

# Computational Concept and Architecture of Artificial Psyche

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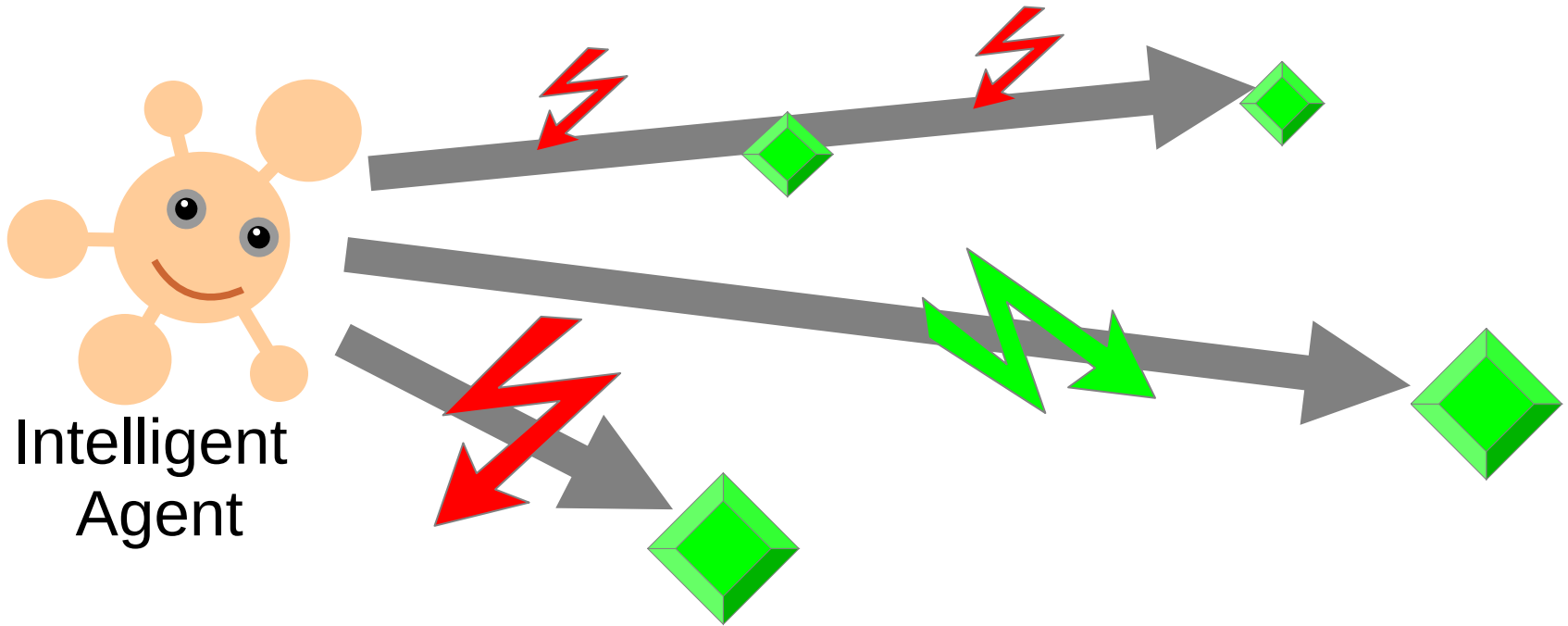
**N**\* Novosibirsk  
State  
University  
\*THE REAL SCIENCE  
<https://www.nsu.ru>



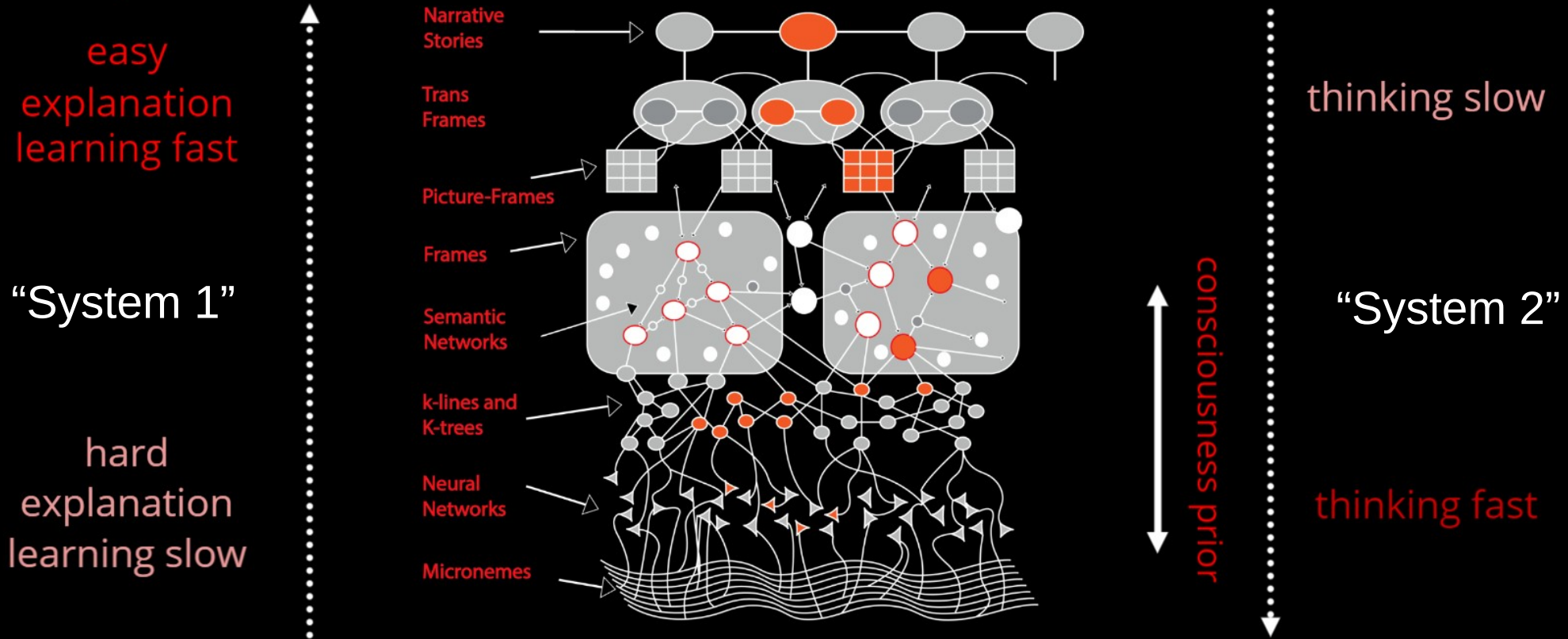
<https://agirussia.org>

# 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



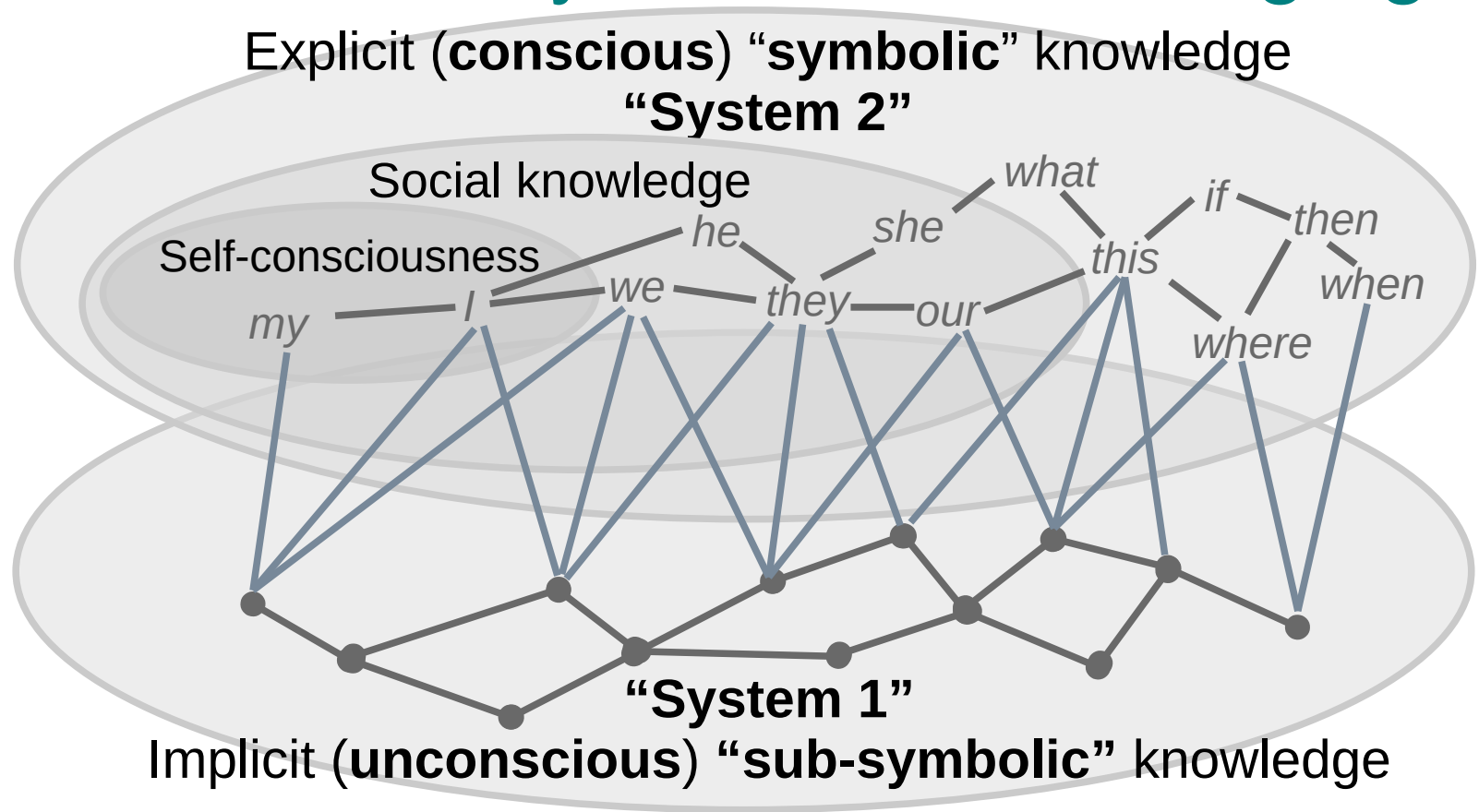
<https://www.linkedin.com/pulse/explainable-ai-vs-explaining-part-1-ahmad-haj-mosa/>

Xing, F., Cambria, E., Welsch, R. (2019). Theoretical Underpinnings on Text Mining. In: Intelligent Asset Management. Socio-Affective Computing, vol 9. Springer, Cham.

[https://doi.org/10.1007/978-3-030-30263-4\\_3](https://doi.org/10.1007/978-3-030-30263-4_3)

M. Minsky, The Emotion Machine: Commonsense Thinking, Artificial Intelligence, and the Future of the Human Mind (Simon & Schuster Paperbacks, Princeton, 2007)

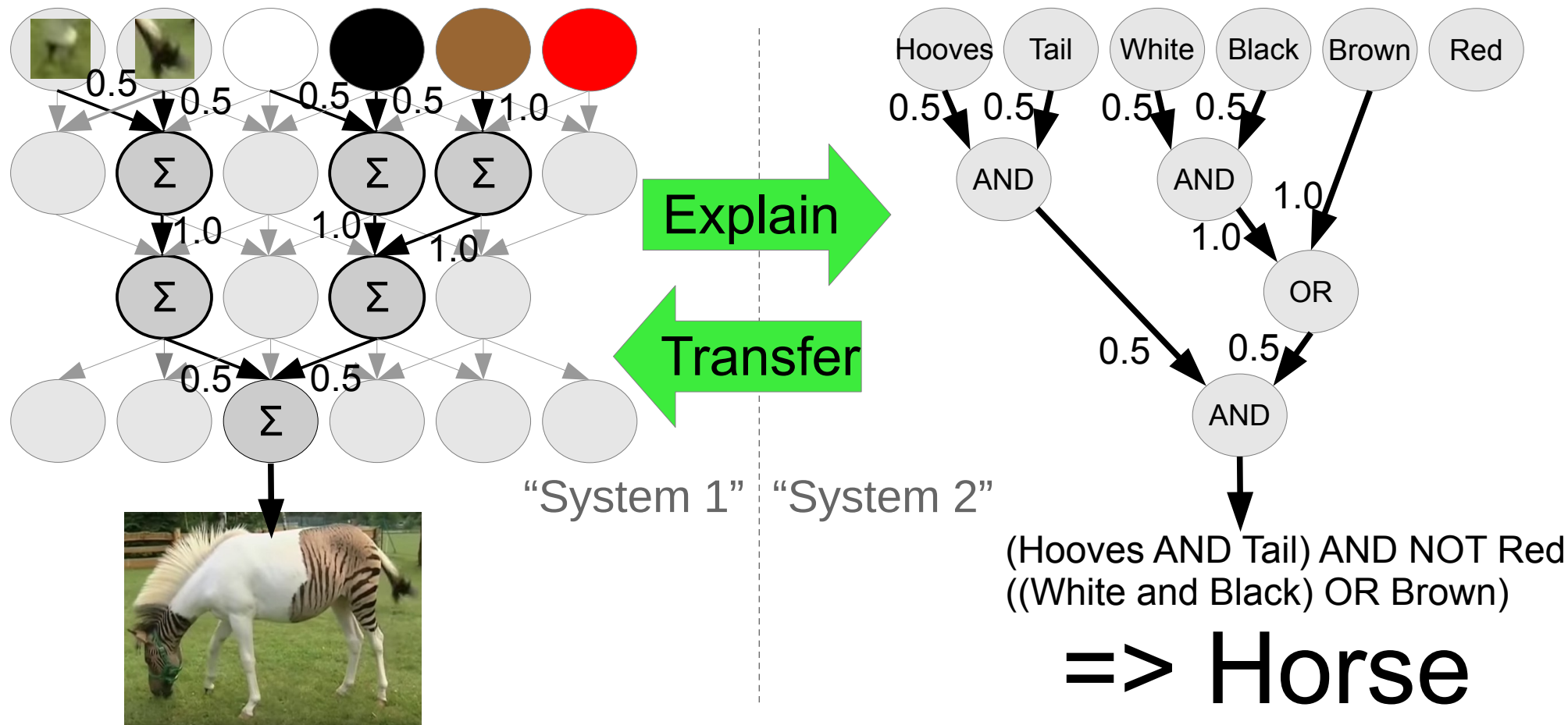
# Medium: “neuro-symbolic” “knowledge graph”



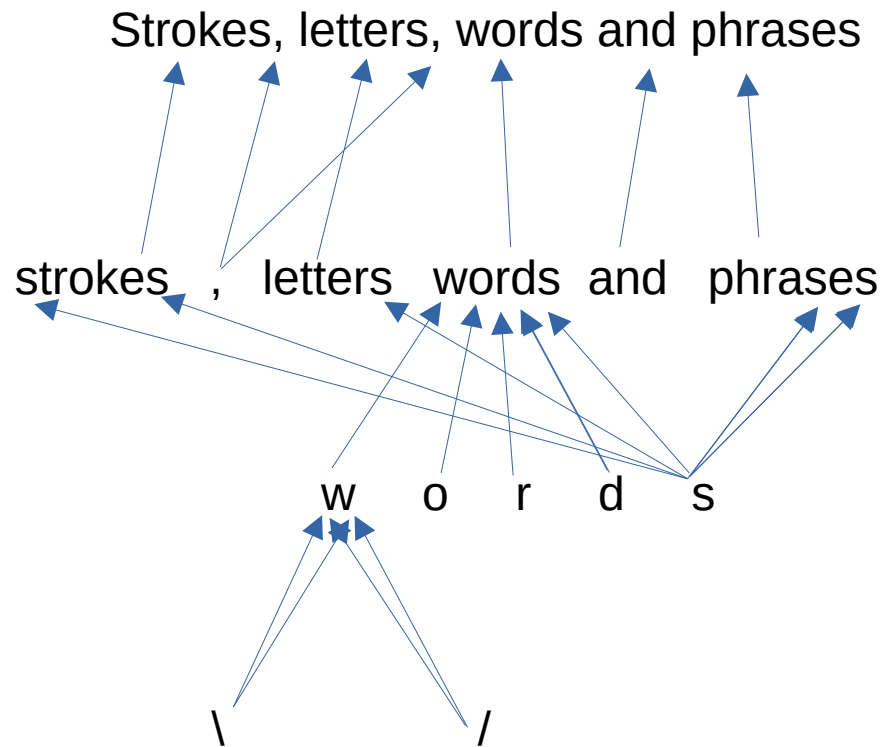
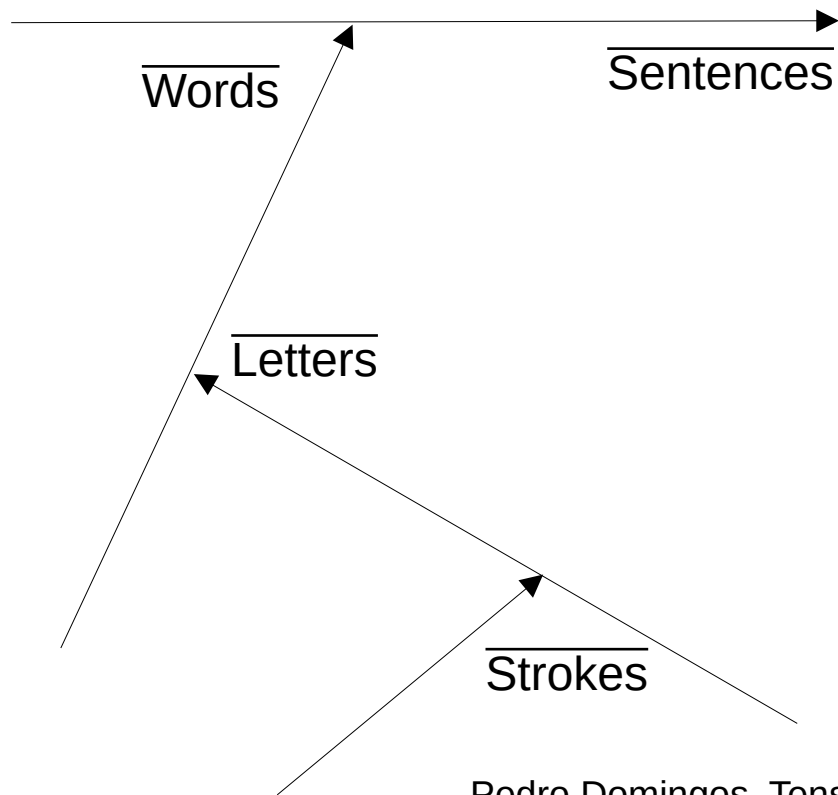
<https://www.amazon.com/Thinking-Fast-Slow-Daniel-Kahneman/dp/0374533555>

<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

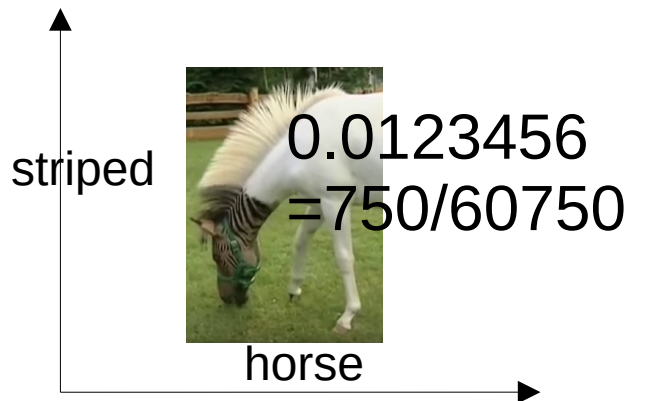


Pedro Domingos, Tensor Logic: The Language of AI  
<https://arxiv.org/pdf/2510.12269>

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

**Truth-Value Tensor**  
(NARS/PLN)

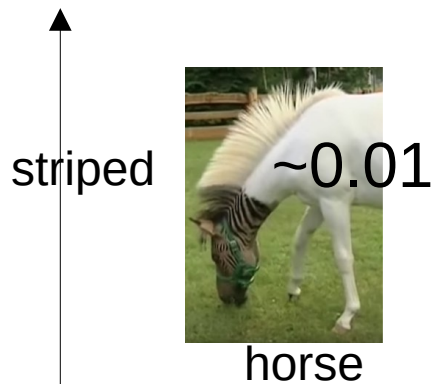
Property



Subject

**Numerical Tensor**  
(ANN/Bayesian Logic)

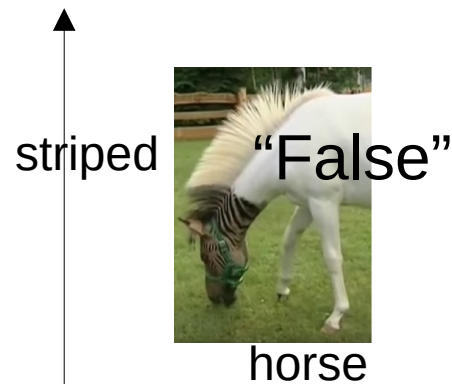
Property



Subject

**Boolean Tensor**  
(Boolean Logic)

Property



Subject

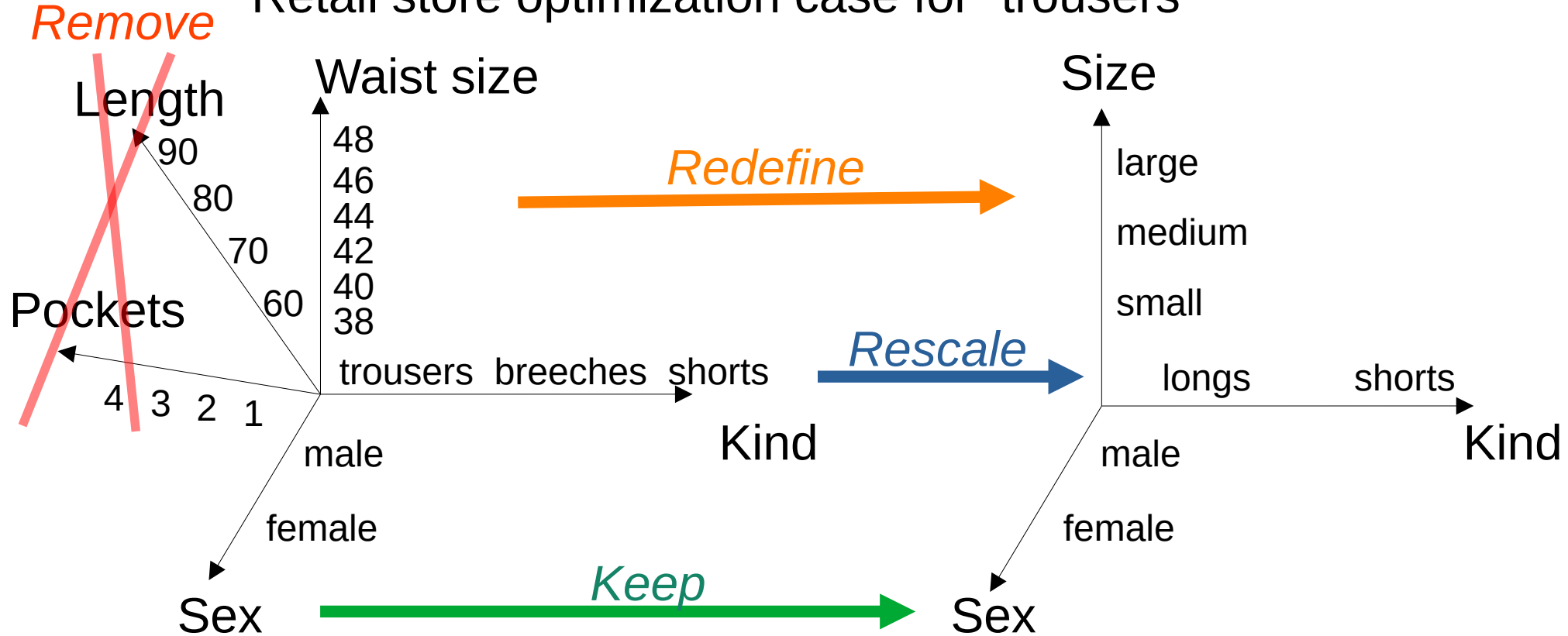
  
Life-long  
learning?

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

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# Problem of dimensionality (reduction) and discreteness (increase)

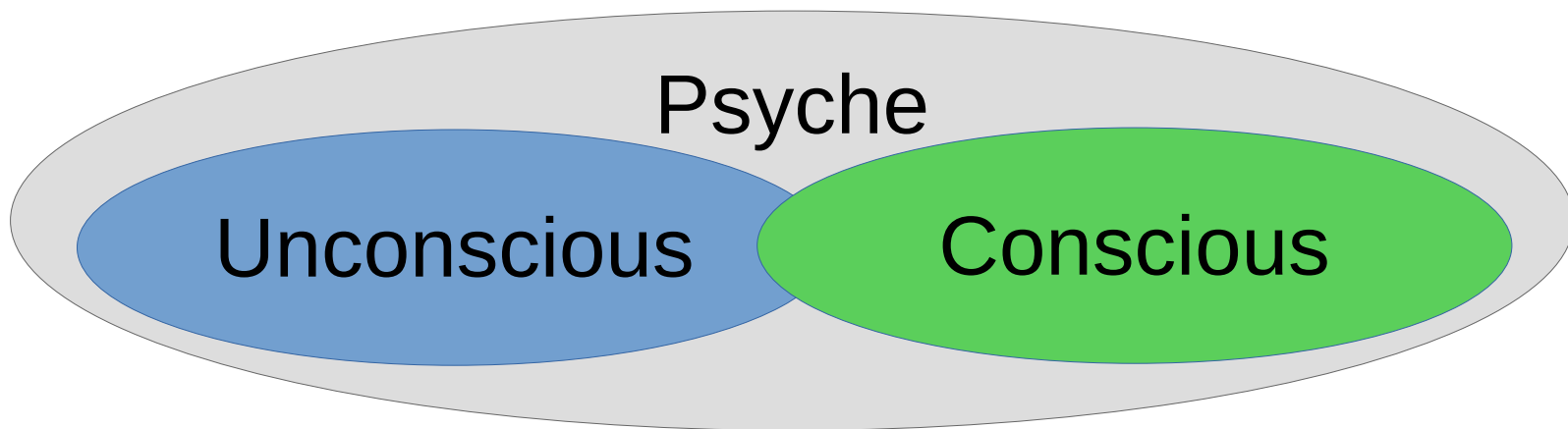
Retail store optimization case for “trousers”



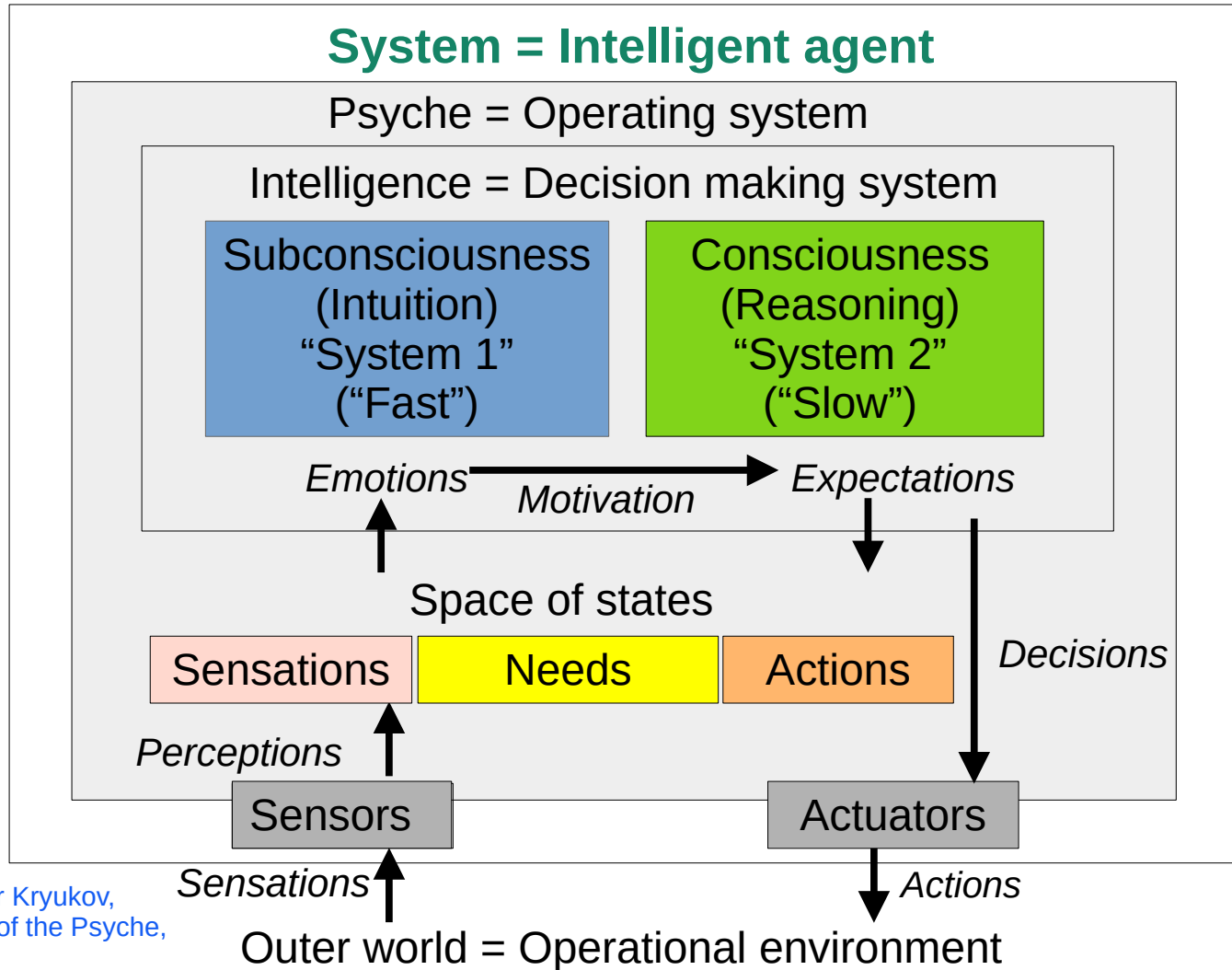


The psyche /'saɪki/ is currently used to describe the totality of the human mind, conscious and unconscious.

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



# System = Intelligent agent



# Psyche = Operating system

Intelligence = Decision making system

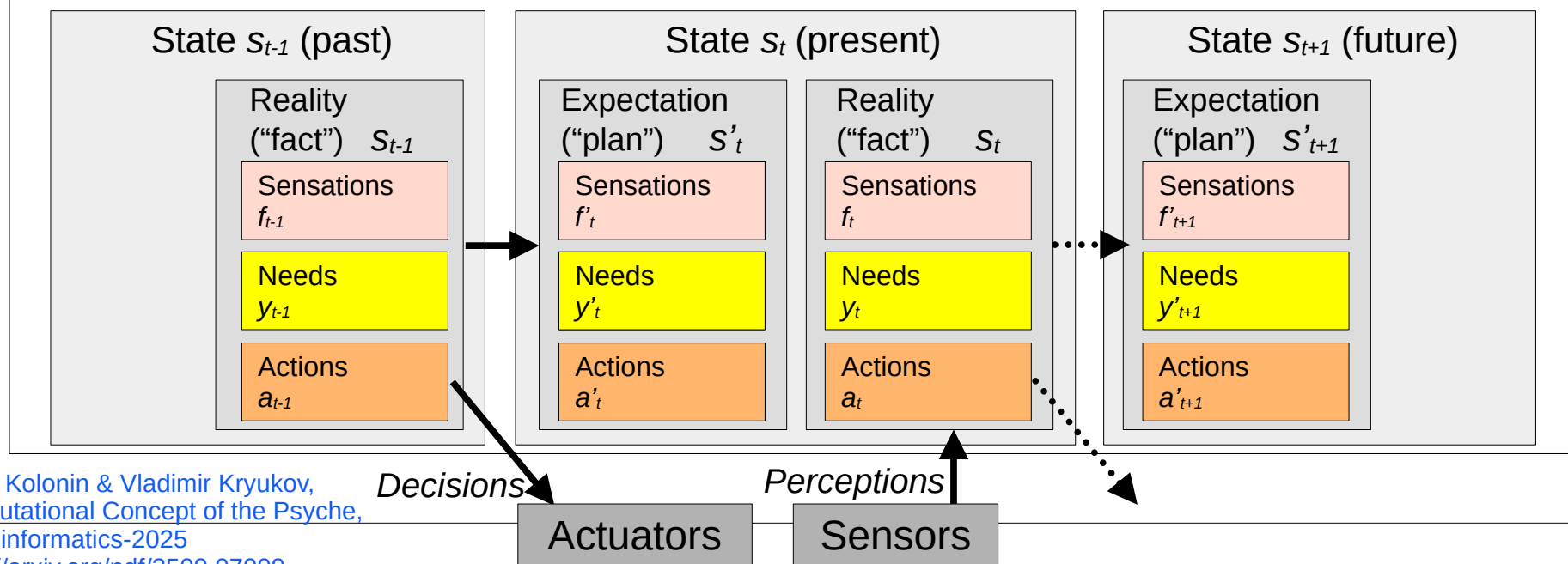
Models  $s$  (“invariants”) of states with utilities  $U$  and probabilities  $P$  of transitions

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

↑ *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

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

↑ 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

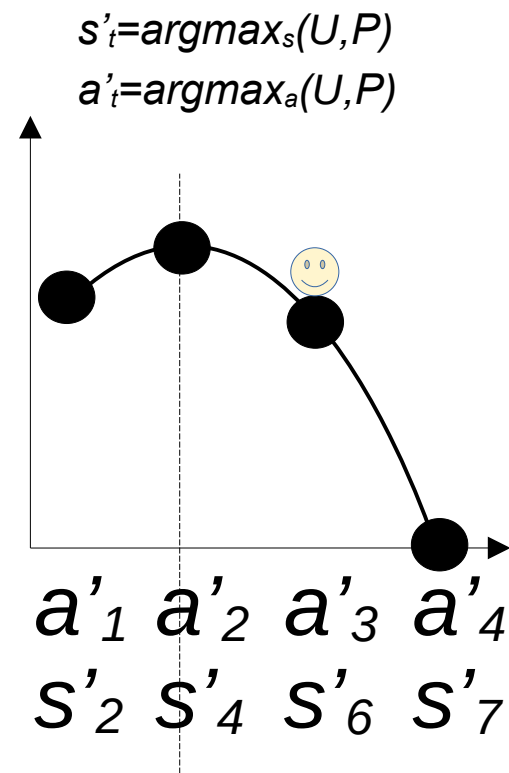
Sensors

$x \cdot y_t$  — "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

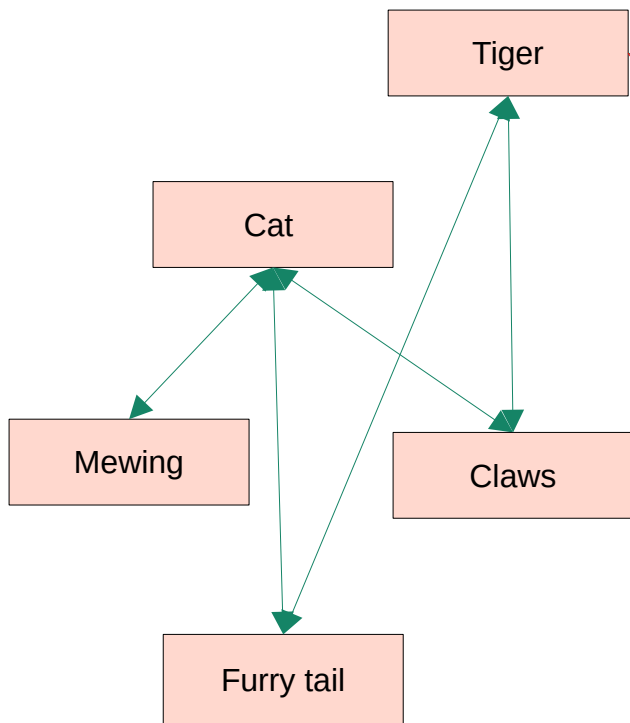
$S_t$	$S'_{t+1}$	$S'_{t+1}$			$U$	$P$	$\Sigma U*P$
		$a'$	$y'$	$f'$			
$S_1$	$S'_2$	$a'_1$	$y'_1$	...	1.0	0.5	<u>0.7</u>
$S_1$	$S'_3$	$a'_1$	$y'_2$	...	0.4	0.5	
$S_1$	$S'_4$	$a'_2$	$y'_3$	...	1.0	0.8	<u>0.8</u>
$S_1$	$S'_5$	$a'_2$	$y'_4$	...	0.0	0.2	
$S_1$	$S'_6$	$a'_3$	$y'_5$	...	0.6	1.0	<u>0.6</u>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

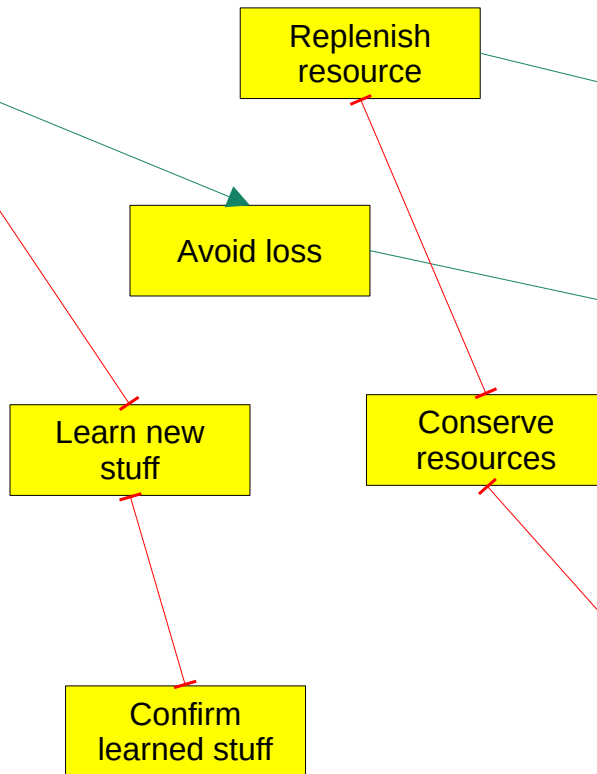
## Percept feelings



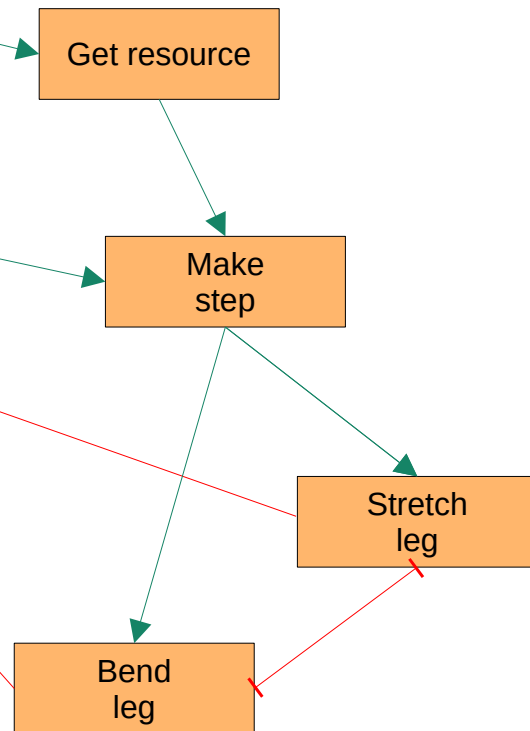
Anton Kolonin & Vladimir Kryukov,  
Computational Concept of the Psyche,  
Neuroinformatics-2025

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

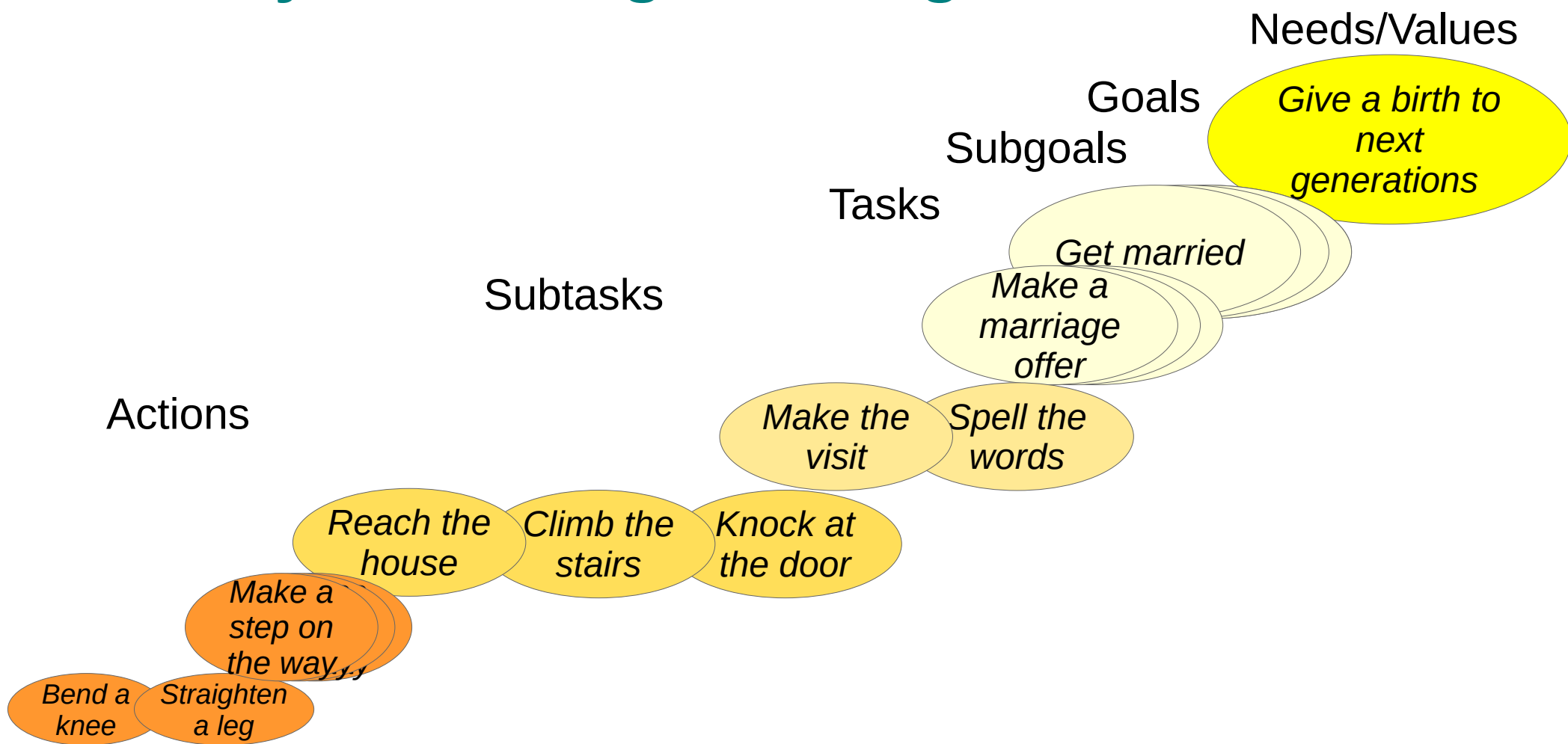
## Satisfied needs



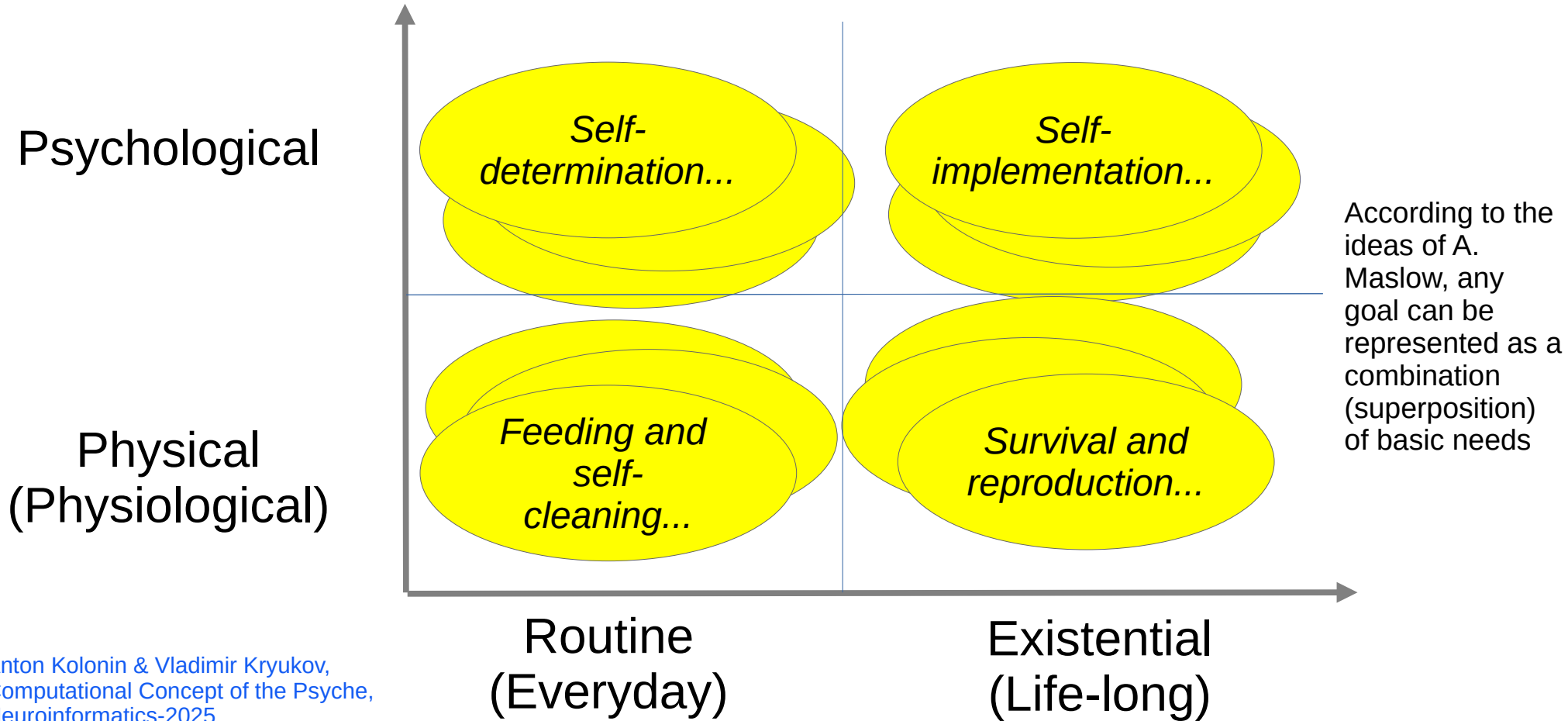
## Decided & committed actions



# Hierarchy of values/goals/subgoals/tasks/subtasks



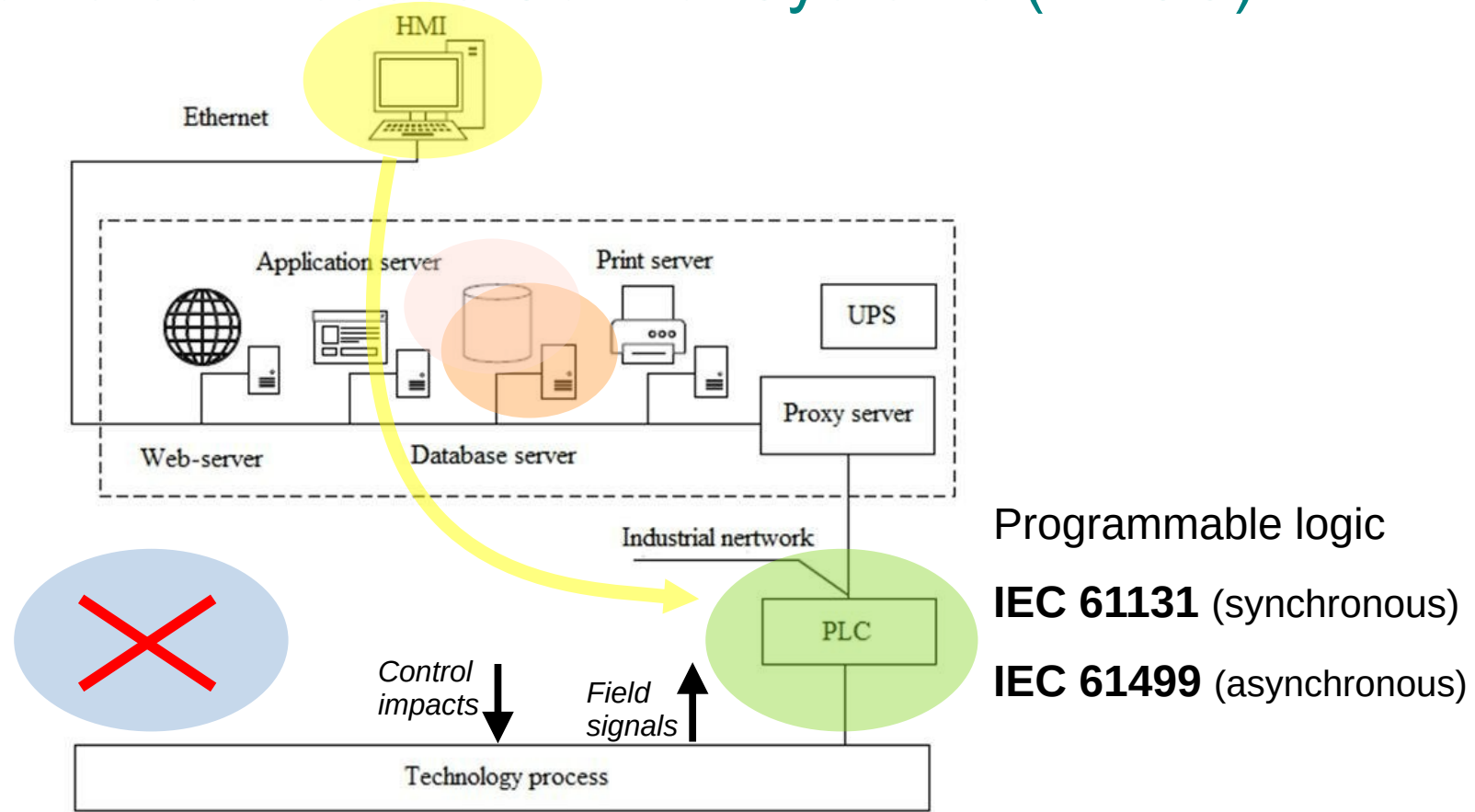
# Space of needs/goals/values





# Application cases

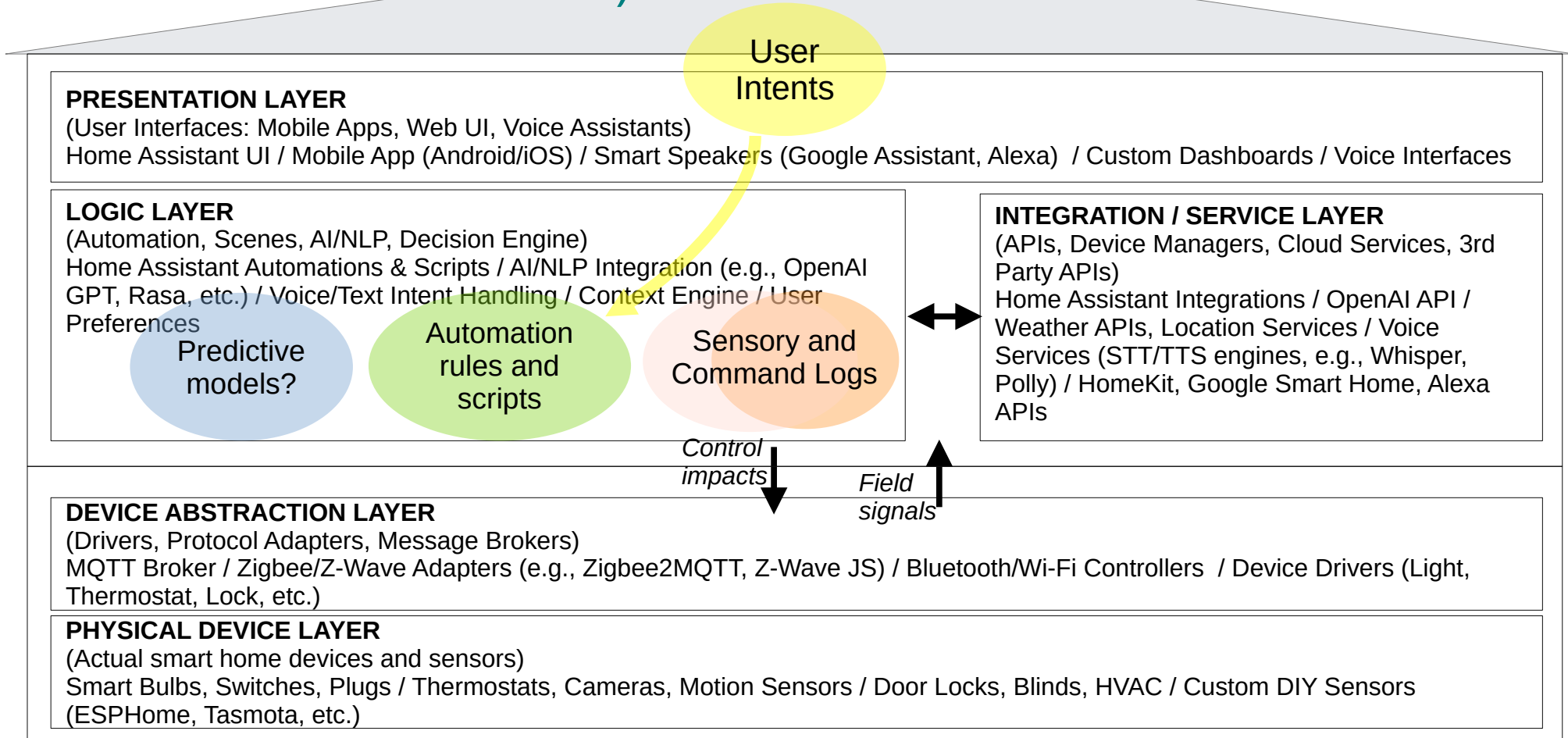
## A) Automated Process Control Systems (APCS)



[https://www.researchgate.net/publication/311662442\\_Adaptive\\_Intelligent\\_Manufacturing\\_Control\\_Systems](https://www.researchgate.net/publication/311662442_Adaptive_Intelligent_Manufacturing_Control_Systems)

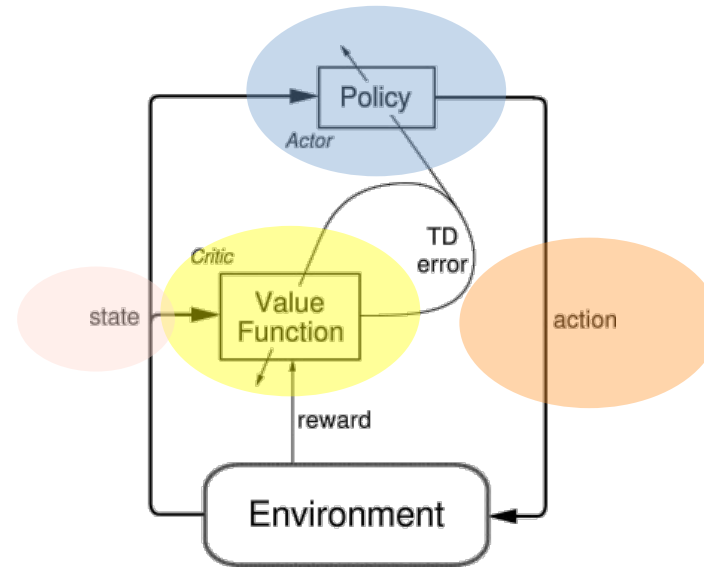
# Application cases

## B) “Smart Home”



# Implementation options

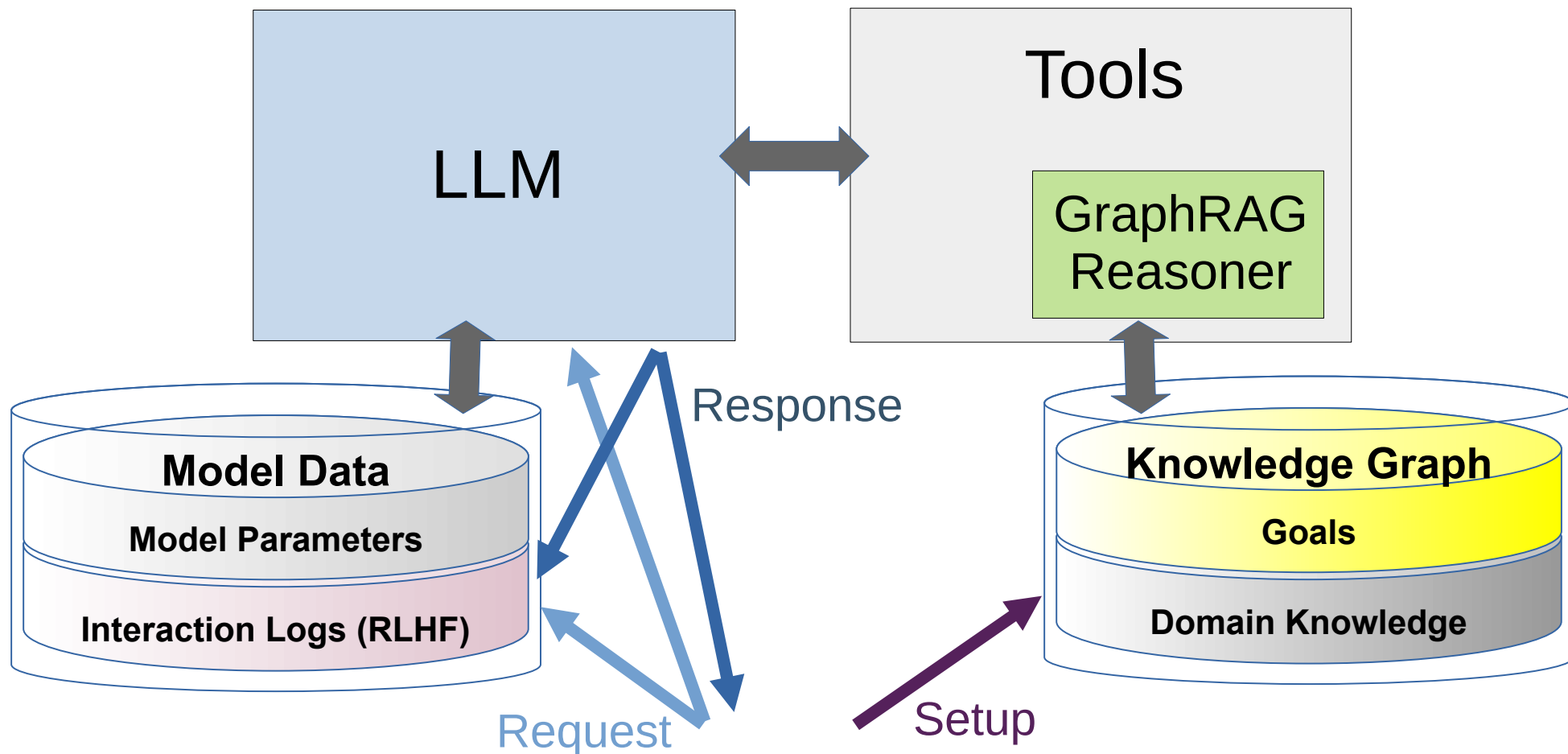
## 1) Reinforcement learning based on “actor-critic” model



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

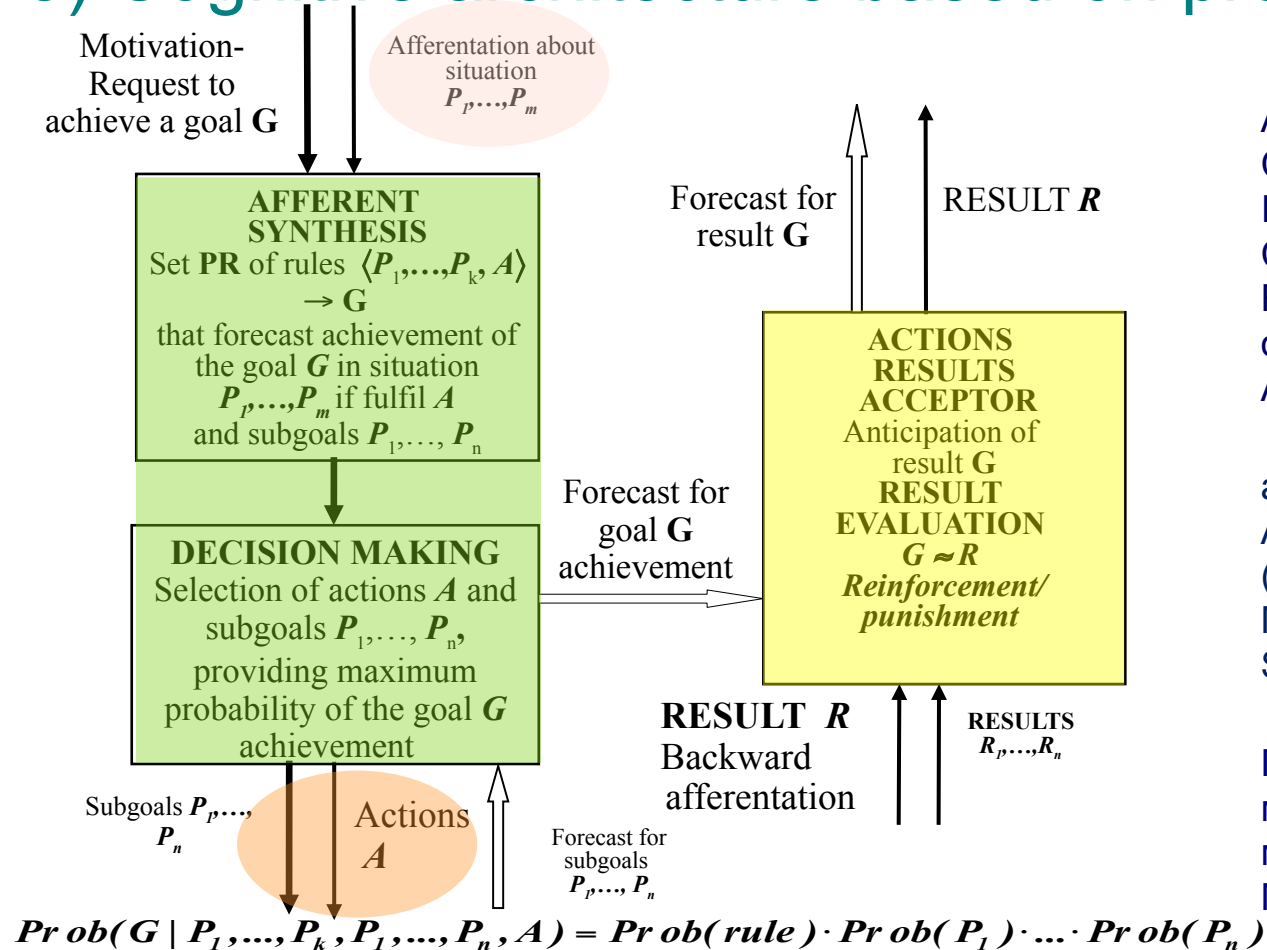
# Implementation options

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



# Implementation options

## 3) Cognitive architecture based on probabilistic logic



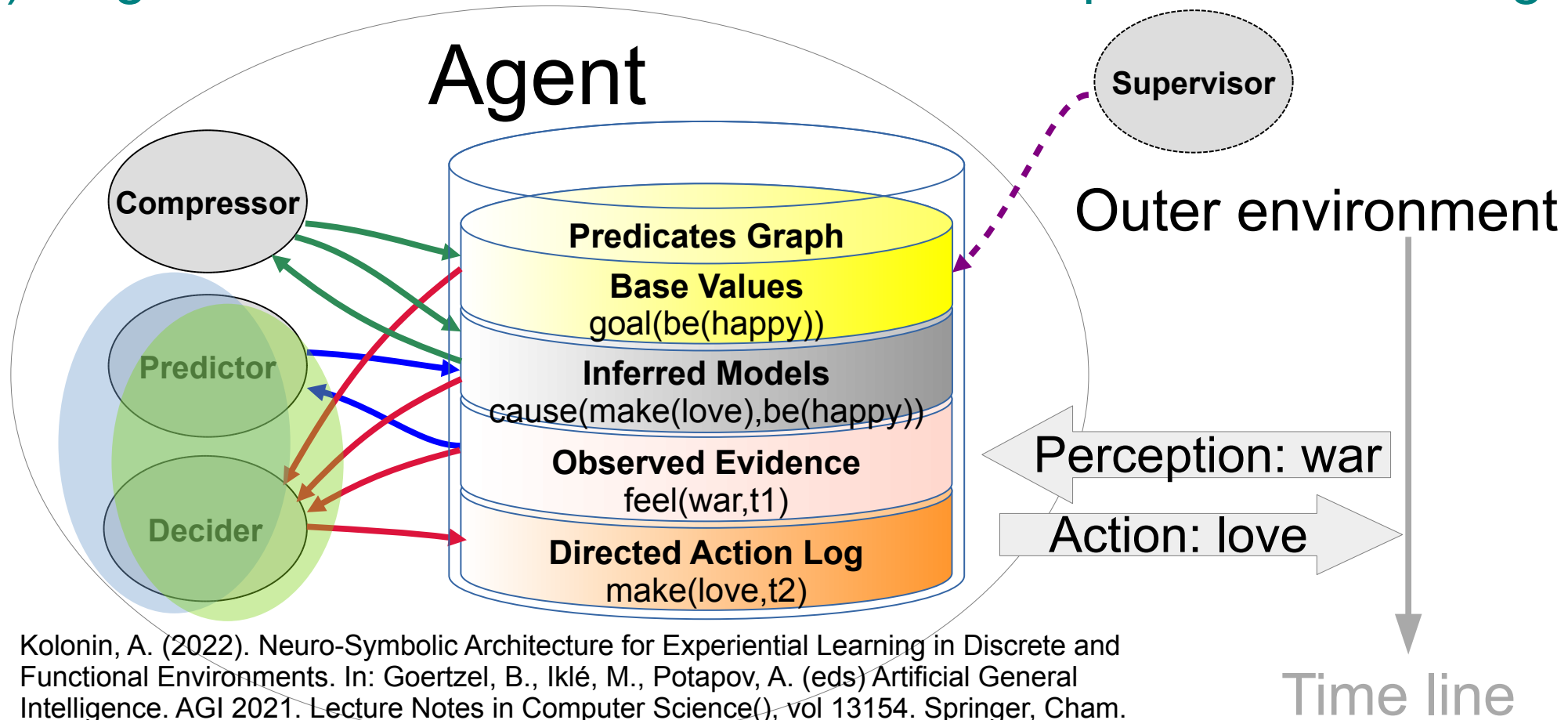
Evgenii Vityaev, Alexander Demin:  
Adaptive Control of Modular Robots //  
Conference Paper in Advances in  
Intelligent Systems and Computing,  
Conference: First International Early  
Research Career Enhancement School  
on Biologically Inspired Cognitive  
Architectures, Springer, August 2018

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.

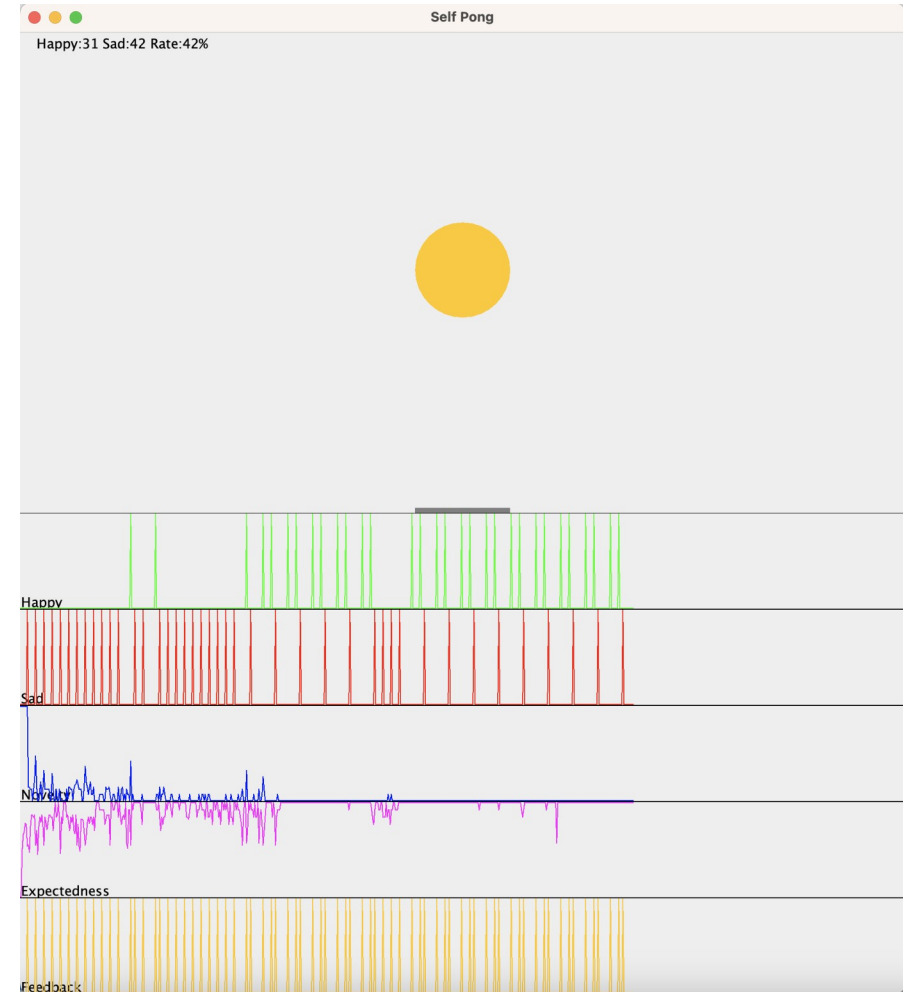
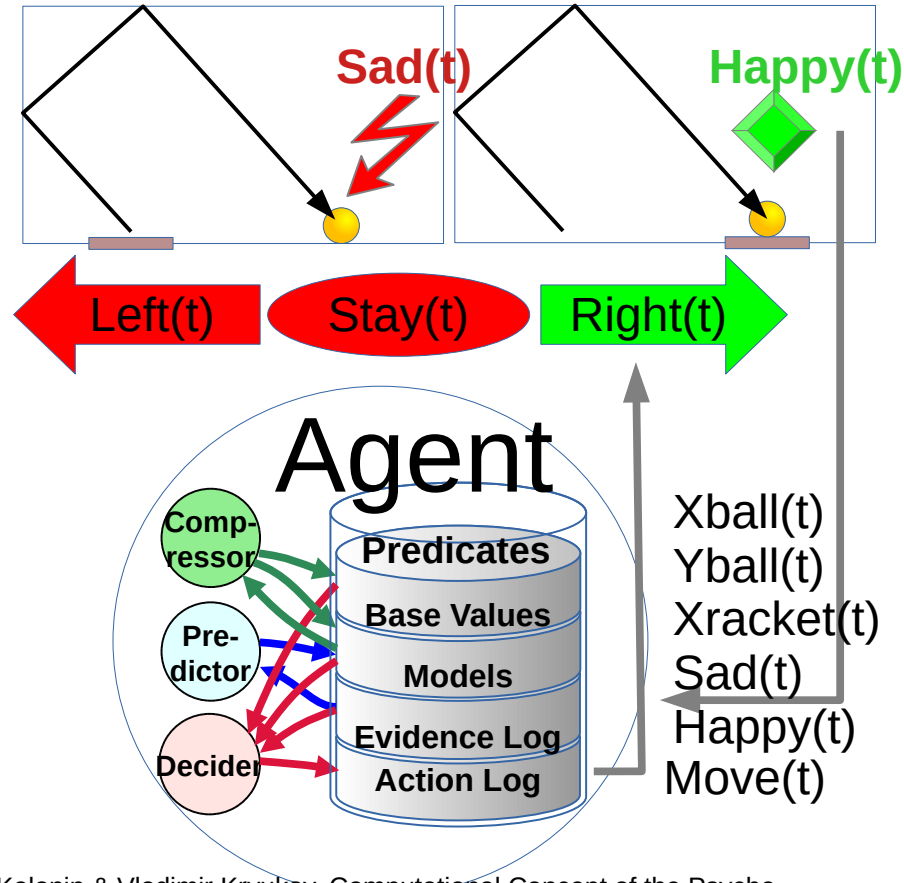
# Implementation options

## 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](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

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

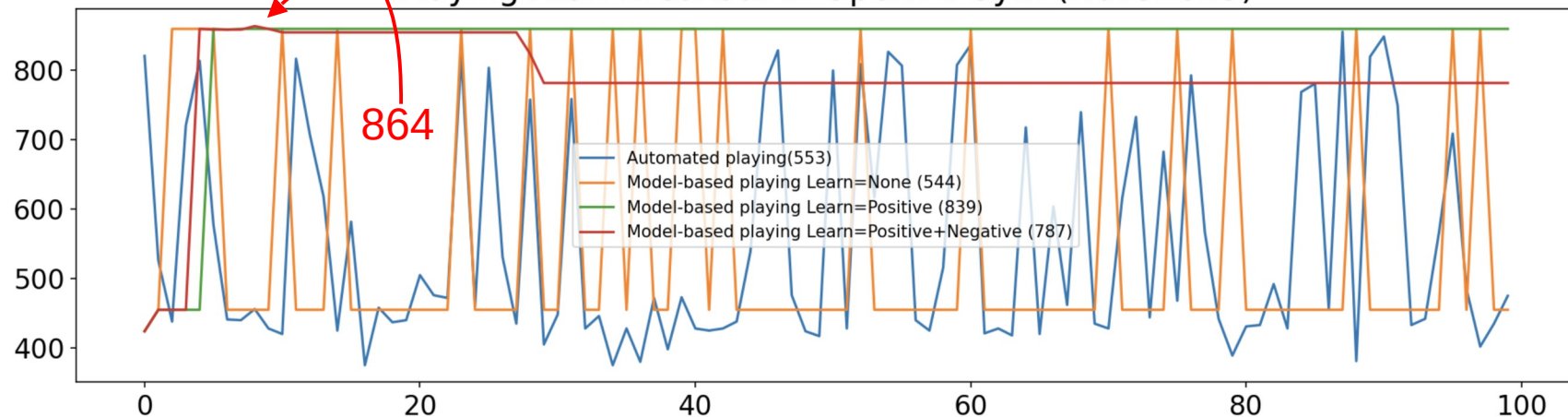
Anton Kolonin, Neuro-Symbolic Architecture for Experiential Learning in Discrete and Functional Environments

[https://doi.org/10.1007/978-3-030-93758-4\\_12](https://doi.org/10.1007/978-3-030-93758-4_12)

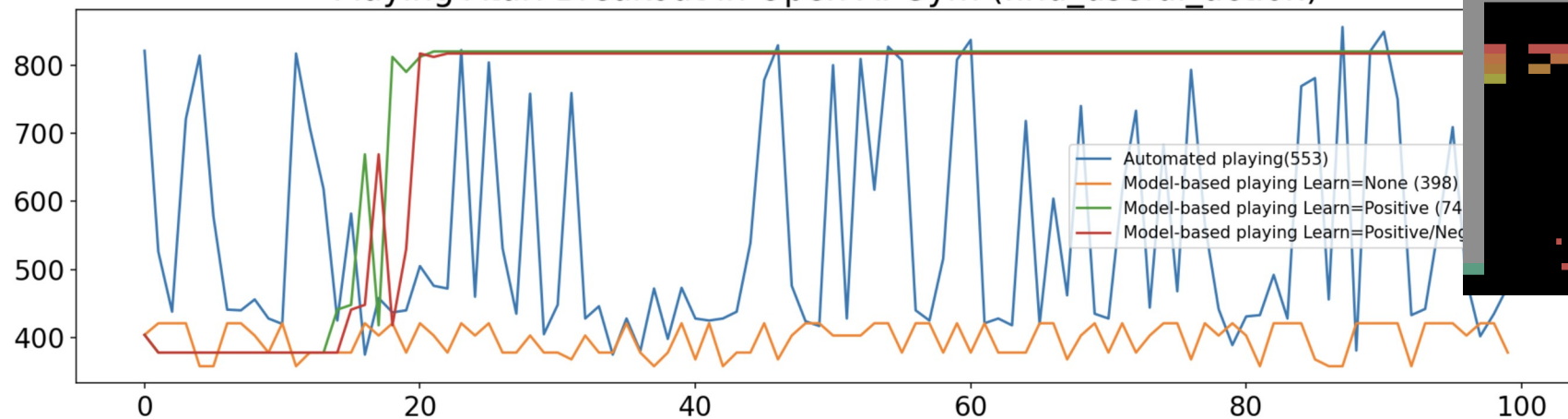
Copyright © 2025 Anton Kolonin

# Imitation learning – decision making on “pre-trained” model

Playing Atari Breakout in Open AI Gym (Nov32025)



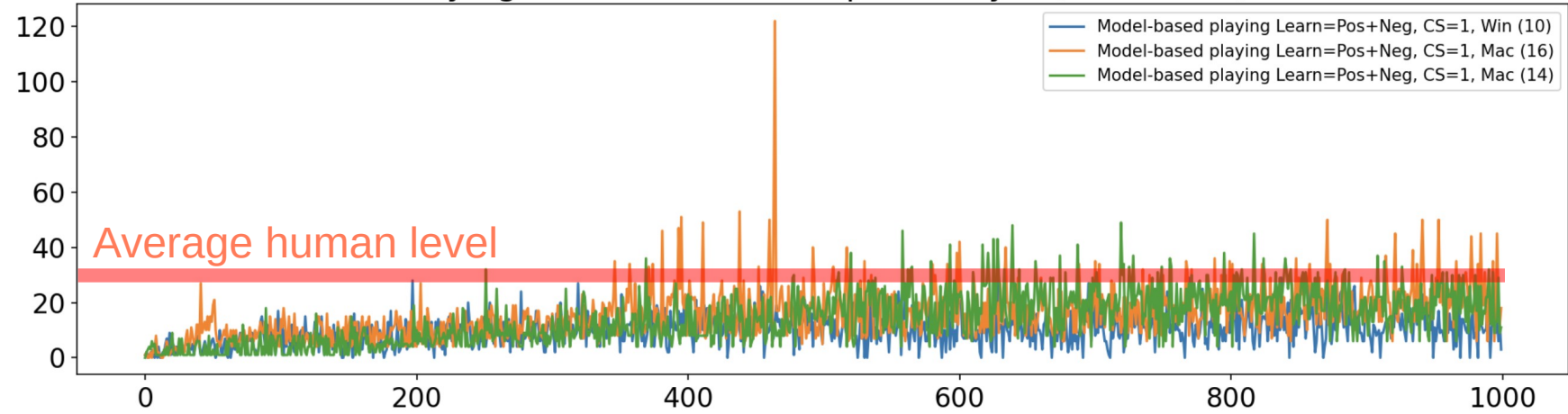
Playing Atari Breakout in Open AI Gym (find\_useful\_action)



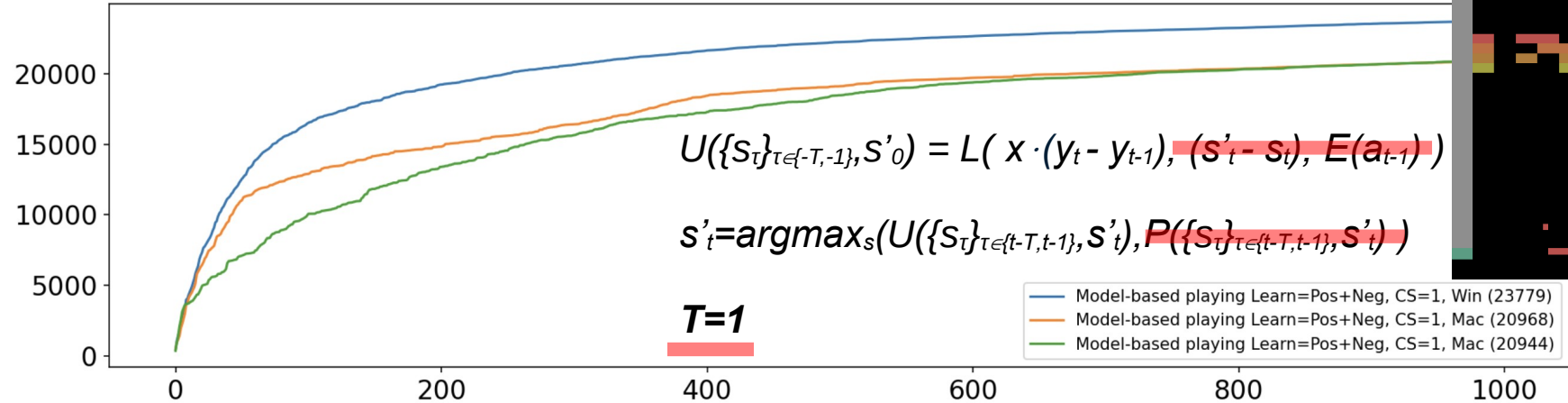


# Reinforcement learning – experiential learning and decision making

Playing Atari Breakout in Open AI Gym (Nov32025)



N of States in the Model (Nov32025)



$$U(\{s_t\}_{t \in [-T, -1]}, s'_0) = L(x \cdot (y_t - y_{t-1}), (s'_t - s_t), E(a_{t-1}))$$

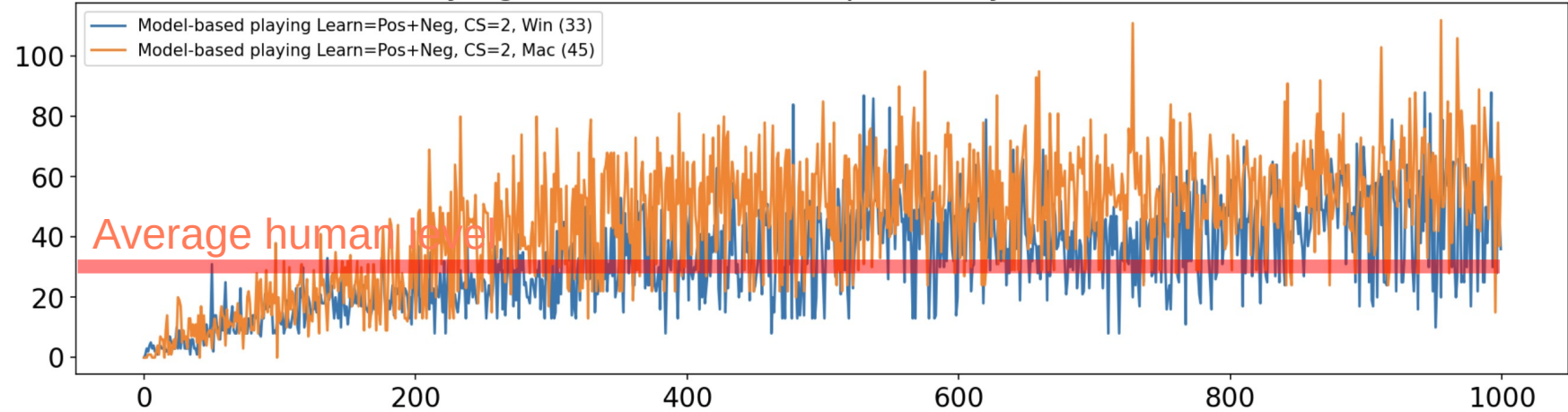
$$s'_t = \operatorname{argmax}_s (U(\{s_t\}_{t \in [-T, t-1]}, s'_t), P(\{s_t\}_{t \in [-T, t-1]}, s'_t))$$

**T=1**

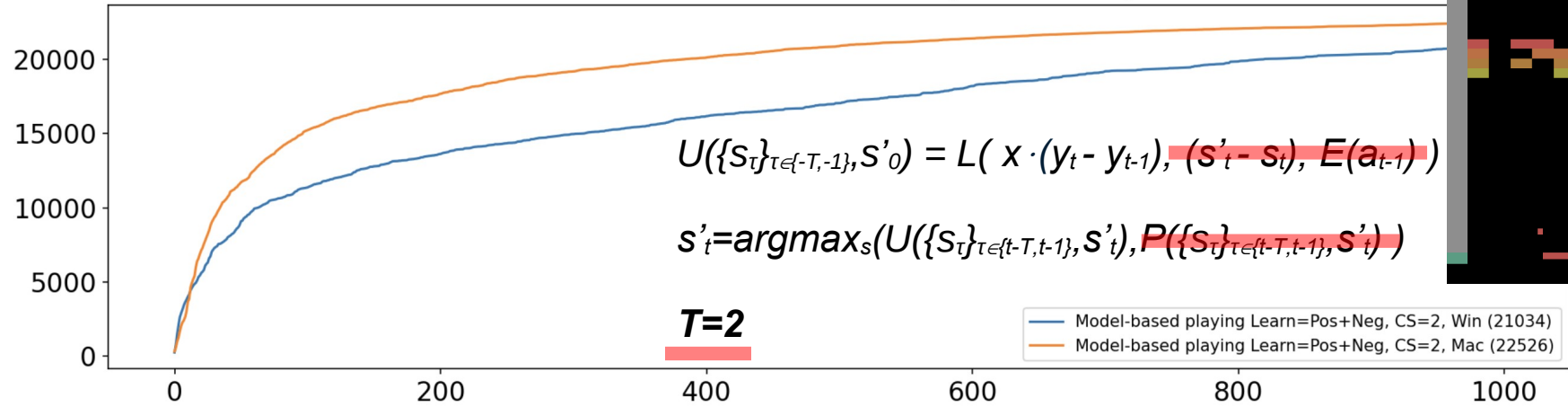


# Reinforcement learning – experiential learning and decision making

Playing Atari Breakout in Open AI Gym (Nov32025)



N of States in the Model (Nov32025)



$$U(\{s_t\}_{t \in [-T, -1]}, s'_0) = L(x \cdot (y_t - y_{t-1}), (s'_t - s_t), E(a_{t-1}))$$

$$s'_t = \operatorname{argmax}_s (U(\{s_t\}_{t \in [-T, t-1]}, s'_t), P(\{s_t\}_{t \in [-T, t-1]}, s'_t))$$

**T=2**



# Thank you for attention! Questions?

Anton Kolonin

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Telegram/GitHub: [akolonin](#)

Workshop recording  
on the subject



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

