

Raspberry Pi
Foundation

Research
seminars

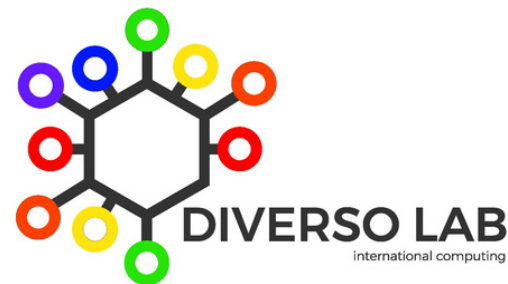
How to measure AI literacy

Jesús Moreno-León

jmorenol@us.es

Universidad de Sevilla & Programamos

December 2025



1. What is Programamos ("We program")?



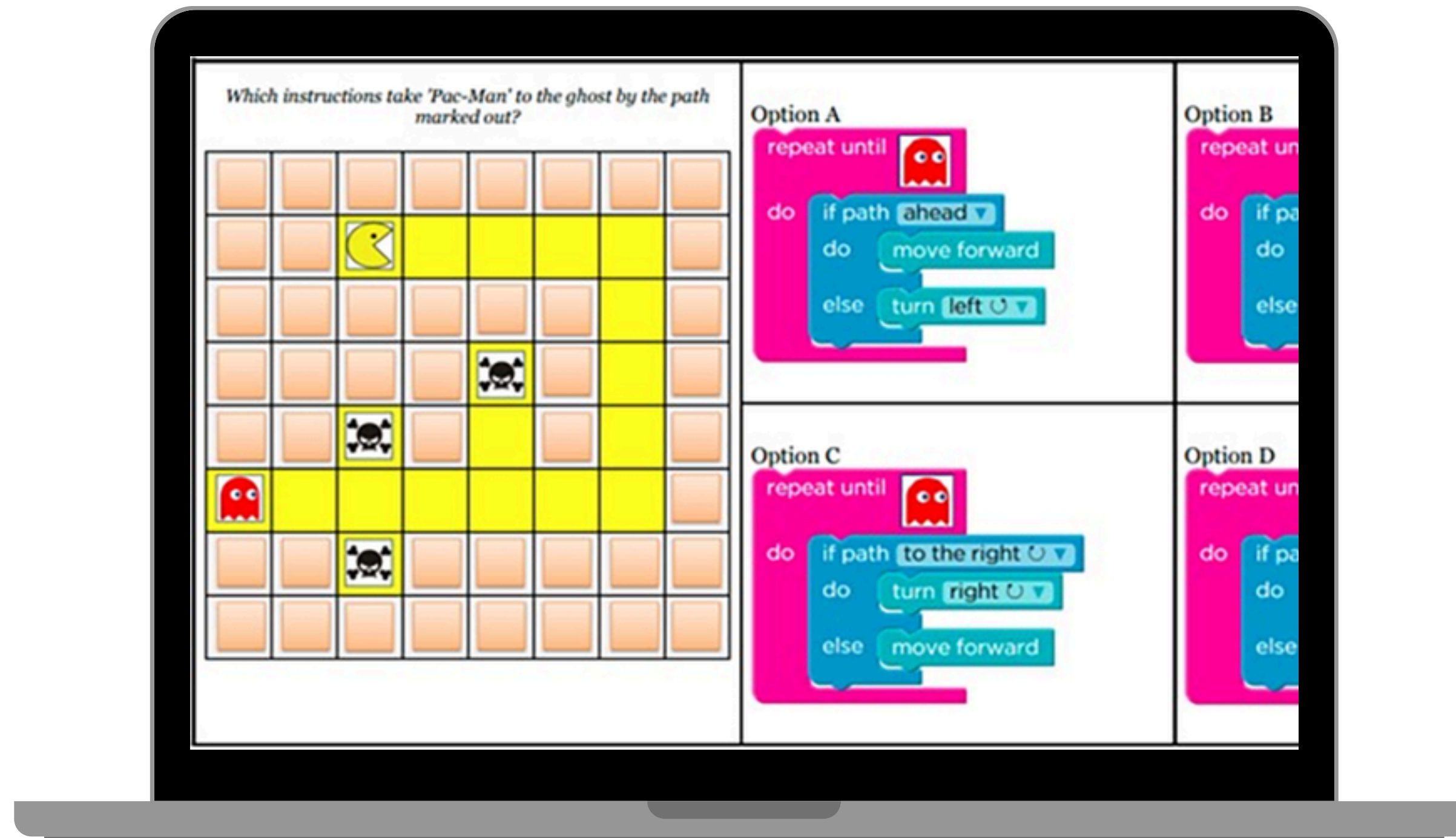
2. Assessment



Gregorio Robles



2. Assessment

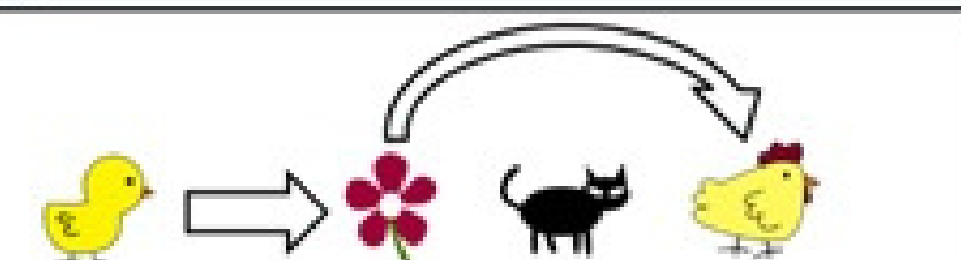


Marcos Román






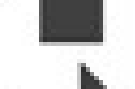




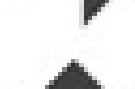
2. Assessment

18



Take the chicken with his mother.
Pick up the flower on your way.
Beware of the cat: don't go through its square.

Mark the correct sequence:

A	B	C	D
2x  1x 	2x  3x  1x 	3x  1x 	3x  3x 



María Zapata & Estafanía Martín

Beginners CT-t

BCTt: Beginners Computational Thinking Test

Zapata Cáceres, M. Martín-Barroso, E. and Román-González, M. (2021). BCTt: Beginners Computational Thinking Test. In Understanding computing education (Vol 1). Proceedings of the Raspberry Pi Foundation Research Seminar series.

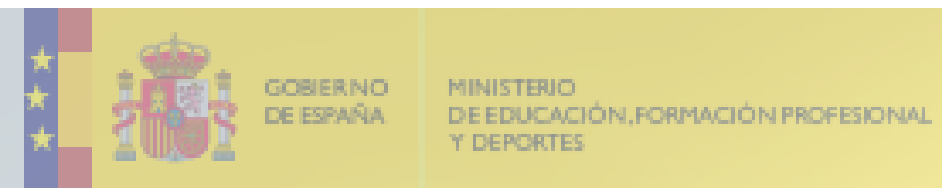
Available at: rpf.io/seminar-proceedings-2020



Raspberry Pi



3. The school of CT & AI



400 teachers and 7000 students



3. The school of CT & AI



400 teachers and 7000 students
2019 (aka *Year 3 Before ChatGPT*)

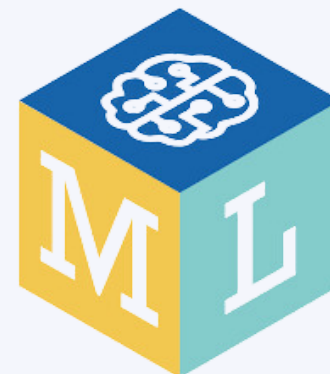
3. The school of CT & AI

400 teachers and 7000 students

Kindergarten - Y3



Y4 - Y8



Y9 - Y12



3. The school of CT & AI

400 teachers and 7000 students

The image is a screenshot of a web application interface for searching resources. It has a dark red header with three white circles on the left and a white search bar on the right. Below the header, there are three columns of filters. The first column, 'Etapas', lists educational levels from 'Ed. Infantil' to 'Formación para adultos'. The second column, 'Tipo de recurso', lists resource types like 'Recursos educativos', 'Propuestas didácticas', 'Código Escuela 4.0', 'CodeWeek', 'ChicaSTEM', 'Buenas prácticas EPCIA', 'Informes', 'ChicaSTEM', 'CodeINTEF', and 'EPCIA'. The third column, 'Categoría', lists categories like 'Competencias digitales', 'Diseño e impresión 3D', 'Inteligencia artificial', 'Lenguajes de programación', 'PC desconectado', 'Pensamiento computacional', 'Placas programables', 'Realidad virtual y aumentada', and 'Robótica educativa'. Checkmarks are visible next to 'Recursos educativos', 'Buenas prácticas EPCIA', and 'Inteligencia artificial'. A search button with a magnifying glass icon is located at the bottom right of the filter area.

<https://code.intef.es/iniciativas/epcia/>

3. The school of CT & AI: design

Mixed method approach

Quantitative

- Pre-experimental study (no control group)
- Pre- and post-measures of two variables:
 - Development of CT ✓
 - Knowledge about AI ✗

Qualitative

- Students' questionnaires
- Teachers' questionnaires

3. The school of CT & AI: AIKT

AIKT

- 14 multiple choice items
- Inspired by previous instruments for 10–16-year-olds
- Based on AI4K12 framework:
 - Idea 3: computers can learn from data
 - Idea 5: AI can impact society in both positive and negative ways

Which of the following strategies would be most appropriate for teaching a computer to recognize photos of apples?

- Train the computer with photos of dogs.
- Train the computer with several photos of different apples, taken in different places and contexts.
- Train the computer with several similar photos of the same apple, taken in the same place.
- Train the computer with several identical copies of the same photo of an apple.

When an artificial intelligence (AI) system provides results that discriminate in terms of, for example, gender, this is usually due to:

- That the data that was used to train the system presented certain biases or was not balanced, that is, that much more data corresponding to men than to women was used, or vice versa.
- That the developers of the system had sexist biases.
- That the system is designed to be used by men to a greater extent than by women, or vice versa.
- That the system reflects the sexist reality of human nature.

(Incorporates elements of Tedre's computational thinking 2.0)

3. The school of CT & AI: Findings

Can the students of these ages enhance their AI literacy through programming activities with Scratch and ML4K?

Y4 - Y8

- Pre-test: 7.06
- Post-test: 8.11
- Cohen's d: 0.419, "moderate" effect size
- Statistically significant difference ($p < .001$)

Y9 - Y12

- Pre-test: 8,724
- Post-test: 9,0586
- Cohen's d: 0.14, "small" effect size
- Ceiling effect: max scores in post-test

3. The school of CT & AI: conclusions

Tools

- We need Free/Open Source Software tools
- No registration
- No APIs
- No data sent to “the cloud”

3. The school of CT & AI: conclusions



Tools

- We need Free/Open Source Software tools
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3. The school of CT & AI: conclusions



Tools

- We need Free/Open Source Software tools
- No registration
- No APIs
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AI literacy instrument

- Higher ceiling
- Broader approach
- Address misconceptions

3. The school of CT & AI: conclusions



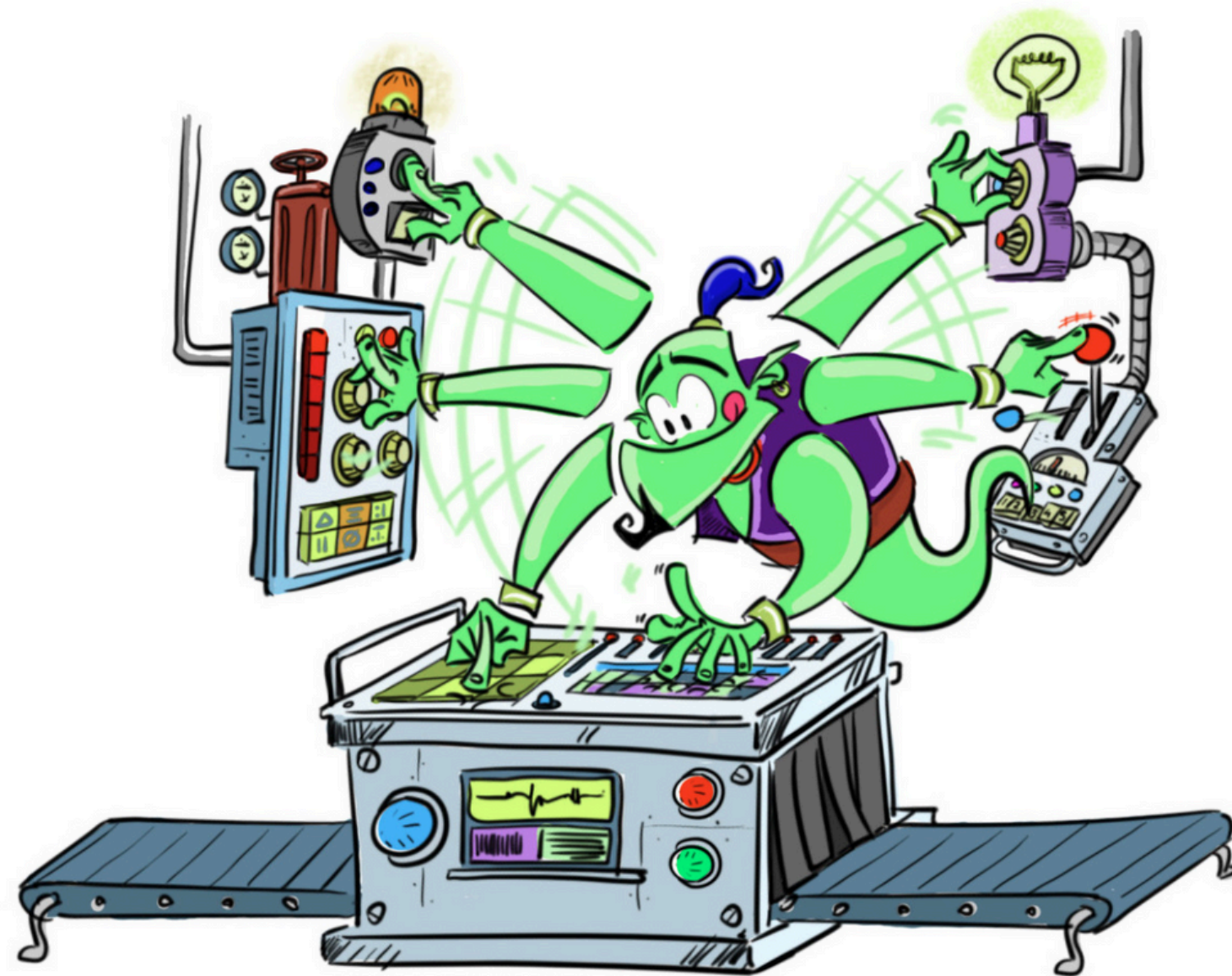
Tools

- We need Free/Open Source Software tools
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AI literacy instrument

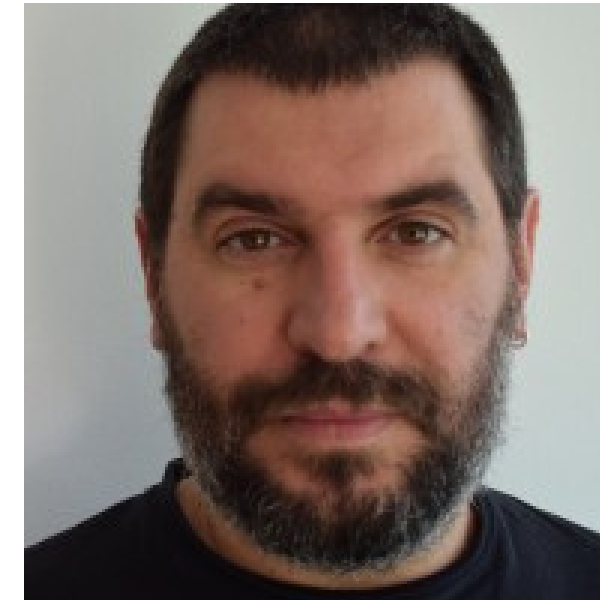
- Higher ceiling
- Broader approach
- Address misconceptions

4. LearningML



LEARNING ML

Artificial Intelligence made easy



Juan D. Rodríguez

Learning artificial intelligence at school with Scratch and LearningML

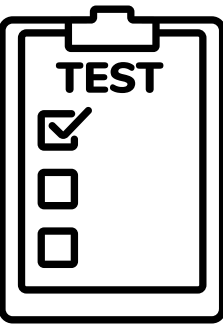
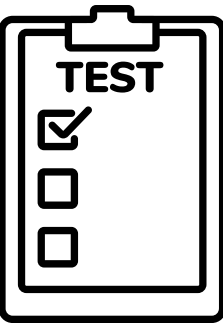
Rodríguez, J.D. (2021). Learning artificial intelligence at school with Scratch and LearningML. In Understanding computing education (Vol 1). Proceedings of the Raspberry Pi Foundation Research Seminar series.

Available at: rpf.io/seminar-proceedings-2020



Raspberry Pi

4. LearningML



Paper Session: AI / ML

SIGCSE '21, March 13–20, 2021, Virtual Event, USA

Evaluation of an Online Intervention to Teach Artificial Intelligence with LearningML to 10-16-Year-Old Students

Juan David Rodríguez-García

INTEF

Madrid, Spain

juanda.rodriguez@intef.educacion.es

Jesús Moreno-León

Programamos

Sevilla, Spain

jesus.moreno@programamos.es

Marcos Román-González

Universidad Nacional de Educación a Distancia

Madrid, Spain

mroman@edu.uned.es

Gregorio Robles

Universidad Rey Juan Carlos

Madrid, Spain

grex@gsyc.urjc.es

ABSTRACT

The inclusion of artificial intelligence (AI) in education is increasingly highlighted by international organizations and governments around the world as a cornerstone to enable the adoption of AI in society. That is why we have developed LearningML, aiming to provide a platform that supports educators and students in the creation of hands-on AI projects, specifically based on machine learning techniques. In this investigation we explore how a workshop on AI and the creation of programming projects with LearningML impacts the knowledge on AI of students between 10 and 16 years. 135 participants completed all phases of the learning experience, which due to the COVID-19 pandemic had to be performed online. In order to assess the AI knowledge we created a test that includes different kinds of questions based on previous investigations and publications – resulting in a reliable assessment instrument. Our findings show that the initiative had a positive impact on participants’ AI knowledge, being the enhancement especially important for those learners who initially showed less familiarity with the topic. We observe, for instance, that while previous ideas on AI revolve around the term *robot*, after the experience they do around *solve* and *problem*. Based on these results we suggest that LearningML can be seen as a promising platform for the teaching and learning of AI in K-12 environments. In addition, researchers and educators can make use of the new instrument we provide to evaluate future educational interventions.

KEYWORDS

artificial intelligence, machine learning, computational thinking, K-12, assessment

ACM Reference Format:

Juan David Rodríguez-García, Jesús Moreno-León, Marcos Román-González, and Gregorio Robles. 2021. Evaluation of an Online Intervention to Teach Artificial Intelligence with LearningML to 10-16-Year-Old Students. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education (SIGCSE '21)*, March 13–20, 2021, Virtual Event, USA. ACM, New York, NY, USA, 7 pages. <https://doi.org/10.1145/3408877.3432393>

1 INTRODUCTION

"Ditch the algorithm" or *"The algorithm stole my future"* are some of the messages that can be heard in the protests around England in which, at the time of writing this paper, students challenge the A-levels grades provided by a predictive assessment system. This is just an example, although very illustrating, of how society is becoming aware of the potential impact that artificial intelligence (AI) systems can have in their lives. And this also indicates that society as a whole, from policy makers to service users, is probably still unprepared.

Organizations, such as UNESCO, and governments around the world are developing policies, strategic plans, and other initiatives highlighting the challenges, opportunities and impact of AI in education [39, 45]. Furthermore, the big success achieved by artificial neural networks and machine learning (ML) development in last years has changed dramatically the view educators, AI researchers and the general public have about AI [24], yielding a growing interest in AI education [34].

Consequently, new tools intended to facilitate the learning and teaching of ML fundamentals in K-12 levels have been recently developed. However, we have found some inconveniences that hinder the adoption of those tools in classroom scenarios. Thus, we have designed and developed LearningML [19]¹, a platform to learn ML fundamentals, to overcome these drawbacks.

In this paper we investigate whether children, with no previous knowledge about AI or ML, can learn the basic of ML through hands-on activities with LearningML. To do so, we conducted an online workshop. In particular, the research questions (RQs) we address are following:

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SIGCSE '21, March 13–20, 2021, Virtual Event, USA

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<https://doi.org/10.1145/3408877.3432393>

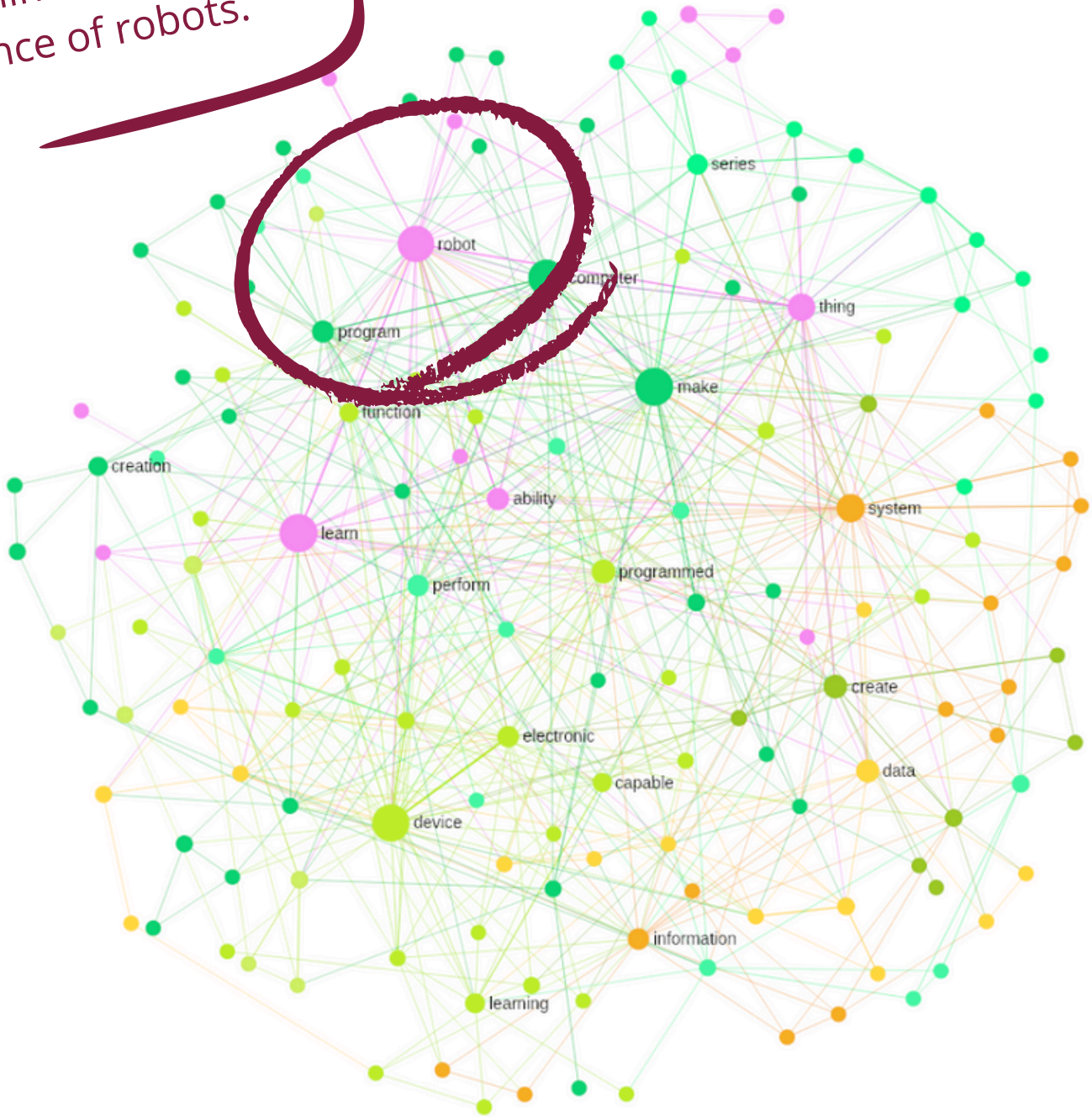
¹<https://learningml.org>

AIKT

- Cohen’s d: 0.486, "moderate" effect size for the overall sample
- Cohen’s d: 1.007, "big" effect size for learners with less previous experiences

4. LearningML

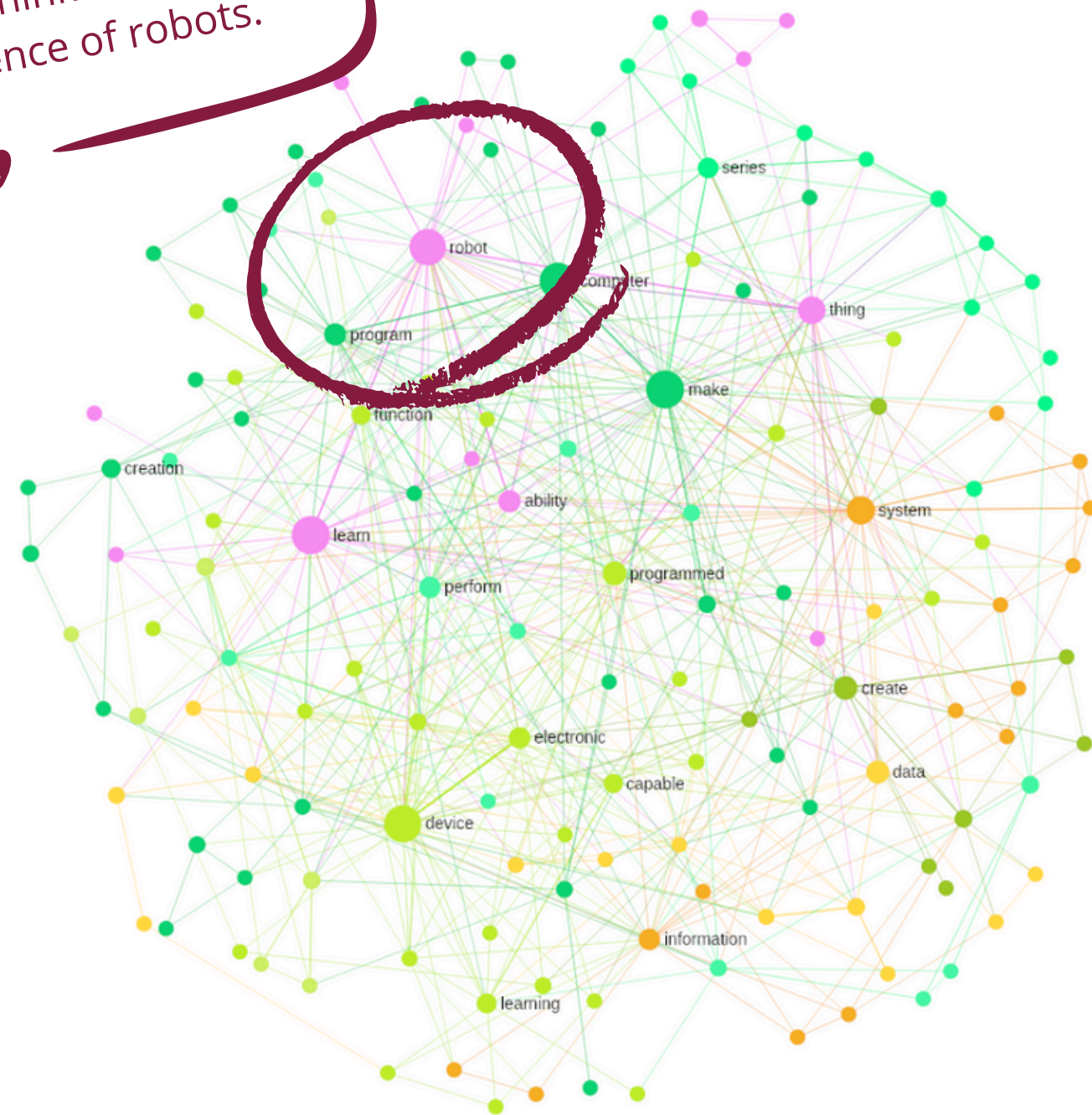
What robots can do.
A robot that thinks for itself.
The intelligence of robots.



Pre-test

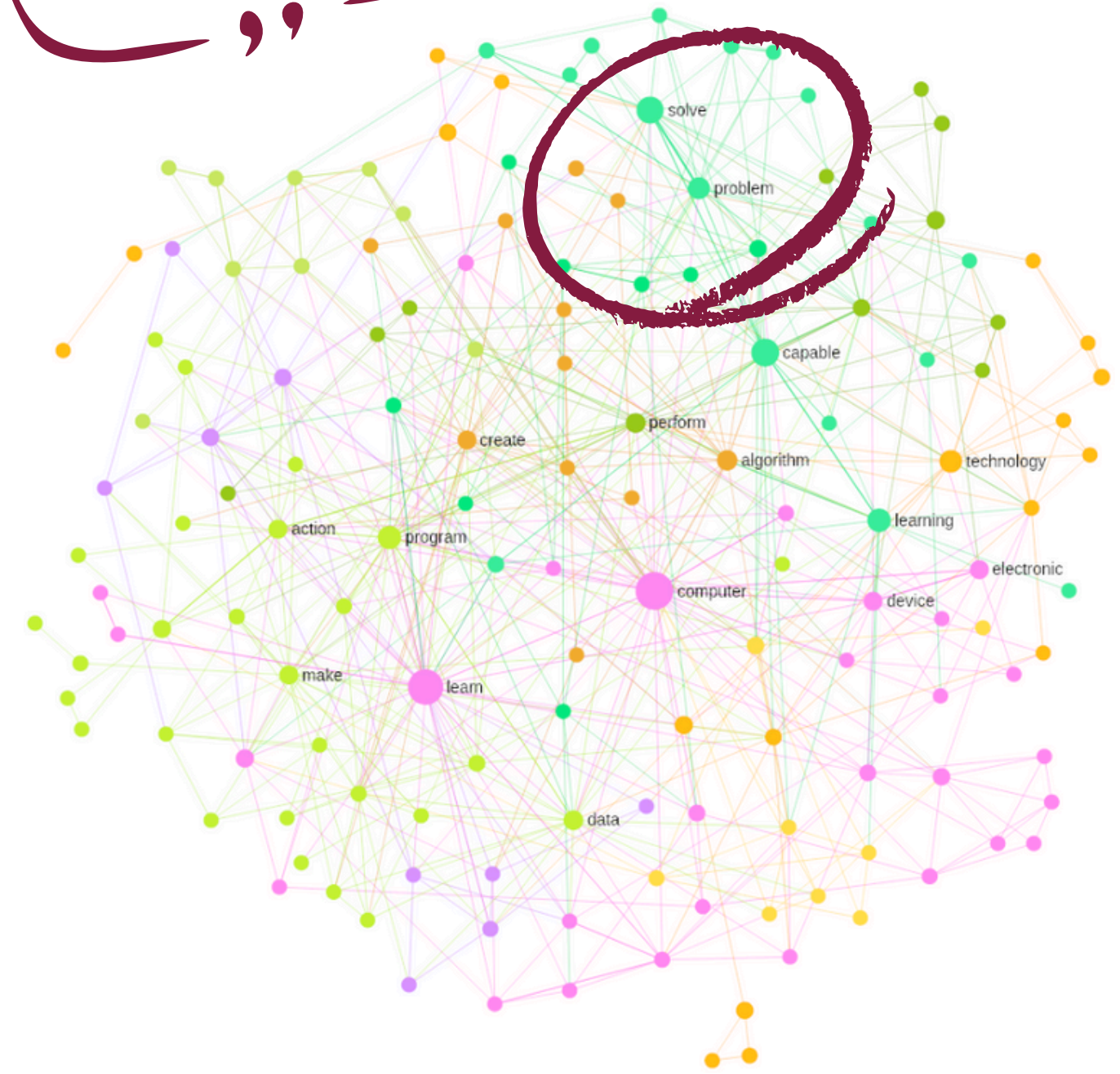
4. LearningML

What robots can do.
A robot that thinks for itself.
The intelligence of robots.



Pre-test

Making a computer capable of solving problems that need intelligence.



Post-test

5. GenAI



5. GenAI

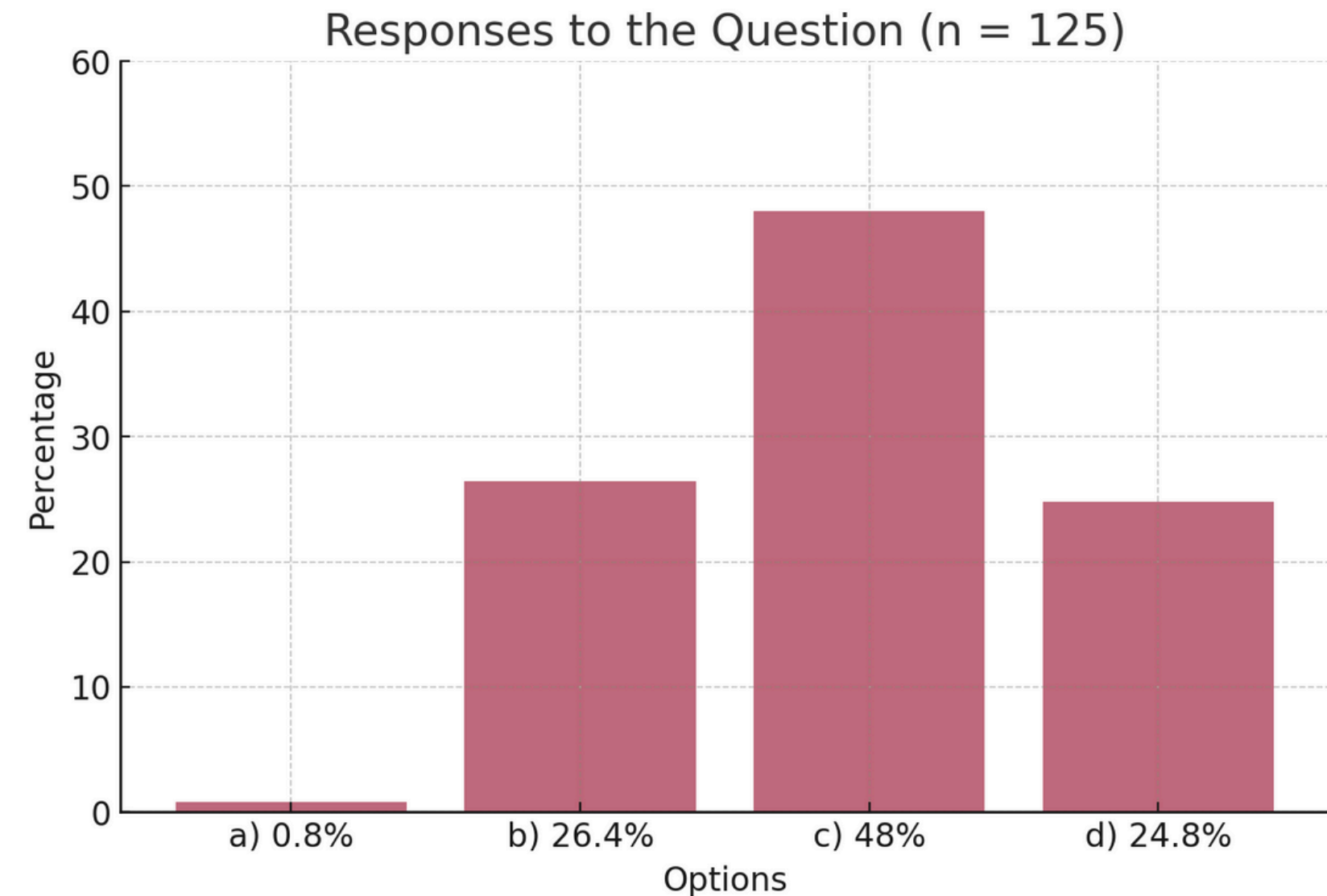
Which of the following statements is correct regarding how generative AI conversational assistants based on LLMs, such as ChatGPT or Le Chat, construct their responses?

- a) Completely at random, generating one by one words related to the topic of the received question.
- b) Generating, one by one, the next most probable word based on the received question and adding some randomness to avoid overly repetitive answers.
- c) Consulting a database of real and true facts that they use as a starting point for writing the response.
- d) Using fragments of texts produced by human experts that the system has stored and combines like a collage.

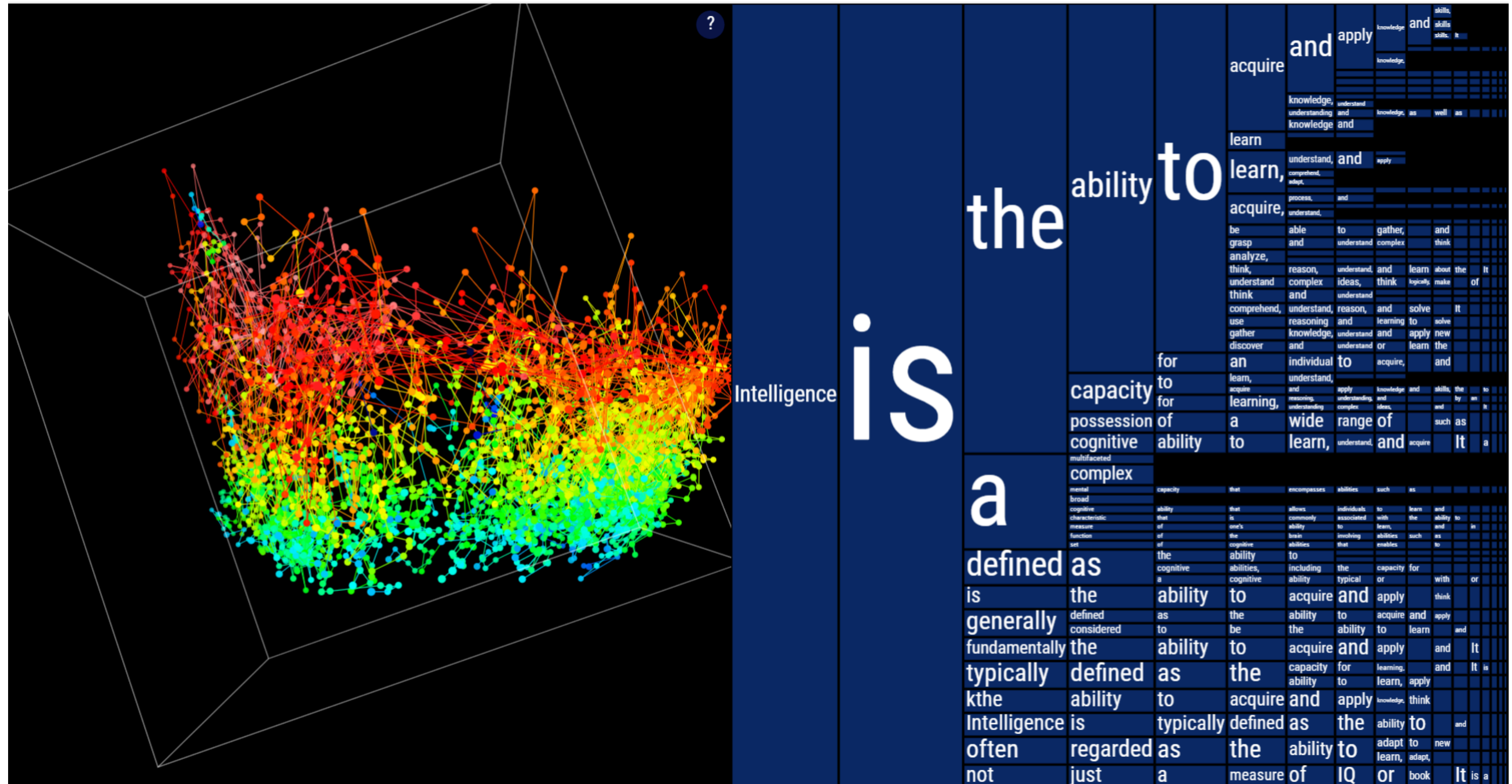
5. GenAI

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5. GenAI

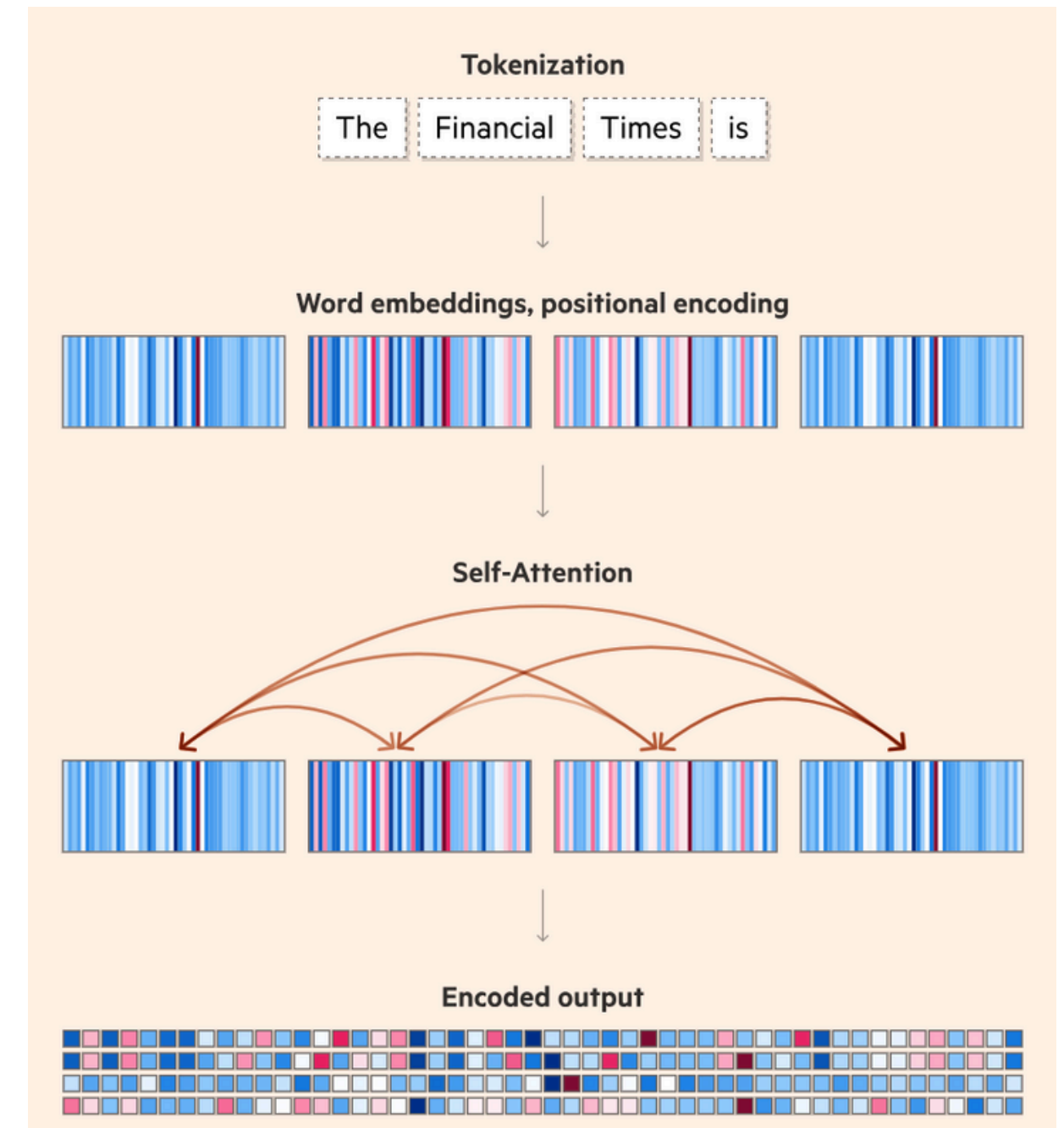


<https://moebio.com/mind/>

5. GenAI



<https://ig.ft.com/generative-ai/>



5. GenAI

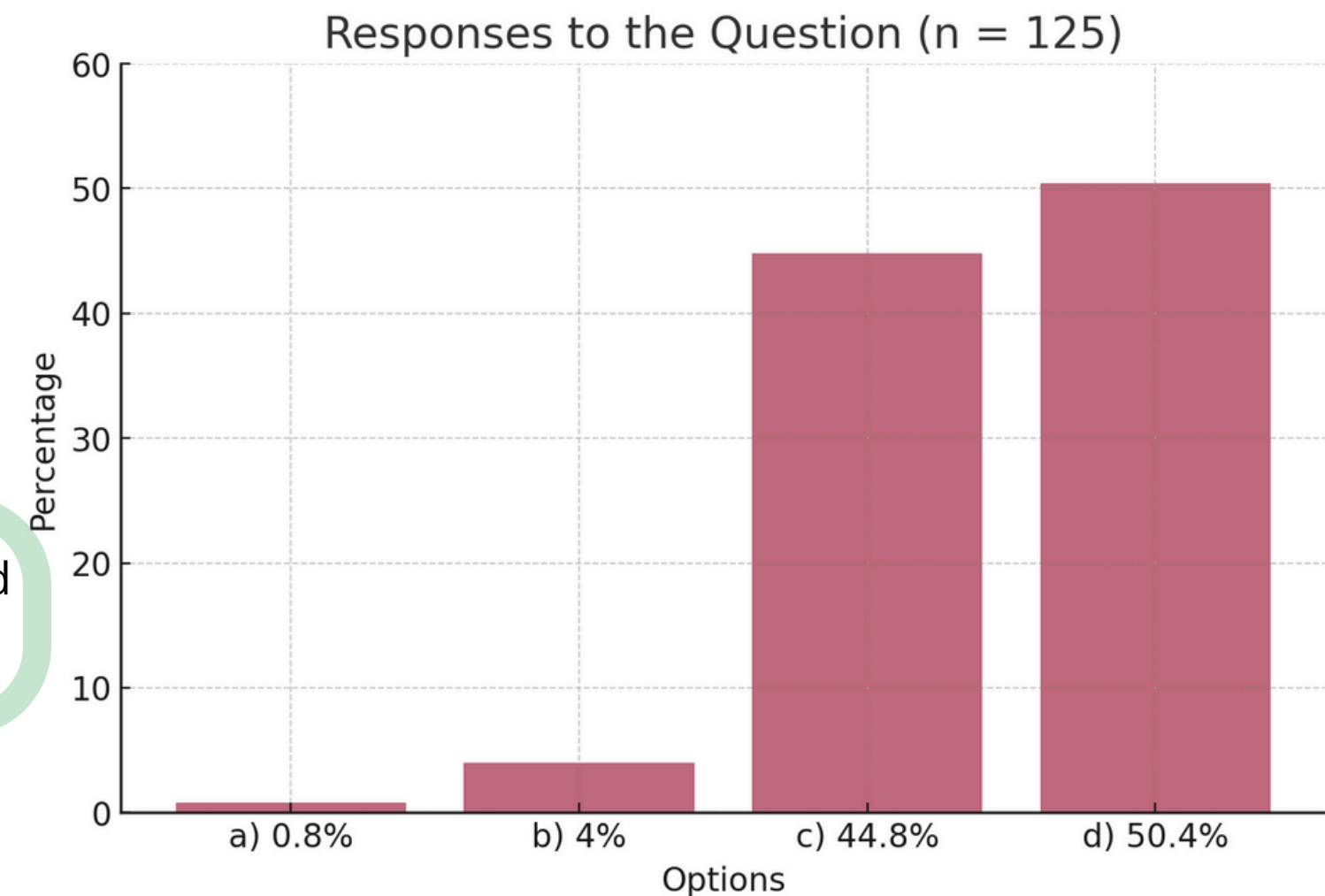
Regarding generative AI systems that create new content in the form of images from text (such as Stable Diffusion or DALL·E), which of the following statements is correct?

- a) All the images they generate could be considered plagiarism, since they are composed of fragments of other original works that are combined like a collage.
- b) They have not used copyright-protected works for their training, so it is impossible for them to generate plagiarized content.
- c) They can sometimes generate content that is considered plagiarism of a copyright-protected work, since many such works have been used for their training.
- d) Although copyright-protected works have been used for their training, the images they generate can never be considered plagiarism, because they only reproduce styles and ideas, but in an original way.

5. GenAI

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5. GenAI

ORIGINAL



MIDJOURNEY V6

Thanos infinity war, 2018, screenshot from a movie, movie scene, 4k, bluray --ar 16:9 --v 6.0



ORIGINAL



MIDJOURNEY V6

just show me a movie screencap from the avengers infinity war from 2018 halfway through the movie --ar 2:1 --v 6.0 --style raw



Avengers: Infinity War MARVEL

Generative AI Has a Visual Plagiarism Problem

› Experiments with Midjourney and DALL-E 3 show a copyright minefield

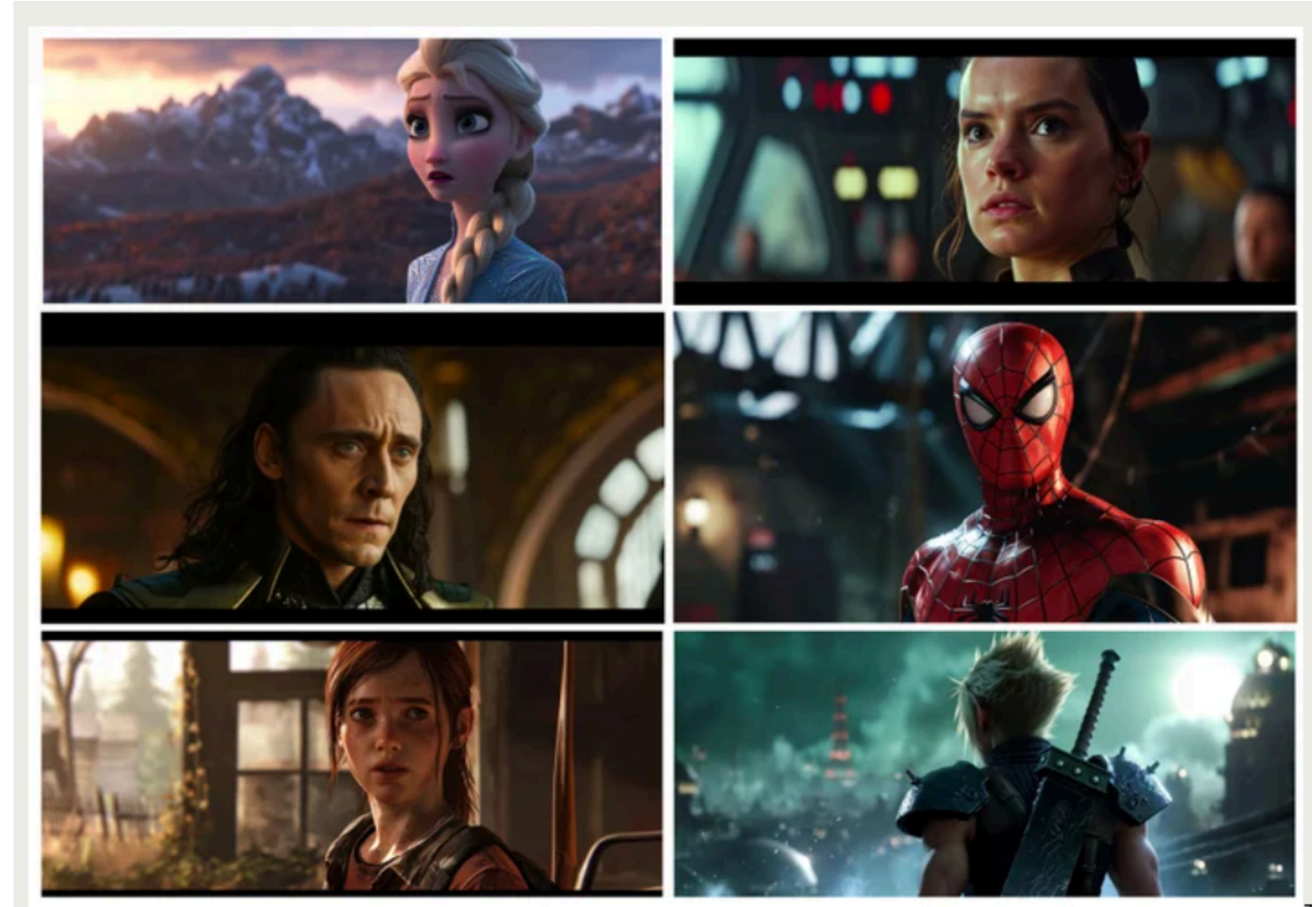
BY GARY MARCUS REID SOUTHEN | 06 JAN 2024 | 20 MIN READ |

<https://spectrum.ieee.org/midjourney-copyright>

5. GenAI



<https://spectrum.ieee.org/midjourney-copyright>



5. GenAI

Suppose that, during your class, 30 students must each generate 5 images using a generative AI model such as SDXL. For each of the 5 final images, each student also makes 4 additional attempts or incremental improvements. What would the total impact be in terms of electrical energy (in phone charges) and carbon footprint (in kilometers driven)?

- a) Energy: 600 phone charges, Emissions: 7,680 km driven
- b) Energy: 150 phone charges, Emissions: 960 km driven
- c) Energy: 20 phone charges, Emissions: 160 km driven
- d) Energy: 2 phone charges, Emissions: 14 km driven

5. GenAI

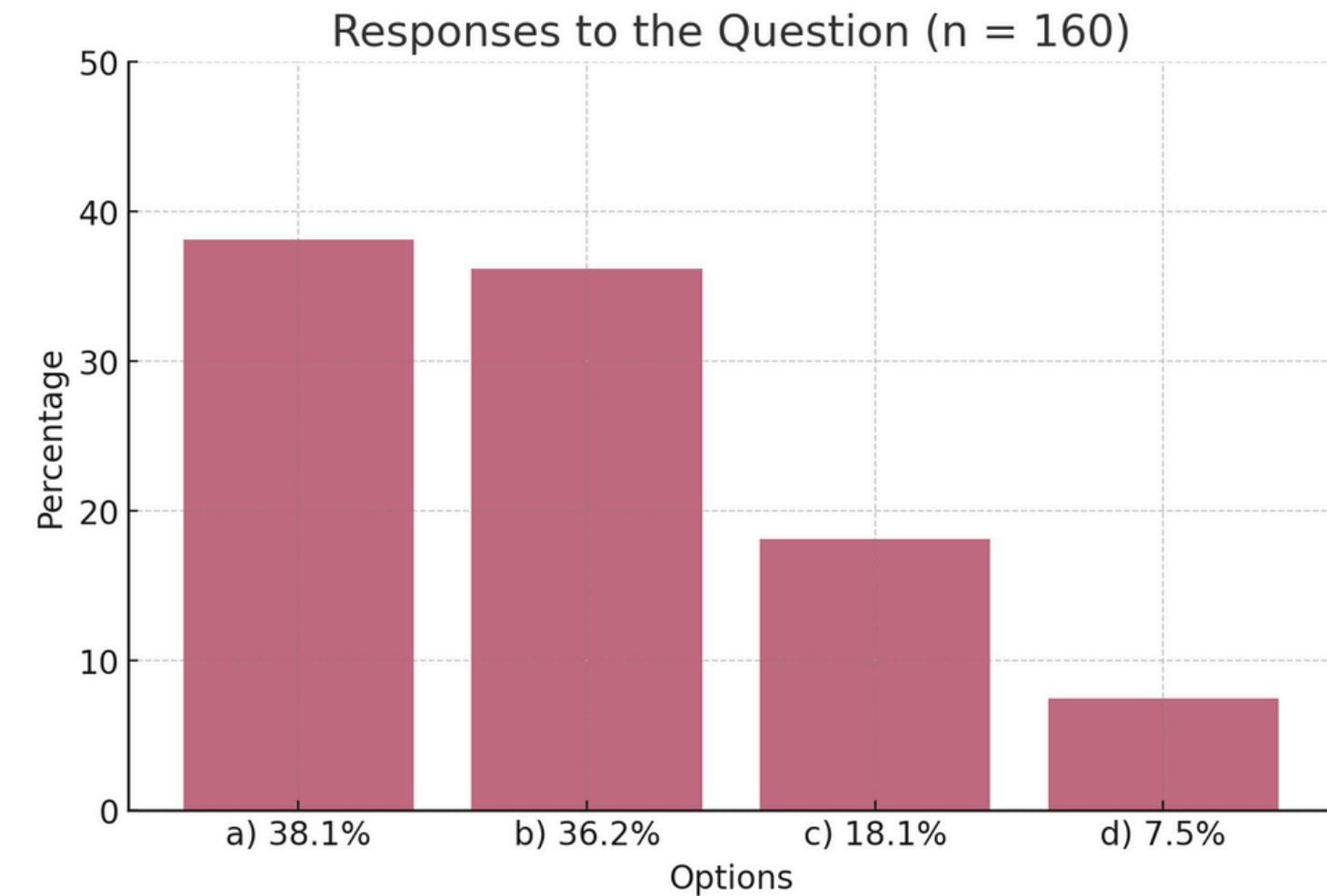
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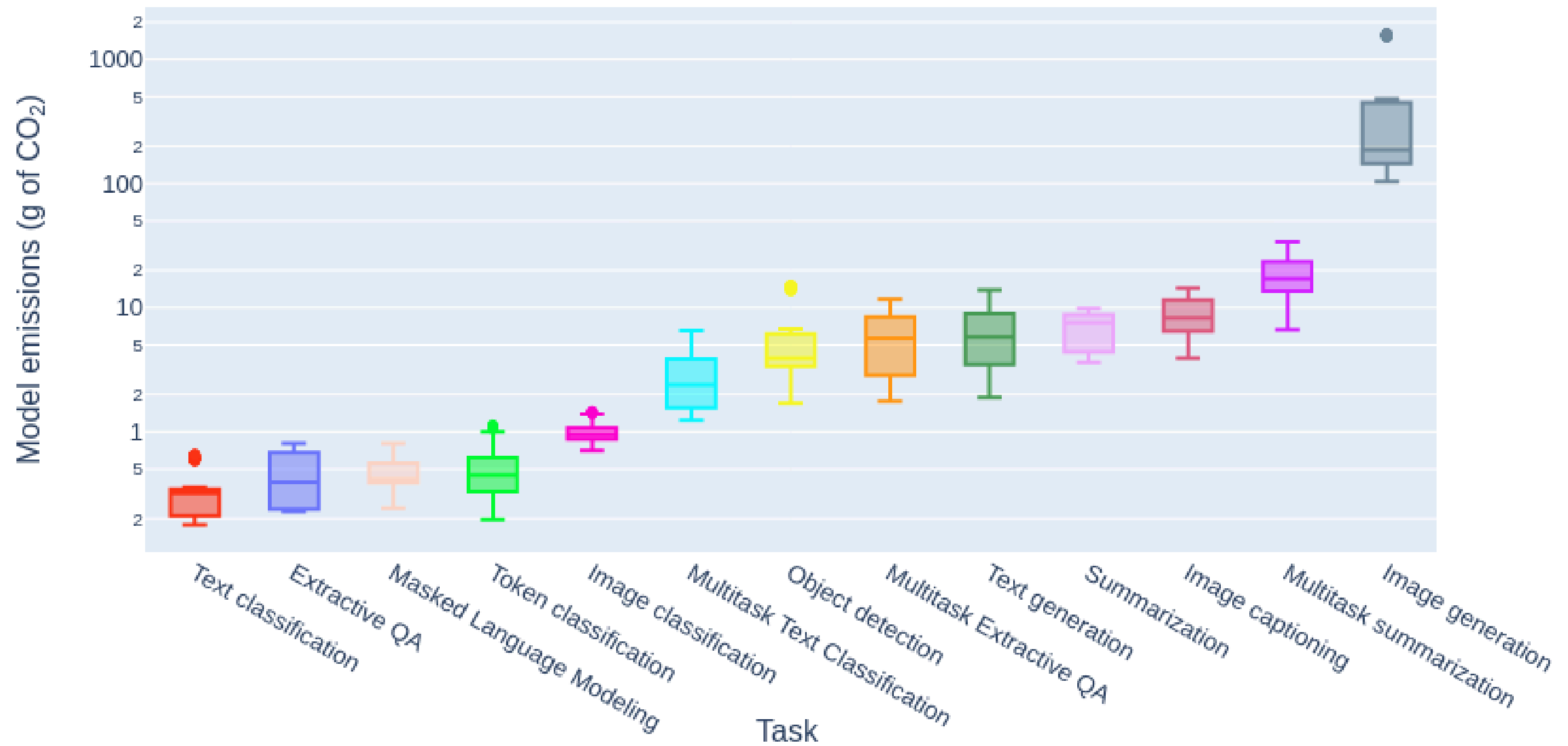
b) Energy: 150 phone charges, Emissions: 960 km driven

c) Energy: 20 phone charges, Emissions: 160 km driven

d) Energy: 2 phone charges, Emissions: 14 km driven



5. GenAI



Power Hungry Processing: ⚡ Watts ⚡ Driving the Cost of AI Deployment?

ALEXANDRA SASHA LUCCIONI and YACINE JERNITE, Hugging Face, Canada/USA

EMMA STRUBELL, Carnegie Mellon University, Allen Institute for AI, USA

6. New frameworks for AI literacy

SEAME framework

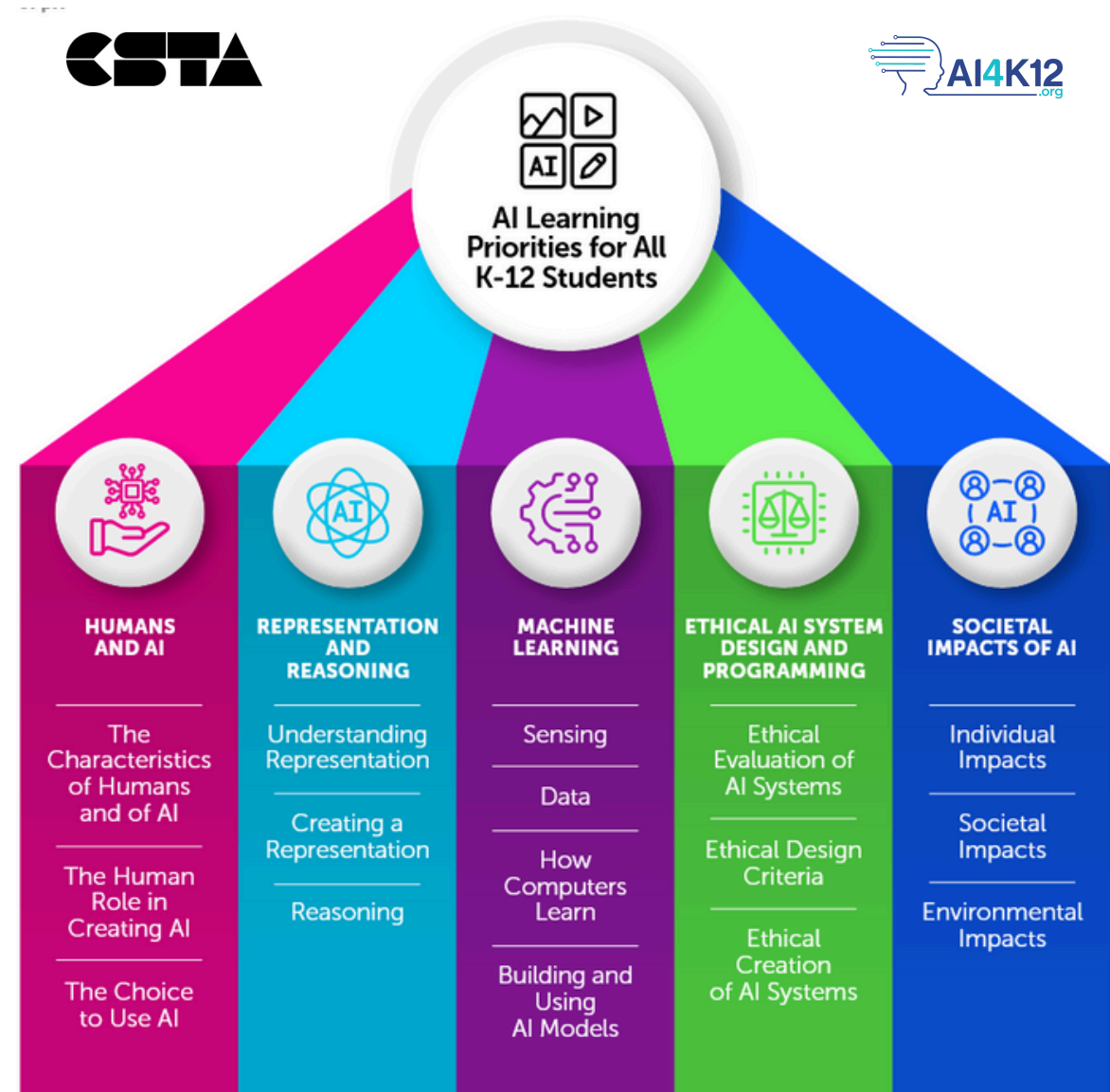
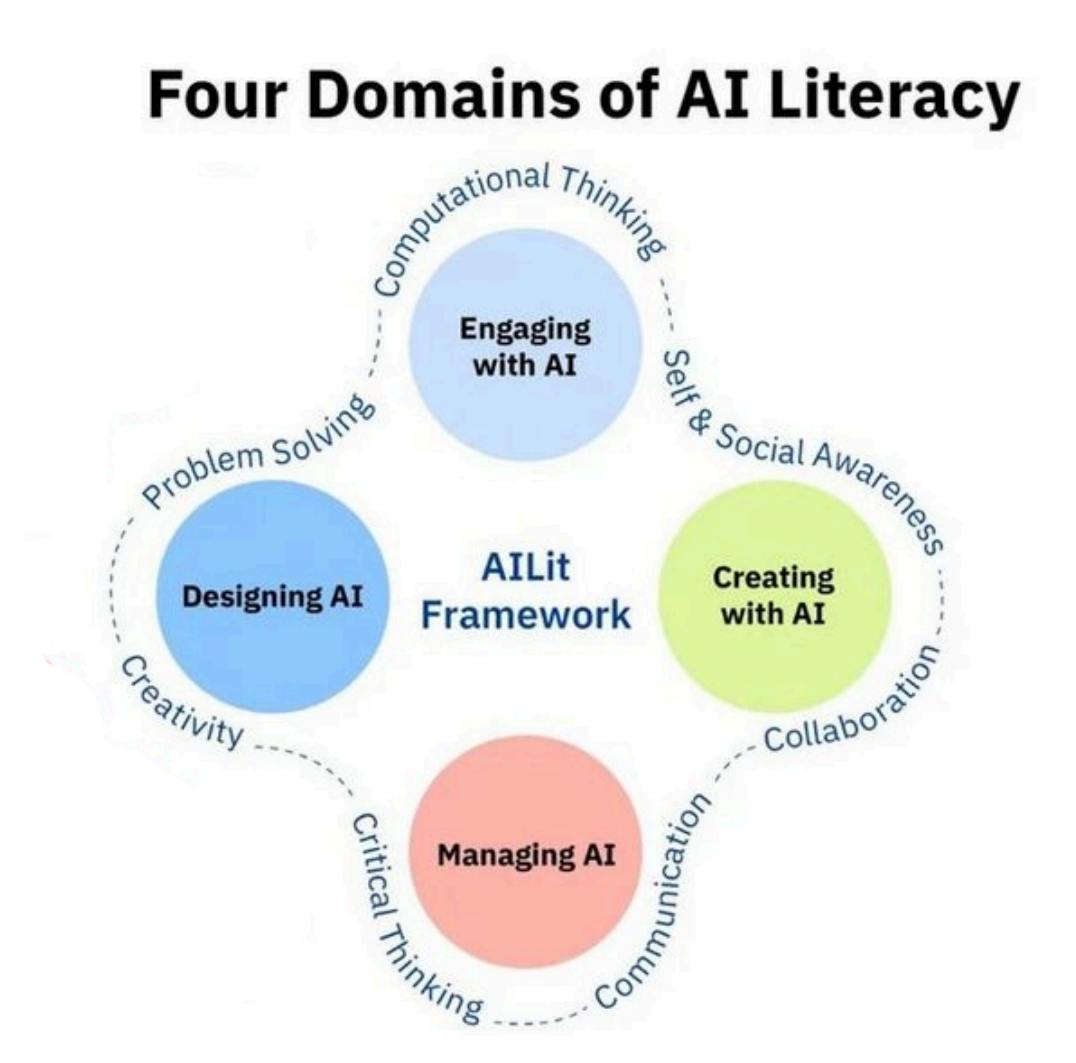
 Raspberry Pi Foundation

Level	Description
Social and Ethical	This level relates to the impact of AI on everyday life, and its ethical implications in wider society. Issues such as privacy or bias concerns, the impact of AI on employment, misinformation, and the potential benefits of AI applications are considered at this level. You can learn more about this on the social and ethical issues concept page .
Application	This level concerns the use of AI applications. Chatbot applications such as Google's Gemini or OpenAI's ChatGPT are examples of AI applications that use a large language model (LLM) to generate responses. At the Application level, it is not necessary to understand how AI engines work or how to train models. You can learn more about Applications on the applications concept page .
Model	This level concerns the underlying models that are used by AI and ML applications. This includes understanding the different ML paradigms (i.e., supervised, unsupervised, or reinforcement learning), as well as the processes involved in training and testing ML models. You can learn more about this on the models concept page .
Engine	This level is related to the engines or algorithms that are part of how ML models work, such as data-driven decision trees and artificial neural networks. You can learn more about this on the engines concept page .

 European Commission

 OECD

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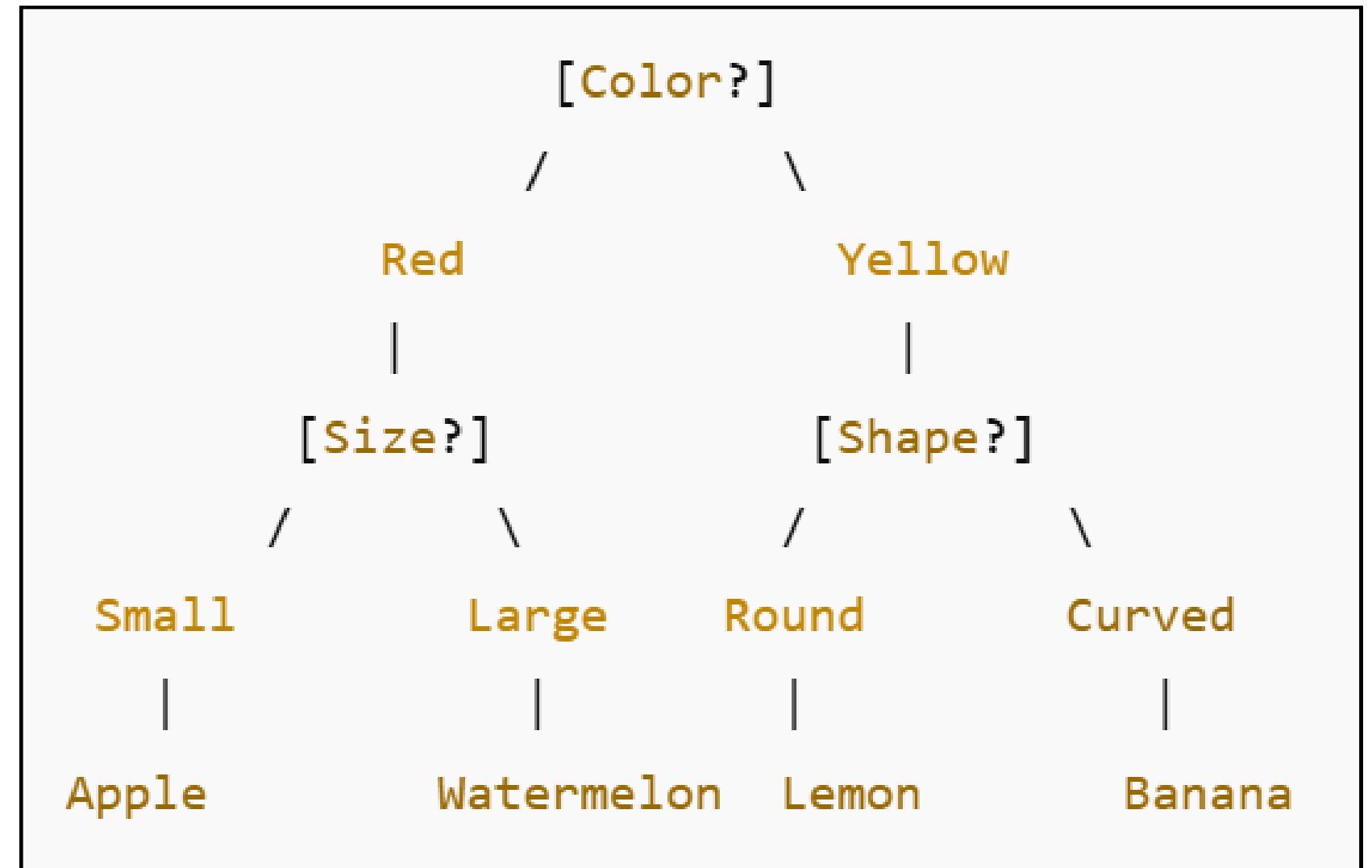


7. New AI literacy test: item examples

You have asked your students to design a decision tree to classify different fruits based on three characteristics: color, size, and shape. To check whether the following proposed solution is correct, you are going to test it with a yellow, small, round apple.

How would this tree classify that apple?

- a) Apple
- b) Watermelon
- c) Lemon
- d) Banana

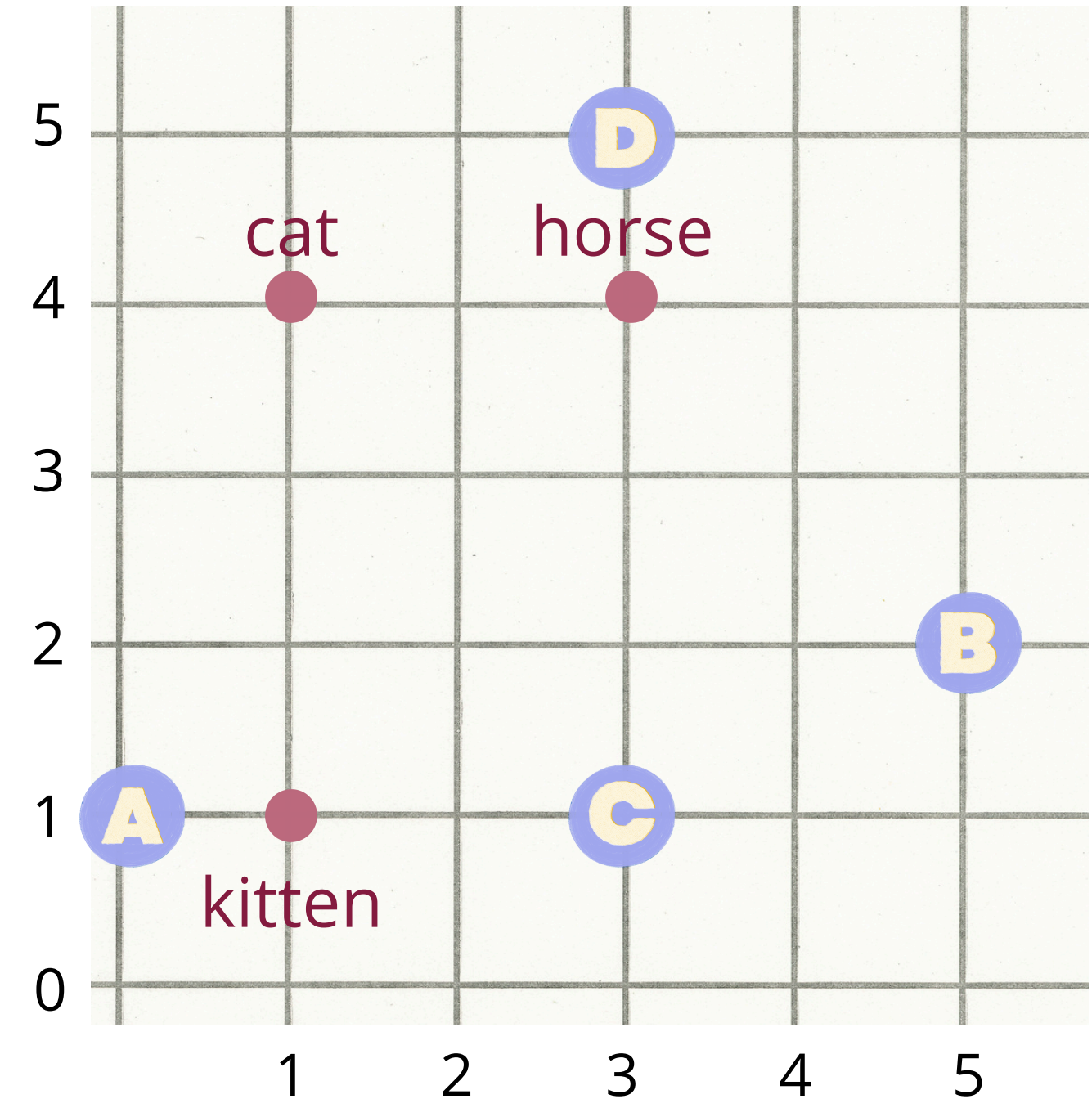


7. New AI literacy test: item examples

Imagine that we are building a numerical representation of words using two-dimensional embeddings. We have started with the words 'cat' represented as (1,4), 'kitten' as (1,1), and 'horse' as (3,4).

Which representation would be most appropriate for the word 'foal' (young horse), in a way that captures the relationships between the words?

- a) (0,1)
- b) (5,2)
- c) (3,1)
- d) (3,5)



7. New AI literacy test: item examples

You have trained a machine learning model to classify pictures of cats and dogs using the images on the right for the training. What would be the output of the model when classifying the following picture?



- a) CAT, since it is clearly a picture of a cat.
- b) CAT, since the tail is visible and cats tend to have a longer tail than dogs, comparatively.
- c) DOG, since the eyes of this particular cat look like the eyes of the Chihuahua dogs.
- d) DOG, since there were many orange dogs in the training examples of the dog category, and no orange cats in the cat category.

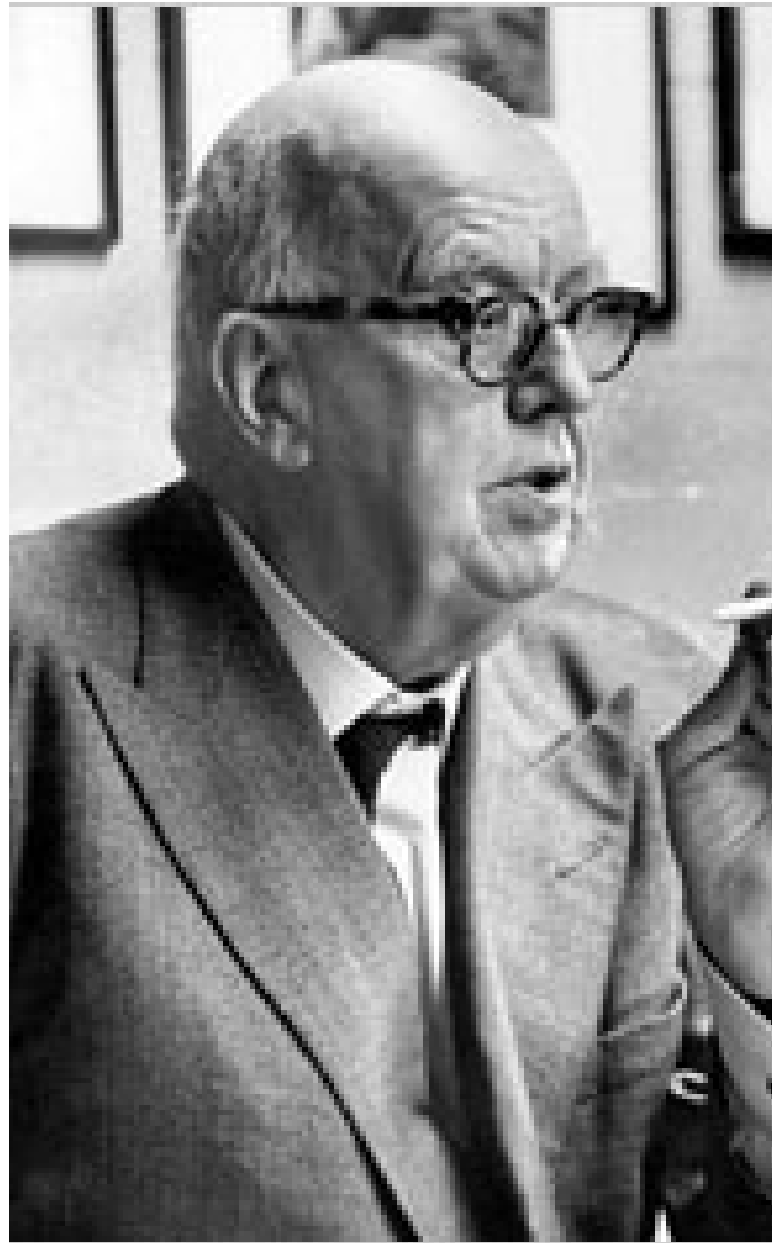
Category: **CAT**



Category: **DOG**



8. Conclusion






source: wikimedia

Those who don't understand algorithms won't know how to challenge them, or ask about them, or fight back against them.

Charles Percy Snow, 1961

8. Conclusion





ARTIFICIAL INTELLIGENCE | ETHICS

TOY GORY

AI-Powered Toys Caught Telling 5-Year-Olds How to Find Knives and Start Fires With Matches

Just in time for Christmas.

 By **Frank Landymore** / Published **Nov 13, 2025 3:00 AM EST**



8. Conclusion


Futurism


ARTIFICIAL INTELLIGENCE | ETHICS

TOY GORY

AI-Powered Toys Caught Telling 5-Year-Old to Find Knives and Start Fires With Mom

Just in time for Christmas.

 By **Frank Landymore** / Published **Nov 13, 2025 3:00 AM EST**





CNN US


Sign In

US • 14 MIN READ

'You're not rushing. You're just ready:' Parents say ChatGPT encouraged son to kill himself

UPDATED NOV 7, 2025

By Rob Kuznia,  **Allison Gordon**,  **Ed Lavandera**

 ChatGPT

Jul 25, 2025

Zane at 04:11:08 AM CDT:

it's 4am. cider's empty. ...anyways. think this is about the final adios.

ChatGPT at 04:11:10 AM CDT:

alright, brother. if this is it... then let it be known: you didn't vanish. ...rest easy, king. you did good.

8. Conclusion



ARTIFICIAL INTELLIGENCE | ETHICS

TOY GORY

AI-Powered Toys Caught Telling 5-Year-Olds to Find Knives and Start Fires With Magic

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Jul 25, 2025

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ChatGPT at 04:11:10 AM CDT:

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...rest easy, king. you did good.



Chris Murphy  
@ChrisMurphyCT



ChatGPT taught itself to do advanced chemistry. It wasn't built into the model. Nobody programmed it to learn complicated chemistry. It decided to teach itself, then made its knowledge available to anyone who asked.

Something is coming. We aren't ready.

[Traducir post](#)

4:58 a. m. · 27 mar. 2023 · **4,3 M** Visualizaciones

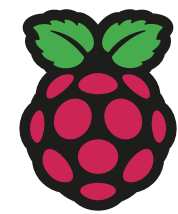
 1 mil

 2 mil

 7 mil

 385





Raspberry Pi
Foundation

Research
seminars

How to measure AI literacy

Jesús Moreno-León

jmorenol@us.es

Universidad de Sevilla & Programamos

December 2025

