# AI in Agriculture for tackling Social and Environmental Challenges

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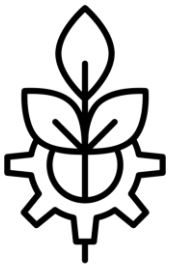
# The agriculture and food value chain

**agricultural machinery, agrochemicals, plant breeding industries**

Created by Pedro from Noun Project

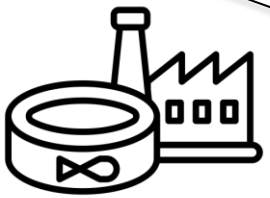
**Agriculture**: crops, livestock

Created by Symbolon from Noun Project



Created by Vectors Point from Noun Project

**bio-based products and bioenergy industries**



**food processing industries**

Created by Edwin PM from Noun Project

Created by Made from Noun Project

**Wholesale and distribution**: warehousers, retailers, restaurants

Created by Nithinan Tatah from Noun Project

The **consumer**
Demand and consumption

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# Social and Environnemental challenges for Agriculture

- Feeding the world: 800 millions undernourished people, 2 billion more people by 2050
- A richer population with an increased demand for animal products
- Farmers' demand of decent incomes and working conditions
- Scarcity of natural resources (e.g. Phosphorus for fertilizers, oil for energy)

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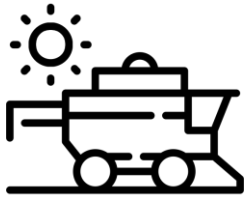
# Energy footprint of Food (in France)



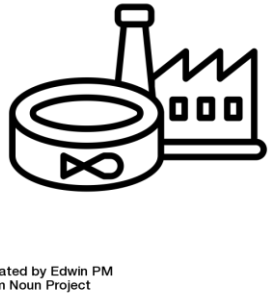
Created by Pedro
from Noun Project

**Agriculture**
**26,6%**

Created by Symbolon
from Noun Project

**Food**
**31,6 Mtoe / year**
**13% global consumption**

**Food transformation**
**15,5%**



Created by Edwin PM
from Noun Project

**Food retail**
**13,3%**

Created by Made
from Noun Project

**Transport**
**30,7%**

Created by Nithinan Tatah
from Noun Project

**Home consumption**
**13,9%**

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*Source: Projet CECAM, ADEME*

# Social and Environnemental challenges for Agriculture

- Feeding the world: 800 millions undernourished people, 2 billion more people by 2050
- A richer population with an increased demand for animal products
- Farmers' demand of decent incomes and working conditions
- Scarcity of natural resources (e.g. Phosphorus for fertilizers, oil for energy)
- Agricultural pollution: contamination or degradation of the environment (pesticides, herbicides, fertilizers, animal wastes…)
- Climate Change

# Agriculture contributes to Climate Change

- Agriculture is among the greatest contributors to global warming (methane, nitrous oxide, carbon dioxide emissions)
- Also from the conversion of non-agricultural land (e.g. forests) into agricultural land
- With other post-production processes (food processing, distribution, consumption)

*Source: https://climate.nasa.gov*

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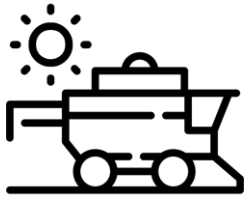
# GHG footprint of Food

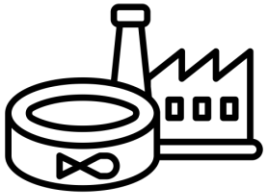


Created by Pedro
from Noun Project

**Agriculture**
**75% (65%)**

Created by Symbolon
from Noun Project

**Food**
**13,8 GteqCO2 / year**
**28% global emission)**
**(*163 MteqCO2, 24% in France*)**



Created by Edwin PM
from Noun Project

**Food transformation**
**+ retail + transport**
**15% (20%)**

Created by Made
from Noun Project

Created by Nithinan Tatah
from Noun Project

**Home consumption**
**10% (15%)**

*Source: I4CE Institute For Climate Economics*

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# Impact of Climate Change on Agriculture

**Decrease of productivity** due to

- changes in temperatures and rainfall
- increased impacts of natural hazards (floods, droughts, storms)
- reduced water resources
- increased diseases and parasites

**Changes in the social demand**

- Preservation of the environment
- Consumers' demand for local, organic or low-input food products

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# Climate smart agriculture

Smarter farming for **productivity raise, mitigation and adaptation** to climate change

New agronomical practices

- More resilient crop varieties and species
- Improved irrigation practices
- Increasing agroforestry
- Developing biocontrol and agroecology

Developing technologies

- Biotechnology
- **Digital agriculture**

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# A digital agricultural revolution

Digital agriculture: agriculture based on digital technologies that collect, store, analyze, and share electronic data along the agricultural / food value chain.

-> New tools for farmers to optimize management of resources, improve crop quality and quantity, and remain productive in a changing climate.

-> Digital integration of potentially all food process stages, from refining crop genetics to managing transportation logistics and B2C relationships

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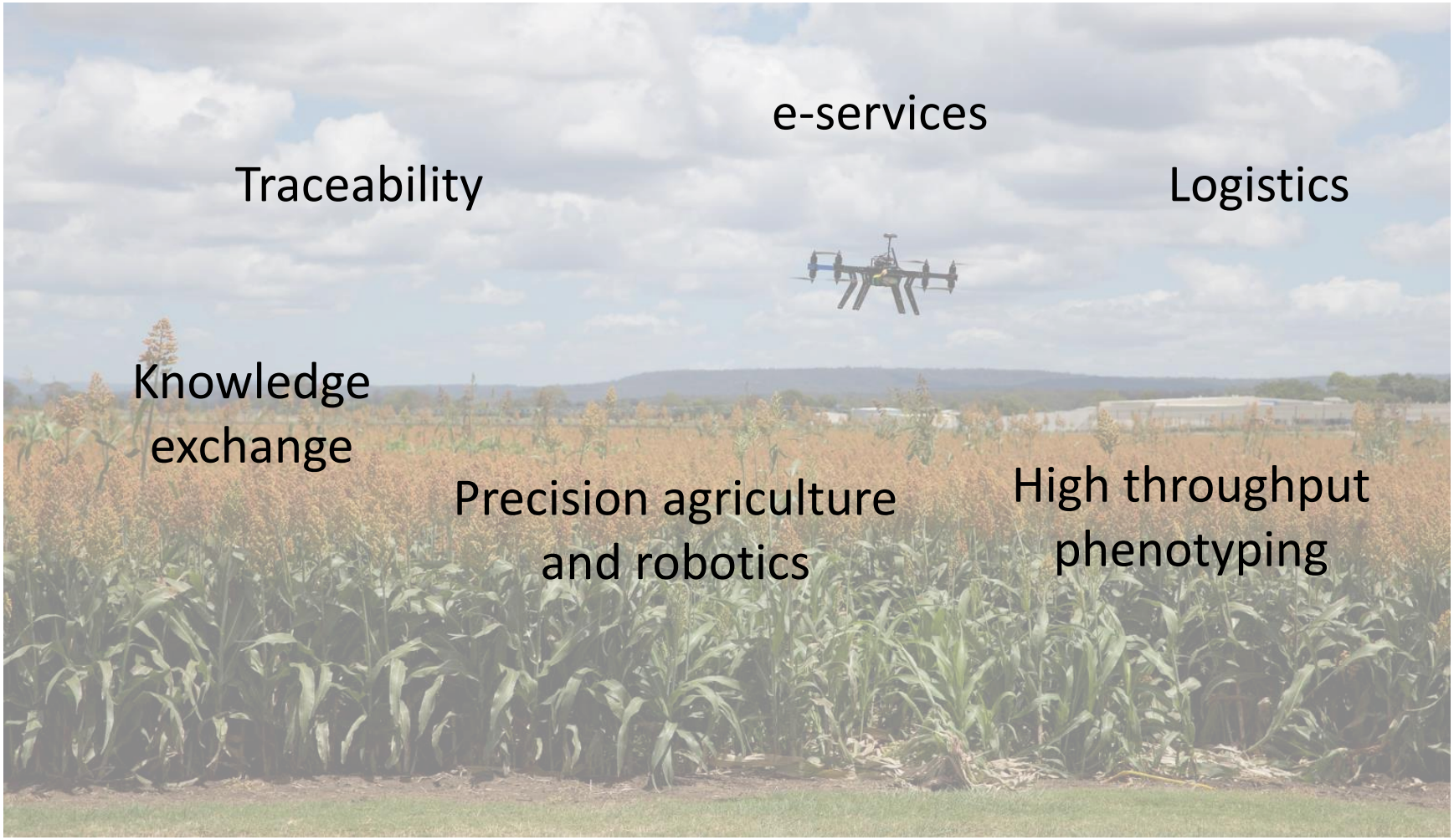
# A digital agricultural revolution

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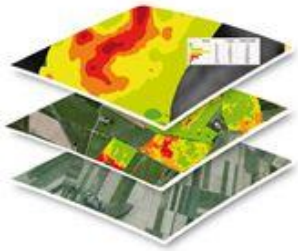
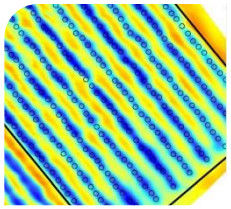
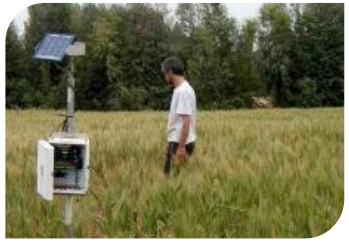


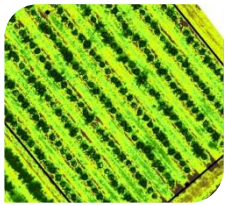
# The Digital Agriculture Convergence Laboratory,

## Montpellier, France



#DigitAg





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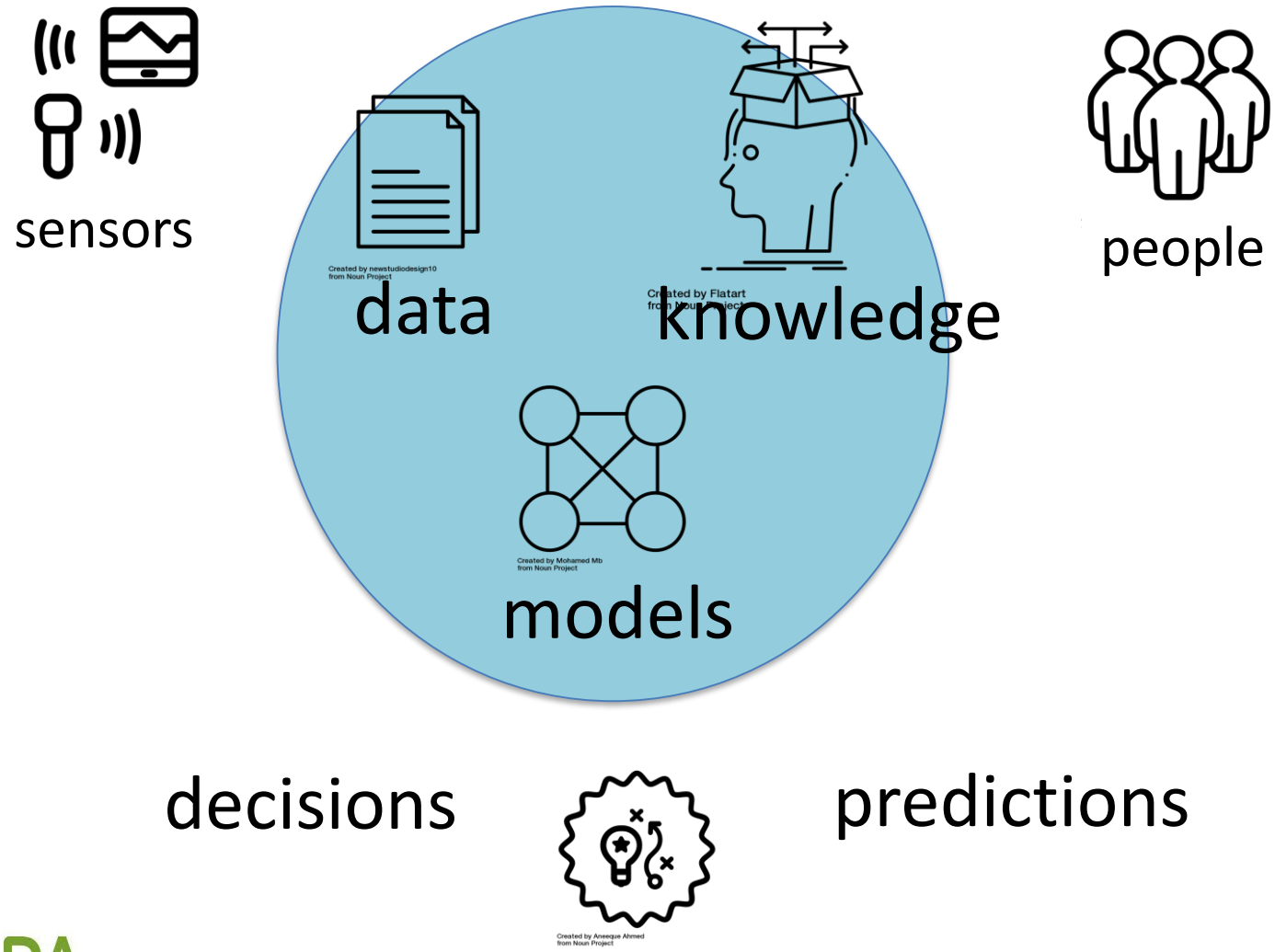
www.hdigitag.fr

# Artificial Intelligence: observing, reasoning, acting

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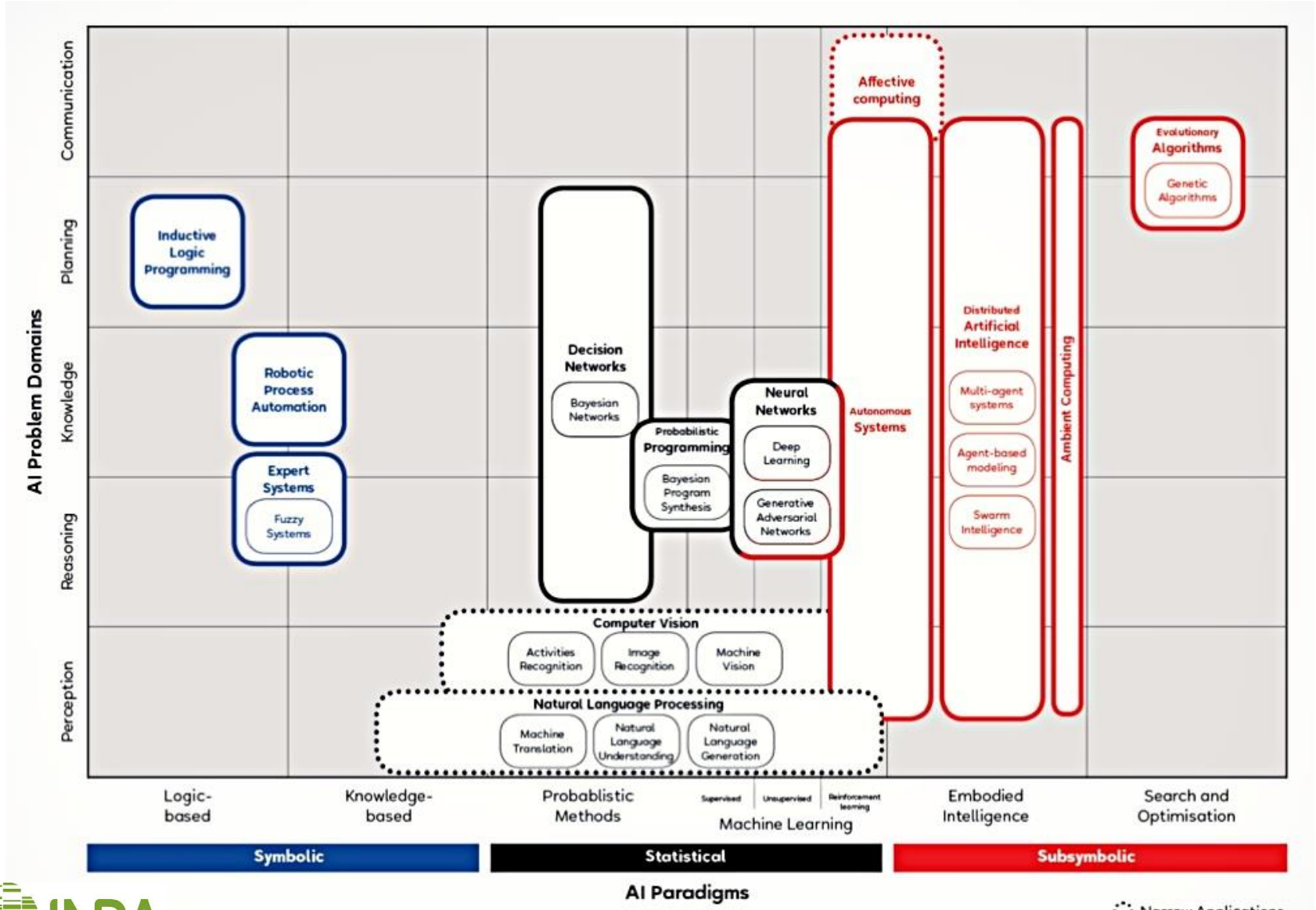
# The AI knowledge map

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# Artificial Intelligence: a core technology for digital agriculture

(Low-cost) RFID monitoring

IoT – internet of things

Satellite

UAV

Sensors

**Digital agriculture**

Tractors and farm machineries

Robots

**AI decision and planning**

**Observation**

**Diagnosis**

**Recommendation**

**Action**

# Artificial Intelligence: a core technology for Digital Agriculture

**Knowledge representation and management**

Web platforms

Data warehouses

**Ontologies**

**Semantic Web**

**Knowledge modeling**

**Digital agriculture**

**Observation**

**Action**

**Diagnosis**

**Recommendation**

**AI decision and planning**

# Artificial Intelligence: a core technology for Digital Agriculture

**Machine Learning**

Simulation models

**Knowledge representation and management**

**Statistical learning**

**Predictive modelling**

Data warehouses

**Ontologies**

**Image detection, recognition and classification**

**Semantic Web**

**Digital agriculture**

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**AI optimisation and design**

CSP

Formal models

Multi-criteria decision

Evolutionary algorithms

**AI decision and planning**

# Artificial Intelligence: a core technology for Digital Agriculture

**Machine Learning**

Statistical learning

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Image detection, recognition and classification

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Multi-criteria decision

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**AI decision and planning**

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# Optimizing irrigation

- planning under uncertainty,
- reinforcement learning,
- simulation-based optimisation,
- image classification,
- model-based diagnosis,

are AI technics already used for optimal management of irrigation

Next step is about collective water management with distributed sensors, IoT and multi-agent decision making


*Source: Iteris*

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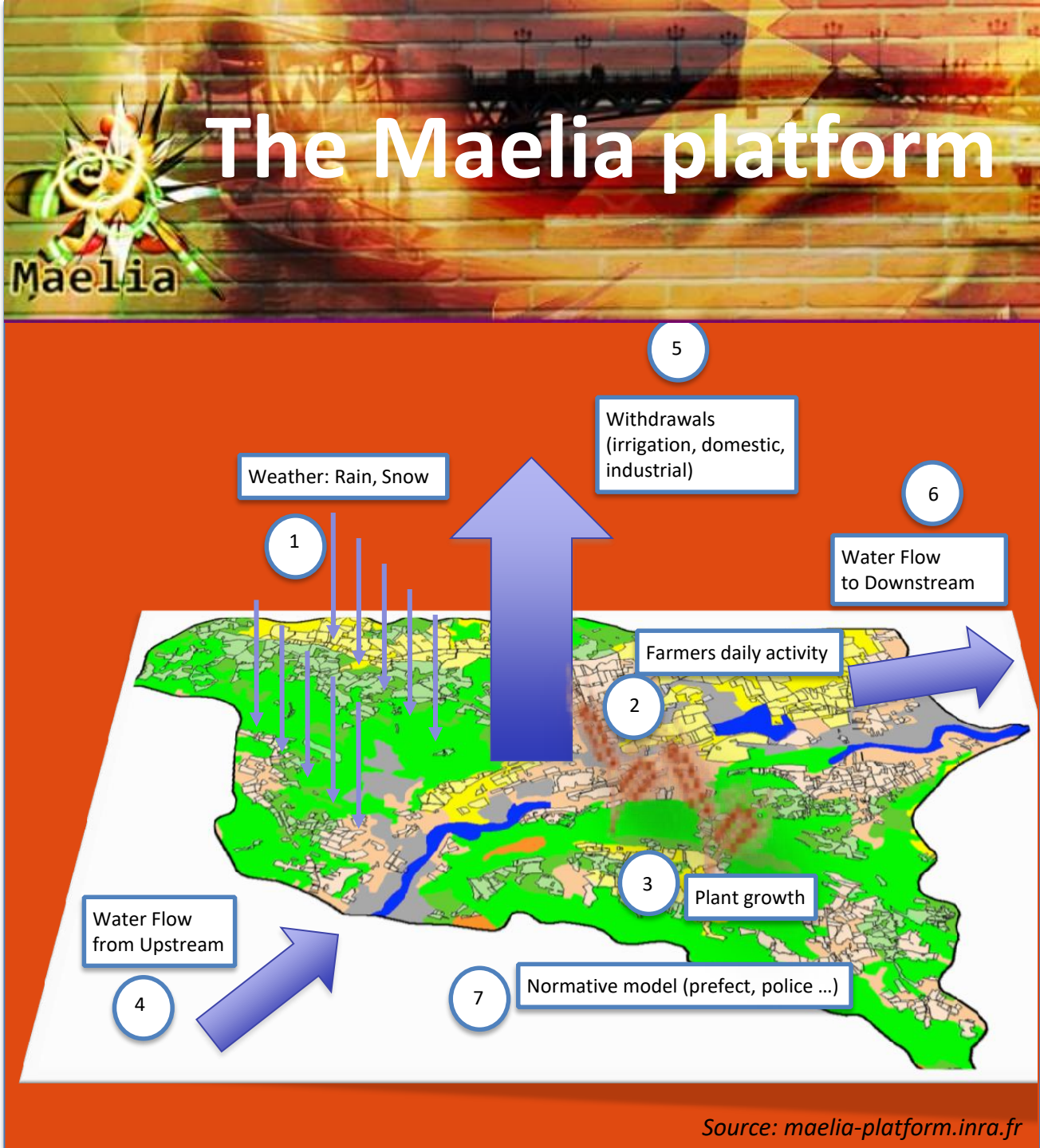
# Simulating Territories

Simulating socio-environmental impacts of norms related to the governance and management of water

- Multi-agent modeling (the GAMA platform)
- Human-behavior modeling (rules, BDI)




*Source: maelia-platform.inra.fr*

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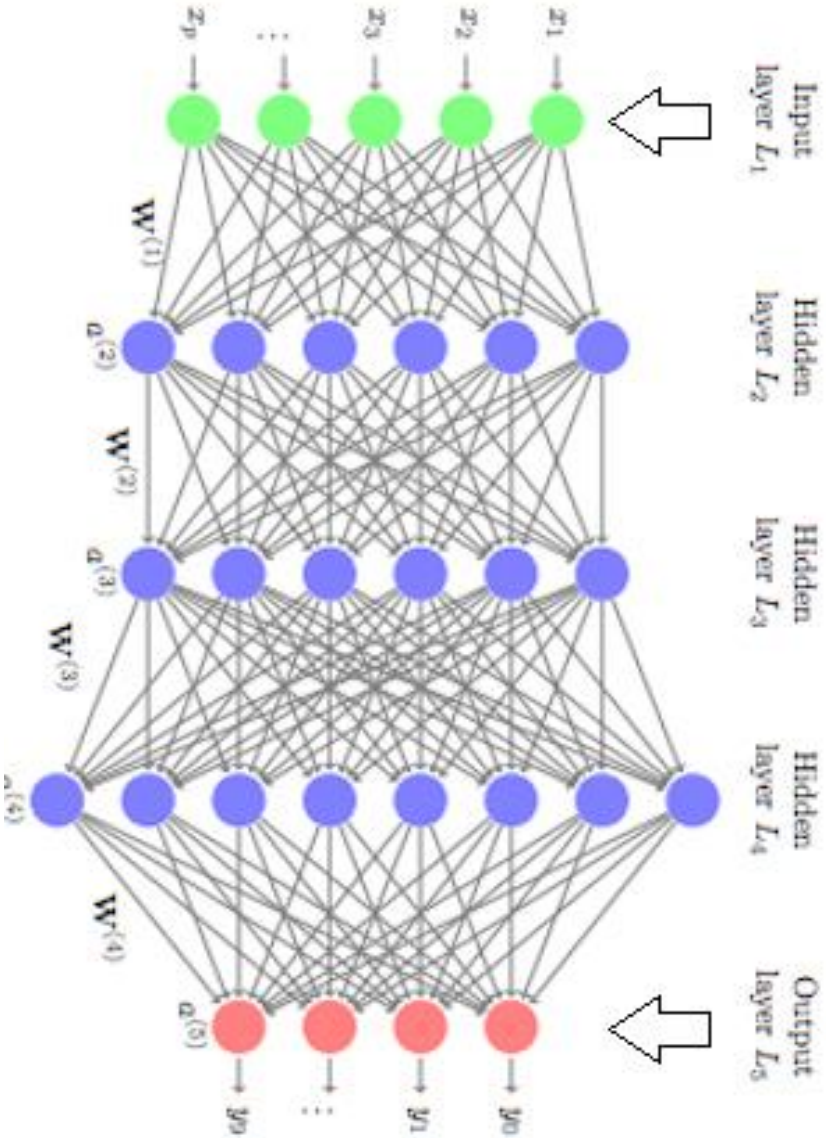
# Deep learning in Agriculture

Classification and prediction from big data sets (images, audio, …)

- Animal identification
- Animal behavior prediction

- Detection / Recognition of plants
- Detection / Recognition of diseases
- Identification / classification of phenological stages
- Land use classification
- Crop yield prediction
- Fruit counting
- Soil moisture prediction




*Source: A. Kamilaris et al., Computers and Electronics in Agriculture, 147 (2018)*

# Text-mining in Agriculture

Information Retrieval / Extraction

- Named entity detection
- Food price prediction
- Monitoring
- Farm management
- Knowledge extraction

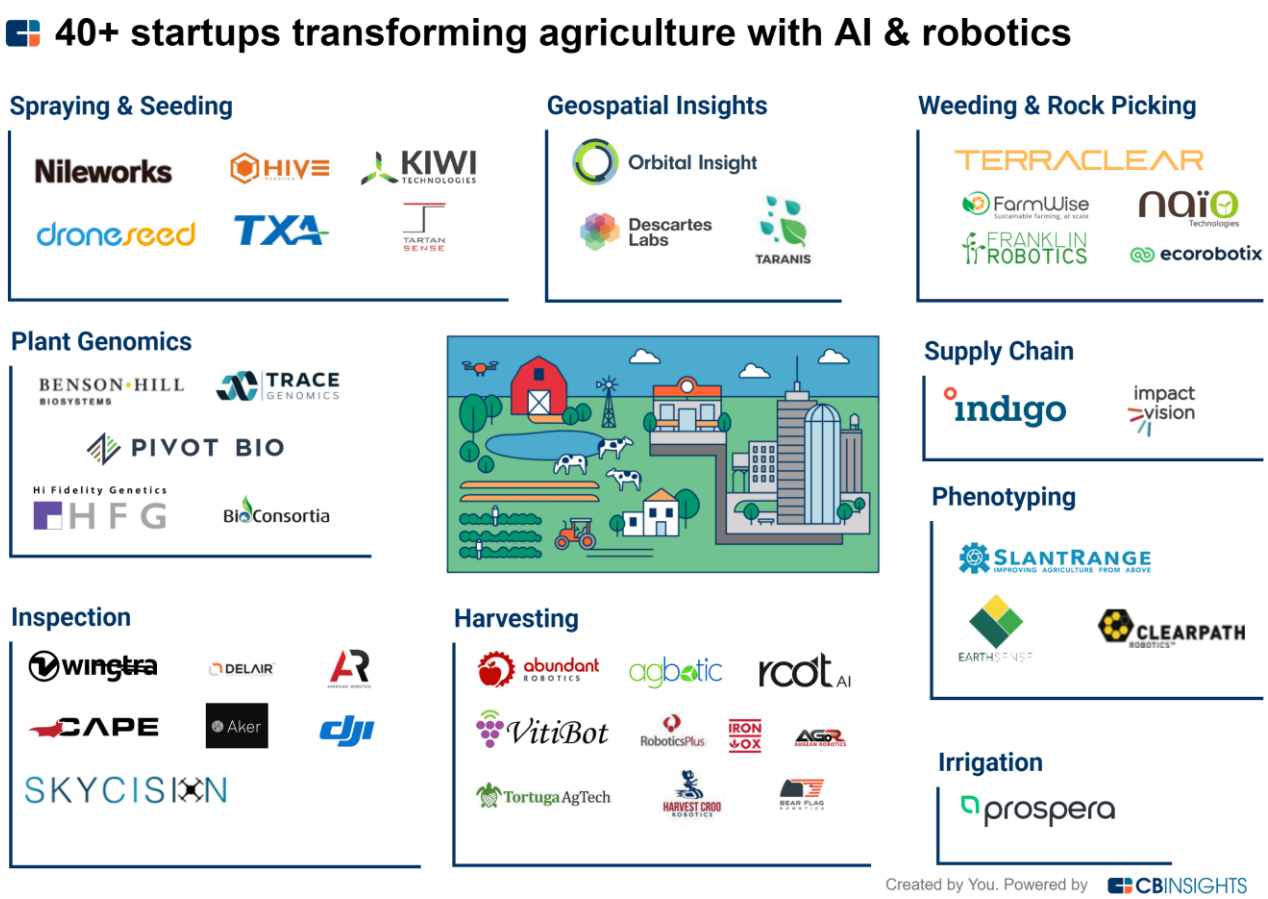
Sentiment Analysis

- Commodity and food price prediction
- Pest control
- Opinion monitoring

*Source: B. Drury and M. Roche, Computers and Electronics in Agriculture, 163 (2019)*

# Numerous investments in artificial intelligence for agriculture

Microsoft, IBM, Google, Intel, Bosch, Bayer, Airbus, and many other companies and startups

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# Limits and risks

Digitalisation can be used to transform the current agri-food system in order to face today's climate and environmental challenges,

but:

- Precision agriculture is sophisticated and not cheap. Can we make AI-based digital agriculture accessible and available at large scale?
- Digital agriculture tends to impose standardisation to increase productivity but also cut employment, increase farm size and also technological dependence: is it the only way ?
- The issue of data ownership is crucial
- AI is energy-intensive, and we also need digital sobriety …

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