Improving Efficiency and Labor Conditions with the Help of AI

the case of smart-viticulture

Symposium
Transdisciplinary research for a healthy planet

UNIVERSITÉ DE REIMS CHAMPAGNE-ARDENNE

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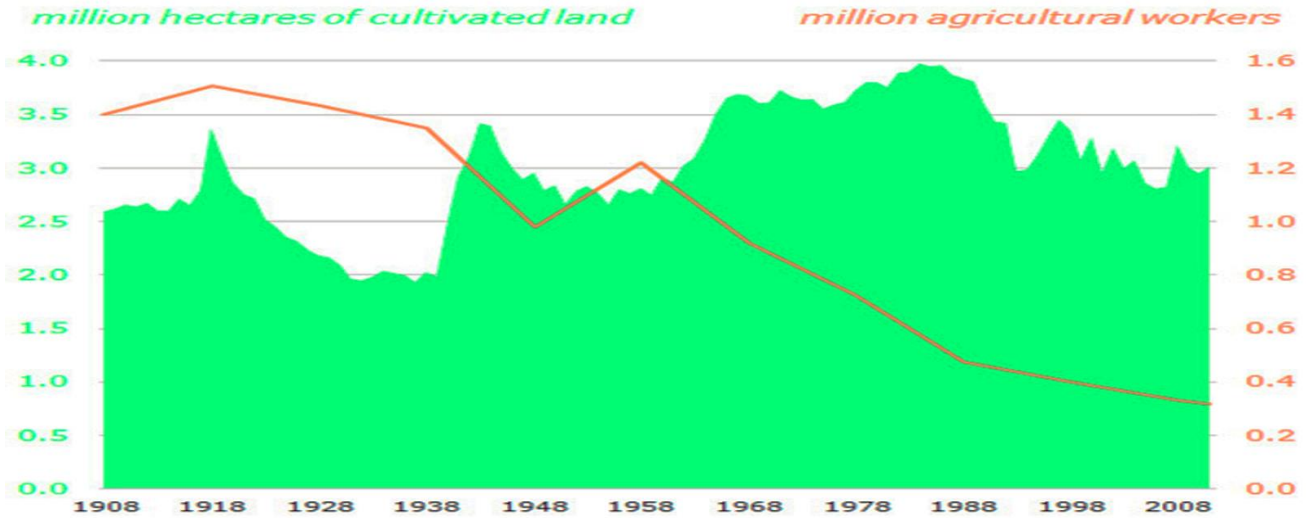
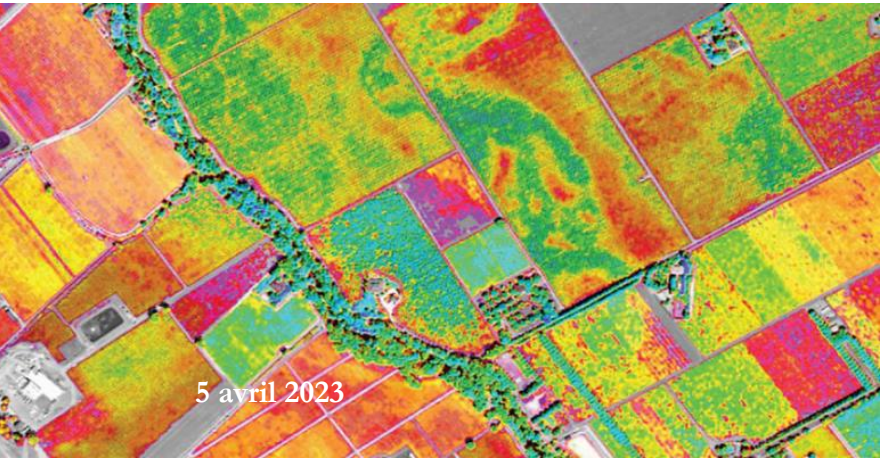
Agriculture and automation, a long history

- Agriculture is the oldest and still the most important economic human activity
  - provide food, fibers, and fuel necessary for our survival
- Technology reduces the amount of time people dedicate to basic activities like food production and made life easier and enjoyable.
- Transportation has changed over time to be more efficient and safer.
  - Agriculture has also undergone the same changes.
- With the global population expected to reach 9 billion by 2050, agricultural production must meet the increasing demands for food and bioenergy.

Impact of technology

- Changes in equipment have made a large impact on the way farmers are able to farm and grow food.
- Farmers use technology to make advances in producing more food for a growing world.



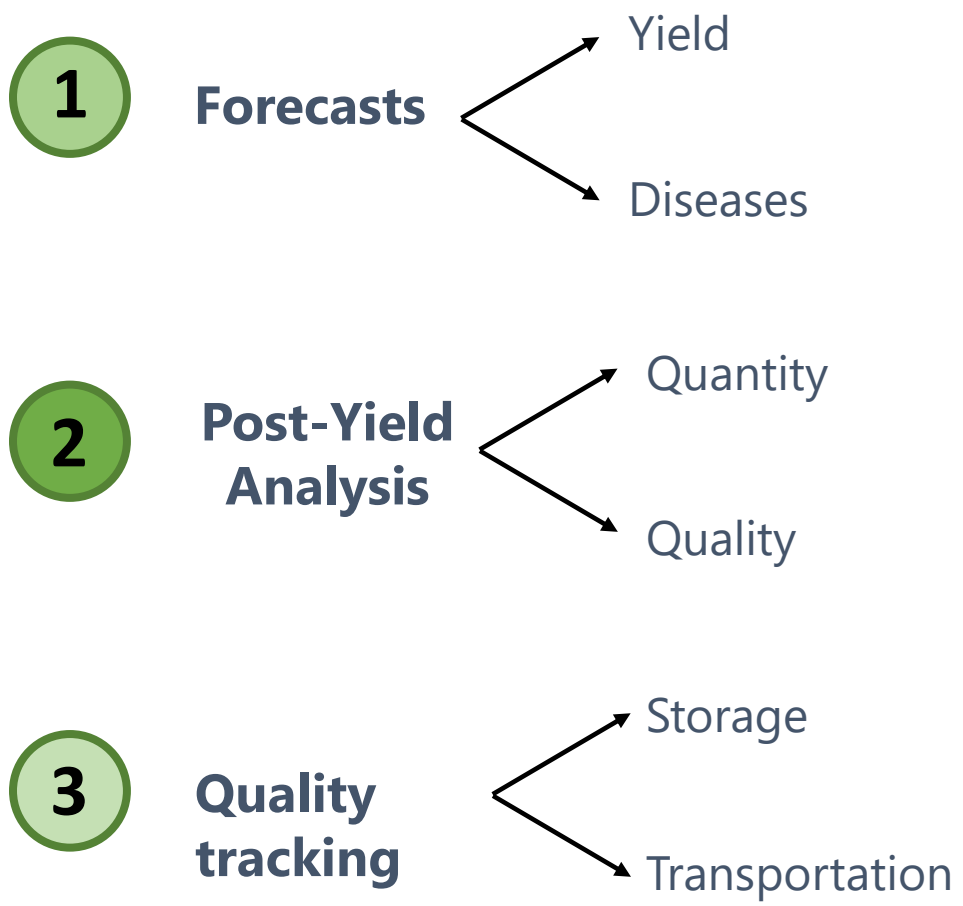


What is Smart Agriculture

- Smart Agriculture represents the application of modern Information and Communication Technologies (ICT) into agriculture.
  - combined application of ICT solutions such as precision equipment, IoT sensors, GPS, Big Data, drones, robotics, etc.
- Smart Agriculture has a real potential to deliver a more productive and sustainable agricultural production, based on a more precise and resource-efficient approach.
  - In the USA about 80% of farmers use some kind of Smart Agriculture tools
  - in Europe, this is less than 25%

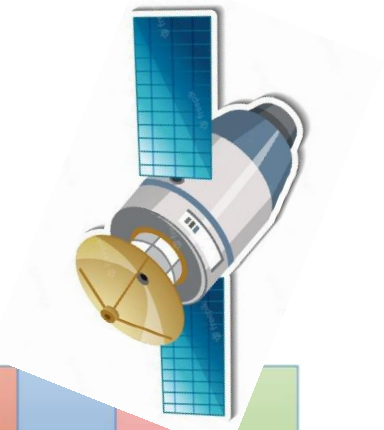
Smart Agriculture Main Areas

- Smart Agriculture provides added value for **better decision making** or more **efficient exploitation and management**:
  - **Management Information Systems**: collection, processing, and disseminating of data needed to carry out a farm's operations and functions.
  - **Precision Agriculture**: management of spatial and temporal variability to improve economic returns and reduce environmental impact
    - relay on GPS, drones and satellites, allowing the creation of maps with target variables.
    - Ex: crop yield, terrain features, organic matter content, moisture levels, nitrogen levels, etc.
  - **Agricultural automation and robotics**: The process of applying robotics, automatic control and artificial intelligence techniques at all levels of agricultural production, including farmbots and farmdrones.

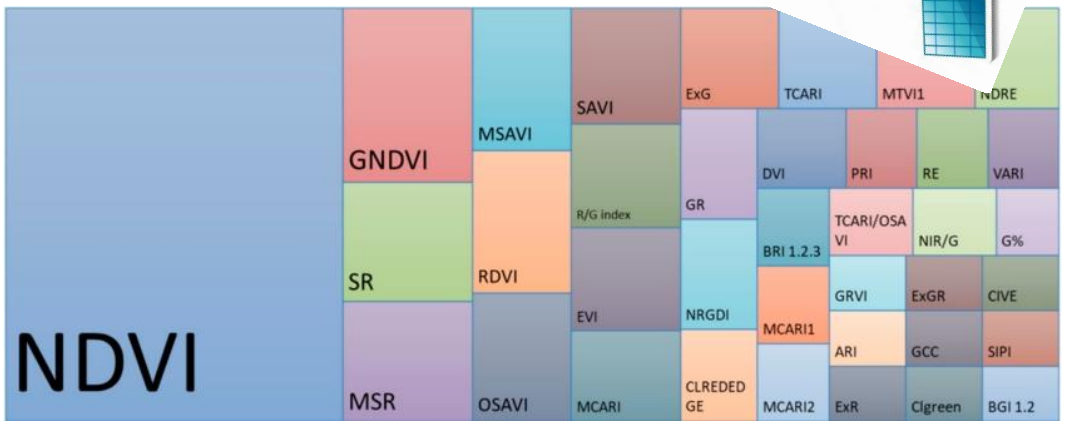


The Potential of AI in Transforming the Industry

- Smart Agriculture has a huge potential but also a big problem
  - **Too much data disables your decision making**



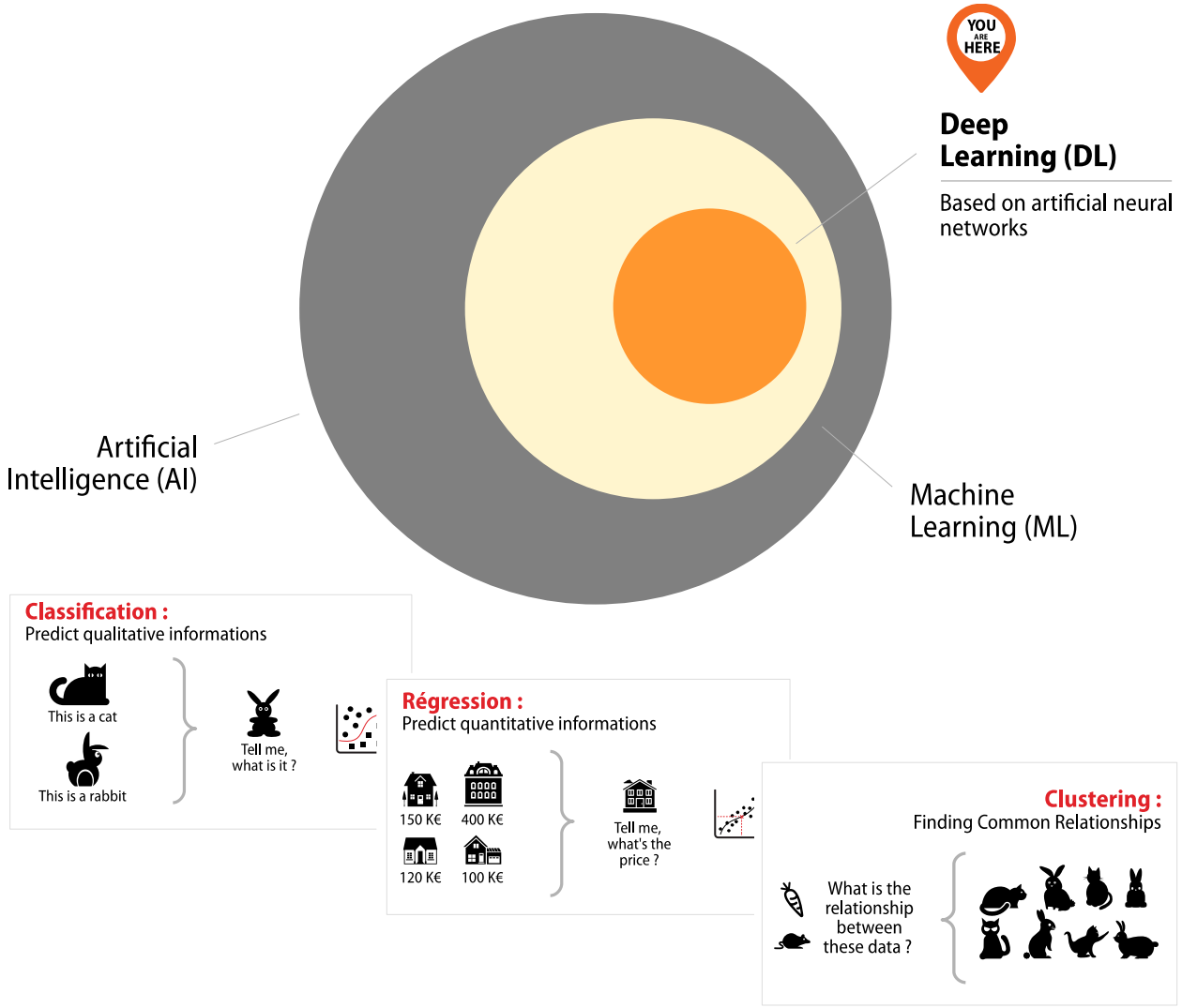
- So many products, so many "index", which one to use?
  - Shall I use NDVI* or moisture levels to drive my choices?
  - How these index affect my plants?
  - Are they dependent on other factors?



- AI helps to give a direction and a cursor to explore these data.

What is Artificial Intelligence

- Artificial intelligence (AI) refers to the simulation of human intelligence.
  - may also be applied to traits associated with a human mind such as learning and problem-solving.
- A subset of AI is **machine learning** (ML), which refers to the concept that computer programs can automatically **learn from new data**.
  - **Learn by example**
- **Deep learning** techniques enable automatic learning through the absorption of unstructured data such as text, images, or video.
  - **Automatic pattern detection**



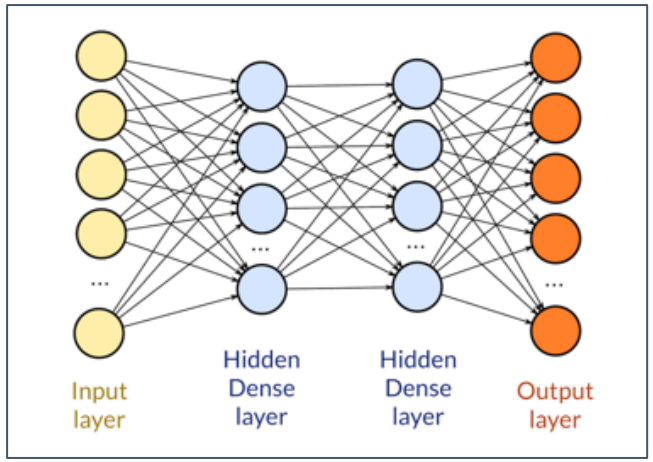
But what kind of data can we deal with?

- AI has hundreds of algorithms, one probably fits your problem
  - **Image analysis**
    - RGB/hyperspectral photos, topographical maps, meteorological charts
  - **Aggregation of sensors' data**
    - Agricultural sensors
  - **Time series**
    - Yield and climatological history, volume of intrants, costs…

- All you need is an **objective** and sufficient data

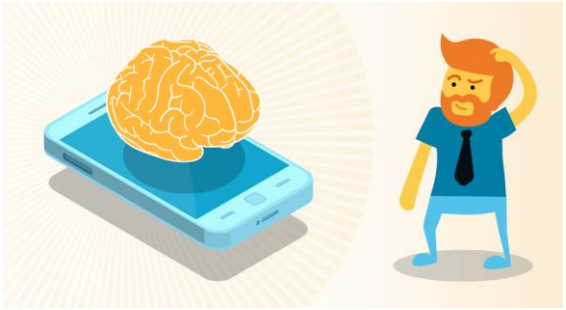
What it costs to make AI?

- Any newspapers say that training an IA model requires a lot of data and huge computing resources
  - *Partially true*
- Data
  - More data often leads to better results
  - Several models can work fine with less than a hundred entries
- Computing resources
  - Complex Deep Learning models take time to train (especially with lots of data)
  - Dedicated infrastructures help to accelerate training, but are not required
- Bonus: deep learning often allows the **reuse** of existing models



And to use AI? Do we need a good machine?

- A trained model is often simple to run
  - We all have IA applications in our telephon



- Cloud computing is also an option
  - Requires only a working network

- An IA model can be deployed close to the final user
  → **Edge computing**

How IA can Innovate the Champagne *Savoir-Faire*

- Champagne production follows a strict regulation chart
  - **Tradition** is the main keyword
- Many activities require direct human intervention
  - Plot labor, harvest, wine blend
- Potential for improvement on both performance and working conditions
  - Logistics organization
  - Automation of repetitive tasks
  - Assessment uniformization
  - Predictive management

Wine production forecast

- Ideally, estimations as soon as possible:
  - Decision-making to preserve the fruits quality
  - Preparer the harvest logistics
  - Respect the appellation rules (quotas)

- Production forecast formula:

  Production = Nb plants x Nb grapes x Average grape weight

- Assessing the production today:
  - Random fruit sampling
  - Weighting and counting

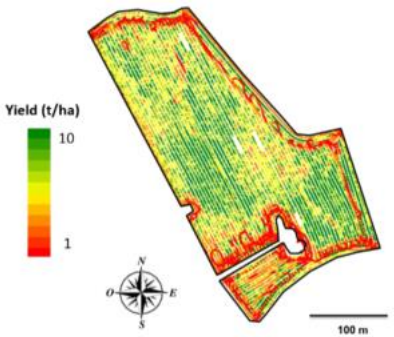
  ← Mostly performed by humans

- Manual and limited:
  - Time-consuming (how many people to cover a vineyard?)
  - Variability according to the parcels
  - Limited number of samples as it is a destructive process

Real-time Grape Counting

- Benefits of automatic grape counting
  - Less error due to parcel variability
  - Elaboration of productivity charts
- All **during the regular vineyard labor** (no extra tasks for the workers)

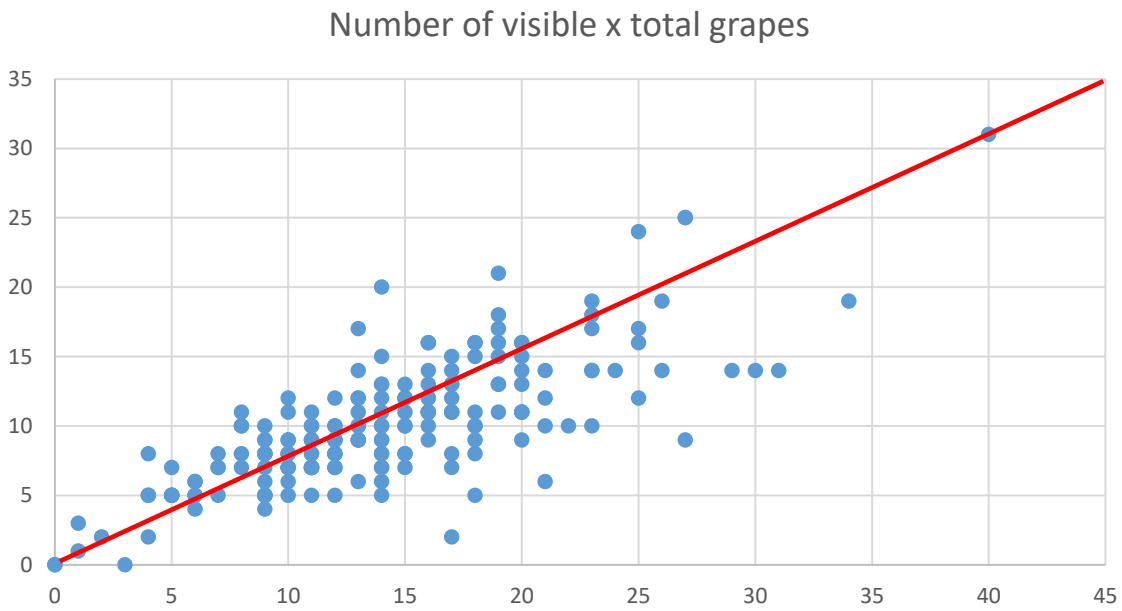
Production = <u>Total Nb grapes</u> x Average grape weight

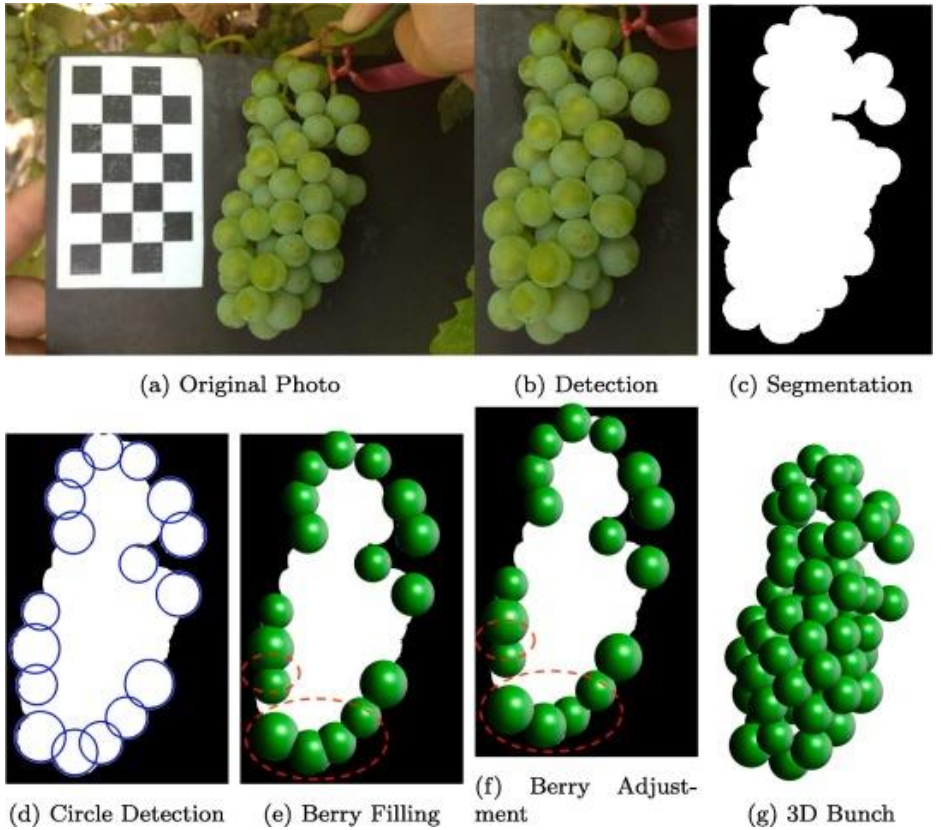


Yield Prediction

Production = Total Nb grapes x Average grape weight

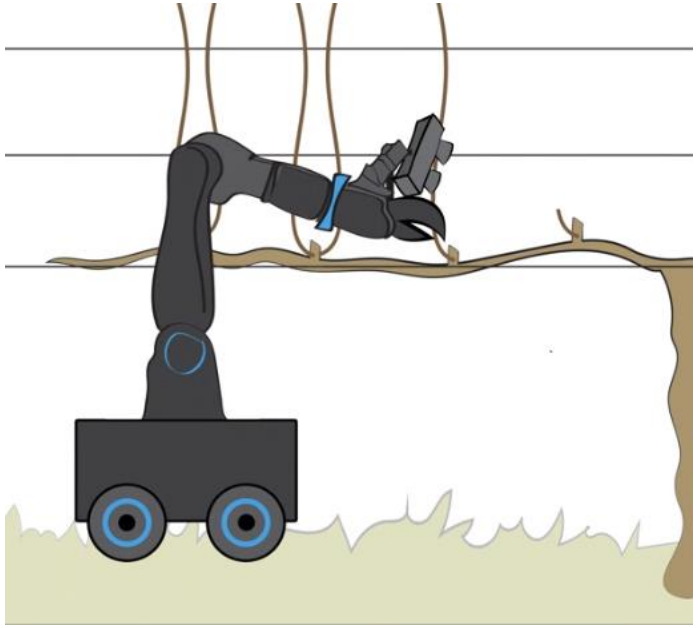
- We can go further and estimate the yield with:
  - Correlation between visible and hidden grapes
  - Counting of berries in a grape (grape size/weight)
- **Yield prediction = logistics organization**

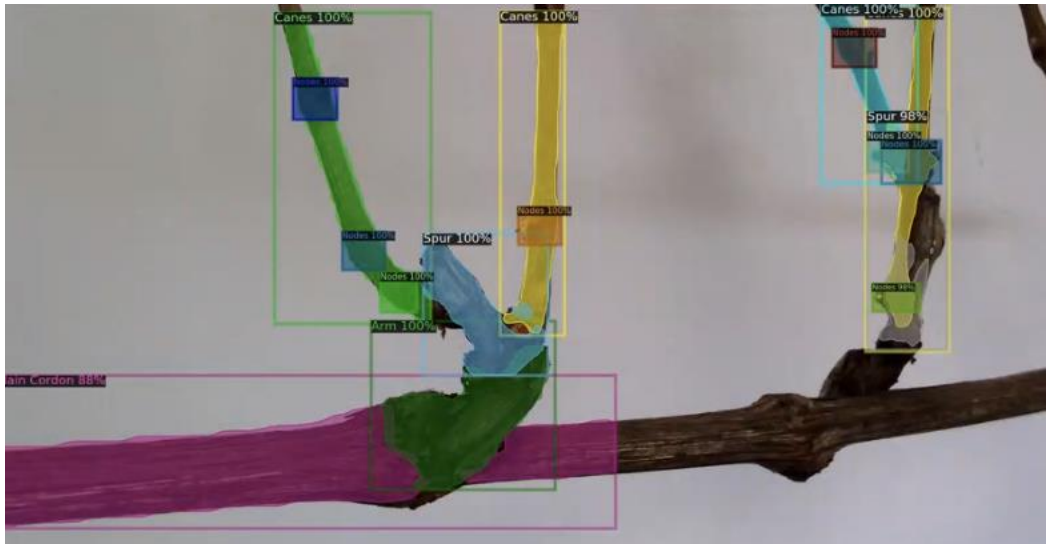




Winter Pruning Automation

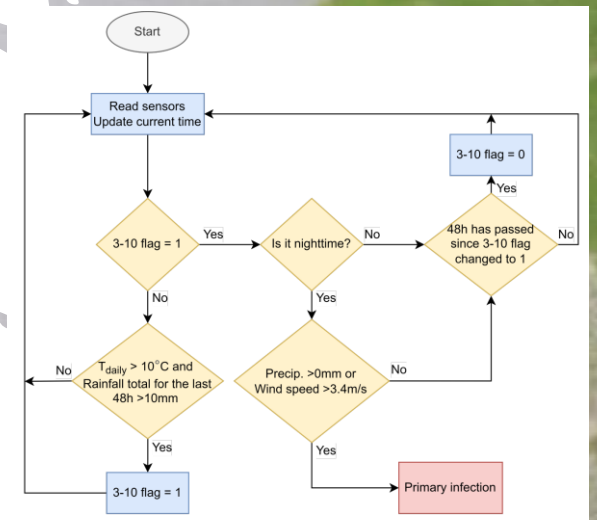
- Winter pruning is labor-intensive
  - Manual operation in **unpleasant weather**
  - Shortage of skilled workers
- Even if pre-pruned by machines, require finishing by hand
- AI model for detection of spur and robotic pruning





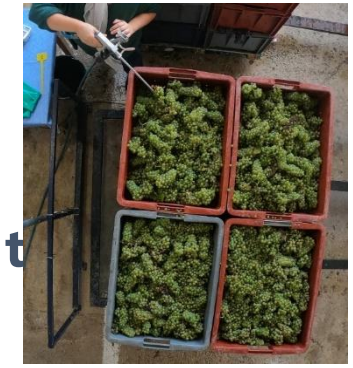
Disease Detection and Control

- Many disease detection products rely on fixed conditions
  - Ex : **Downy Mildew** incubation cycle (1936)
    - Specific conditions of temperature, humidity and wind that favor the infection
- IA solutions rely on data from agricultural sensors and observations on the field, without « a priori »
  - Adapted for each user case
  - Answer the question "**Why mildew infection occurs in my vineyard and not on my neighbor's one?"**
- Better detection and reduced quantity of phytosanitary products



Grape Quality Assessment

- Assessment is performed in pressing sites at the arrival of the grapes
  - **General aspect**
  - **Presence of diseases**
  - Chemical analysis (sugar, acidity)
- All **visual inspection is repetitive and subjected t human error**
- AI models for disease detection and automatic grading
  - Operators are freed to perform other tasks



Impact of AI on Production and Labor conditions

- Most of these examples aim at improving productivity
  - Extract **business knowledge** from data
  - Estimation of necessary resources
  - Business planning

- Also **positive impact** on labor conditions
  - Less repetitive tasks
  - Less exposure to bad weather conditions
  - Mitigate labors' shortage

Challenges and limitations

- Smart-viticulture is a tool, not an objective
  - **Decision-making** tools
  - **Automation** of specific tasks
  - Interesting **only if adds value to the products**
- We cannot fully replace the human beings
  - Even advanced IA models can perform only one task
    - Viticulture has thousands of tasks and procedures
    - Data is still limited – long plant lifecycle
  - **Living beings** always surprise us with new behaviors
    - Plants too!!!

Future Directions and Possibilities for AI in Viticulture

- Vineyard **robots** are becoming common
  - However, only for tasks such as plowing, hoeing or weeding.
  - **Legislation** still restrictive about unsupervised operation of robots.
- More opportunities for AI on data assimilation and decision-making
  - Adding value to data from precision agriculture.
  - AI needs to be precise AND generalizable.
- Ethical implications of AI in viticulture
  - Most wines follow strict production rules.
  - Introduction of AI and automation is a curiosity for now, what about its massification?

Conclusion

- As everywhere, Artificial Intelligence opens **opportunities** for automation and decision-making.
- The first wave of smart agriculture contributed to data gathering but not to **knowledge extraction**
  - It is up to the final users to identify objectives and usages
  - AI can help to give a sense to all this data
- **Repetitive tasks or in poor conditions** are natural candidates for automation
  - Improve productivity
  - Improve working conditions
  - **Free the workers to do more relevant tasks**
- **AI** does not solve all problems, and is still **far from generalization**
- Changes in the production methods require concertation and parsimony
  - **Added value** is a good indicator

Key Takeaways from the Presentation

- **AI is here** and can be used in several ways
- Many efforts to bring IA to the workplace
- AI models require a **well-defined problem** and **sufficient data**
- Deep Learning allows fast prototyping by reusing other models (transfer learning)