Authenticating

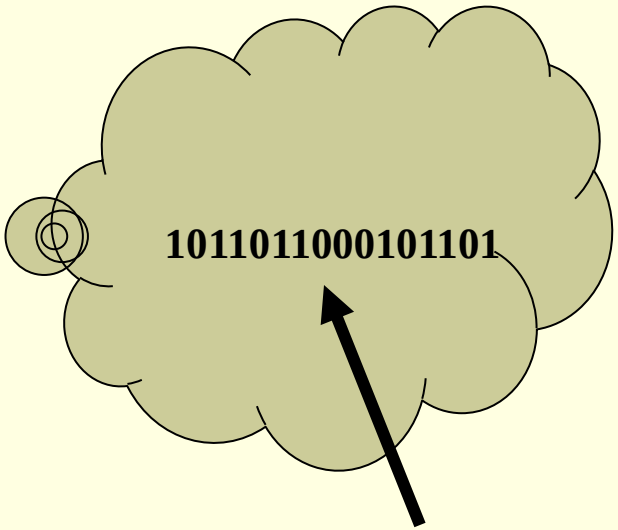
- ***SmartData: authenticate credentials of requestors***
- ***Requestors: authenticate credentials of SmartData***
  - ***Digital signatures and biometrics***

Analog output option

- ***Digital-to-analog or digital-to-image within SmartData***

No Personal information in the cloud: Just SmartData

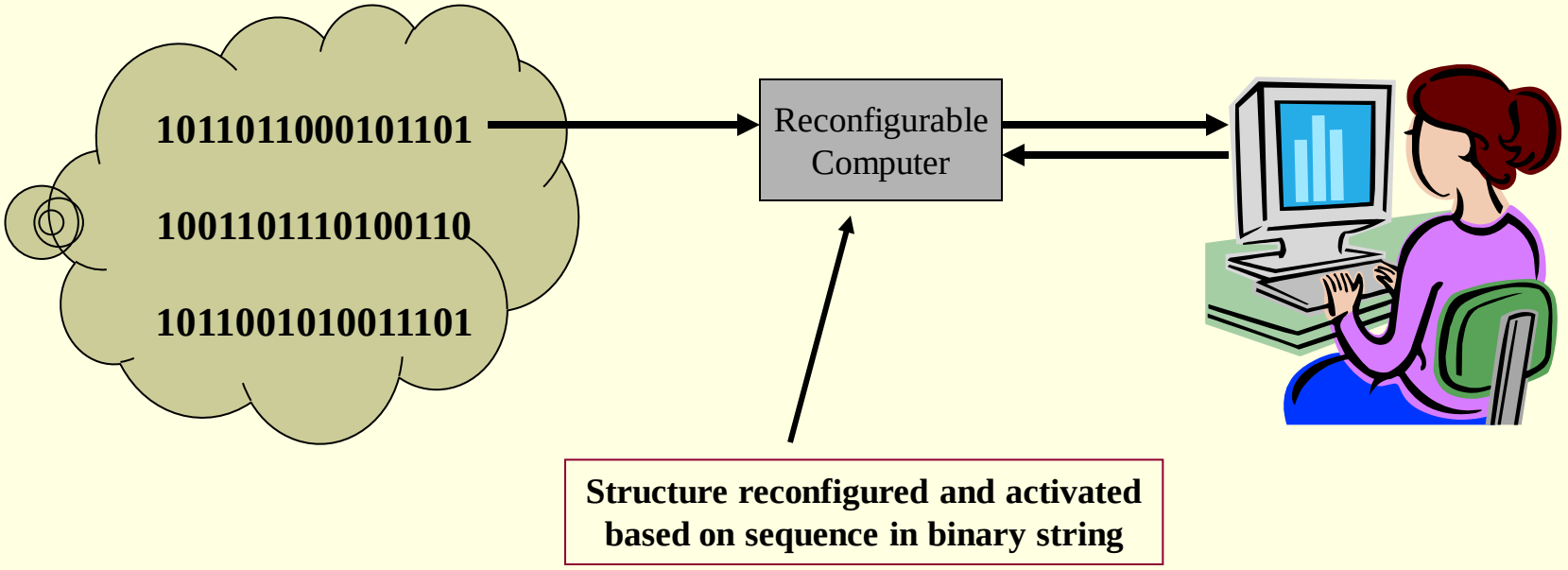
- **Only SD binary string is transmitted**



SmartData binary string – personal information locked inside

- There would be no personal or proprietary “raw” data out in the open.
- It would instead be housed “within” a SmartData agent

SmartData as an Electronic Health Record



Houston, we have a problem!

- ***Details of brain's algorithm is far to complex.***
- ***Brains may not use algorithms at all, but heuristics tailored to each individual.***
- ***Solution: Copy nature – evolution and natural selection.***

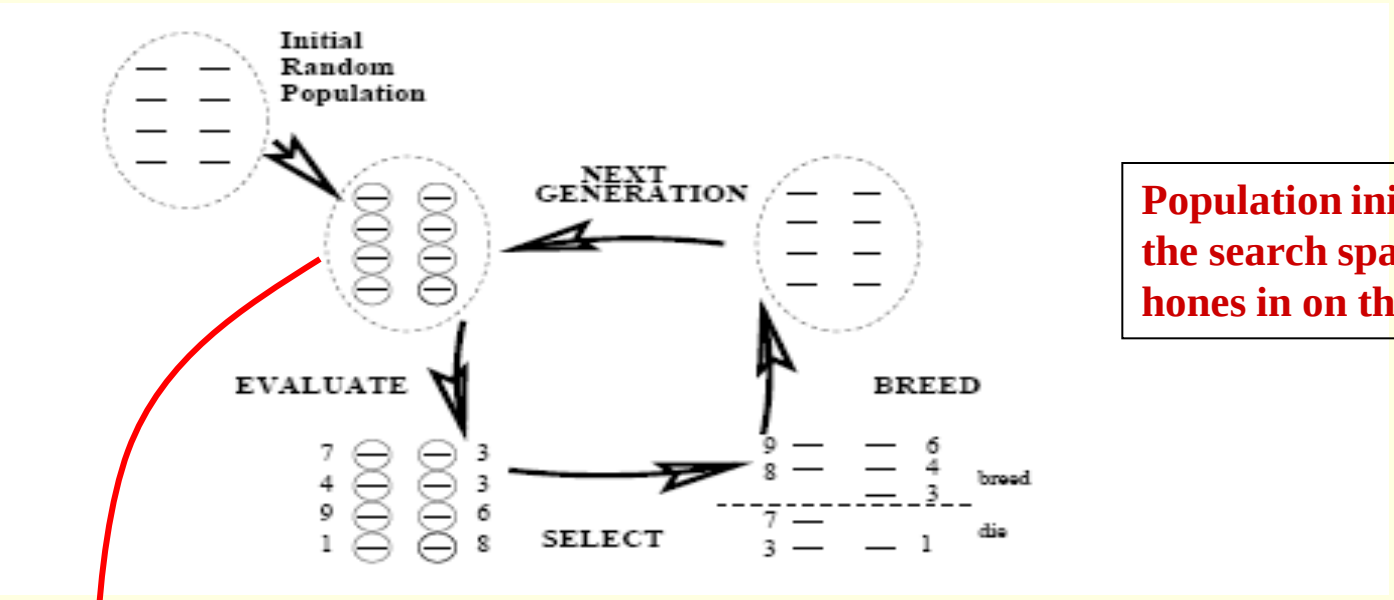
Embodied Cognition

- ***Contents and operations of cognition are determined by the whole body and the environment in which the body is situated.***
  - ***Not just the brain alone.***
  - ***Physical, "organismic", and conceptual embodiment.***
- ***The body is the active interface to the world.***
  - ***transforms physical variables in the environment via the sensors into neural control system parameters.***
  - ***converts neural variables via motor action into environmental parameters.***

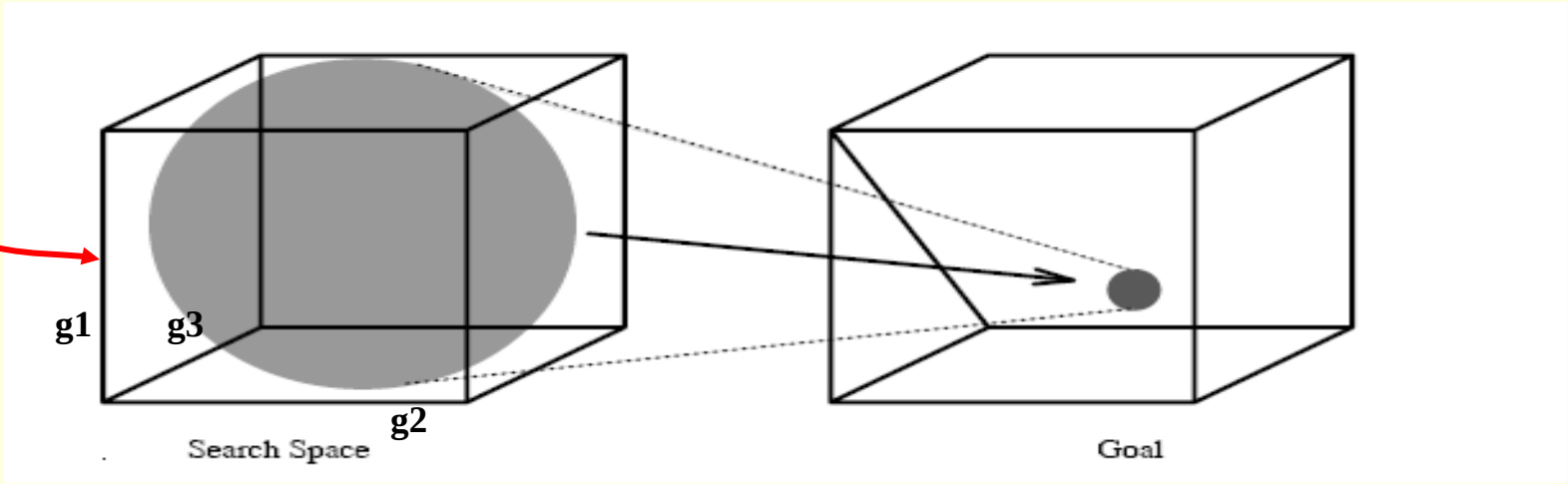
Evolutionary Robotics

- ***Uses principles of natural evolution to create artificial agents.***
- ***Bottom-up methodology versus top-down as in the field of Artificial Intelligence.***
- ***No initial design – only an initial design objective.***

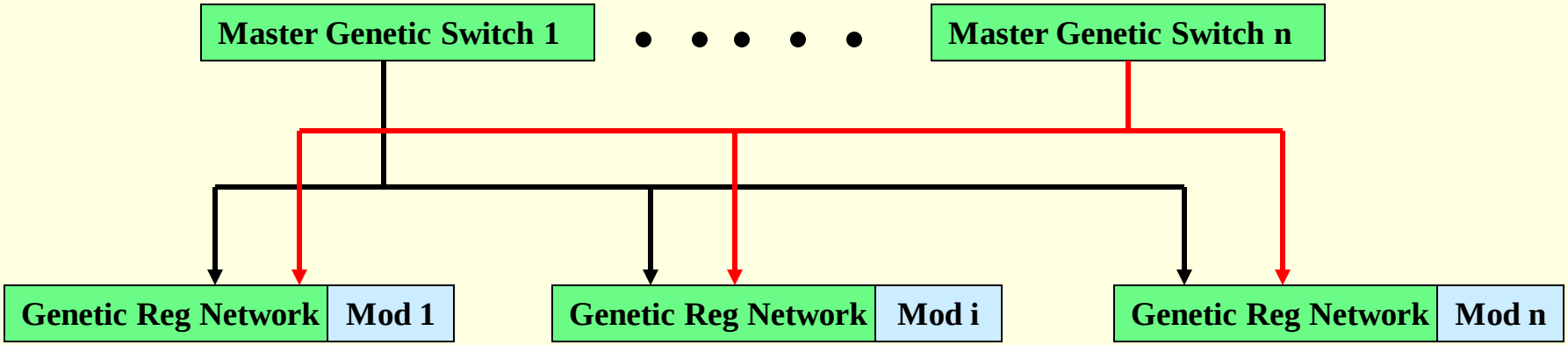
The Genetic Algorithm Cycle



Population initially spans the search space and progressively hones in on the optimum



Evolution by Modifying Design

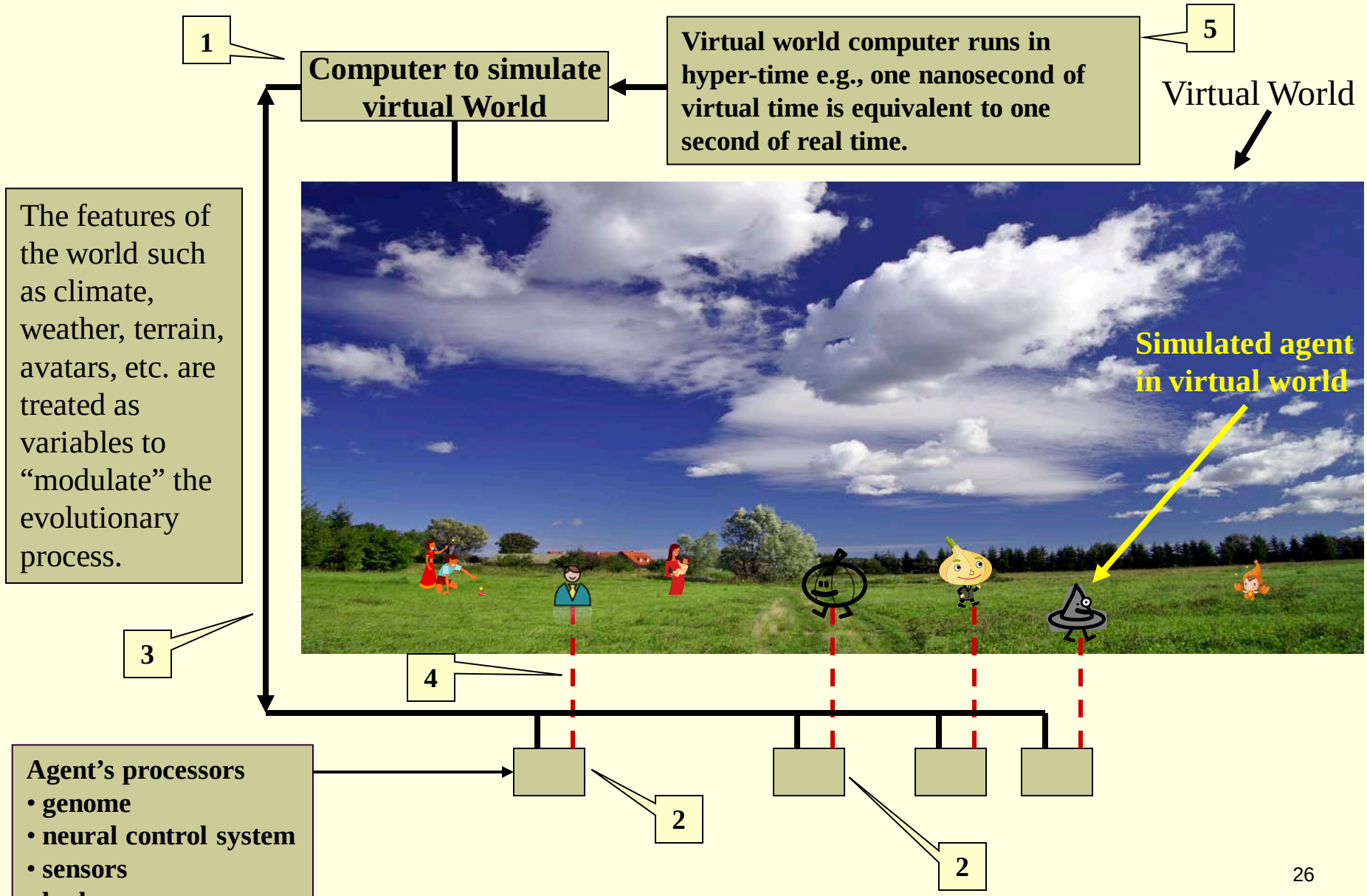


Mod 1 = neuron (w,x,y,z…)
Where:
w = type of neuron;
x = number of neurons;
y = transfer function;
z = rules for LTP;

Mod i = sensor (x,y,x,z…)
Where:
w = type of sensor;
x = number of sensors;
y = location of sensors;
z = resolution;

Modules conserved;
GRN controls variables (,w,x,y,z);
GRN and MGS will undergo mutation

The Matrix of Virtual Evolution



Evolution is a knowledge-gaining process of the world

- ***The world "selects" the cognitive structures.***

- ***Therefore, must "build-into" and organize the virtual world such that it will select the necessary structure for SmartData.***

Embodied Dynamical Systems Framework

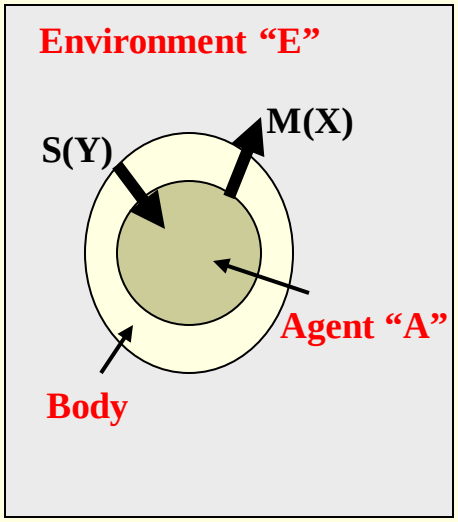
Simulate E

Evolve A

$$\frac{dX}{dt} = A\left(X; S\left(Y\right); U\right)$$

$$\frac{dY}{dt} = E\left(Y; M\left(X\right); V\right)$$

Coupling Parameters



Where:

A = Agent's transition map;

E = Environment's transition map;

X = Output variable of Agent's neurons;

Y = Output variables of environment;

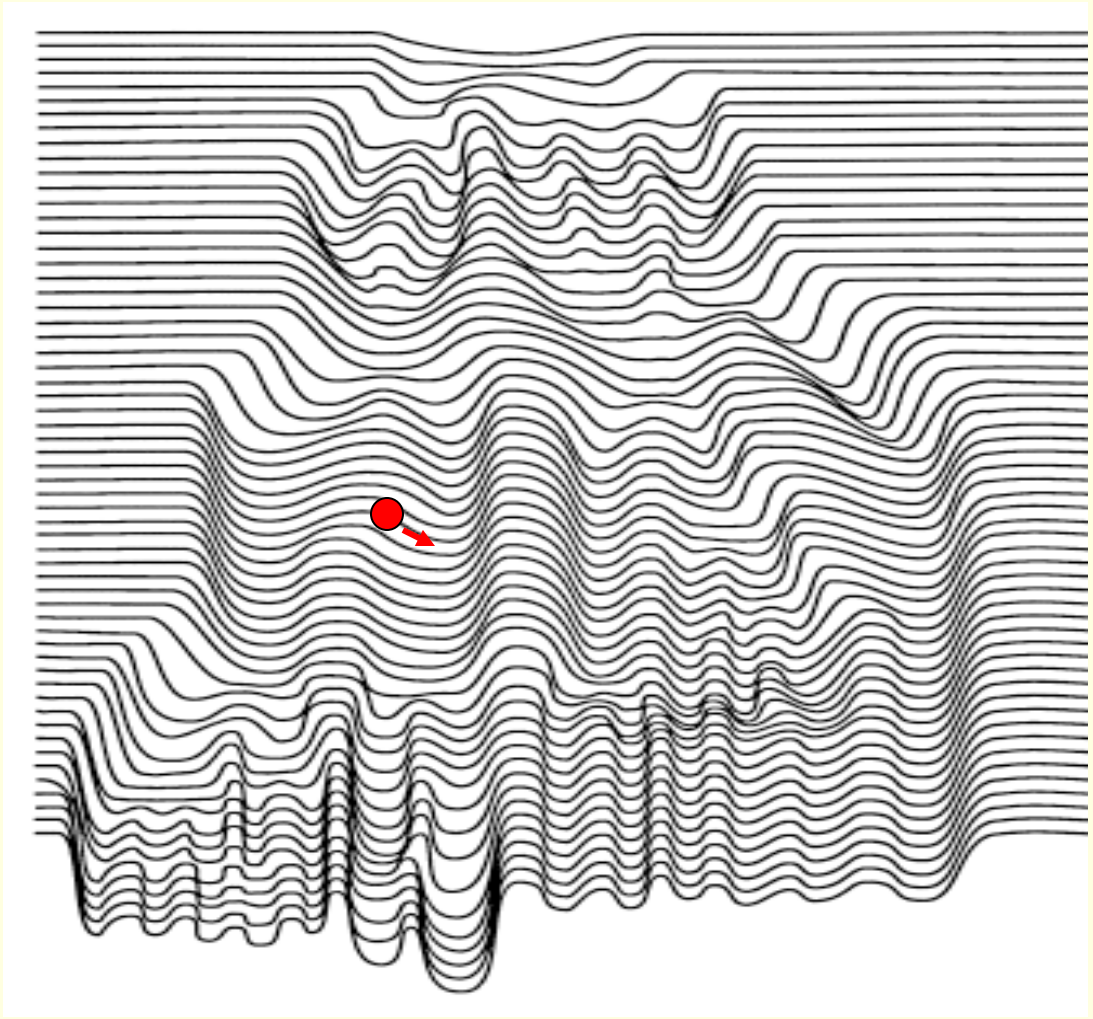
S(Y) = transformation of environment's variables into sensory parameters;

M(X) = transformation of Agent's variables into motor parameters that affect the environment;

U = Agent's internal parameters;

V = Environment's parameters

Dynamical System as a Dancing Landscape



Auditory Sensory Input

Visual Sensory Input

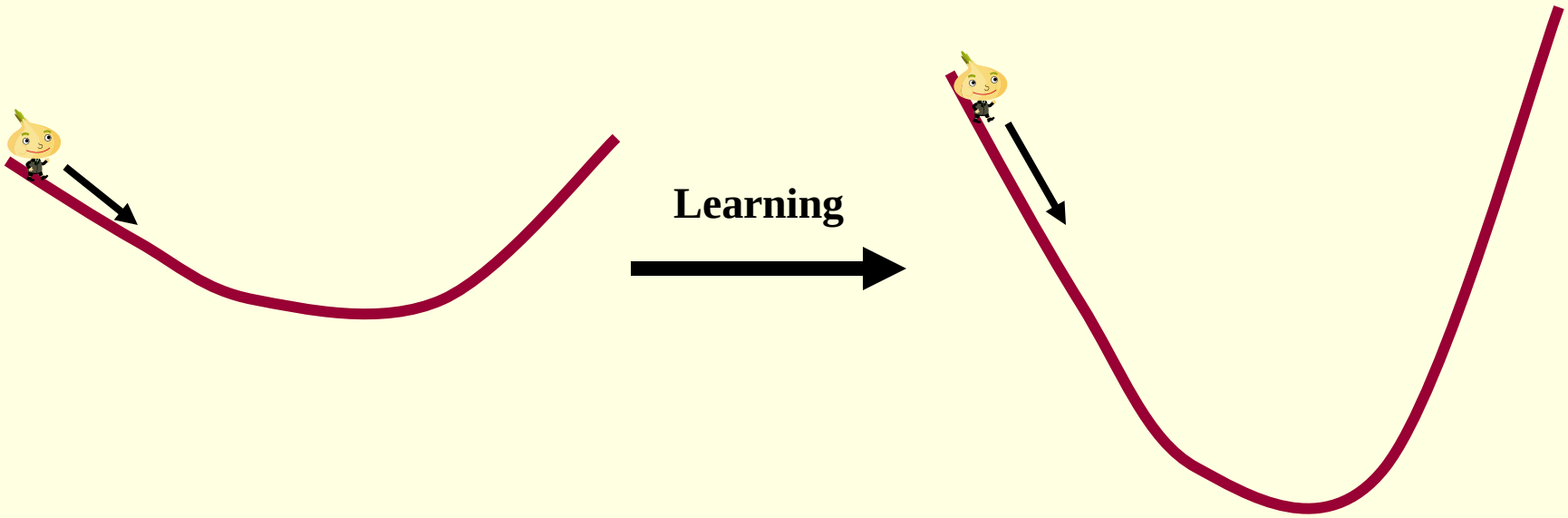
Life is Just a Journey

- ***In the dynamical systems framework, all behaviours – perception, motor, language, thinking, reasoning, and memories – are one and the same.***

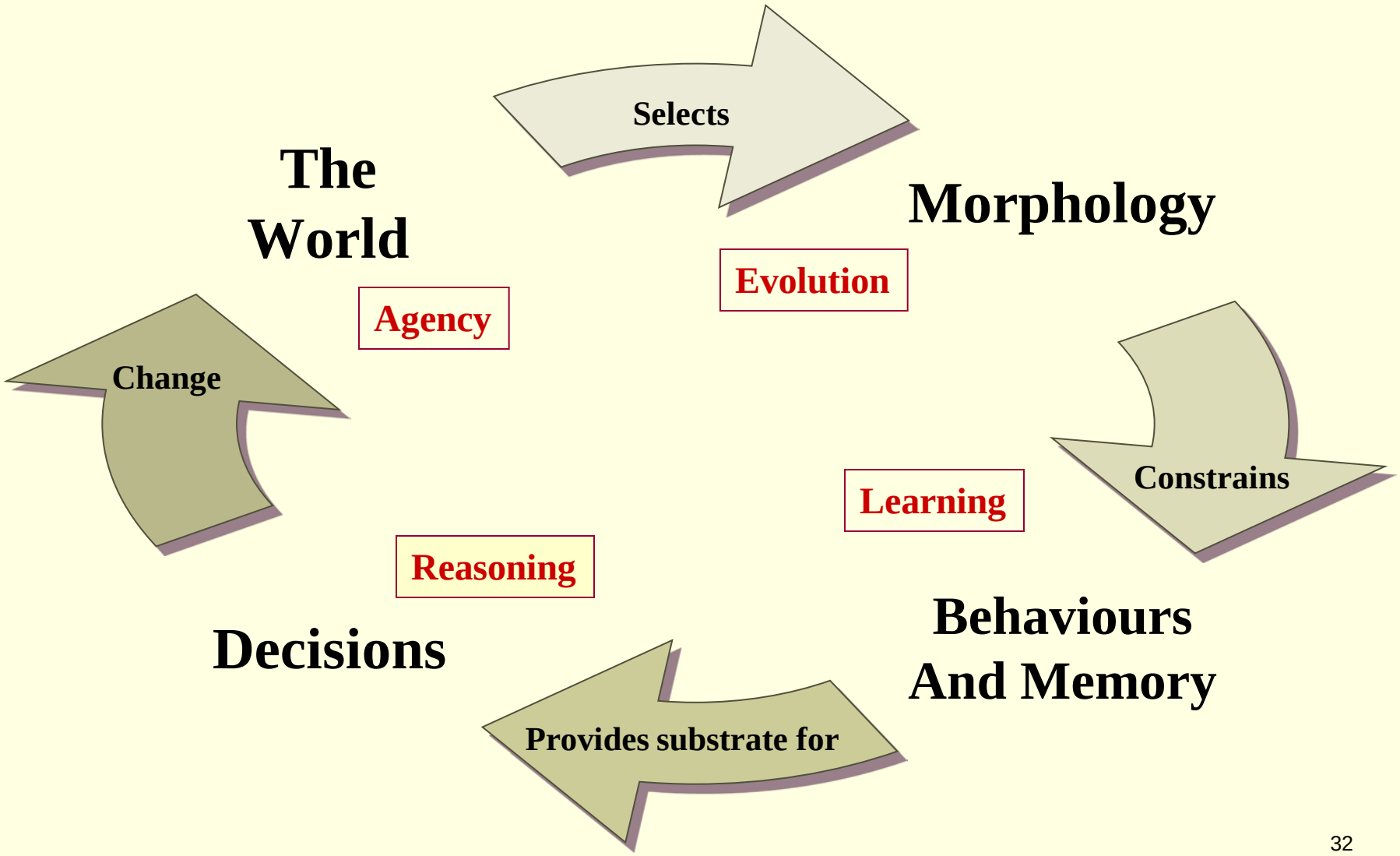
- ***They are trajectories in an appropriate basin of attraction***

And Learning is …

- about changing shallow basins of attraction into deep basin that are more stable to change



The Nested Loops of Artificial Agency



Conclusions

- ***Current-day protections are largely ineffective – reactive.***
- ***Empower virtual, cognitive agents to act on our behalf to protect the data entrusted to them – proactive.***
- ***The ultimate embodiment of Privacy by Design.***
- ***SmartData – an innovative approach to protecting privacy and security.***