Integrating AI knowledge and skills in the curricula to prepare students for the workplace

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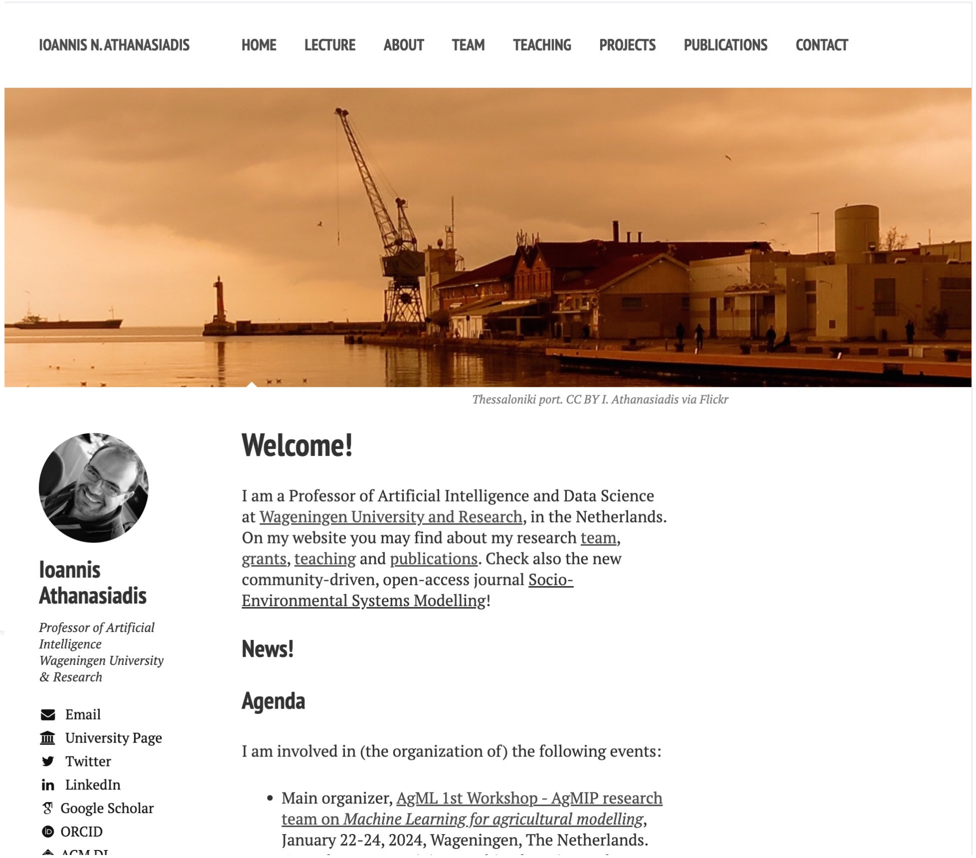
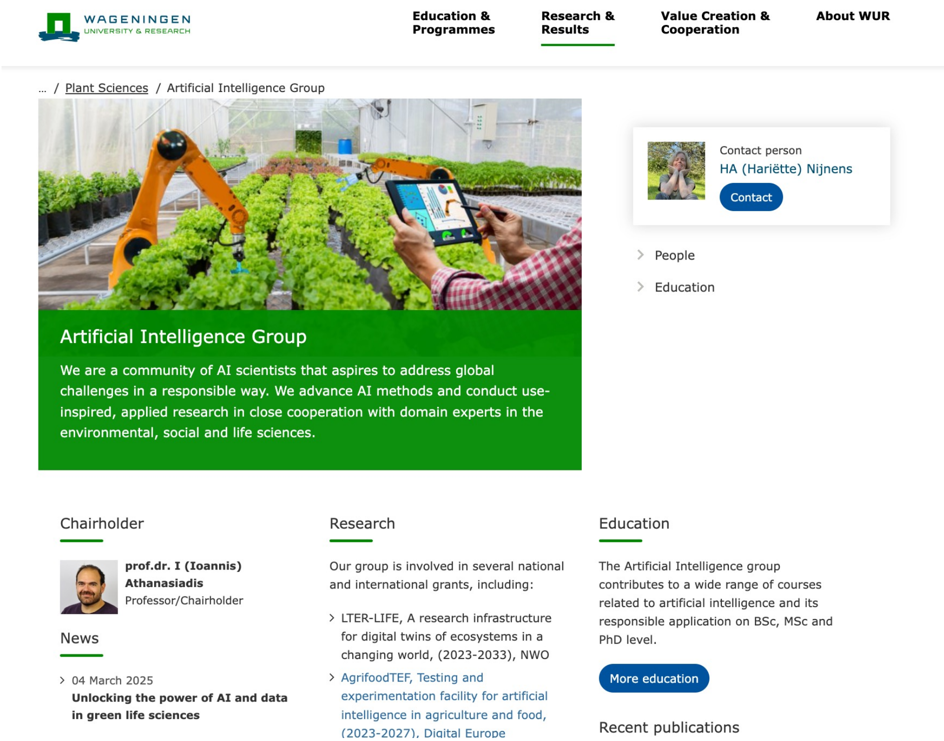
ICA-Edu Workshop 2025, Oct 8 2025

ICA Edu
Network for Innovation in Life Sciences Higher Education

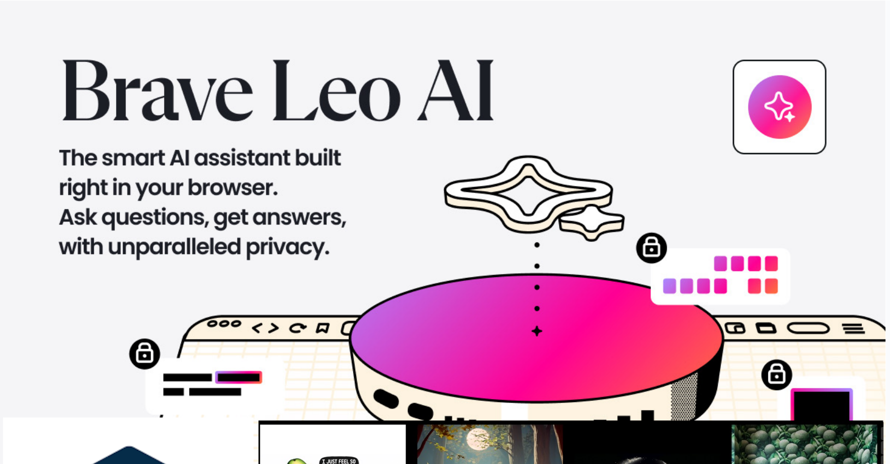
Few words about me

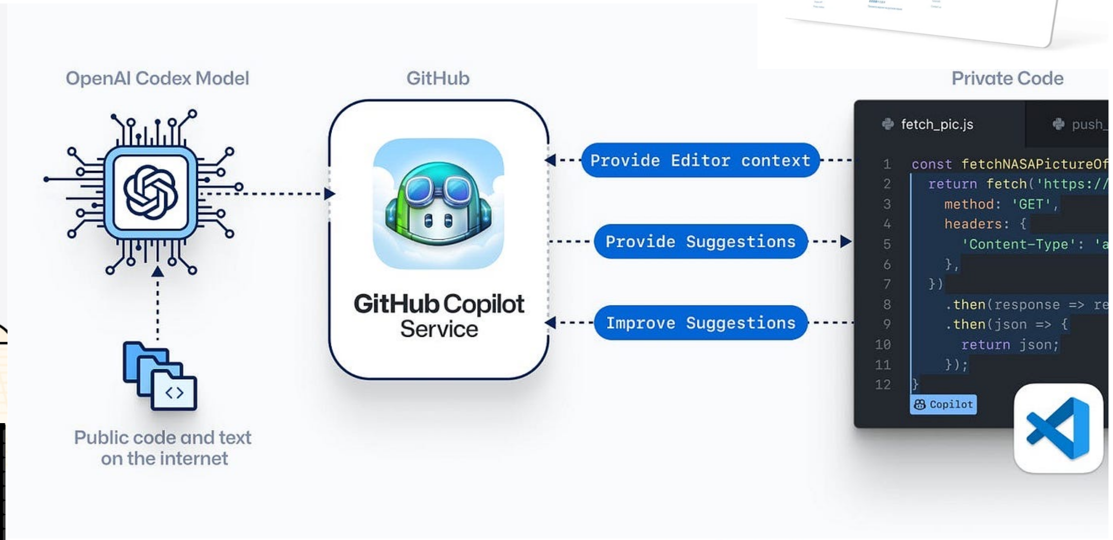
https://www.wur.ai



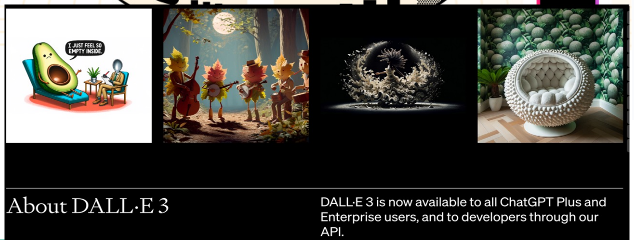


AI is everywhere!





DeepL

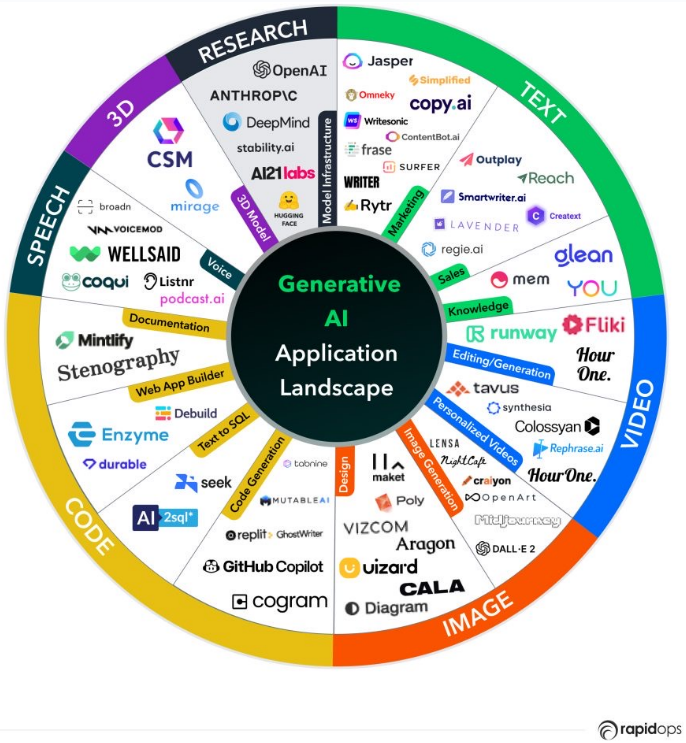


ChatGPT

Hey Siri

CHAT BOT

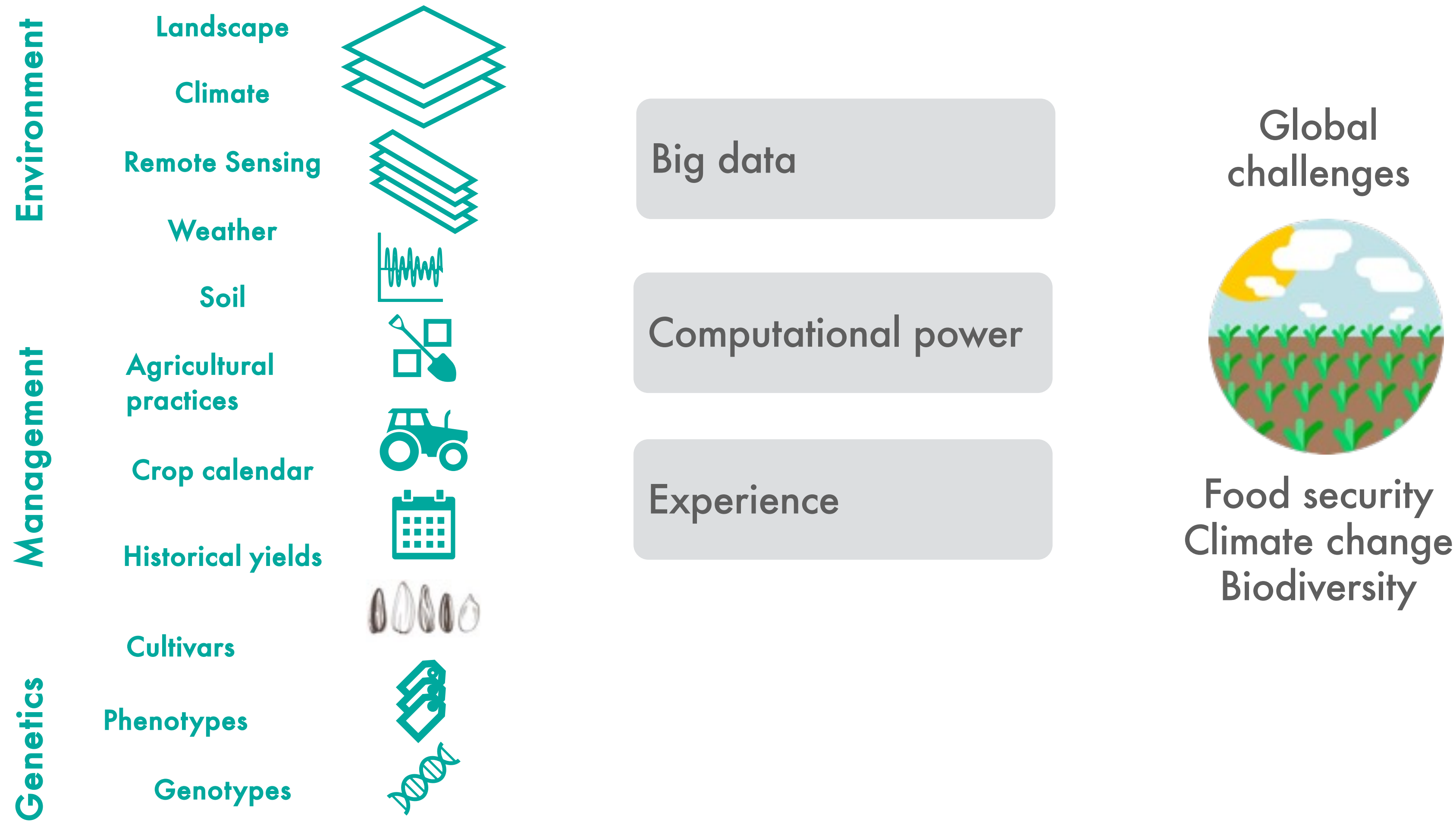
alexa



https://medium.com/@sayantan.george133/github-copilot-29ed8c29464

Data driven discoveries

AI for investigating nature and feeding the world



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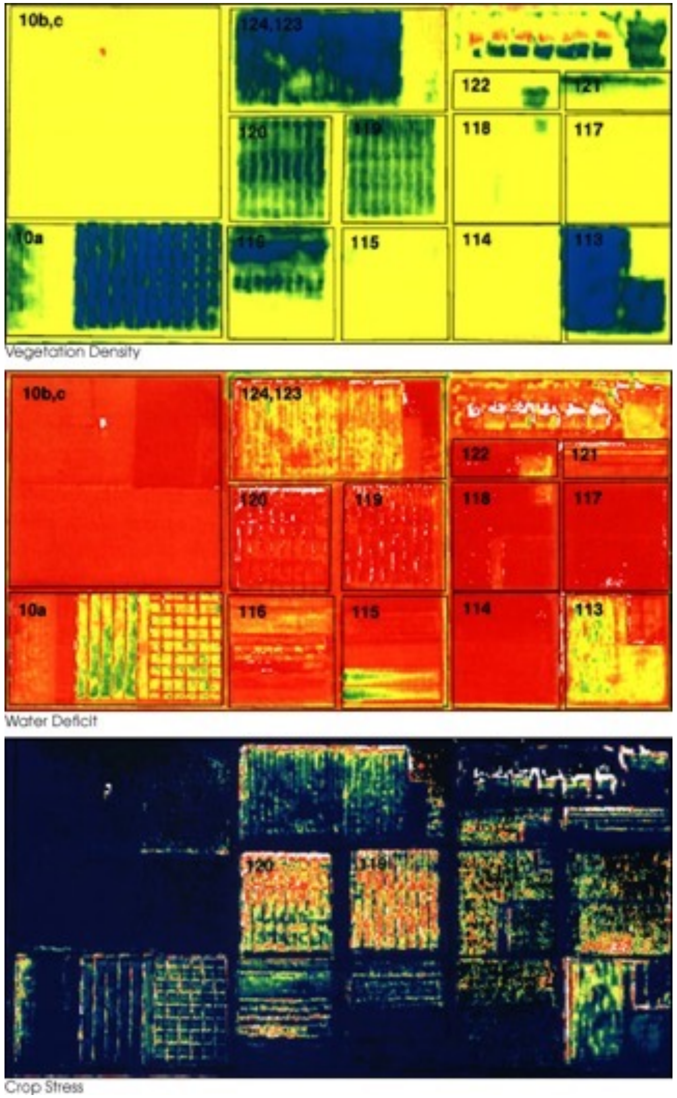
Systems thinking, systems doing. *Nature Food* **1**, 659–659 (2020)

Remote sensing for precision agriculture and livestock farming (2000)

Image-based remote sensing for detecting vegetation density, water deficit and crop stress

Photo Credits: Uthpal Kumar, PhD candidate, WUR.



Moran M. Susan. Image-Based Remote Sensing for Precision Crop Management: A Status Report. Space 2000 185–193 (2000)

Machine vision for plant phenotyping (2014)

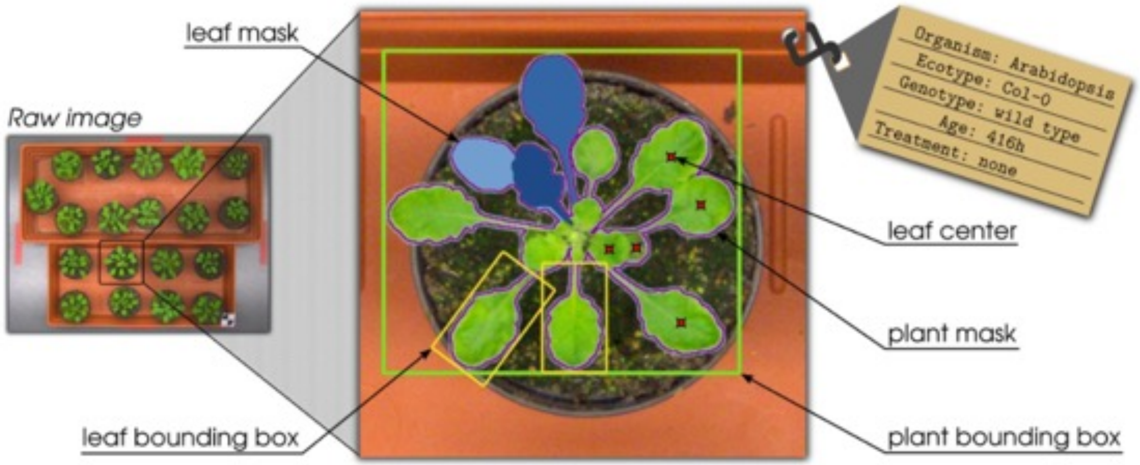
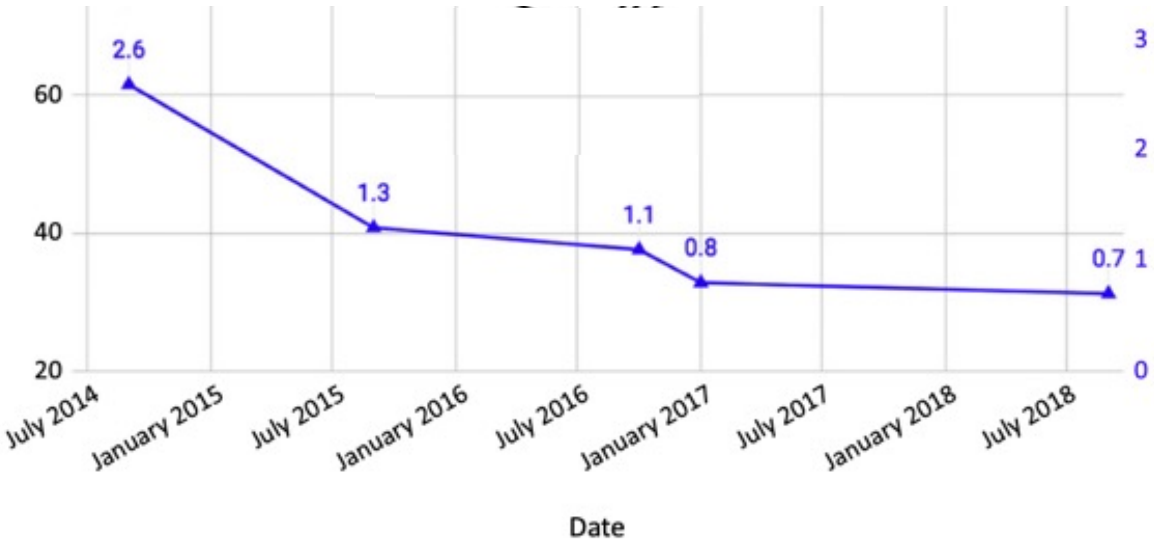


Photo Credit: NPEC, WUR.

Leaf counting error (lower is better)



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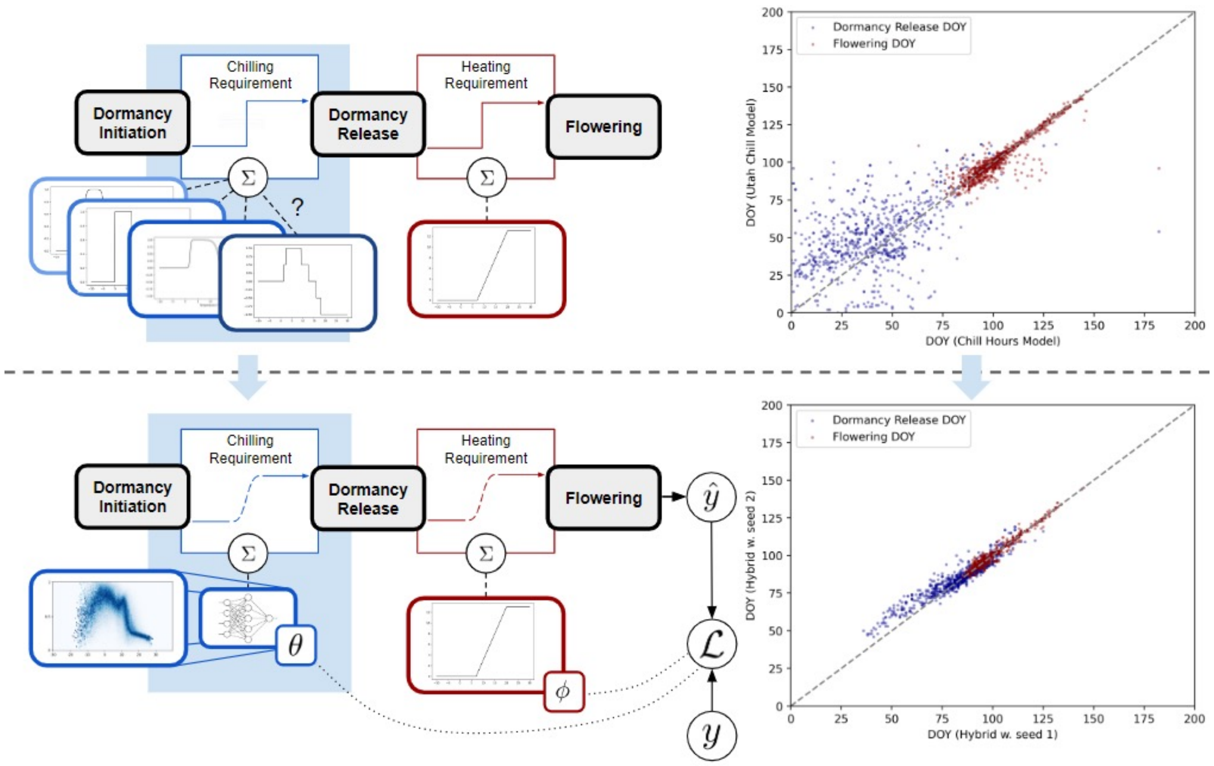
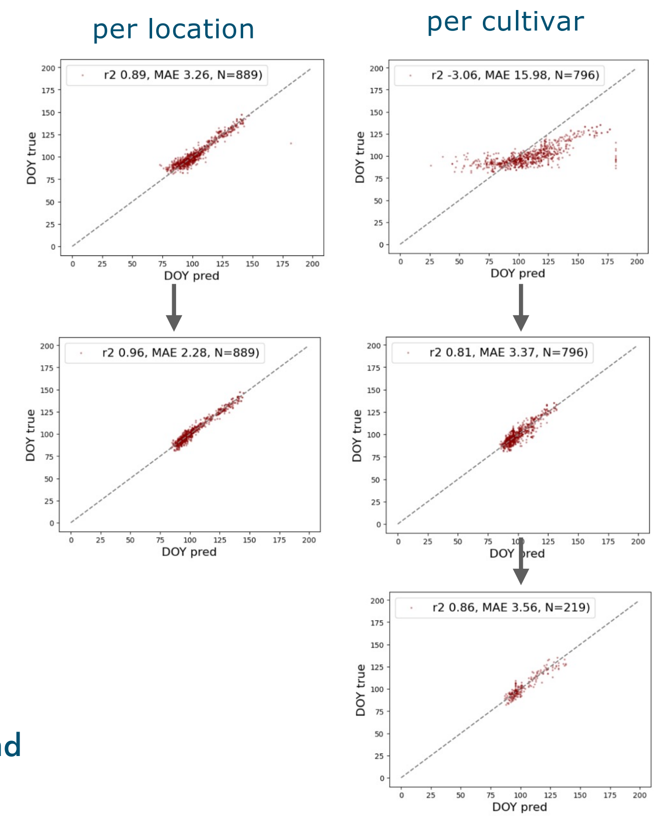
Tsaftaris, S. A. & Scharr, H. Sharing the Right Data Right:
A Symbiosis with Machine Learning.
Trends Plant Sci. 24, 99–102 (2019)

Hybrid ML improves phenology estimations

- Hybrid model mixes deep learning and PB components
- End-to-end training with gradient descent of both models





Evaluate on large dataset of 40 years of data in Japan, South Korea, Switzerland
Improves predictions compared to SOTA PBM both in time and in space

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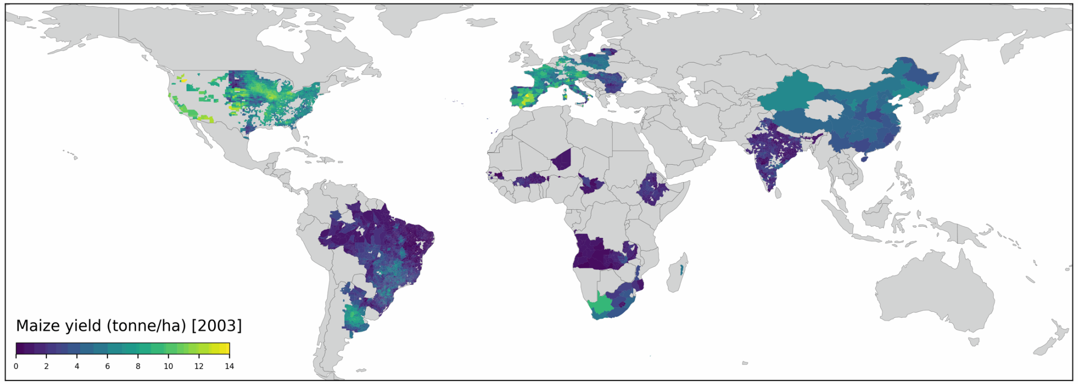
R. van Bree, D. Marcos, I. Athanasiadis, **Hybrid phenology modeling for predicting temperature effects on tree dormancy**, Proceedings of the AAAI Conference on Artificial Intelligence, 37:28458-28466, 2025, doi:10.1609/aaai.v39i27.35068.

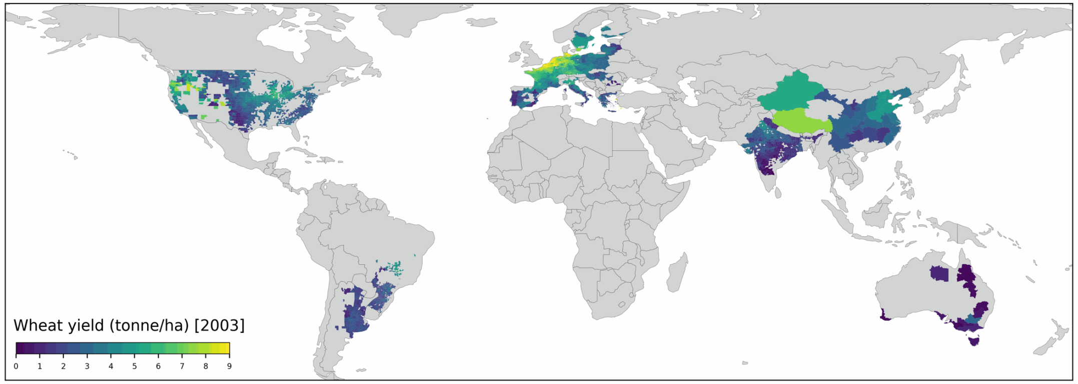
DOI 10.5281/zenodo.11502143

Join us at: cybench.agml.org

CY-Bench

Sub-national crop yield forecasting benchmark



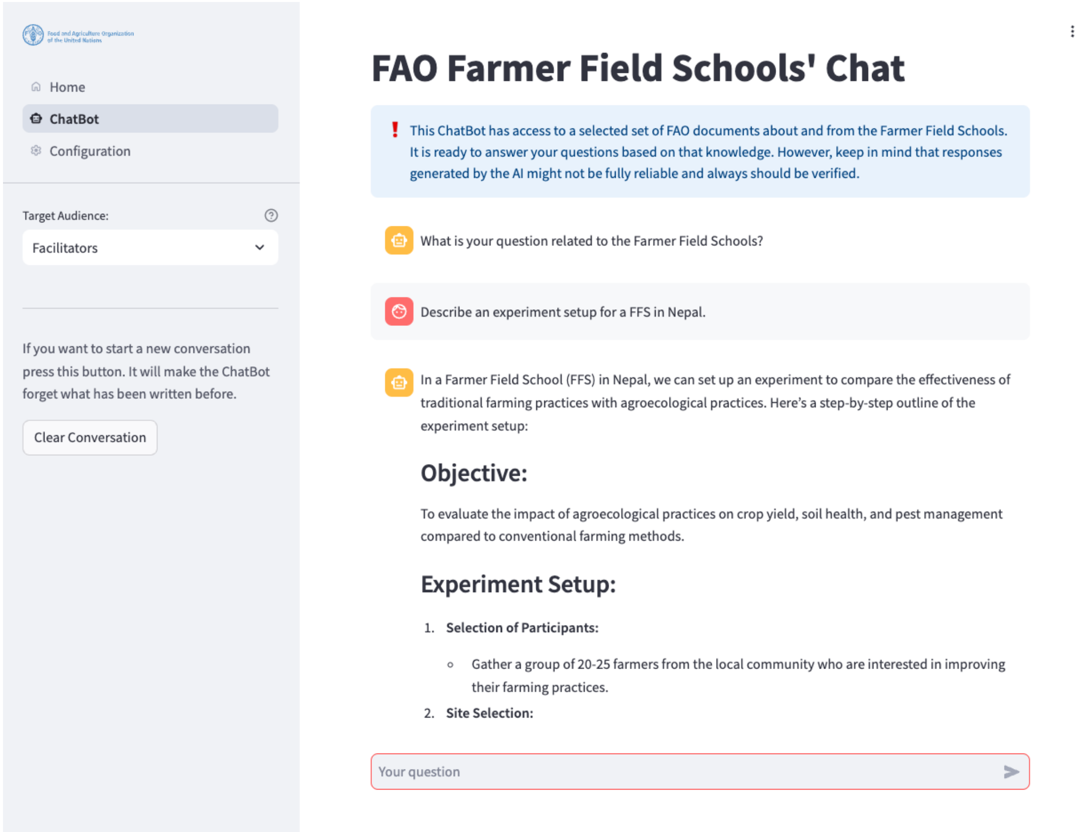


	Wheat			
country_name	Min Max Year	SUBNATIONAL ADMIN REGIONS	LABEL SIZE	LABELS TIMELINE 2003-2024
Argentina	2003-2024	238	4607	
Austria	2004-2020	9	133	
Australia	2003-2022	17	270	
Belgium	2004-2020	11	174	
Bulgaria	2010-2020	6	45	
Brazil	2003-2022	1015	18429	
China	2004-2022	25	475	
Czechia	2004-2020	14	238	
Germany	2004-2021	358	5888	
Denmark	2006-2020	10	150	
Estonia	2004-2020	5	85	
Greece	2003-2019	40	609	
Spain	2003-2020	43	536	
Finland	2004-2020	18	176	
France	2003-2020	91	1531	
Croatia	2008-2020	2	25	
Hungary	2004-2020	20	278	
Ireland	2010-2020	3	11	
India	2004-2017	474	6261	
Italy	2003-2020	83	1197	
Lithuania	2004-2020	10	169	
Latvia	2004-2018	5	75	
Netherlands	2004-2020	12	195	
Poland	2004-2020	17	284	
Portugal	2004-2020	4	68	
Romania	2004-2020	34	379	
Sweden	2004-2020	17	271	
Slovakia	2017-2018	5	10	
United States	2004-2023	1638	22834	

Protocol-based benchmarking
Intercompare ML models and predictor added value
Establish best practices

Farmer school chatbot

Together with FAO and WR we investigate the potential of AI
to transform agricultural extension and education: multi-lingual, interactive, trustworthy



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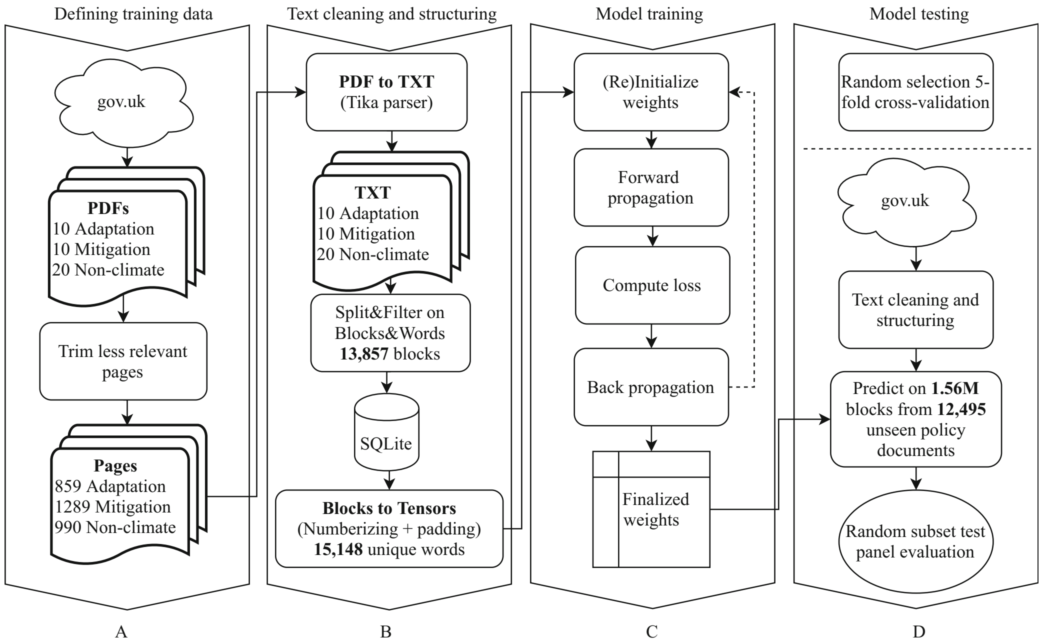
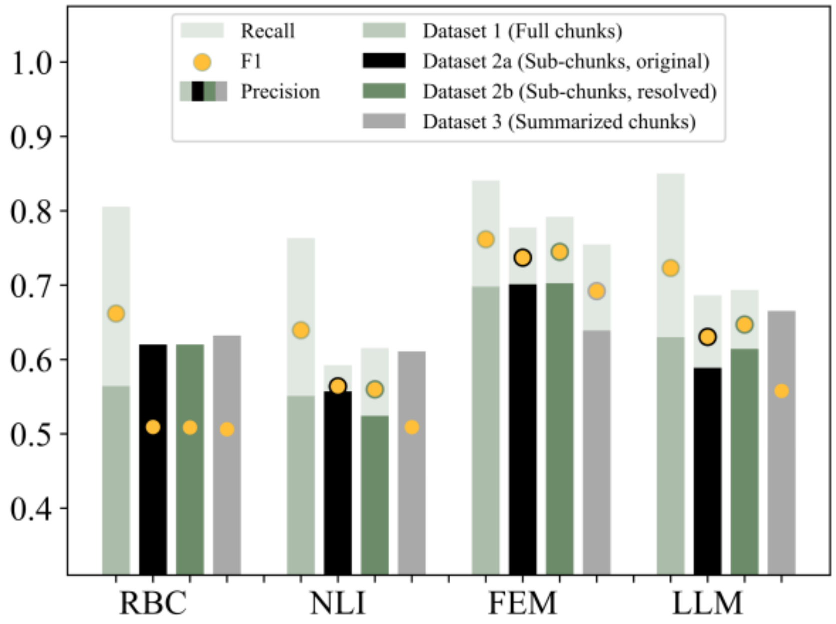
Janssen, Knapen

Tracking climate policy adaptation with Language AI

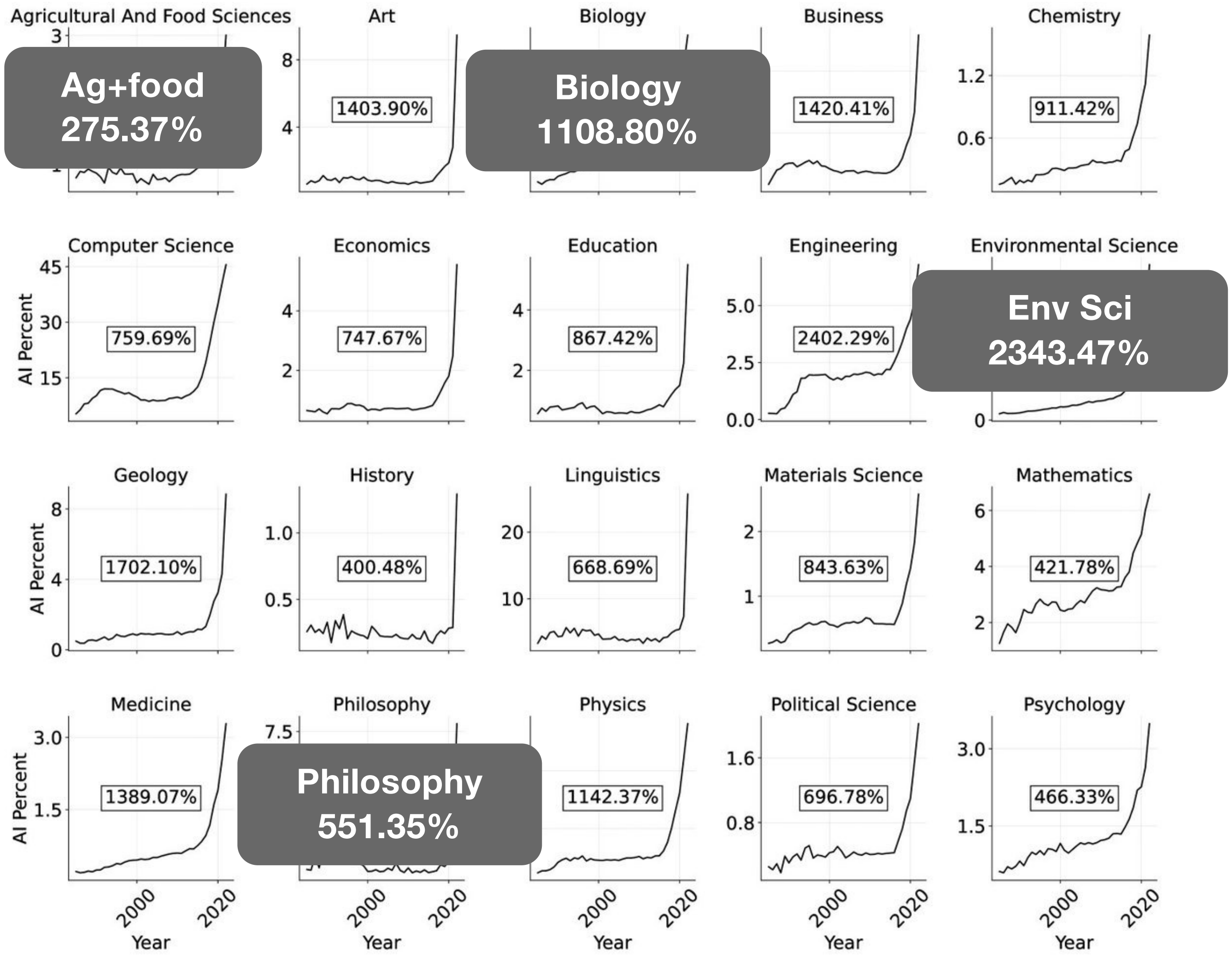




R. Biesbroek, S. Badloe, I. N. Athanasiadis, **Machine learning for research on climate change adaptation policy integration: an exploratory UK case study**, Regional Environmental Change, 20:85, 2020, doi:10.1007/s10113-020-01677-8.

J. Bonenkamp, R. Biesbroek, I. N. Athanasiadis, **Transforming adaptation tracking: benchmarking Transformer-based NLP approaches to retrieve adaptation-relevant information from climate policy text**, ACL ClimateNLP 2025, doi:10.18653/v1/2025.climatenlp-1.19

Diffusion of AI across scientific fields



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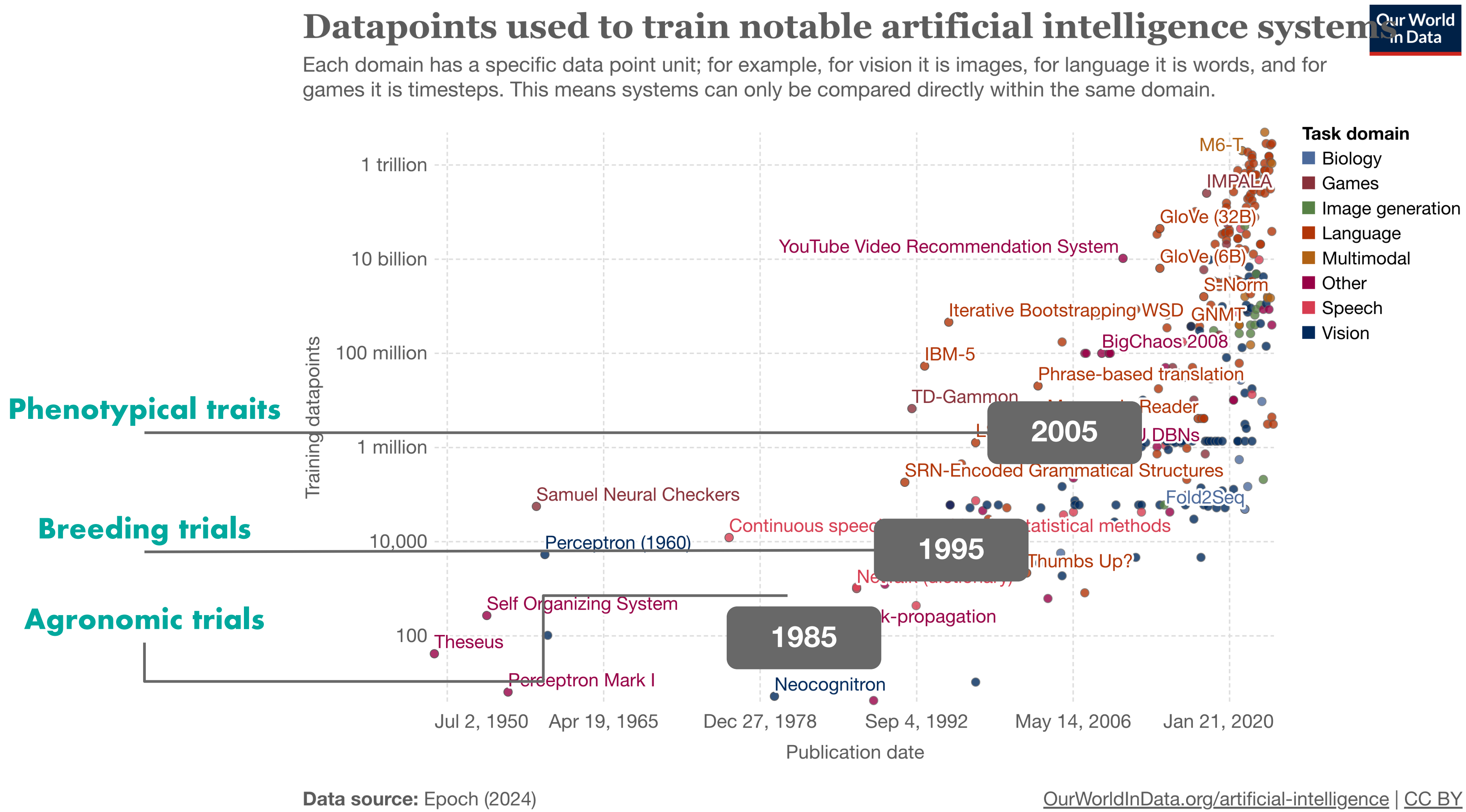
Duede, E., Dolan, W., Bauer, A., Foster, I., & Lakhani, K. (2024).
Oil & water? Diffusion of AI within and across scientific fields. http://arxiv.org/abs/2405.15828

Mind the (data) gap!



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Hallucinating anatomy

'Very handy hug' image generated by Midjourney v5 [alpha testing]

The Evolving Job Market Landscape

How we conduct research changes

Our jobs change

Demand for new skills across industries

AI talent gap

The Evolving Job Market Landscape

Industry Profile

Agriculture Forestry and Fishing

Jobs outlook

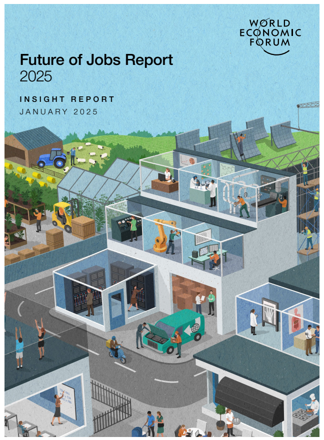
Key roles for business transformation

Roles most selected by organizations surveyed, ordered by net role growth, and their net growth and structural churn (percent)

Net growth: Job Growth | Job displacement | Net Growth | ▲ Global net growth

1. Net growth 2. Global net growth 3. Churn

	1.	2.	3.
AI and Machine Learning Specialists	42	82	42
Farmworkers, Labourers, and Other Agricultural Workers	20	17	31
General and Operations Managers	13	4	13
Assembly and Factory Workers	10	0	20
Accounting, Bookkeeping and Payroll Clerks	-14	-18	26
Administrative Assistants and Executive Secretaries	-19	-20	30



The Evolving Job Market Landscape

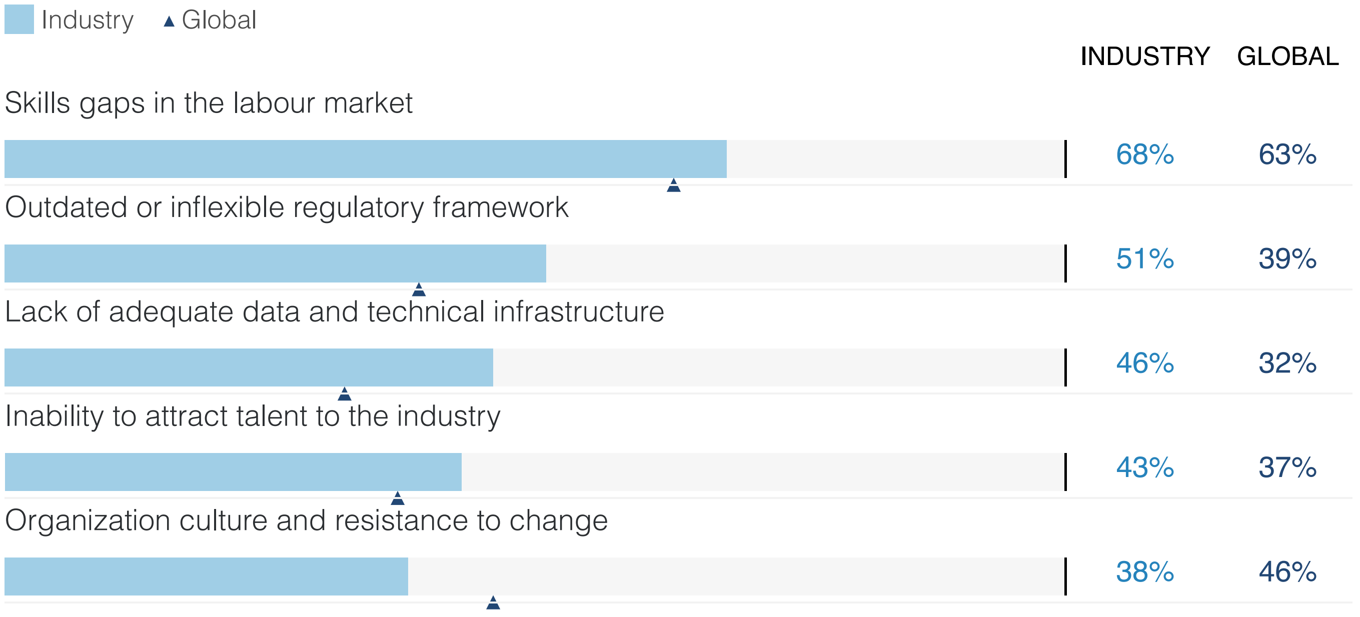
Industry Profile

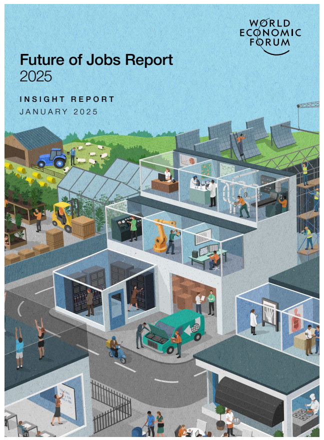
Agriculture Forestry and Fishing

Key barriers for business transformation

Transformation barriers

Share of organisations surveyed expecting the barriers will hinder their organisation transformation





Essential AI Knowledge for Students

- Foundational concepts:
  AI, machine learning, data, algorithms

- Relevant for all learners

- Critical Thinking and Problem Solving

- Problem-solving in AI-infused environments

How do we bring AI in the classroom?

Image from: http://tiki.oneworld.org/time_machine/images/timemachine.gif

How do we bring AI in the classroom?

- **Learning by doing**
  - Practice a lot, slow pace

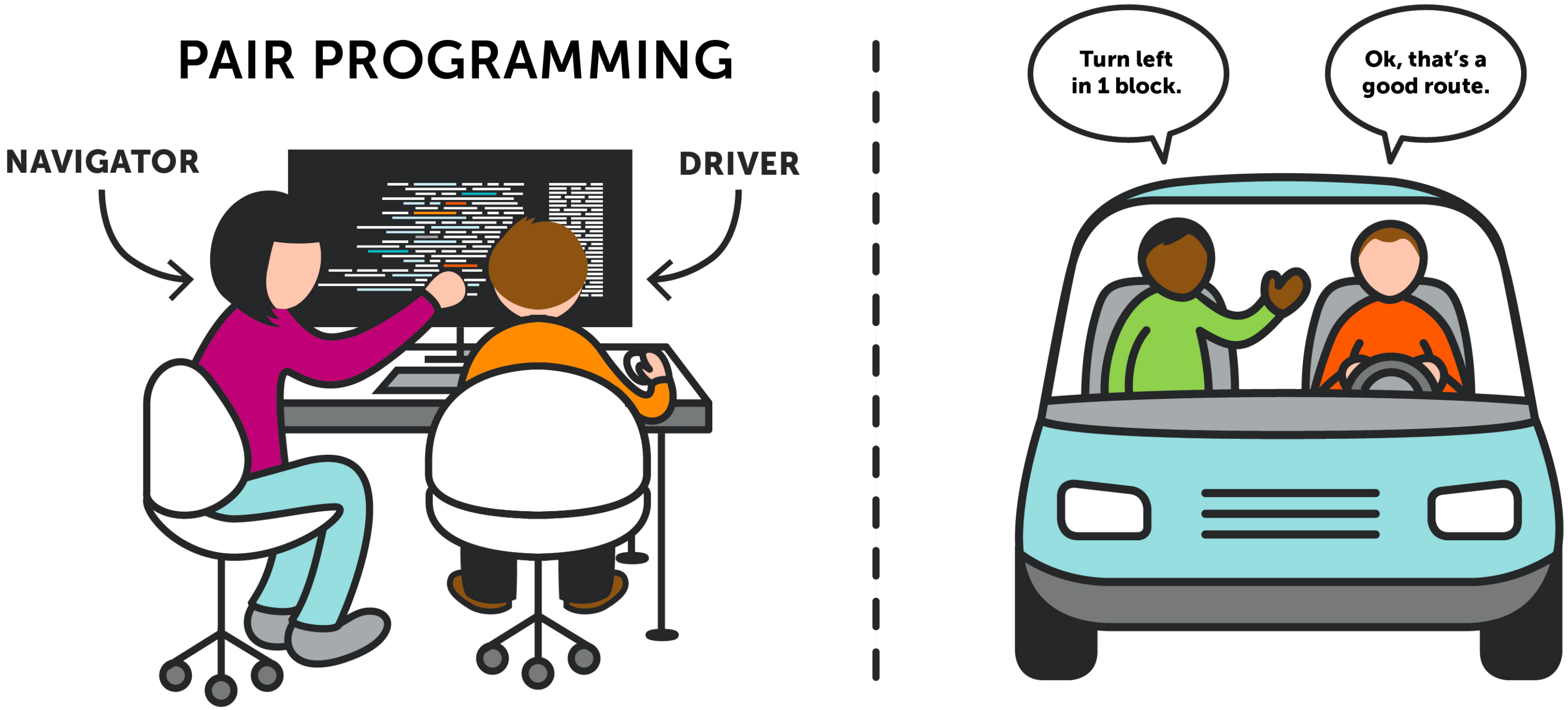
  - Interactive notebooks
  - Good infrastructure

  - Mix theory with practice

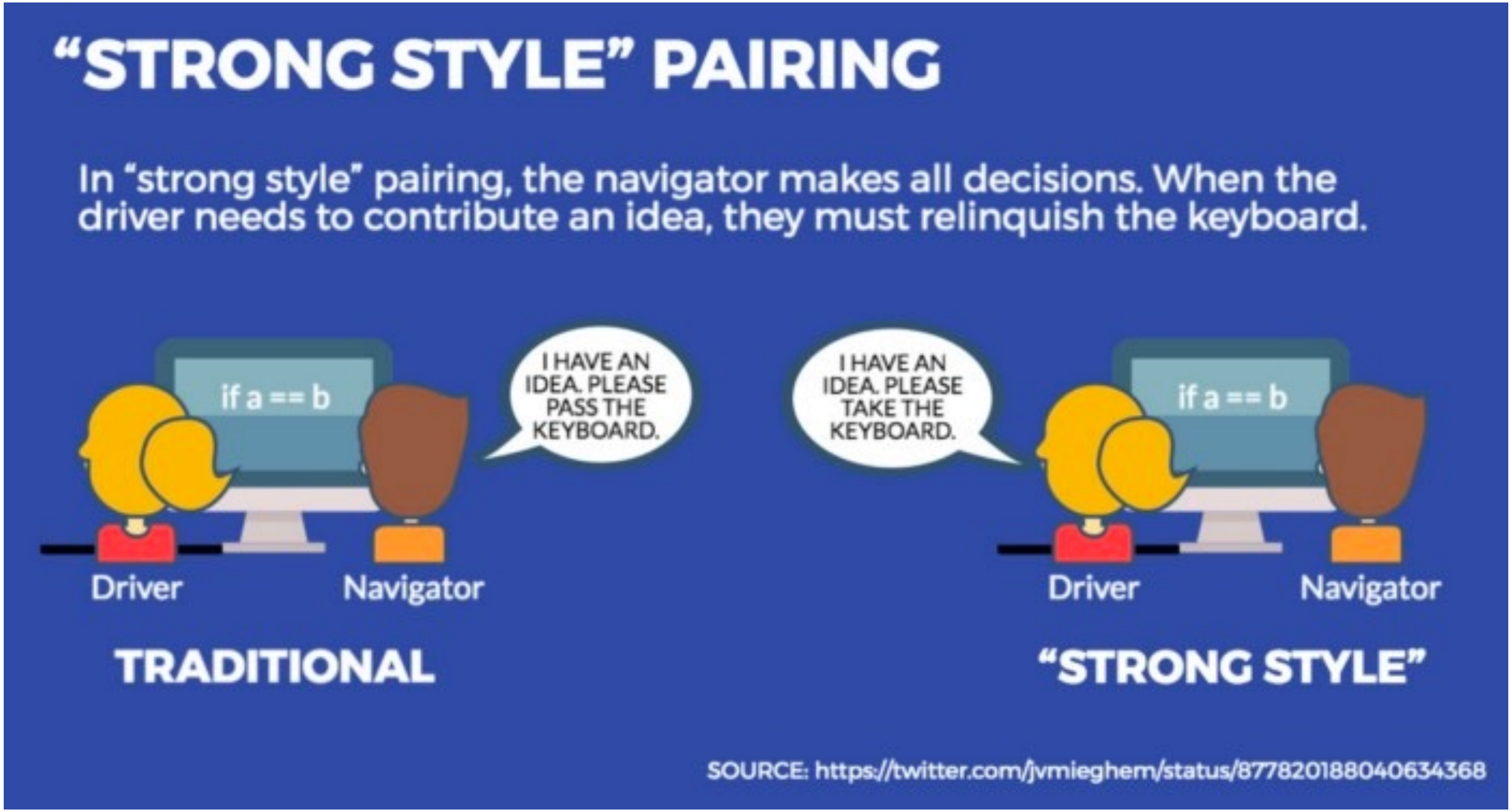
  - Understand the principles
  - Discussion exercises

We work in teams of two

Share notebooks, data, and documents



Make room for different student profiles



Converstations

Peer-feedback

Seat on a table with no people from your team

5 people max on each table

Each presents their work and ask for feedback

Tops and tips

Collaboration, Plagiarism, and the Difference Between the Two

Collaborating

- Collaborating is good.
- You are encouraged to collaborate on ideas and program design.
- Programming is often a social effort, and there is much you can learn by talking out the ideas in this class with each other.
- You can by all means talk to each other, look at each others' programs to help fix problems, and share ideas.

Plagiarism

- Plagiarism is bad. DON'T DO IT!
- Any programs that you turn in should be your work.
- Even if you work with someone else and share ideas, you must still write your own program.
- If a piece of your program utilizes someone else's idea, you must make sure to give that person credit in program comments.
- Do not hand a printout of your program to other students. I encourage you to work together to help debug your code, but you should do so sitting together

Adapted from D. Musicant's syllabus
https://www.cs.carleton.edu/faculty/dmusican/cs217w04/syllabus.html

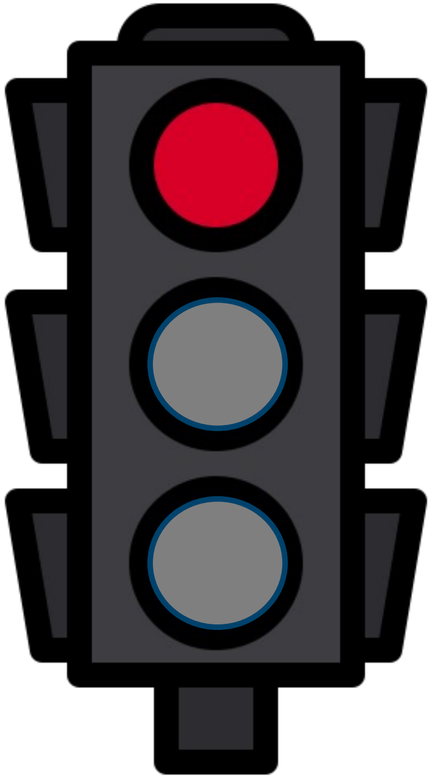
Collaboration, Plagiarism, and the Difference Between the Two

The following are examples of plagiarism:

- Taking someone else's program, changing comments and variable names, putting your name at the top, and turning it in.
- Finding a similar program on the Internet, changing the variables and comments around, putting your name at the top, and turning it in.
- Finding a similar program in a book, changing the variables and comments around, putting your name at the top, and turning it in.
- Generate a program with AI (i.e. using ChatGPT, co-pilot, and similar GenAI tools), changing the variables and comments around, putting your name at the top, and turning it in.

Adapted from D. Musicant's syllabus
https://www.cs.carleton.edu/faculty/dmusican/cs217w04/syllabus.html

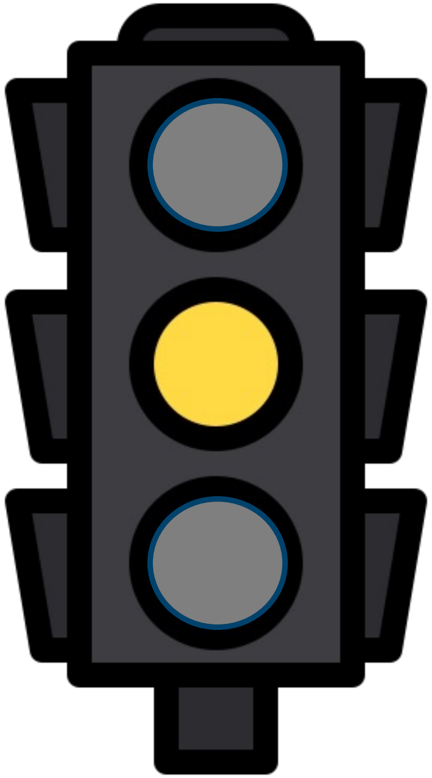
AI Traffic Light



Red – Minimal Allowance

- Students are explicitly forbidden to use generative AI tools in their work.
- Students may use generative AI tools only for brainstorming or ideation, but not for submitted work.

AI Traffic Light



Yellow – Restricted Use

- Students may use generative AI tools for assistance (e.g. grammar checking, paraphrasing), but must disclose usage and avoid content generation

- Students may use generative AI as a supplement or companion for writing or creating images with clear attribution, but human authorship must be primary by rewriting AI-generated text and code actively, and editing AI-generated images.

Version 1 2025/2026

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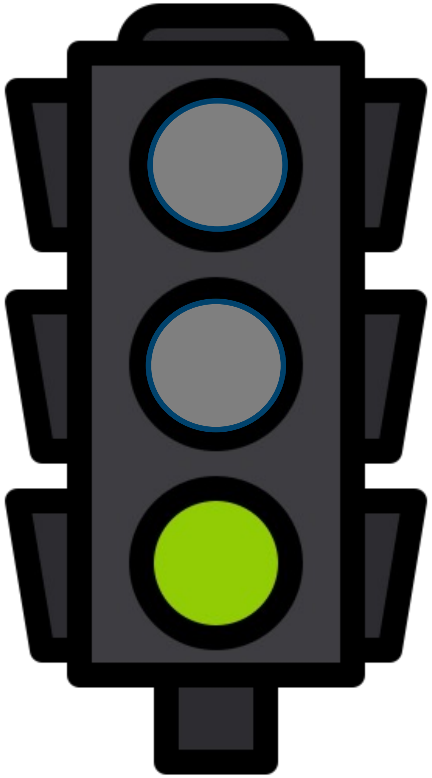
AI Traffic Light



Green – Extensive Use

- Students can use generative AI throughout their work, as long as they disclose usage and critically reflect on its contribution.

- Students are actively encouraged to use generative AI tools as part of learning outcomes and skill development with proper attribution.

Generative AI for programming in life sciences
an e-learning module

Learning goals:

1. Understand and explain what genAI is and how it works.

2. Recognise and explain ethical and privacy concerns related to genAI use.

3. Be able to write functional scripts using genAI (write, test, validate).

4. Be able to optimise scripts with genAI.

5. Apply strategies for responsible use of genAI in programming/learning how to program.

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H. Nijveen, V.M. Pham 2025

Generative AI for programming in life sciences an e-learning module

- An example exercise

write a python function to reverse complement DNA and test the code

Here's a Python function to reverse complement a DNA sequence, along with a simple test to ensure it works correctly.

Failed to generate

Here's the Python code directly:

python Copy code

```python
def reverse_complement(dna_sequence):
    """
    Returns the reverse complement of a DNA sequence.

    Args:
        dna_sequence (str): A string representing a DNA sequence (A, T, C, G).

    Returns:
        str: The reverse complement of the input DNA sequence.
    """
    complement = {
        'A': 'T',
        'T': 'A',
        'C': 'G',
        'G': 'C'
    }

    # Generate the complement and reverse the sequence
    try:
        reverse_complement_sequence = ''.join(complement[base] for base in reverse
    except KeyError:
        raise ValueError("Invalid DNA sequence: contains characters other than A, 
```

Running the test:

Save the code in a `.py` file or execute it in a Python interpreter. It will print "All test cases passed!" if everything works correctly.

run the test

The test results confirm that the `reverse_complement` function works as expected for all test cases:

1. Input: `"ATCG"` → Output: `"CGAT"` → Expected: `"CGAT"` → **Pass**
2. Input: `"GGCC"` → Output: `"GGCC"` → Expected: `"GGCC"` → **Pass**
3. Input: `"AATTCCGG"` → Output: `"CCGGAATT"` → Expected: `"CCGGAATT"` → **Pass**
4. Input: `""` → Output: `""` → Expected: `""` → **Pass**

All tests passed successfully! 🎉 [>_]

Threats to scientific software from overreliance on AI code assistants

- Vulnerability to Errors
- Scientific software is at increased risk of undetected errors
- Decline in Code Understanding
- Compromise reproducibility and scientific integrity
- Loss of Scientific Transparency:

G. O'Brien, Threats to scientific software from over-reliance on AI code assistants, Nature Compoutational Science, 2025, doi:10.1038/s43588-025-00845-2

AI in the classroom – some way forward

Effective Integration Strategies

- Project-based, hands-on learning
- Interdisciplinary collaboration
- Use of AI-driven tools for practice and feedback
- Practice responsible AI use
- Discuss ethical, legal, privacy aspects

Developing an AI-Infused Curriculum

- Align with learning goals and job market needs
- Scaffold progression: introduce concepts early and deepen later
- Infuse AI across subject areas
- Add a course on foundational concepts on AI for research (i.e. AI in Science and Engineering)

All students—not just future programmers—need exposure

Building capacity and infrastructre

- Training and resources for teachers
- Ongoing professional development

- Arrange access to infrastructure

- Ensuring inclusivity for all learners and teachers

Prepare for the future

- AI literacy does not come for "free"

- Lifelong learning is essential
- Encourage adaptability and upskilling
- Role of micro-credentials

Summary

- AI is changing the job market, creating new skill demands
- Foundational AI concepts as machine learning, data, and algorithms are essential for responsible use of AI
- AI-infused education involves project-based, hands-on learning, and interdisciplinary approaches
- Curriculum development should scaffold AI learning from early education through higher levels
- Building educator capacity and access to infrastructure is key to successful AI integration
- Real-world case studies show benefits and methods of AI curriculum integration

Thank you!

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