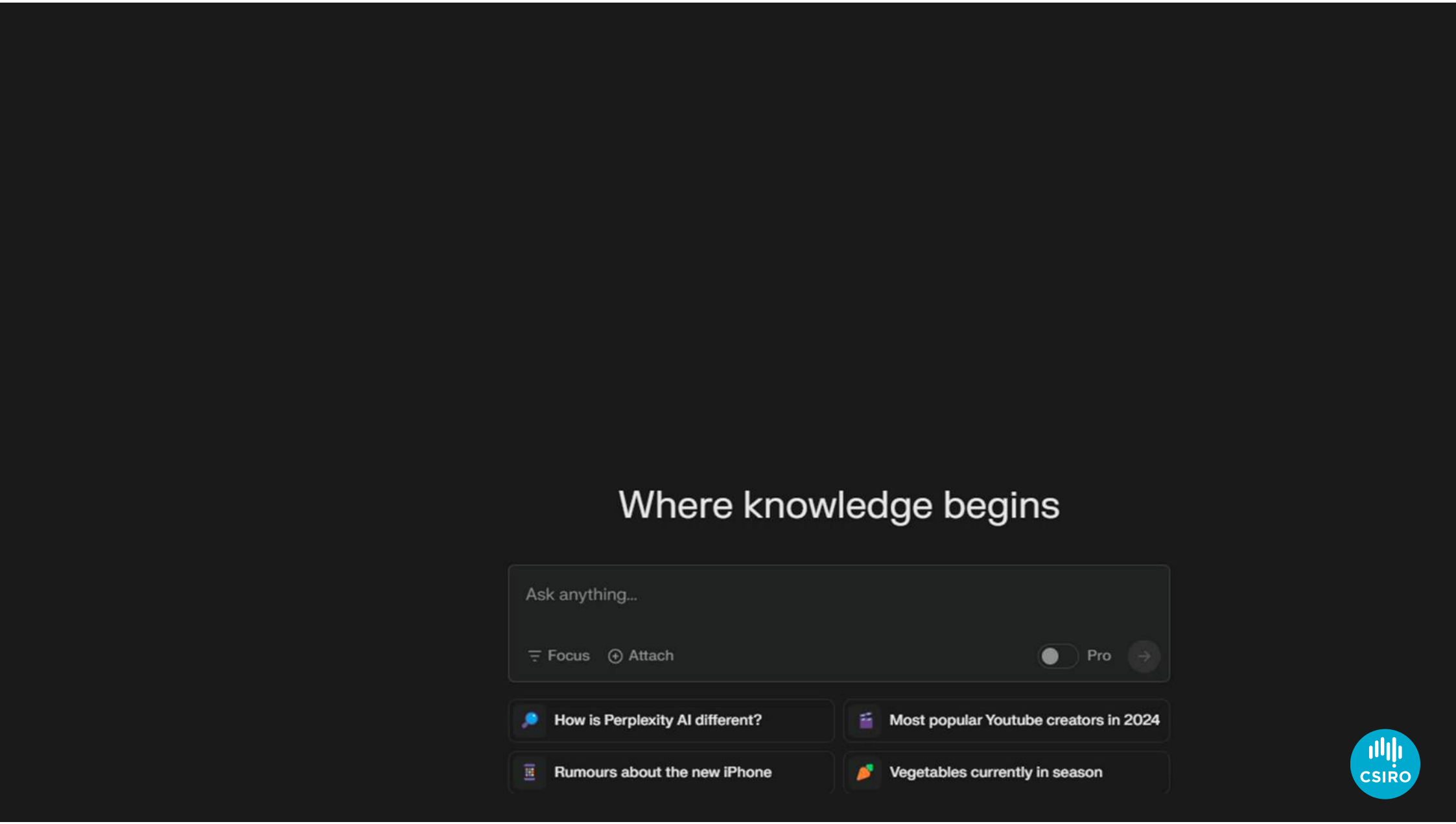
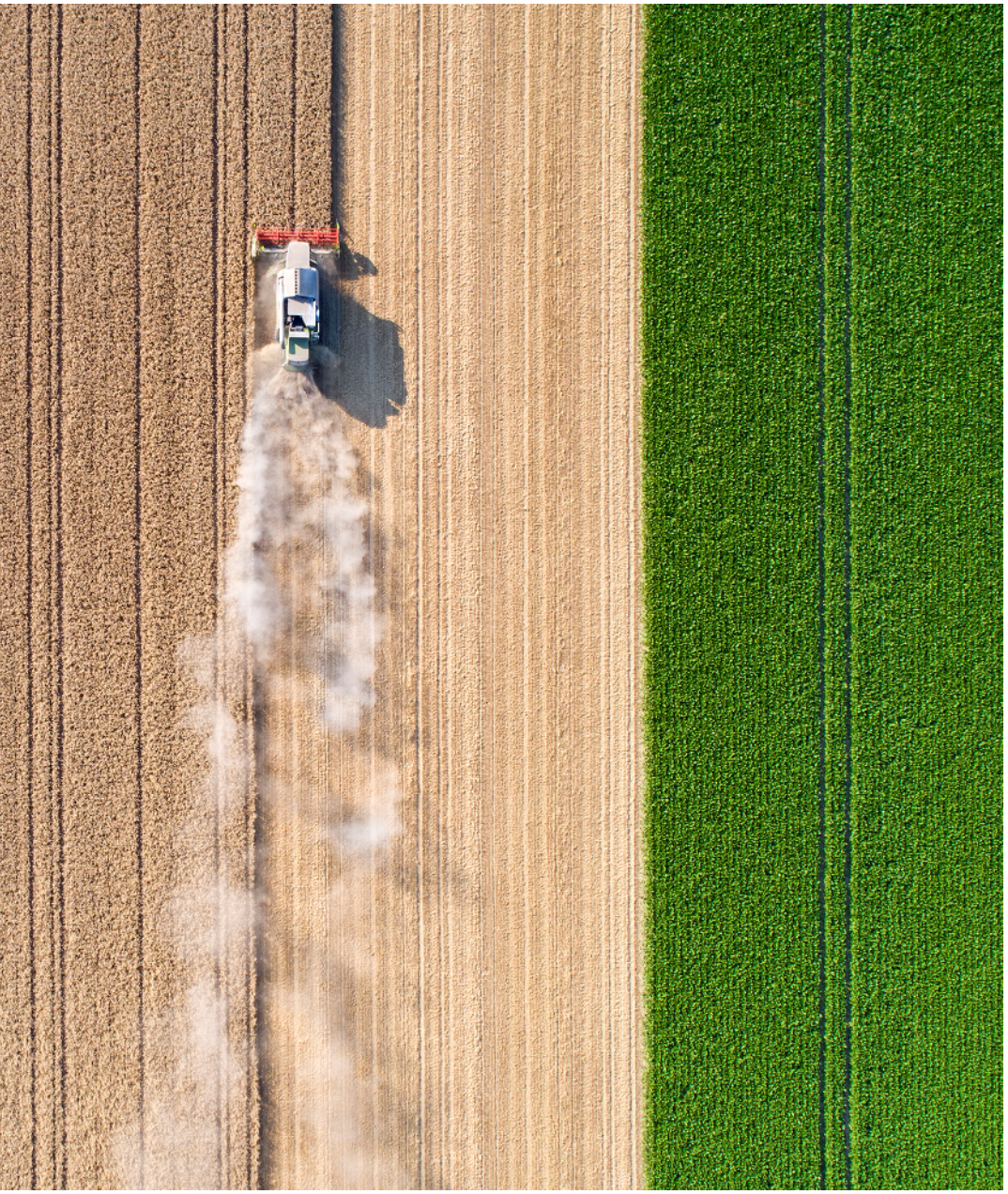
# Artificial Intelligence in Agriculture:
# Is AI helping grow farming?

Jonathan Richetti & Roger A Lawes | 22 October 2024

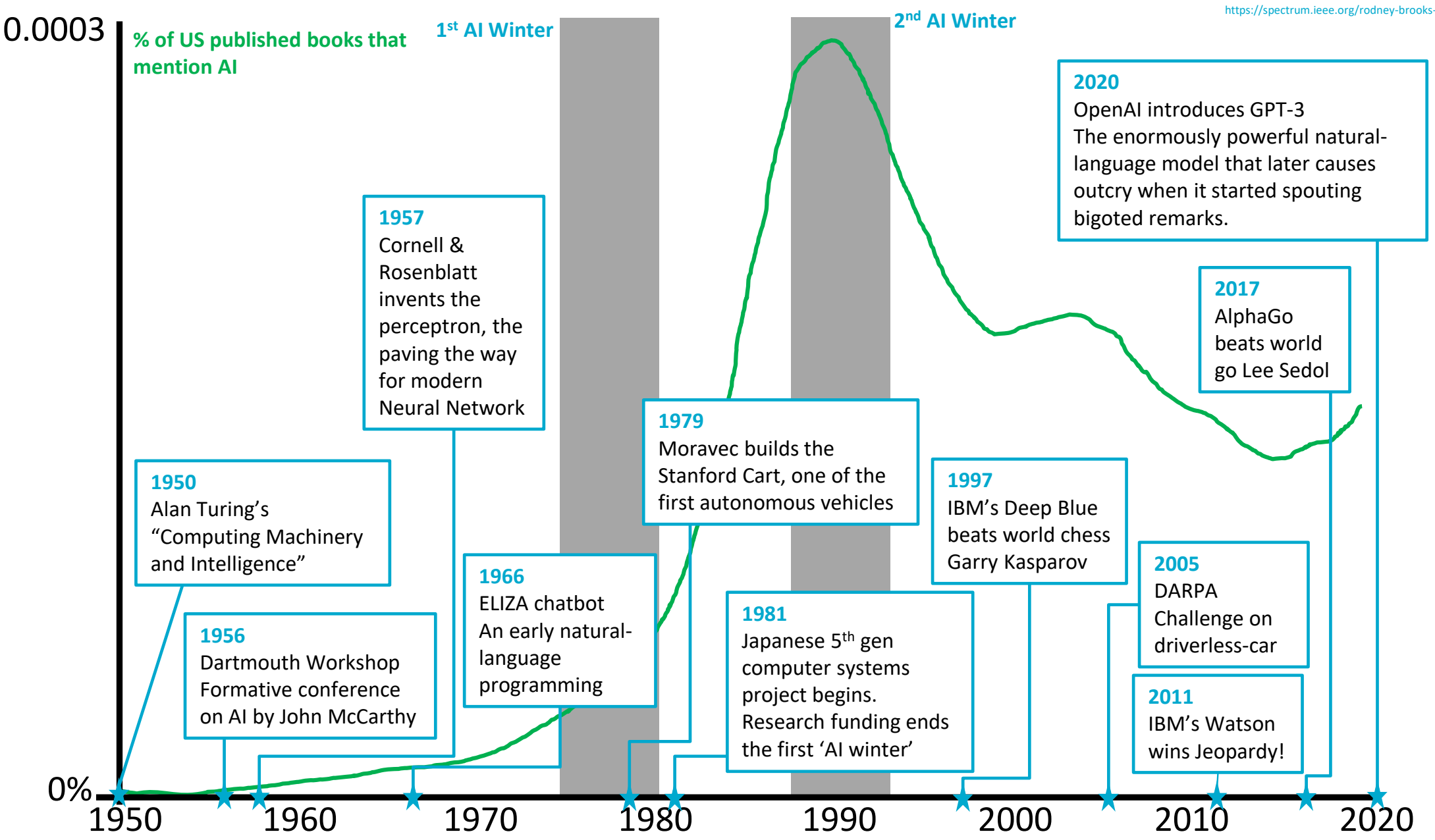
Australia's National Science Agency


Where knowledge begins
Ask anything...
Focus
Attach
Pro
How is Perplexity AI different?
Most popular Youtube creators in 2024
Rumours about the new iPhone
Vegetables currently in season
CSIRO

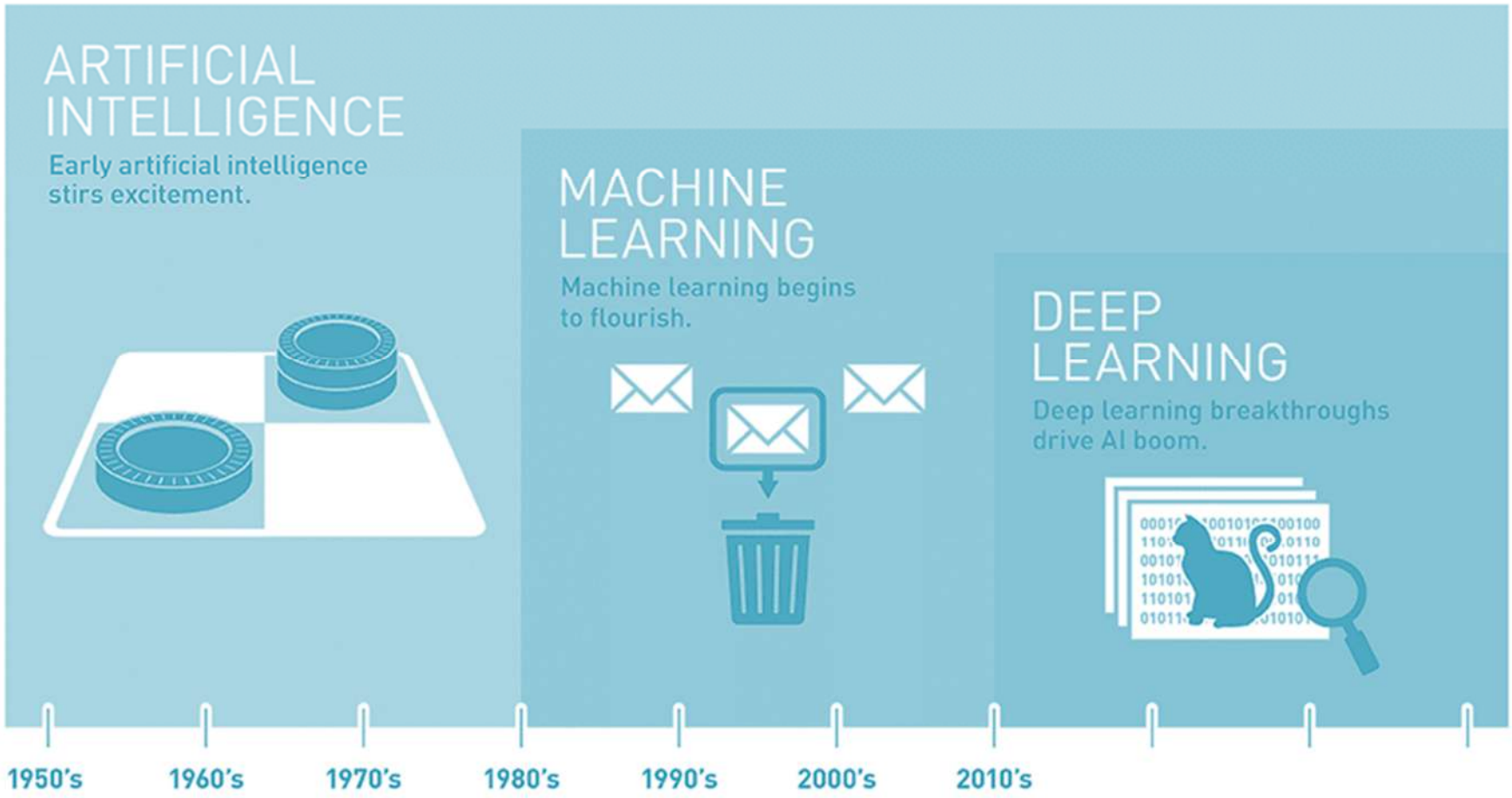


# What's for today

- Story time & AI de-jargonising
- Categories & Examples in Agriculture
- AI Guidelines and best practices – how to make AI learn?

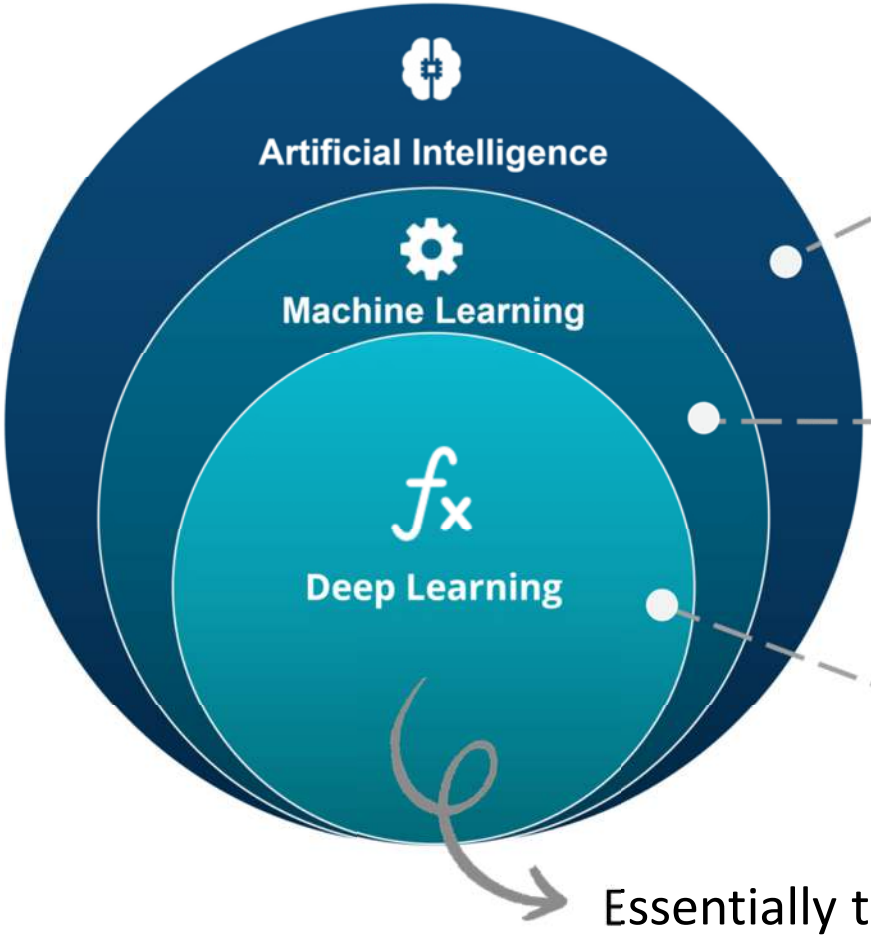

https://spectrum.ieee.org/rodney-brooks-ai
0.0003
% of US published books that mention AI
1st AI Winter
2nd AI Winter
2020
OpenAI introduces GPT-3
The enormously powerful natural-language model that later causes outcry when it started spouting bigoted remarks.
1957
Cornell & Rosenblatt invents the perceptron, the paving the way for modern Neural Network
2017
AlphaGo beats world go Lee Sedol
1979
Moravec builds the Stanford Cart, one of the first autonomous vehicles
1950
Alan Turing's "Computing Machinery and Intelligence"
1997
IBM's Deep Blue beats world chess Garry Kasparov
1966
ELIZA chatbot
An early natural-language programming
2005
DARPA Challenge on driverless-car
1956
Dartmouth Workshop
Formative conference on AI by John McCarthy
1981
Japanese 5th gen computer systems project begins.
Research funding ends the first 'AI winter'
2011
IBM's Watson wins Jeopardy!
0%
1950
1960
1970
1980
1990
2000
2010
2020

# What is what?




Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

# What is deep learning?




**ARTIFICIAL INTELLIGENCE**
A technique which enables machines to mimic human behaviour

**MACHINE LEARNING**
Subset of AI technique which use statistical methods to enable machines to improve with experience

**DEEP LEARNING**
Subset of ML which make the computation of multi-layer neural network feasible

Essentially this means neural networks

CSIRO

# AI in the real-world

- Cost of failure is negligible
- Human in the loop

# AI de-jargonising

- What AI actually does?
- What is AI, after all?

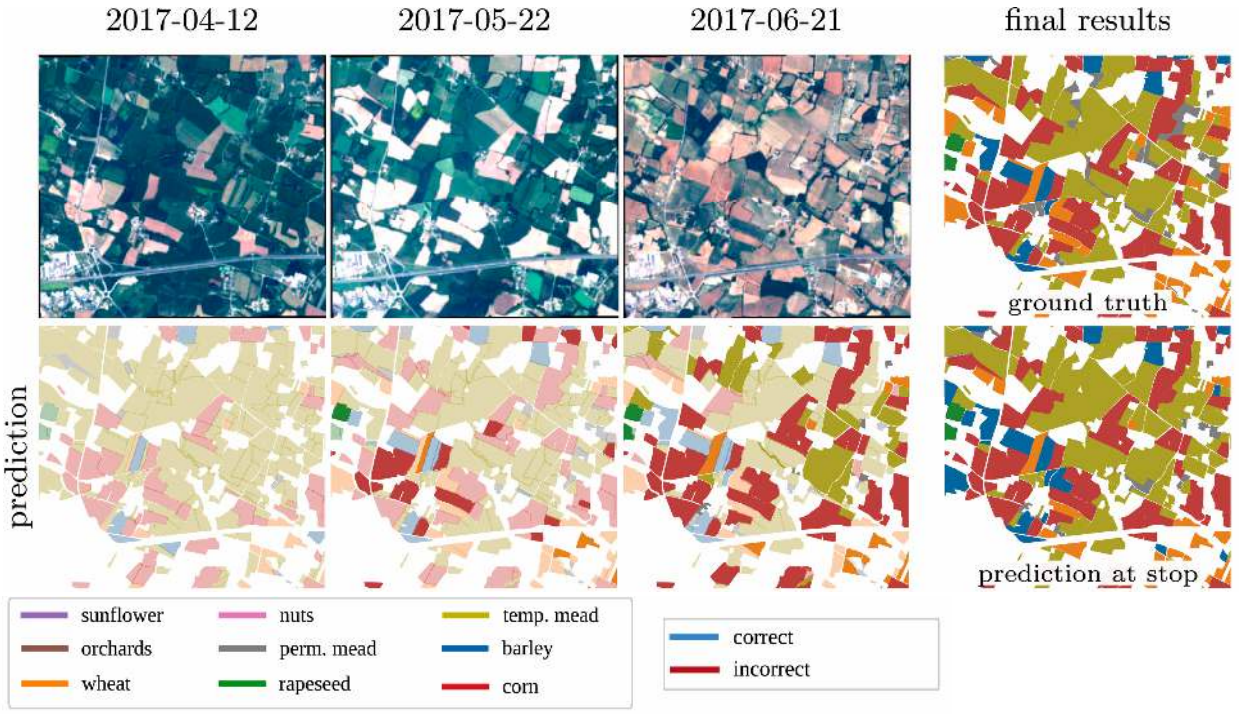
# What it does is important

- Supervised (needs label or target)
  - Classification
  - Regression

- Unsupervised (no-label)
  - Clustering (~association)
  - Dimensionality Reduction

# What it does is important

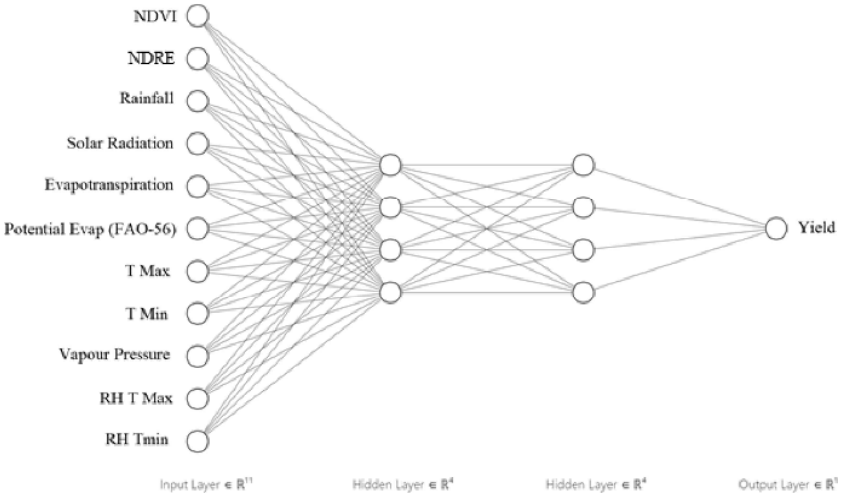
- Supervised
  - Classification → semantic segmentation



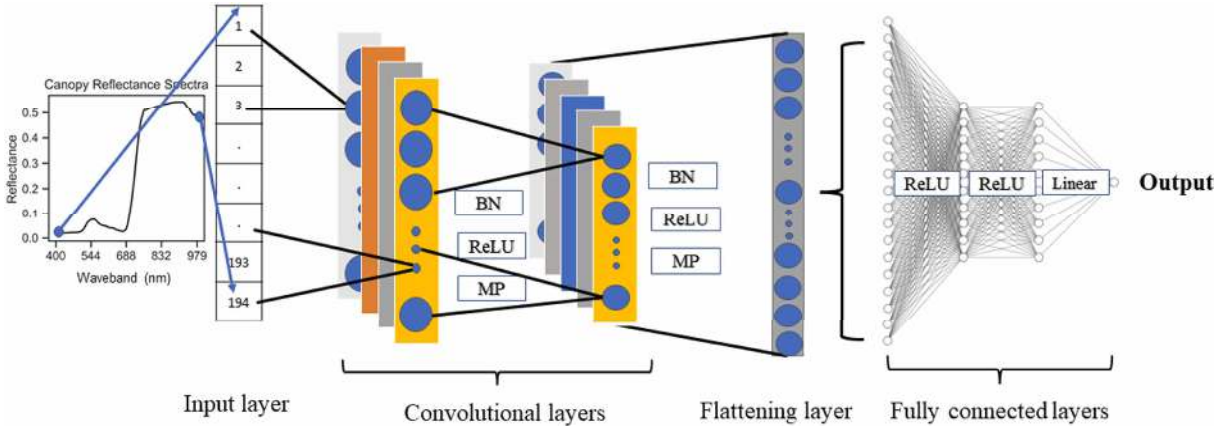

https://doi.org/10.1016/j.isprsjprs.2022.12.016

# What it does is important

- Supervised
  - Regression




Richetti et al (2023) A methods guideline for Deep Learning in Agriculture https://doi.org/10.1016/j.compag.2023.107642

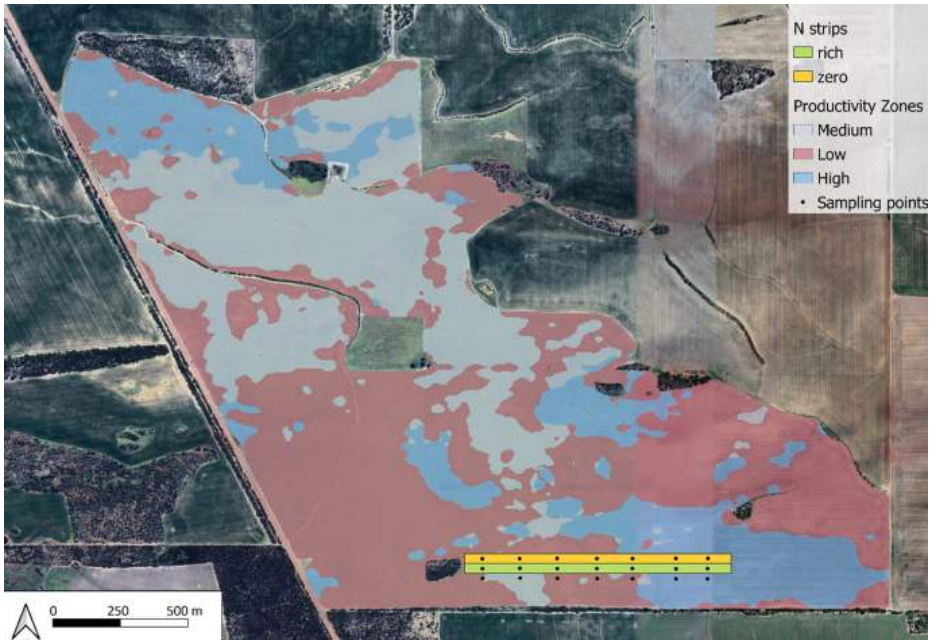



Patel et al (2023) Retrieving canopy nitrogen concentration and aboveground biomass with deep learning for ryegrass and barley: Comparing models and determining waveband contribution https://doi.org/10.1016/j.fcr.2023.108859

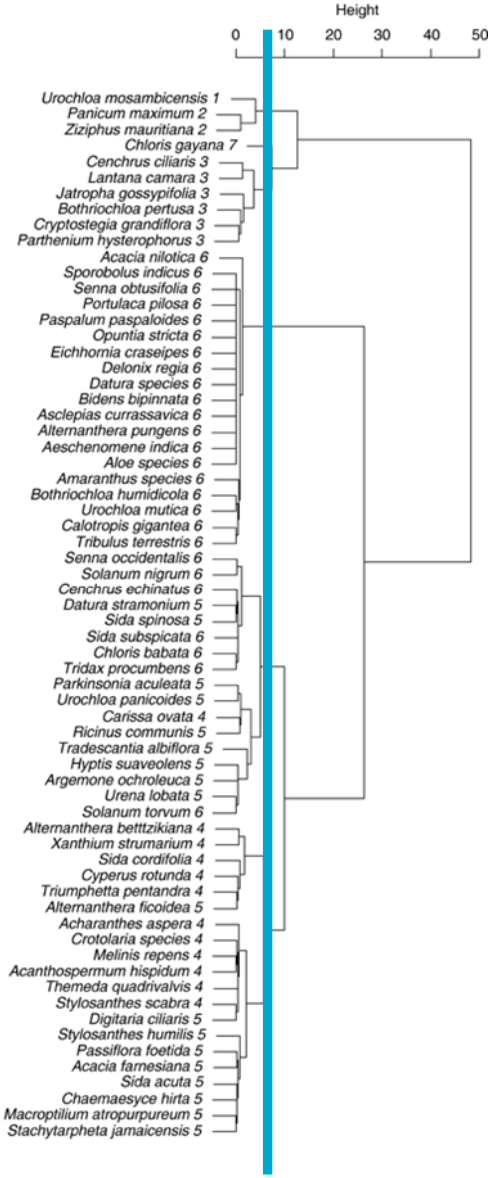
# What it does is important

- Unsupervised
  - Clustering (~association)

Ratcliff, Christina; Gobbett, David; & Bramley, Rob (2020): PAT - Precision Agriculture Tools. CSIRO. v3. Software. https://doi.org/10.25919/5f72d61b0bca9



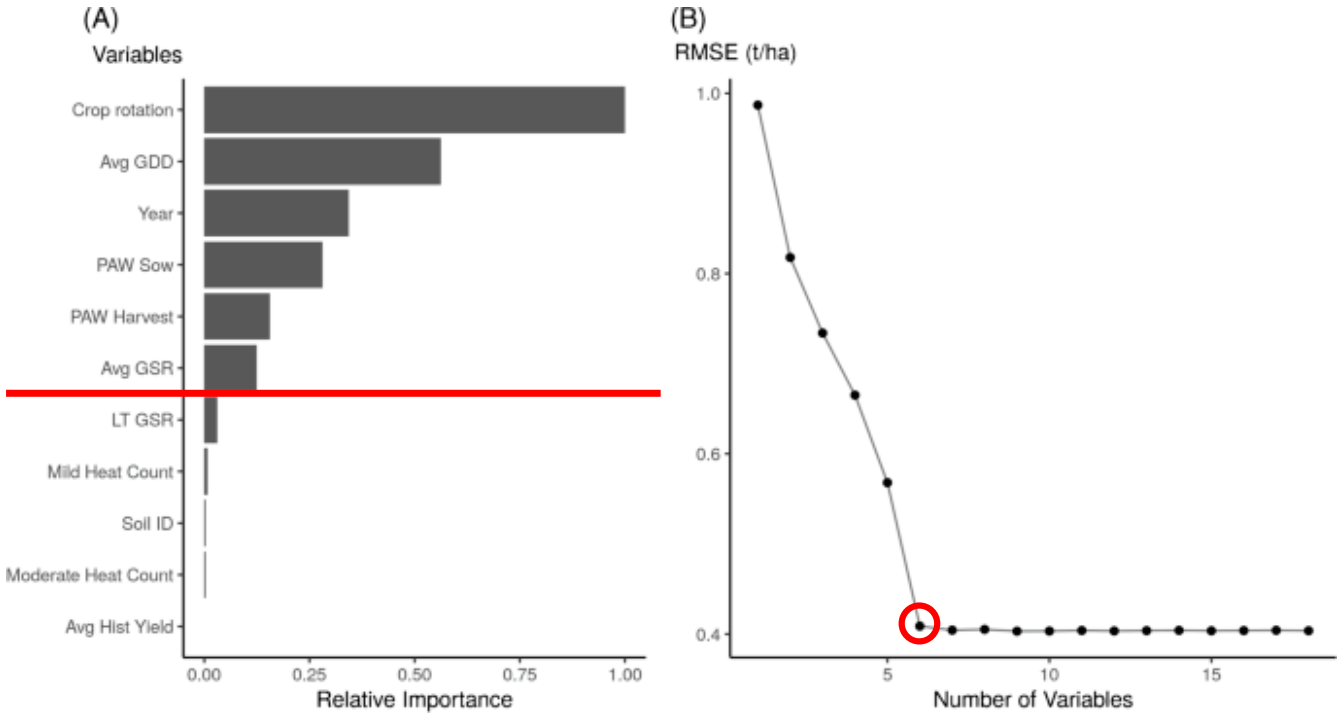

Colaço et al. (2024) Digital strategies for nitrogen management in grain production systems: lessons from multi-method assessment using on-farm experimentation. https://doi.org/10.1007/s11119-023-10102-z




Lawes et al. (2006) Comparing agglomerative clustering and three weed classification frameworks to assess the invasiveness of alien species across spatial scales https://doi.org/10.1111/j.1472-4642.2006.00291.x

# What it does is important

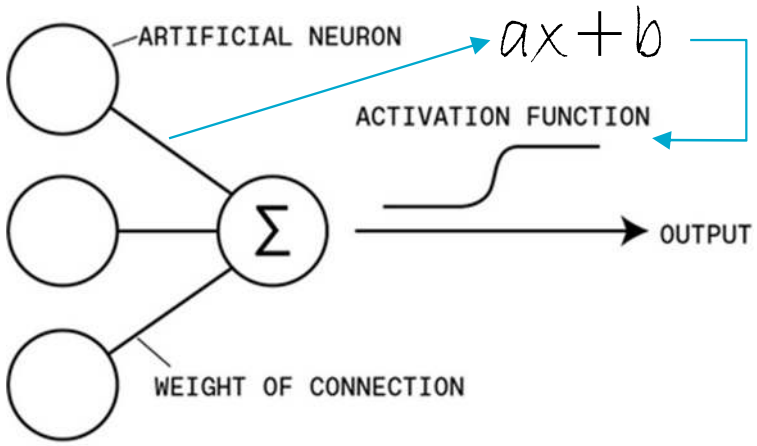
- Unsupervised
  - Dimensionality Reduction

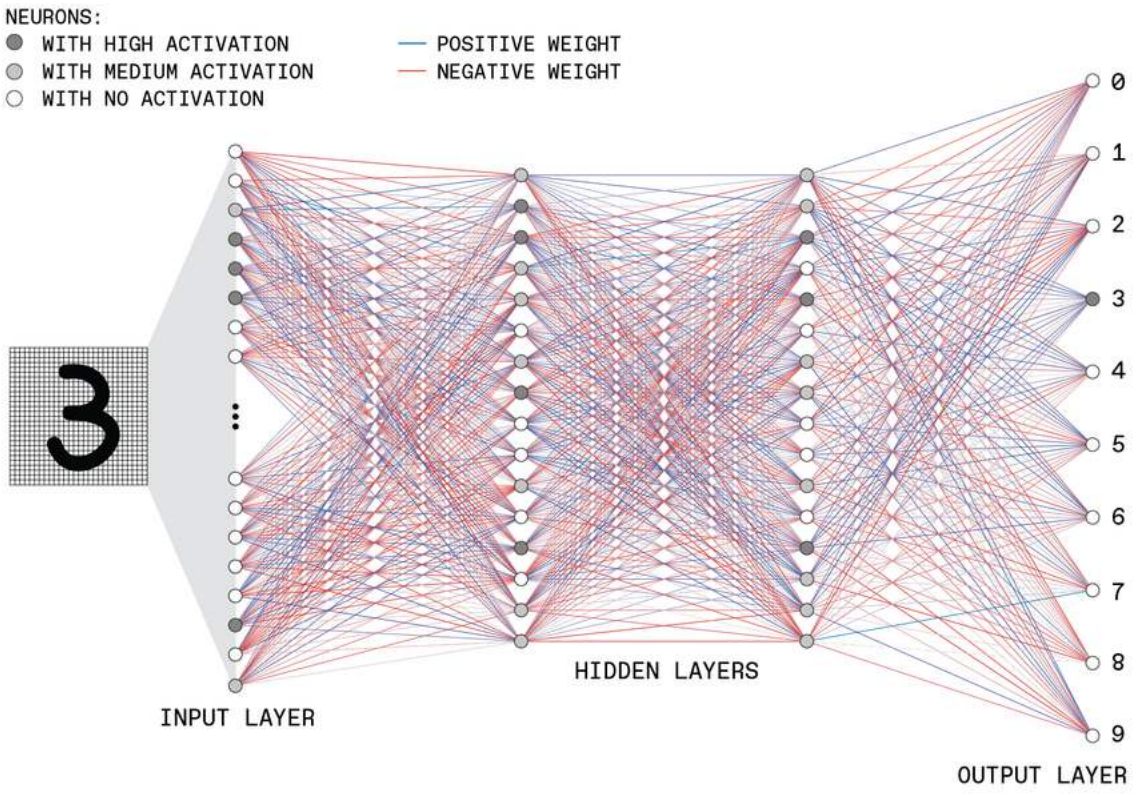



Lawes *et al. (2022)* Using remote sensing, process-based crop models, and machine learning to evaluate crop rotations across 20 million hectares in Western Australia https://doi.org/10.1007/s13593-022-00851-y

# What is it after all

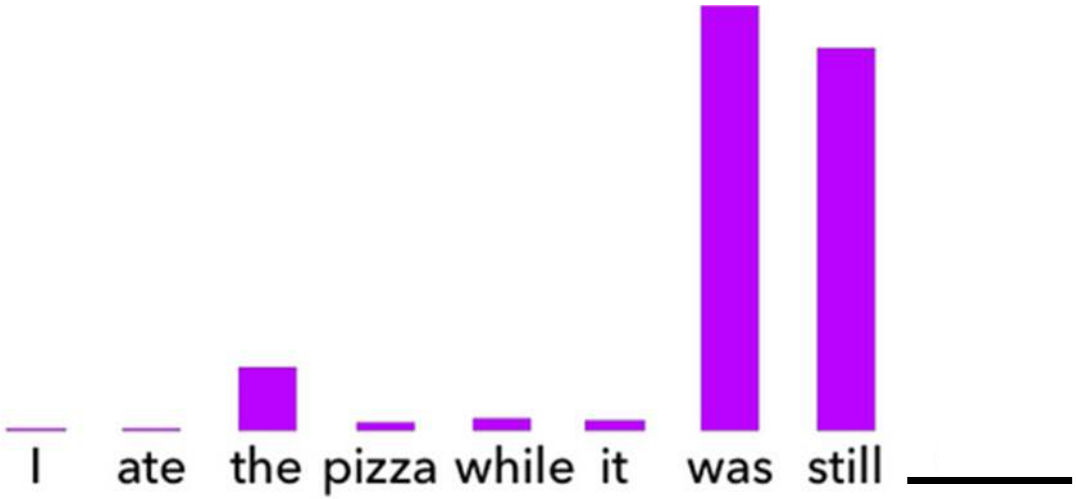
- If it solves a regression problem and the AI is a fancy regressor!
- Focus on Deep Learning: all Neural Networks share the same building block:



# Bonus: What is it after all?

- LLMs and the likes of ChatGPT – stochastic parrots



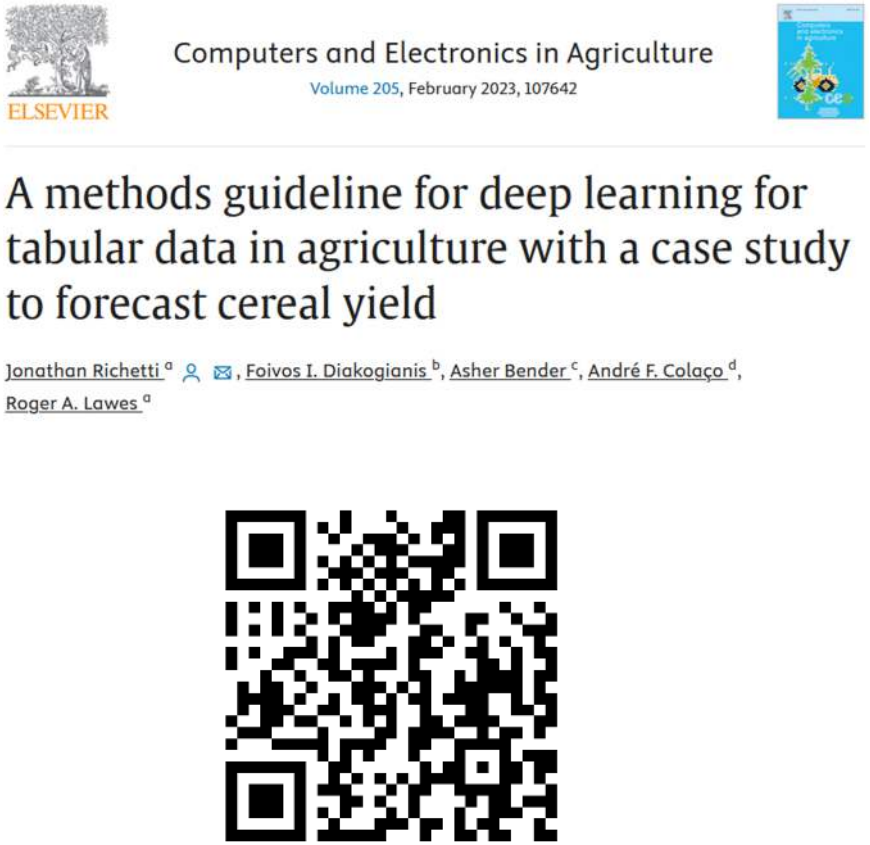

https://towardsdatascience.com/how-to-sample-from-language-models-682bceb97277

# How to make machines learn?

## Little guidelines and tips

# How to make the machine learn?

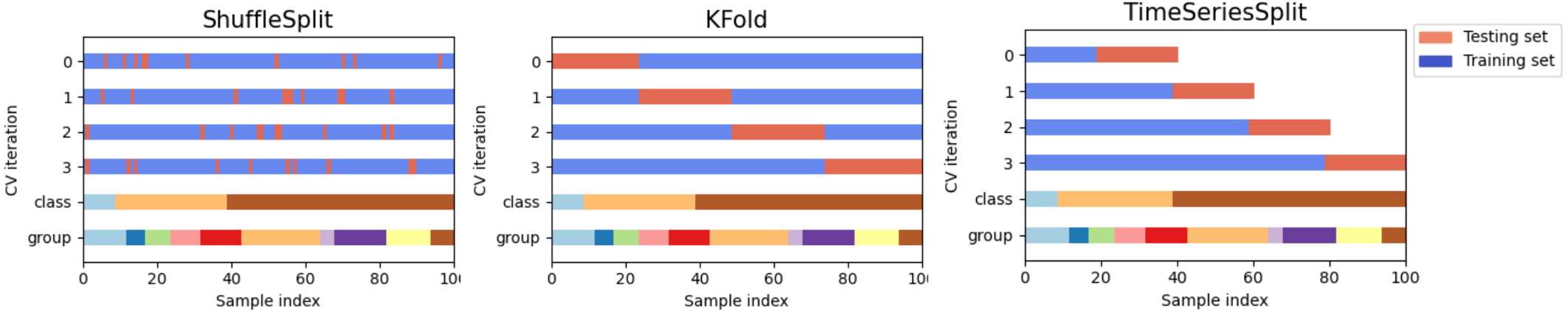
- Once the problem is defined
  - Pick a suitable algorithm
  - Check your data
  - Define cross-validation scheme and metrics
  - Train model
  - Evaluate/Test model




CSIRO

# From decision tree to neural network

- How does one evaluate the models?



# From decision tree to neural network

- How does one evaluate the models?

| CV Split | MLP | TabNet | RF | XGBoost |
|---|---|---|---|---|
| | RMSE (t/ha) | | | |
| **3** | **1.10** | **0.68** | **1.01** | **0.93** |

# From decision tree to neural network

- How does one evaluate the models?

| CV Split | MLP | TabNet | RF | XGBoost |
|---|---|---|---|---|
| | RMSE (t/ha) | | | |
| **8** | **0.63** | **0.82** | **0.74** | **0.67** |

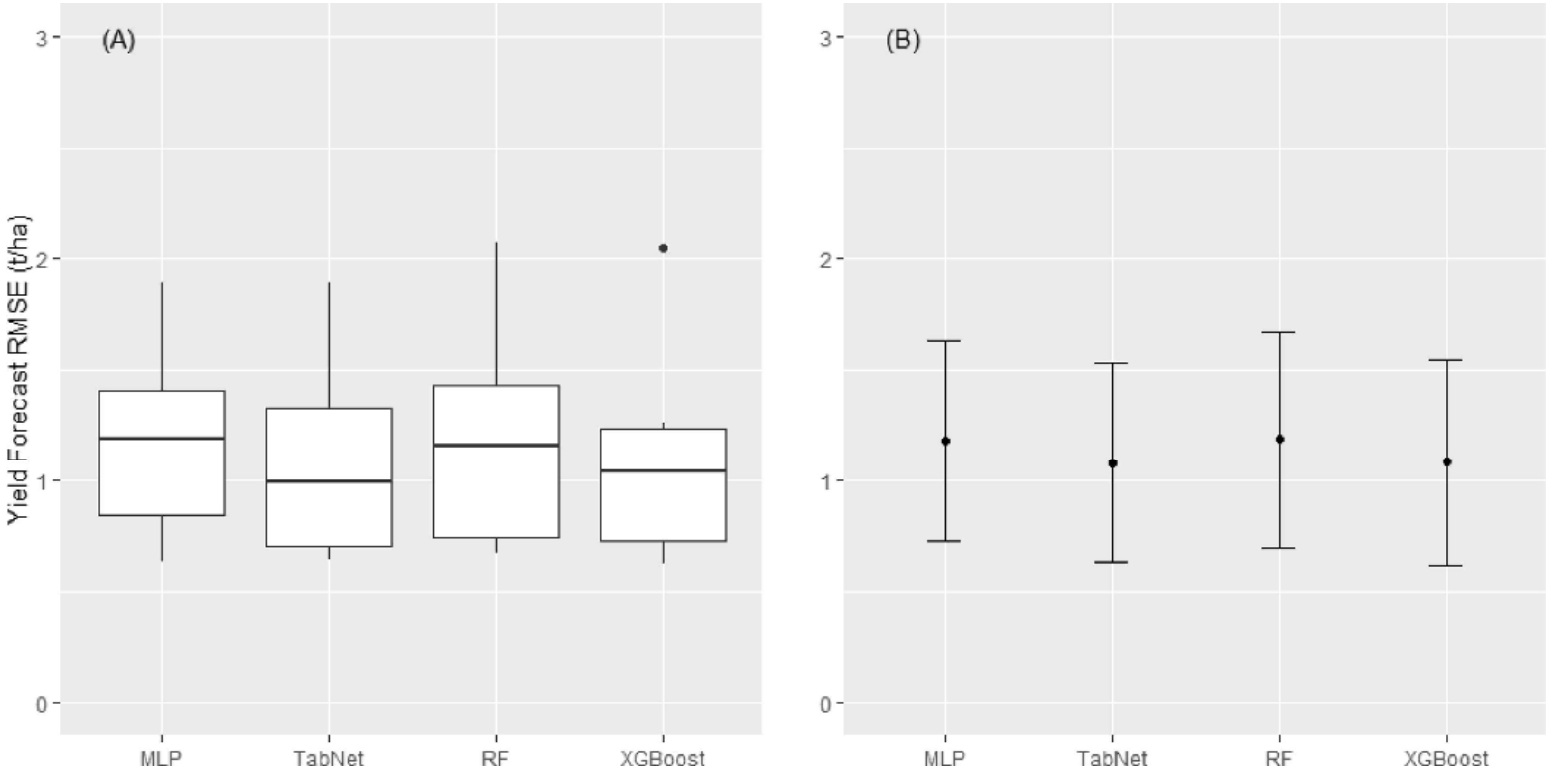
# From decision tree to neural network

- How does one evaluate the models?

| CV Split | MLP | TabNet | RF | XGBoost |
|---|---|---|---|---|
| | RMSE (t/ha) | | | |
| 1 | 1.65 | 1.28 | 1.53 | 1.26 |
| 2 | 0.65 | 0.64 | 0.67 | 0.62 |
| **3** | **1.10** | **0.68** | **1.01** | **0.93** |
| 4 | 1.27 | 1.15 | 1.39 | 1.14 |
| 5 | 0.90 | 0.71 | 0.74 | 0.75 |
| 6 | 1.32 | 1.44 | 1.30 | 1.23 |
| 7 | 1.90 | 1.89 | 2.07 | 2.05 |
| **8** | **0.63** | **0.82** | **0.74** | **0.67** |
| Average (t/ha) | 1.18 | 1.08 | 1.18 | 1.08 |
| Standard Deviation (t/ha) | 0.45 | 0.45 | 0.49 | 0.46 |
| Coefficient of Vatiation | 38 % | 41 % | 41 % | 43 % |

# From decision tree to neural network

- How does one evaluate the models?



# Is AI help grow farming?

- Yes but…
- Not the panacea that might be advertised
- Few steps will go a long way for a good solution

# Take home messages

- Think of the process you're trying to solve – maybe the problem requires multiple models
- Adequate Data
- Set-up a proper cross-validation strategy


# Thank you

**Agriculture & Food**
Jonathan Richetti PhD, Msc, Bsc

Research Scientist

M: +61 0411 150 425

Jonathan.Richetti@csiro.au
https://people-my.csiro.au/R/J/jonathan-richetti

Australia's National Science Agency