AgriFood Innovation in era of digitalisation & sensing

Ondernemersdag - 29 oktober 2019

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Agenda

• AgriFoodTech: cross-overs between Agri-Food and HighTech
• Effective bridge between Deep Science and Fast Innovation
• New talent able to work at interfaces
• The role of A.I. & Data

New technology opportunities for AgriFood sector
What can we learn from other sectors, e.g. the pharmaceutical industry?
The human genome, the blueprint of life and wise investments in science will lead to a revolution to detect, treat, and prevent disease (...) and new products.
Crossing the Valley of Death
Crossing the Valley of Death by connecting the dots

Translational Medicine
Integrating eco systems incl. key role of SMEs & Data

Source: *Compromiso Empresarial and Philanthropic Intelligence; interview Scott Johnson, September 2013*
Agrifood & Data is key JADS topic

New ways of working

- Fourth paradigm research
- Data Talent (MSc, PDEng, PhD)
- Workshops, masterclass, deepdives
- MKB-Data Lab (e.g. data maturity scan)
- Promoting start-ups
Data-Driven Food Value Chain @ JADS

research, education and valorization

AgrifoodInnovation symposium (June 2019):
Artificial Intelligence for Agri&Food

FARM-IT! project
MSc JADS course
A.I. for Agri&Food
A global challenge to meet future food supply

Reasons, e.g.
Expanding world population; ca. 9 billion in 2050
Shortage of agricultural land, water and energy
Climate change

At the same time:
We need to increase food production by 70% in 2050!
Currently >30% of all food produced is wasted
>60% of global water resources are needed for agriculture.

World-wide challenge:
Sustainable, secure, and affordable production of healthy food

Time is ripe for cross-overs between AgriFood and HighTech
The Netherlands has become an agricultural giant

Innovation & technology focused on producing as much of food products at the lowest possible costs
Feed People ..... Oh yeah, what about Nature?
Circular Agriculture

Sustainability

Global Consumers
World-wide more investments in AgriFoodTech startups

AgriFood Tech startups, raised $16.9 billion in 2018.

This is a 43% year-over-year increase.

\textit{In comparison: Global Agriculture revenue is $4.8 Trillion}

However, pace of innovation is not enough (WEF; McKinsey)
Many ongoing AgriFoodTech projects@ TU/e & JADS

- Precision farming: A.I. and control systems
- Energy solutions for small agricultural equipment
- 3D Food printing
- Stimuli-responsive materials for greenhouses
- Computer vision & data for breeding & animal welfare
- Plasma technology to replace Pesticides
- Mild food processing & soft matter
- (Last mile) logistics for Short chains
- Automation & control of greenhouses
- Consumer acceptance for sustainable food products
- Dynamic Pricing Strategies to reduce food-waste
- ...and many more...
Dynamic Pricing Strategies to reduce food-waste

- Relation between demand, price, shelf life, and waste, taking product type and demography into account.
- Incorporate consumers’ prospective
- Develop data driven models to balance food waste and profitability

Tarkan Tan (t.tan@tue.nl)
Zaandam, 20 mei 2019

Albert Heijn zet kunstmatige intelligentie in tegen voedselverspilling

Start proef met dynamisch afprijzen van kip en vis

Albert Heijn zet vandaag een nieuwe stap in het verminderen van voedselverspilling met de proef ‘dynamisch afprijzen’. Hierbij worden producten automatisch afgeprijsd op basis van de houdbaarheidsdatum: hoe korter de houdbaarheid, hoe hoger de korting. Een algoritme houdt rekening met verschillende factoren die de verkoop van een product beïnvloeden om zo de beste korting te berekenen. De proef vindt plaats in de Albert Heijn in Zandvoort bij de gevogelte- en visproducten. Albert Heijn heeft zich voor deze proef laten adviseren door antiverspillingsbedrijf Wasteless.
Precision Farming Project: *how can we create value by big data, sensing and robotics?*

**tasks & goals incl.:**

- Integrated data science environment for treatment decisions and predictive crop growth models
- Intelligent control systems e.g. to manage a fleet of small agri-robots
**FAIR-based Data integration platform for precision farming (DIPPA)**

**Digital Architecture: Openness of platform** to connect with other data lakes & powerful (commercial) data solutions (e.g. Microsoft Azure, etc.)
TU/e goal is to develop intelligent controlling systems to manage a fleet of small agri-robots

Real-time field insights for harvest, planting and spraying

Mathematical models to predict the future in uncertain environment

For each subfield $j$, the DT dynamics are:

$$x_{t+1}^j = x_t^j + f^j(x_t^j, u_t^j, w_t^j)$$

Objective is to maximise expected value of economic profit:

$$J_t = \sum_{j=1}^{N_a} \left( \pi^T x_t^j + \sum_{i=1}^{T-1} \rho^T u_t^i + \sum_{i=1}^{N_a} \sigma_i a_t^i \right)$$

Hence, max $\mathbb{E}_W \{ J_t \}$

Experimental Swarm Agribots?

Key future challenge is to let a team of small robots & drones working together to spray, plant and harvest.
High tech to replace monoculture by mixed cropping for sustainable agriculture

Source: Intercropping, Oregon State University;

TU/e soccer robot team won the world title RoboCup 2018

Swarm robots to make labour intensive multicropping feasible
AgriFoodInnovation: 12 moonshots

1. Slimme varkensketen
2. Digitale gewasketen
3. Milde conservering
4. Geïntegreerde fabriek
5. Voer van lokale oorsprong
6. Transparante keten
7. Verwerking van suikerbiet
8. Precision poultry processing
9. Indoor farming 2.0
10. Verwerking van plantaardige stromen
11. Mest verwerking
12. Duurzame eiwitten

Several Involved companies
Moonshot: Digitalization allow food value chain integration

Precise
- Optimize operations & Price
- Shorter & optimized Production chains
- Enabled traceability
- Consumer driven

Value
- Predict market dynamics
- Anticipate demand & supply

Circular
- Reduce input & resources
- Reduce waste & GHG emissions

Connected
- Systems Integration to rewrite business models
Mobile is fastest growing technology of all time

Mobile give:
- Consumers power to get what they want
- Companies insight what to produce & how to market it

- Significantly increased searches for even small & mundane things
- Smart phones made customers “research-obsessed”:

Source Google Data US
Enabled traceability as part of business model

MARS Food uses blockchain to revolutionize supply chain tracking

Blockchain improving turkey traceability

Last year Cargill trialled blockchain technology that allowed consumers to trace their festive turkey back to the farm on which it was reared.
New players in Agri & Food?

“Data Analytics” as basis for product development & supply chain optimization in Agri&Foods
Integrated “short food” supply chains

New opportunities to produce local, high quality food delivered at your doorstep

- Online platforms & customer understanding
- Last mile logistics
- (Miniaturized) engineering solutions
- (Remote) food quality sensing

Source: Korte Ketens, GrowCampus, Den Bosch
Is A.I. in AgriFood real or is it just a hype?

Artificial Intelligence is the answer to Kenya's food insecurity
The UN Food and Agricultural Organization (FAO)
TUESDAY MARCH 12 2019

Global AI in Agriculture Market Will Generate New Growth Opportunities by 2024
Source SBWire / DigitalJournal

How Sensors, Robotics And Artificial Intelligence Will Transform Agriculture
Forbes

Artificial Intelligence (AI) in Agriculture market growing at a 20.8% CAGR by 2025 detailed in new research report
WhaTech Channel: IT Market Research
Published: 05 March 2019
Data from “Food Value Chain” extremely complex and divers: *structured and unstructured data*

Food Value Chain

<table>
<thead>
<tr>
<th>Input</th>
<th>Farm</th>
<th>Processing</th>
<th>Distribution</th>
<th>Retail</th>
<th>Consumer</th>
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<tr>
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<td>Aggregators</td>
<td>Distributors</td>
<td>Retailers</td>
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Information systems based on FAIR principles to apply A.I.

User-friendly interfaces

Dashboards
DeepMind’s Go-playing A.I. doesn’t need human help to beat us

Reinforcement learning — learn by obtaining rewards for reaching certain goals;
No guidance or previous human expertise or data but running millions of tests
DeepMind’s Go-playing A.I. doesn’t need human help to beat us

According to DeepMind it can do much more...

**Reinforcement learning** — learn by obtaining rewards for reaching certain goals; No guidance or previous human expertise or data but running millions of tests
Cleverbot is an artificial intelligence algorithm to have conversations with humans.
Machines “think” different

Some key questions:

• How to evaluate your algorithm or model?

• Are we looking at the right data, and right hypothesis?

• Is the right (business) question asked?

• Are these measures sufficient to evaluate the quality of an algorithm?

• When the world changes, so must your model

• And so on
Deep Learning vs. Some Other Algorithms

- **Bayesian Belief Networks**
  (e.g. Infectious Diseases)

- **Genetic Algorithms**
  (e.g. Search formulae for milk yield prediction)

- **Process Mining**
  (e.g. Effective treatments and interventions by farmers)

- **Ant-Colony Meta Heuristics & and Cellular Automa**
  (e.g. Ship Safety System)

And several other A.I. related algorithms...

Supervision comes in multiple forms. Human involvement is required in all cases.
A.I. and advanced sensing technology for Dairy Farming

Sensors to measure Health, Fertility, Behavior, Activity, Feeding etc.
(e.g. Breath Analysis, Milk Analysis, Ultra Scans, Location & Weight, Vision, Sound, Movement)

Example: Connecterra, Amsterdam Based Startup in the field of A.I. for Dairy Farming

Recently raised 4.2MEur series.

Sicco Pier van Gosliga
R&D director Connecterra
Member JADS AgrFood&Data Team
Predictive A.I. for dairy industry enterprises developed by Connecterra

Connecterra used open source TensorFlow Google Platform

“"The hope is that even ancient industries can harness technology’s magic. For example, Connecterra, The Amsterdam-based startup uses Google AI to create digital sensors that farmers can use to monitor their livestock’s movement and eating habits.""

Source:
Dr. Sicco Pier van Gosliga,
• Founding Member & Director of R&D at Connecterra
• Member of JADS AgriFood&Data team

Sundar Pichai, CEO Google
OF DATA

Including Data ownership, Privacy & Security
“To get things done, just do it”

Johan Cruijff (philosopher)
1947 – 2016
Acknowledgements

Michiel Gribnau
Leon Frenken
Peter Haring
Rob Hamer
Don Willems
Remko Boom
Dick van Olderen
Jacob vd Borne
Paul van Zoggel
Klaartje Rietkerken
Maurice Heemels
Rene vd Molengraft
Roy Cobbenhage
Bulga Enkhtaivan
George Fletcher
Bram Visser
Ruud Huirne
Rogier Brussee
Kees de Graaf
Sietske Klooster
Katja Pahnke
Eric van der Linden
Ernst van der Ende
Meriam Smiggels
Ronald Visschers
Elies Lemkes
Henny an Gurp
Johan van Arendonk
Thijs Hendrix
Corne Kempenaar
Tarkan Tan
Caroline Hummels
Guus van Roessel
Ge Backus
Lenny van Erp
Sicco Pier van Gosliga

And many more…