AI in Agriculture

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Areas covered

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- Rationale, why?
- Economic drivers of AI
- AI segmentation
- Applications in agriculture

Why?

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- The global human population is exploding, with an estimated 9.7 billion in 2050 (United Nations).
  - Food demand projected to leap 35%—56% between 2010-2050 (Dijk et al., 2021). AI helps enhance food security and safety
  - Scarcity of arable land
- Climatic changes that make resources like water and farmable land scarce
  - Reduce resource use

Why?

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- Rapidly growing interest in AI
  - Global spending on "smart" agriculture, including AI and machine learning, is projected to hit $15-20 billion by 2025 (Forbes report). World Bank allocated about $3 billion in 2023 in climate smart agriculture
  - The market size of AI in agriculture should expect a compound annual growth rate (CAGR) of 20% (GlobeNewswire, 2021)

Economic Drivers of AI demand

- Advancements in Ag production systems
  - Vertical farming
  - Hydroponics
  - Aquaponics

Economic Drivers Cont..

- Human labor problems
  - Shortages, sick leave, family emergencies
  - Direct costs: Health & benefits
  - Human error & Working conditions
  - Experience the future of Ag --TARANIS ad
- Efficiency, work remotely, etc. (Espinel et al., 2024)

Key AI Players in Ag Market

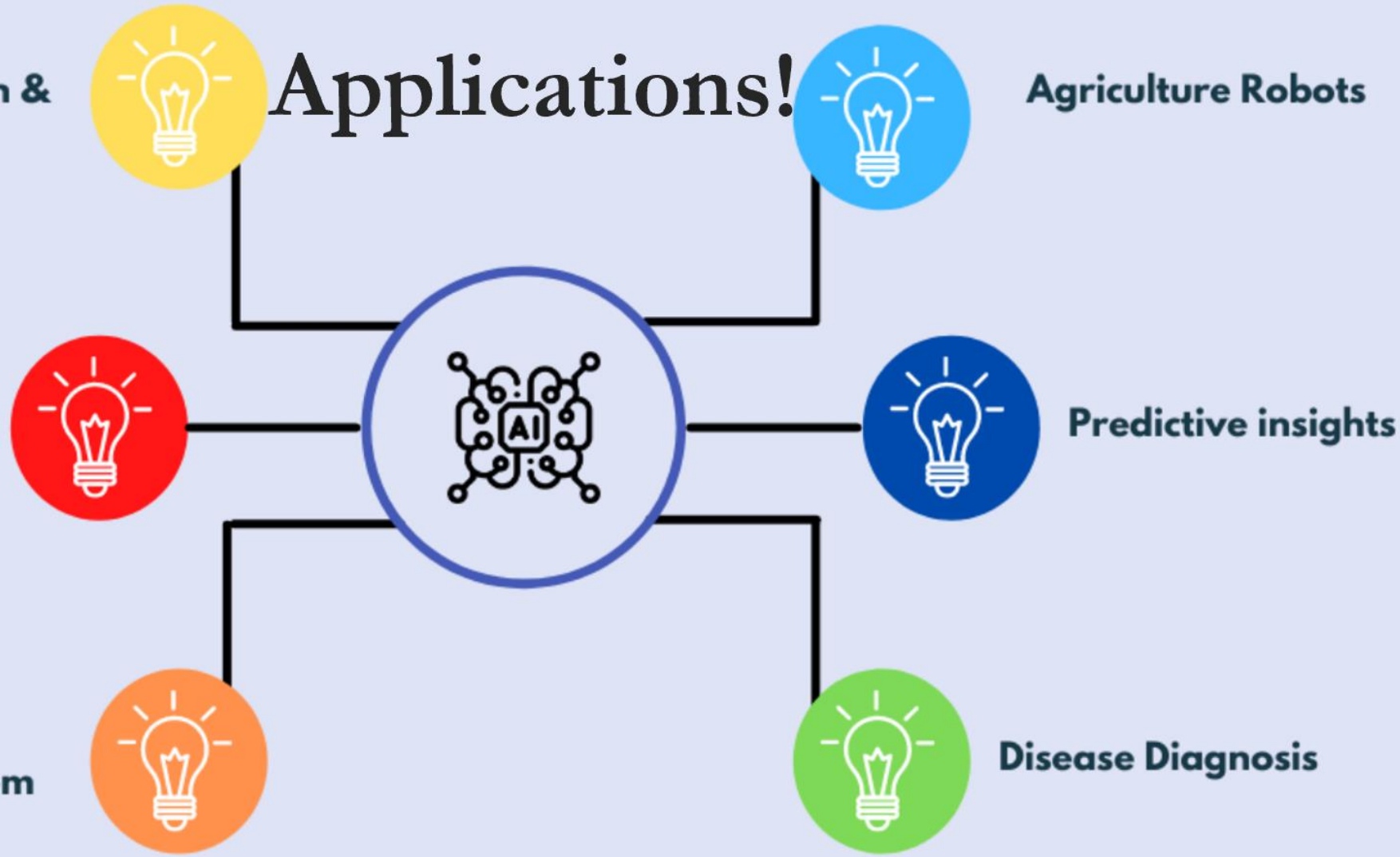
- Microsoft Corp (NASDAQ:MSFT-through Azure Data manager), Gamaya, Precision Hawk, Agribotix, IBM, John Deere, CropX, Harvest Croo, FarmBot, Kubota, etc.
- TARANIS
- BLUE RIVER works with John Deere

AI Segmentation in Agriculture

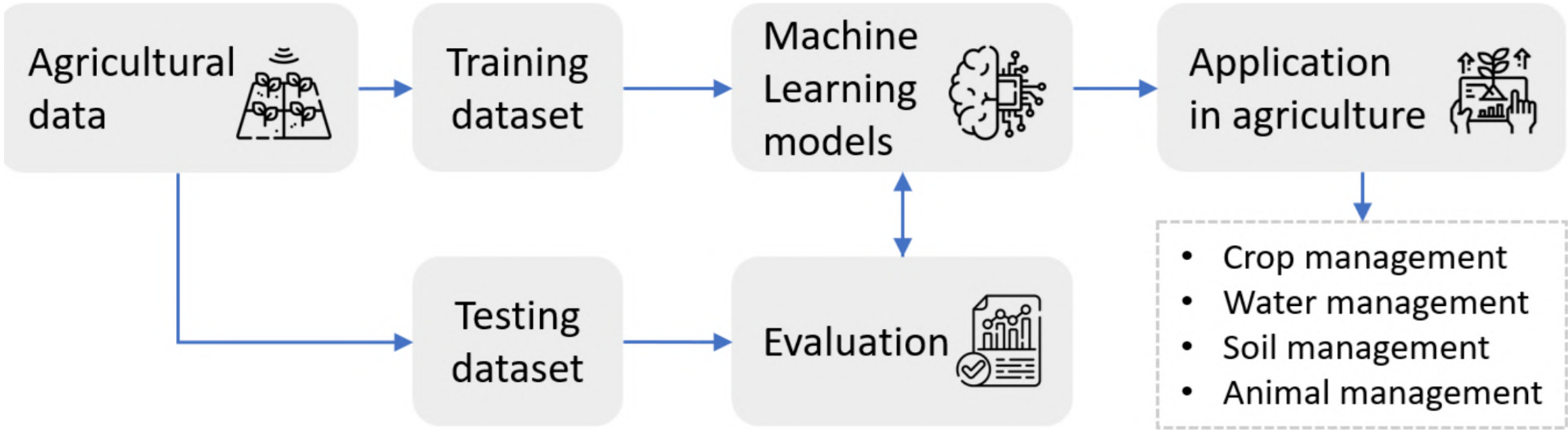
- Technology segmentation: Machine learning, computer vision, predictive analytics
- Application segmentation: Precision farming, Livestock monitoring, Drone analytics, agriculture robots, IoT
- Component segmentation: Hardware, software, AI in futures markets
- Deployment segmentation: Cloud, On-premise, Hybrid

Source: Globe Newswire, 2021

Applications!



General flow: The creation of Machine Learning models and their application in agriculture (Araújo et al., 2023).



Application Segmentation

- Precision farming is a method of farm management that uses information technology to make sure that crops and soil receive exactly what they need for optimum growth and productivity—reducing costs max profits
- Sensing devices, irrigation monitoring systems aid farmers by reducing monthly bills for irrigation and limited water resources (Keswani et al., 2018).

Application Segmentation

- AI algorithms use historical data to predict weather patterns and irrigation requirements accurately.
- Used to capture, translate, and analyze digital data. Weed-Killing AI Drones May Be the Future of Farming, Intelligent sprayers, GPS machines, sensors, etc.
- Farmers can tailor fertilizers or pesticides based on accurate results and predictions—using the VRT!

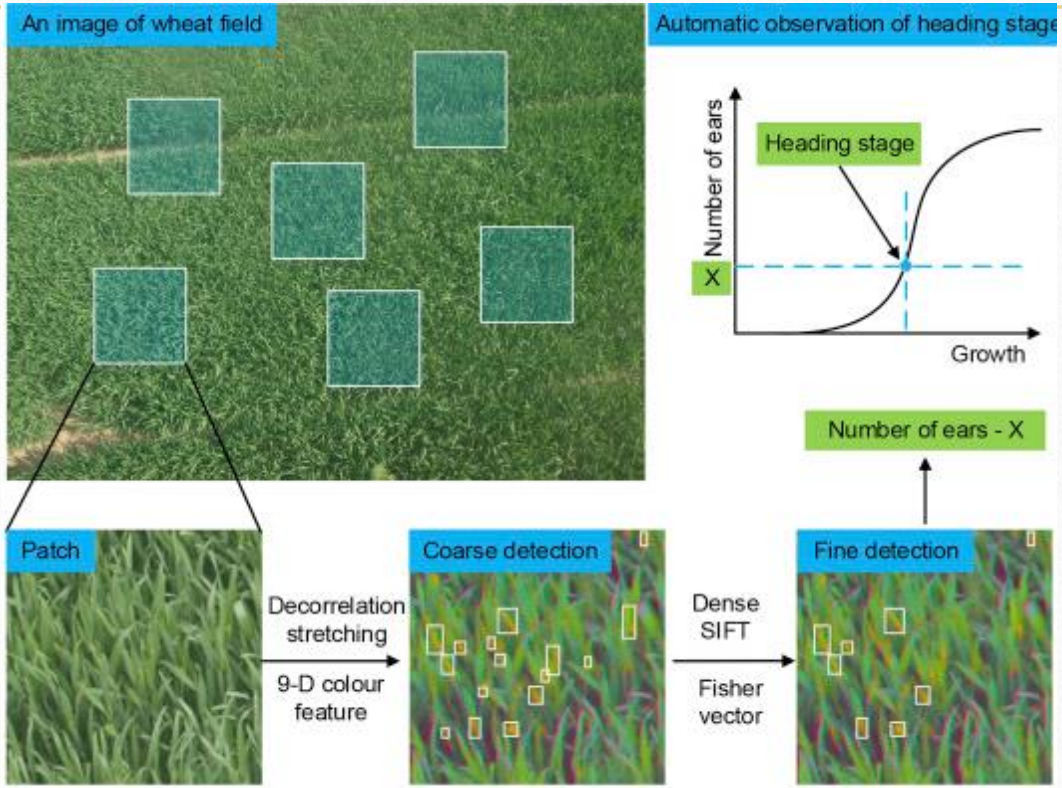
Applications Cont.…

- Track soil and overall crop growing conditions and/or health
  - calculating the amount of soil, water, fertilizer, and pesticides required
  - monitoring the stages of growth—essential to optimizing production efficiency
- Detect and manage crop pests and diseases faster than humans
  - It's vital to understand interactions between crop growth and the environment in order to make adjustments for improved crop health

Observing Crop Progress

- Manual observation of wheat head growth stages is a labor-intensive process that AI can help with in precision agriculture.
  - collecting images of wheat at different "heading" stages across three years and in different lightings, has enabled researchers to create a "two-step coarse-to-fine wheat ear detection mechanism".
  - This computer vision model has outperformed human observation in accurately identifying wheat growth stages, meaning that farmers no longer have to make daily treks into the fields to examine their crop.
    - https://www.sciencedirect.com/science/article/pii/S1537511015300349

Automatic observation of wheat heading stage



Crop monitoring

- Kubota All-Terrain KATR
- Track crop growth and maturity—Tomatoes, grapes, etc.
- Monitoring crop yields, make accurate yield predictions

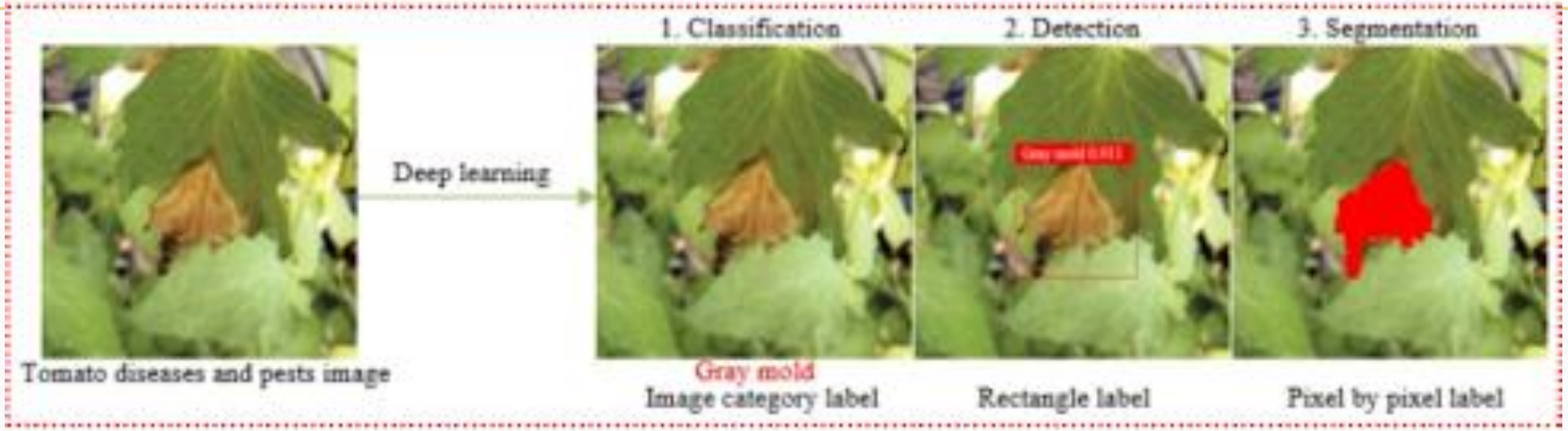
Observing Crop Progress

- AI can help check the ripeness of tomatoes (computer vision).

Insect and Plant Diseases Detection

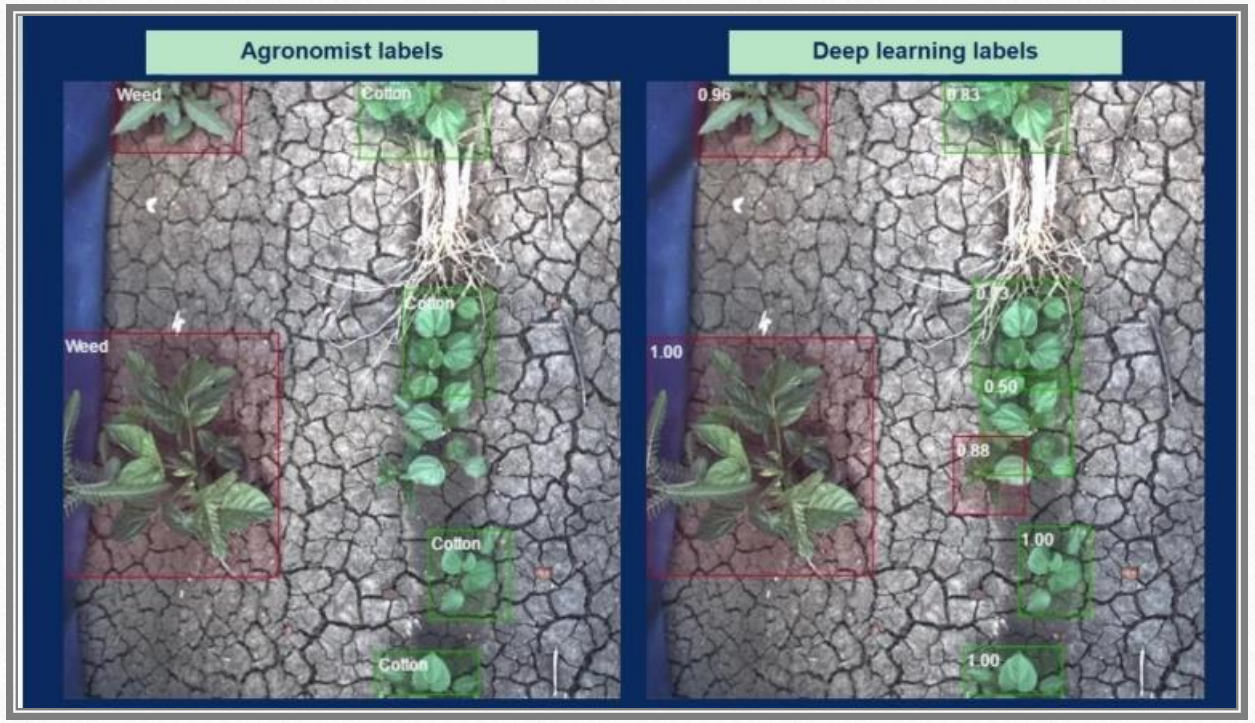
Using image recognition technology based on deep learning, we can now automate detection of plant diseases and pests.

Using image classification, detection, and image segmentation methods to build models that can "keep an eye" on plant health.



Machine learning and weeding

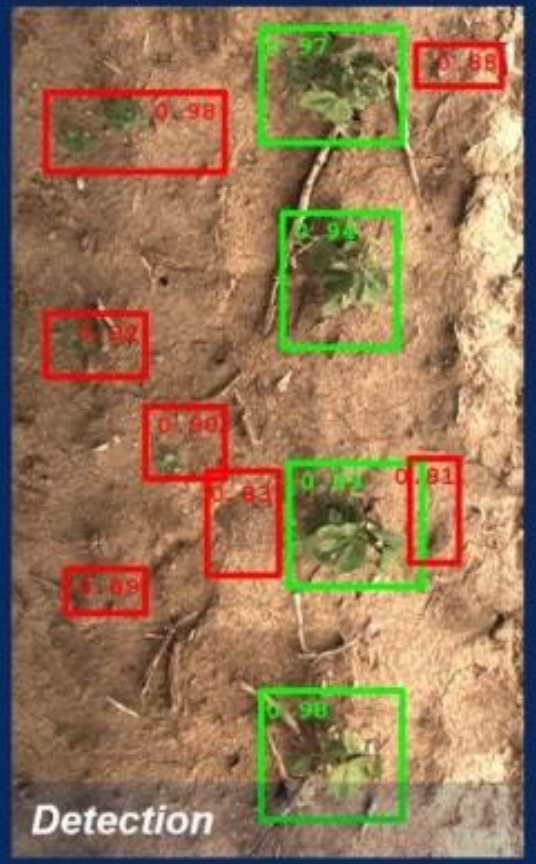
- After teaching the AI to identify crop plants from weeds, it performed better than a trained Agronomist



See & Spray uses artificial intelligence to identify and spray individual plants in milliseconds

Sense & Decide: Blue River's artificial intelligence identifies subtle differences between crops (green) and weeds (red)

Act: Only weeds are sprayed, reducing chemicals by >90%



Finding bugs!

- say you'd like to know not only *if* your crops have pests, but *how many* there are, computer vision systems for insect detection has that covered as well.

Robots and weeding!

- Agricultural robots that uses camera and image recognition technology to find weeds and remove them
- It learns to distinguish between weeds and crops through image training on leaf size, shape, and color.

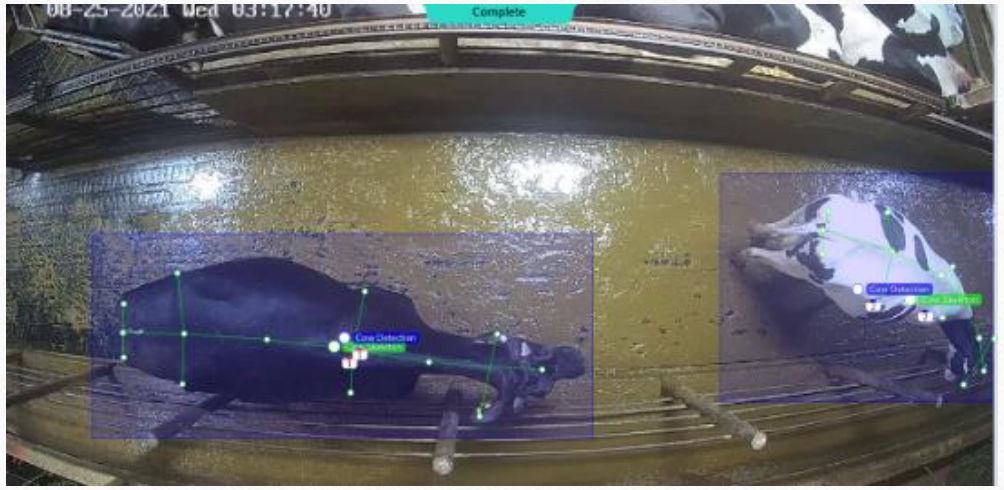
Weed and mature corn field annotation using V7

Livestock monitoring

- Monitoring of livestock
  - increased used of drones, smart sensors, GPS trackers, etc.
- Helps farmers organize farm data

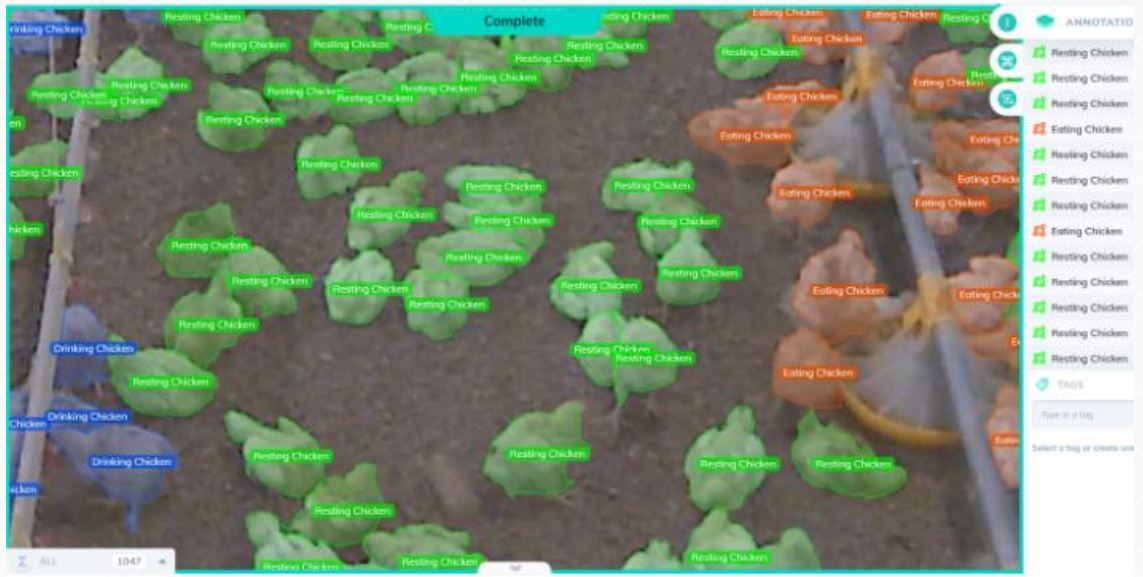
Livestock health monitoring

- Example uses CattleEye's (Co.) AI
- Computer vision can also
  - Count animals, detect disease, identify unusual behavior, and monitor significant activities such as giving birth.
  - Collect data from cameras and drones (UAVs)



Livestock health monitoring

- What are chickens up to?
  - drinking, eating, sleeping, or
  - doing something odd that may be indicative of disease
  - Bird flu detection?



Drinking, eating, and resting chickens annotated using V7's auto-annotate tool

AI in Futures Markets!

- Benefits of AI in commodity trading

Unlimited Applications

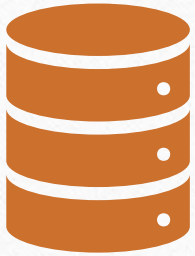
- Agriculture robots powered by AI incorporate field sensors and data analytics, that can be used for a wide range of tasks.
- Robots can monitor plant growth and harvesting systems.

A Future of Unlimited Applications!

Challenges

- High start-up and maintenance costs,
- High skills requirement to operate/use
- High obsolescence – becoming out of date/no longer in use
- Huge investment in research and development may restraint market growth
  - However, the use of the AI bots increase farm efficiency and productivity—profits

Way forward!



Open Data Framework NIFA grants, etc.

Help from extension offices and/or Land grant universities

Training and workshops!

The End!

- Questions?? Comments!! Concerns!!

State of the 2025 agriculture industry | Watch

Work Cited

- A. Subeesh, C.R. Mehta (2021). Automation and digitization of agriculture using artificial intelligence and internet of things, Artificial Intelligence in Agriculture, Volume 5, (278-291)
- Espinel, R., Herrera-Franco, G., Rivadeneira García, J. L., & Escandón-Panchana, P. (2024). Artificial intelligence in agricultural mapping: A review. Agriculture, 14(7), 1071.
- https://www.sciencedirect.com/science/article/pii/S2589721721000350
- https://www.sciencedirect.com/topics/computer-science/irrigation-system
- https://www.sciencedirect.com/science/article/pii/S1537511015300349

More Videos!

- **Agras T30 - Full Spraying Demo**
  - https://www.youtube.com/watch?v=0FQ5KYtMyv8
- **Monitoring Crop Health With Drones | Maryland Farm & Harvest**
- https://www.youtube.com/watch?v=P2YPG8PO9JU (Not English!)

Precision Ag