

Computational Concept and Architecture of Artificial Psyche

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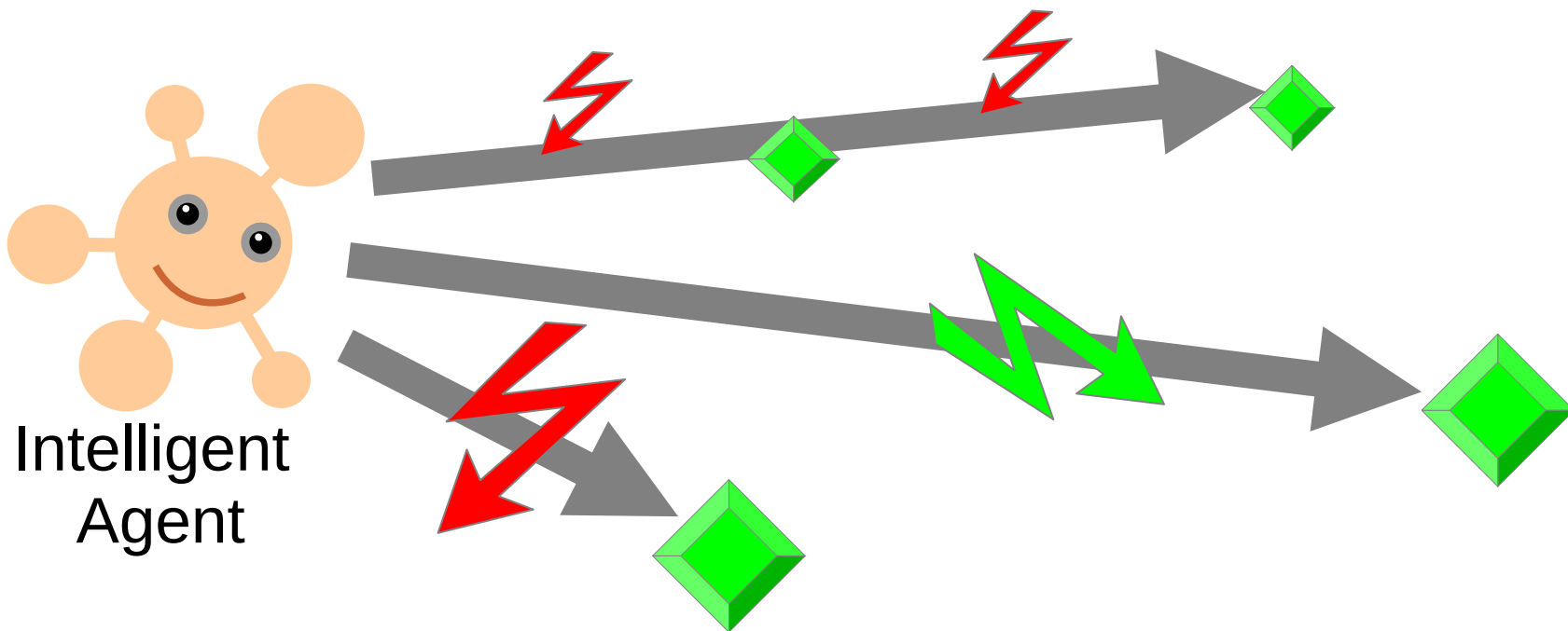
N* Novosibirsk
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University
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<https://www.nsu.ru>



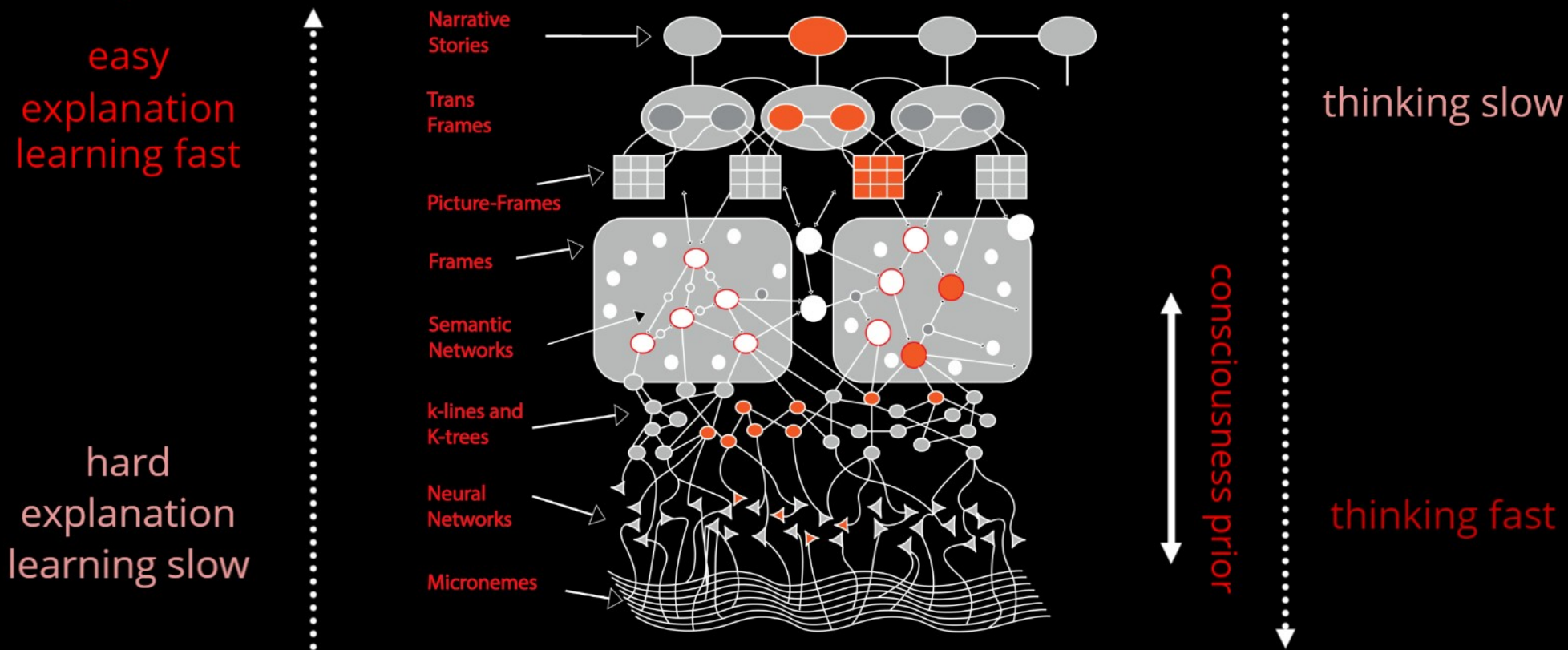
<https://agirussia.org>

General Intelligence:

Reaching complex **goals** in **different** complex **environments**, using **limited resources** under uncertainty
(Ben Goertzel + Pei Wang + **Shane Legg** + **Marcus Hutter**)

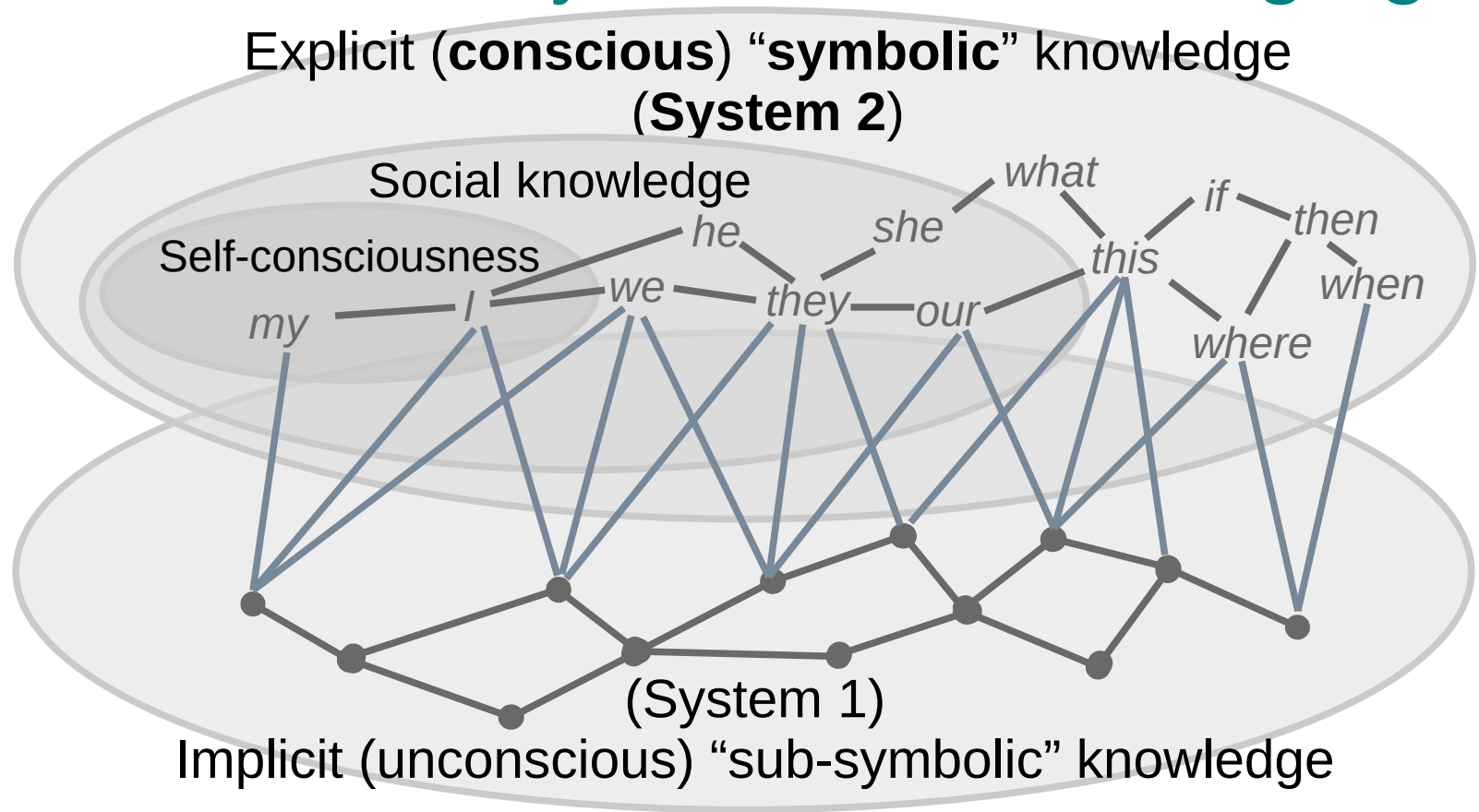


“Fast and Slow Thinking” – Daniel Kahneman



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

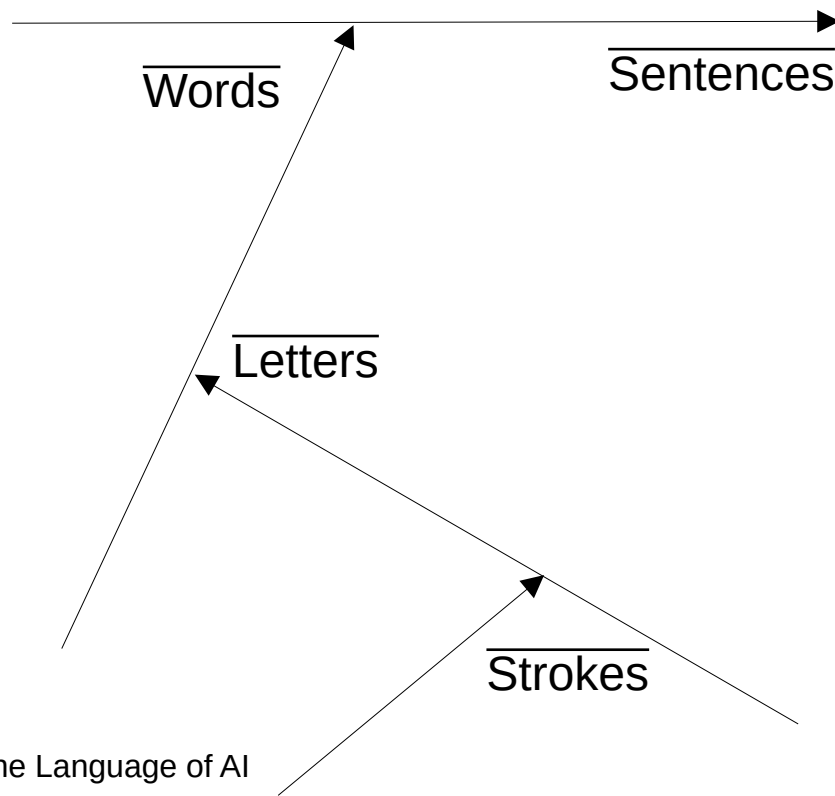
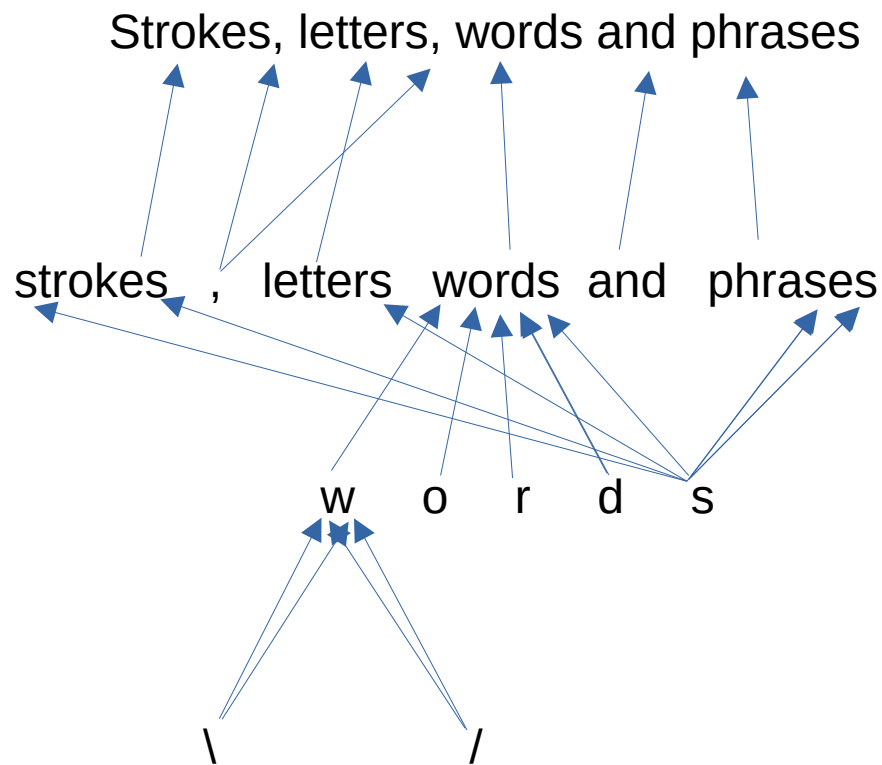
Medium: “neuro-symbolic” “knowledge graph”



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

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

Functional equivalence of graph and ~~neural network~~ tensor models

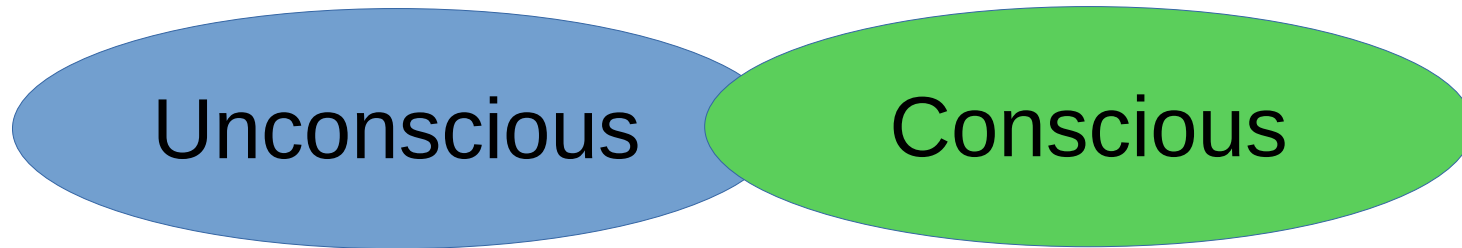


Pedro Domingos, Tensor Logic: The Language of AI
<https://arxiv.org/pdf/2510.12269>

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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

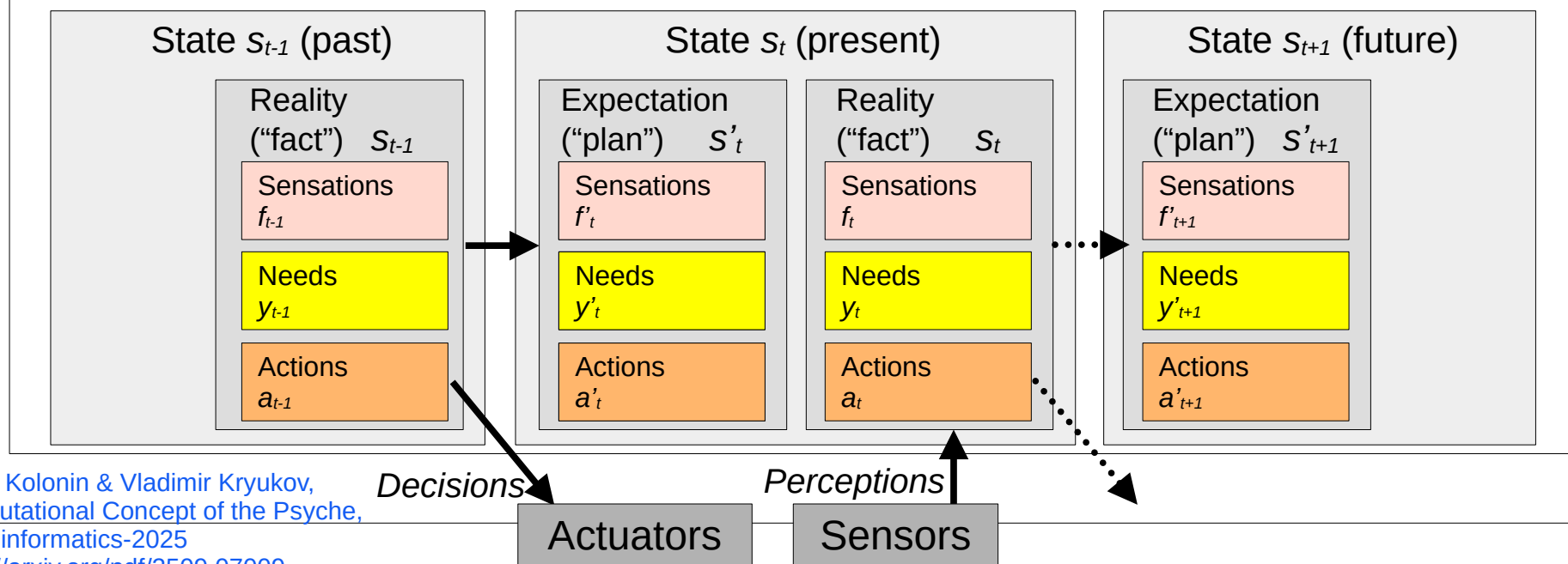
Models s ("invariants") of states with utilities U and probabilities P of transitions

$$U(\{s_t\}_{t \in \{-T, -1\}}, s'_0) = L(x \cdot (y_t - y_{t+1}), s'_t - s_t, E(a_t)) \quad s'_t = \operatorname{argmax}_s (U(\{s_t\}_{t \in \{-T, -1\}}, s'_t), P(\{s_t\}_{t \in \{-T, -1\}}, s'_t))$$

↑ *Experiential learning*

↓ *Decision making*

Space of states and episodic memory ("precedents")



Psyche = Operating system

Intelligence = Decision making system

Models s ("invariants") of states with utilities U and probabilities P of transitions

$$U(\{s_t\}_{t \in \{-T, -1\}}, s'_0) = L(x \cdot (y_t - y_{t+1}), s'_t - s_t, E(a_t)) \quad s'_t = \operatorname{argmax}_s (U(\{s_t\}_{t \in \{-T, -1\}}, s'_t), P(\{s_t\}_{t \in \{-T, -1\}}, s'_t))$$

↑ Experiential learning

↓ Decision making

Space of states and episodic memory ("precedents")

State s_{t-1} (past)

Reality
("fact") s_{t-1}

Sensations
 f_{t-1}

Needs
 y_{t-1}

Actions
 a_{t-1}

State s_t (present)

Expectation
("plan") s'_t

Sensations
 f'_t

Needs
 y'_t

Actions
 a'_t

Reality
("fact") s_t

Sensations
 f_t

Needs
 y_t

Actions
 a_t

State s_{t+1} (future)

Expectation
("plan") s'_{t+1}

Sensations
 f'_{t+1}

Needs
 y'_{t+1}

Actions
 a'_{t+1}

Decisions

Perceptions

Actuators

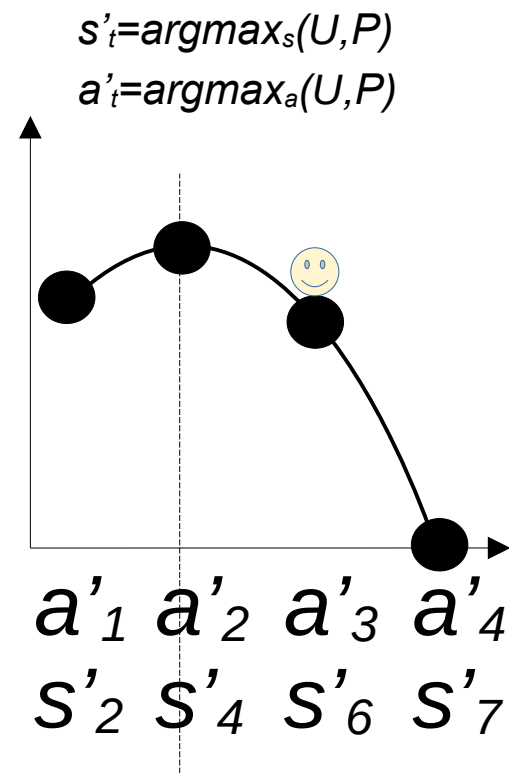
Sensors


$x \cdot y_t$ — "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

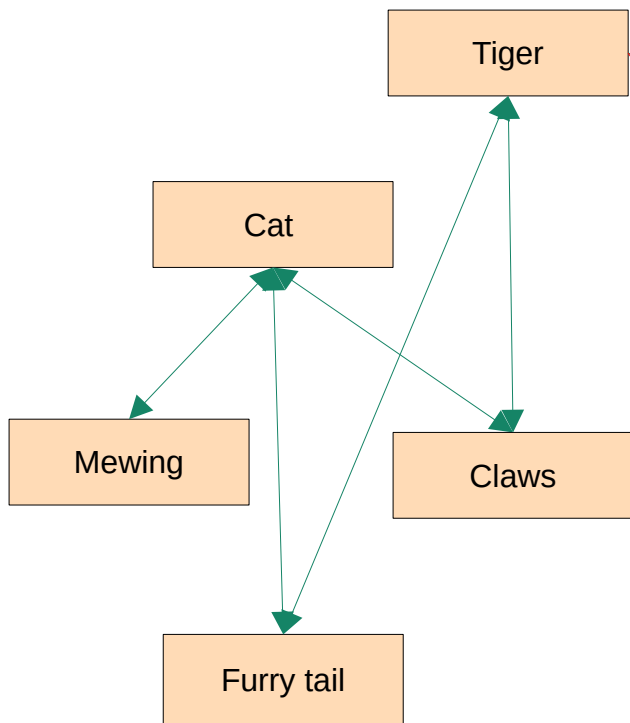
S_t	S'_{t+1}	S'_{t+1}			U	P	$\Sigma U*P$
		a'	y'	f'			
S_1	S'_2	a'_1	y'_1	...	1.0	0.5	<u>0.7</u>
S_1	S'_3	a'_1	y'_2	...	0.4	0.5	
S_1	S'_4	a'_2	y'_3	...	1.0	0.8	<u>0.8</u>
S_1	S'_5	a'_2	y'_4	...	0.0	0.2	
S_1	S'_6	a'_3	y'_5	...	0.6	1.0	<u>0.6</u>
S_1	S'_7	a'_4	y'_6	...	0.0	1.0	<u>0.0</u>



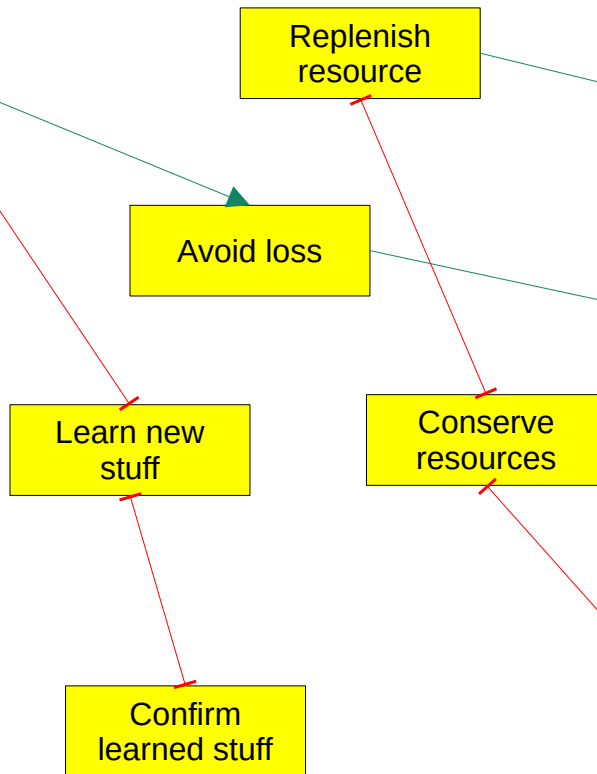
 Tversky & Kahneman:
 most people choose a'_3 и s'_6
 ("smaller profit with
 greater reliability")

Mutual dependency of state variable subgraphs tensors

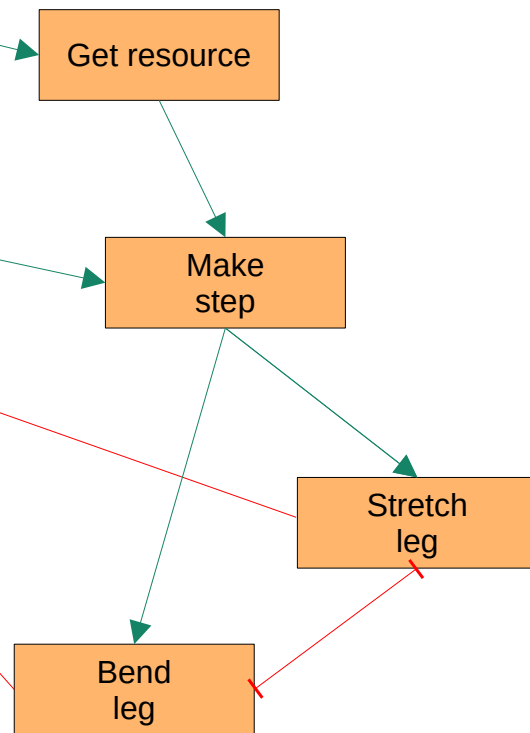
Percept feelings



Satisfied needs



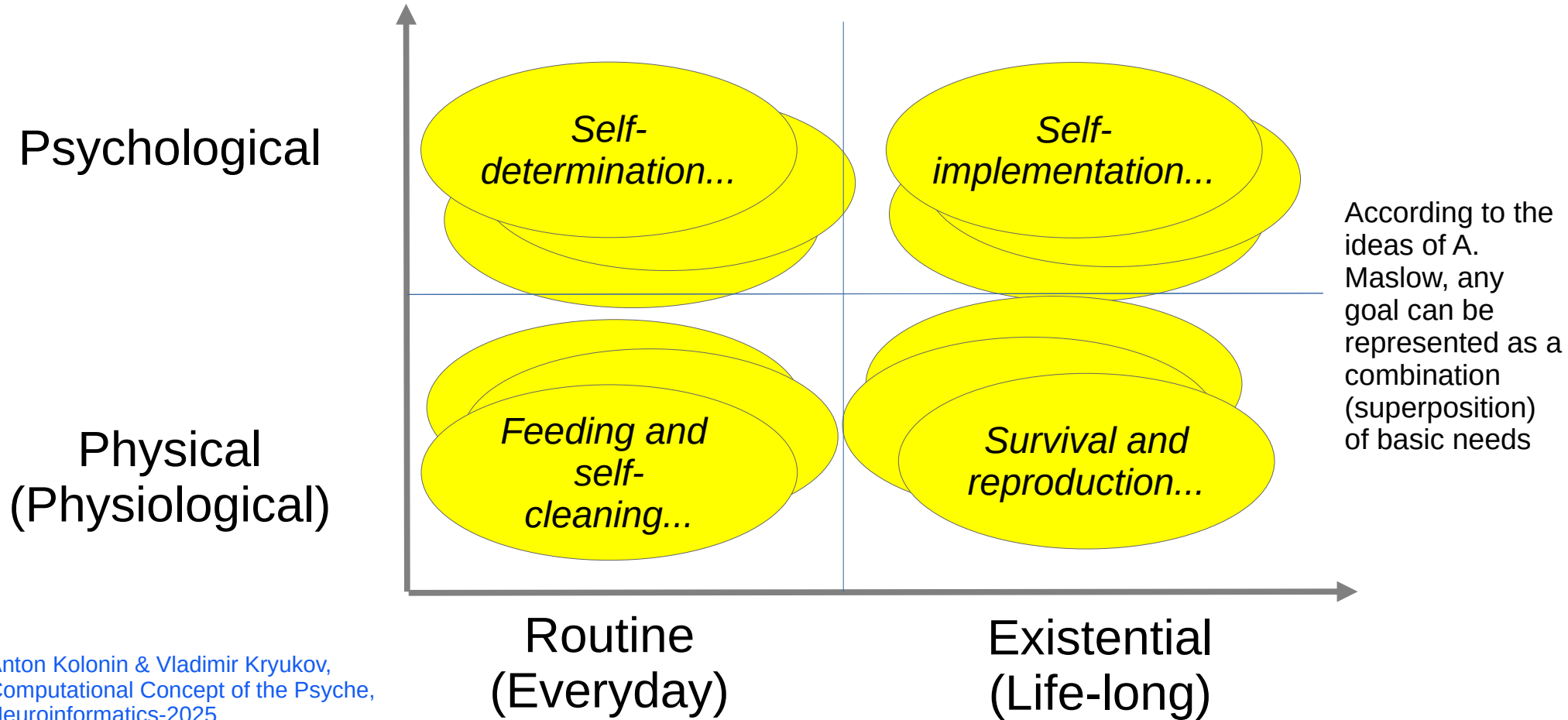
Decided & committed actions



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

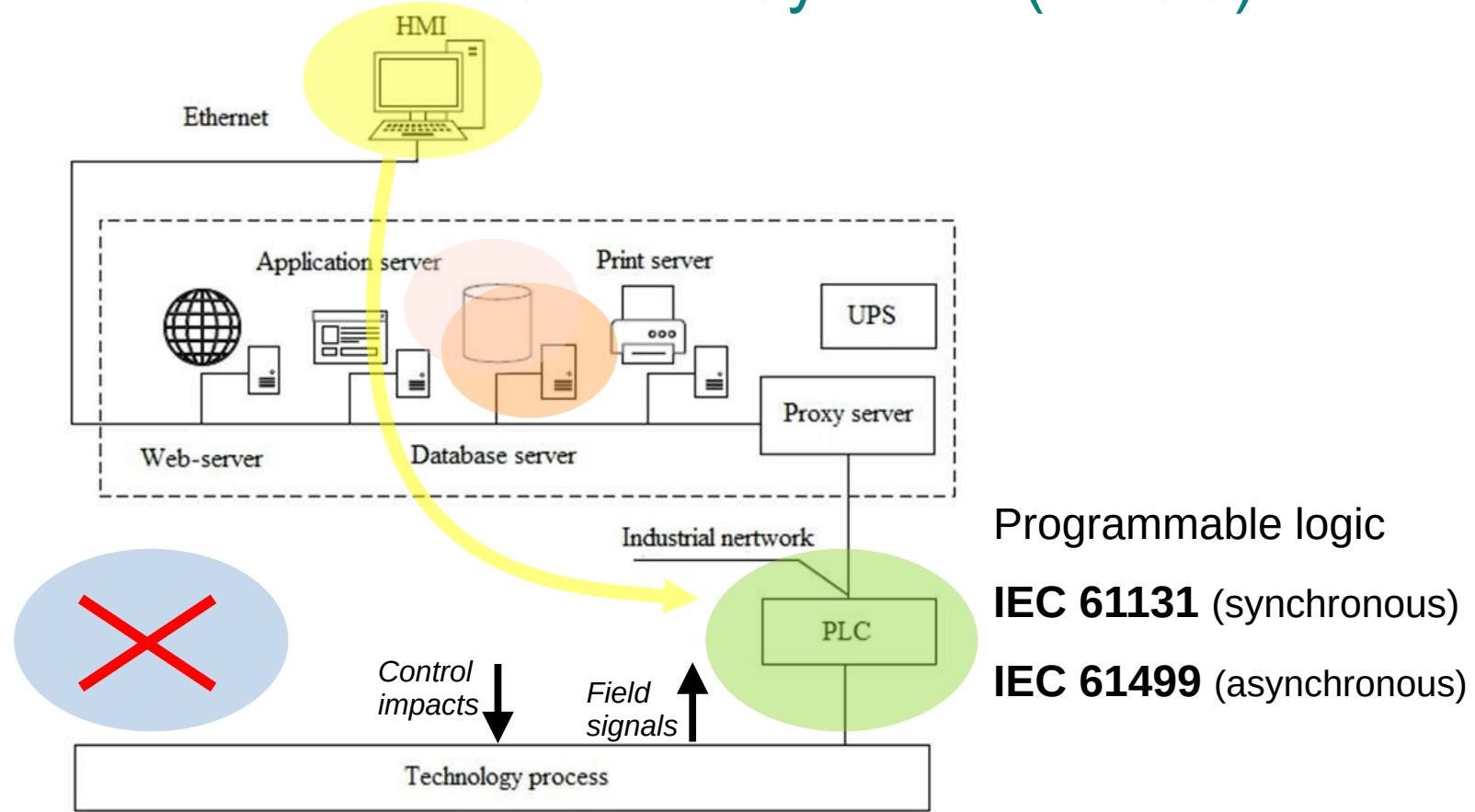
<https://arxiv.org/pdf/2509.07009>

Space of needs/goals/values



Application cases

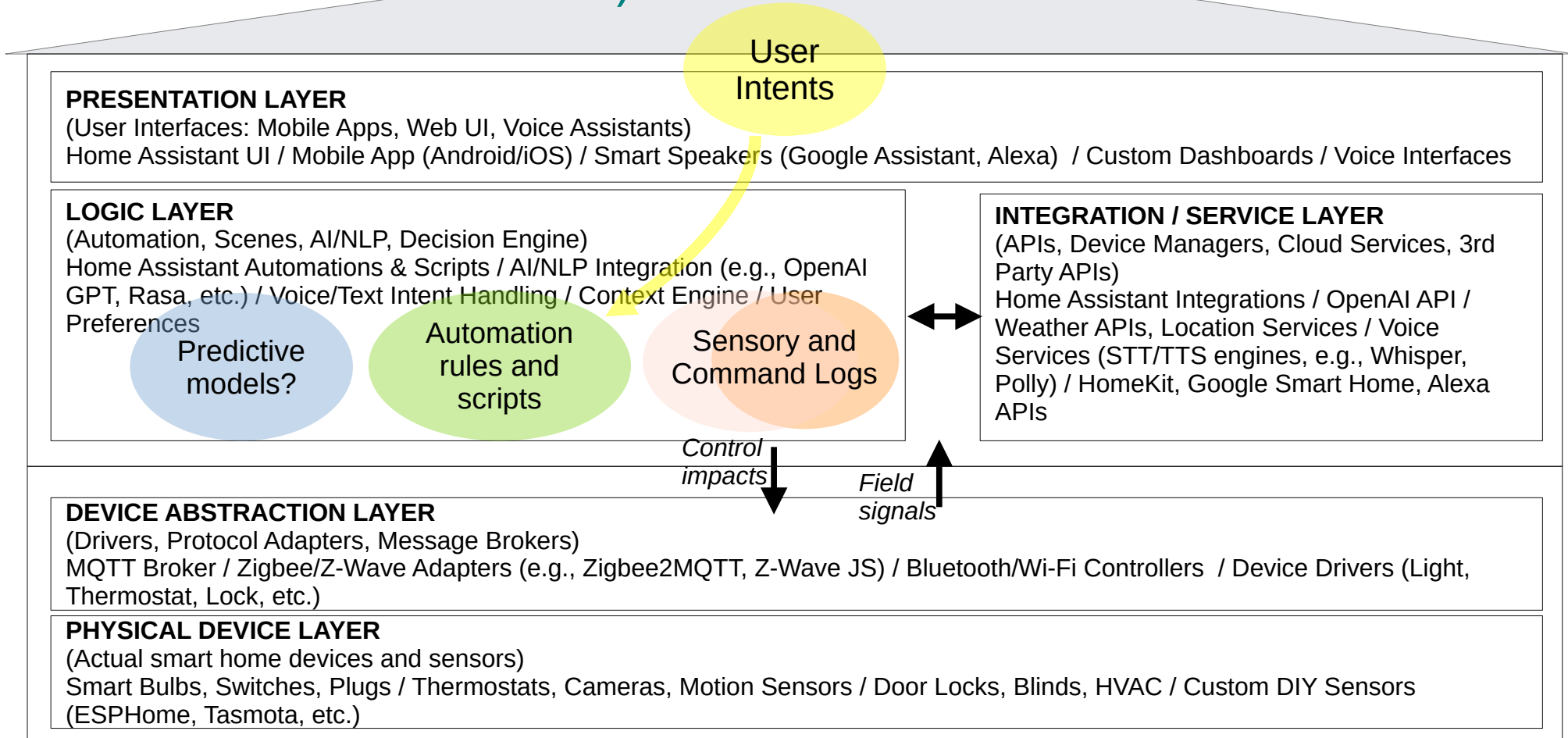
A) Automated Process Control Systems (APCS)



https://www.researchgate.net/publication/311662442_Adaptive_Intelligent_Manufacturing_Control_Systems

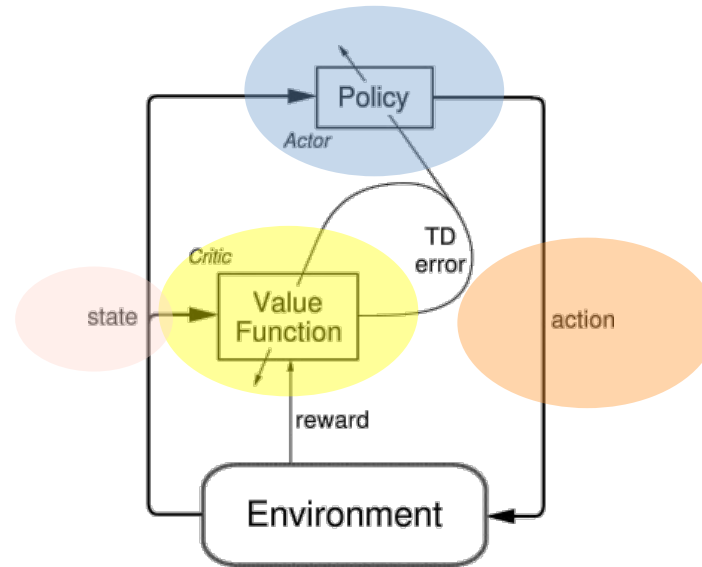
Application cases

B) “Smart Home”



Implementation options

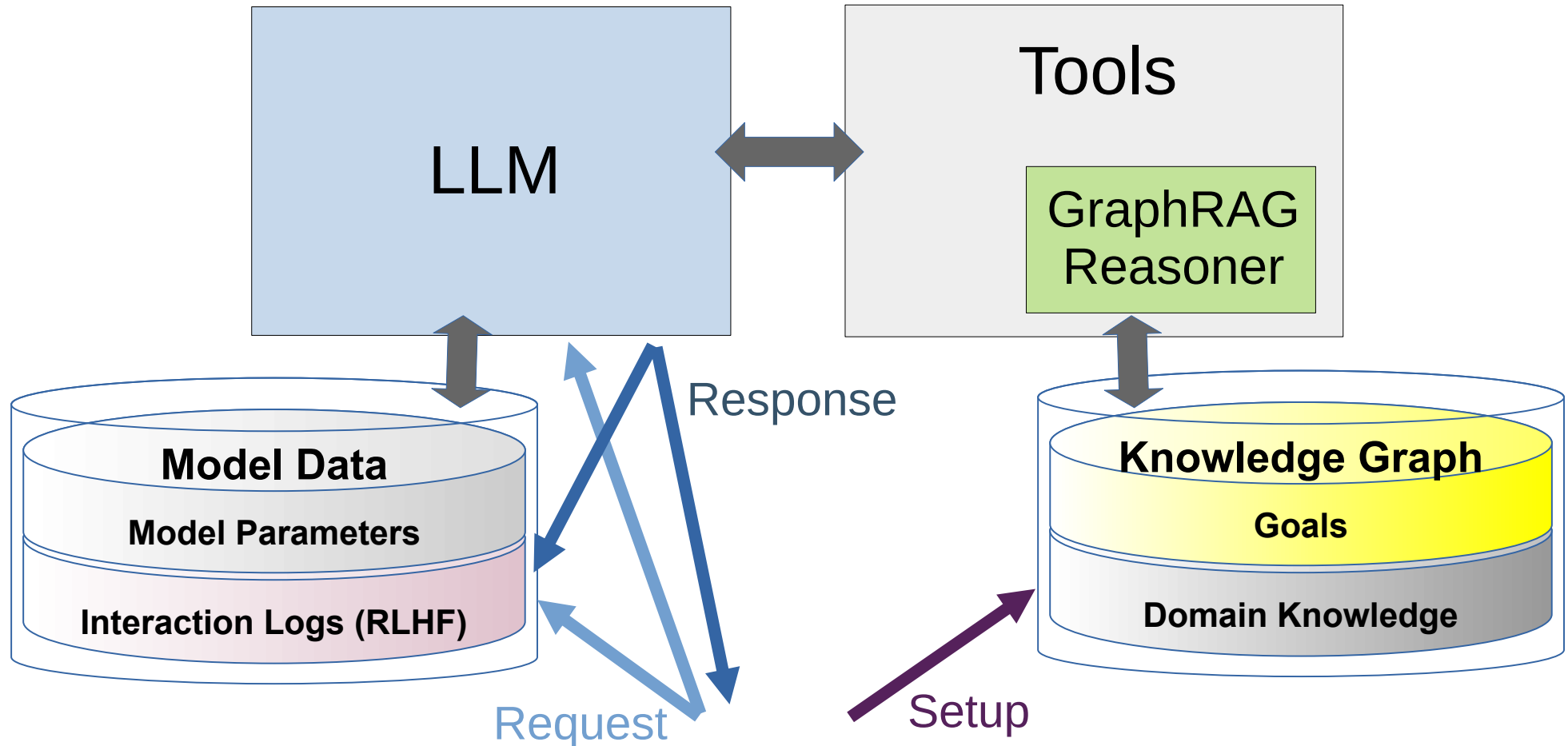
1) Reinforcement learning based on “actor-critic” model



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

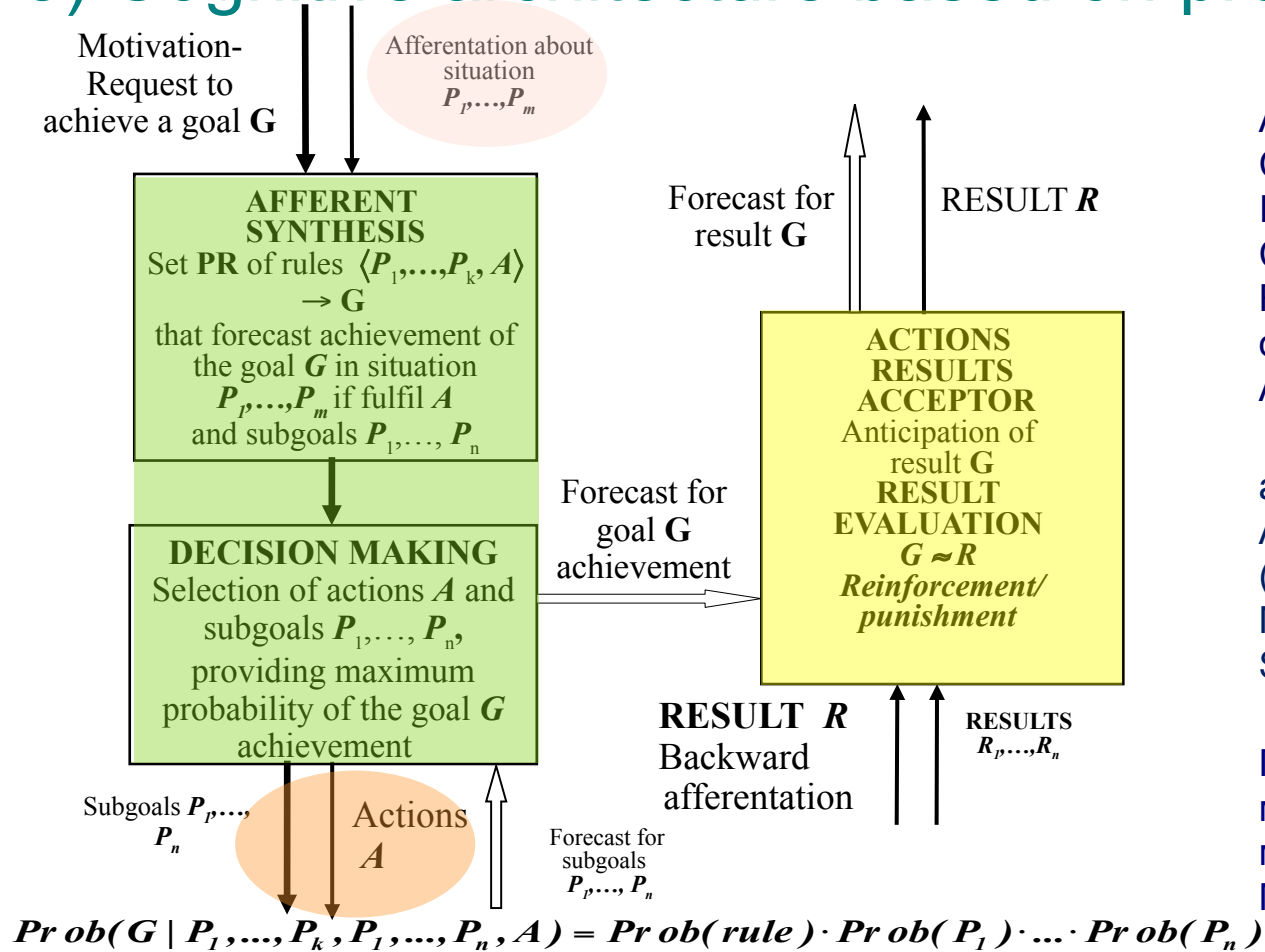
Implementation options

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



Implementation options

3) Cognitive architecture based on probabilistic logic



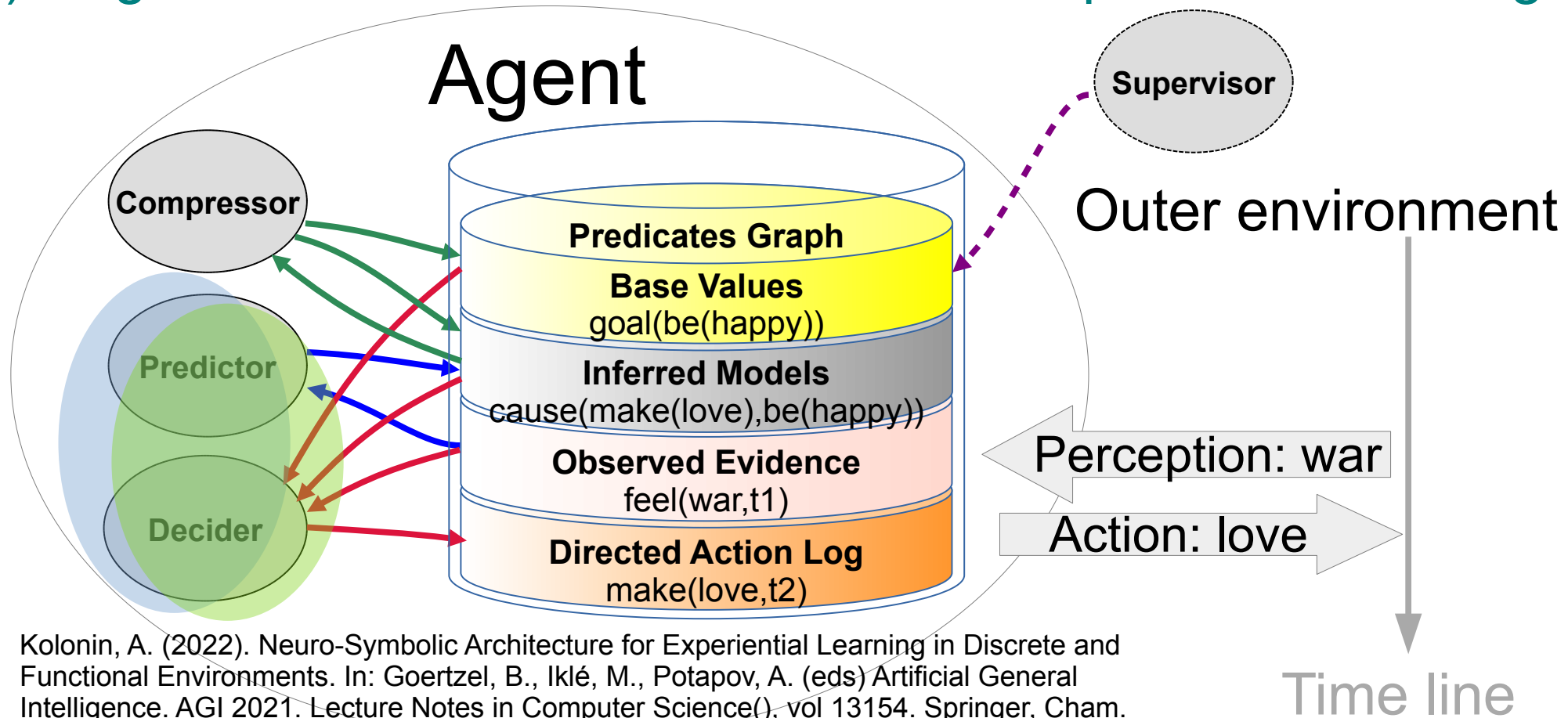
Evgenii Vityaev, Alexander Demin:
Adaptive Control of Modular Robots //
Conference Paper in Advances in
Intelligent Systems and Computing,
Conference: First International Early
Research Career Enhancement School
on Biologically Inspired Cognitive
Architectures, Springer, August 2018

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.

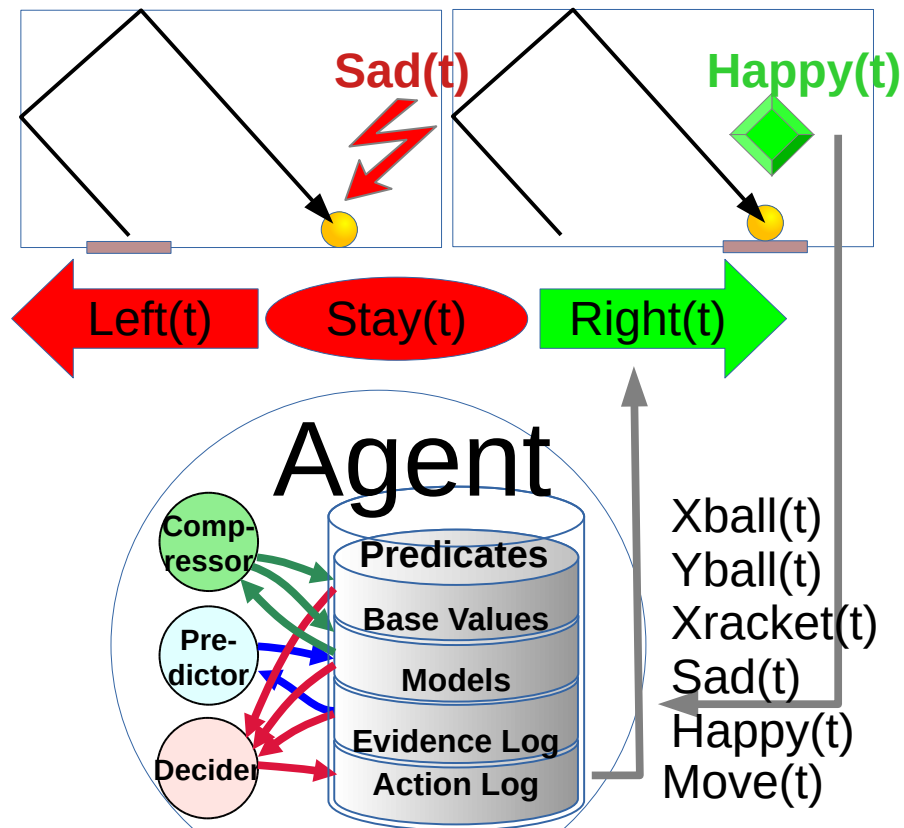
Implementation options

4) Cognitive architecture of value-based experiential learning

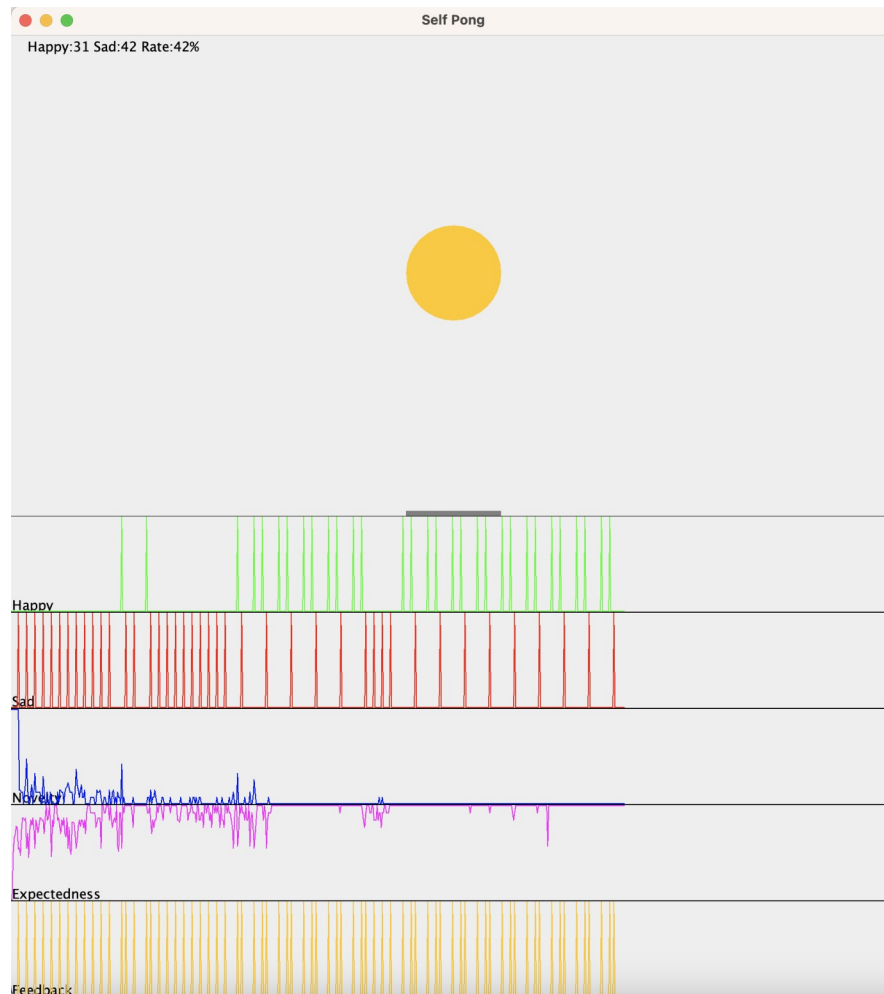


Kolonin, A. (2022). Neuro-Symbolic Architecture for Experiential Learning in Discrete and Functional Environments. In: Goertzel, B., Iklé, M., Potapov, A. (eds) Artificial General Intelligence. AGI 2021. Lecture Notes in Computer Science(), vol 13154. Springer, Cham.
https://doi.org/10.1007/978-3-030-93758-4_12

Cognitive architecture of value-based experiential learning



Anton Kolonin & Vladimir Kryukov,
Computational Concept of the Psyche,
Neuroinformatics-2025
<https://arxiv.org/pdf/2509.07009>



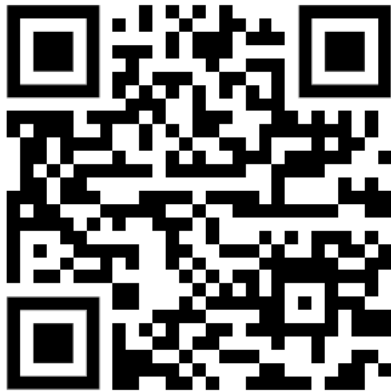
Thank you for attention! Questions?

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Workshop recording
on the subject



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

