4 Artificial intelligence in experimental biology

What is artificial intelligence?

What Encyklopedia Brittanica says:

Artificial intelligence (AI)

the ability of a computer or computer-controlled robot to perform tasks commonly associated with intelligent beings - **learning, reasoning, problem solving, perception, and using language**.

> All but the simplest human behaviour is ascribed to intelligence, while even the most complicated insect behaviour is usually not taken as an indication of intelligence. What is the difference? Consider the behaviour of the digger wasp, *Sphex ichneumoneus*. When the female wasp returns to her burrow with food, she first deposits it on the threshold, checks for intruders inside her burrow, and only then, if the coast is clear, carries her food inside. The real nature of the wasp's instinctual behaviour is revealed if the food is moved a few inches away from the entrance to her burrow while she is inside: on emerging, she will repeat the whole procedure as often as the food is displaced. Intelligence—conspicuously absent in the case of *Sphex*—must include the ability to adapt to new circumstances.

4 Artificial intelligence in experimental biology

Methods and goals in AI - **top-down** versus **bottom-up** approach

What Encyklopedia Brittanica says:

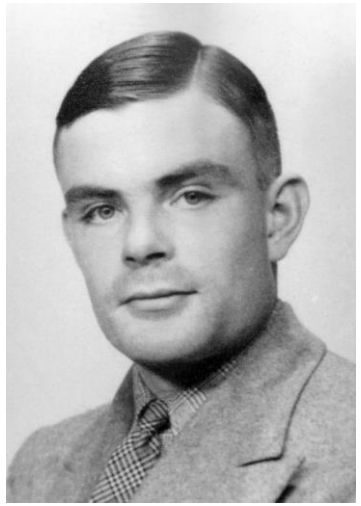
AI research follows two distinct, and to some extent competing, methods, the symbolic (or "top-down") approach, and the connectionist (or "bottom-up") approach. The top-down approach seeks to replicate intelligence by analyzing cognition independent of the biological structure of the brain, in terms of the processing of symbols—whence the *symbolic* label. The bottom-up approach, on the other hand, involves creating artificial neural networks in imitation of the brain's structure—whence the *connectionist* label.

To illustrate the difference between these approaches, consider the task of building a system, equipped with an optical scanner, that recognizes the letters of the alphabet. A bottom-up approach typically involves training an artificial neural network by presenting letters to it one by one, gradually improving performance by "tuning" the network. (Tuning adjusts the responsiveness of different neural pathways to different stimuli.) In contrast, a top-down approach typically involves writing a computer program that compares each letter with geometric descriptions. Simply put, neural activities are the basis of the bottom-up approach, while symbolic descriptions are the basis of the top-down approach.

4 Artificial intelligence in experimental biology

Who was the pioneer of artificial intelligence?

Alan Turing,
British mathematician and logician



Artificial intelligence pioneer

Turing was a founding father of artificial intelligence and of modern cognitive science, and he was a leading early exponent of the hypothesis that the human brain is in large part a digital computing machine. He theorized that the cortex at birth is an "unorganised machine" that through "training" becomes organized "into a universal machine or something like it." Turing proposed what subsequently became known as the Turing test as a criterion for whether an artificial computer is thinking (1950). In late 2022, the advent of ChatGPT reignited conversation about the likelihood that the components of the Turing test had been met.

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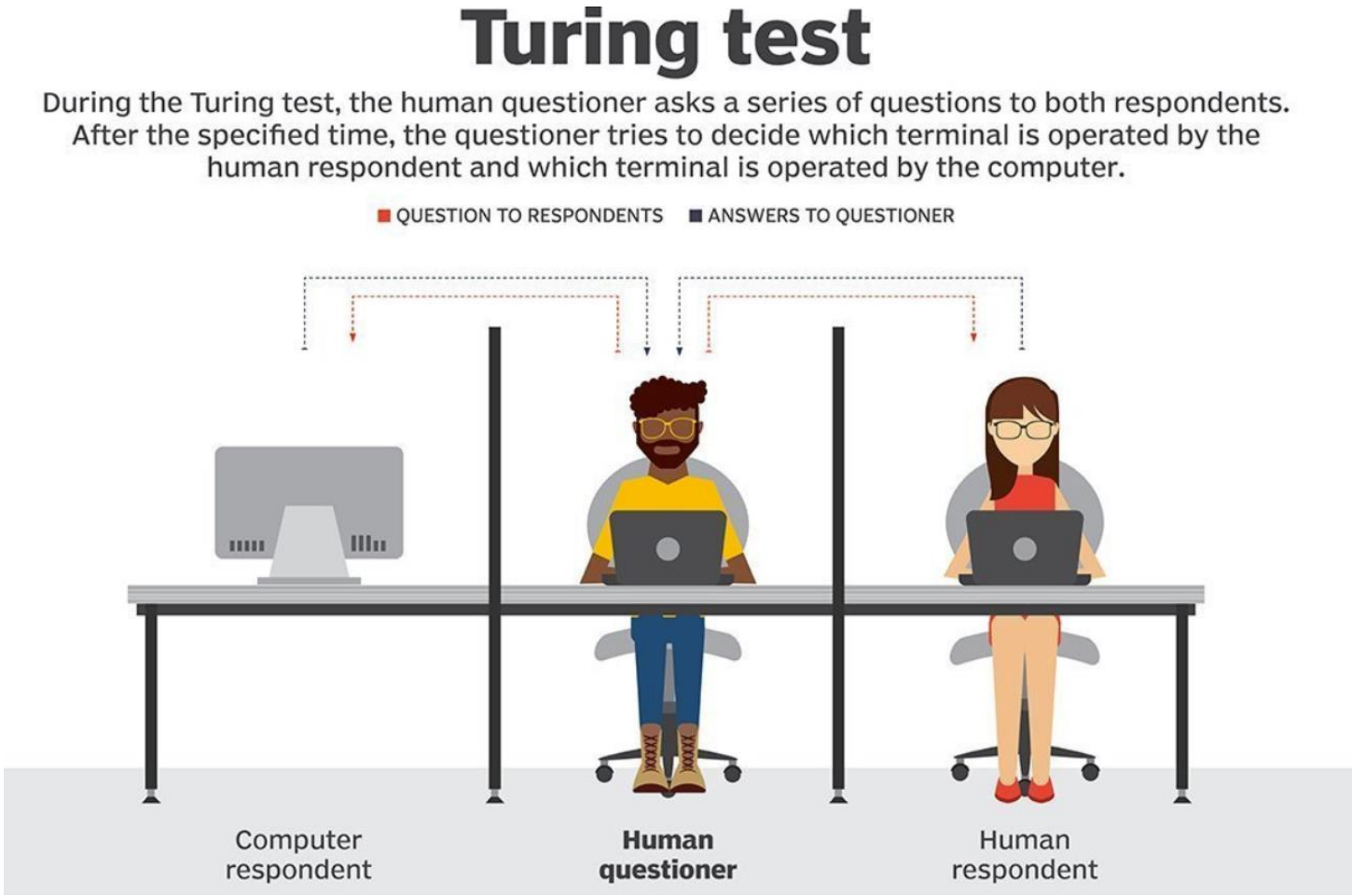
What is Turing test?

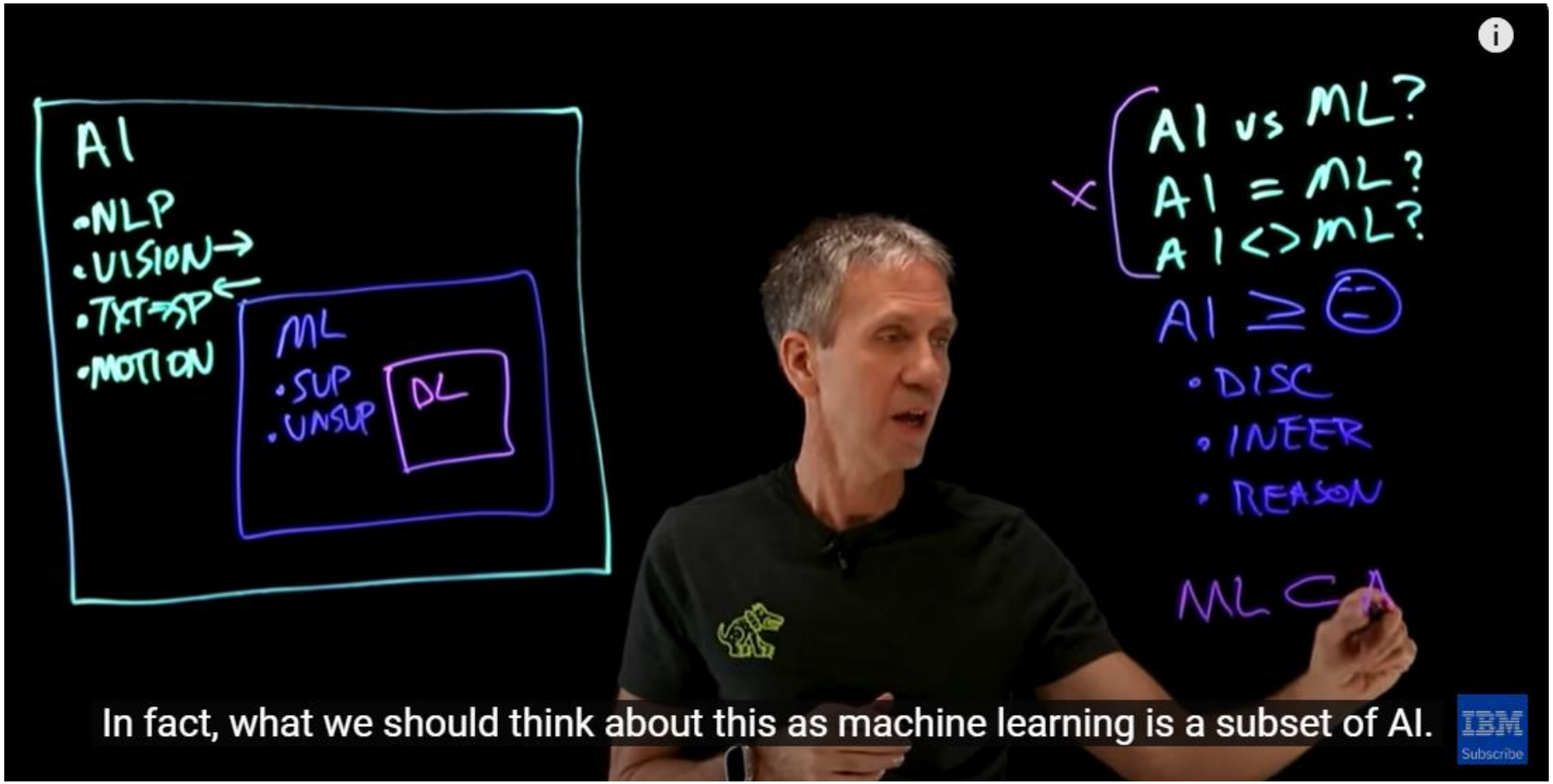
Method to determine whether a machine demonstrates human intelligence



[What is a Turing Test? A Brief History of the Turing Test and its Impact - YouTube]

4 Artificial intelligence in experimental biology

Machine learning, deep learning - subsets of AI relevant for experimental biology

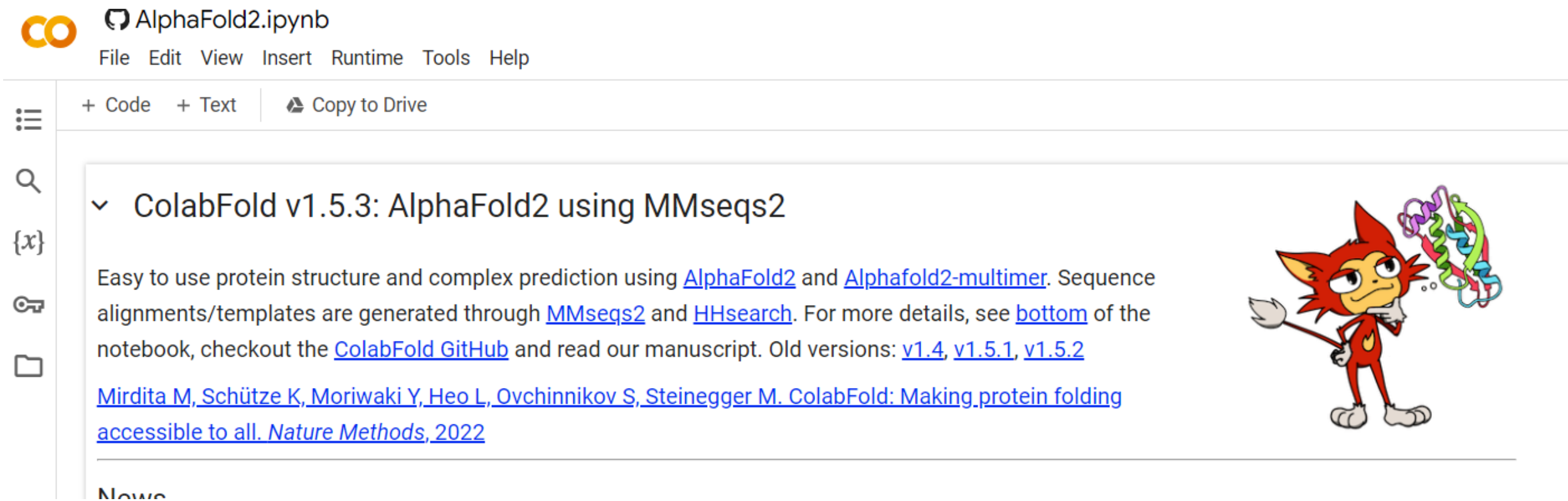


[AI vs Machine Learning - YouTube]

4.1 AI in the handling and processing of experimental data

For what we can use AI or ML in the lab?

Folding of proteins of prediction of new drugs



4.1 AI in the handling and processing of experimental data

For what we can use AI or ML in the lab?

Evaluation of the activity of promoters

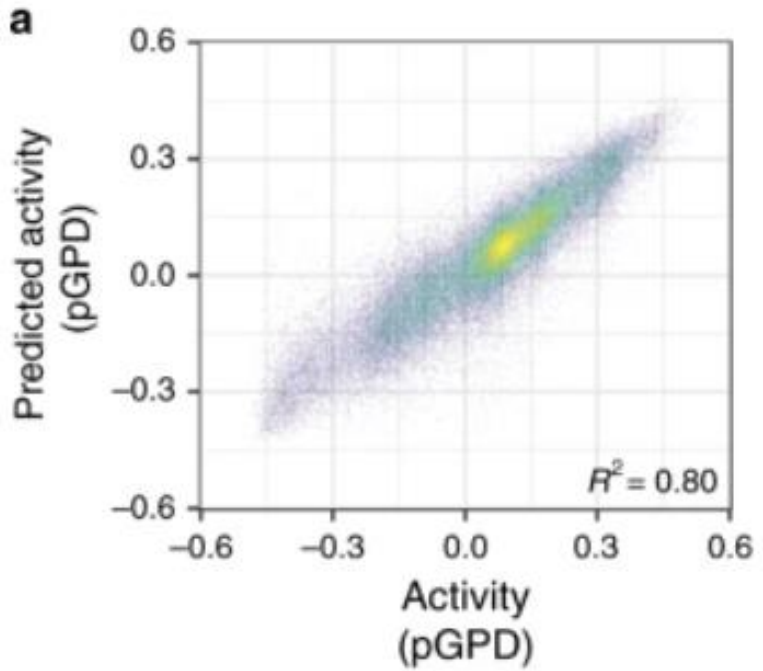
Article | Open access | Published: 30 April 2020

Model-driven generation of artificial yeast promoters

Benjamin J. Kotopka & Christina D. Smolke

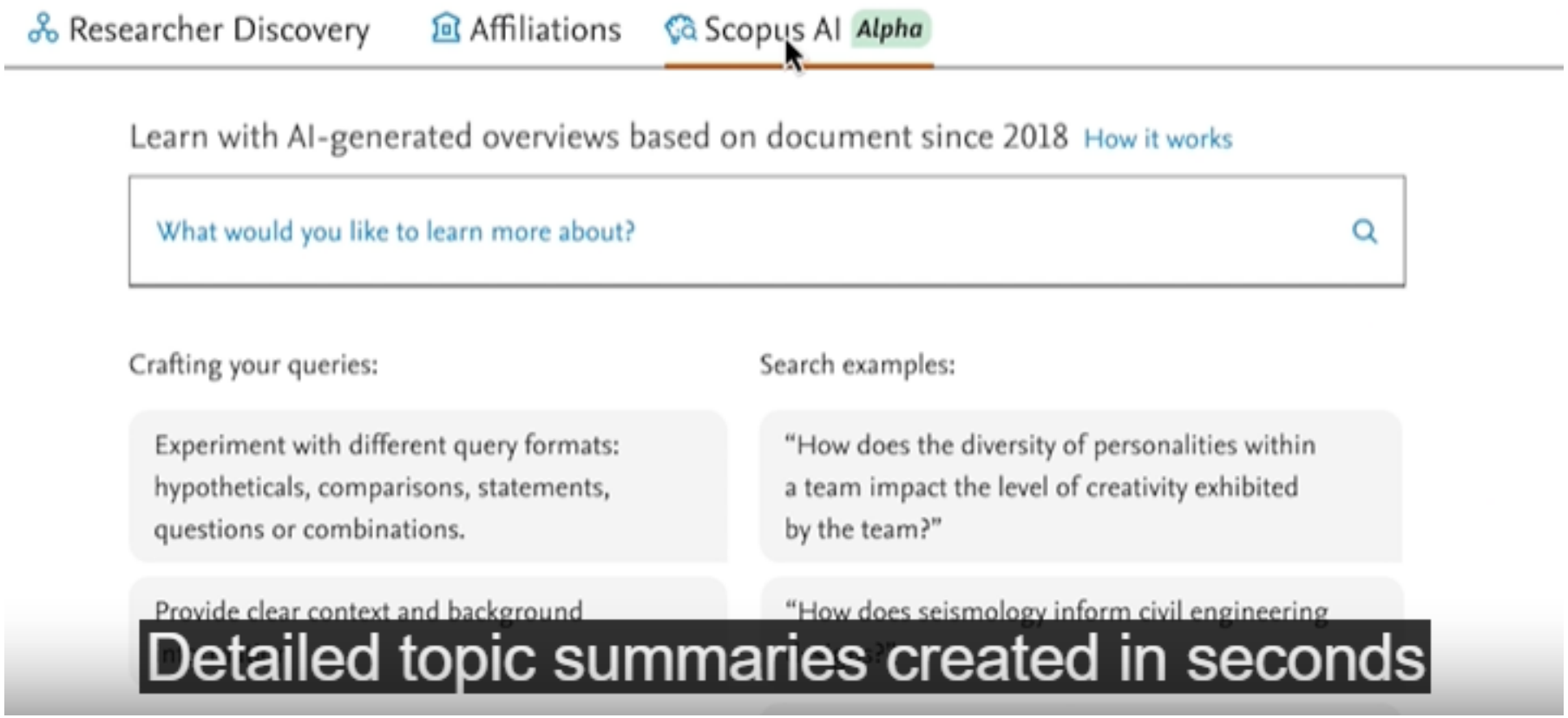
Nature Communications **11**, Article number: 2113 (2020) | Cite this article

efforts in this model organism. We measure the gene expression activity of over 675,000 sequences in a constitutive promoter library and over 327,000 sequences in an inducible promoter library. Training an ensemble of convolutional neural networks jointly on the two data sets enables very high ($R^2 > 0.79$) predictive accuracies on multiple sequence-activity prediction tasks. We describe model-guided design strategies that yield large, sequence-diverse sets of promoters exhibiting activities higher than those represented in training data and similar to current best-in-class sequences. Our results show the value of model-guided design as an approach for generating useful DNA parts.



4.2 AI in the bibliography search and scientific writing

Bibliographic databases freshly release their AI assistants



[Scopus AI: Change the way you view knowledge (elsevier.com)]

4.2 AI in the bibliography search and scientific writing

AI-assisted scientific bibliography search and writing

Generative pre-trained transformers

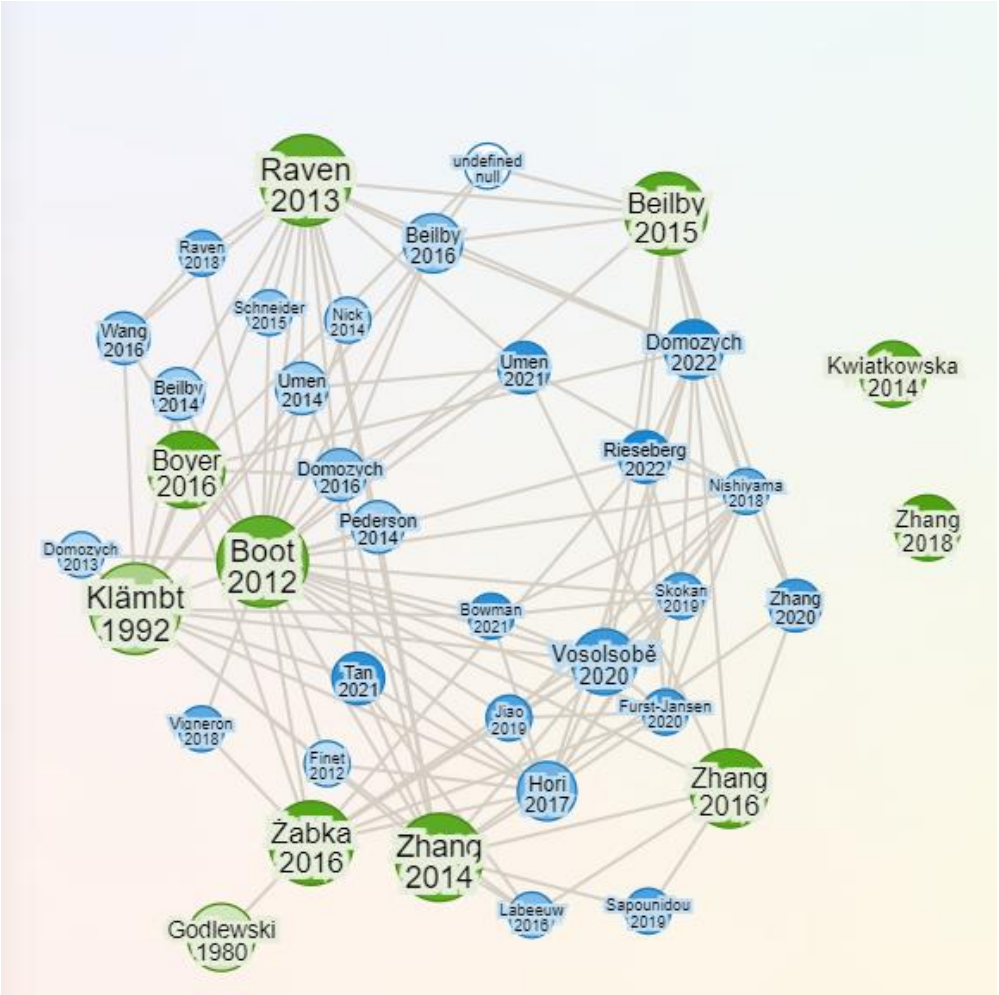
What is GPT? Everything you need to know | Zapier

4.2 AI in the bibliography search and scientific writing

A new era of literature research

www.researchrabbit.ai

https://www.youtube.com/watch?v=W1W51rYJA3I&ab_channel=ResearchRabbit



4.2 AI in the bibliography search and scientific writing

A new era of literature research

Scite

- Paid, but there is 7-day free trial
- Finding supporting or disputing evidence among your citations
- How was something cited?
- Answering your question by real articles

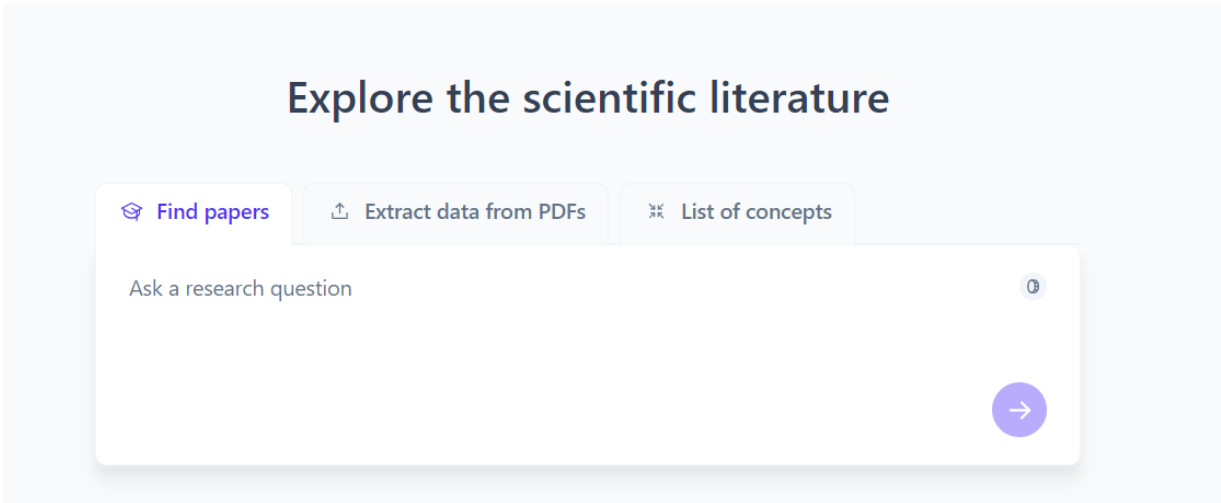
https://www.youtube.com/watch?v=RAPq3FnXp7k&list=PLHn2nrhhPBltNk12i0dIBGGRGSM-TpG5a&ab_channel=scite

4.2 AI in the bibliography search and scientific writing

A new era of literature research

Elicit

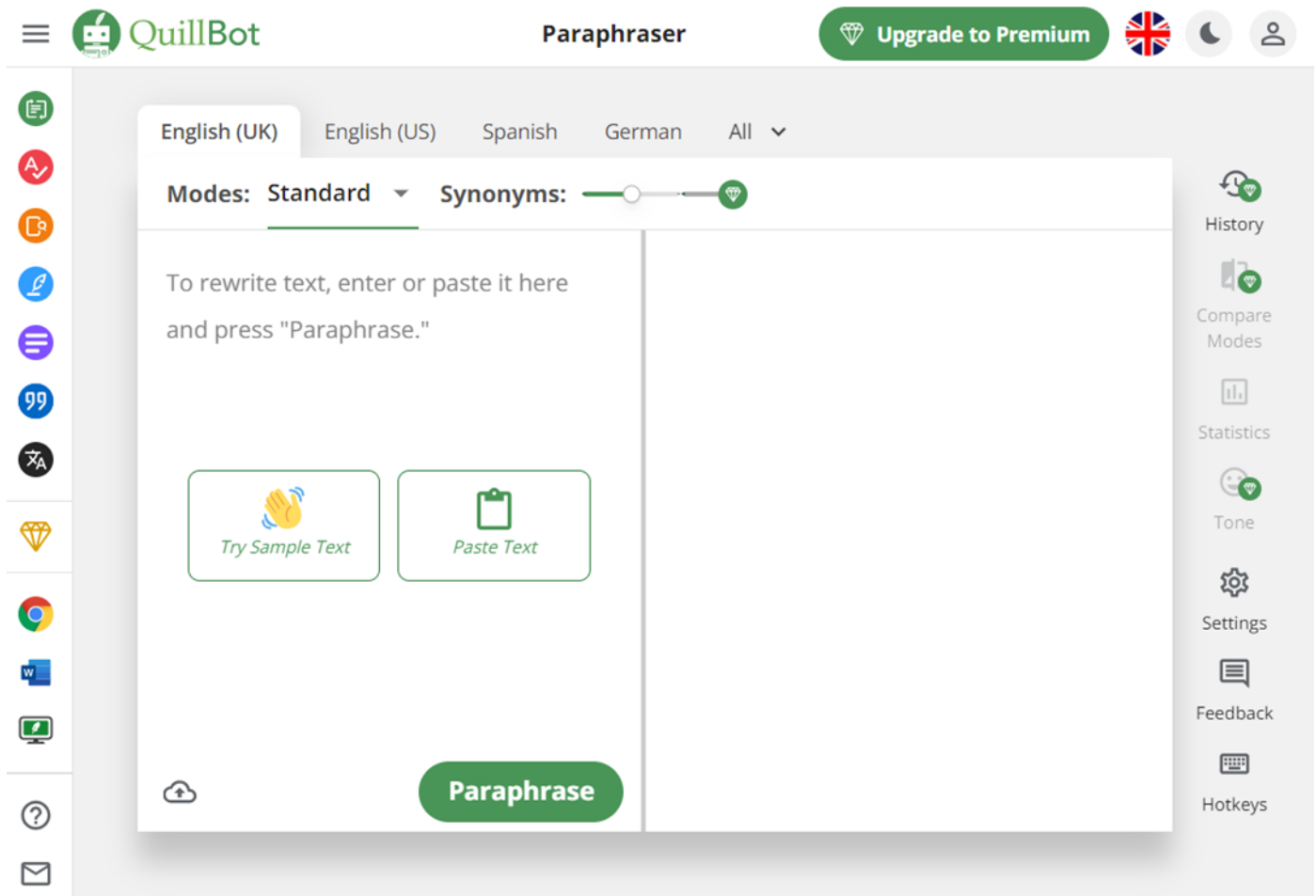
- Ask a research questions
- Getting answers in a form of research papers
- There is a free version to explore what Elicit has to offer
- Limited “credits”



4.2 AI in the bibliography search and scientific writing

Paraphrasing tool

- Sometimes coming up with synonyms and new words can be difficult
- In that case paraphrasing tools can be useful
- But one should be careful not to just copy what AI tool suggested and carefully examine if the meaning has not been largely changed



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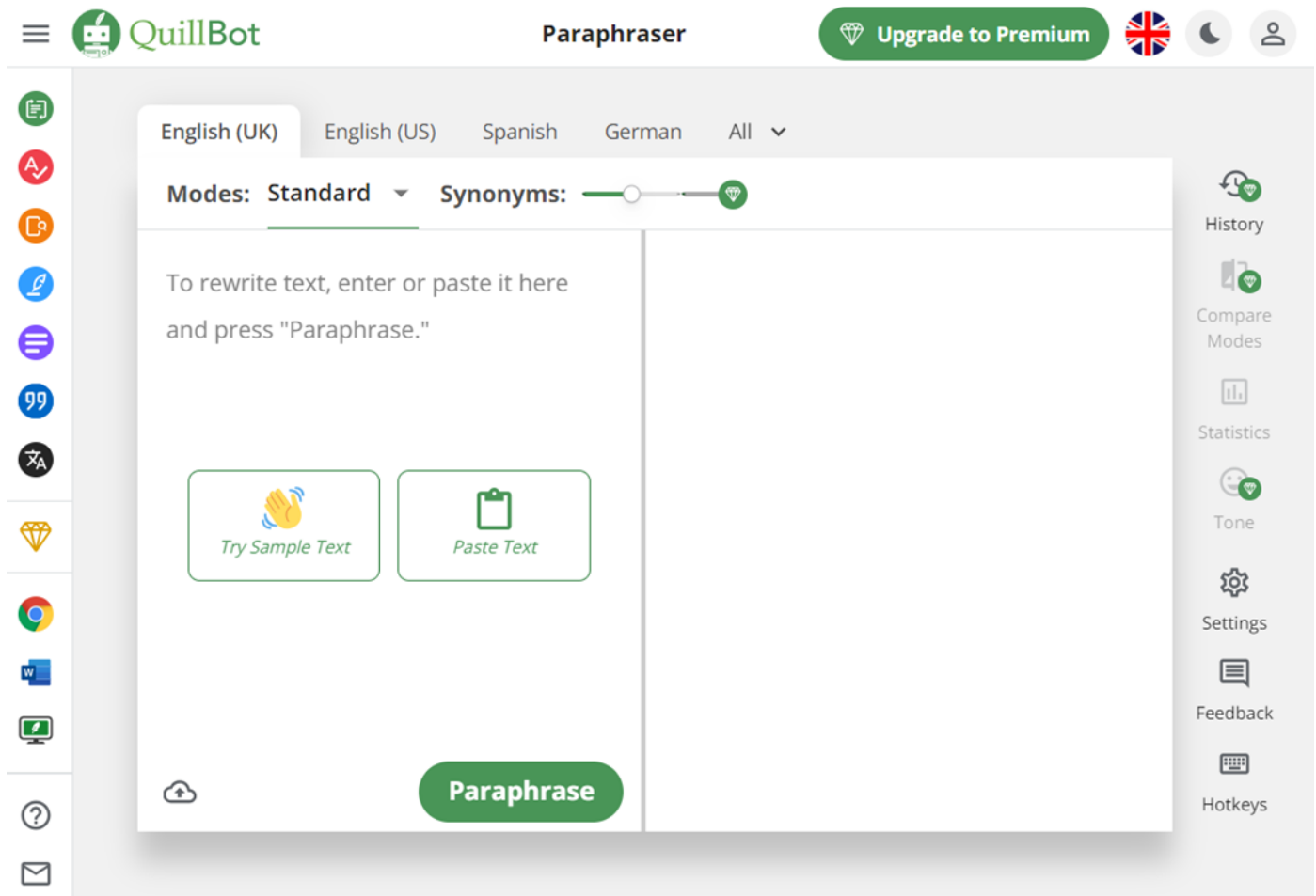

4.2 AI in the bibliography search and scientific writing

And what about the ethics of AI-assisted writing?