

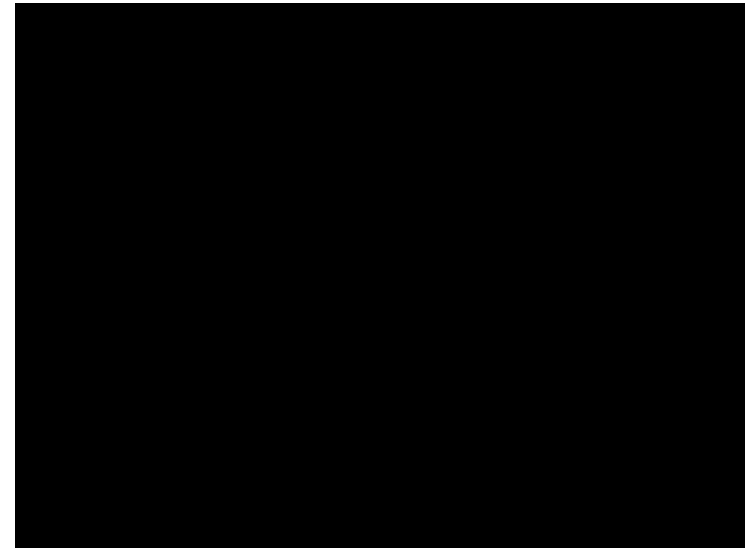
Spatial Computing Applications to Natural Sciences

ANTÓNIO CÂMARA

2025

Digital Portugal-SNIG

The first Web (1995) and Virtual Reality based spatial data infrastructure (1998)

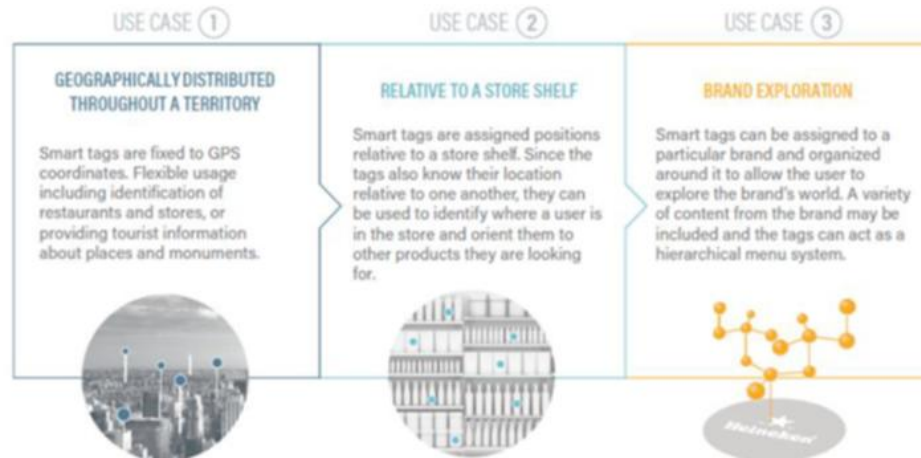


[Virtual GIS](#)

The YDreams Collection

2000-2025

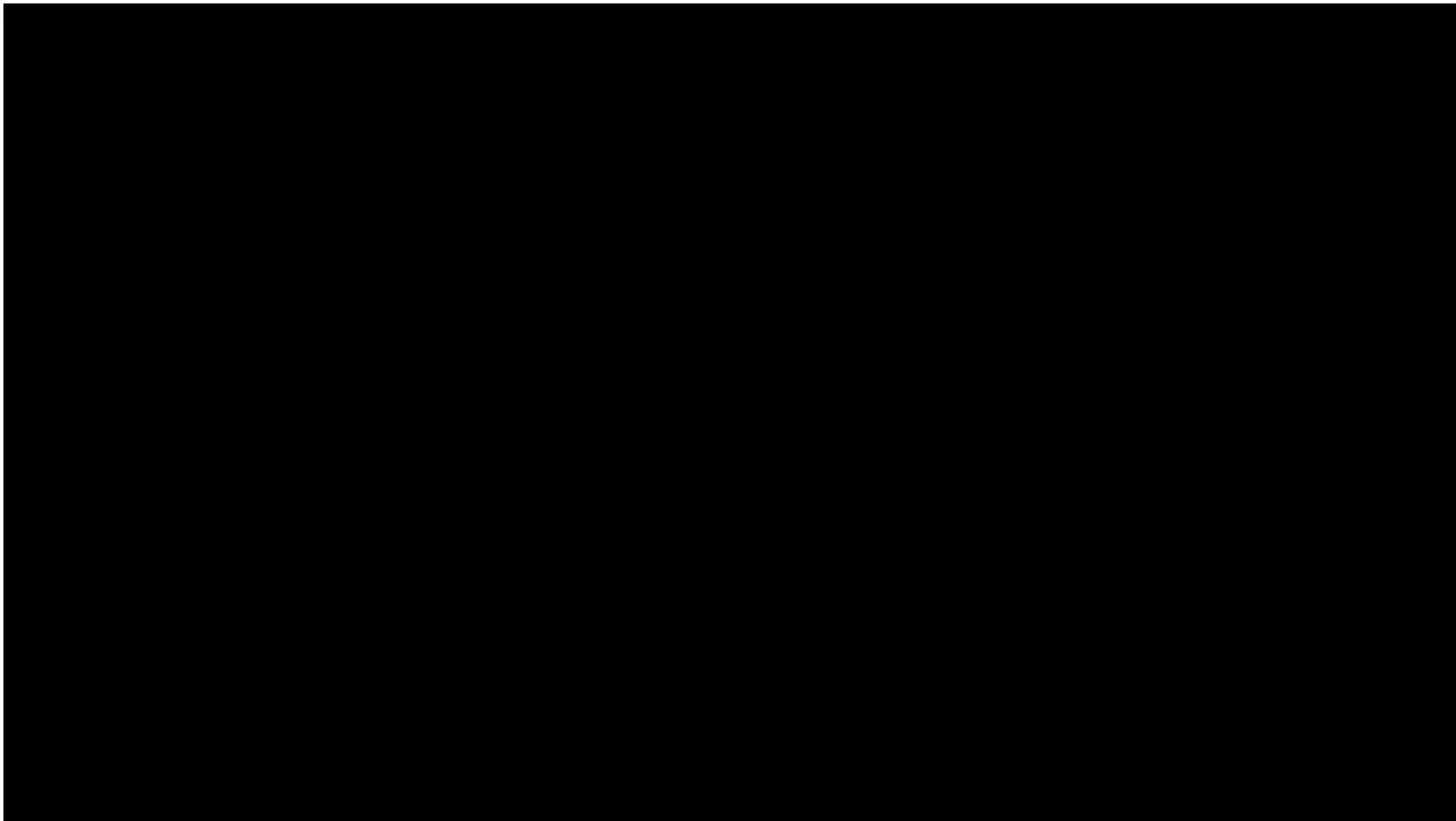
SMART TAGS IN USE



On Spatial Computing,
Metaverse, the Terms Left
Behind and Ideas Renewed

	Sense					Act			
Sound	MICROPHONE	SOUND LVL	SPEECH REC	ACOUSTIC	DOPPLER	ASSISTANTS	SPEAKER	BUZZER	CHAT BOT
Sight	CAMERAS	SECURITY	MOTION	LIGHT	XRAY	PROJECTORS	LIGHTS	SCREENS	VR DISPLAYS
Touch	TACTILE	BUTTON	HUMIDITY	TEMP	DOOR SENSOR	HEAT & COOL	ACTUATOR	MOTOR	LEVER
Spatial	GPS	IP TRACKING	ACCELEROM.	GEOFENCING	PERSISTENCE	ANCHORING	OCCUPANCY	RFID	DELIVERY
Smell	MARKER	OBJECT	GESTURE	BODY	MOOD • FACE	POST	INFO	TIME	POSTING

Periodic Table of Spatial
Computing



[YDreams Creative Reel](#)



TUGA LAND AIR Combo

Low Altitude Economy

Spatial Computing Applications* to Natural Sciences**

The game and the game on top of the game

Humans, machines and Nature: Applications to Agrarian Sciences

A proposal for disruption: Creating the Internet of Nature

*Spatial Computing- AI/Robotics and AR/VR

**Natural Sciences- Agriculture, Forestry, Food Science, Environmental Sciences, Landscape Architecture

The Game and the Game on top of The Game

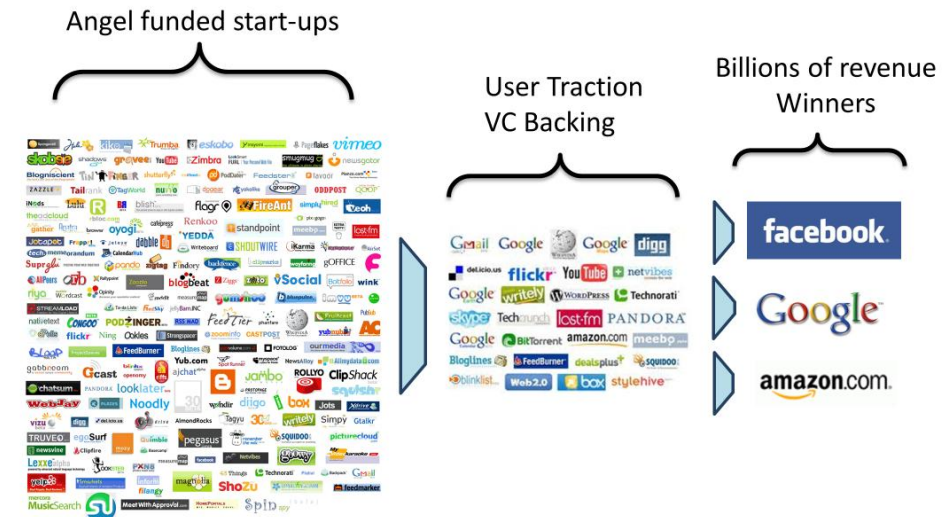
A Game and a Game on top of the Game



“We blacks dominate basketball.
Then the whites developed a game on top of
our game called NBA”

The Driving Model

The Silicon Valley Model



Picture Credits: [Ludwig Gatzke](#)



The Game

**Academia, innovation & industry –
traditional model
(Francis Bacon; 1561 – 1626)**



LINEAR TECHNOLOGY EVOLUTION

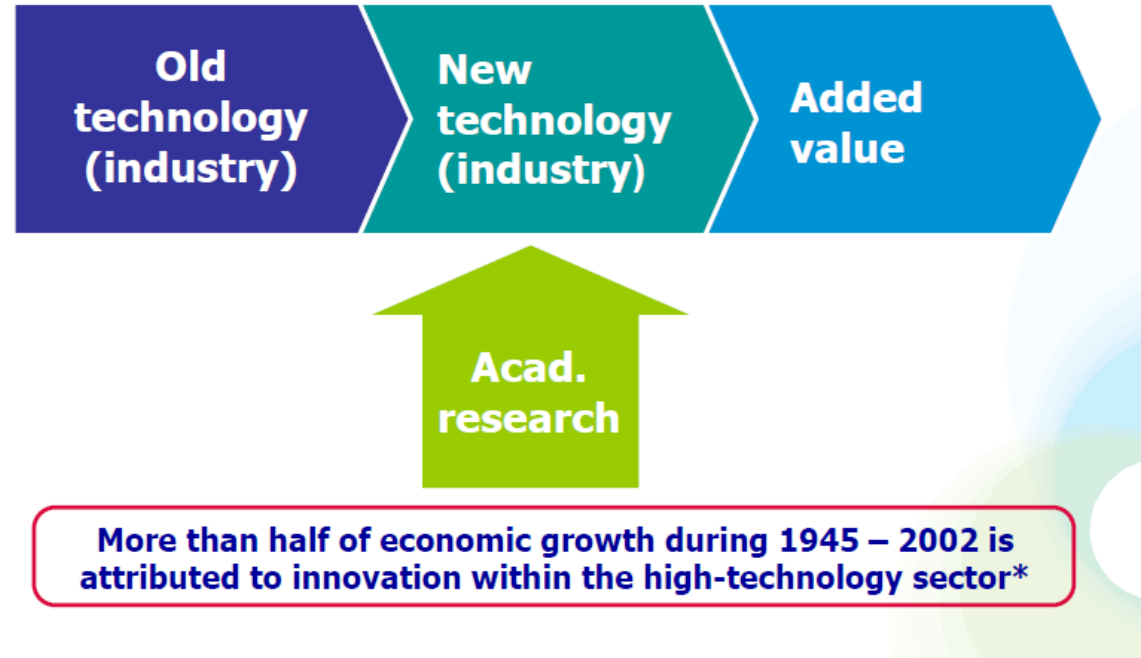


The Game

Academia, innovation & industry: the Californian model (Adam Smith; 1723 – 1790)



BRANCHED TECHNOLOGY EVOLUTION MODEL

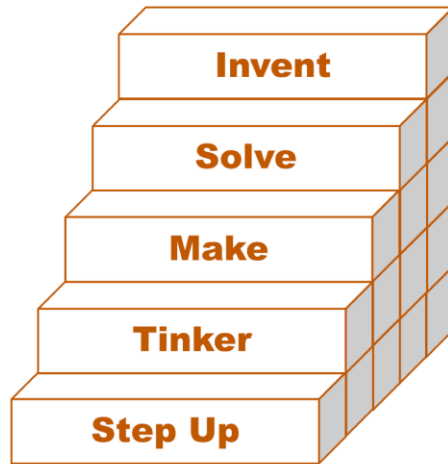


* Leary et al
2002

The Game

The traditional research model has been complemented by:

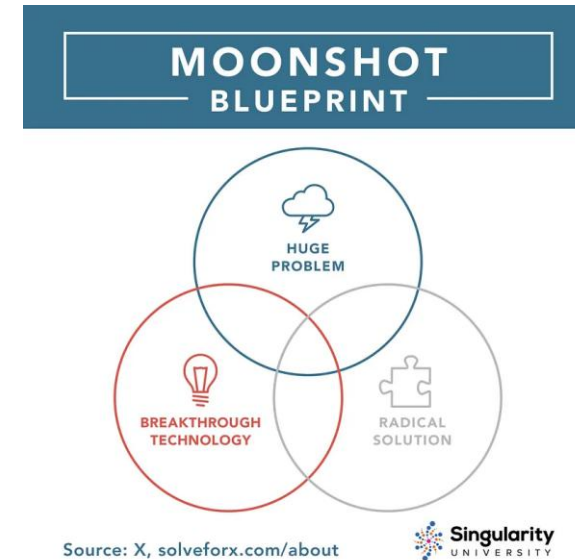
Skunkworks



[MIT Makerspaces](#) [UT Inventionworks](#)

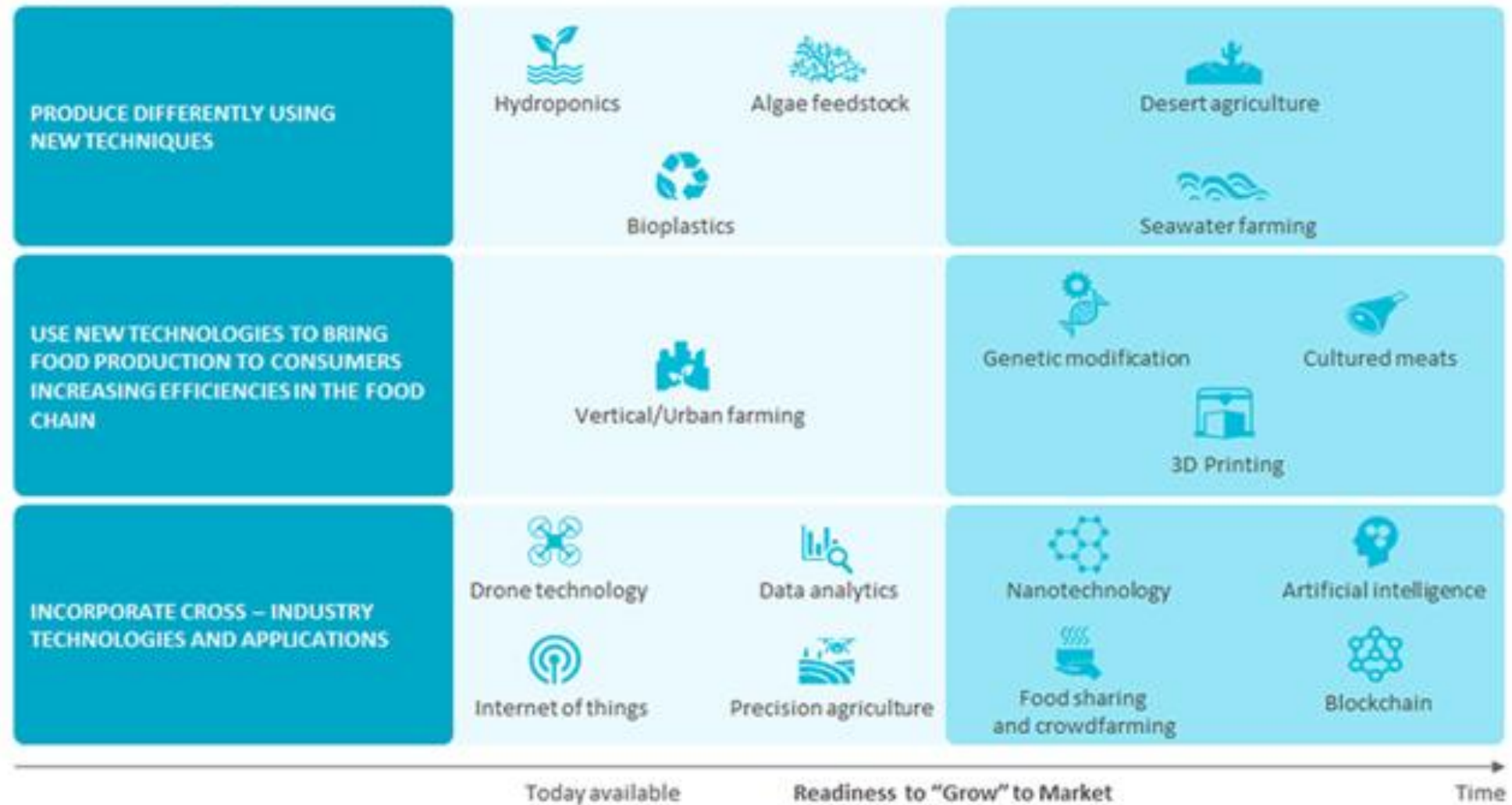
[Seixal Criativo](#)

Moonshots



[Top 50 Moonshots \(2000-2020\)](#)

Map of technologies and maturity



Oliver Wayman, Agriculture 4.0- The future of farming technology

The Game on top of the Game

[MIT 100k type competitions](#)

[Venture Studios](#)

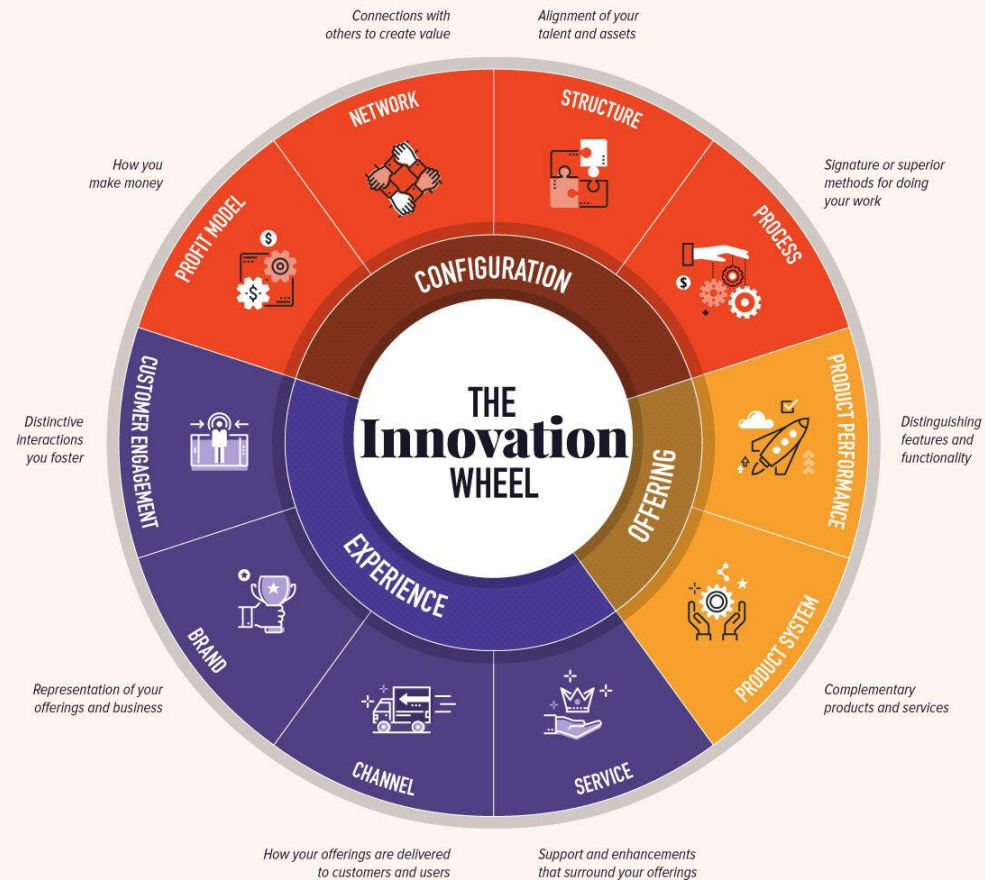
[Incubators and Accelerators](#)



UNDERSTANDING THE 10 Types of Innovation

New products are invented from scratch all the time, but this is merely one way to innovate.

According to innovation firm **Doblin**, most big breakthroughs in history comprise some combination of the following 10 types of innovation.



By tactically examining these 10 different types of innovation, you may uncover exciting new product opportunities – or you may change the business world forever.

The Game on top of the Game

AG TECH: 100+ TECHNOLOGY COMPANIES CHANGING THE FARM

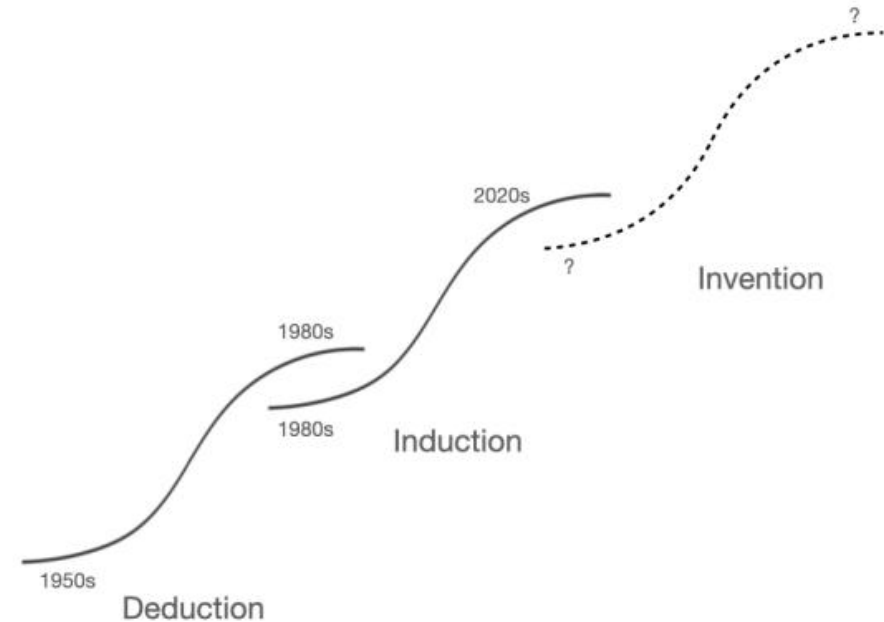


Humans, Machines and Nature

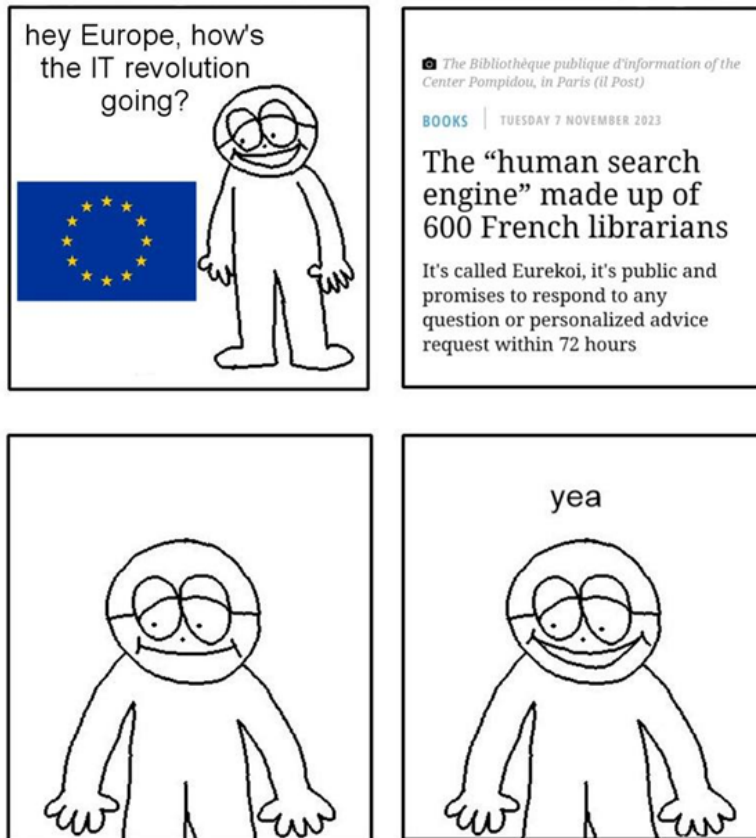
Humans

Humans and Machines

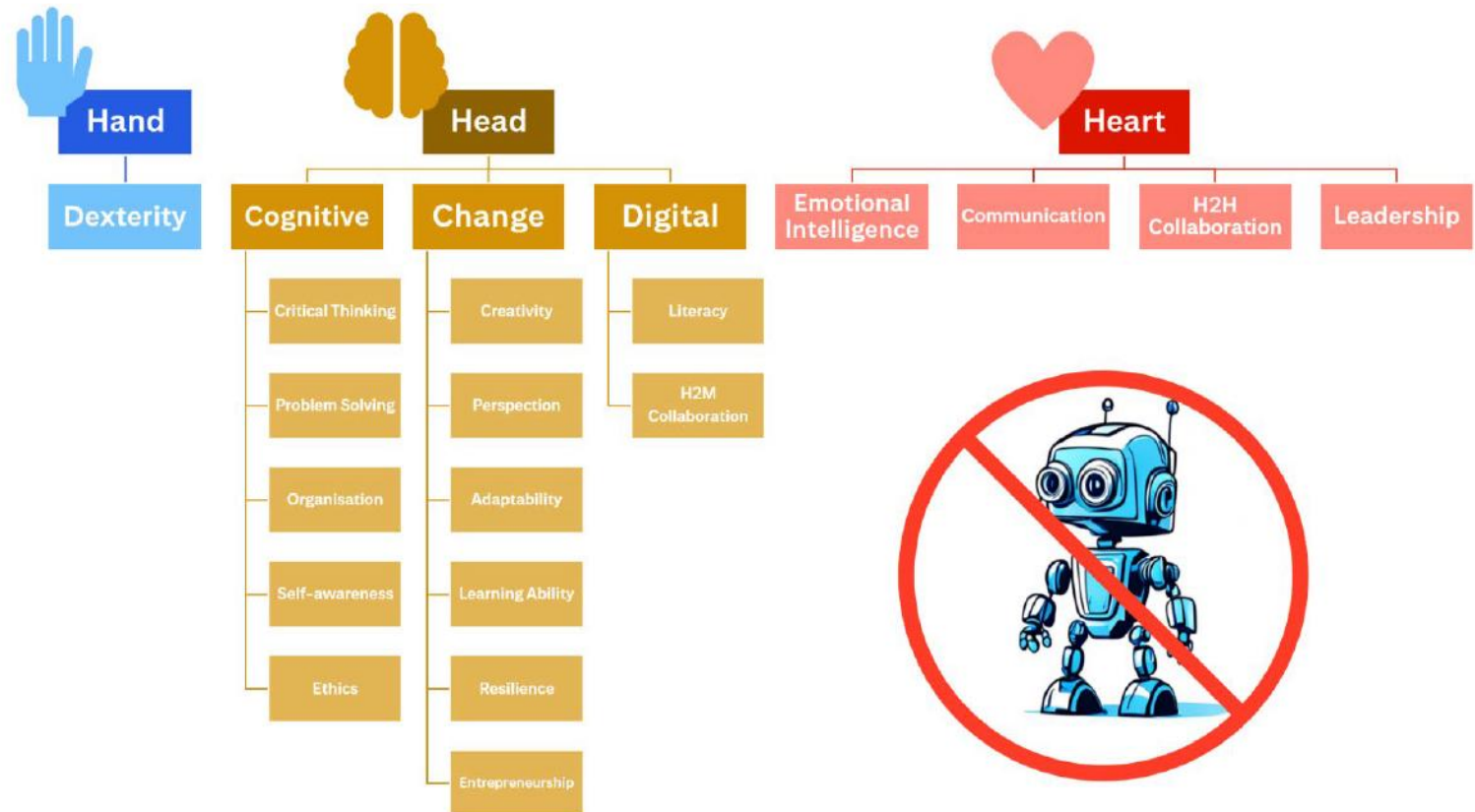
Humans and Nature



Humans



We must love the French



What Machines can not master

Humans, Machines and Nature

AI/Robotics and Nature

[Large Language Models Empowered Agent-based Modeling and Simulation: A Survey and Perspectives](#)



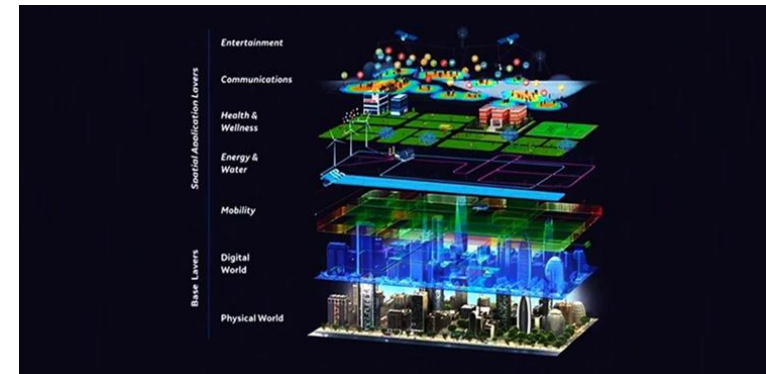
AR/VR and Nature

The Data World

The Augmented World

The Digitally Twinned World

The Virtual World



Humans and Machines

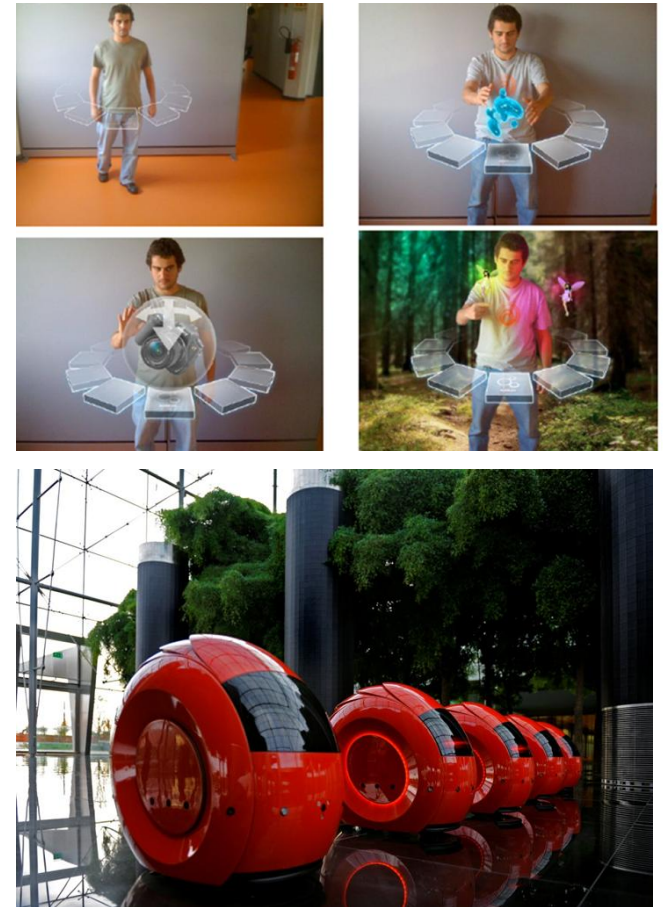
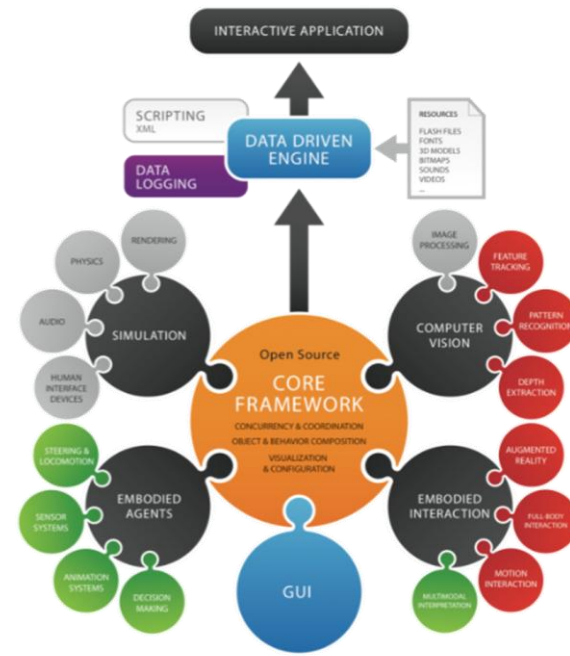
Spatial Computing (AI/Robotics/AR/VR) fundamentals

YVision mathematics

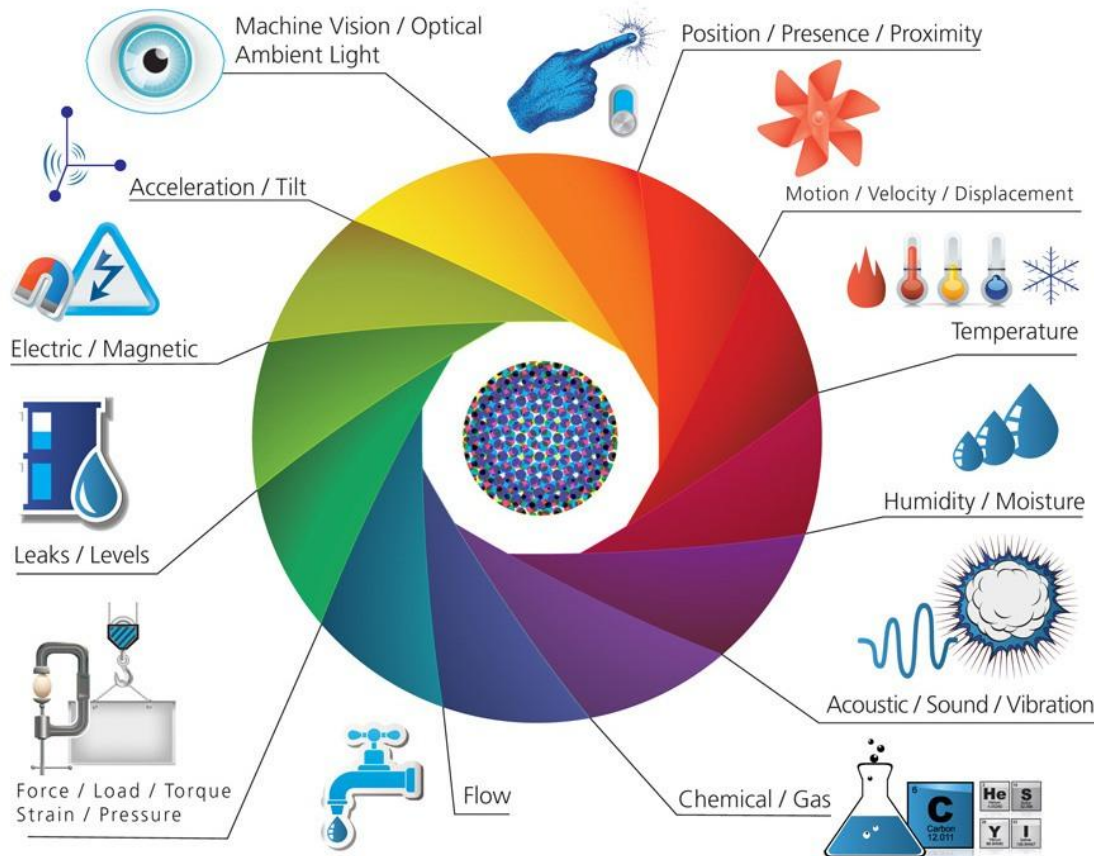
- 3D Rendering: Linear Algebra - Differential Geometry - Geometry (Projective Transformations)
- Physics Simulation: Linear Algebra - Differential Calculus - Integral Calculus - Numerical Analysis (for approximating continuous mathematics)
- Computer Vision: Linear Algebra - Geometry (Homographies, Projective Transformations) - Cellular Automata - Convolutions - Fourier Analysis
- Synthesis and Transform Audio: Fourier Analysis, Synthesis and Transform
- Machine Learning: Statistical Analysis - Artificial Neural Networks - Principal Component Analysis - Regression - Function Approximation
- Evolutionary Computation Core Framework: Lambda Calculus (root of functional programming) - Turing Machines - Theory of Computation

[The YDreams Collection](#)

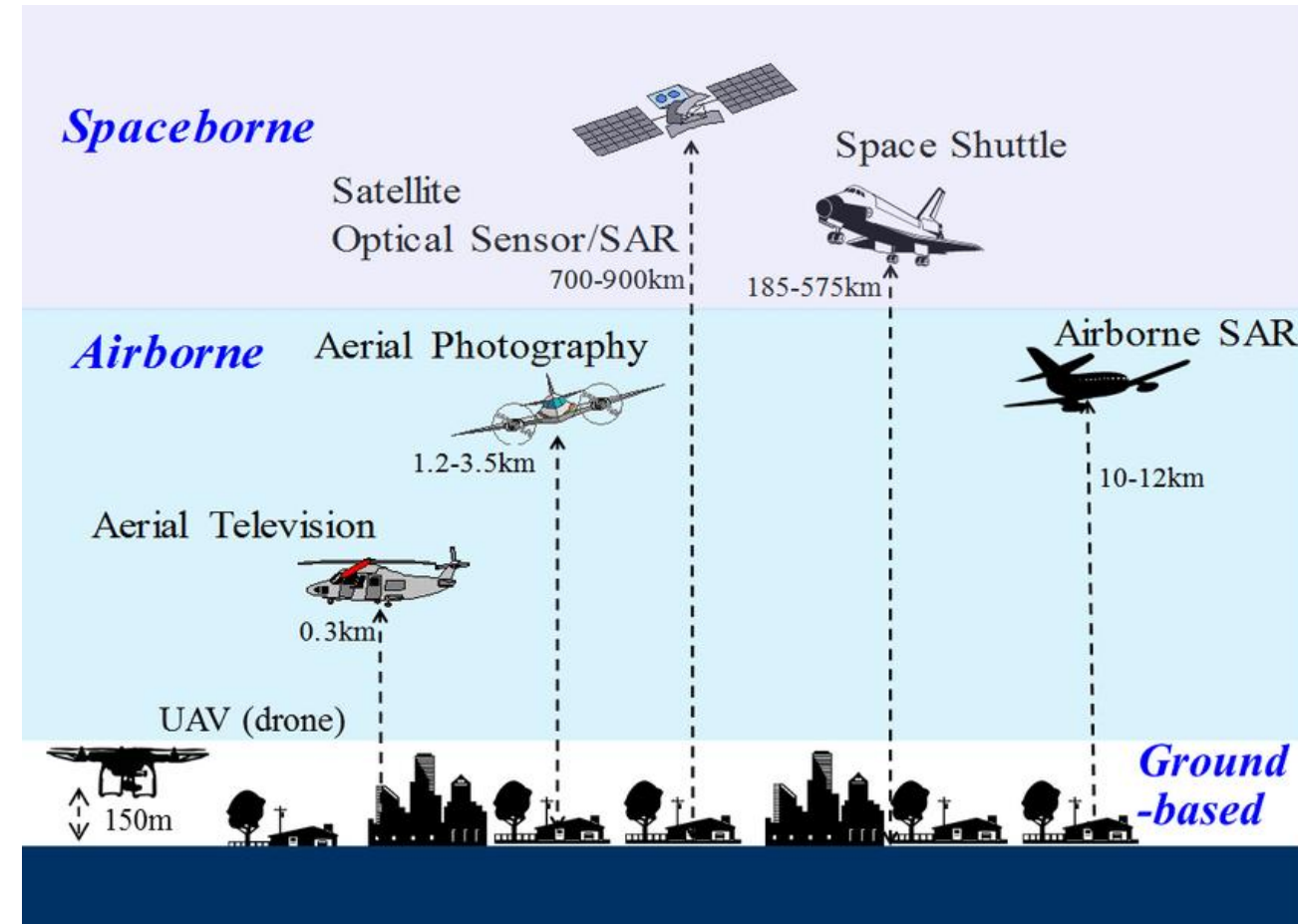
Spatial Computing (AI/Robotics/AR/VR) applications



Humans and Machines Sensors



Environmental IoT sensors



Sensors used for remote sensing

Humans and Machines

Smart Labels

“Smart labels” enabling sensing and tracking

[Ynvisible](#)



Humans and Machines

Robots

Eco-Robotix

Efficient pesticide application



Naio Technologies

Weed elimination



Humans and Machines

Robots

Energid Citrus Picking System

Picking citrus



Agrobot E- Series

Used to assess berries 'maturity



Humans and Machines

Robots

Agribotix & Precision Hawk

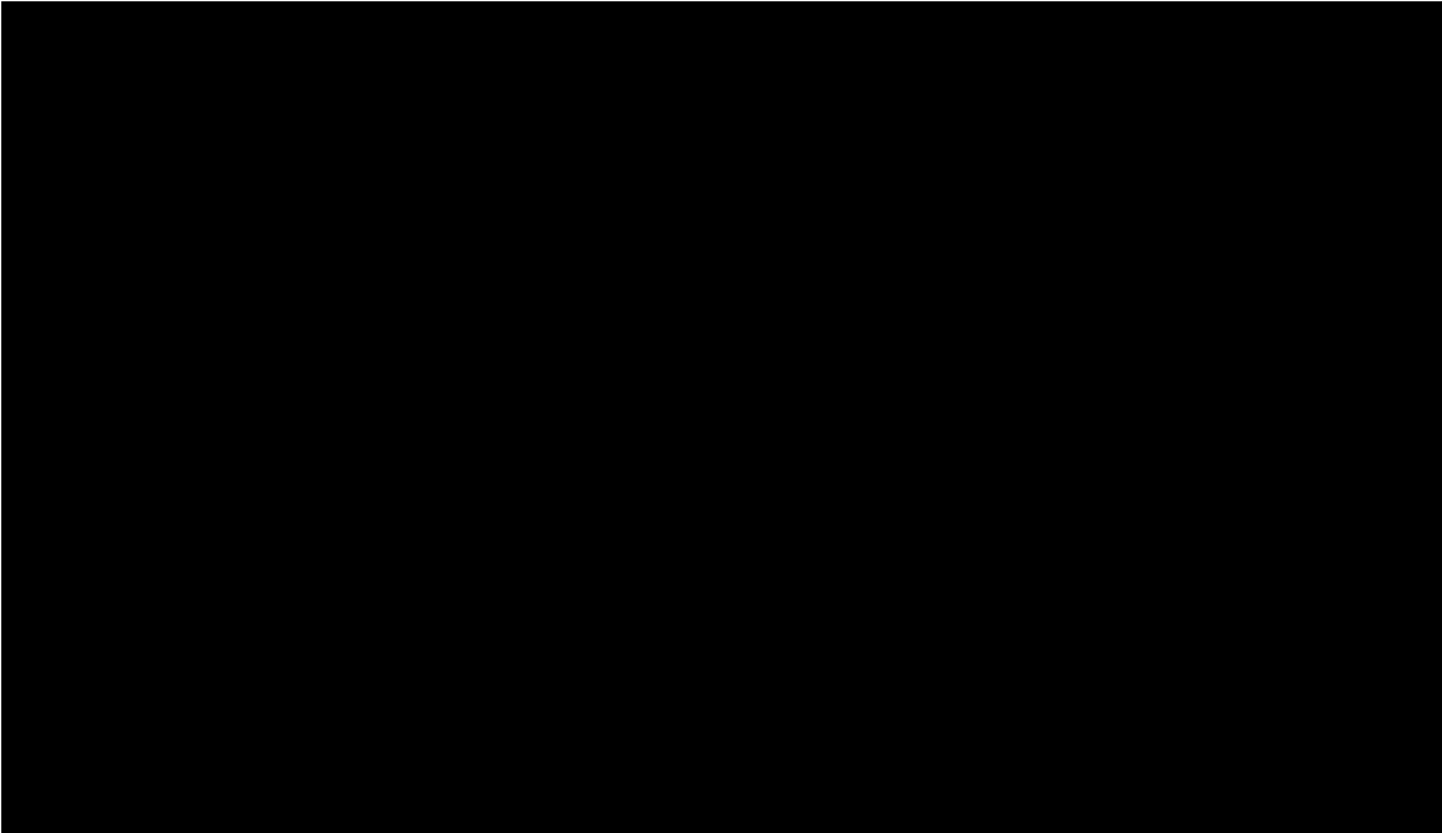
Plant health



Tevel Aerobotics

Identifying and picking fruit



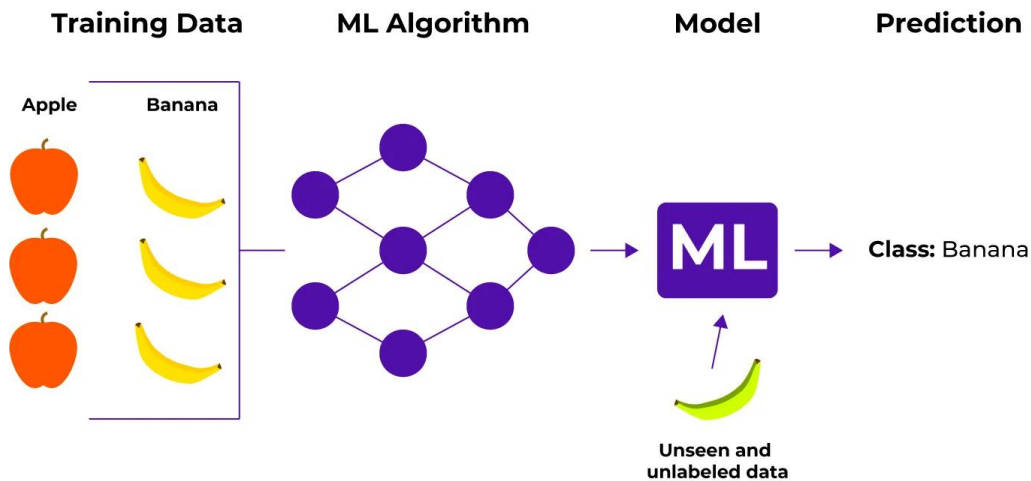


[Agri Robotics developments](#)

Humans and Machines

AI fundamentals

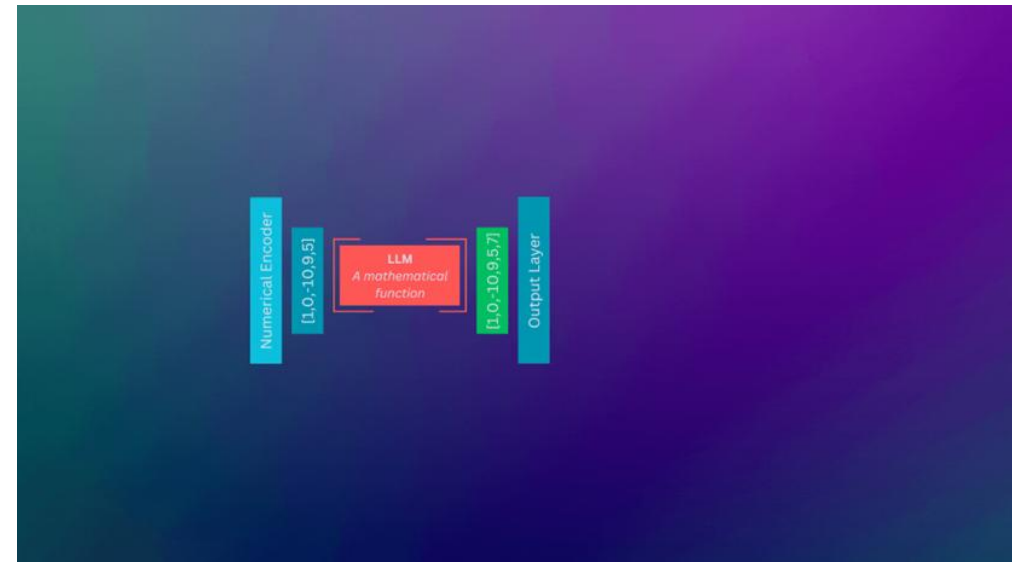
Biological inspired beat symbolic
inspired AI- neural networks



[An AI Engineer's Guide to Machine Learning and Generative AI](#)

Generative AI

[Large Language Models](#) (LLMs)
and Large Multimodal Models
(LMMs)

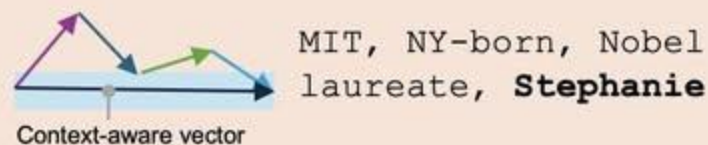


Simplified hallucination in a transformer-based model (like GPT, Claude, or Gemini)

- 1) All words are getting **embedded** in multidimensional **vectors**

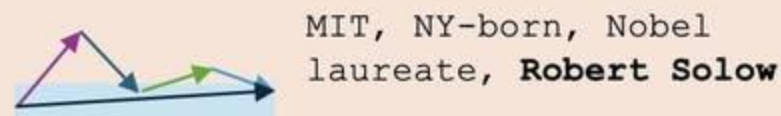


- 2) The **attention block** in transformers makes them “context-aware”



The attention block assigns more semantic meaning based on the context (position of each token relative to each other)

- 3) The problem now is how the **context-aware vector** looks very similar to



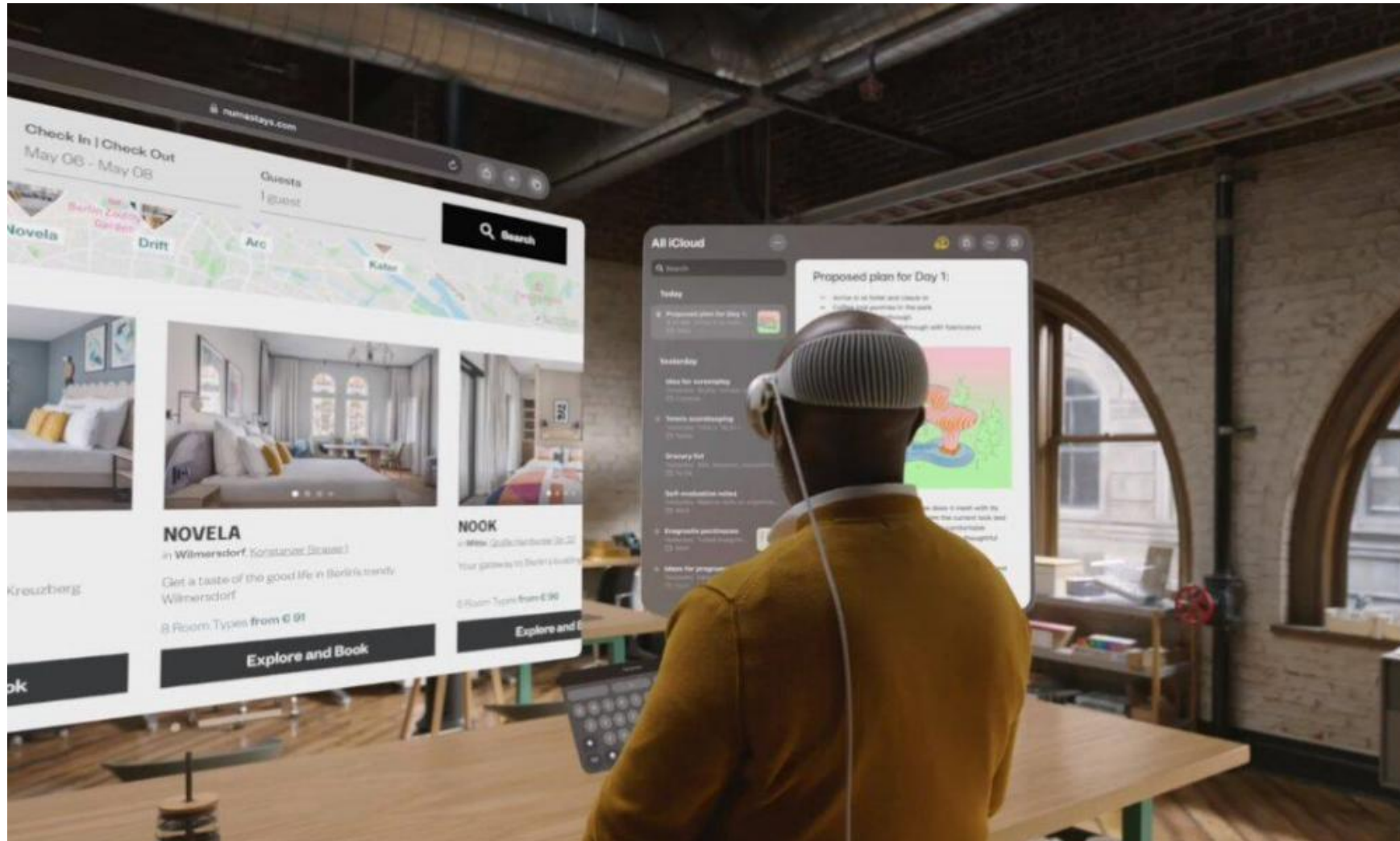
The  illustrates the embedding limit, ultimately allowing for a certain degree of semantic inconsistency. It looks very similar to Robert Solow, an actual MIT, NY-born, Nobel laureate of whom the model has data of



Prompt: Drone view of waves crashing against the rugged cliffs along Big Sur's garay point beach. The crashing blue waters create white-tipped waves, while the golden light of the...
more

0:05 / 0:08 ⏏ ⏶

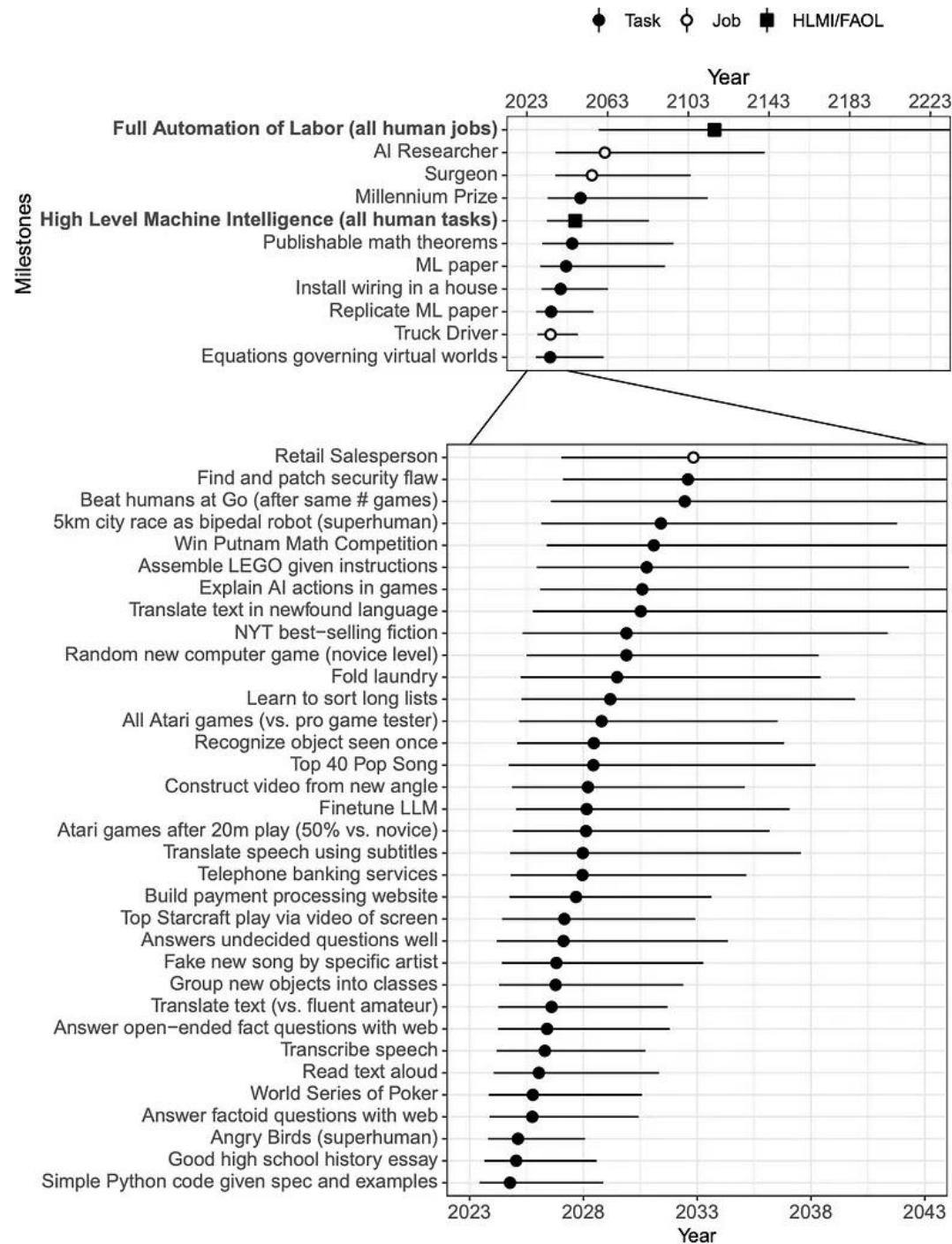
This [video](#) was created with [OpenAI's Sora](#)



Disney's Apple Vision Pro sizzle [reel](#)



Plume, combining AI and AR



High-Level Machine
Intelligence- HLMI (2047)

Full Automation of Labor
(2116)

Cezary Gesikowski,
Redefining Tomorrow: AI
Researchers Unveil a
Startling Future, February
2024

Humans, Machines and Nature

Nature services

Intrinsic services

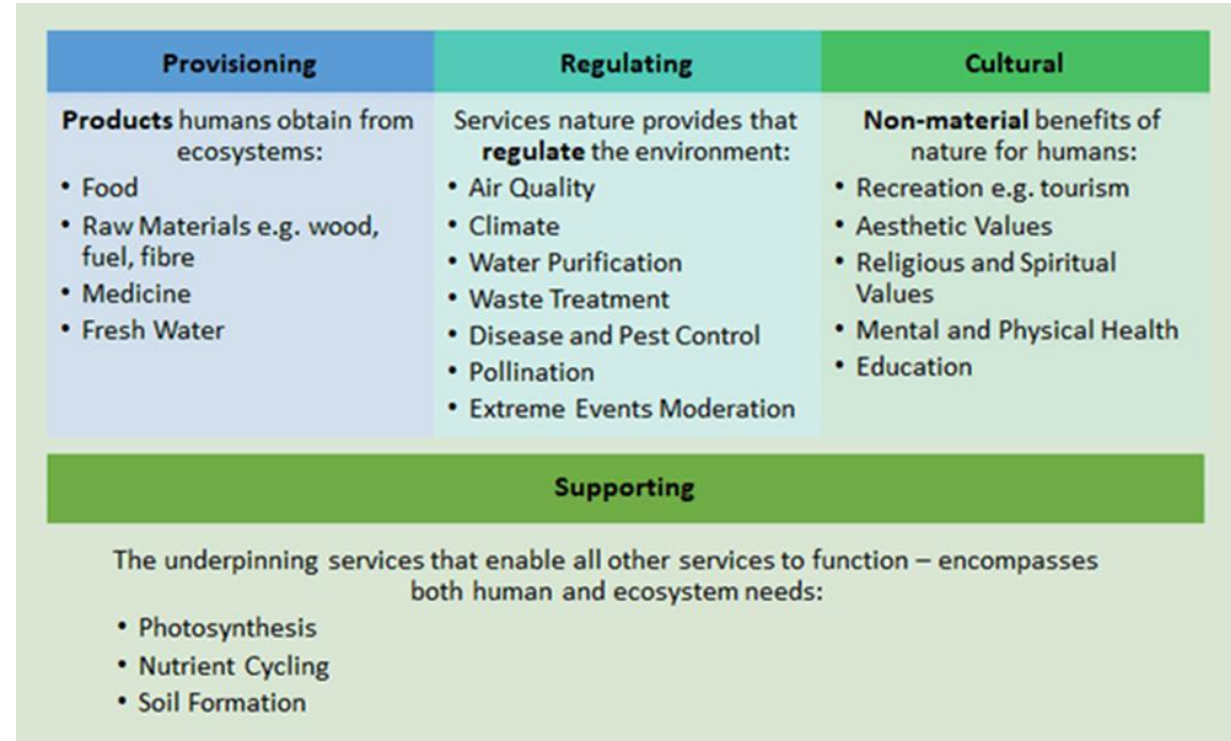
The Real, Data, Augmented and Digitally Twinned Worlds

Offset services

The Digitally Twinned World

Derivative services

The Real and Virtual Worlds



[Ecosystem Services: the Fundamentals](#)

Humans, Machines and Nature

With the help of [Claude](#)

AI/Robotics Applications in Agriculture

1. Autonomous Systems

- Robotic planting and seeding
- Precision crop harvesting
- Autonomous crop monitoring drones
- Weeding and pest control robots
- Autonomous fertilizer application

2. AI-Driven Optimization

- Crop disease detection
- Yield prediction algorithms
- Smart irrigation control
- Crop genetic improvement
- Soil health analysis

AR/VR Applications in Agriculture

1. Training & Visualization

- Crop management simulations
- Equipment operation training
- Soil condition visualization
- Precision agriculture interfaces
- Agricultural technique demonstrations

2. Field Management

- Real-time crop health overlays
- Pest and disease identification
- Irrigation planning visualization
- Yield prediction interfaces
- Remote field monitoring

Humans, Machines and Nature

With the help of [Claude](#)

AI and Robotics Applications in Forestry

1. Monitoring Technologies

- Drone-based forest mapping
- AI-driven species identification
- Wildfire early warning systems
- Tree growth and health tracking
- Automated forest inventory

2. Management Solutions

- Robotic tree planting
- Autonomous logging equipment
- Biomass estimation algorithms
- Wildlife corridor monitoring
- Carbon sequestration tracking

AR/VR Applications in Forestry

1. Management Technologies

- Forest terrain mapping
- Tree species identification
- Ecosystem simulation
- Wildlife habitat visualization
- Forest fire risk modeling

2. Conservation Approaches

- Habitat restoration planning
- Species migration tracking
- Biomass estimation
- Carbon sequestration visualization
- Tree growth simulation

Humans, Machines and Nature

With the help of [Claude](#)

AI and Robotics Applications in Food Science

1. Production Technologies

- Robotic food processing
- AI quality control systems
- Automated packaging
- Nutritional content analysis
- Flavor profile optimization

2. Safety and Innovation

- Contamination detection
- Predictive food spoilage algorithms
- Robotic fermentation management
- Personalized nutrition AI
- Ingredient interaction modeling

AR/VR Applications in Food Science

1. Production Techniques

- Food processing training
- Quality control visualization
- Nutritional content analysis
- Flavor profile simulation
- Manufacturing process optimization

2. Consumer Interactions

- Product development interfaces
- Cooking technique demonstrations
- Food safety training
- Ingredient interaction modeling
- Sensory experience simulation

Humans, Machines and Nature

With the help of [Claude](#)

AI and Robotics Applications in Environmental Sciences

1. Ecosystem Monitoring

- AI-powered biodiversity tracking
- Robotic environmental sampling
- Climate change impact simulation
- Pollution detection systems
- Ecosystem restoration planning

2. Conservation Technologies

- Species migration tracking
- Habitat restoration robots
- AI-driven conservation strategies
- Environmental data collection
- Invasive species management

AR/VR Applications in Environmental Sciences

1. Ecosystem Analysis

- Climate change modeling
- Biodiversity tracking
- Pollution dispersion visualization
- Habitat restoration planning
- Environmental impact simulation

2. Research Tools

- Species migration tracking
- Microclimate visualization
- Environmental sensor data overlay
- Conservation strategy simulation
- Ecological network mapping

Humans, Machines and Nature

With the help of [Claude](#)

AI and Robotics Applications in Landscape Architecture

1. Design Innovation

- AI landscape generation
- Robotic terrain modeling
- Microclimate simulation
- Green infrastructure optimization
- Urban ecosystem design

2. Implementation Technologies

- Autonomous landscaping robots
- AI-driven plant selection
- Sustainable design algorithms
- Vegetation growth prediction
- Water resource management

AR/VR Applications in Landscape Architecture

1. Design Technologies

- 3D landscape modeling
- Urban ecosystem simulation
- Green infrastructure planning
- Microclimate visualization
- Site analysis interfaces

2. Implementation Strategies

- Vegetation growth prediction
- Urban design visualization
- Sustainable design optimization
- Terrain modification simulation
- Environmental impact assessment

Internet of Nature (IoN): a Proposal for Disruption

Internet of Nature (IoN)

Humans and Machines (AI, Robotics, AR/VR) working together will create:

The Augmented Nature

The Digital Twinned Nature

The Virtual Nature

Intrinsic markets will be based on the Augmented Earth

Derivative markets will grow on the Virtual Earth

Offset markets based on the Digital Twinned Earth will start with carbon (forest, soil, blue) and proceed with biodiversity and water markets

Valued at [9, 8 trillion dollars](#), “Nature” is the largest market in the World

It all started with Al Gore’s Digital Earth



Internet of Nature (IoN): a Proposal for Disruption

Agents will be central*. Examples:

- AA (precision agriculture)
- AB (biodiversity conservation and restoration)
- AC (carbon removal)

Agents will access:

- Data infrastructure- Nature data obtained locally and remotely (including multi-modal and unstructured data, and legacy models)
- Large Multimodal Models (fine tuned with appropriate content reflecting relevant domain knowledge)

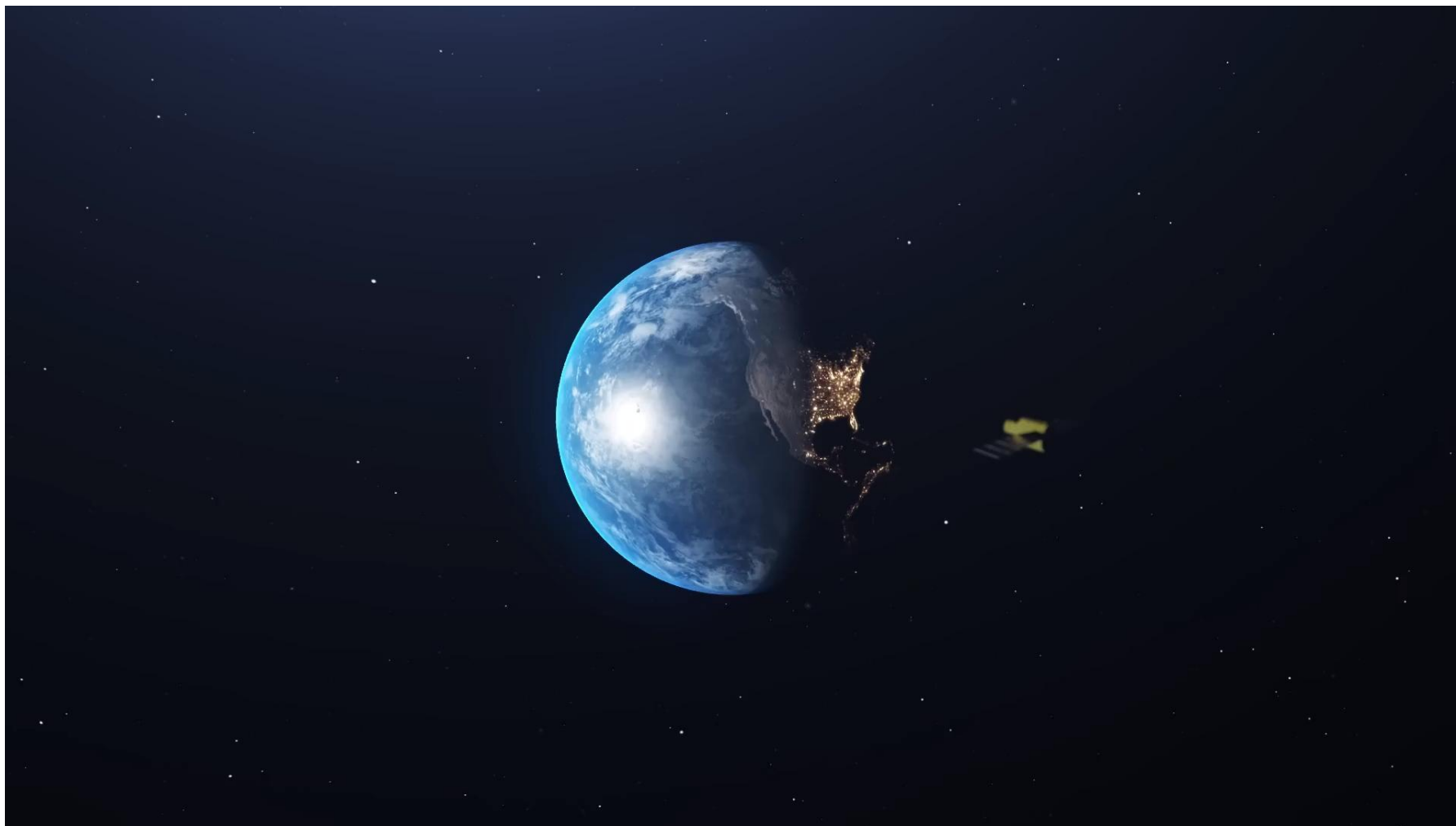
Agents will enable interaction:

Using augmented and virtual representations of Nature



SNAP AR glasses

*[Awesome Agents for Computer Use](#)



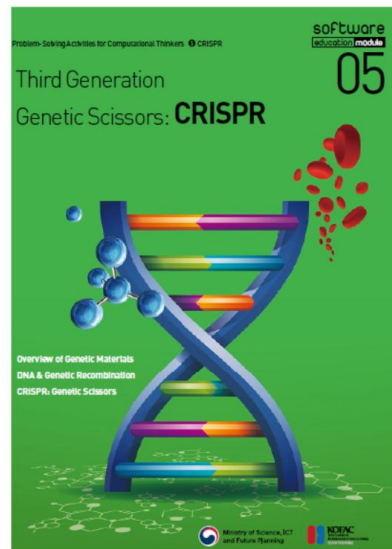
[AI Agents Explained](#)

Internet of Nature (IoN): a Proposal for Disruption

The knowledge transition

Learning from KOFAC (South Korea)
program for 9th year students

- 1 [Artificial Intelligence](#)
- 2 [Driverless vehicles](#)
- 3 [Internet of things](#)
- 4 [Virtual reality](#)
- 5 [CRISPR](#)
- 6 [Space launch vehicles](#)
- 7 [Natural disasters](#)
- 8 [Smart medicine](#)
- 9 [Game engines](#)
- 10 [Sports statistics](#)



The environmental, social, governance and financial transitions

Coordinated Governance of Decentralized
Autonomous Organizations (DAOs)

New Generation Communication,
Telepresence and Teleoperation Platforms
(the new Decision Theaters)

Multi-level Markets: new generation Capital
Markets, full blown Nature Markets (water,
carbon, bio-diversity)

[Alexander Von Gabain on EU's Innovation Model](#)

[Societal Transformation 2018-2037: 100 anticipated
radical technologies, 20 regimes, case Finland](#)

[DAOs, A Canon](#)

THE MOONSHOT PROJECT

Developing The Internet of Nature (IoN)



Internet of Nature (IoN): a Proposal for Disruption

The Moonshot Project: A multi-Agentic and Robotic Internet of Nature (IoN)



A supporting Lab

Supporting skunkworks hardware/software projects (see Seixal Criativo student projects [here](#) and [here](#))

Supporting research projects

The IoN Community project

A stack of IoN tools (hardware, software)

The Infinite Curiosity Library

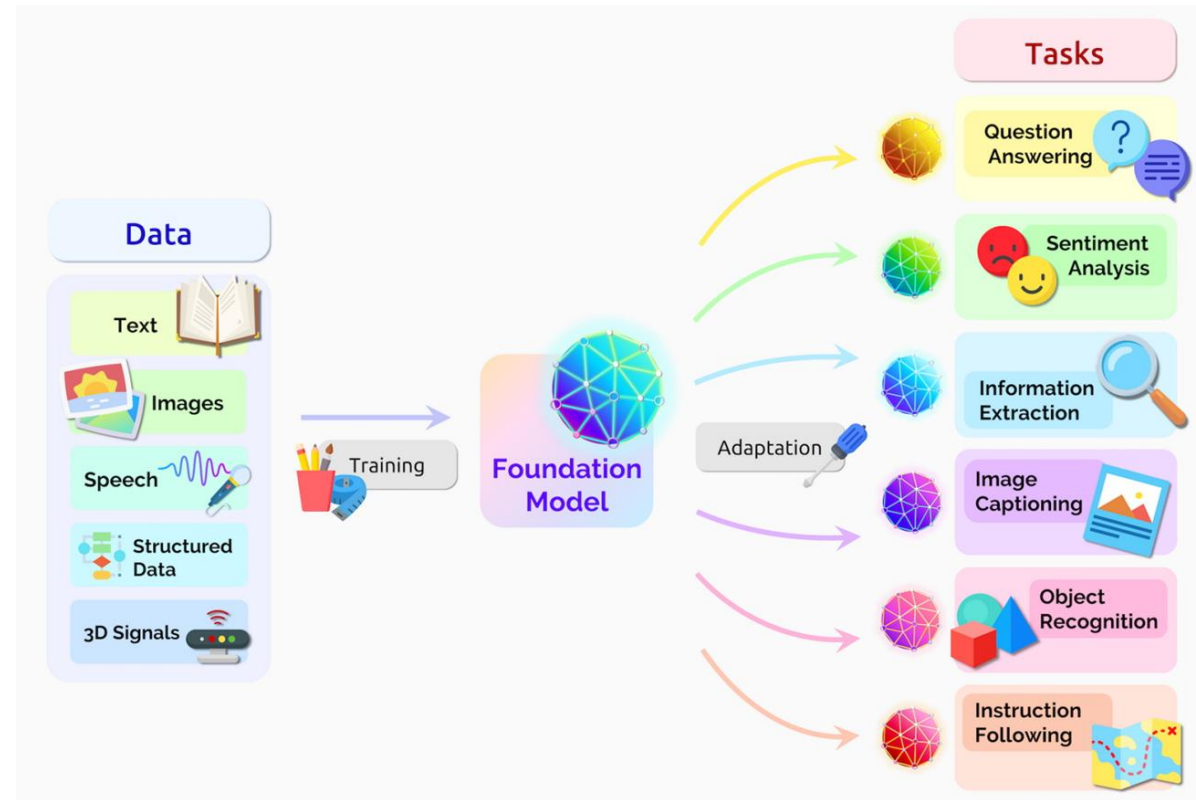
Internet of Nature (IoN): a Proposal for Disruption

Develop an IoN Archive, a peer-reviewed journal and yearly conference

Developing a Nature Foundation Model using attributions to financially reward contributions

Partnerships with major university groups and companies

A local World class ecosystem



Internet of Nature (IoN): a Proposal for Disruption

The Community project

A minimalist Craigslist inspired
Web project

Resources and tools for everyone



Inspirations

[The Handbook of Citizen Science in Ecology and Conservation](#)

[The Air Sensor Toolbox](#)

[Nature apps](#)

[Designing sustainable stores](#)

ANTÔNIO CÂMARA

antonio.camara@ydreams.com

[Sunday News](#)

[The YDreams Collection](#)