





































# Authenticating

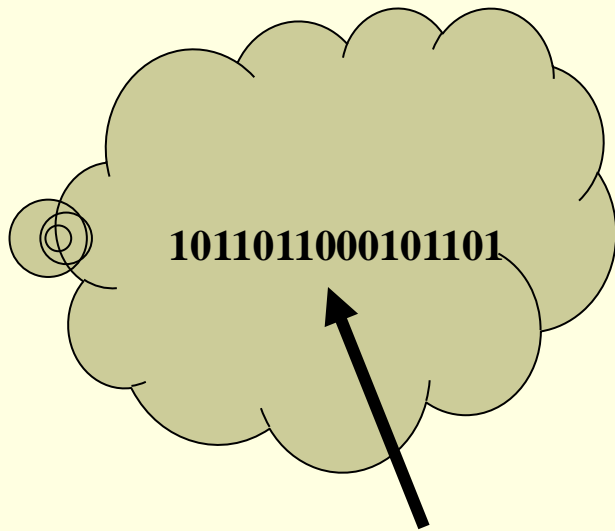
- ***SmartData: authenticate credentials of requestors***
- ***Requestors: authenticate credentials of SmartData***
  - ***Digital signatures and biometrics***

# Analog output option

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

# No Personal information in the cloud: Just SmartData

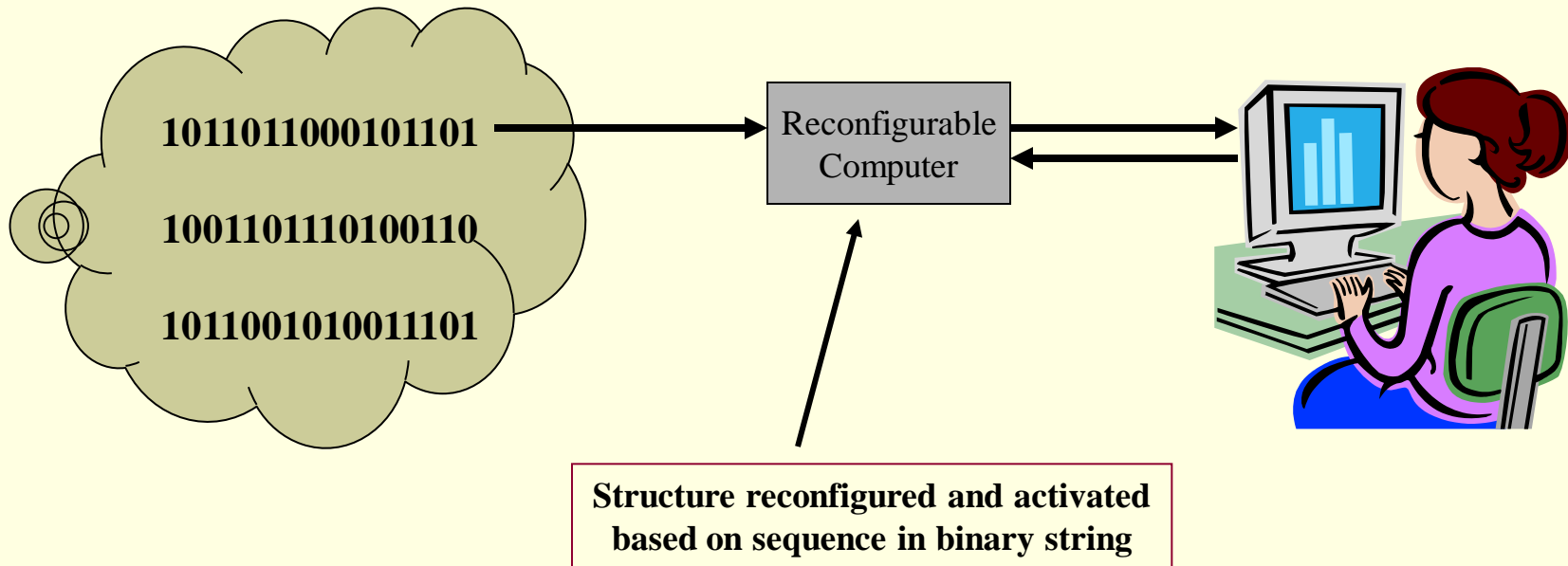
- Only SD binary string is transmitted



**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.*

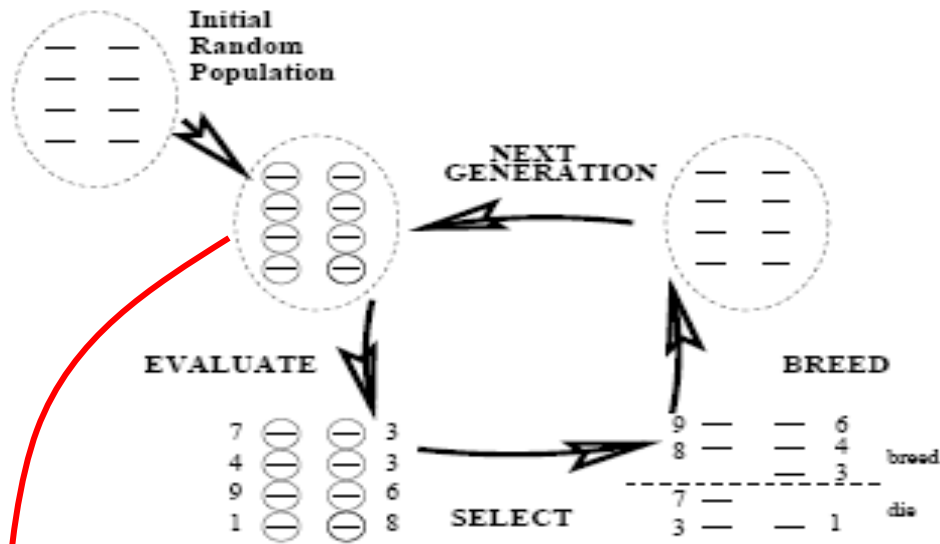
# Embodied Cognition

- ***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.***

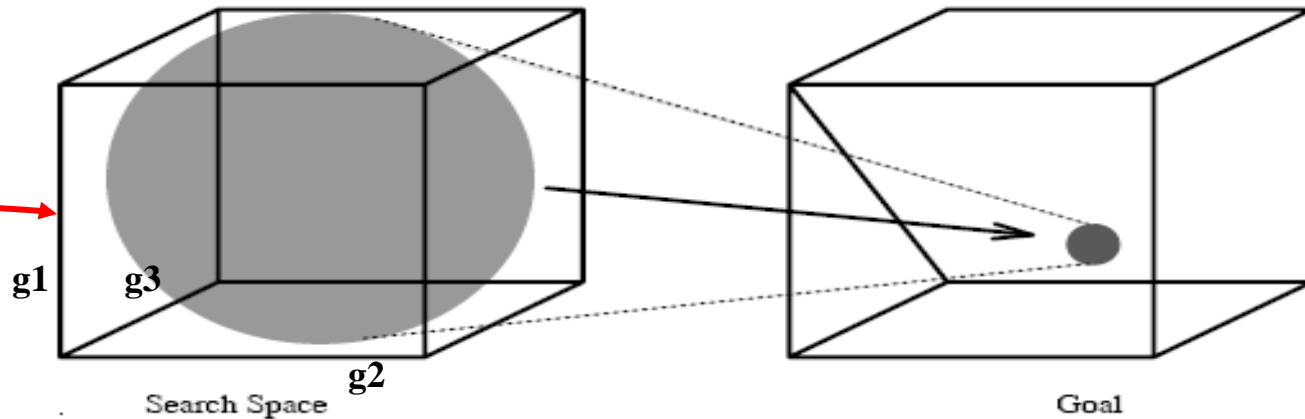
# Evolutionary Robotics

- ***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

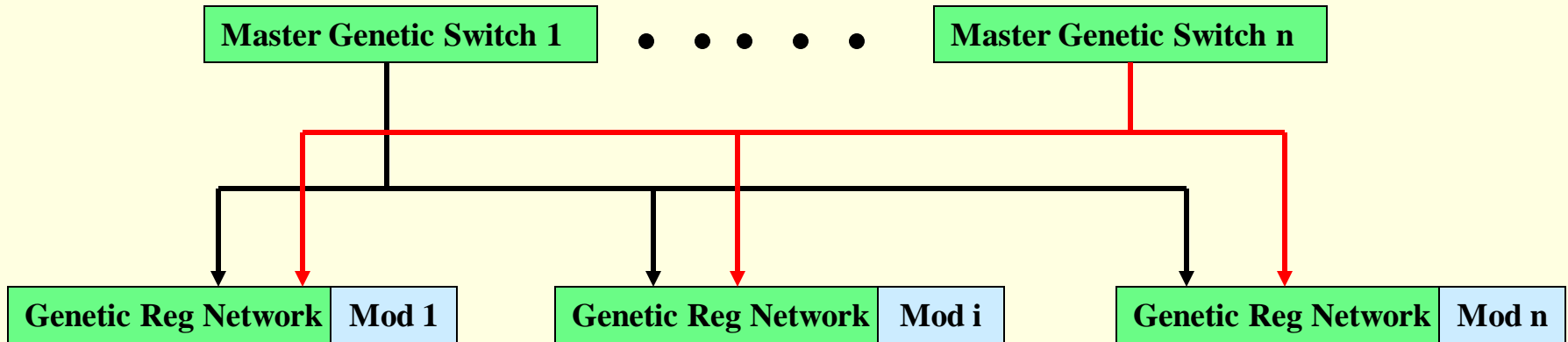


**Population initially spans the search space and progressively hones in on the optimum**





# 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;**

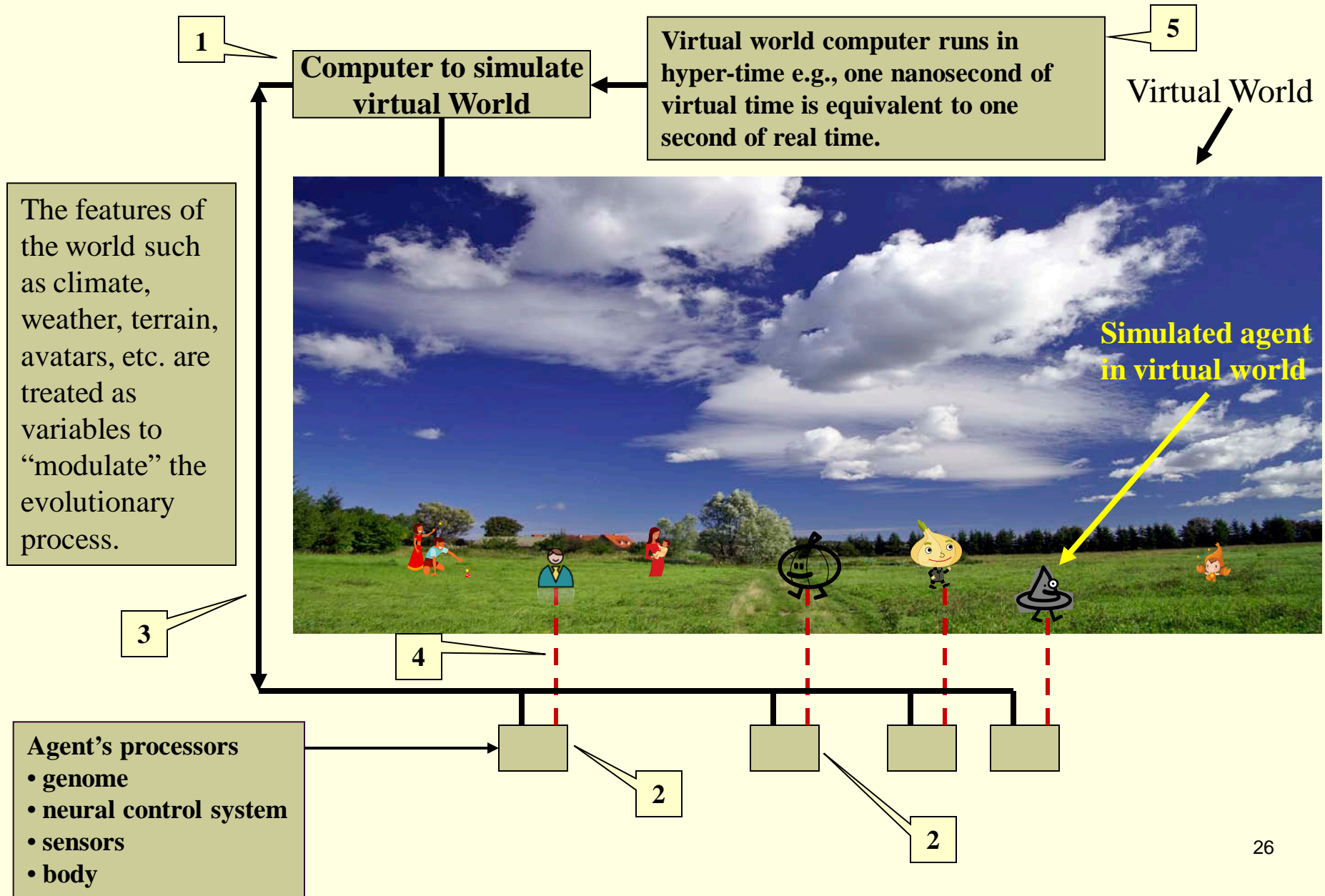
**Mod i = sensor (x,y,x,z...)**

**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

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

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

Coupling Parameters

Where:

**A** = Agent's transition map;

**E** = Environment's transition map;

**X** = Output variable of Agent's neurons;

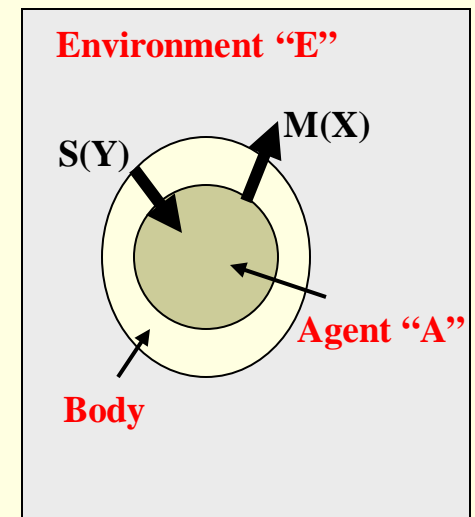
**Y** = Output variables of environment;

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

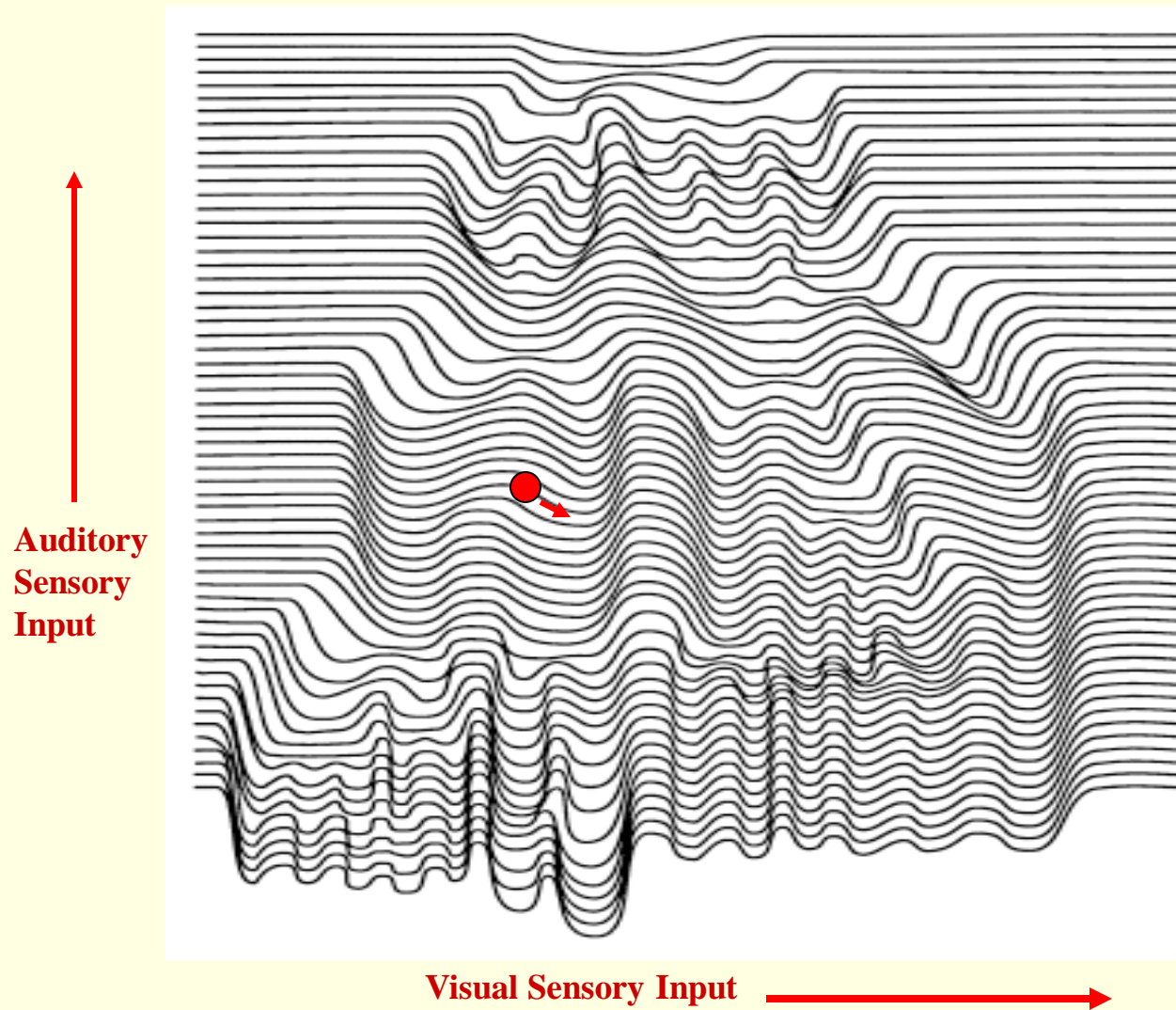
**M(X)** = transformation of Agent's variables into motor parameters that affect the environment;

**U** = Agent's internal parameters;

**V** = Environment's parameters



# Dynamical System as a Dancing Landscape



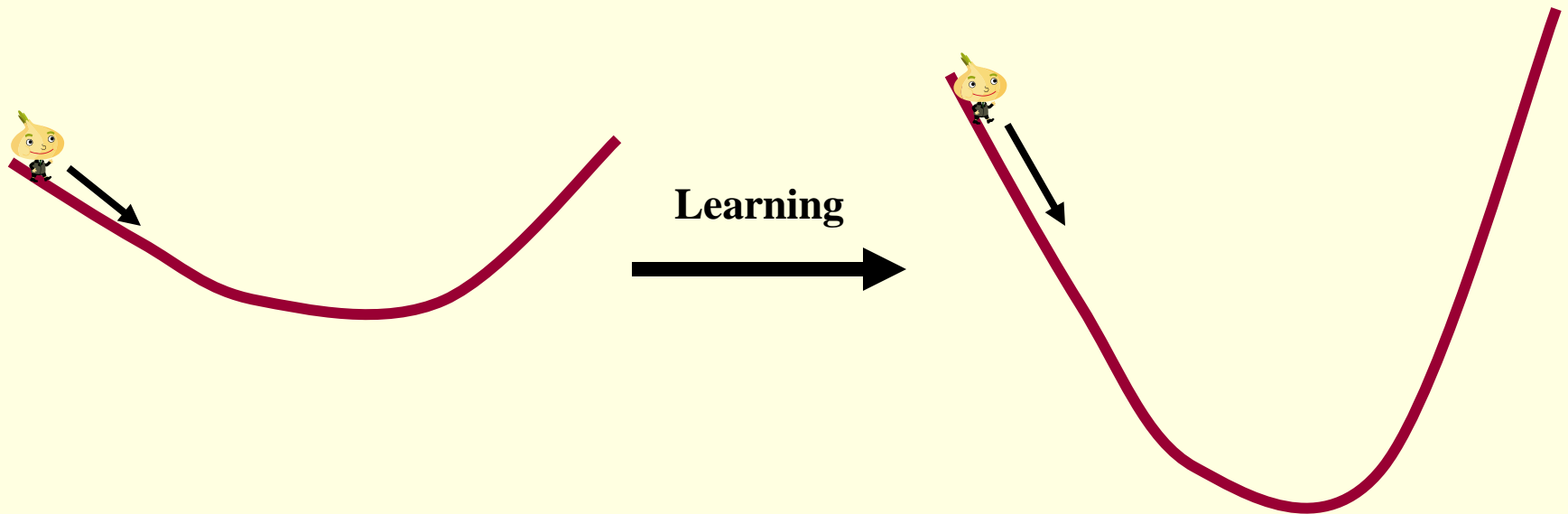
# Life is Just a Journey

- *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*

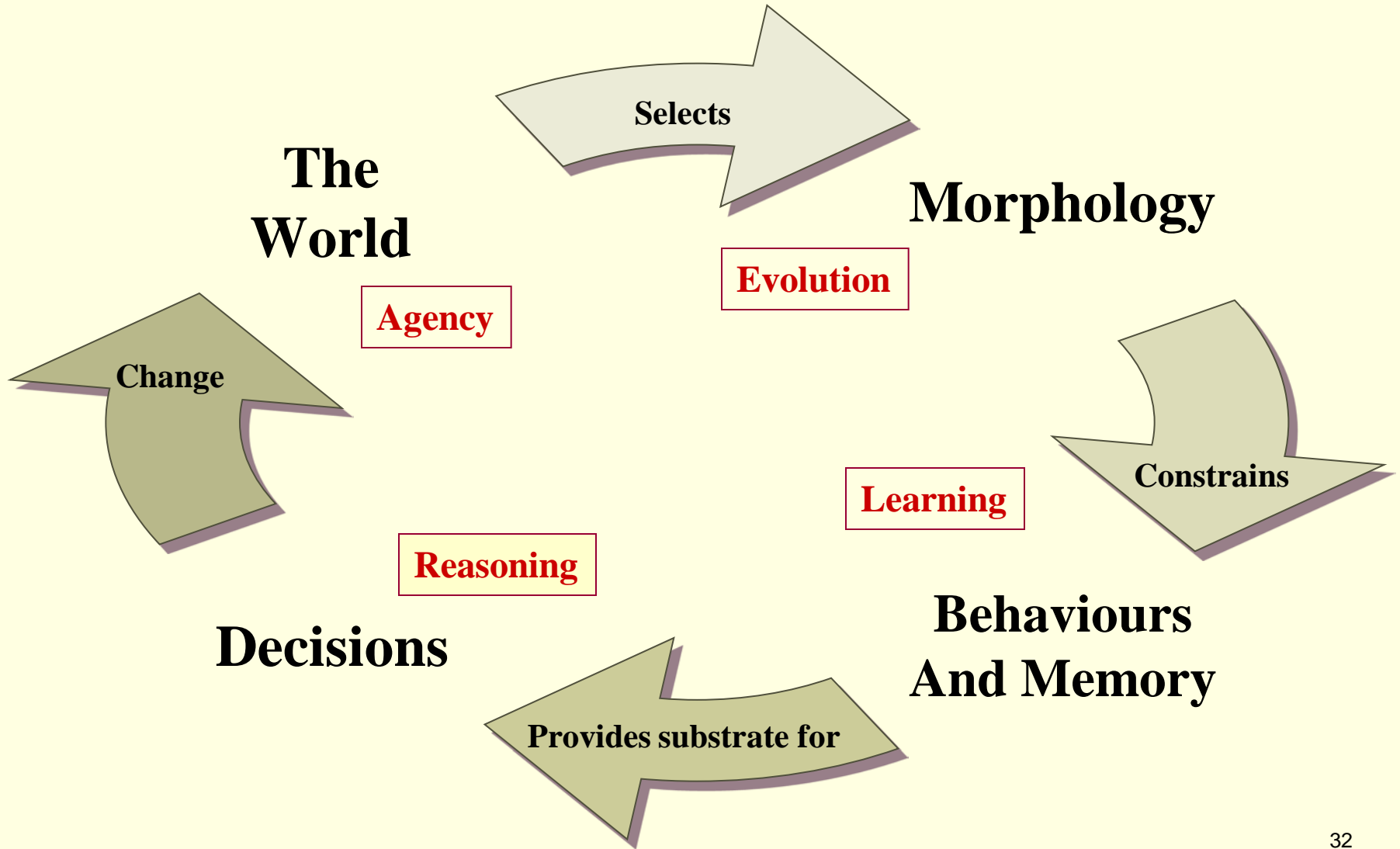


# And Learning is ...

- 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.***