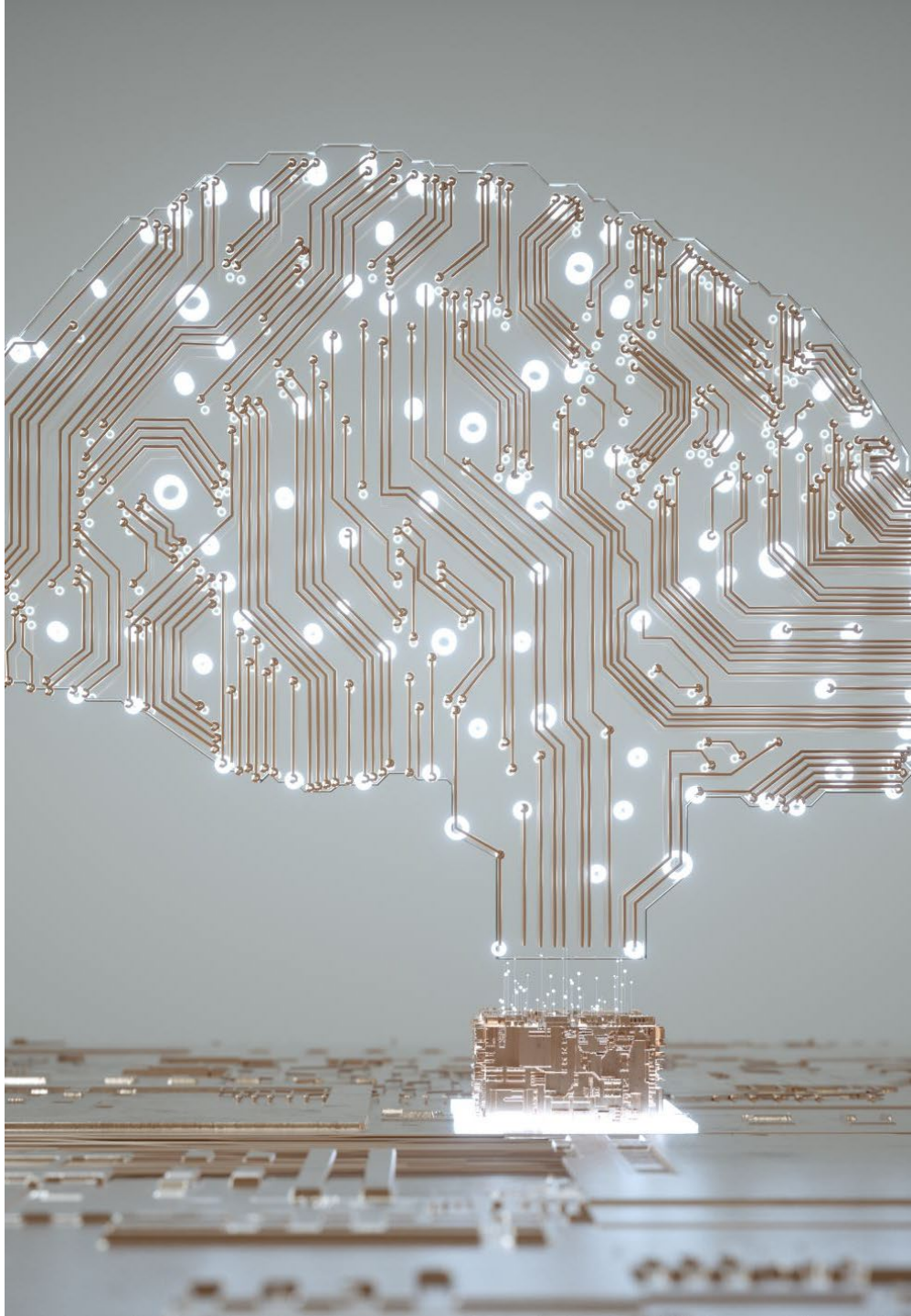
AI, LEARNING AND THE GPS: THE SCENIC ROUTE OR THE CHOSEN ROUTE?

Bo Kampmann Walther

Kolding: AI til læring, 22.04.22

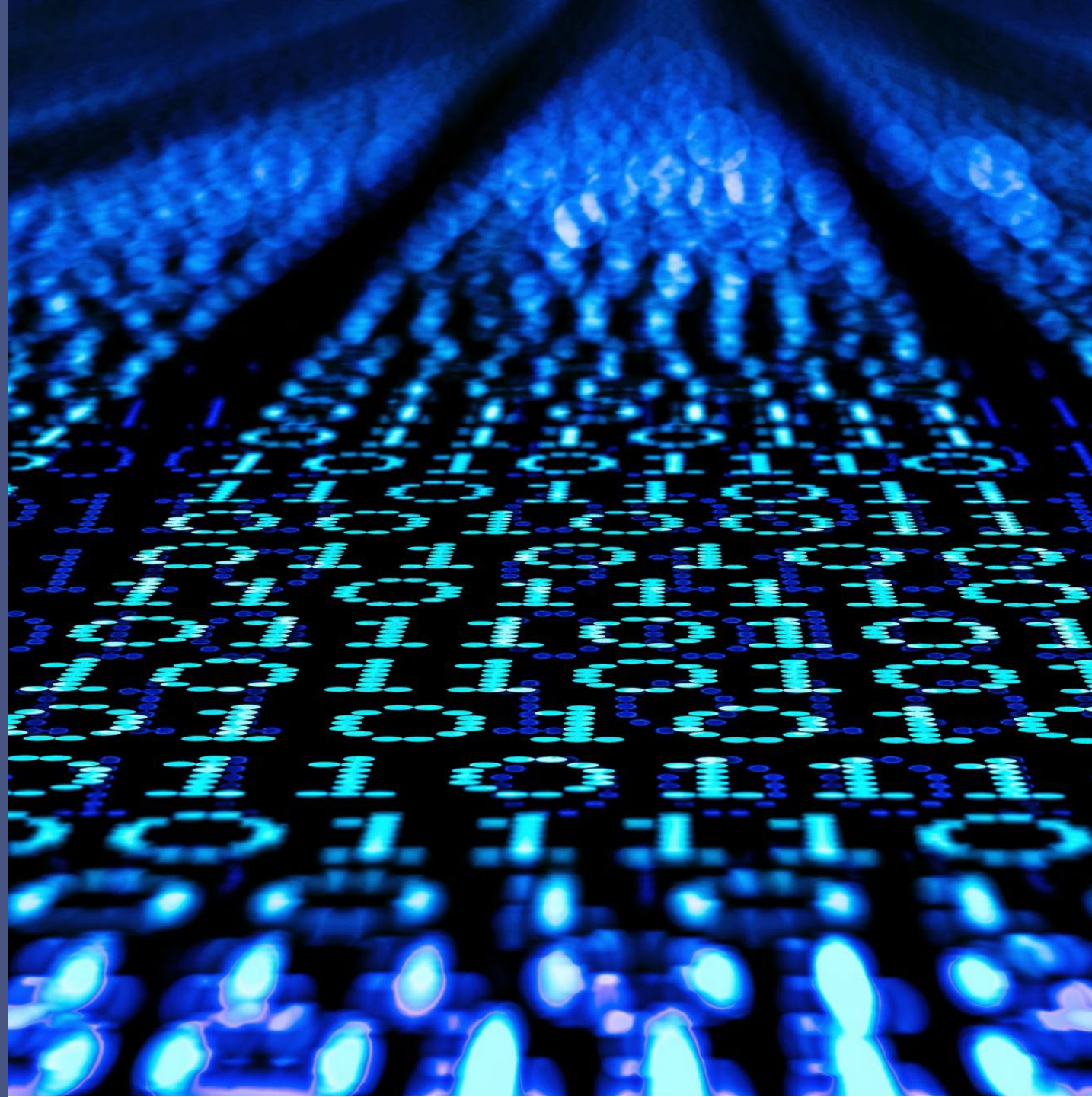
MY GENERAL AIM WITH THIS TALK

To show some of the connections between contemporary ”cybernetically artificial” technologies, such as the GPS and Gamification, and their relation to **learning** – and why this can be both a rich and a challenging journey.



ON OUR PROGRAM TODAY

- *AI AND THE GPS*
- *LEARNING CHALLENGES*
- *DISCUSSION*

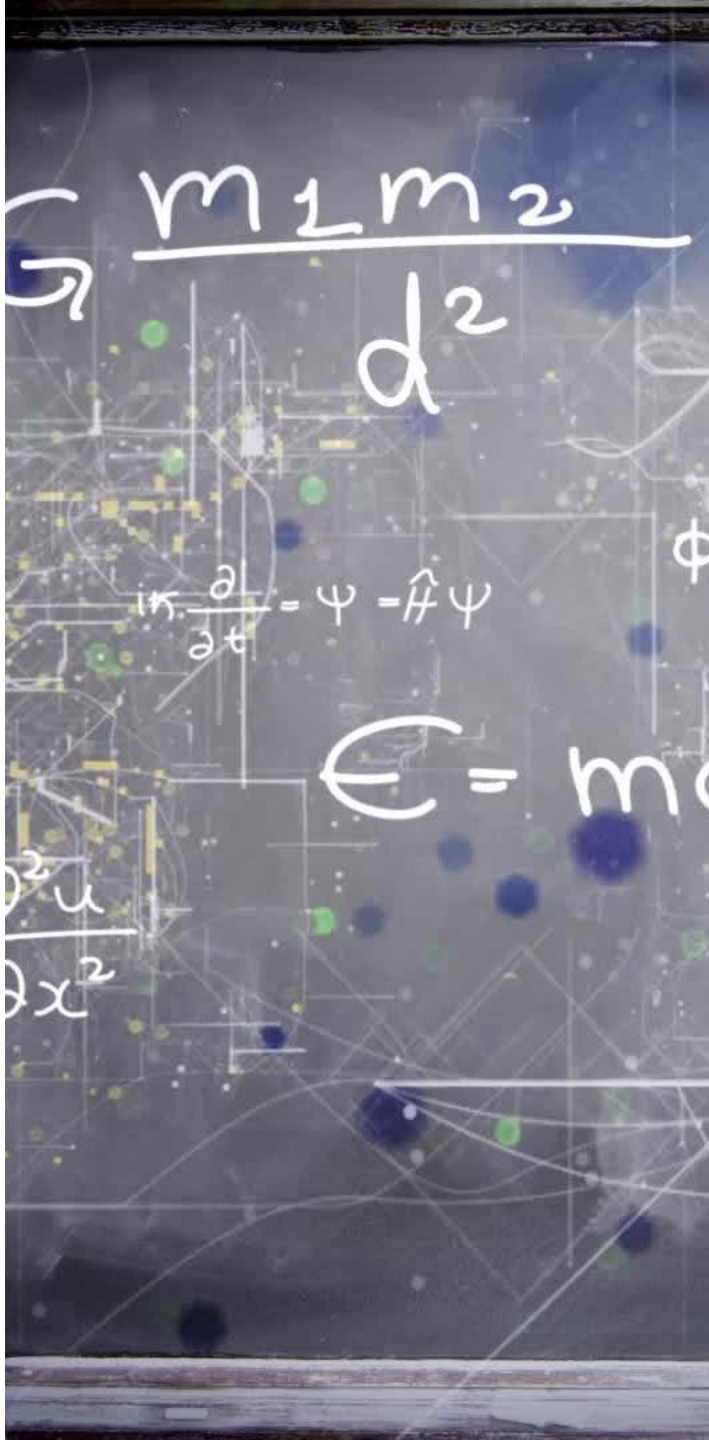


THE BACKGROUND: IS ARTIFICAL GENERAL INTELLIGENCE (AGI) POSSIBLE?

Despite this long record of failure, AGI must be possible. That is because of a deep property of the laws of physics, namely the universality of computation. It entails that everything that the laws of physics require physical objects to do can, in principle, be emulated in arbitrarily fine detail by some program on a general-purpose computer, provided it is given enough time and memory.

(David Deutsch 2012)

[Draws on Alan Turing's **Completeness Theorem**]



VOL. LIX. NO. 236.] [October, 1950

MIND

A QUARTERLY REVIEW

OF

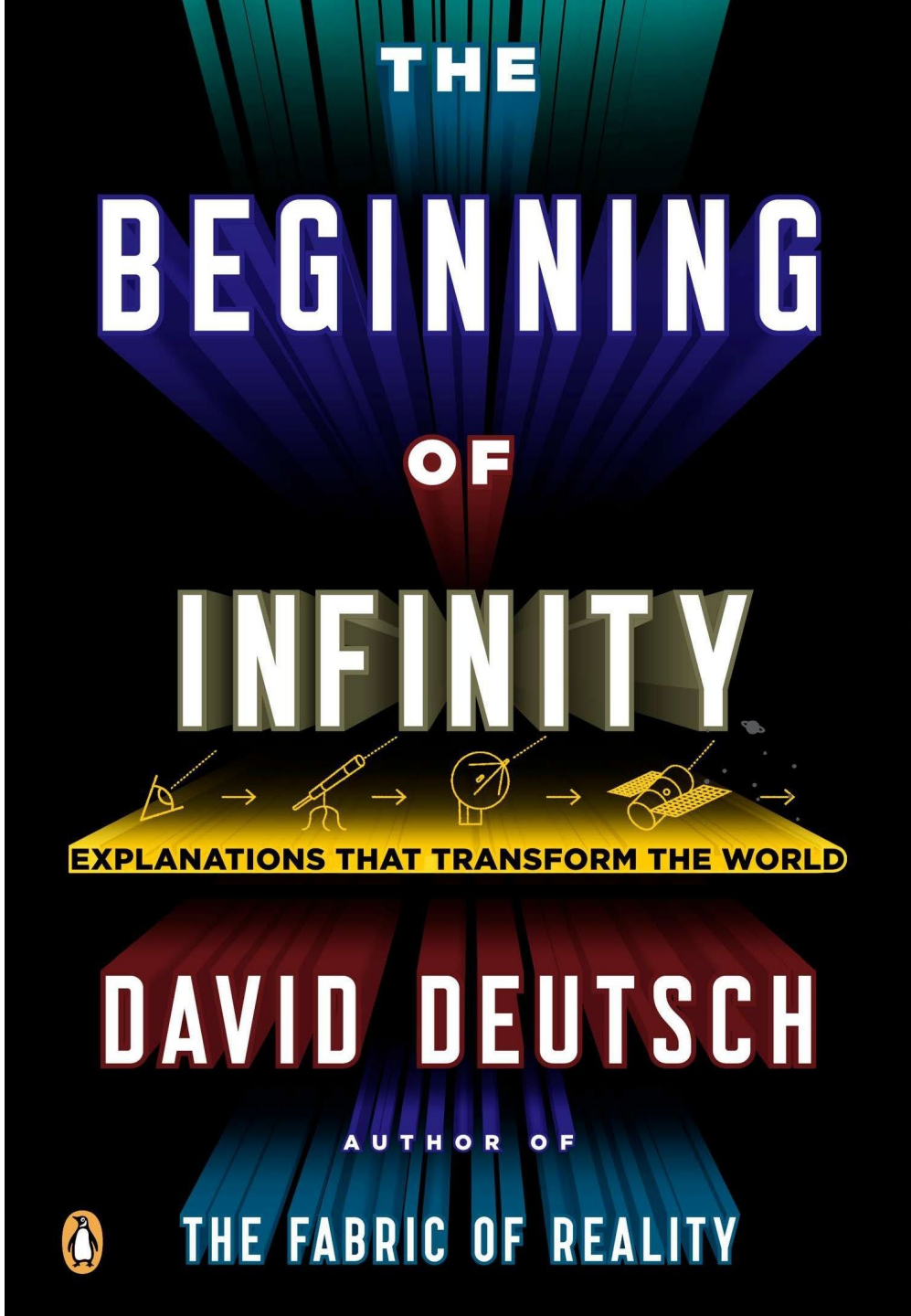
PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

1. *The Imitation Game.*

I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup



NEXT UP FOR BACKGROUND

If, when, and by what means Artificial General Intelligence (AGI) is possible spills over into two questions:

- *Can computers ever be smart enough to perform (simulate) truly (general) human tasks?*
- *Is the human brain in itself a computer?*

Consider the definition of Turing's Universal Computer:

- In computer science, a Universal Turing Machine (UTM) is a Turing machine that simulates an arbitrary Turing machine on arbitrary input. The universal machine essentially achieves this by **reading both the description of the machine to be simulated as well as the input to that machine from its own tape**.
- Meaning: The human brain (hardware) contains (or has access to) the explanatory framework (software) for the handling (execution) of data – in one and the same medium. I.e., we do not have to "switch apparatus" when performing "calculations" based on, say, love and work (like switching from a violin to a guitar). The brain is a Universal Constructor.

- Machine learning for dummies: Microsoft PowerPoint detected the word "brain" among the typed words on this slide, and swiftly suggested this "design" ☺

THE GPS (METAPHOR)

GPS AND AI

GPS navigation systems **use stored map information for determining optimal route selection based on a shortest path algorithm**.

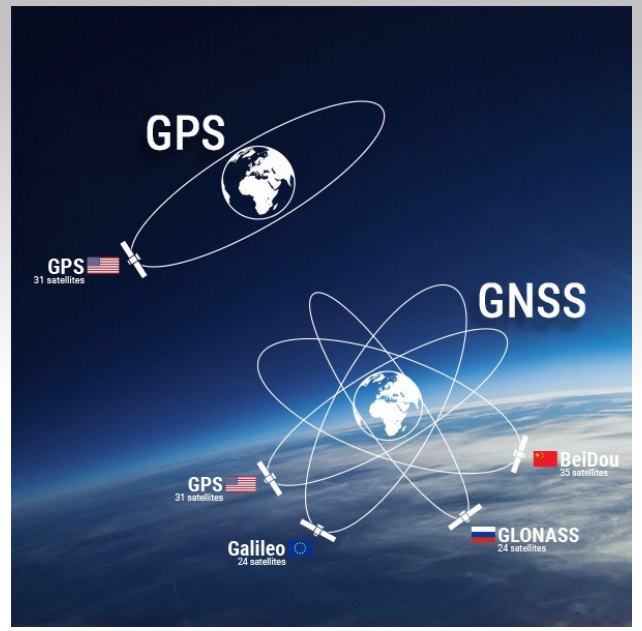
The AI-based autonomous navigation system software enhances the autonomy level and capability of platforms to achieve their mission through helping them to understand their environment, even in GPS-denied locations, allowing them to respond to changing conditions in real-time without any need for human intervention.

Speaks into developing areas of automatisation, machine learning, self-sustaining adaptive technologies

GPS LIMITATIONS

- GPS only works on Earth
- The GPS satellites orbit at an altitude of about d = 20,000 km. **Each GPS satellite can only "see" about 38% of earth's surface in a given instant.** Therefore, you would need a bare minimum of three GPS satellites in order to "see" the entire globe at once.

THE GPS: THREE SEGMENTS



Space Segment

GNSS Satellites

GNSS Broadcast Signals

GNSS Control Channel

Data Uploading Stations

Master Contol Stations

Monitor Stations

Control Segment

User Segment


BACK TO AI

TYPES OF AI

- **ANI** is the artificial narrow intelligence that is good at performing single tasks, such as playing chess, making predictions and suggestion. ANI is the only level of AI achieved by mankind so far.
- **AGI** is the artificial general intelligence, also known as human-level AI.
- **ASI** is the artificial super intelligence that is smarter than the collective intellect of the smartest humans in every field (”post-humanity weapons”).
- **Grey Goo** is a hypothetical end of the world-scenario involving self-replicating robots and molecular nanotechnology that spirals out of control and consumes all biomass on Earth while building more of themselves, a scenario is called also ecophagy.

ANOTHER CLASSIFICATION OF AI

TYPES OF AI

REACTIVE

Has no memory, only responds to different stimuli

LIMITED MEMORY

Uses memory to learn and improve its responses

THEORY OF MIND

Understands the needs of other intelligent entities

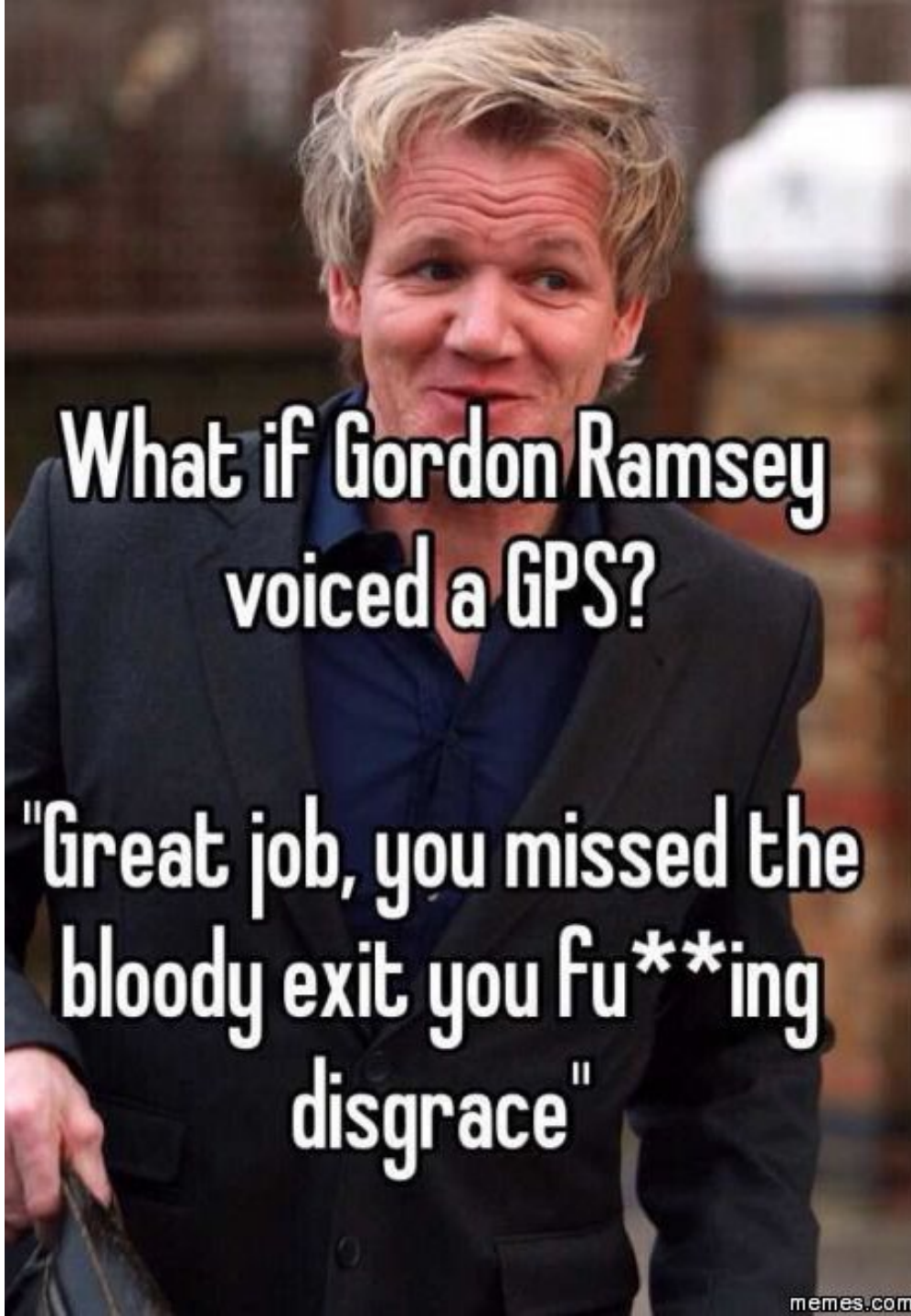
SELF-AWARE

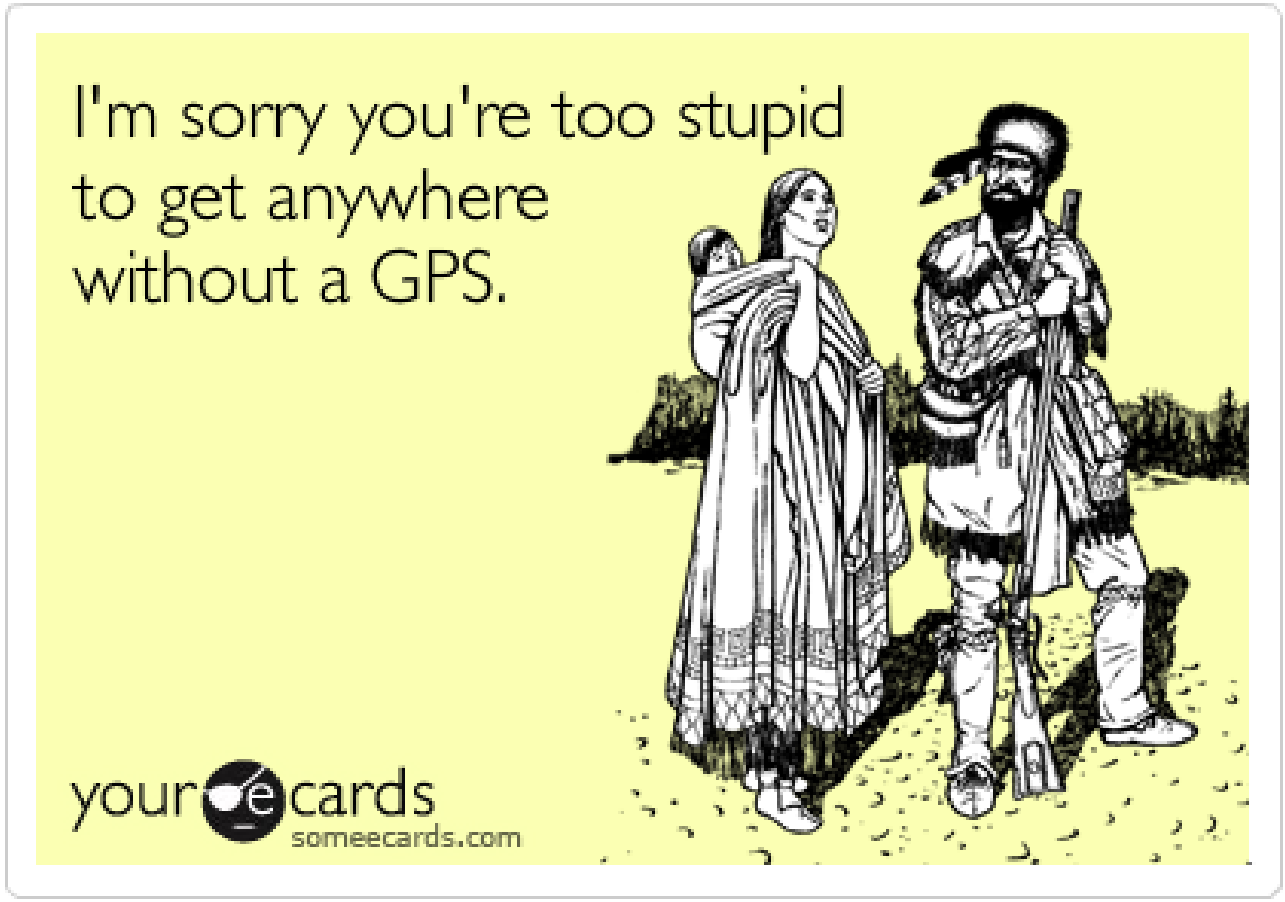
Has human-like intelligence and self-awareness

LEARNING

NOW, COMING BACK TO THE GPS – WHY IS IT A GOOD METAPHOR FOR LEARNING?

- Because the GPS provides **structure**, care for detail, and accuracy (so that the driver can relax and enjoy the ride)
- Because the GPS produces quasi-intelligent, patient **commands** (rather than relying on loopsided feedback)
- Because the GPS can actually save us from **tight spots**: Dementia wayfinding, getting troops out of 'deserted' areas, locating and actually getting to that wonderful spot



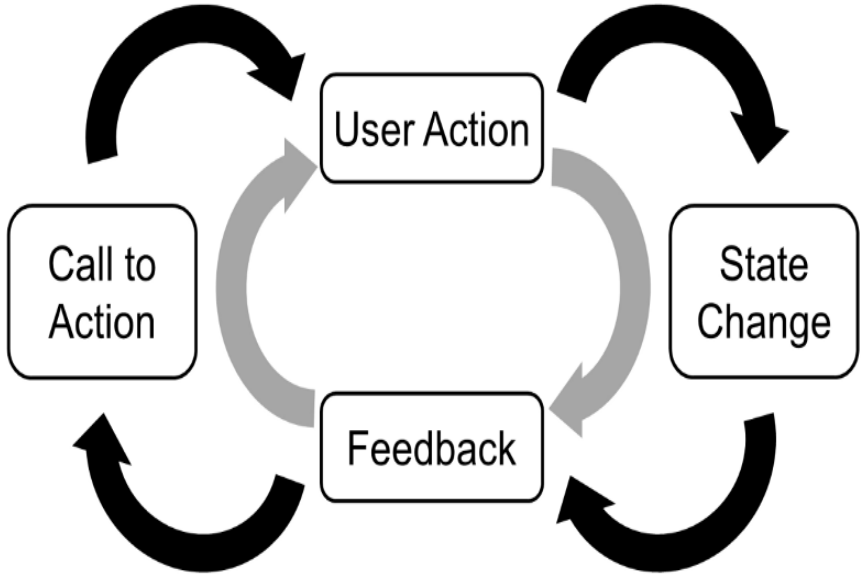


WHY IS THE GPS A BAD METAPHOR FOR LEARNING?

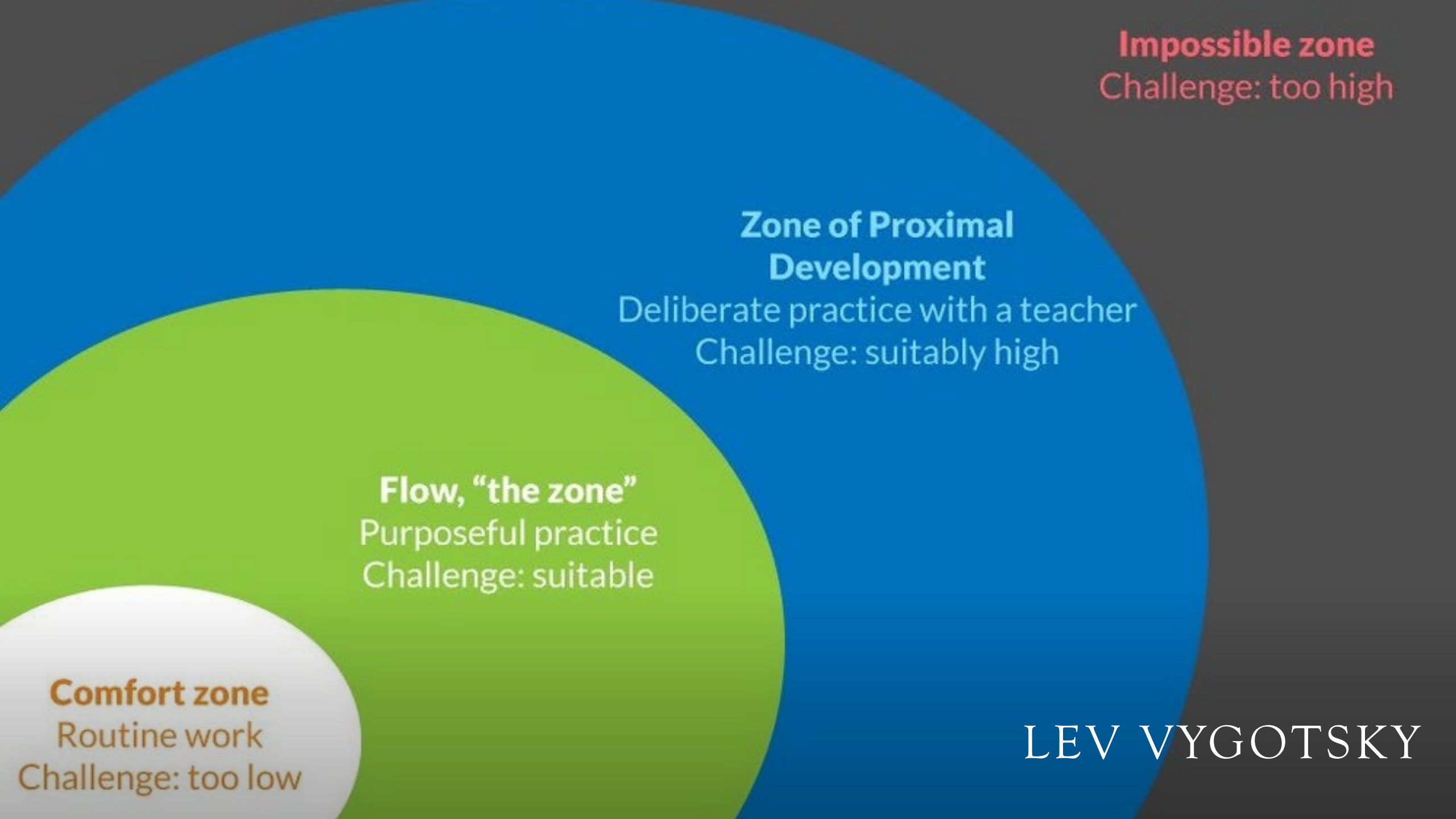
- Does learning always have a fixed **destination**?
- Is the **shortest** route always the best?
- The silent scaffolding behind getting from A to B may be precise and reliable – but what about the **detours** and trial-and-error experiences?

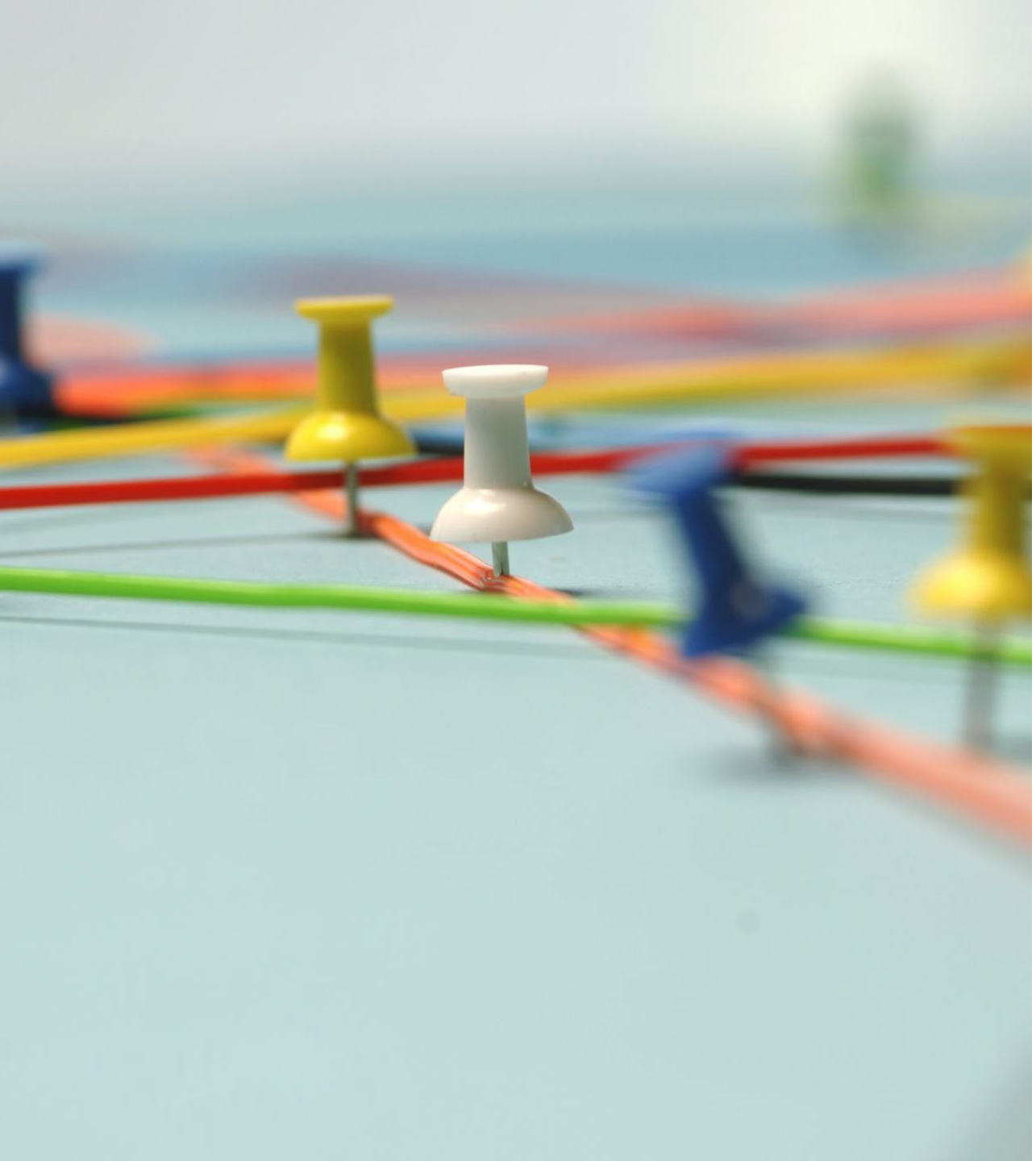
THE TYPICAL GAMIFICATION FEEDBACK MODEL

Action / Feedback Loop



Gamified UK


Impossible zone
Challenge: too high
Zone of Proximal Development
Deliberate practice with a teacher
Challenge: suitably high
Flow, "the zone"
Purposeful practice
Challenge: suitable
Comfort zone
Routine work
Challenge: too low
LEV VYGOTSKY



THE EXAMPLES FROM THE GPS, AI ENHANCED LEARNING, AND FROM GAMIFICATION

... all asumme that learning entails a **goal state**

[so that if learning is parallel to simulating a jump; it's not just about the geometry behind the jump, but the jump *towards* something]

THE BIG QUESTION

Is ”learning” a cybernetic system, ie., can it stand the test of the following three parameters (how to make a system cybernetic)?

- A way to represent its **current state**
- A way to represent its **goal state**
- A way to **strategize** about how to get to the goal state from the current state

For instance:

The dial on a thermostat and the destination input on a GPS are both ways of inputting a goal state from outside the system.

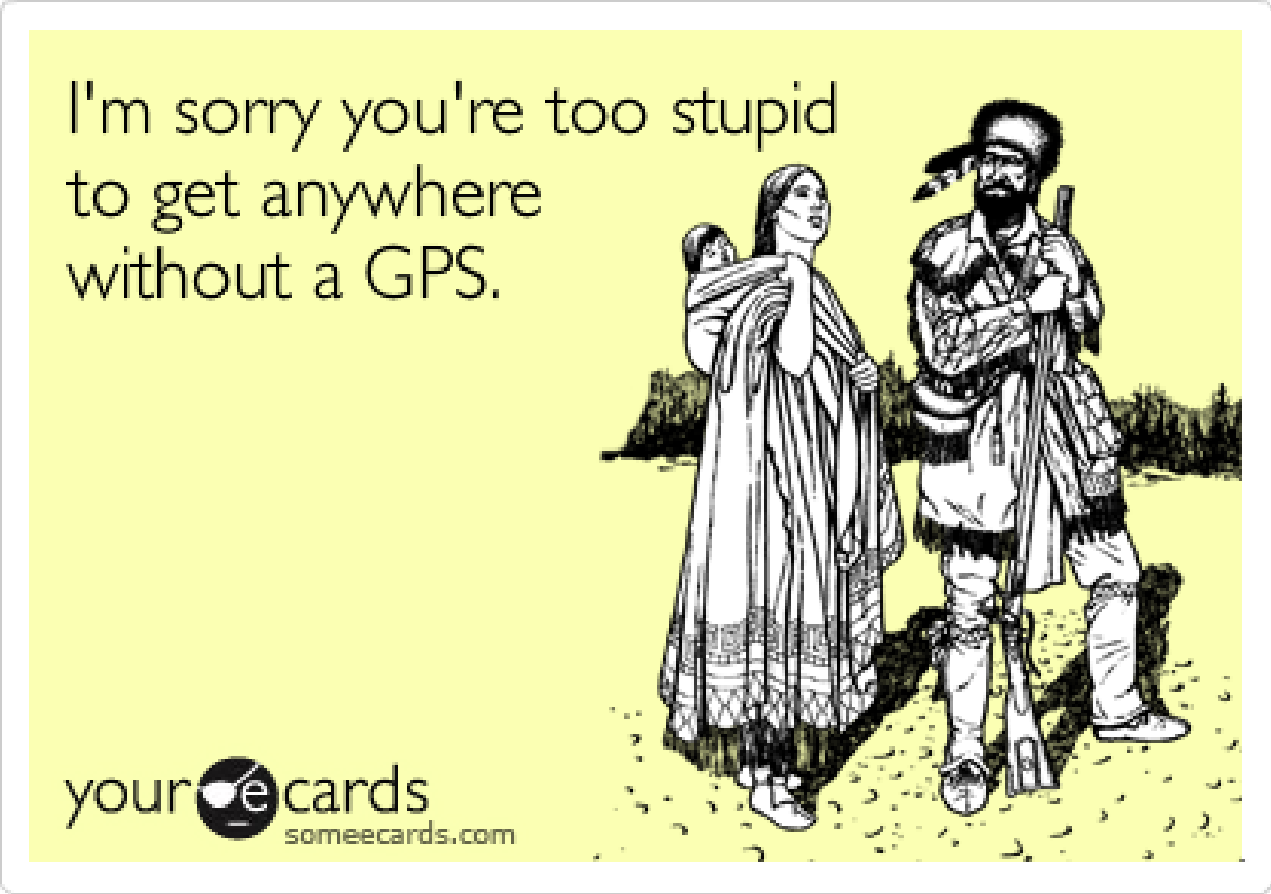
IF WE USE THE GPS AS A METAPHOR (OR CYBERNETICALLY GUIDING PRINCIPLE) FOR LEARNING, THEN

we work from the axiomatic that ”learning” must become a **purposive system**. Through either a **command state model** (the GPS) or a **feedback-reward model** (the Gamification model), it should be able to compare the two states (start and goal) and check if they match. If they don’t match (”impossible zone”), the system needs its final component, a **strategy of actions that will get it to where it wants to be.**

WHY IS THIS CHALLENGING?


THIS THEORY PLAYS OUT UNDER THE ASSUMPTION
THAT LEARNING IS MISSION-BASED, I.E., THAT IT'S
ESSENTIALLY A GAME

Vygotsky says that instruction is only useful (for the learner) when it operates ahead of the actual stage of development. Relying on automatisation technology – such as wayfinding/tracking – has often been accused of **stupidifying users because it functions way too much as "instruction behind", i.e., a soft curling mechanism**.



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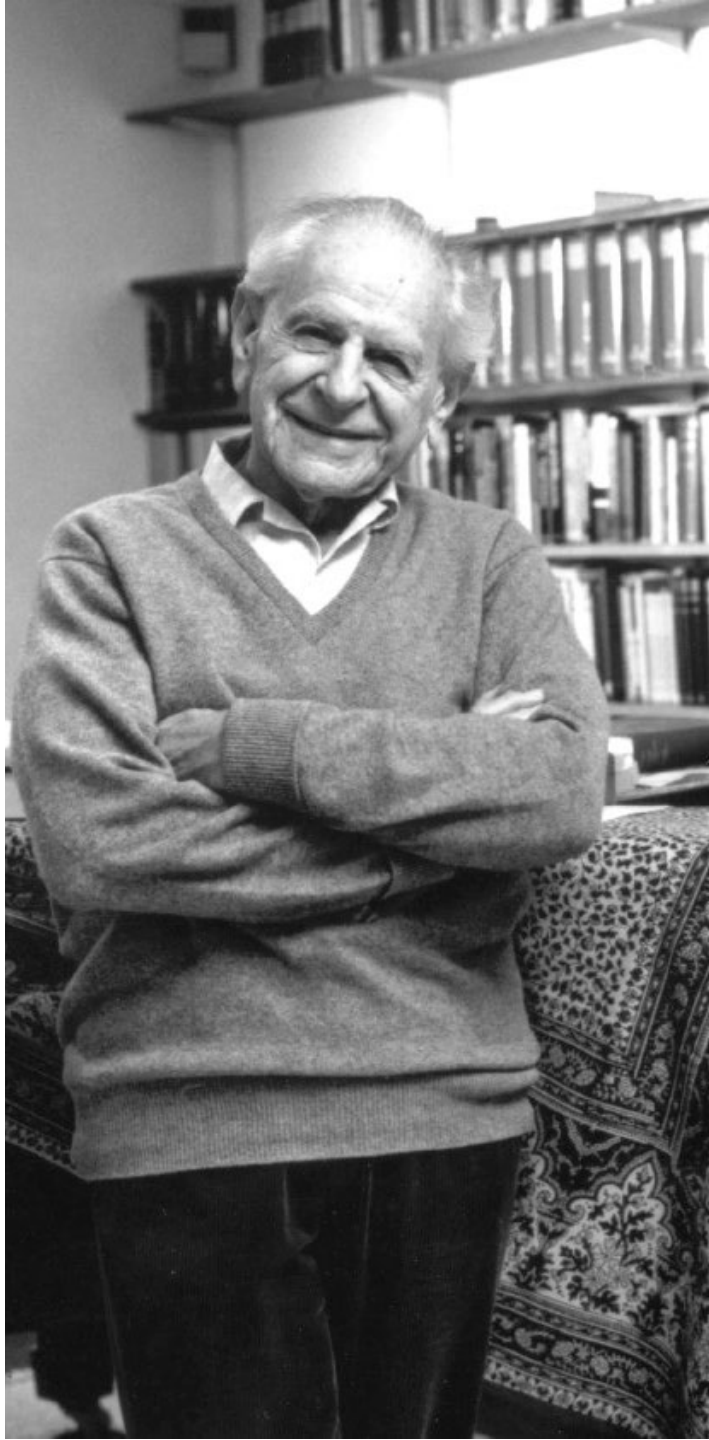
LEARNING IS (ALSO) A MATTER OF ADAPTIVELY AND PROGRESSIVELY (OFTEN STOCHASTICALLY) USING **RECURSIVITY** (REMEMBRANCE PLUS SELF-CORRECTION)

However, can't machines do that?

Machine learning algorithms are now capable of training themselves, thanks to the reinforcement learning methods of their **OpenAI Baselines**.* Now, a new algorithm lets their AI learn from its own mistakes, almost as human beings do.

* OpenAI Baselines is a set of high-quality implementations of reinforcement learning algorithms.



(DOWN TO) EARTH

- The GPS only function on Earth (geo-metrics: meter on Earth/on the ‘ground’)
  - But what if we want to go to another planet?
  - What if learning is interstellar?
  - What if the Zone of Proximal Development is outside of the map?
  - What if the most stupid route turned out to be the most intelligent road?
  - Finally (the Popper argument): ”Artificial” systems are inherently ”non-falsificational” – they do not stress error-making (making the ”right mistakes”), but rely on constant self-correction. The entire history of science shows that this is not good for progressive learning!


THANKS