

4 Artificial intelligence in experimental biology

What is artificial intelligence?

What [Encyklopedia Britannica](#) 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.

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

What [Encyklopedia Britannica](#) 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.

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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.

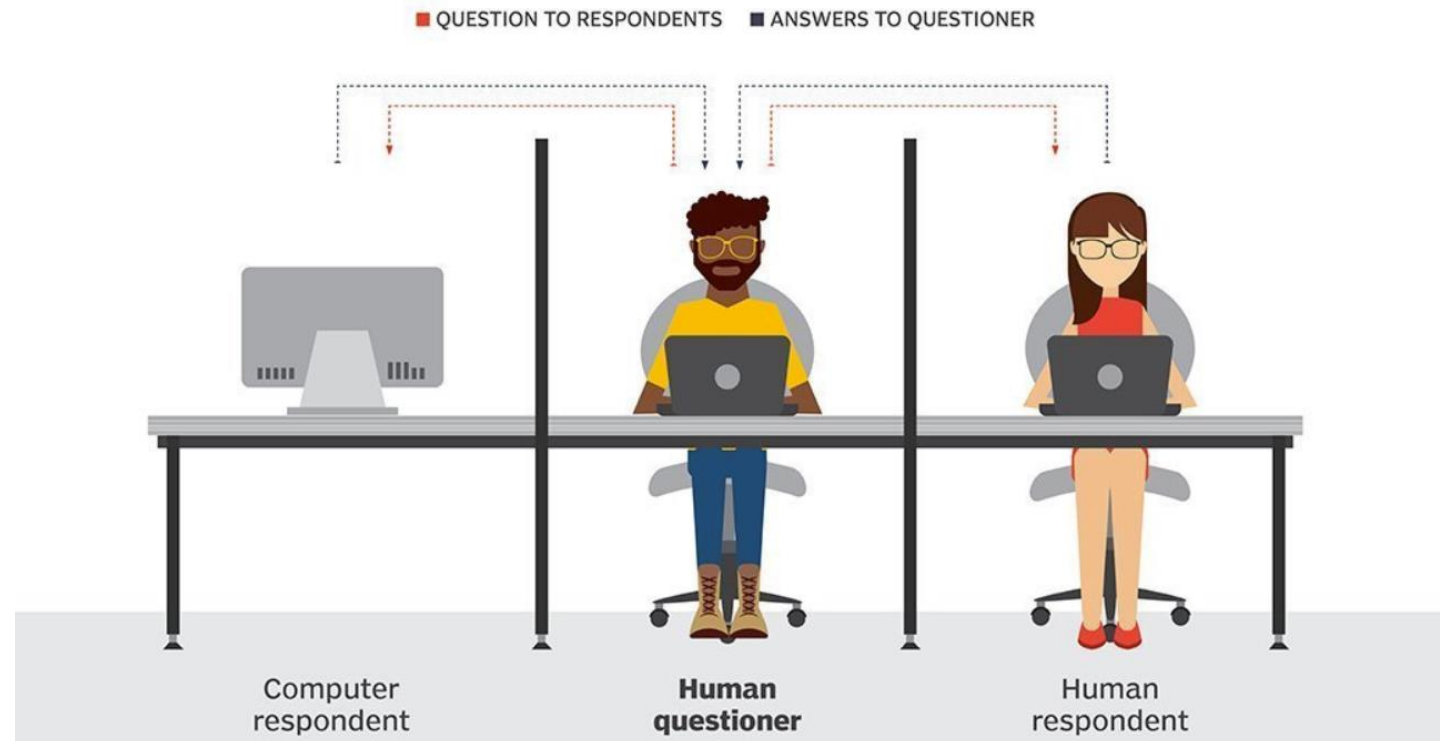
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What is Turing test?

Method to determine whether a machine demonstrates human intelligence

Turing test

During the Turing test, the human questioner asks a series of questions to both respondents.
After the specified time, the questioner tries to decide which terminal is operated by the human respondent and which terminal is operated by the computer.



[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

- NLP
- VISION →
- TXT → SP ←
- MOTION

ML

- SUP
- UNSUP

DL

AI vs ML?

AI = ML?

AI <> ML?

AI ≥ ☹️

- DISC
- INFER
- REASON

ML CA

In fact, what we should think about this as machine learning is a subset of AI.

IBM
Subscribe

[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



AlphaFold2.ipynb

File Edit View Insert Runtime Tools Help

+ Code + Text Copy to Drive

ColabFold v1.5.3: AlphaFold2 using MMseqs2

Easy to use protein structure and complex prediction using [AlphaFold2](#) and [Alphafold2-multimer](#). Sequence alignments/templates are generated through [MMseqs2](#) and [HHsearch](#). For more details, see [bottom](#) of the notebook, checkout the [ColabFold GitHub](#) and read our manuscript. Old versions: [v1.4](#), [v1.5.1](#), [v1.5.2](#)

[Mirdita M, Schütze K, Moriwaki Y, Heo L, Ovchinnikov S, Steinegger M. ColabFold: Making protein folding accessible to all. Nature Methods, 2022](#)



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

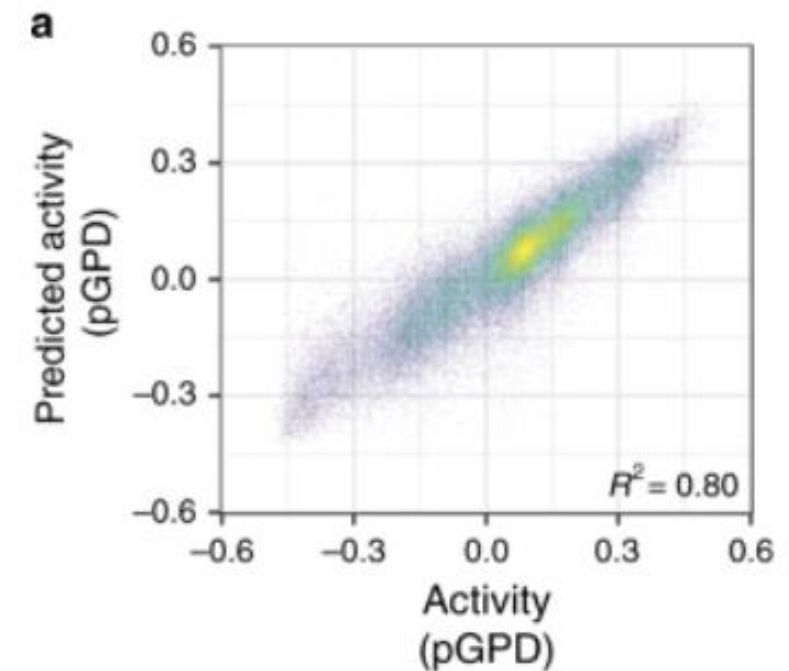
Article | [Open access](#) | [Published: 30 April 2020](#)

Model-driven generation of artificial yeast promoters

[Benjamin J. Kotopka](#) & [Christina D. Smolke](#) 

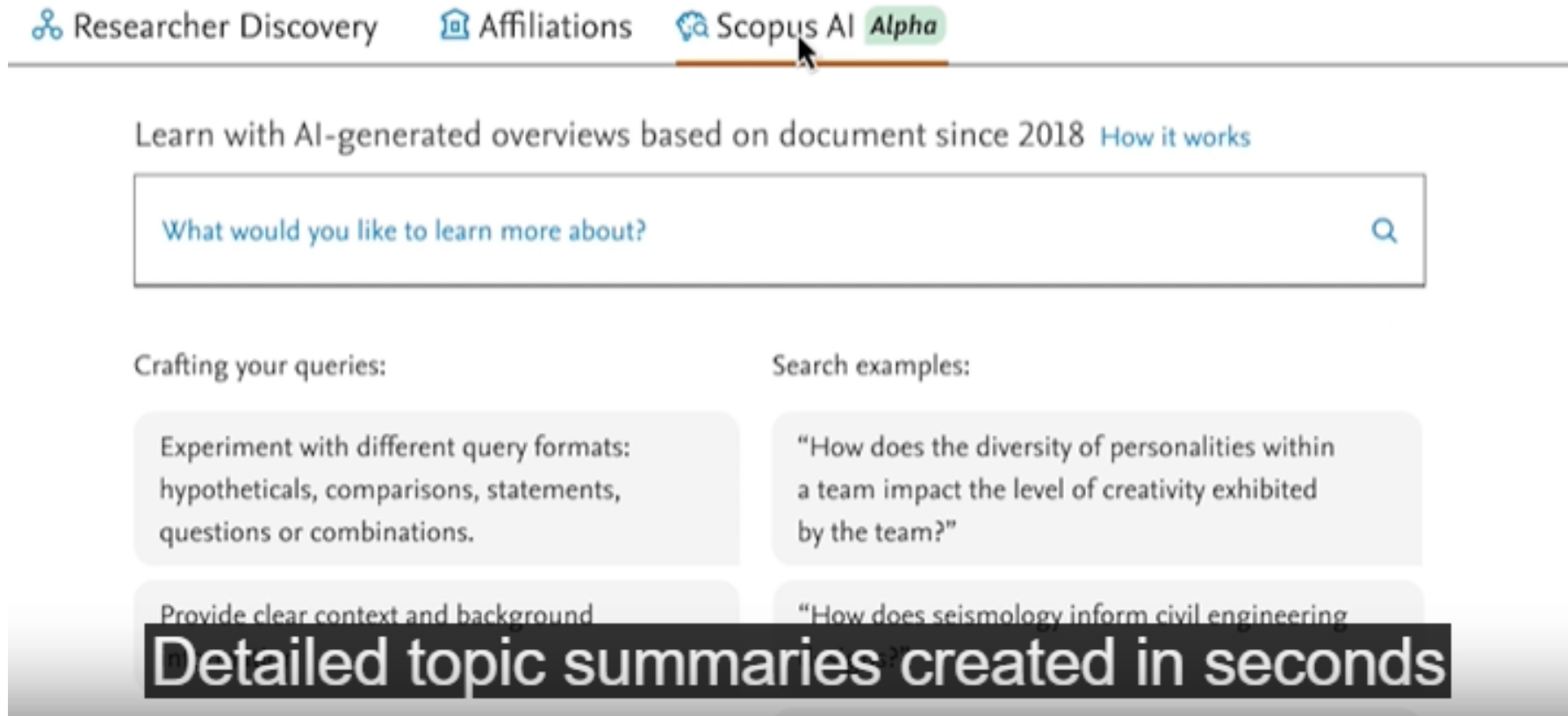
[Nature Communications](#) **11**, Article number: 2113 (2020) | [Cite this article](#)

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



The screenshot displays the Scopus AI Alpha interface. At the top, there are navigation links: "Researcher Discovery", "Affiliations", and "Scopus AI Alpha". Below these is a search bar with the placeholder text "What would you like to learn more about?". Underneath the search bar, there are two columns of examples. The left column is titled "Crafting your queries:" and contains two boxes: "Experiment with different query formats: hypotheticals, comparisons, statements, questions or combinations." and "Provide clear context and background". The right column is titled "Search examples:" and contains two boxes: "How does the diversity of personalities within a team impact the level of creativity exhibited by the team?" and "How does seismology inform civil engineering". At the bottom of the interface, a large black banner with white text reads "Detailed topic summaries created in seconds".

[Scopus AI: Change the way you view knowledge \(elsevier.com\)](https://elsevier.com/scopus-ai)

4.2 AI in the bibliography search and scientific writing

AI-assisted scientific bibliography search and writing

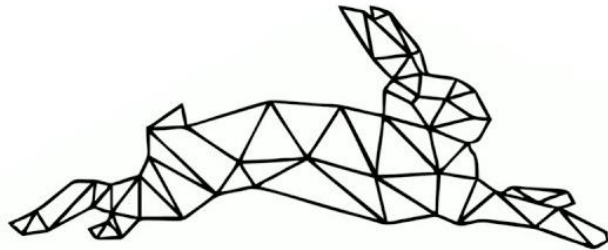
Generative pre-trained transformers



[What is GPT? Everything you need to know | Zapier](#)

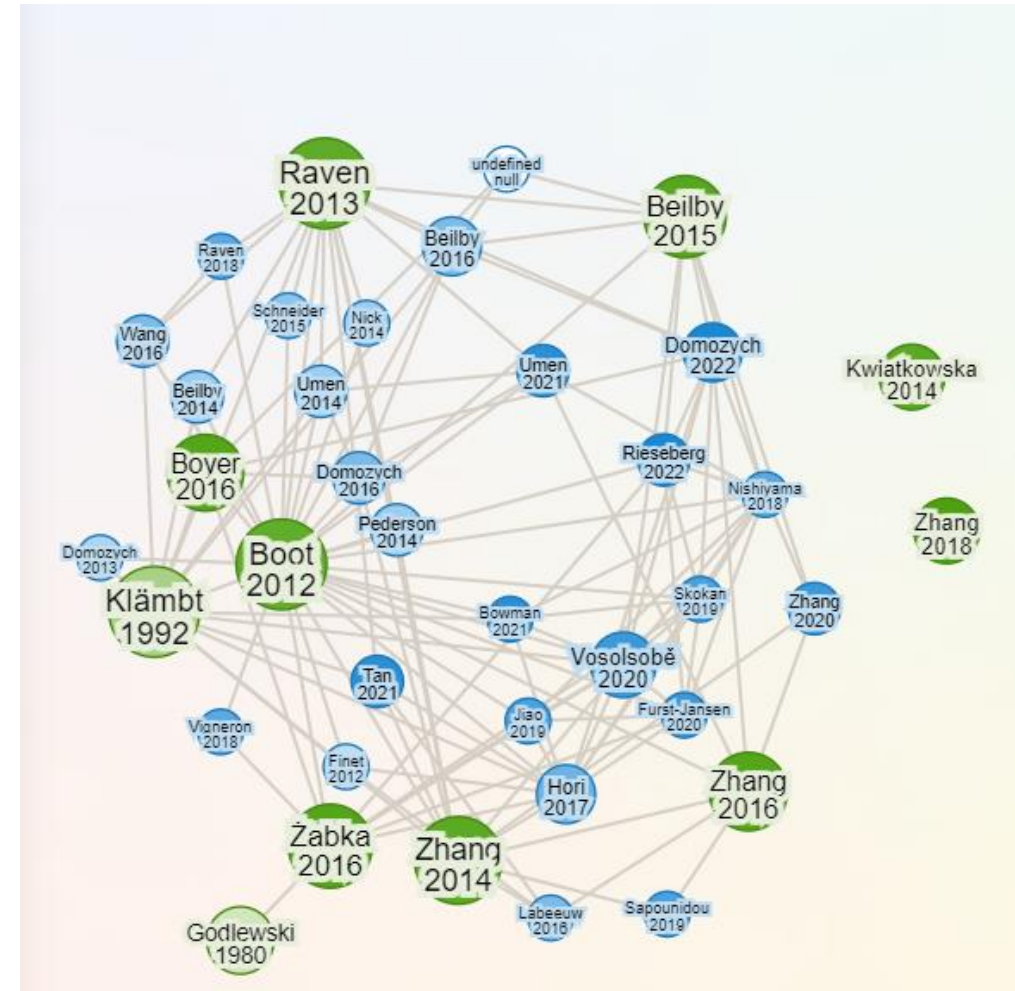
4.2 AI in the bibliography search and scientific writing

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



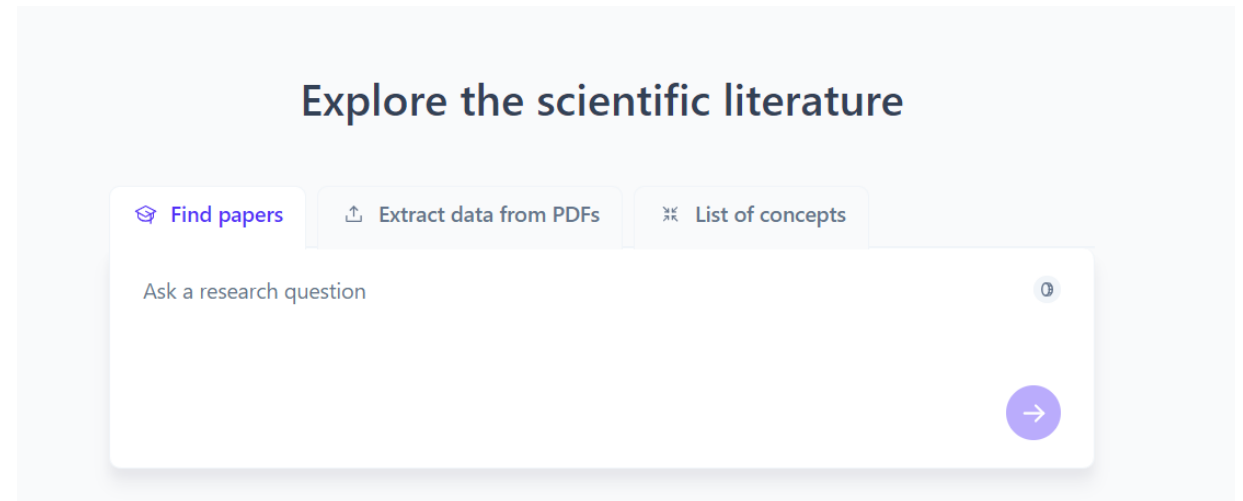
https://www.youtube.com/watch?v=RAPq3FnXp7k&list=PLHn2nrhhPBltNk12i0dIBGGRGSM-TpG5a&ab_channel=scite

4.2 AI in the bibliography search and scientific writing

A new era of literature research

Elicit

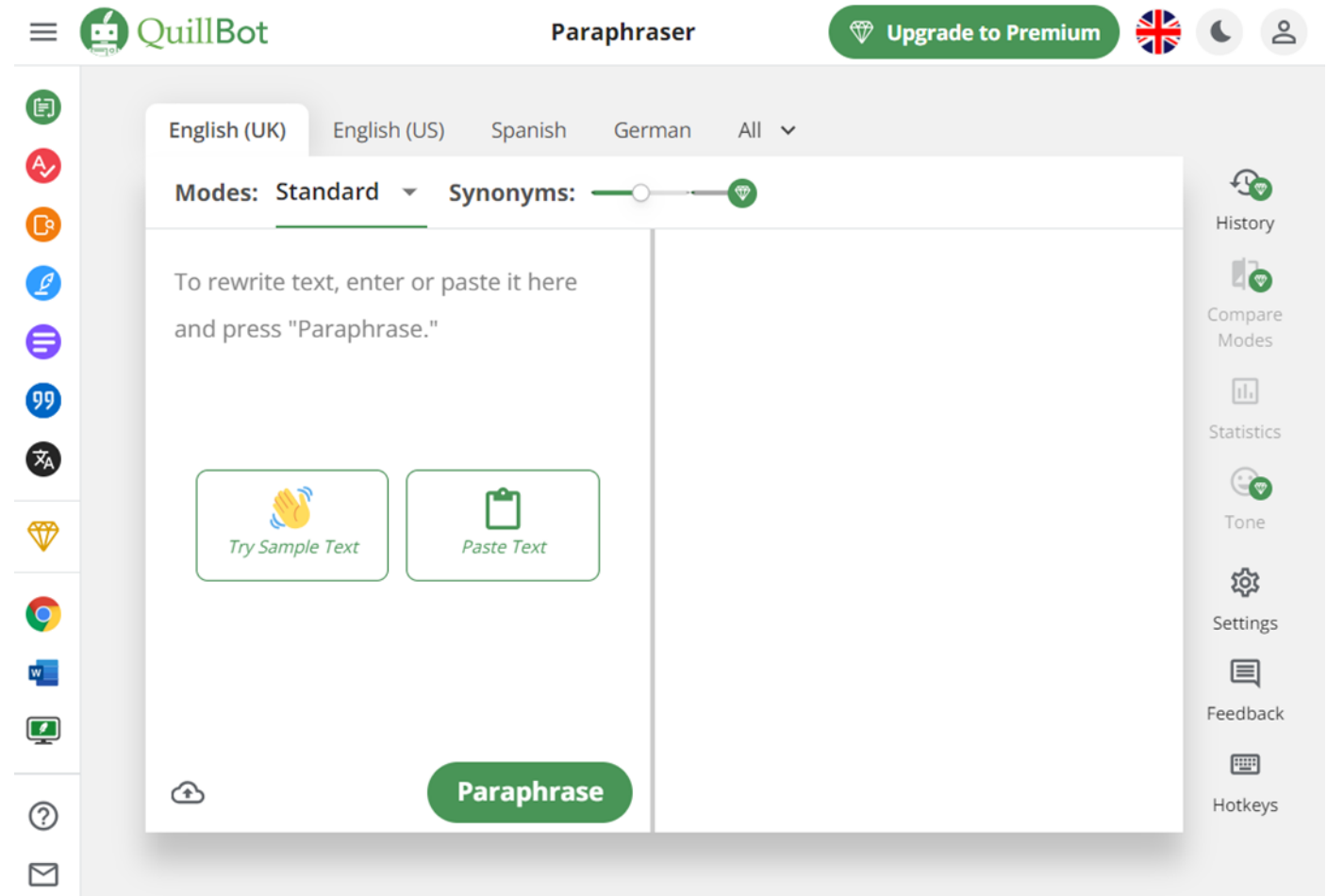
- Ask a research questions
- Getting answers in a form of research papers
- There is a free version to explore what Elicit has to offer
- Limited “credits”



4.2 AI in the bibliography search and scientific writing

Paraphrasing tool

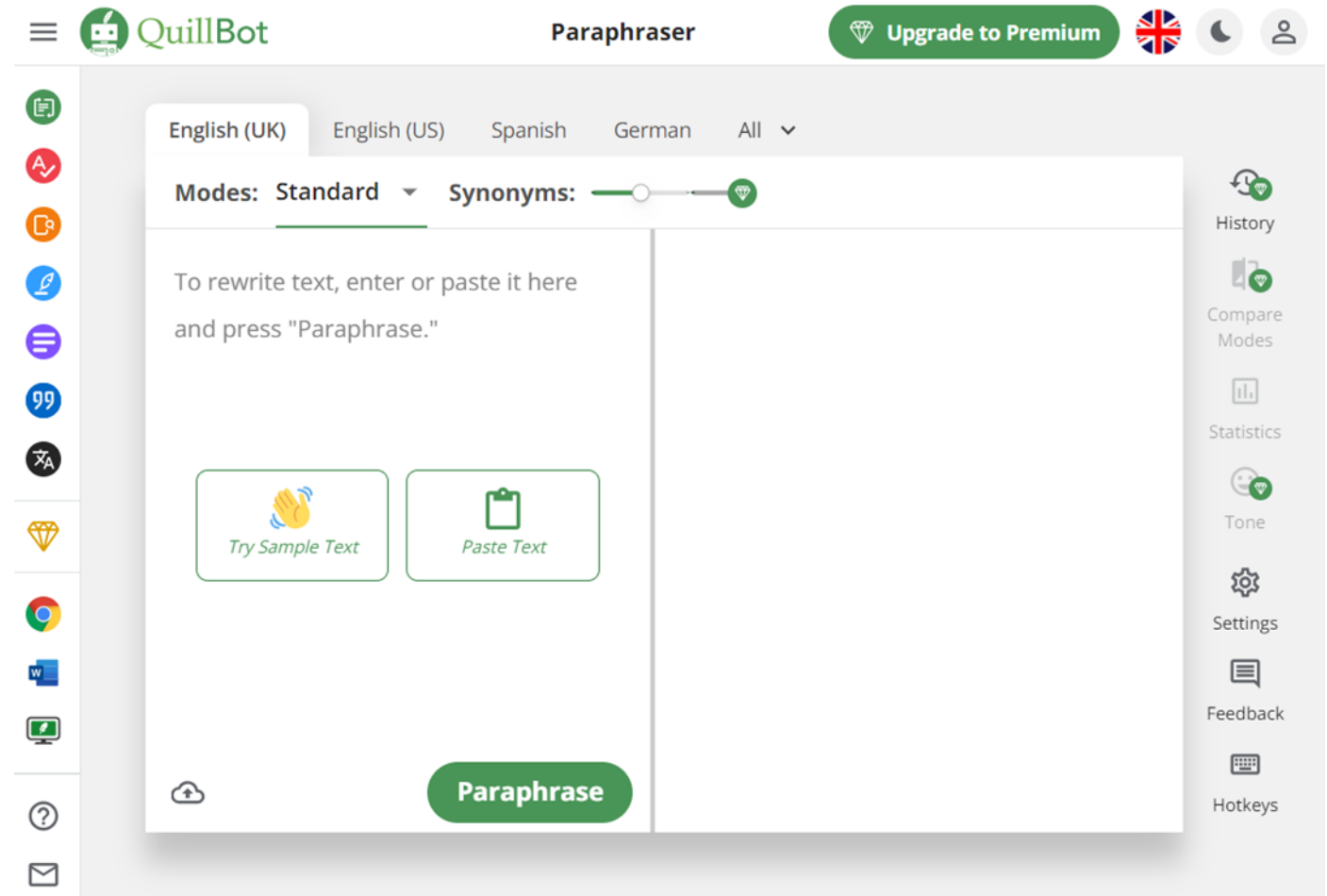
- Sometimes coming up with synonyms and new words can be difficult
- In that case paraphrasing tools can be useful
- But one should be careful not to just copy what AI tool suggested and carefully examine if the meaning has not been largely changed



4.2 AI in the bibliography search and scientific writing

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And what about the ethics of AI-assisted writing?