Setting up

- **No zoom chat**
  - Questions will be answered at specific times
- **Suppress distractions**
  - Clear notifications
    - Turn off your phone, mails, Facebook…
- Get ready: Open a clean browser with only:
  - Your personal report
  - Course instructions: https://tinyurl.com/instructions-fund-of-ai

EMBODIED AI
ARTIFICIAL EVOLUTION
EMERGENCE

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Fundamentals of Artificial Intelligence

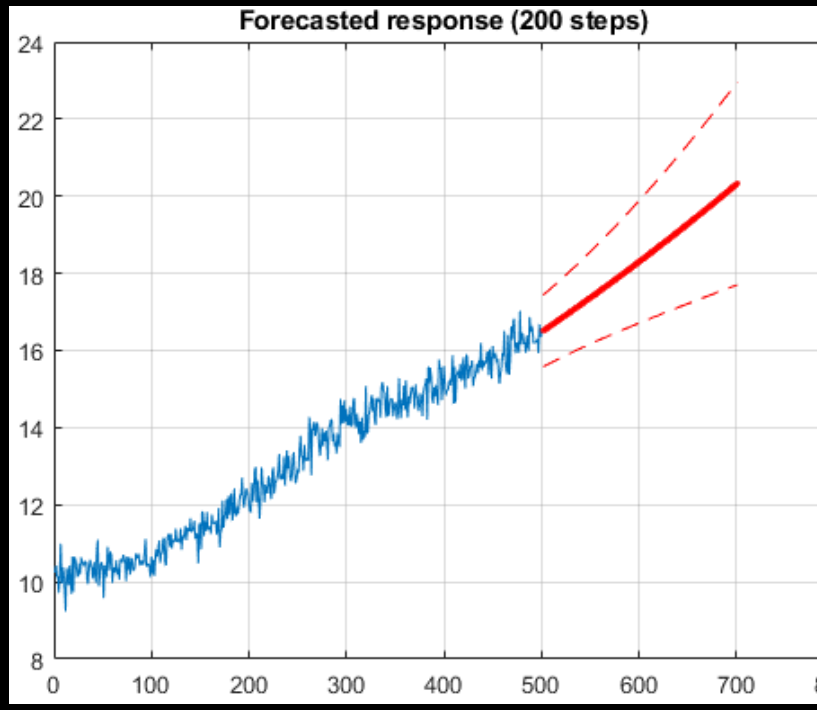
Department of Computing Science

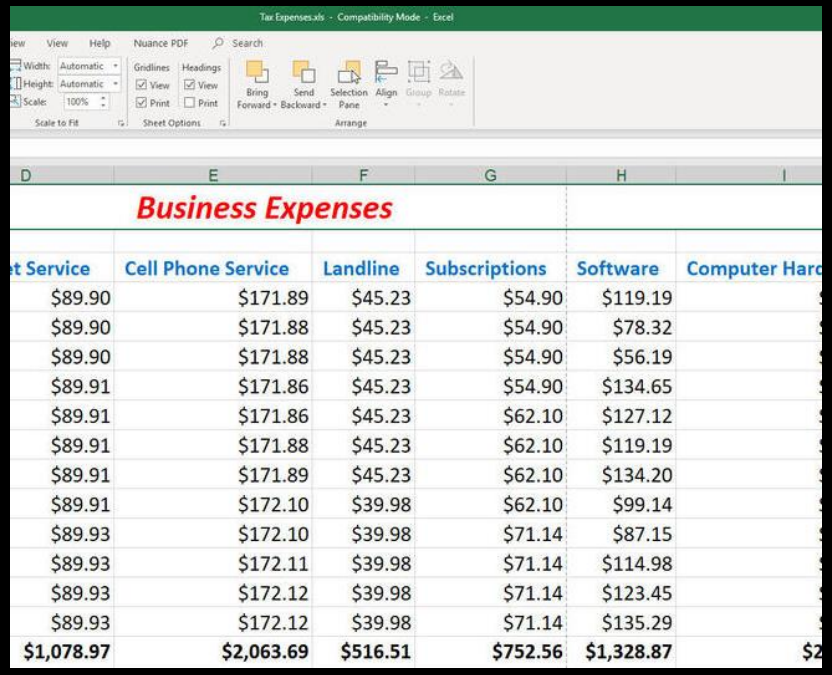
UMEÅ UNIVERSITY

Cognitive tasks can be more or less easy or hard

Is that true?

Some complex tasks for humans can be easy for computers





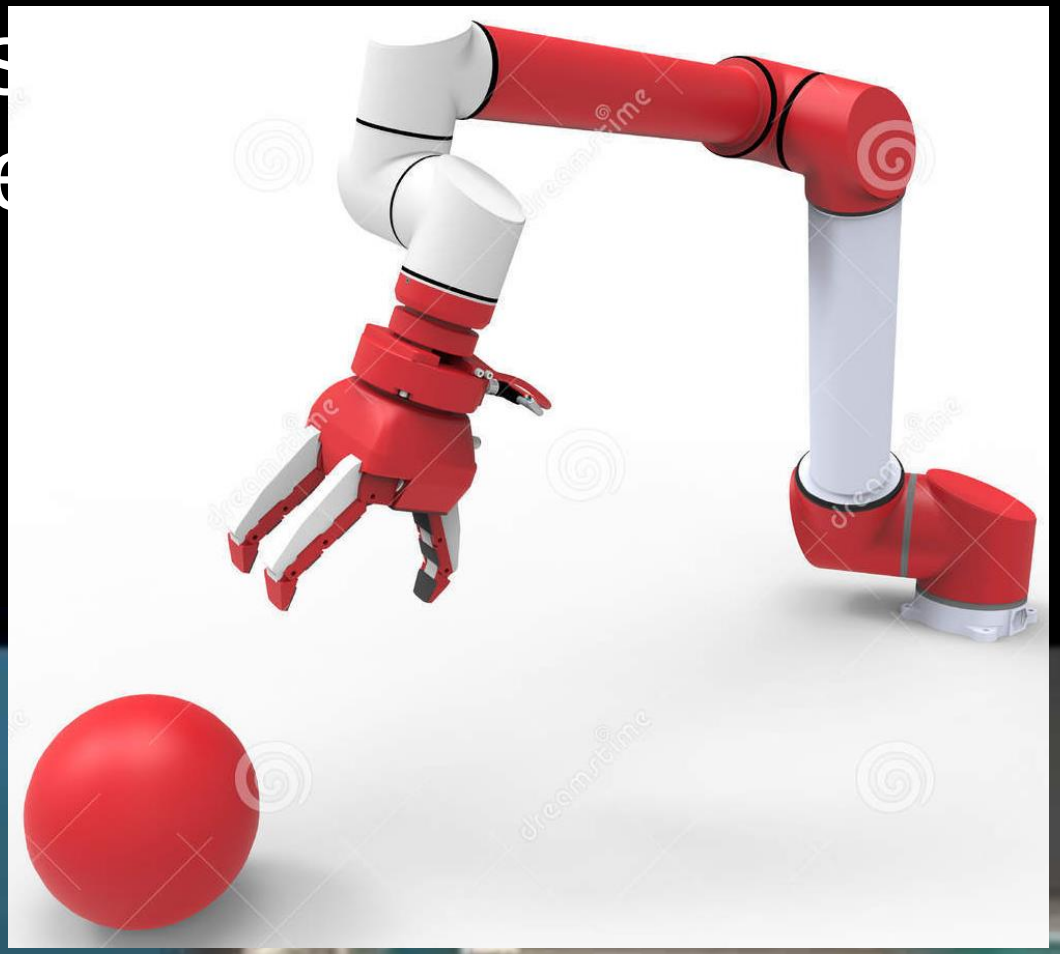
Business Expenses

t Service	Cell Phone Service	Landline	Subscriptions	Software	Computer Hard
$89.90	$171.89	$45.23	$54.90	$119.19	
$89.90	$171.88	$45.23	$54.90	$78.32	
$89.90	$171.88	$45.23	$54.90	$56.19	
$89.91	$171.86	$45.23	$54.90	$134.65	
$89.91	$171.86	$45.23	$62.10	$127.12	
$89.91	$171.88	$45.23	$62.10	$119.19	
$89.91	$171.89	$45.23	$62.10	$134.20	
$89.91	$172.10	$39.98	$62.10	$99.14	
$89.93	$172.10	$39.98	$71.14	$87.15	
$89.93	$172.11	$39.98	$71.14	$114.98	
$89.93	$172.12	$39.98	$71.14	$123.45	
$89.93	$172.12	$39.98	$71.14	$135.29	
$1,078.97	$2,063.69	$516.51	$752.56	$1,328.87	$2

Some easy tasks for humans can be very hard for compute

```
climb(stairs)
{
        while(any_more_step_in_stairs())
        {

}
```

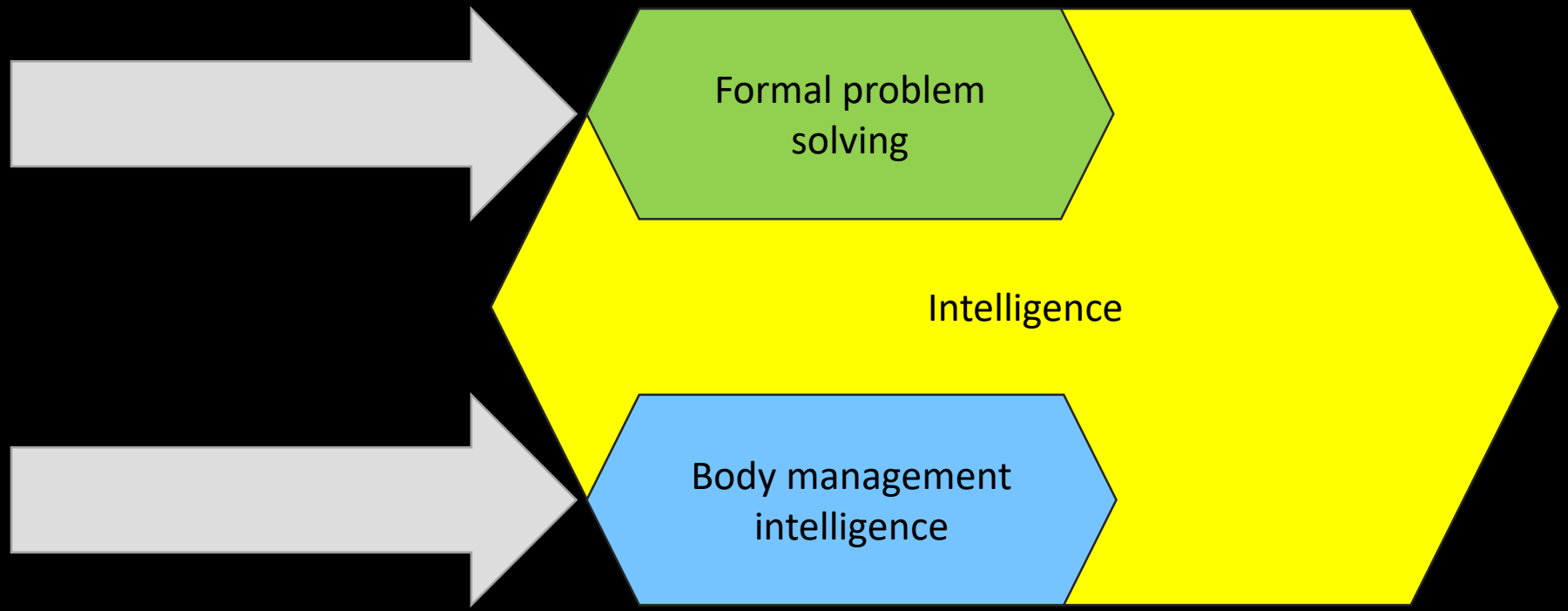


https://www.youtube.com/watch?v=VTlV0Y5yAww

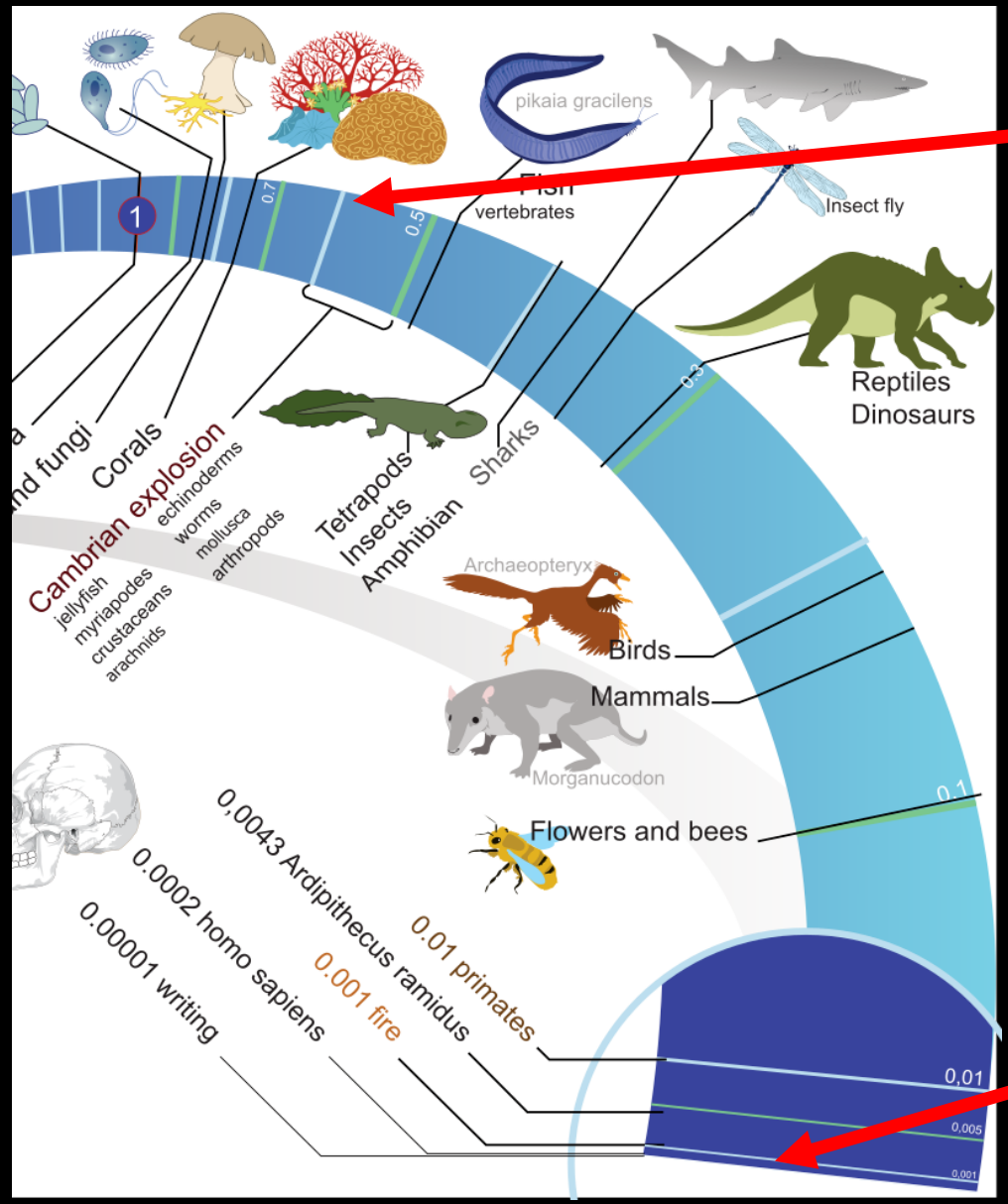
Millennia conceiving problems difficulty… Just got broken by AI?

Hard

Surprisingly super hard



Maybe not!

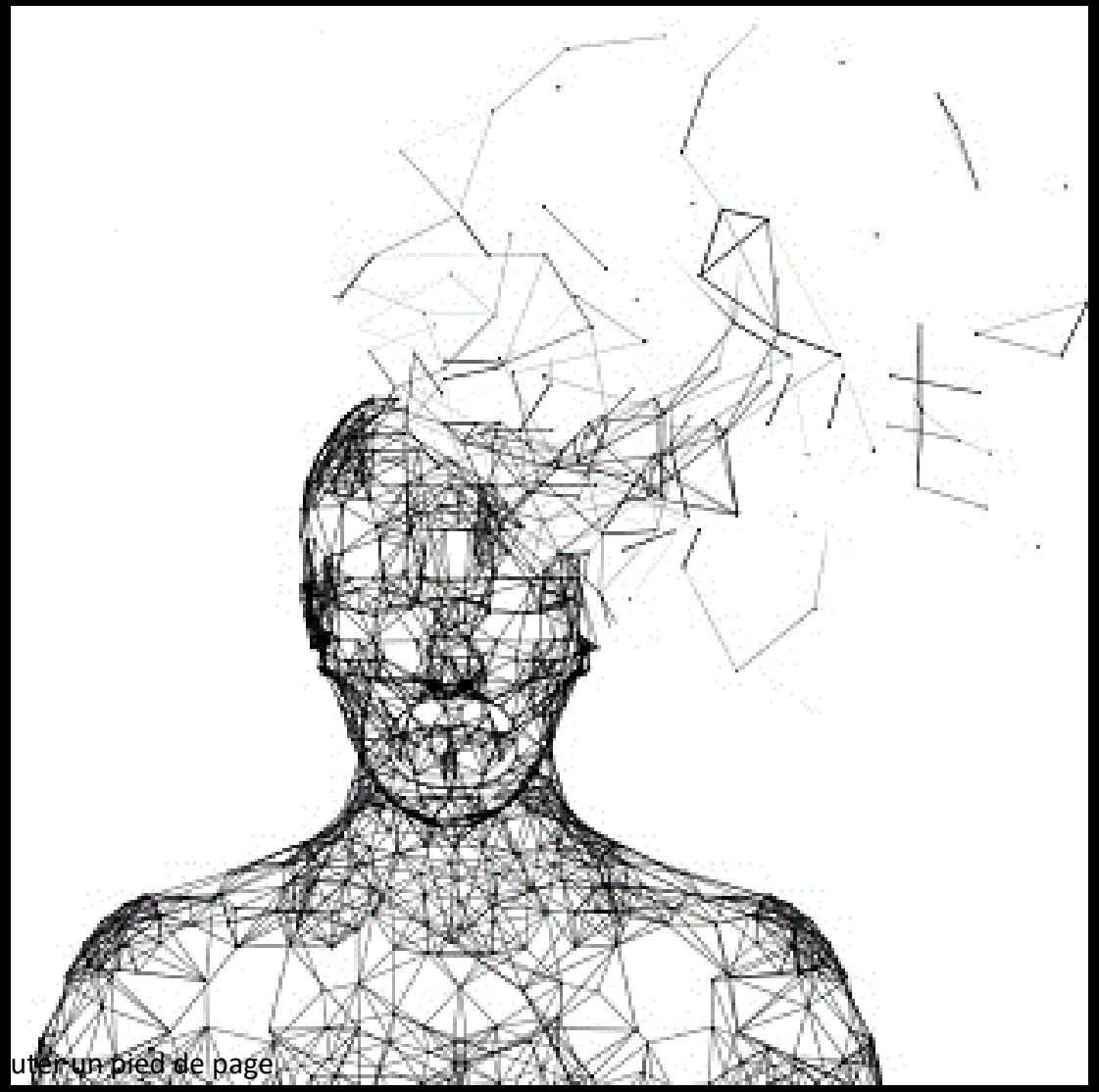


Time since body management is important

And maybe robot body (motors, hard pieces) is less fit for the task

Time since mathematics are important

Human and artificial intelligences are inherently shattered



uter un pied de page

Just not the same way

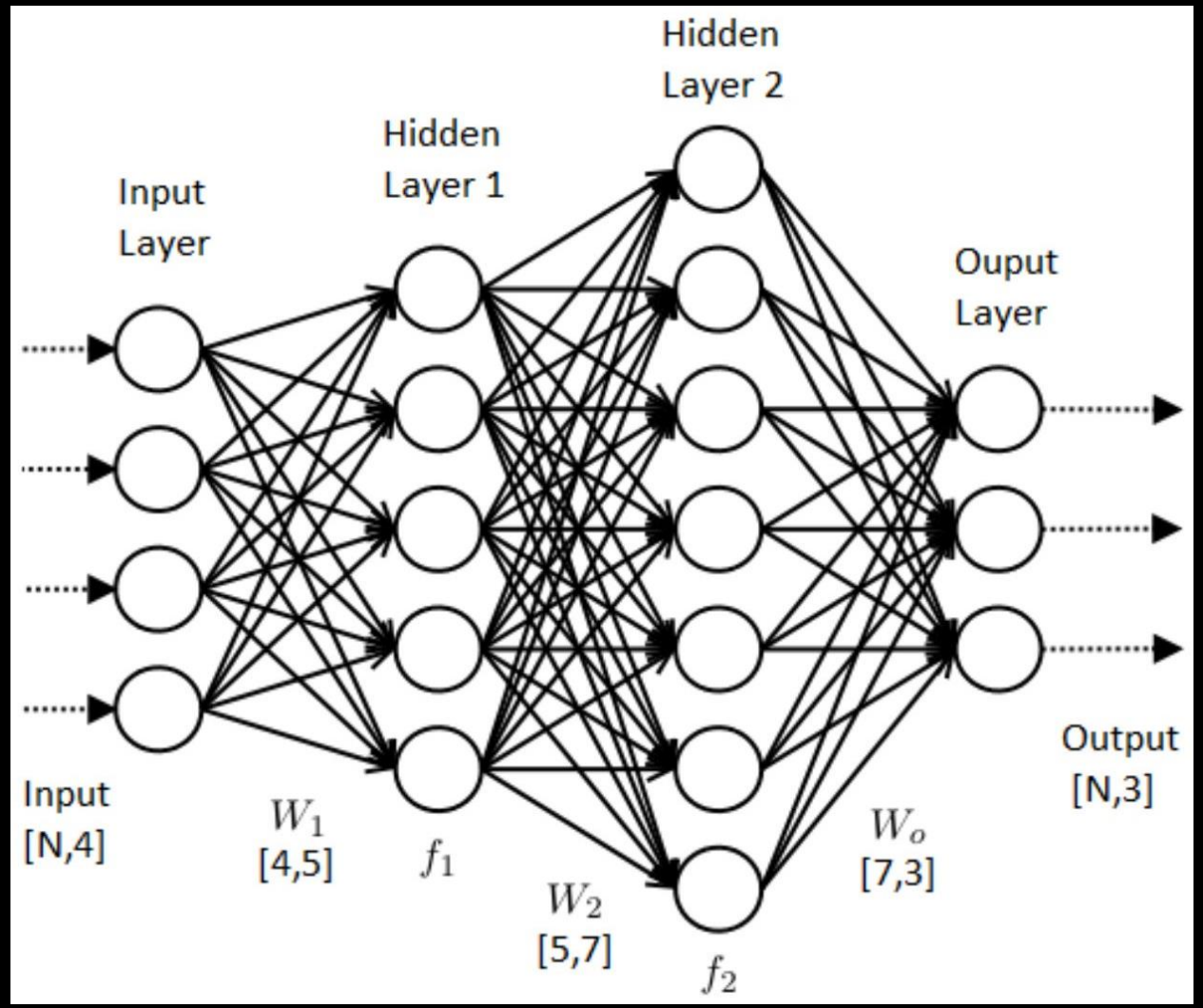
Can you think in 4D? 5D?
Can you open a door?

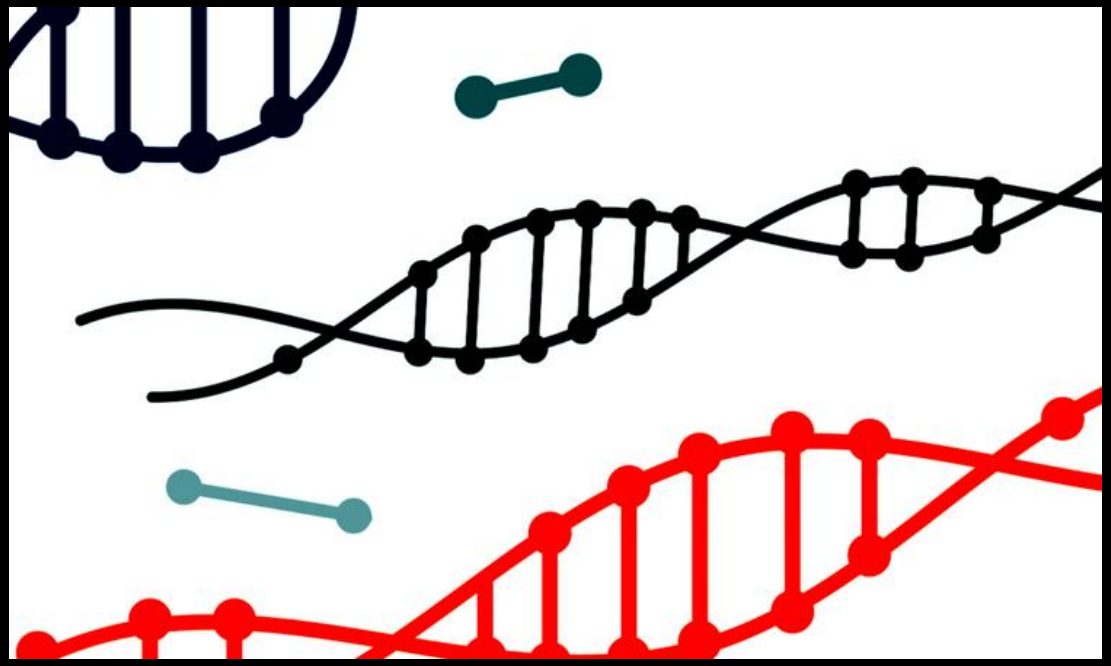
AI is very bad at « body intelligence »

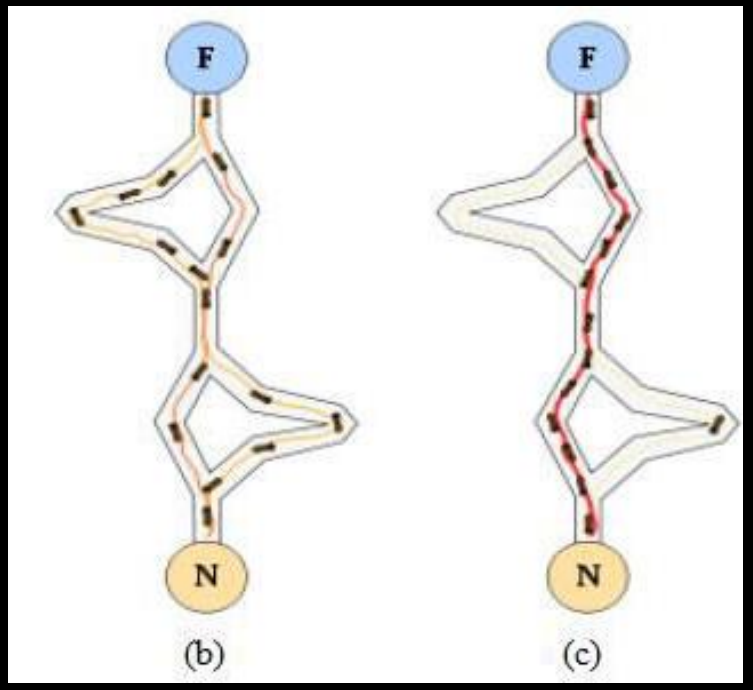
Inspiration for building well-working embodied systems?

Artificial life
Evolution

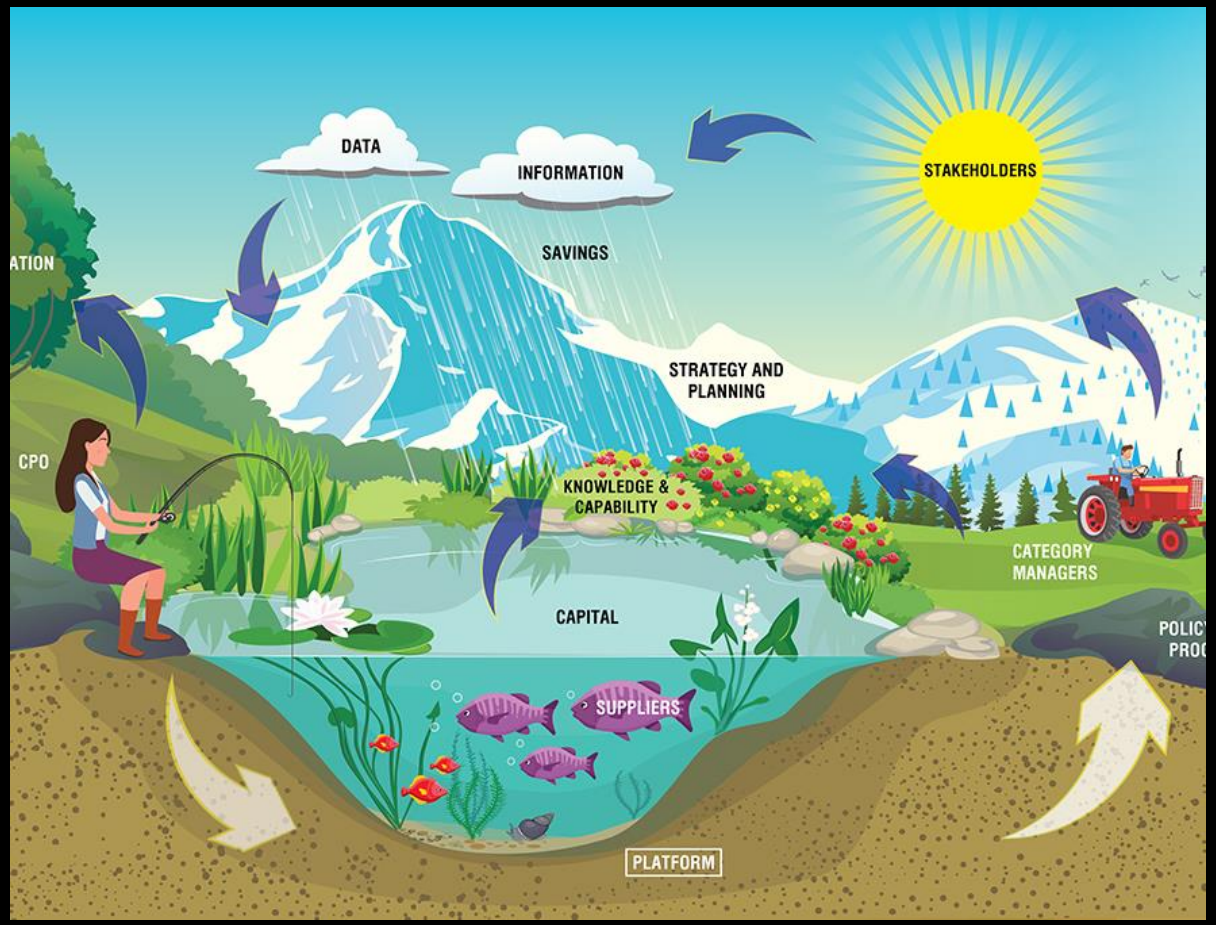
Nature makes workable embodied intelligent systems

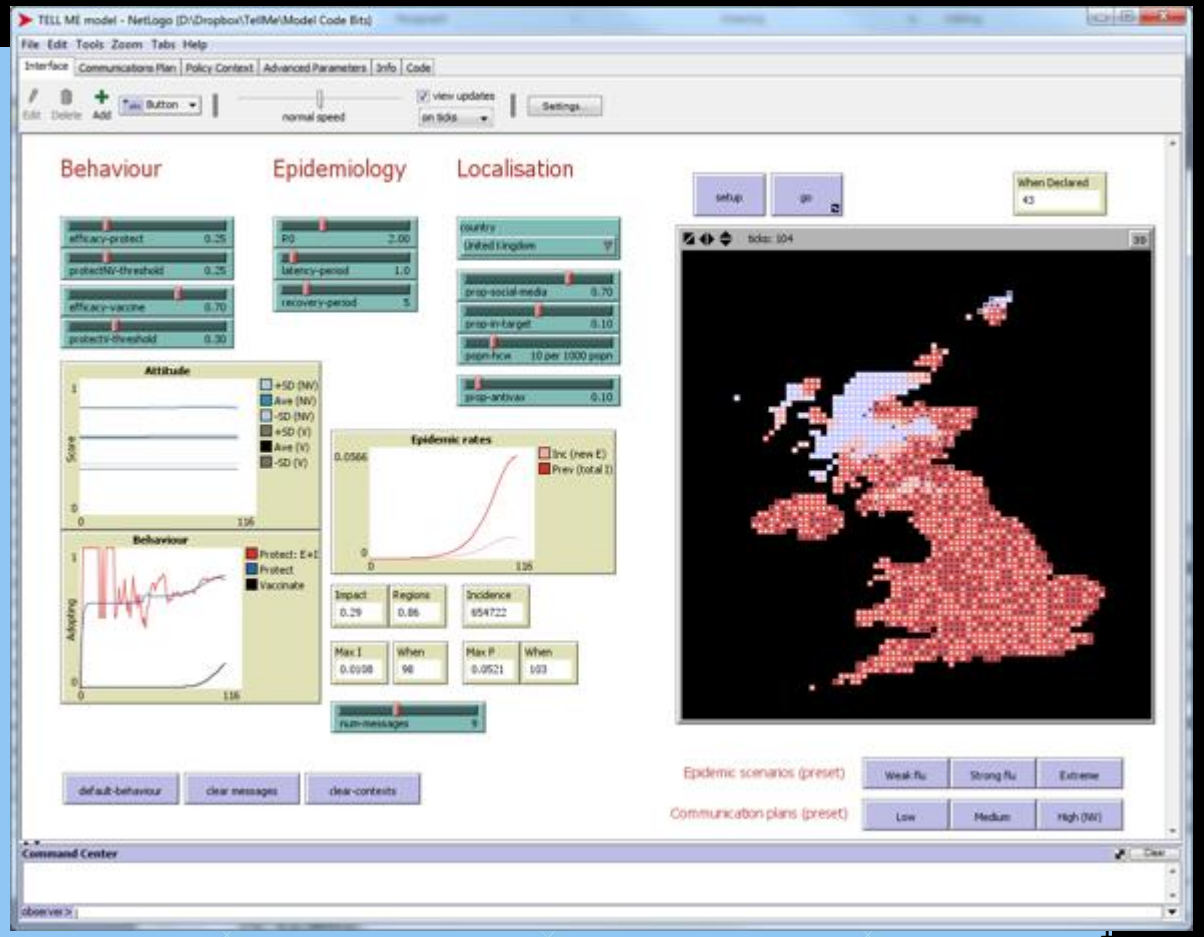

Hidden
Layer 2
Hidden
Layer 1
Input
Layer
Ouput
Layer
Output
[N,3]
Input
[N,4]
W_1
[4,5]
f_1
W_2
[5,7]
f_2
W_o
[7,3]




F
N
(b)
F
N
(c)

In return, replicating with AI can help understanding nature & society





We have so much to learn from each other!

AI inspired by humans/nature

- Planning
- Search
- Learning
- Neural nets
- …

Still pretty hard to replicate for AI

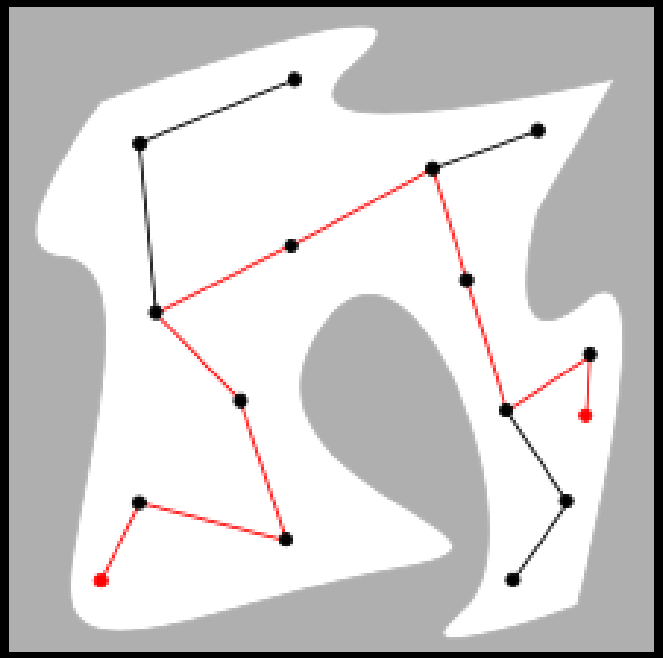
- Motion/body intelligence
- General intelligence
- Common sense

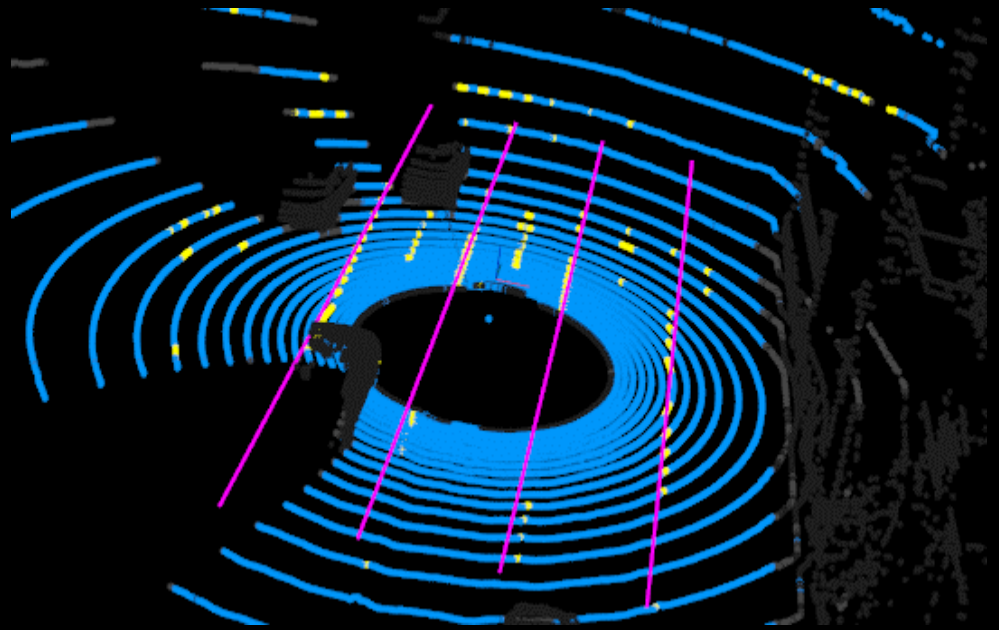
Using AI for understanding nature

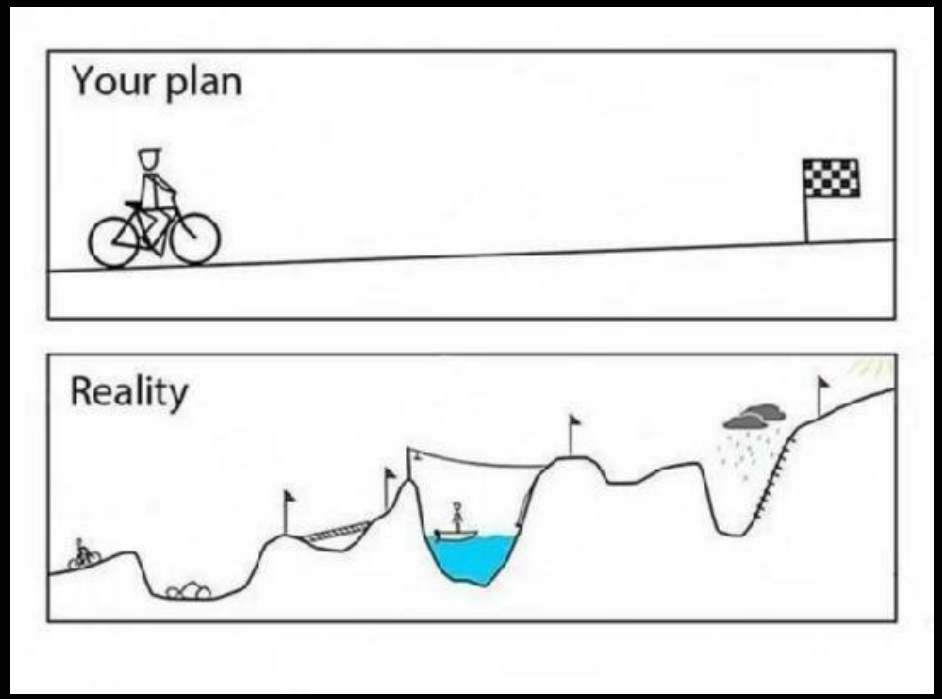
- Simulation
- Modelling

What is at play in embodied intelligence

Hint: more than body and intelligence!

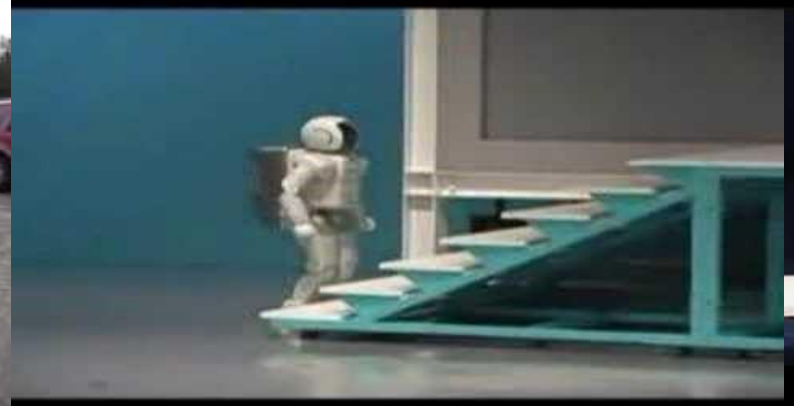


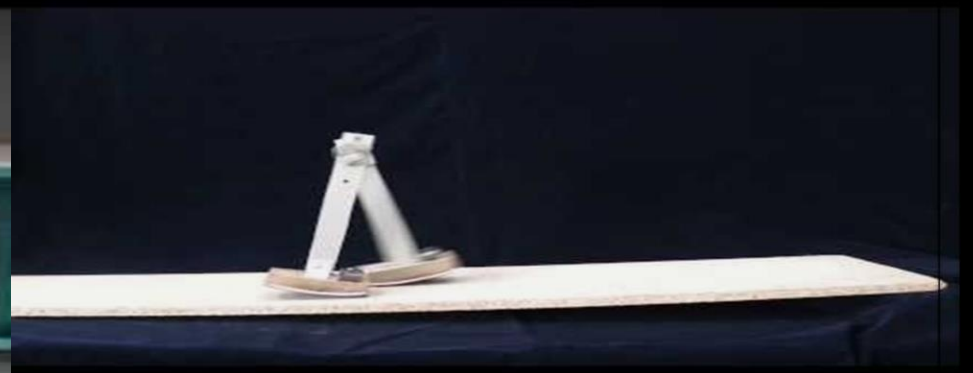



Your plan
Reality


J'STAR

The right body can lower cognitive needs (or cognitive challenge)

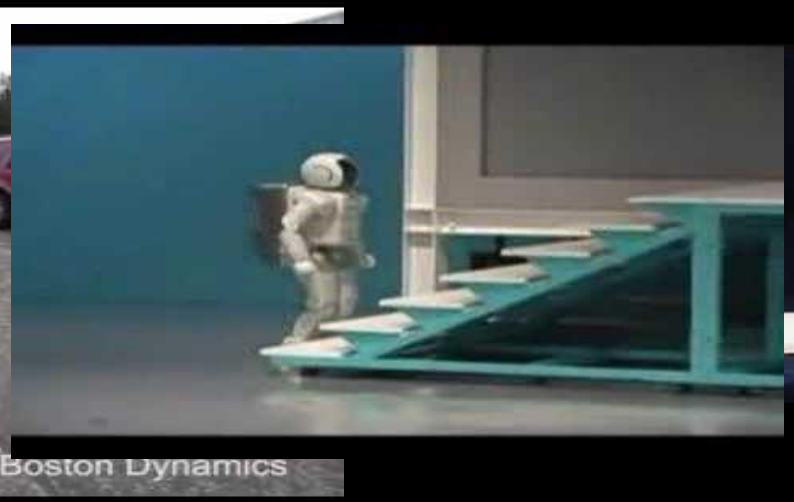


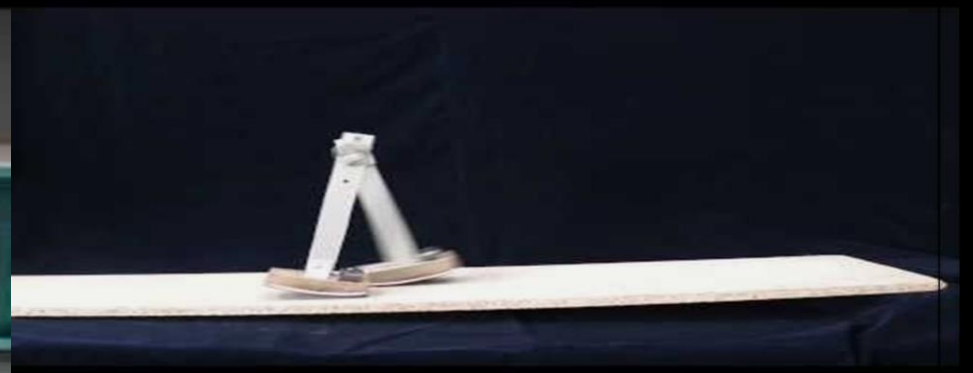


https://www.youtube.com/watch?v=4PaTWufUqqU

https://www.youtube.com/watch?v=CK8IFEGmiKY

The right body in the right environment can lower cognitive needs (or cognitive challenge)





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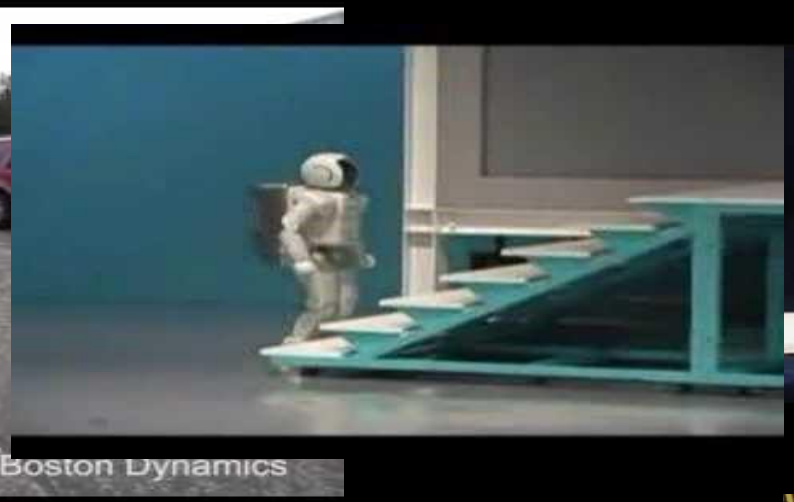
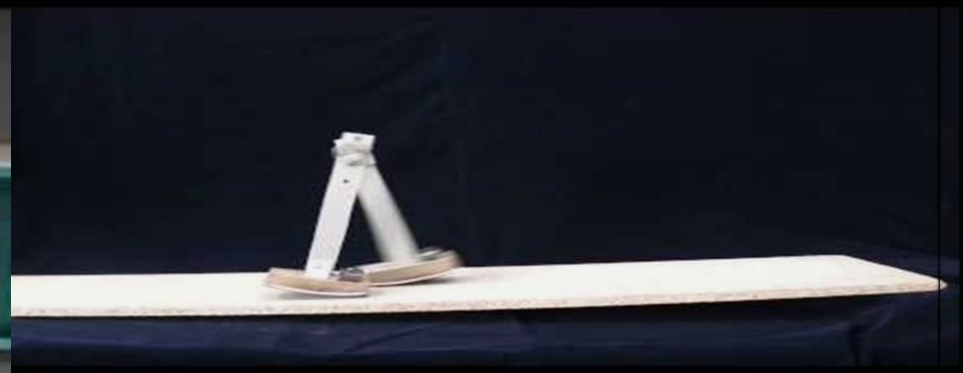
The right body in the right environment and right socioecological niche can lower cognitive needs (or cognitive challenge)





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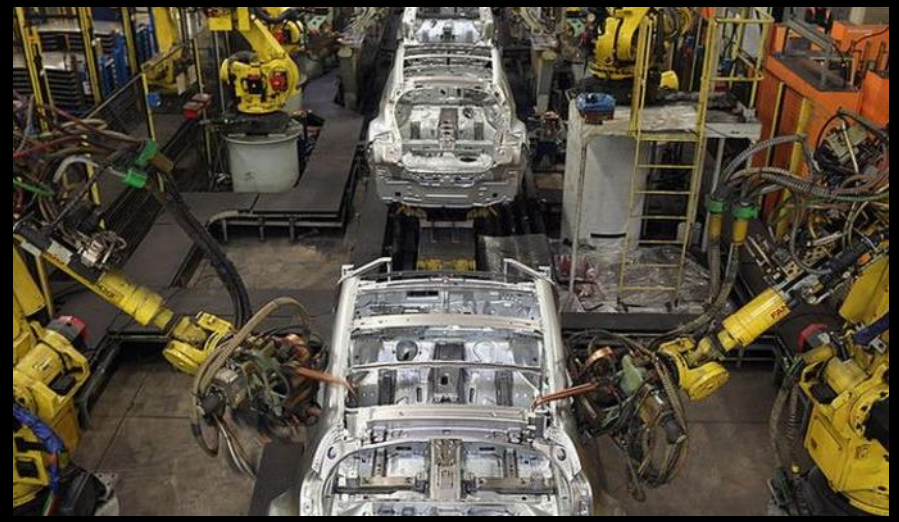


https://www.youtube.com/watch?v=CK8IFEGmiKY

The right body in the right environment and right socioecological niche can lower cognitive needs (or cognitive challenge)

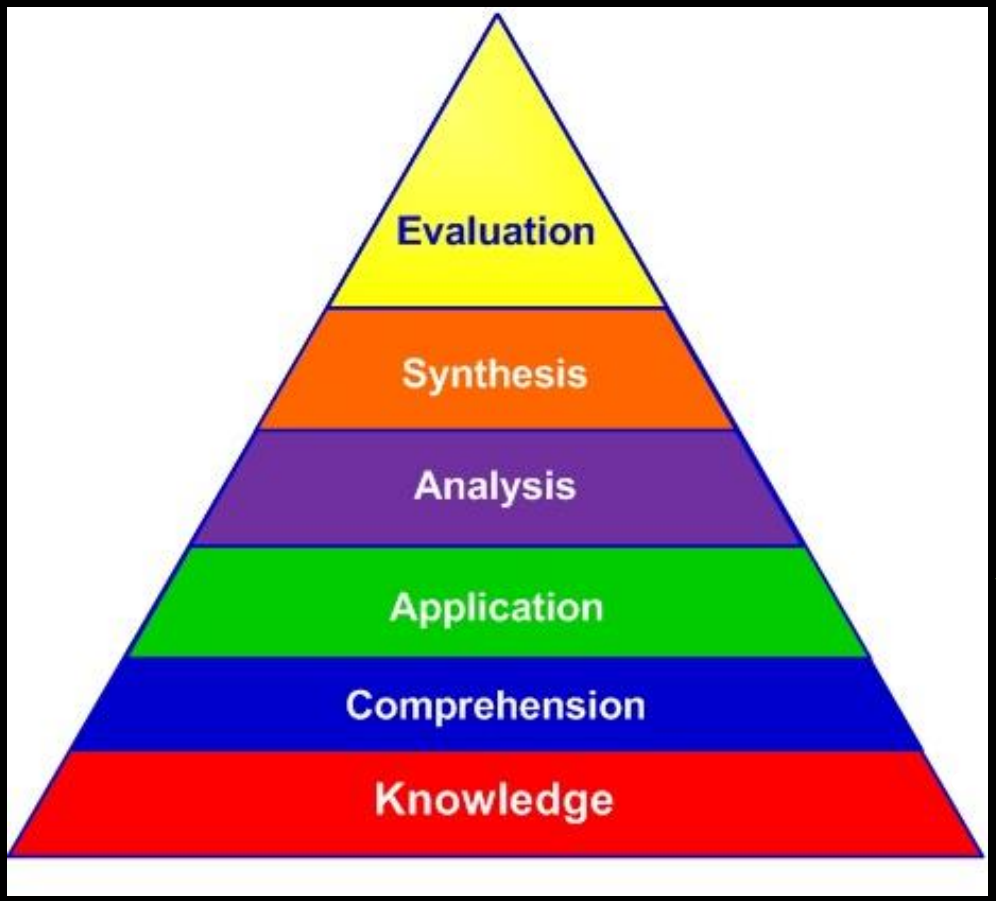
- An engineering treasure
- But
  - In the wrong environment
  - With a body unfit for the task
  - Trying to resolve the problem with insufficient support

- **Today we are going to learn how to avoid such traps**
- **And what bio-inspired systems can bring and offer**

Embodied AI
Artificial Evolution
Emergence

Your turn to play

Intended learning outcomes



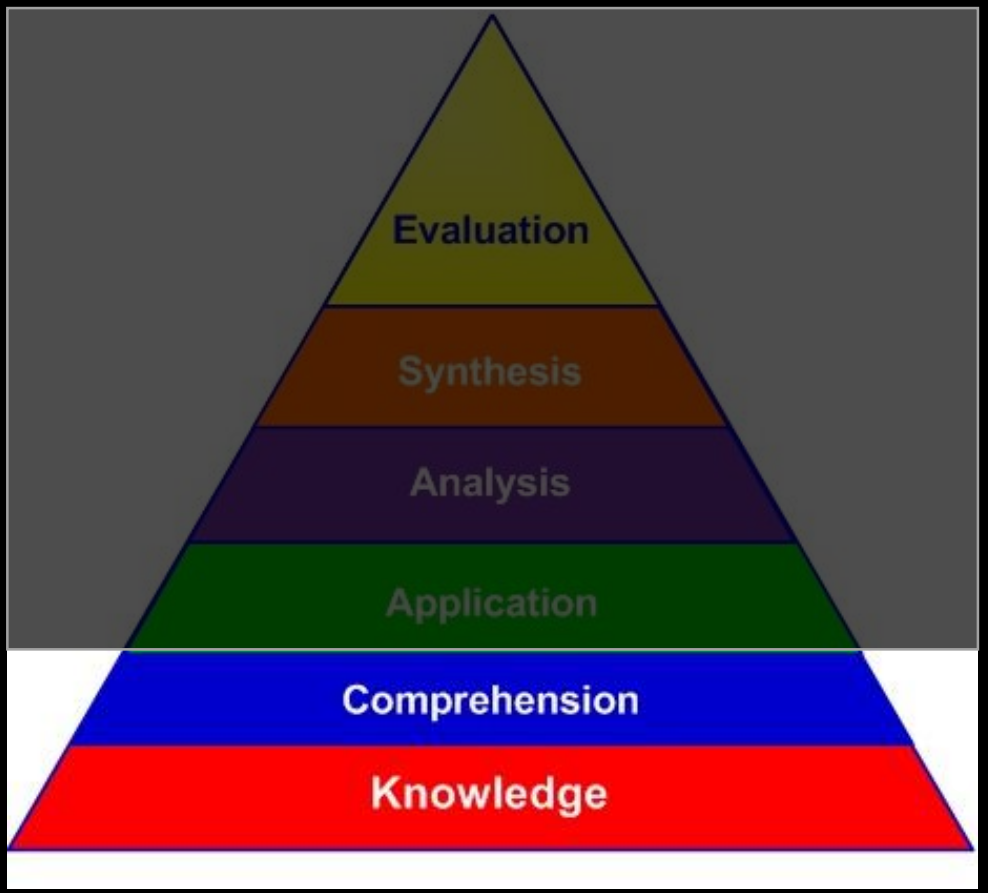
List and define the key concepts related to **artificial life, emergence, and embodied AI**

Relate these concepts with each other and those of **other courses & disciplines**

Apply **Genetic Algorithms** for solving concrete problems

Create a sketch of an Artificial Life

Intended learning outcomes



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https://tinyurl.com/fundOfAI

Turn on your micro and camera when your question is picked up

Please write your name

On an ideal white board (and in your mind in the exam)

If you cannot come up with, define and relate these concepts, consolidate them during the post-class

Embodied agent
Sensor
Effector
Physics

Artificial Life
Mind
Body
Environment
Ecosystem
Niche
Evolution

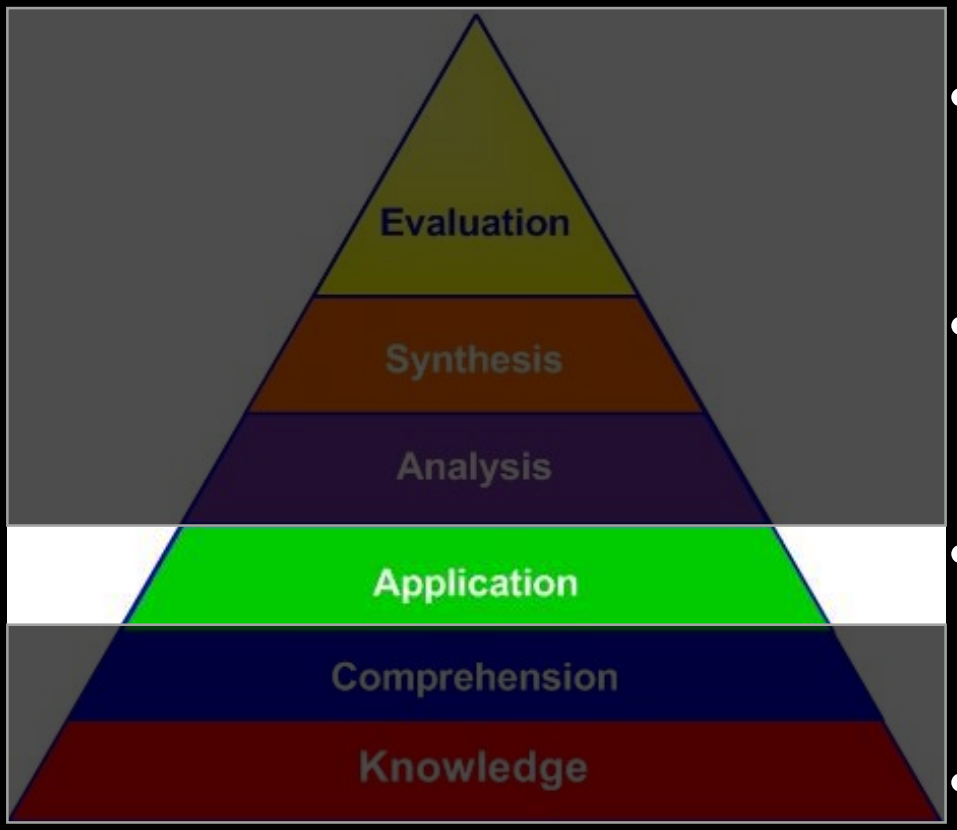
Adaptability
Robustness

Social simulation
Social sciences
Cognitive sciences

Mind-body-environment-niche relation

Emergence
Stygmergy
Neural networks
Symbol grounding problem

Generic algorithm
Genotype
Phenotype
Selection
Mutation
Reproduction



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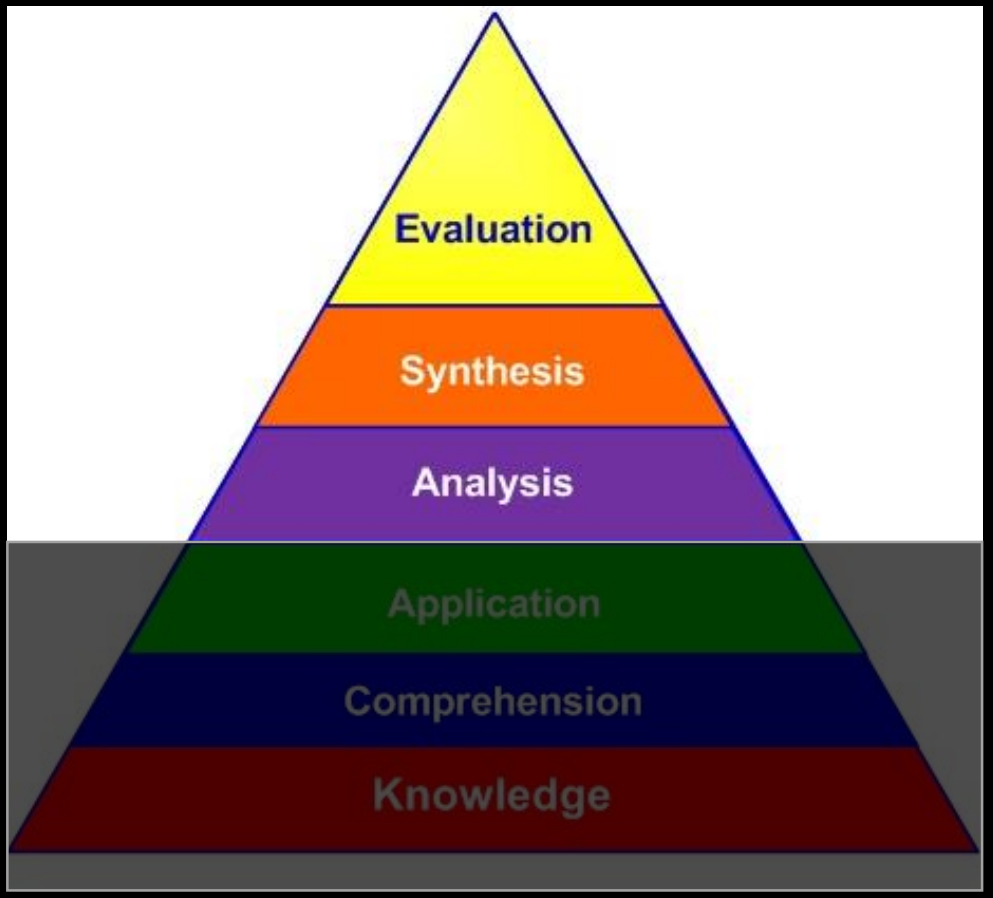

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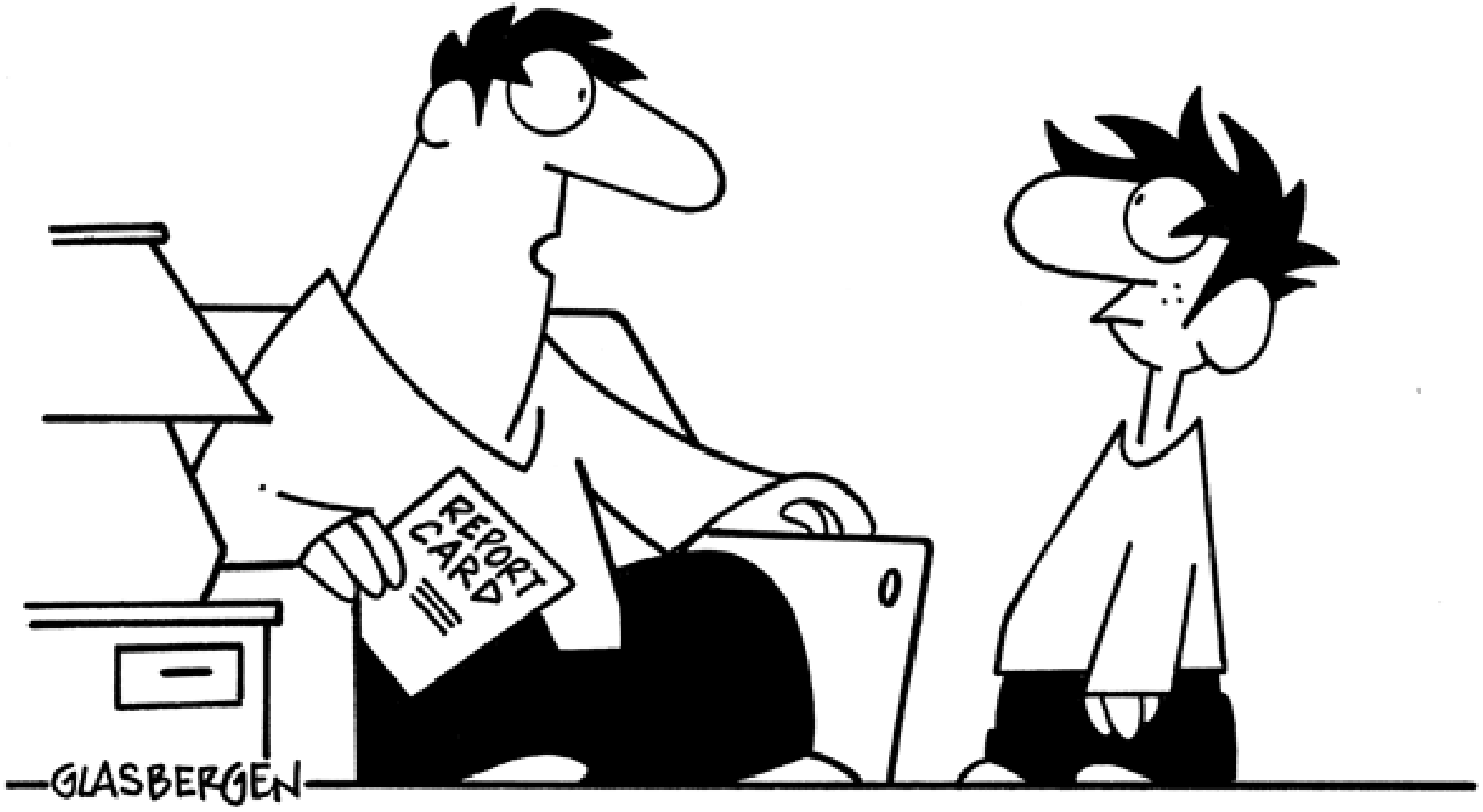


**"I probably remember 20% of the stuff
I learned in school and forgot the other 90%."**

Take home message

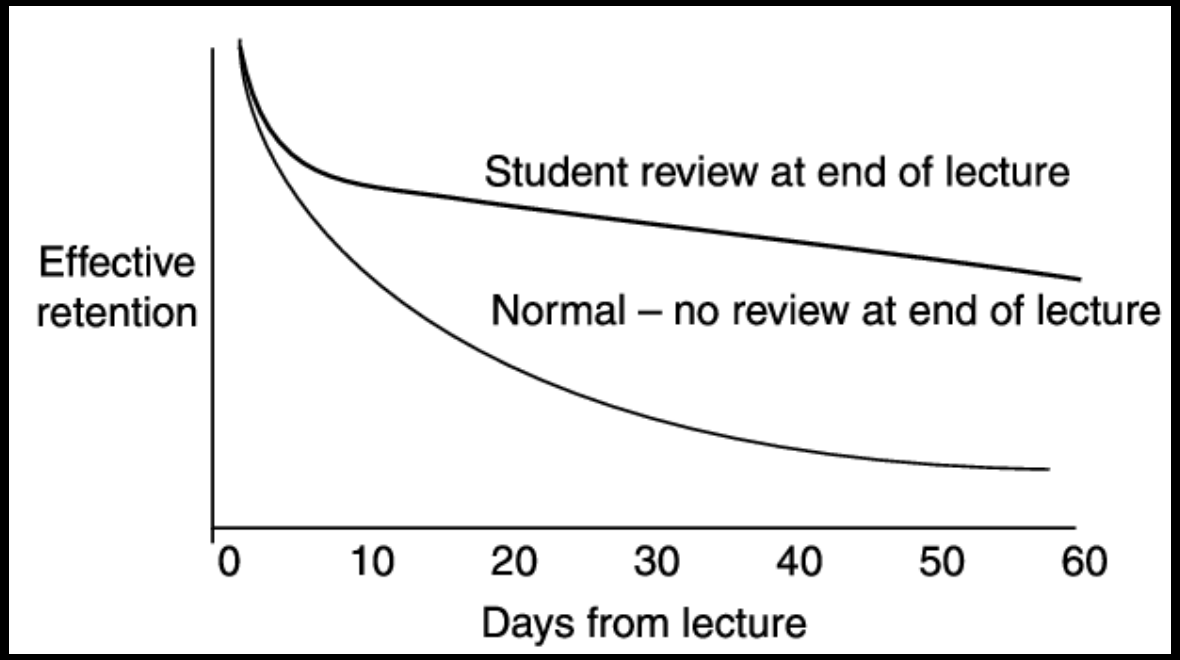
- Body management is a hard problem
- Bio/socio-inspired systems is a great approach for solving AI problems
- Artificial life is a great application of AI for other disciplines
- Body, mind, eco/sociosystems, and environments are deeply interleaved
- Emergence involves a new level of interpretation that changes system dynamics. Emergence is frequent in AI, from collective intelligence to consciousness

If you want to learn more

- Checkout online resources on Canvas
- Mingle with your colleagues
  - Go talk to your colleagues
  - Checkout their report
  - Checkout which artificial life they created ☺
- Implement an agent society
- Teach agents to walk using genetic algorithms

Anchoring

https://tinyurl.com/fundOfAI-LR



This is anchoring:
State what you learned

Write your answers on a sheet of paper if you can (though it helps us to know what you learned)

Save your feedback for later