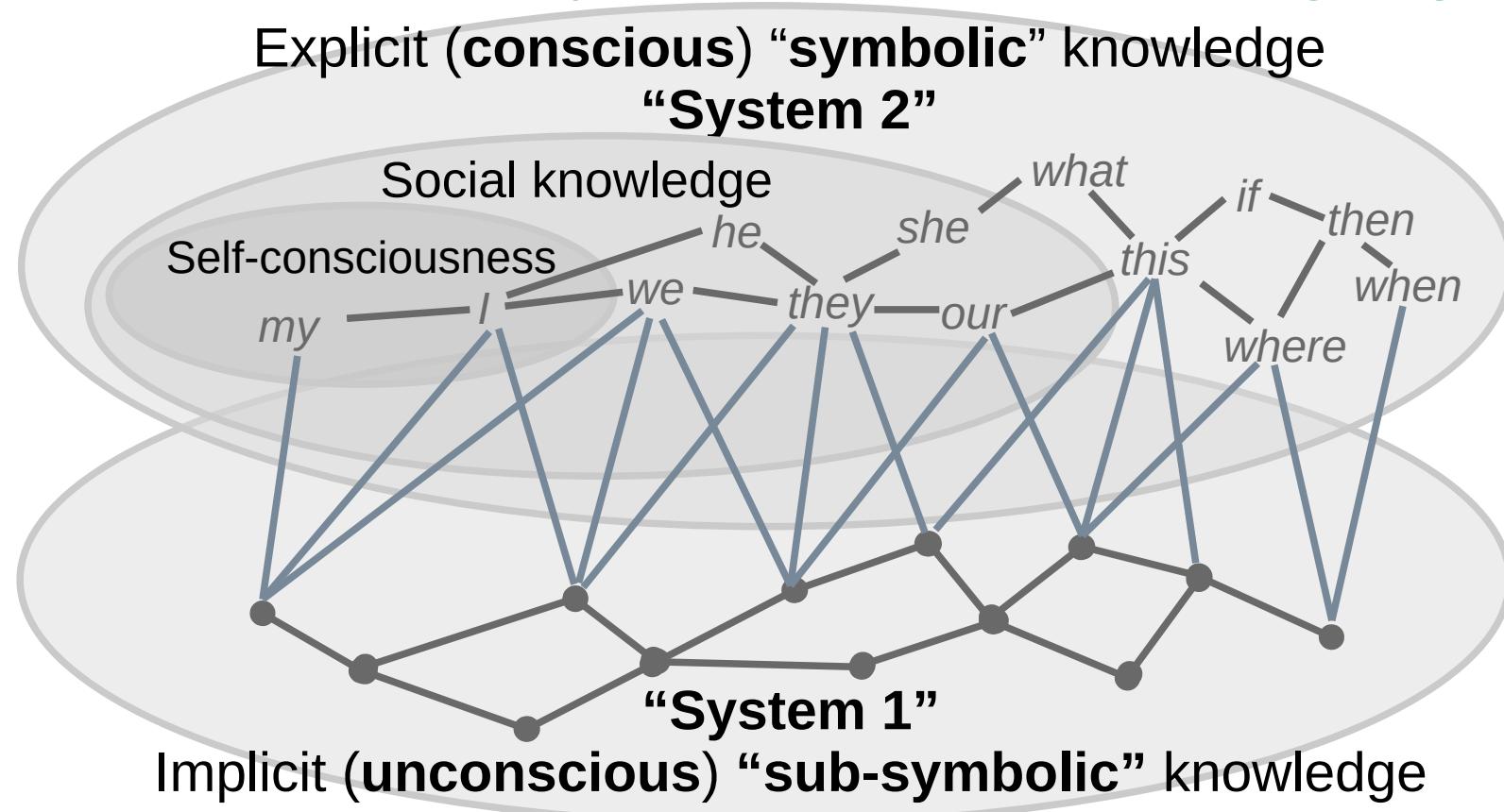


“Fast and Slow Thinking” – Daniel Kahneman



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

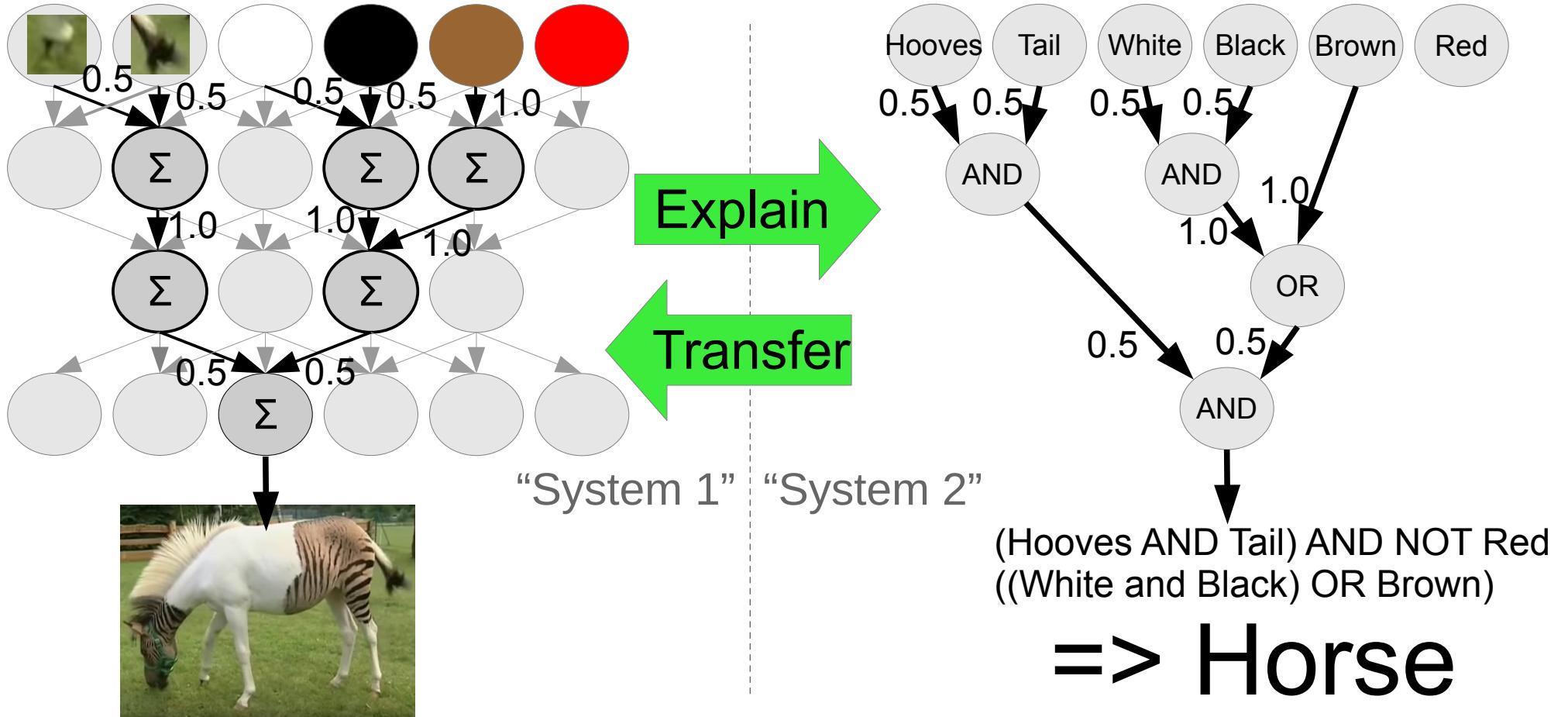
Medium: “neuro-symbolic” “knowledge graph”



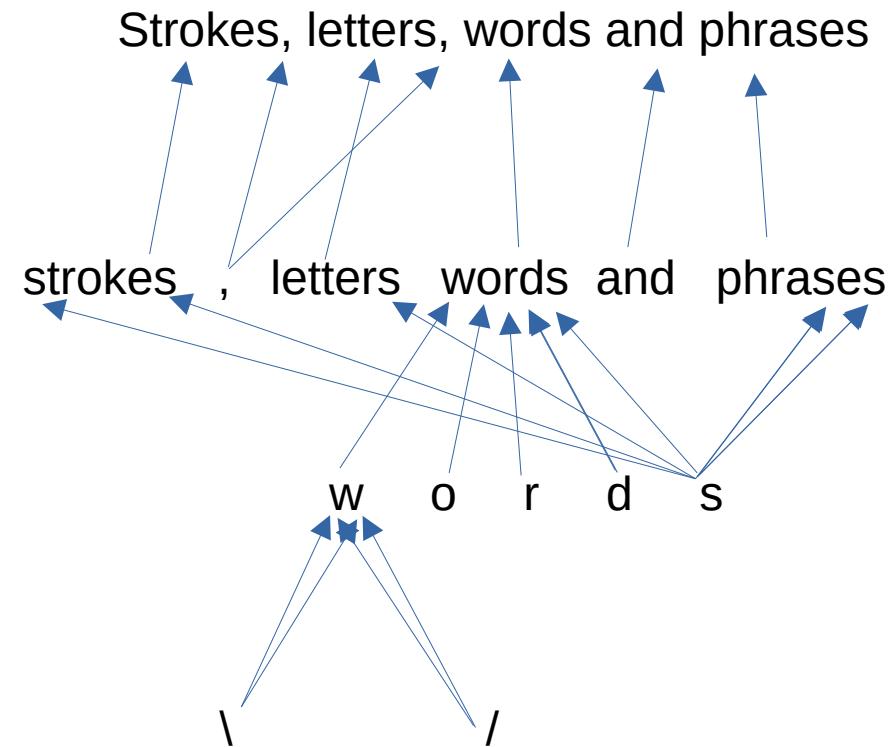
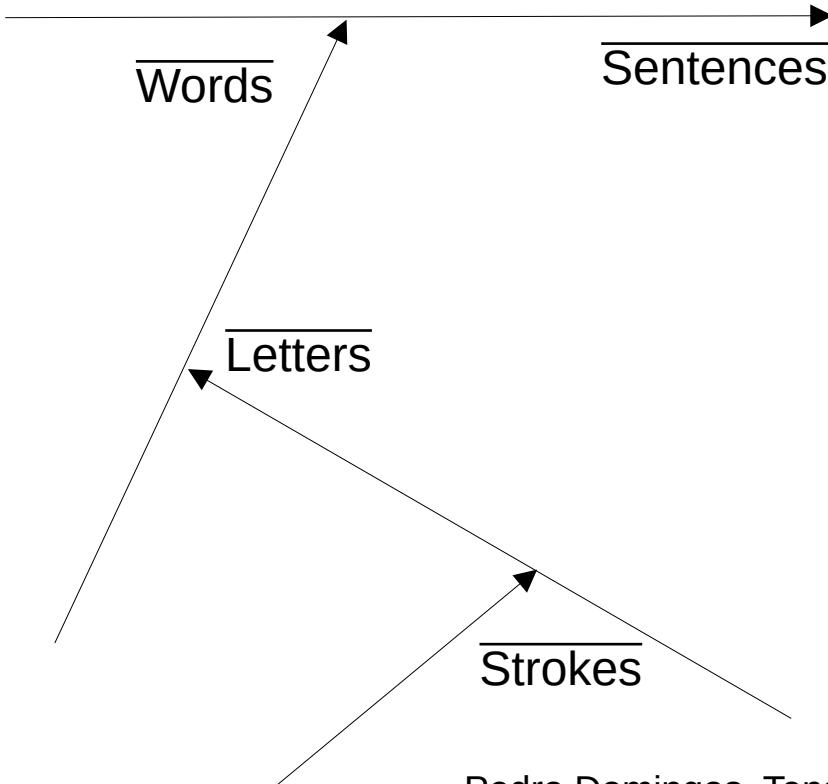
<https://www.amazon.com/Thinking-Fast-Slow-Daniel-Kahneman/dp/0374533555>

<https://amit02093.medium.com/atomspace-hyper-graph-information-retrieval-system-450cab9d751e>

Neuro-Symbolic Integration for Interpretable AI



Functional equivalence of neural network tensor and graph (symbolic) models



Pedro Domingos, Tensor Logic: The Language of AI
<https://arxiv.org/pdf/2510.12269>

Typed tensor logic for different kinds of AI-s (logical, sub-symbolic, probabilistic/non-axiomatic)

Truth-Value Tensor

Property

striped



0.0123456
= 750/60750

horse



Life-long
learning?

Subject

Numerical Tensor

Property

striped



~0.01

horse

Subject

Boolean Tensor

Property

striped



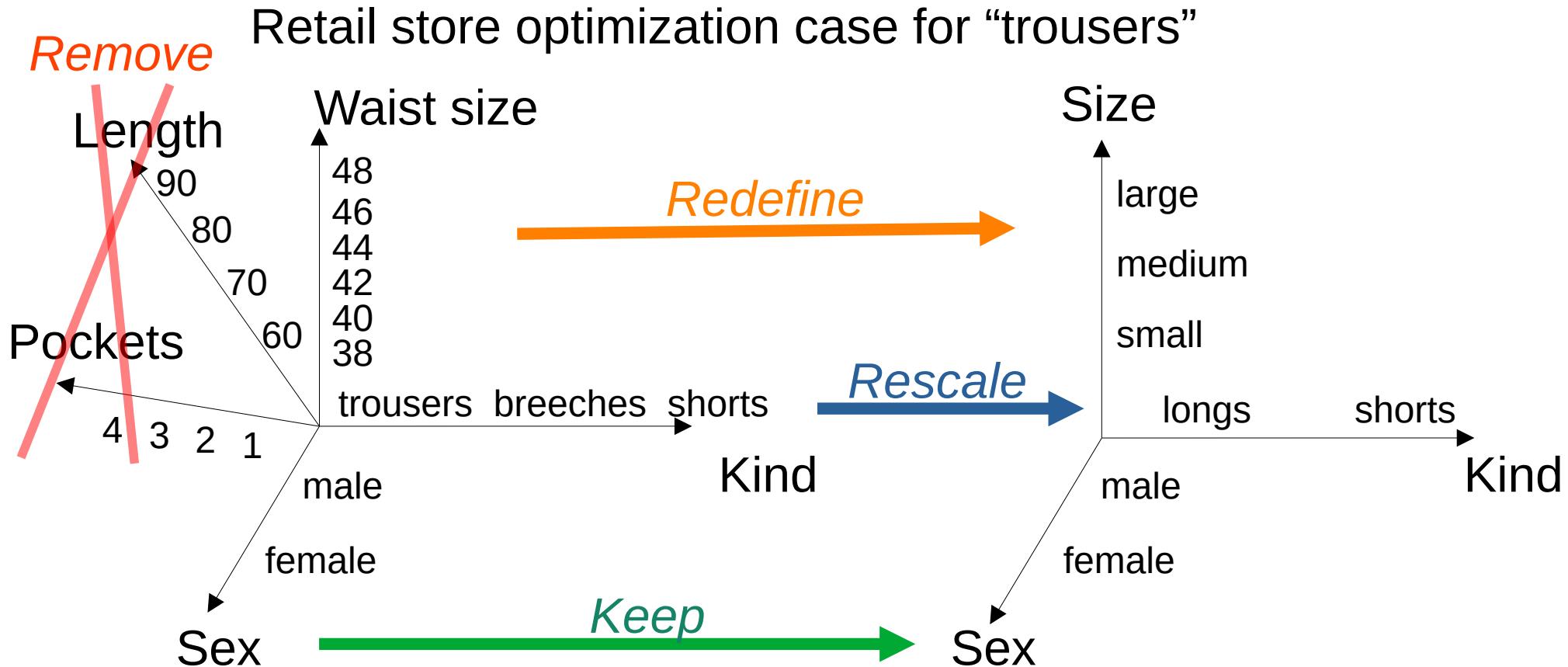
“False”

horse

Subject

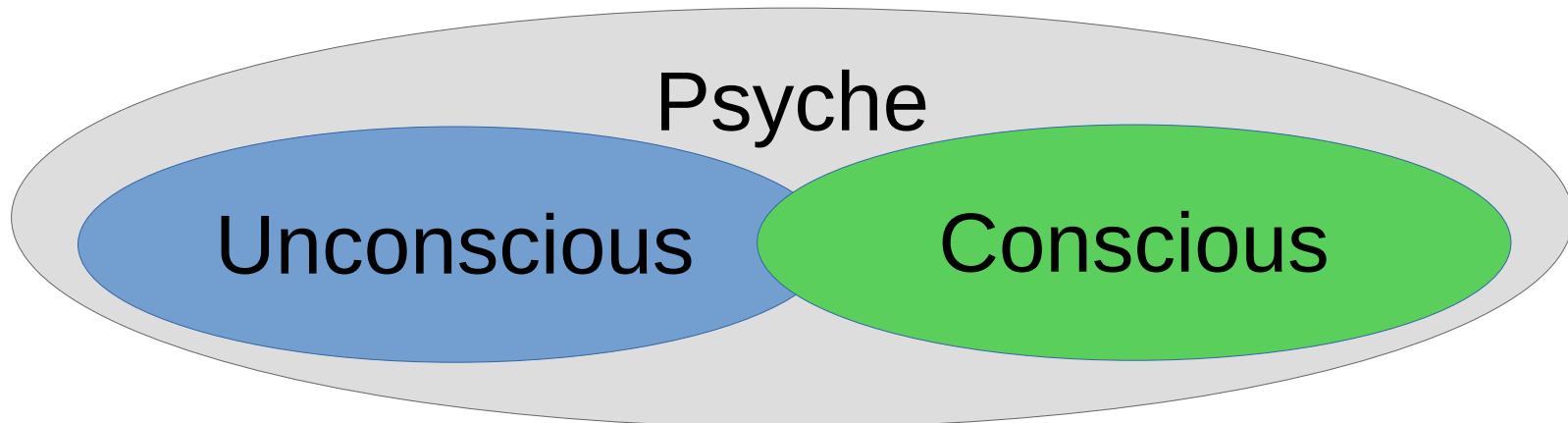
Pedro Domingos, Tensor Logic: The Language of AI
<https://arxiv.org/pdf/2510.12269>

Problem of dimensionality (reduction) and discreteness (increase)



The psyche /'saɪki/ is currently used to describe the totality of the **human mind**, **conscious** and **unconscious**.

<https://en.wikipedia.org/wiki/Psyche>



System = Intelligent agent

Psyche = Operating system

Intelligence = Decision making system

Subconsciousness
(Intuition)
“System 1”
 (“Fast”)

Consciousness
(Reasoning)
“System 2”
 (“Slow”)

Emotions → *Motivation* → *Expectations*

Space of states

Sensations Needs Actions Decisions

Perceptions

Sensors

Actuators

Sensations

Actions

Outer world = Operational environment

Psyche = Operating system

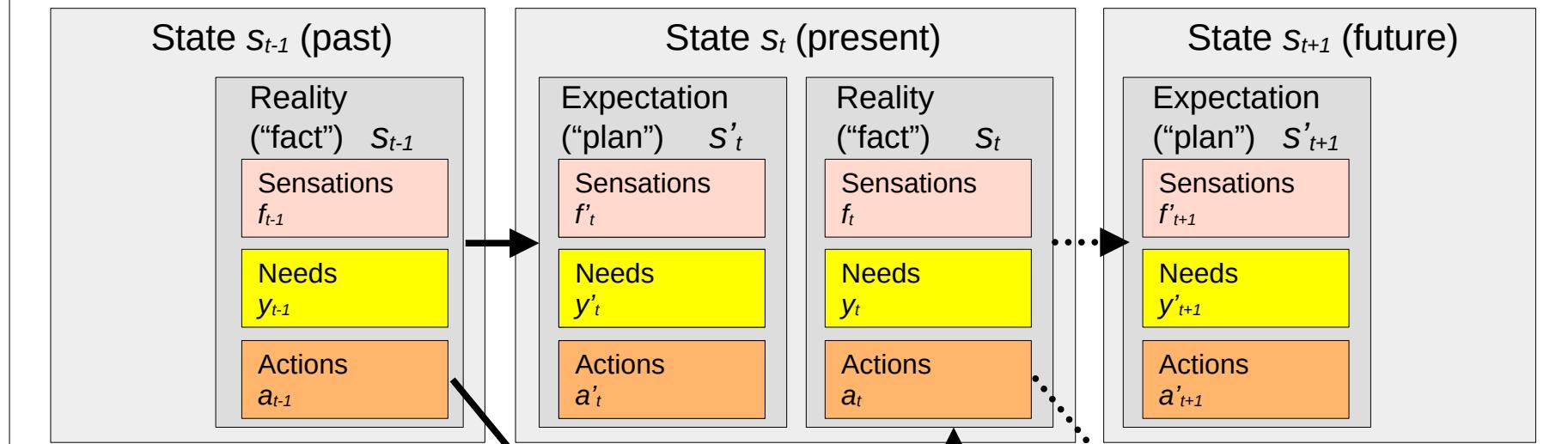
Intelligence = Decision making system

Models s ("invariants") of states with utilities U and probabilities P of transitions
 $U(\{S_T\}_{T \in \{t-T, t-1\}}, S'_0) = L(x \cdot (y_t - y_{t-1}), (s'_t - s_t), E(a_{t-1}))$ $s'_t = \text{argmax}_s(U(\{S_T\}_{T \in \{t-T, t-1\}}, S'_t), P(\{S_T\}_{T \in \{t-T, t-1\}}, S'_t))$

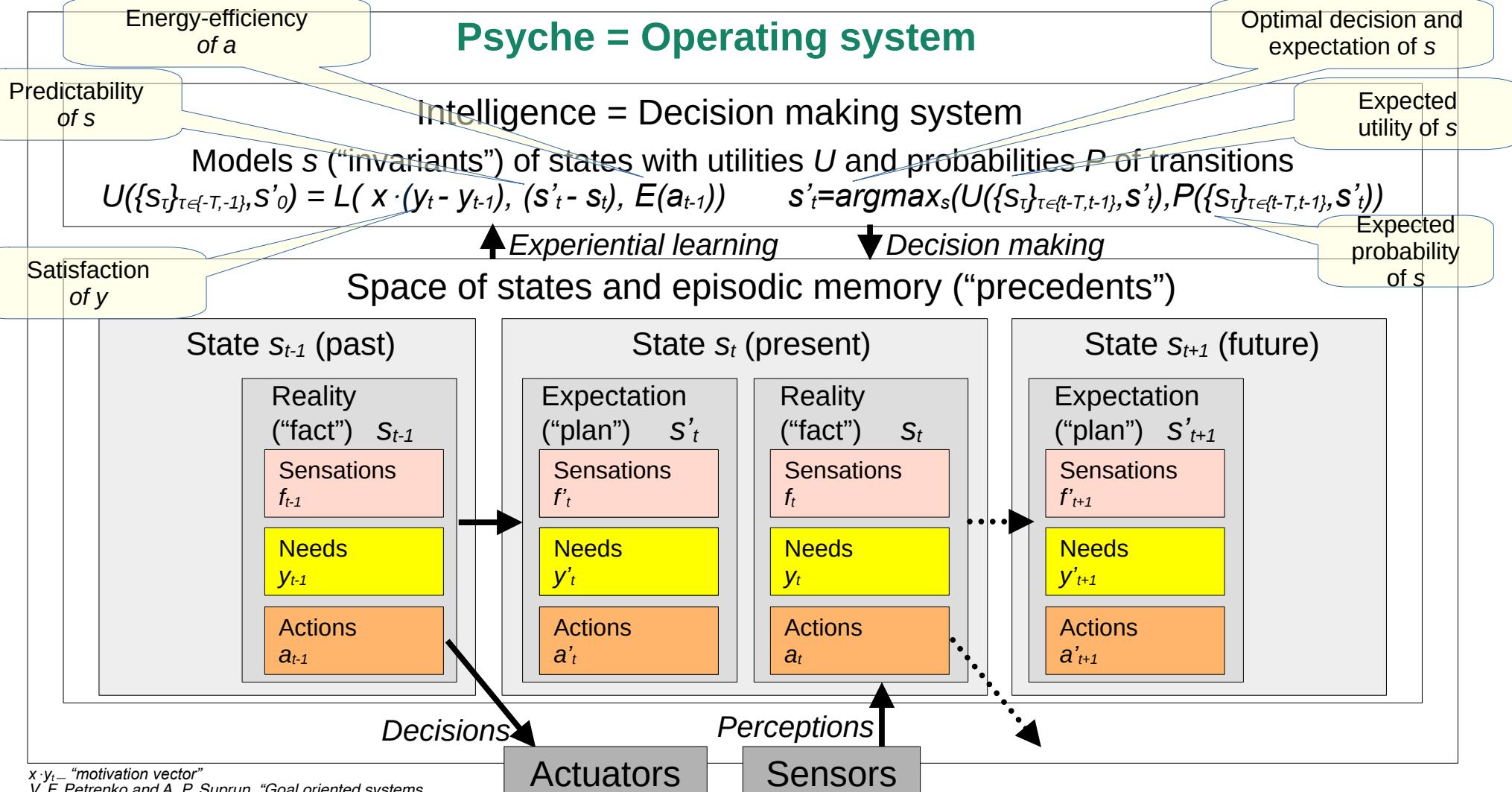
↑Experiential learning

↓Decision making

Space of states and episodic memory ("precedents")



Psyche = Operating system

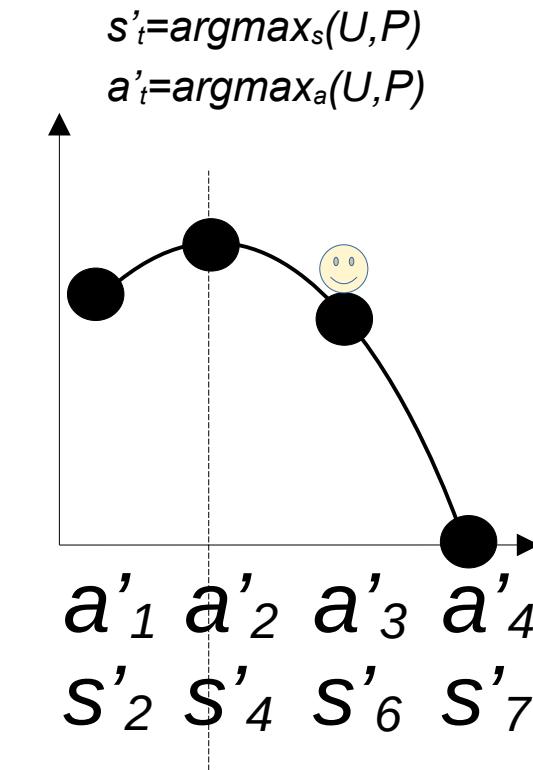


$x \cdot y_t$ – "motivation vector"

V. F. Petrenko and A. P. Suprun, "Goal oriented systems, evolution, and the subjective aspect in systemology," Tr. Inst. Sistem. Analiza RAN 62 (1) (2012)

Decision making as operational risk management

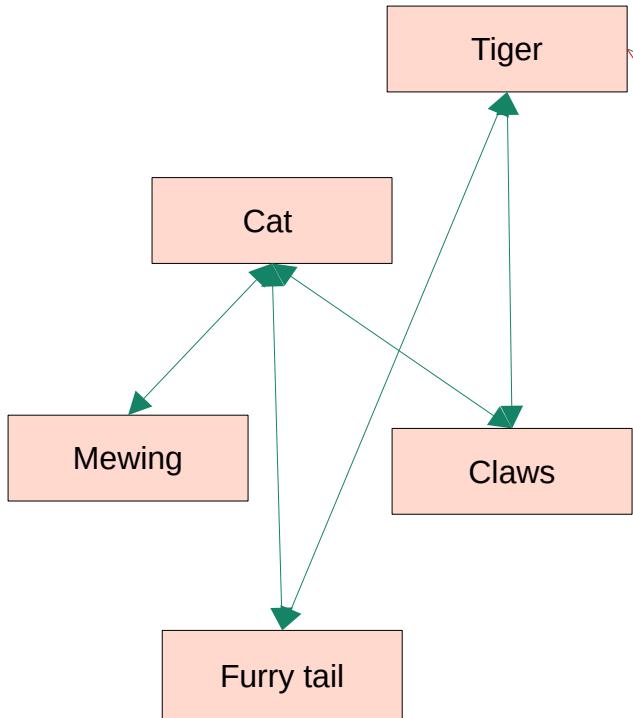
s_t	s'_{t+1}	s'_{t+1}			U	P	$\sum U^*P$
		a'	y'	f'			
s_1	s'_2	a'_1	y'_1	...	1.0	0.5	<u>0.7</u>
s_1	s'_3	a'_1	y'_2	...	0.4	0.5	
s_1	s'_4	a'_2	y'_3	...	1.0	0.8	<u>0.8</u>
s_1	s'_5	a'_2	y'_4	...	0.0	0.2	
s_1	s'_6	a'_3	y'_5	...	0.6	1.0	<u>0.6</u>
s_1	s'_7	a'_4	y'_6	...	0.0	1.0	<u>0.0</u>



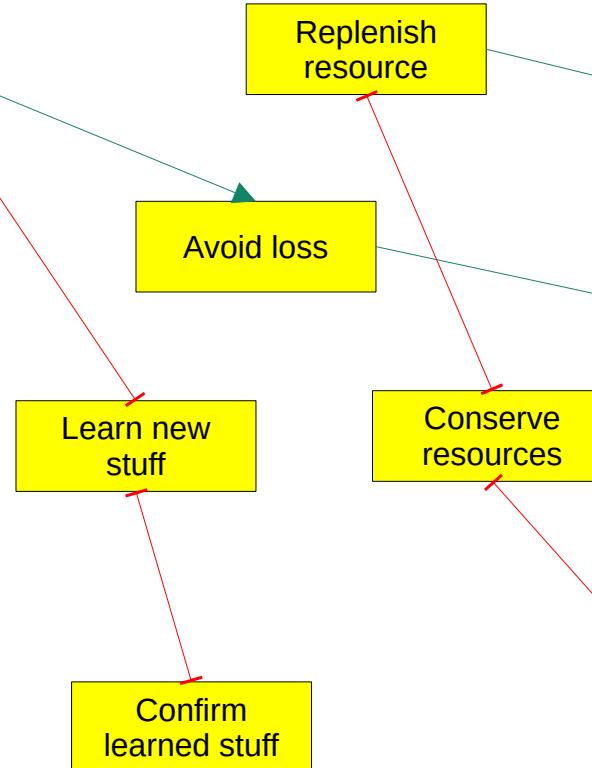
Tversky & Kahneman:
most people choose a'_3 и s'_6
("smaller profit with greater reliability")

Mutual dependency of state variable subgraphs tensors

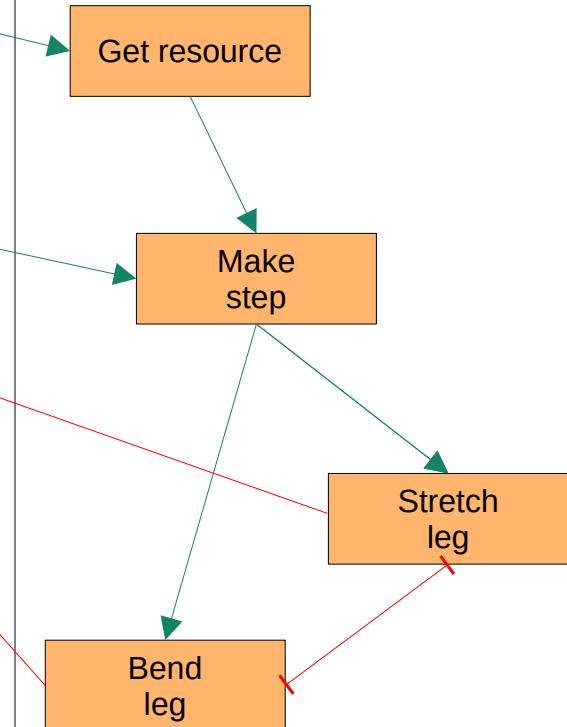
Percept feelings



Satisfied needs



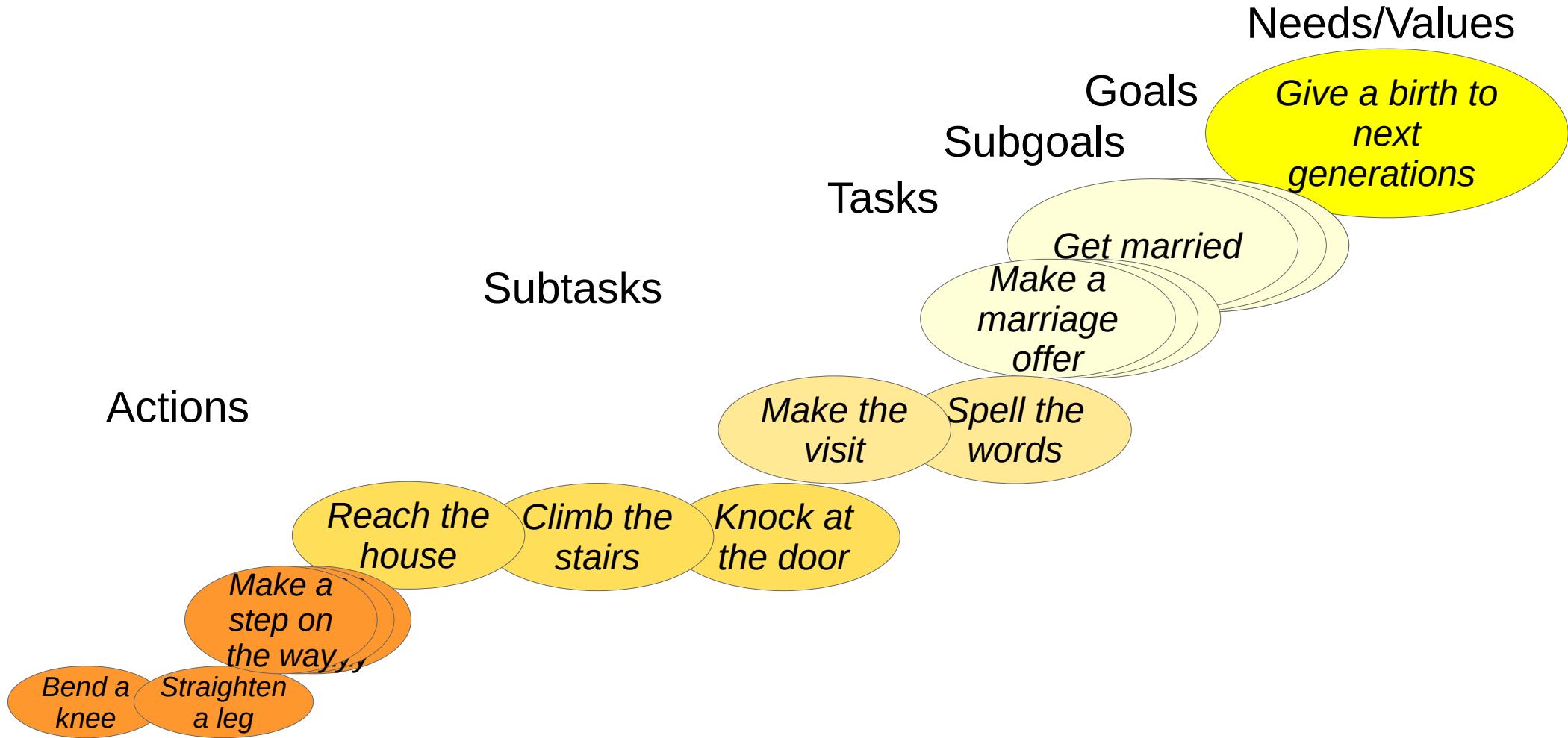
Decided & committed actions



Anton Kolonin & Vladimir Kryukov,
Computational Concept of the Psyche,
Neuroinformatics-2025

<https://arxiv.org/pdf/2509.07009>

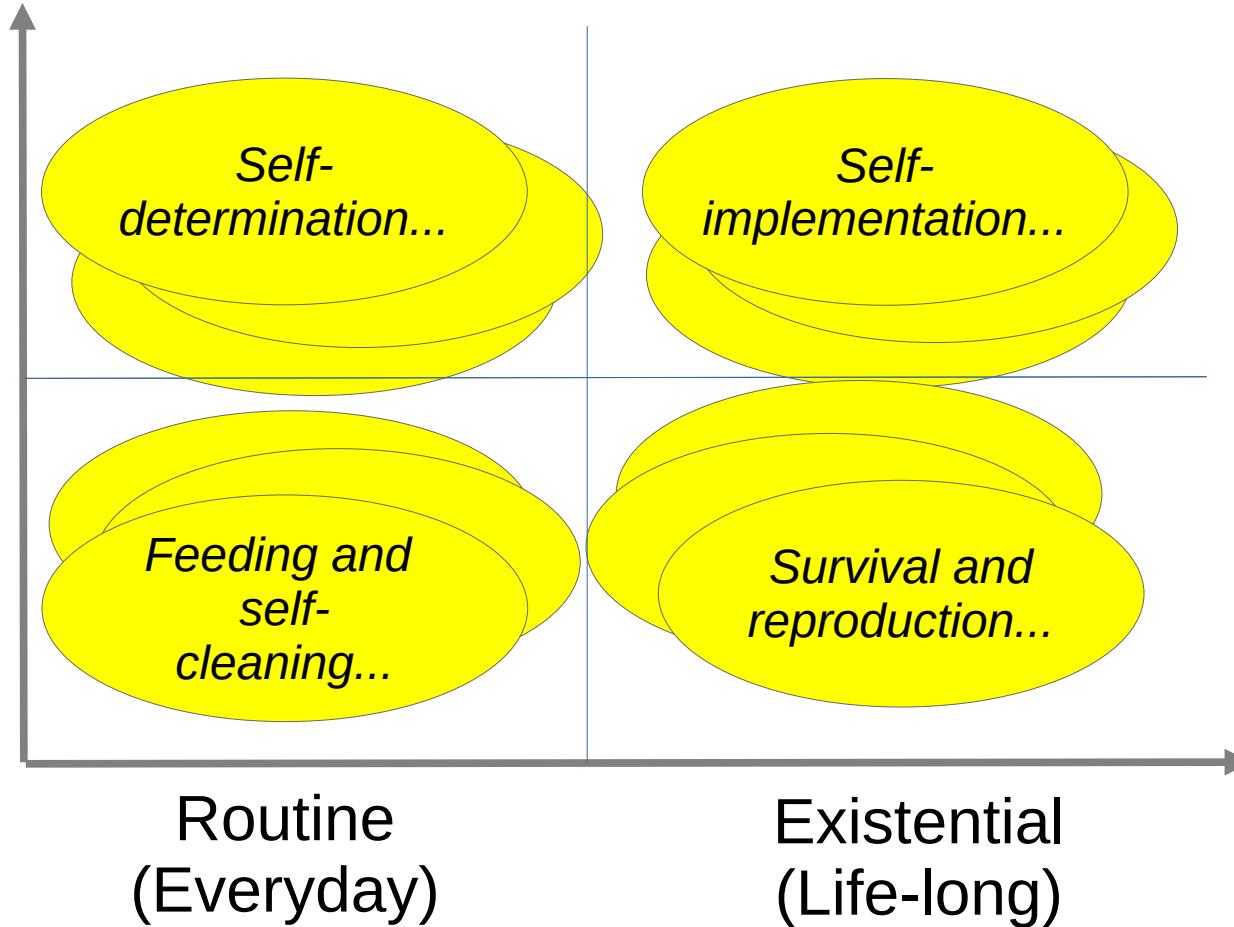
Hierarchy of values/goals/subgoals/tasks/subtasks



Space of needs/goals/values

Psychological

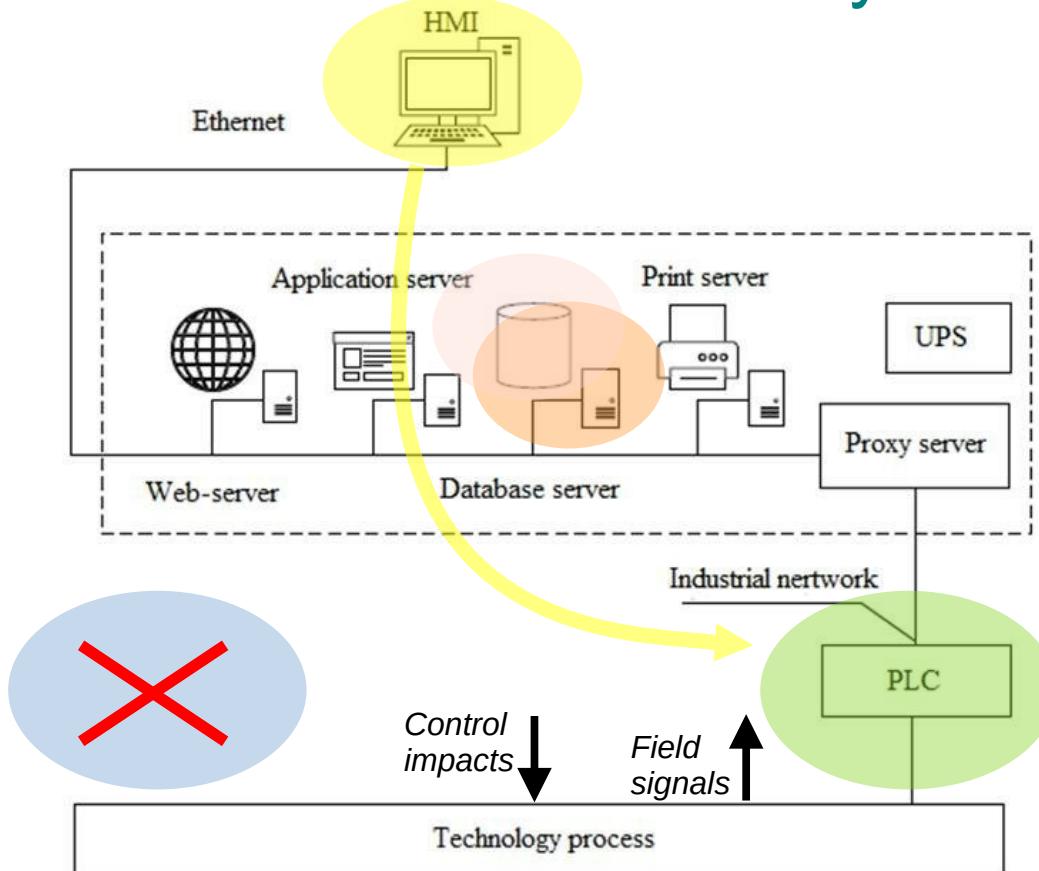
Physical
(Physiological)



According to the ideas of A. Maslow, any goal can be represented as a combination (superposition) of basic needs

Application cases

A) Automated Process Control Systems (APCS)



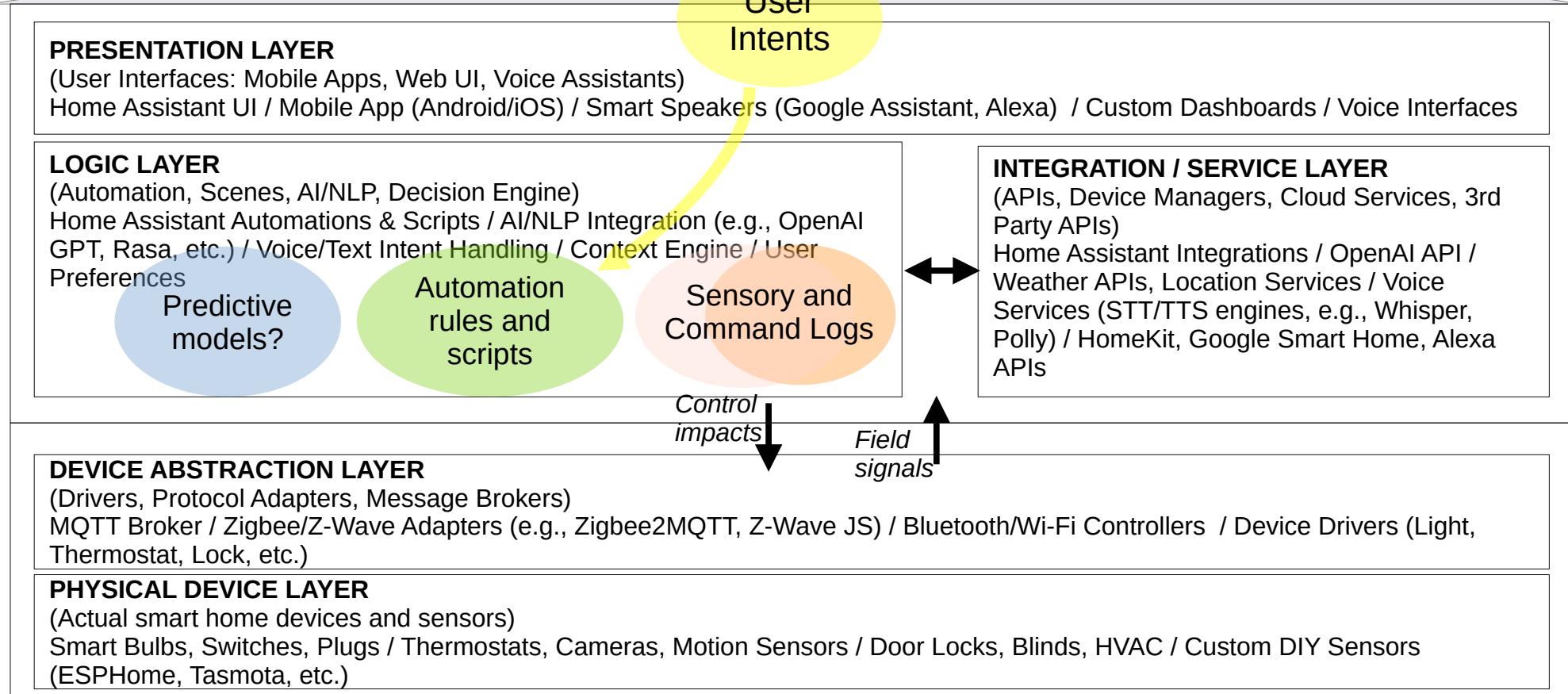
Programmable logic

IEC 61131 (synchronous)

IEC 61499 (asynchronous)

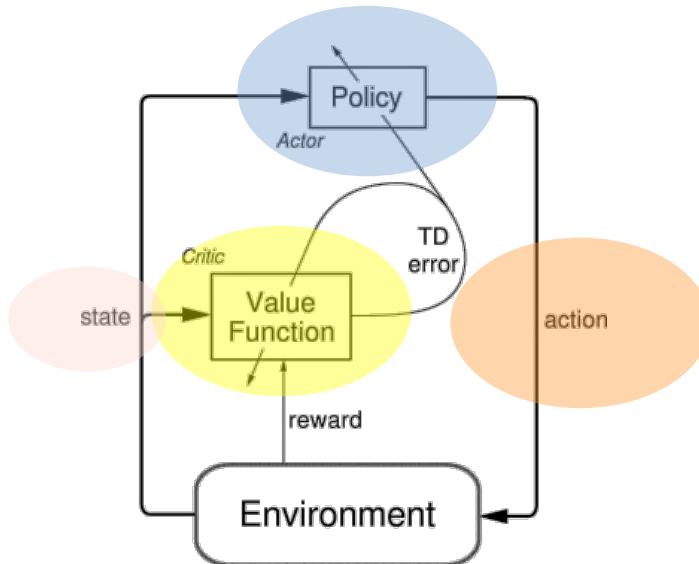
Application cases

B) “Smart Home”



Implementation options

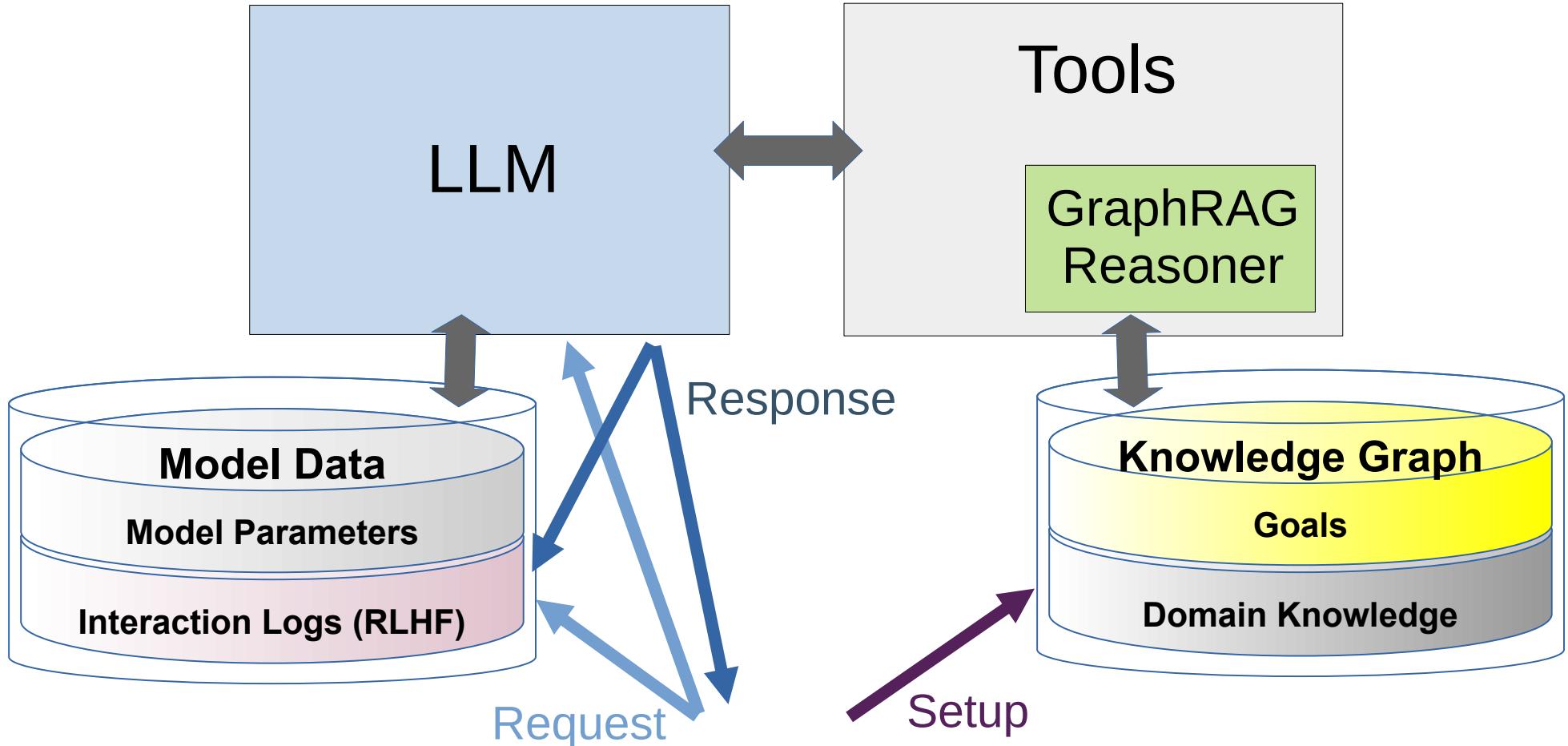
1) Reinforcement learning based on “actor-critic” model



<https://medium.com/intro-to-artificial-intelligence/the-actor-critic-reinforcement-learning-algorithm-c8095a655c14>

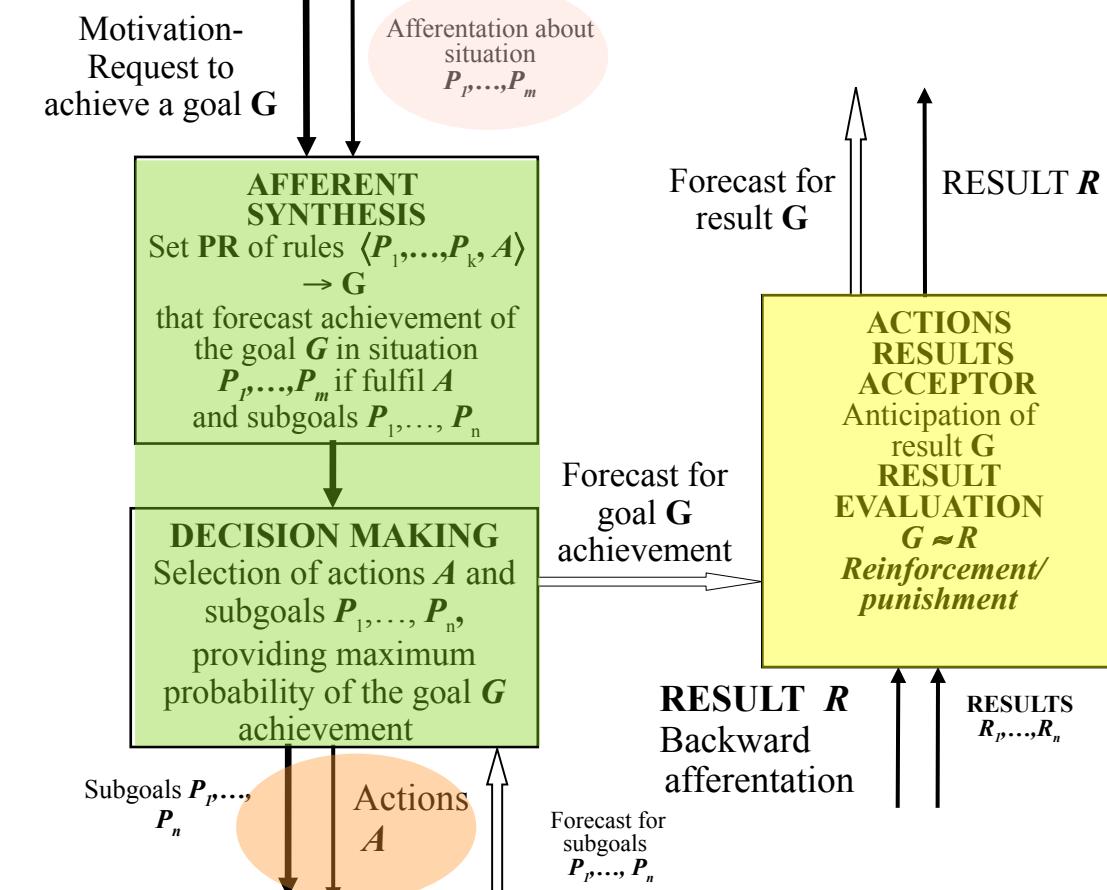
Implementation options

2) Cognitive architecture based on LLM and (active) GraphRAG



Implementation options

3) Cognitive architecture based on probabilistic logic



$$\text{Prob}(G | P_1, \dots, P_k, P_1, \dots, P_n, A) = \text{Prob}(\text{rule}) \cdot \text{Prob}(P_1) \cdot \dots \cdot \text{Prob}(P_n)$$

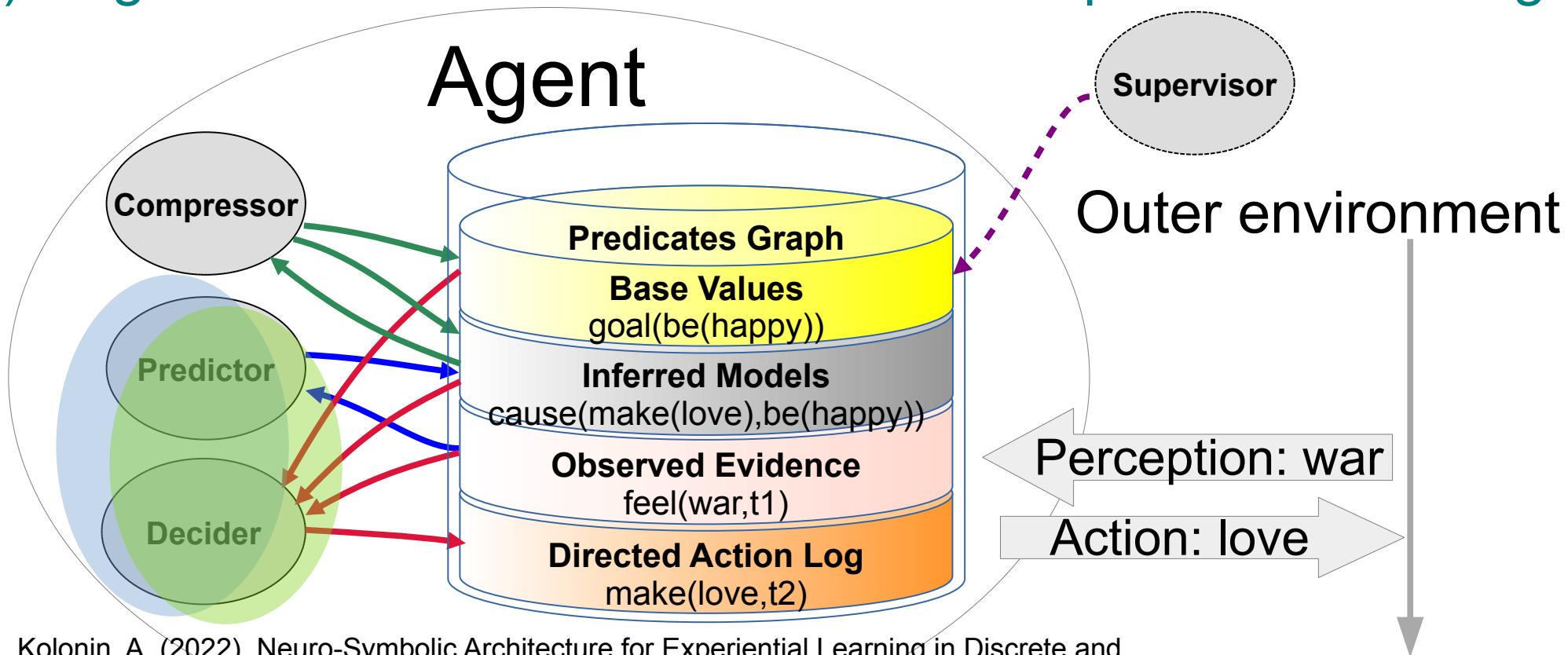
Evgenii Vityaev, Alexander Demin:
Adaptive Control of Modular Robots // Conference Paper in Advances in Intelligent Systems and Computing, Conference: First International Early Research Career Enhancement School on Biologically Inspired Cognitive Architectures, Springer, August 2018

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.

Витяев Е.Е. Логика работы мозга. Подходы к моделированию мышления. (сборник под ред. д.ф.-м.н. В.Г. Редько). УРСС Эдиториал, Москва, 2014г., стр. 120-153.

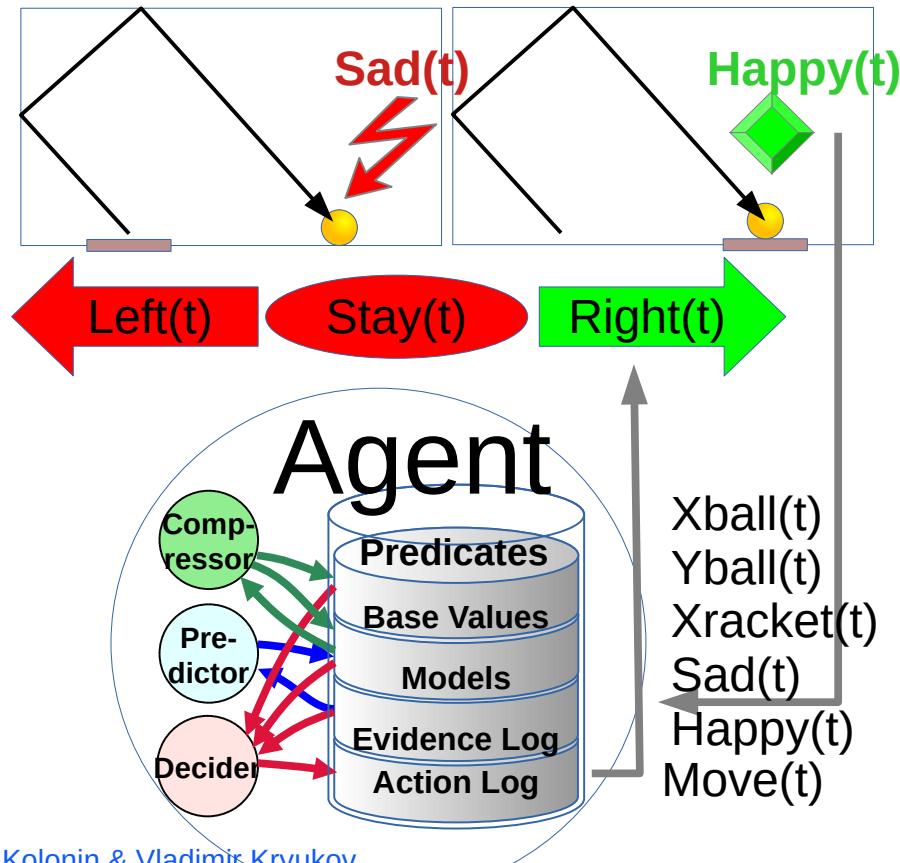
Implementation options

4) Cognitive architecture of value-based experiential learning

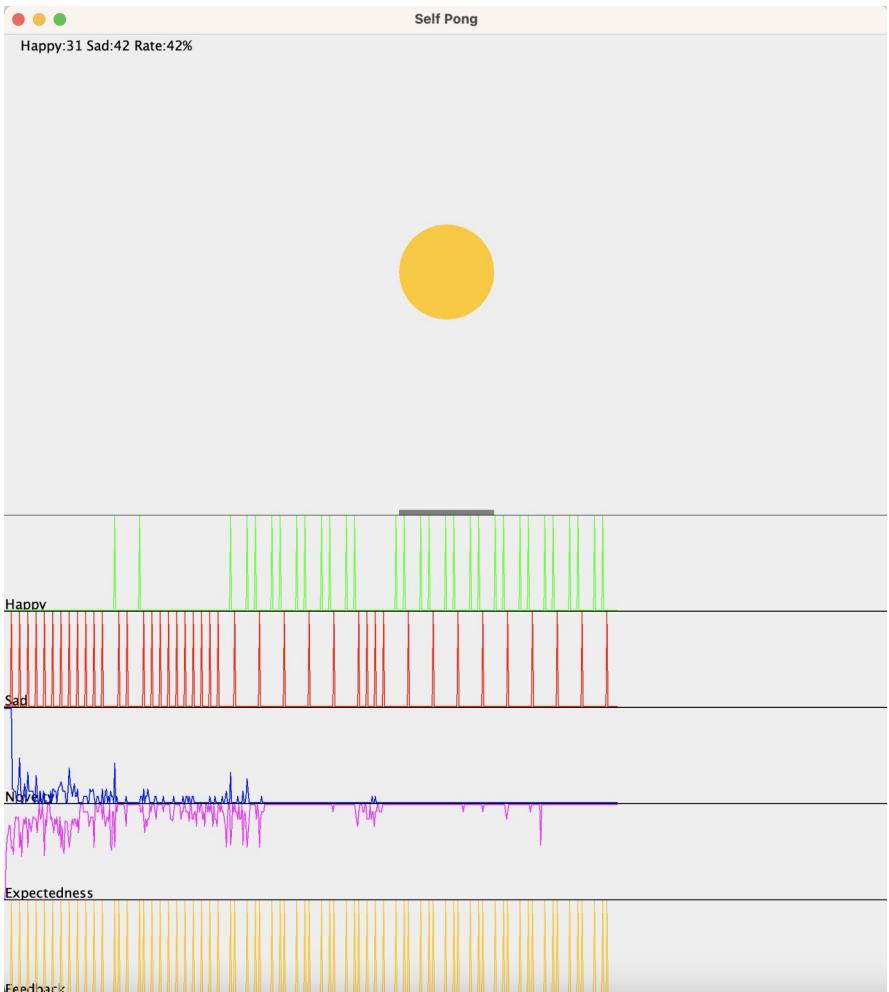


Kolonin, A. (2022). Neuro-Symbolic Architecture for Experiential Learning in Discrete and Functional Environments. In: Goertzel, B., Iklé, M., Potapov, A. (eds) Artificial General Intelligence. AGI 2021. Lecture Notes in Computer Science(), vol 13154. Springer, Cham.
https://doi.org/10.1007/978-3-030-93758-4_12

Cognitive architecture of value-based experiential learning

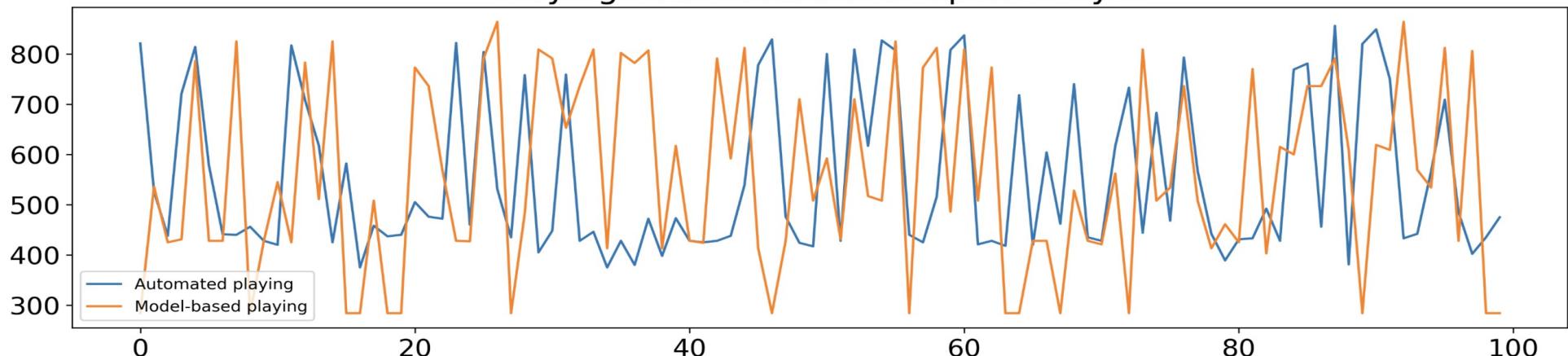


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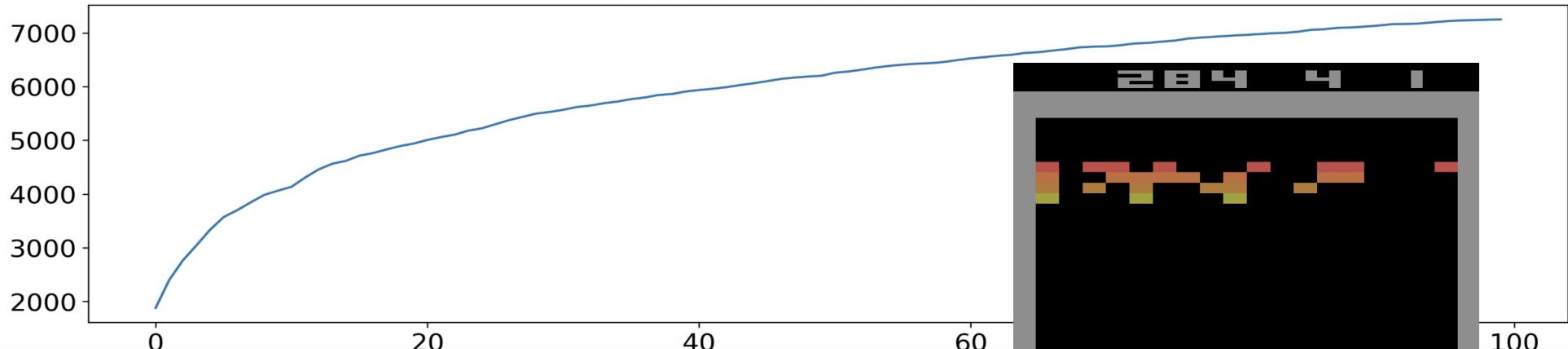


Reinforcement learning – decision making on “pre-trained” model

Playing Atari Breakout in Open AI Gym

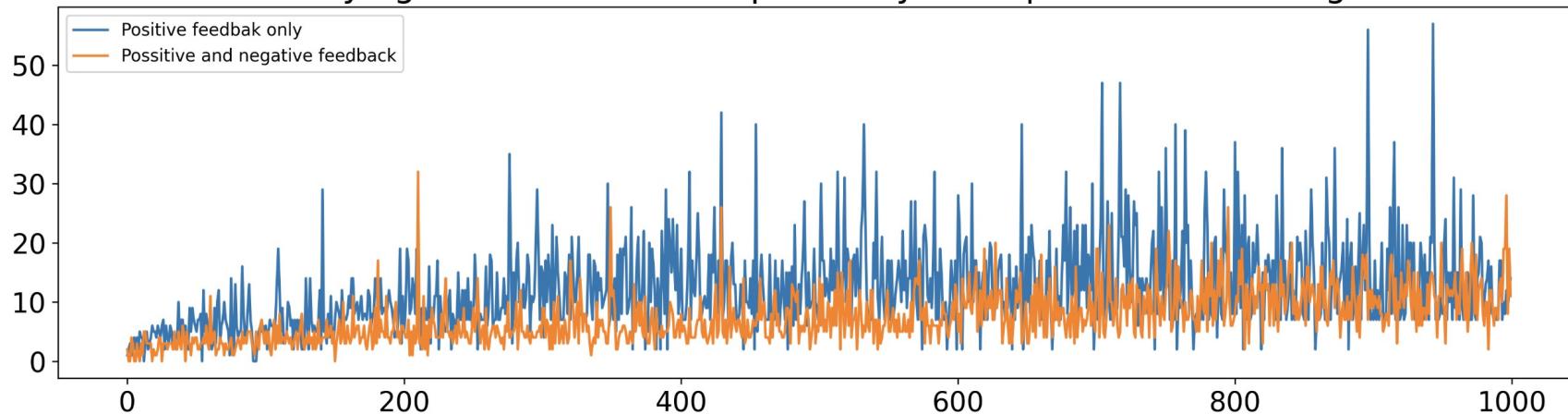


N of States in the Model

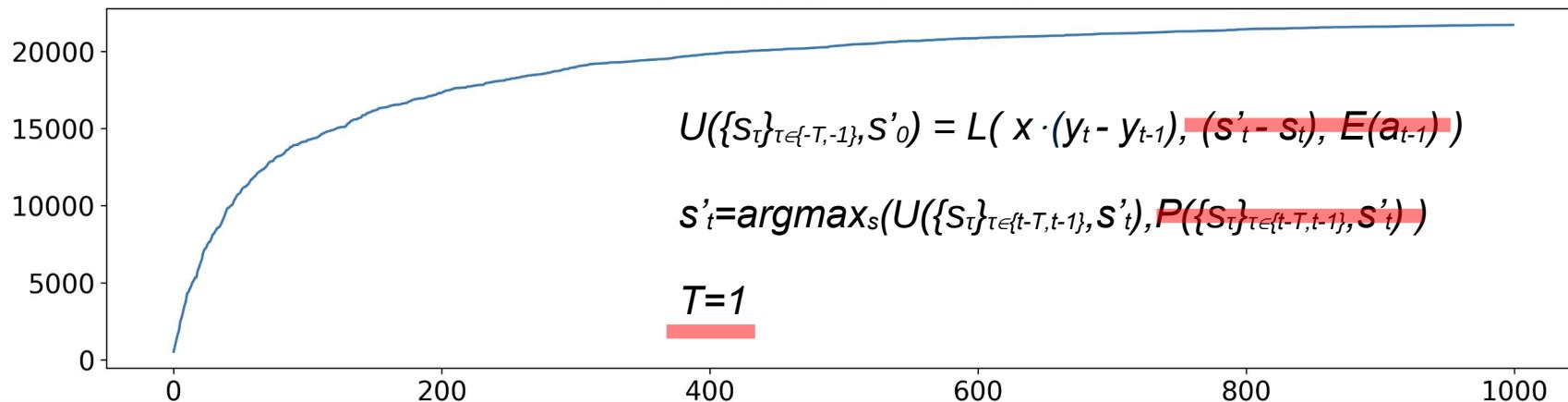


Reinforcement learning – experiential learning and decision making

Playing Atari Breakout in Open AI Gym - Experiential Learning



N of States in the Model



Thank you for attention! Questions?

Anton Kolonin

akolonin@aigents.com

Telegram/GitHub: akolonin

Workshop recording
on the subject



Anton Kolonin & Vladimir Kryukov,
Computational Concept of the
Psyche, Neuroinformatics-2025

