Big Data in Agriculture Challenges

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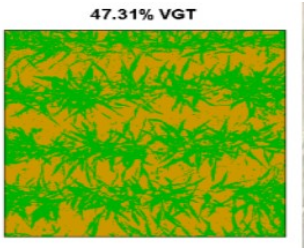
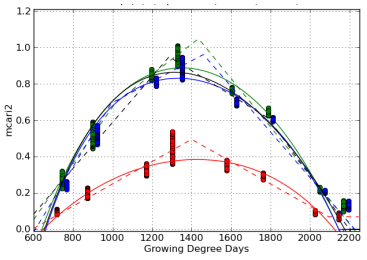
The rise of Big Data in agriculture

- **More data production from heterogeneous sources**

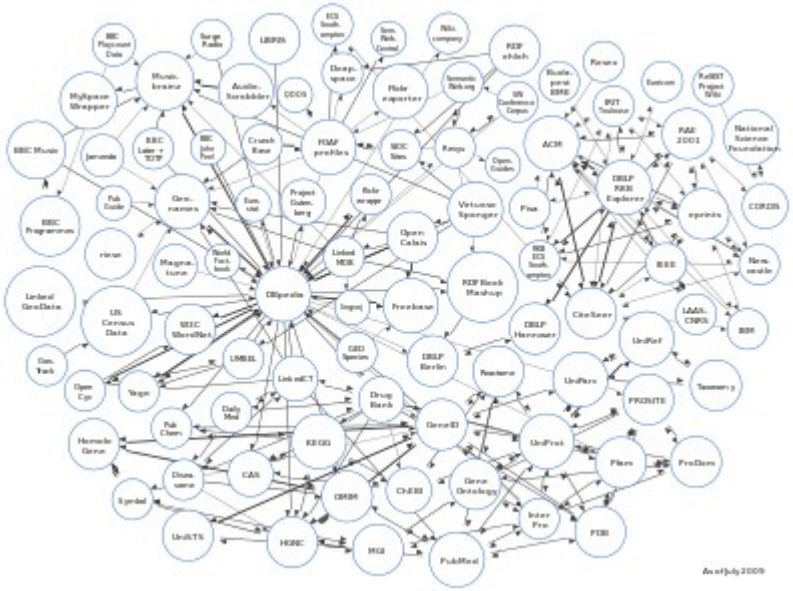




The rise of Big Data in agriculture

More and more data services and datasets on Web

- **Breeding data**
- **Crop data**
- **Weather data**
- **Soil data**
- **Environmental data**
- **Genomic data**
- **Economic, health etc.**

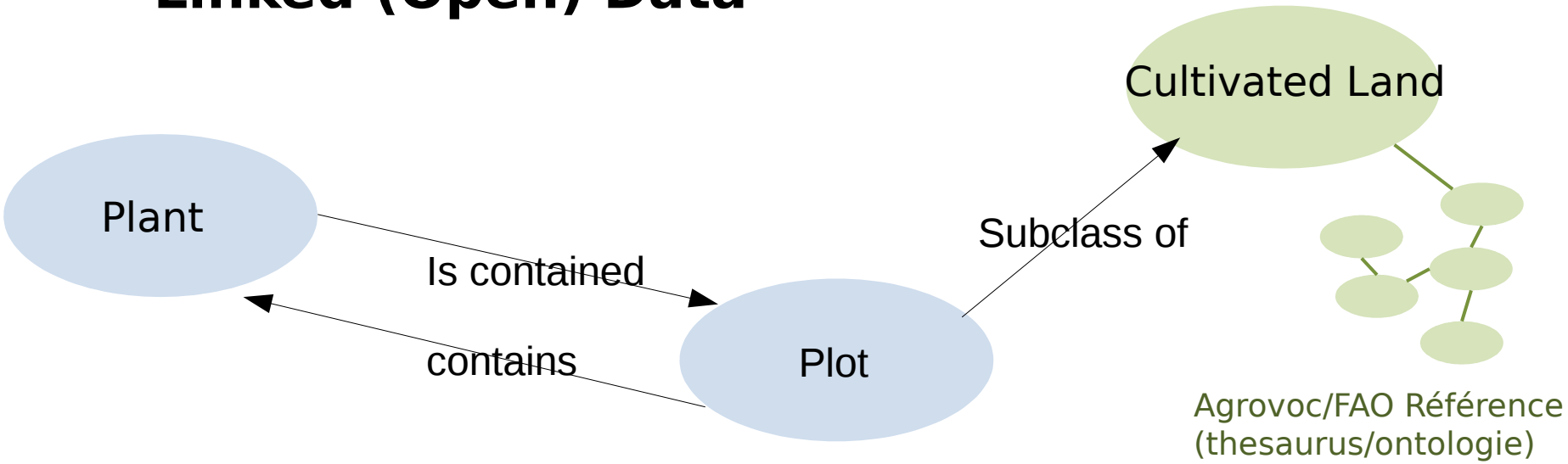


The rise of Big Data in agriculture

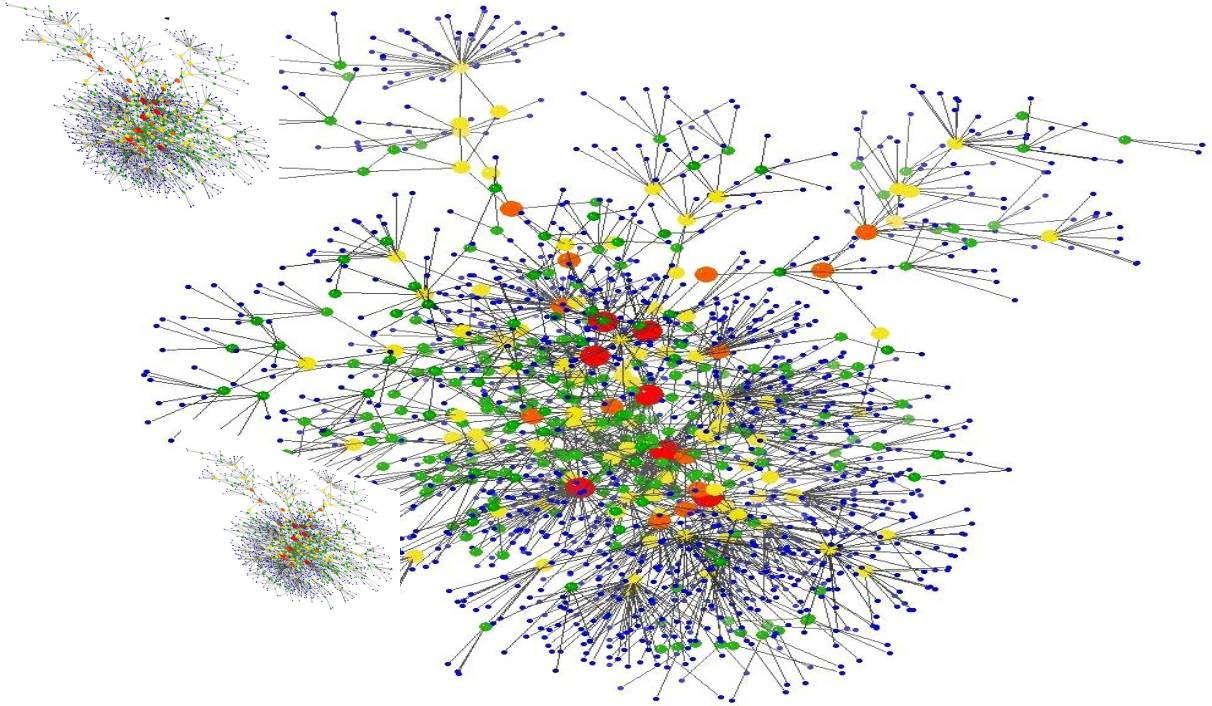
Ontology

Common conceptualisation: to link data we need to define concepts and the relations between concepts

Linked (Open) Data



The rise of Big Data in agriculture



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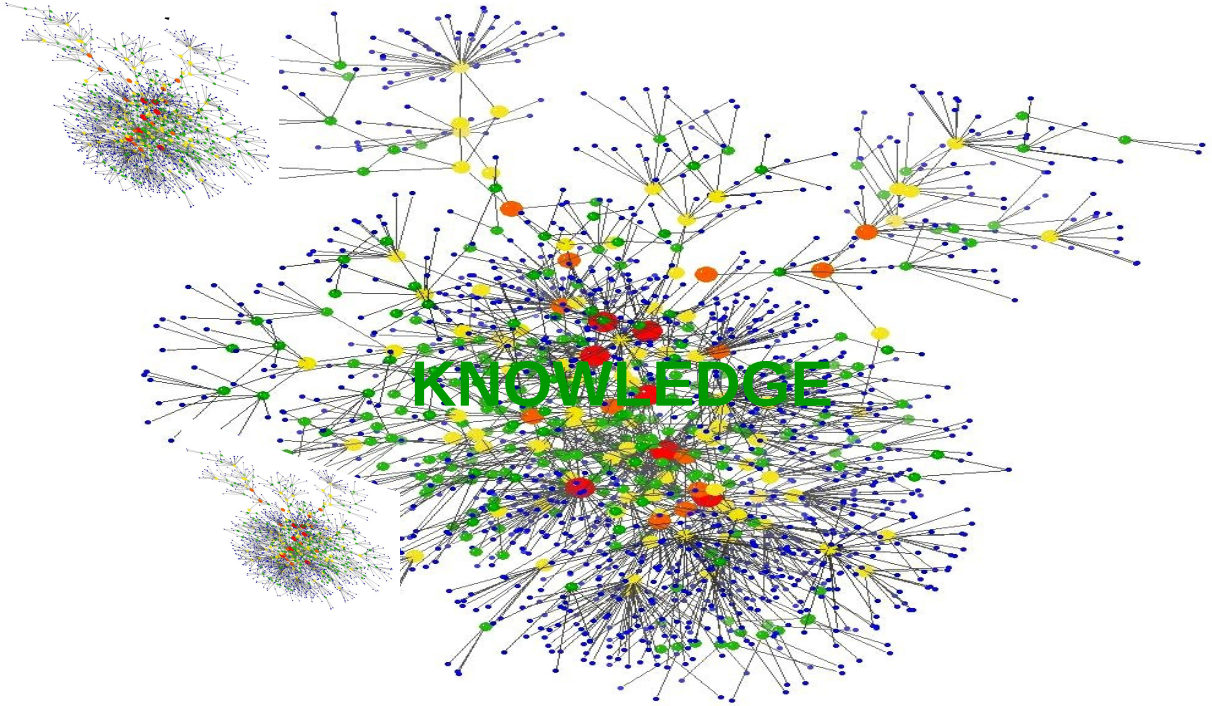

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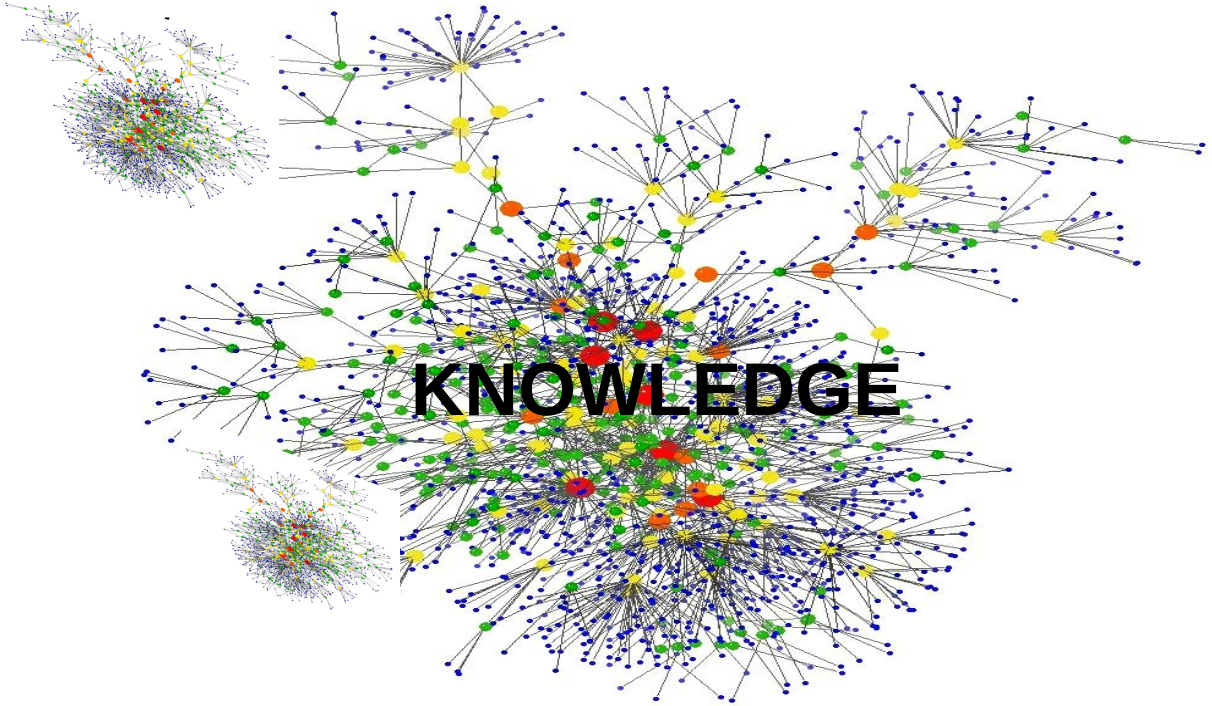
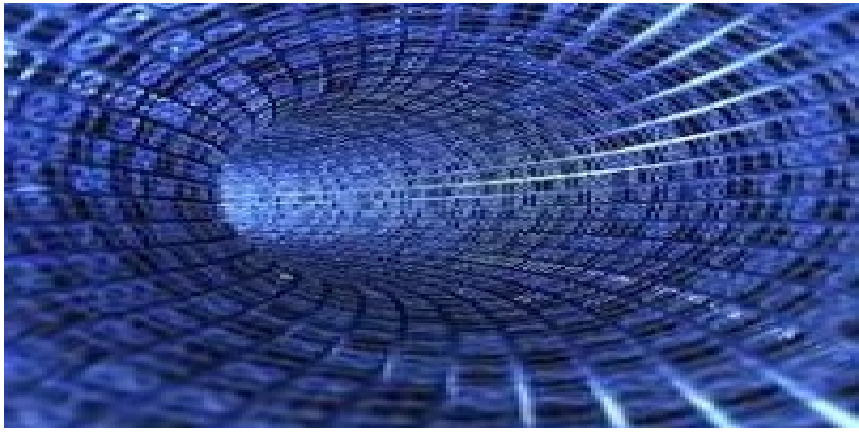


Big Data

A definition: *data sets grow so **large** and **complex** that it becomes **impossible** to process using traditional data processing methods (**Management** and **Analysis**)*

Make data **valuable** (information, knowledge, decision support)



Agronomic Big Data
V characteristics

- **Volume**: massive data and **growing size**
  → *hard to store, manage and analyze*

- **Variety and Complexity**: different sources, scales, disciplines different semantics, schemas and formats etc.
  → hard to understand, combine, integrate

- **Velocity**: speed of data generation
  → have to be processed on line

- **Veracity, Validity, Vocabulary**, Vulnerability, Volatility, Visibility, Visualisation, Vagueness, etc.

Why Big Data is important for Agriculture?

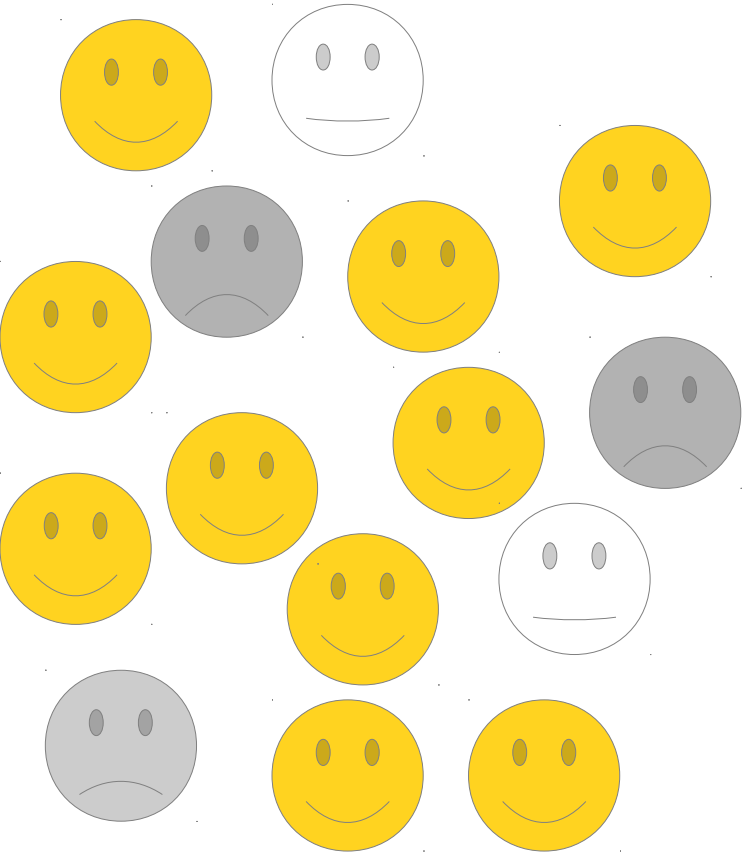
Production of a lot of heterogeneous data for understanding

- **Open new insights**
- **Allow to know:**
  - **Which theories are consistent and which ones are not!**
  - **When data did not quite match what we expect…**
- **Discover patterns, Discover frequent associations**
- **"Big Data" vs "Sample and Survey"**

→ data-driven decision support
(dynamic, integrative and predictive approaches)

Why Big Data is important for Agriculture?

Population treatment
Some respond and some don’t



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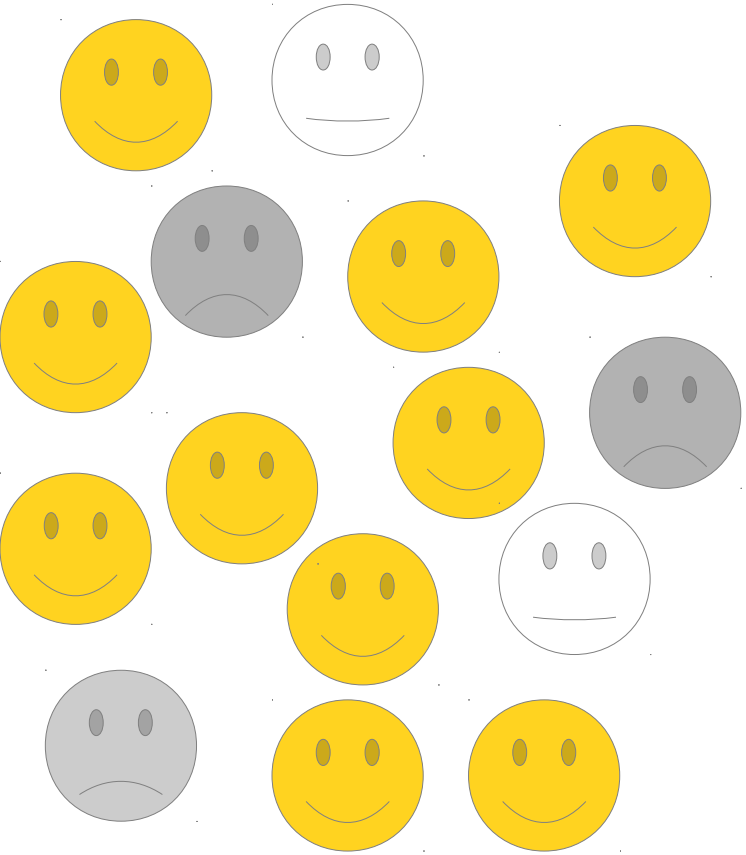
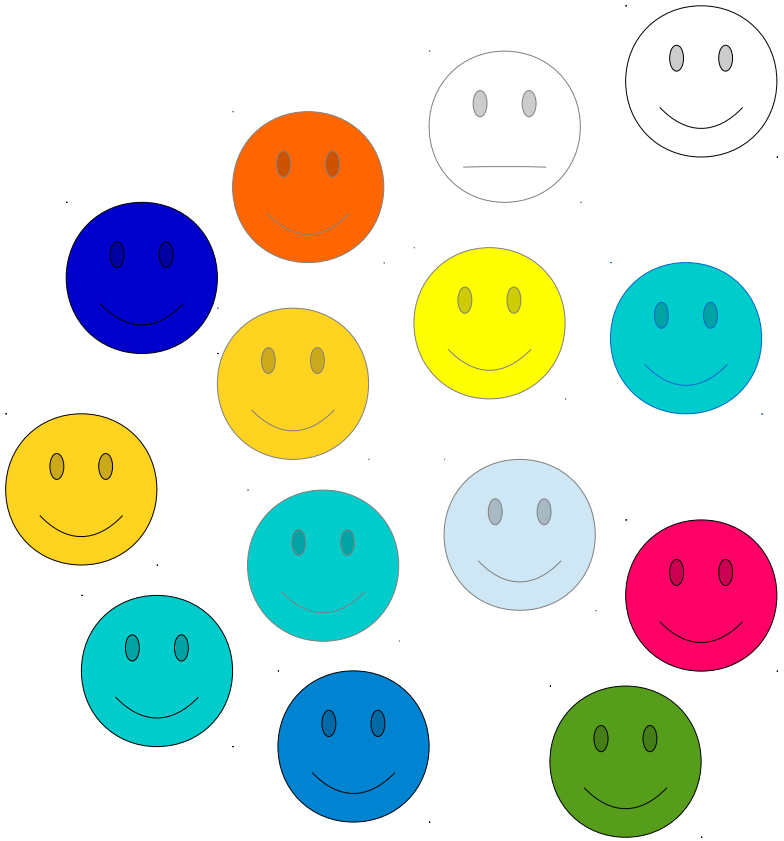


Individualized treatment
All targeted population respond



Why Big Data is important for Agriculture?

Gather->Organize->Analyse->Understand->Decide

- **Adaptation to climate change**
- **Taking into account human health (farmer, consumer)**
- **More efficient use of natural resources (including water or soil) in our farming practices**
- **Sustainable management, biodiversity and Equity**
- **Food security**
  Crop performance (yields are globally decreasing)
- **...**

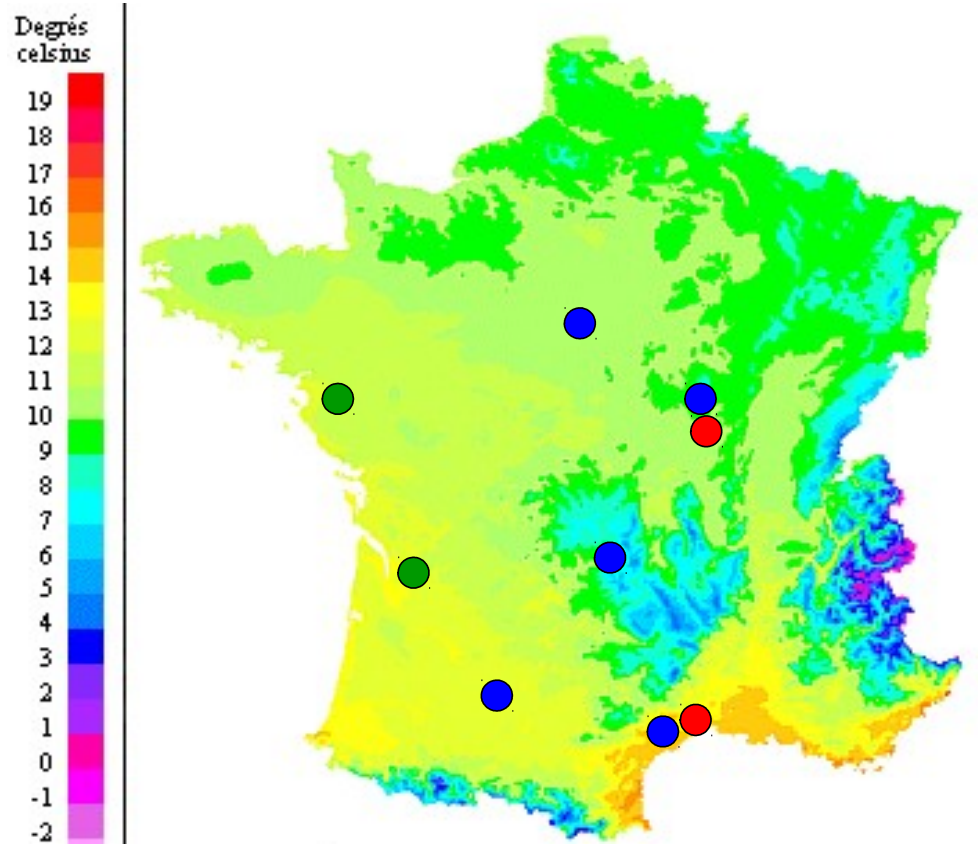
Phenome

High throughput plant phenotyping
French Infrastructure

Phenome

High throughput plant phenotyping
French Infrastructure
9 multi-species platforms

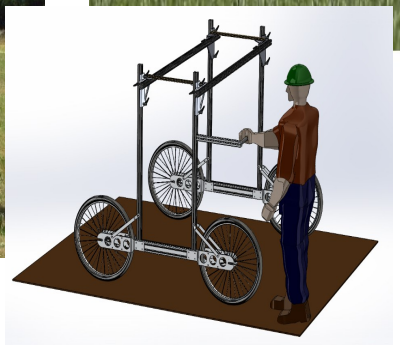
- 2 green house platforms
- 5 field platforms
- 2 omics platforms

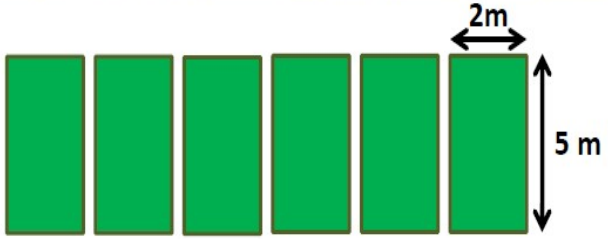


5 Field Platforms

Various scales and data types

- Cell, organ, plant, population
- Images, hyperspectral, spectral, sensors, human readings...

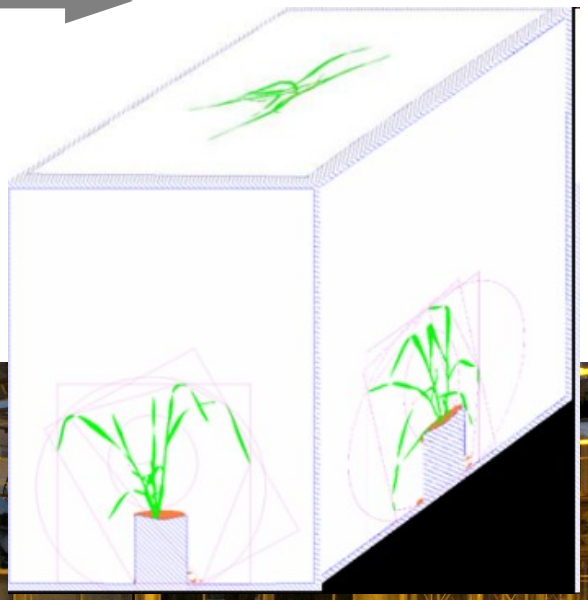


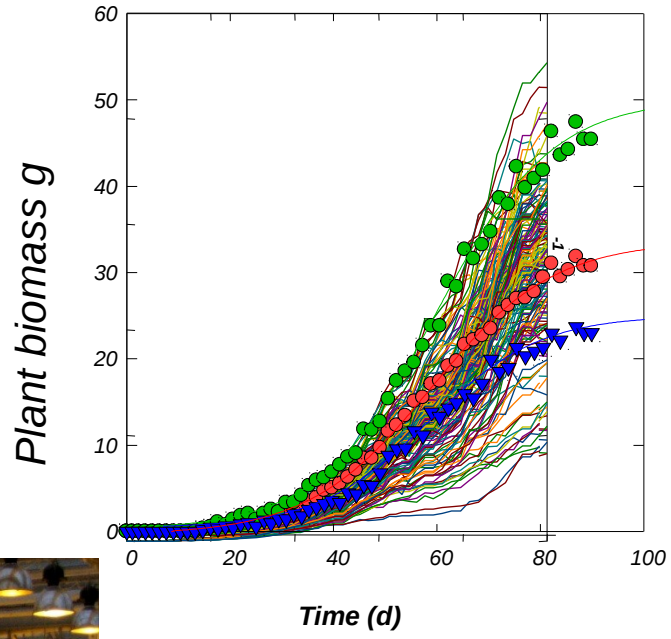


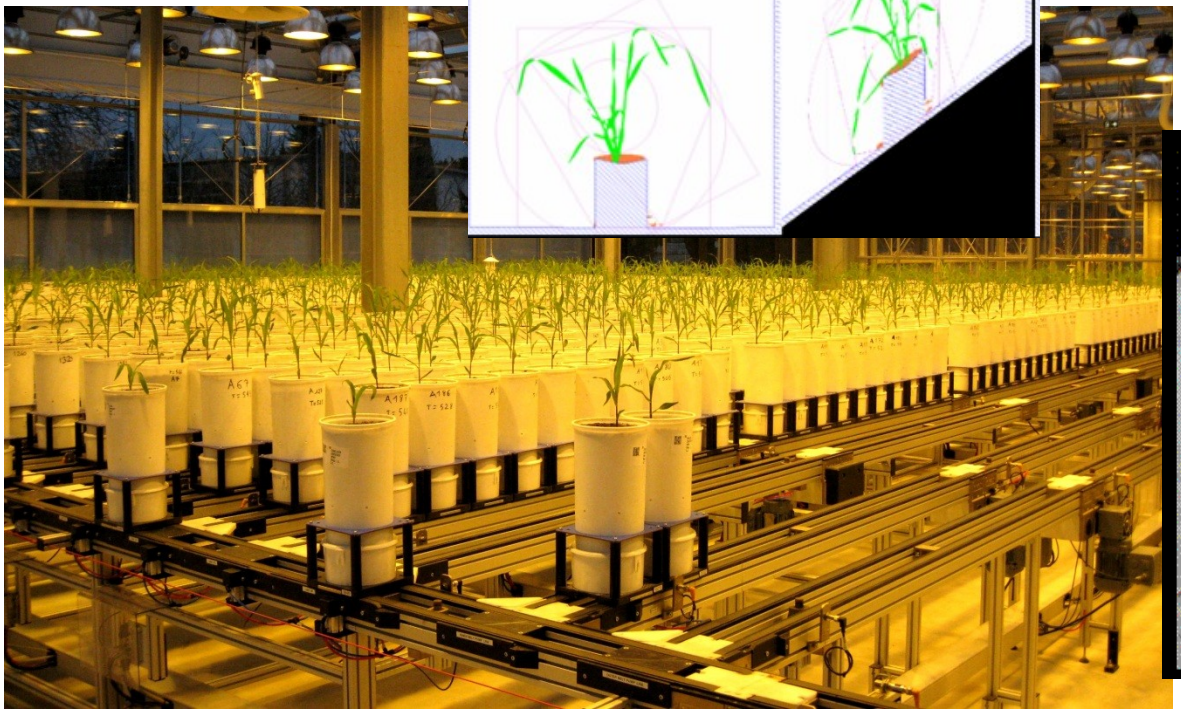
2 Green house Platforms

Various scales and data types

time





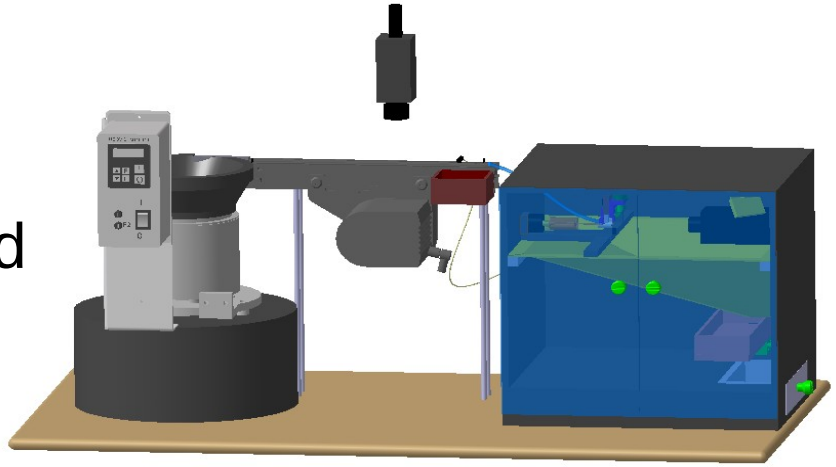


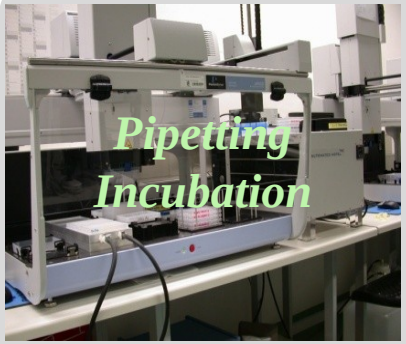
2 « Omics » platforms

Various data complex types

Composition and structure

Quantification of metabolites and enzyme activities





Data management challenges in Phenome: **Volume growth**

40 Tbytes in 2013, 100 Tbytes in 2014, …

- **Volume is a relative concept**
  - **Exponential growth makes hard**
    - **Storage**
    - **Management**
    - **Analysis**

Phenome HPC and Storage → Cloud and Grid computing (FranceGrille, EGI)

- **On-demand infrastructure and Elasticity**
- **Virtualization technologies**
- **Data-Based parallelism (same operation on different data)**

Data management challenges in Phenome: **Variety**

- **Produced by different communities (geneticians, ecophysiologists, farmers, breeders, etc)**
- **Data integration needs extensive connections and associations to other types of data**
- **(environments, individuals, populations, etc.)**
- **Different semantics, data schemas, …**

Extremely diverse data

Approaches:

→ **Web API, Ontology sets, NoSQL and Semantic Web methods**

Data management in Phenome: **Velocity**

- **Green House platforms produce tens of thousands images/day (200 days/year)**
- **Field platforms produce tens of thousands images/day (100 days/year)**
- **Omic platforms produce tens of Gbytes/day (300 days/year)**

Approaches:

- **Scientific Workflow**
  OpenAlea /provenance module (Virtual Plant INRIA team)
  Scifloware (Zenith INRIA team)

Data management challenges in Phenome: **Validity**

Data cleaning

- **Automatically diagnose and manage:**
  - **Consistency? Duplicates? Wrong?**
  - **Annotation consistency?**
  - **Outliers?**
  - **Disguised missing data?**
  - **...**

Approaches (dynamic):

  - **Unsupervised Curve clustering (Zenith INRIA team)**
  - **Curve fitting over dynamic constraints**
  - **Image Clustering**

Conclusion

Make agricultural data:

- Findable
- Accessible
- **Interoperable**
- Reusable (**over discipline**)

Discover knowledge on the world described by data (data mining, integrative methods, etc.)

E-Infrastructure

Big data is Cultural and technical challenges