Common School Notions to De-anthropomorphize AI. A High School Workshop Experience

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Abstract

Anthropomorphic representation of AI, emphasized by the ChatGPT media wave, was an obstacle set aside in a workshop on expert systems and machine learning applications. The experience involved the fifth-year classes of the Information Systems Articulation at the Technical-Economic High School "Jacopo Barozzi" in Modena. The students understood the statistical recombination work that GPTs do, but overall broadened their vision of what historically has been defined time to time as AI. Then, doing an exercise in Prolog followed by examples of machine learning paradigms, they focused on the differences between the two branches. It emerged a need of curricular applied mathematics, especially statistics. On the positive side, that workshop gave students a pragmatic and familiar attitude toward AI applications.

Keywords

AI anthropomorphism, AI teaching, AI popularization, Neural networks, Expert systems

1. Introduction

Contextualization of AI psychologized jargon and recalls of logic and mathematical notions made it possible to affordably introduce GPTs, expert systems, and neural networks to fifth-year classes of the "Jacopo Barozzi" Technical-Economic High School in Modena, Italy. These paradigms, freed from their psychological aura, were practiced by students through computer exercises. The students perceived the continuity between these examples and ordinary software programming as well as applied mathematics studies. The philosophical question of AI, along with the actual communicative and commercial use of the related terminology, emerged from time to time in the conversation. This brief treatise does not make a list of common school notions useful to de-anthropomorphize AI. Instead, it describes how an experience of plain interactive teaching, with typical mathematic and logic notions, can counteract a sort of popular mythology about AI now dazzling people.

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2. The "Jacopo Barozzi" High School workshop experience

2.1. General information

- Period: early 2023.
- Design and conduction: Ermanno Zuccarini, tenured teacher in computer science.
- Classes involved: four 5th-year classes of the Information Systems Articulation.
- Hours for each class: two.
- Criteria for effectiveness evaluation: observation of attention, interaction, and questions asked, followed by final brainstorming.

2.2. Objectives

The primary goals of this workshop were to:

1. Provide foundational knowledge of AI, with a historical perspective and a focus on logic-mathematical grounds. This frames psychological analogies with human cognitive processes as a matter of exterior perception.
2. Propose and facilitate hands-on activities in three key areas: GPTs, expert systems, and neural networks, where students experiment with online applications.
3. Encourage students to apply insight thinking to the practical exercises done.
4. Prepare students, as future economic operators, to critically evaluate commercial proposals for AI products and services, as well as periodic media waves about topics related to computer science.

2.3. Structure

1. History and articulation of AI. Far more than ChatGPT.
2. Inner functioning of text generators. A Chinese room metaphor.
3. Reliability and transparency: knowledge bases, inference engines, and expert systems.
4. Textual GPTs vs Wolfram Alpha.
5. Insights into machine learning:
    a) Machine learning and specifically neural networks.
    b) Generative adversarial networks: images, sounds, and deep fakes.
    c) Real-world machine learning is opinion-led: keep mastering it!
6. Beyond AI - Toward hybrid brain-machine intelligence.

2.4. The workshop in detail

2.4.1. History and articulation of AI. Far more than ChatGPT

Initially, the students on the question "What is AI?" identified it with ChatGPT. Only two students mentioned robotics. At that time ChatGPT was the "secret" tool helping in homework. Immediately, their perception was contradicted, giving them a brief overview of AI history and shifting definition, which covers with its vision the frontier of computer science themes from

time to time. It was used a conceptual map derived from the topics of the handbook *Artificial Intelligence: a Modern Approach*[1]. It was integrated with the branch subdivision of machine learning taken from the course for engineers *Intelligenza artificiale e machine learning*[2]. Each concept was followed by an elementary example. Finally, students were warned about the risks of media shouted topics: a professional must have a wider, deeper, and more balanced culture.

2.4.2. Inner functioning of text generators. A Chinese room metaphor

After the introduction of AI branches, it was time to connected to the students' AI background, briefly making them guess the basic text generation principle of a generative pre-trained transformer - GPT. They made a simple mathematical addition exercise with InferKit, a no longer active GPT. It was less mature than ChatGPT, which at that time was not usable due to being constantly overloaded by traffic. The result of their exercise on InferKit was a wrong number, followed by an improvised and out-of-place tale. It was then projected to the classroom a different exercise, where a story was started and InferKit continued with inspiration and compelling language. Why was the latter result brilliant and theirs disappointing? For making them guess, an imaginary situation was introduced, originally reinterpreting the John Searle's Chinese room [3]. The class, not knowing the Chinese language, have to develop a brief essay on a subject indicated them in a phrase written in Chinese language, without explanations. It is forbidden to consult dictionaries and handbooks regarding Chinese language, but they have available 20000 books written entirely in Chinese. It was specified them that it is a very challenging question, the they were let think for ten seconds before giving a suggestion. In one class a student guessed to proceed imitating recurrent combinations of Chinese ideograms. After this pause of reflection, they were suggested to think about text prompter systems. At this time many students gave an answer based on statistic imitation. Now the results of the exercises with InferKit had an explanation. The mathematical one showed that InferKit does not understand the meaning of the writing. The storytelling although resulted brilliant because there are no rules in creativity, while the unexpected and fluid matching of words gives artistic value. In both cases the writing proceeds by blind, inexplicable and unpredictable imitation of previously "ingested" text, not necessarily reliable. All this stochastic work is possible because single words and their "proximity" to other ones are internally managed with numbers by the computer. Hence the large language model - LLM. A sample of LLM was showed, where a list of words is associated to qualities in different percentages. These numbers could be gradually updated with insertions of new text or corrections: this, metaphorically, is the "learning" process. Also the more refined tokenization was cited them. At that point the anthropomorphic traits of GPTs were perceived by the class as an only superficial appearance and some students spontaneously cited clamorous mistakes and biases of ChatGPT they had seen in YouTube videos. To lighten the lesson a real anecdote was told to the class. A student of another school, brilliant but one day not prepared in history, was questioned on "what Machiavelli thinks about mercenary troops". After a pause, he assertively started to imitate typical discourses made during the history course. The teacher who questioned him kept hearing and after two minutes said admired: "You are creating!". The students of the workshop stated that ChatGPT, like InferKit, has always to keep talking in an assertive way. By its statistic imitative nature it makes no distinction between proven facts and invention. A critical remark on mass popularization of ChatGPT at this point

was brought to the attention of the class: average people is impressed by extraordinaryness, not sober and articulated reasoning. Besides, popularizers not qualified, mainly freelancers, often repeat stereotypical messages. Now in 2024 OpenAI makes available impressive tools for personalized training. Hence it is even more needed an educational work that goes to the root of GPTs functioning.

2.4.3. Reliability and transparency: knowledge bases, inference engines and expert systems

The lesson continued introducing the topic of controllable and hence reliable natural language processing, based on facts, rules, and inferences. The solution dates back to the 1970s: the expert systems. Firstly, the class practiced with a small Prolog exercise on the Swish platform [4], then performed a brief query test on Wolfram Alpha [5] and finally was guided to make a comparison with expert systems and textual GPT-based models, also prospecting hybrid solutions. The exercise in Prolog on Swish started with the following code already written:

```
% Facts
friend(vincenzo, miriam). friend(marcello, miriam). friend(giovanni, vincenzo).
% Rules
common_friend(X, Y) :- friend(X, Z), friend(Y, Z).
% Example queries
/** <examples> ?- friend(X, miriam). ?- common_friend(giovanni, vincenzo). ?- common_friend(marcello, X). */
```

The students had never seen before Prolog, but they knew relational databases and relative queries in SQL. It was prompted them an analogy between rules in this knowledge base and conditions after the "where" clause in SQL queries. Rules are stored together with the database, hence the enriched definition of *knowledge base*. Rules are run by the *inference engine*, deriving new facts that could be stored into the knowledge base. Hence a form of *learning*. A pause was needed to make them guess, or search, the meaning of "inference". Then a similitude was indicated them between the separation of two parts of a rule marked by ":-" and the "if-then" in imperative programming. Describing the particular disposition of words in the code, it was mentioned them, without detailing, the first order logic and the previous logics incorporated in it. It was outlined also the slow evolution of philosophical logic through the centuries, from Aristotle syllogisms to the 20th century achievements. All this makes now possible computerized logic programming. Students had some uncertainty about the meaning of X,Y,Z and their difference compared to concrete names. This gap showed their difficulty to transfer into a new language the concepts of abstract variable and universally valid rule. Overcome this difficulty, they were asked to write a query to obtain a list of "who is friends with whom". The answer "?- friend(X, Y)." was deduced with mutual help, hindered by some errors in Prolog typing. Understood the core functioning of an expert system, it was time to try the performances of a fully developed one: Wolfram Alpha. The students were asked to insert into the prompt a beginning of a story. This time the answer was not narrative at all. Lists and tables of data were shown. Why this type of output? The students hadn't addressed yet web interfaces for databases, then some hints were given to correlate that kind of output with the previous queries in Swish and their experience in SQL querying. Another trial on Wolfram

Alpha was done asking a question related to school subjects. This time the response was a page full of tables, graphs, photos and lists. It was made them notice that the input written in natural language is translated into a query, and Wolfram Alpha shows different alternatives regarding the meaning of the input, e.g. different possible queries to activate. The discourse was concluded adding that expert systems have often, in addition to the core, sophisticated input and output modules. Regarding the output, a further step could be the transformation of schematic data into a fluent discourse, using a GPT. To complete the topic, were presented work samples of an internationally recognized software house of Modena, Expert AI[6], centered on unstructured text data and natural language processing. Its previous name was Expert System. The core technology of the company involves expert systems, machine learning and large language models, also in hybrid solutions. Finally, students were asked what differentiates a human expert from an expert system. At that point their answers outlined a not entirely satisfactory picture. Their limited language skills hindered them. Furthermore, they found not intuitive an analogy between their school research experience and that of experts.

2.4.4. Textual GPTs vs Wolfram Alpha

The students drew conclusions about the differences between InferKit and ChatGPT on one side and Wolfram Alpha on the other. The first two make a puzzle game based on previous texts scraped from the web in a cheap way. The latter has an accurate knowledge base, developed and filled by experts with long and expensive work. Why the much greater popularity of ChatGPT? Some students admitted the obvious:

- It offers ready-made content.
- It makes fewer mistakes than students - in the most treated, then repeatedly scraped topics on the web, I added.
- Its fluent talking resembles impressively the human one - unlike historic attempts of natural language processing based on more traditional programming.
- It is self-improving, and this resonates greatly in popular narratives about AI.

At that point, it was time to better understand machine learning.

2.4.5. Insights into machine learning

Machine learning and specifically neural networks There was no time left for an explanation of the main machine learning paradigms, so only some concepts were focused. We are talking about statistics, functional analysis... where the term "learning" means progressive adjustment within mathematical models. This has nothing to do with the far more complex and different biological functioning of the human brain, which is instead studied by neurobiologists. And what about the most iconic paradigm, namely neural networks? A didactic example was shown, citing the origin in the 1940s, when McCulloch and Pitts made a simplified simulation of brain connections. It was remarked that their application, far from their origin and name, is a matter of statistical modeling[7]. This extends now to statistical imitation of text, images, and sounds, producing inedited ones, with the problem of undeclared deep fakes. Indicating

the numbers representing weights and biases on the network, forward and backward propagation were introduced. It was not possible to delve deeper because of their curricular lack of mathematical foundations. This topic was concluded by showing an overall picture of the main different neural network models, citing their respective more typical uses. Once again, it was pointed out to the students how this variety of functioning modes is way different from the biological brain work.

Generative adversarial networks - Images, sounds and deep fakes Once neural networks were introduced, the workshop continued with the intriguing functioning of a generative adversarial network (GAN). Two face pictures were shown, and the students had to guess which was a real photo or a computer generated one. They only focused on details quality. The generative face had smooth skin and the background was a confused combination of colors, due to the always varying real backgrounds in the archive photos. Then a more evident feature was object of hints: the real face was accompanied by partial representations of two other faces. But a neural network imitates; it does not reason. If asked to generate a face, it draws from an archive of images of single faces [8]. It was easy to illustrate the functional schema of GANs for image generation. This is possible because images are made up of pixels, coded with numbers by the computer. Hence, the statistical work of neural networks emerges. The class then exercised with an online generator generically named AI Image Generator [9]. Dall-E was not available yet. They were asked why some images were better detailed than others, thinking to the chosen subject. Some students correctly noticed that for common subjects maybe the generator draws on a higher number of archived images. A further notion was recalled. By combining multiple frames and audio, the latter also coded numerically, it becomes possible to generate new videos. The deep fake issue now was deepened, and the students brought some examples. This part was concluded by referring to an information sheet on deep fakes redacted by the Italian Garante per la Protezione dei Dati Personali [10].

Real-world machine learning is opinion-led: keep mastering it! Moving towards the workshop conclusion, I began talking about something completely different: the imperishable greatness of my favorite soccer team, Juventus, although showing a graph of its controversial progress during the current football season. The students joked and made fun of this. Then I seriously concluded that mathematics in the real world is a matter of opinion, asking them why. Only few students were able to distance themselves from the unbiased way school presents applied mathematics. In real world, where economic, social or just emotional issues are at stake, vested interest in data selection and processing methodology is always present. Machine learning is full of mathematics: you either will master it, or you will be mastered.

2.4.6. Beyond AI - Toward hybrid brain-machine intelligence

Throughout the workshop I brought back to symbolic logic or mathematics what externally could appear analogous to human psychology. But hybrid brain-machine intelligence is slowly progressing in a research stage. Admitting my total unpreparedness, I cited Elon Musk's Neuralink. Then I finished the workshop showing an experiment. In a YouTube video [11] dating back to 2008 a small wheeled robot appears that avoids obstacles. It was not guided by a

silicon processor but by a culture of rat brain cells. The culture survived just some days, but gave evident signs of learning by trial and error. This surprising, but not yet popular achievement, indicates that, while AI goes popular, far-sighted people have already to look at other knowledge, anticipating by years waves of uncritical enthusiasm and disillusionment with rationality.

3. Overall results

Giving students realistic insights into AI, with symbolic logic for expert systems and mathematical hints for machine learning, they gained a critical approach to the actual media wave. In this way, they became better prepared for work and life situations where they have both to evaluate commercial solutions regarding AI technology and to use them consciously. They understood that anthropomorphization of AI gives it communicative impact, but a sober approach based on traditional disciplines, like the one imparted to them during this educational experience, is far more clarifying. The workshop was characterized by an attitude of high attention. During the final brainstorming, the students had to recall the basic concepts they had learned. In most cases, they expressed not generic words that invoke human-like intelligence but technical terms. This indicates a good effectiveness of the initiative, which gave them an attitude to start familiarizing themselves with AI applications. However, their lack of mathematical and statistical modeling skills in relation to concrete problems is an obstacle that deserves some consideration.

4. Threads of discussion

4.1. Comparison of the workshop with current trends, with possible improvements

The pioneering nature of the topic would require specific research. For a worldwide synthetic benchmarking, the reference goes to the article "A systematic review on how educators teach AI in K-12 education" [12], Liu et al., [2024]. The study offers a detailed overview of current trends, methods, and pedagogical strategies in K-12 AI education:

- K-12 AI learning activities are still primarily introductory.
- Experiential learning is prioritized to teach complex AI concepts.
- Collaborative learning is the most widely used strategy, often combined with project-based learning in higher grades.
- Intelligent agents are the most common learning tools, especially for advanced activities in higher grades.
- Qualitative assessments are commonly used, particularly to evaluate AI thinking in younger students.

The workshop described here falls within this framework, although its limit in time. Project-based learning is the most suitable methodology when a sufficient amount of hours is available, as I personally experimented in a workshop for the construction of minirobots[13]. Furthermore, it could be effective to make students try user-friendly construction tools for neural networks and also for classic operational research problems, such as the knapsack. Finally, a discovery

of AI paradigms could be based on group manual work, combining traditional materials and electronic devices - see Arduino kits. The reference goes to another AI workshop, *Lucy*[14], conducted in some middle schools in Modena by the software house Ammagamma.

4.2. Applied statistics preparatory to machine learning has to become curricular

During the workshop, I highlighted, to the students and the other computer science teachers present, that the future of computer science teaching is based on solid mathematical grounds. Besides, exercises on machine learning could demonstrate to students the utility of an otherwise abstract, hence harder, mathematics. To strengthen this argument I cite here my experience of previous workshops on neural networks. I conducted the first one in 2020 with my 4th-year students of the Computer Science Articulation at the "Guglielmo Marconi" Technical Industrial High School in Pavullo, Modena [15]. That time I tried to explain forward and backward propagation in a classification network for cats, with two input nodes converging into a sigmoid. The example was taken from a YouTube playlist of a good communicator, Riccardo Talarico [16]. The result was that the students had a very weak grasp of differential equations. So they were left only with a general idea of how a neural network learns. I made another attempt in 2022 with a 5th-year class of the Information Systems Articulation at the "Jacopo Barozzi". I showed a one-node input and one-node output neural network with a sigmoid, for a classification of a stock title as high or low. They exercised with GeoGebra in mathematically modeling the network and balancing weight and bias of the sigmoid function. But a gap emerged regarding the meaning and utility of building and fine-tuning a mathematical model. They had no experience of statistic research on the field, where a new mathematical model has to be built to correlate data and gain predictive capability. The conclusion is that applied statistical education has to be given as preparatory. Initially it has to be not computer-based, to forward then in ordinary spreadsheet statistic functions and finally in machine learning.

4.3. Why de-anthropomorphize AI

Recent research demonstrates, although evident, that AI is perceived by ordinary people in an anthropomorphic way [17], sometimes with apocalyptic premonitions [18]. The need to de-anthropomorphize AI in educational contexts, to better explain it with common school notions, is justified, among others, by these factors:

1. The AI movement of thought is framed within the scope of American philosophical pragmatism. Hence, the AI psychologized terminology has metaphorical nature, useful in practice but not referred to inner brain functioning. In addition, the philosophical nature of AI could be discussed in plain logic-mathematical terms, drawing on European rationalism instead of pragmatist psychology;
2. It is urgent an educational contrast to the uncritical and lazy use of GPTs, widespread mainly among students. In addition to known negative effects, a further subtle damage is caused by the continuous feeling of being outclassed by a machine, described as "intelligent".

3. A disciplinary distinction has to be made between AI and cognitivist psychology [19]. Cognitivist research was born in parallel with AI and intensively explored basic human cognitive processes through computer simulation, hence its related development with AI and the psychological terminology transferred to it. Since the 1990s, cognitivism declined, and in a profound revision loosened its bonds with computer science. Generally, apart from niche brain studies, designers and programmers of AI applications reason on concrete rational problem solving, not on some imitation of the complex inner human psychology.
4. It has to be highlighted that applied AI is based on disciplines widely present in the traditional education system: operational research, symbolic logic, statistics, etc. whose evolutionary history largely precedes computer science and continues intertwined with it.

5. Concluding remarks

The workshop presented above in detail contributes to fill a gap in the Italian school system. It could be replicated and transformed in an open-learning way. Conclusions on its details have already been exposed above. This experience shows that, also in a few hours, it is possible to transform the opinion of students about AI. The current media wave turns AI into something "real", or worse, into a commercial label in vogue. But its inner functioning, which is commonly perceived as not understandable and reserved to "geniuses", could instead become approachable and even familiar. The school does not realize it yet, but has already the notions and sober attitude to give its distinctive contribution.

References

[1] S. J. Russell, P. Norvig, Intelligenza artificiale - Un approccio moderno, UTET Università, 1998.

[2] G. Barone, n.d. URL: https://www.unioneprofessionisti.com/corsi-di-formazione-in-e-learning/corso-online-di-intelligenza-artificiale-e-machine-learning/.

[3] J. R. Searle, Minds, brains and programs, Behavioral and Brain Sciences 3 (1980) 417–424. doi:10.1017/S0140525X00005756.

[4] Swi-Prolog, n.d. URL: https://swish.swi-prolog.org/.

[5] Wolfram Alpha, n.d. URL: https://www.wolframalpha.com.

[6] Expert.ai, n.d. URL: https://www.expert.ai.

[7] B. Warner, M. Misra, Understanding neural networks as statistical tools, The American Statistician (1970). doi:10.1080/00031305.1996.10473554.

[8] Divisio, Deep fakes - how to spot faked images, 2020. URL: https://divis.io/en/2020/05/deep-fakes-how-to-spot-faked-images/.

[9] D. A. Inc., Ai image generator, n.d. URL: https://deepai.org/machine-learning-model/text2img.

[10] G. per la Protezione dei Dati Personali, Deepfake: dal garante una scheda informativa sui

rischi dell'uso malevolo di questa nuova tecnologia, 2020. URL: https://www.garanteprivacy.it/home/docweb/-/docweb-display/docweb/9512278.

[11] K. Warwick, Robot with a biological brain, 2008. URL: https://www.youtube.com/watch?v=wACltn9QpCc.

[12] X. Liu, B. Zhong, A systematic review on how educators teach ai in k-12 education, Educational Research Review 45 (2024). URL: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85205540124&doi=10.1016%2fj.edurev.2024.100642&partnerID=40&md5=8ca559583529aad8b522d9aaa0dcc397. doi:10.1016/j.edurev.2024.100642.

[13] E. Zuccarini, Smartevolution - project based learning per il making di mini robot e soluzioni domotiche, in: AICA (Ed.), Atti Convegno Nazionale DIDAMATiCA 2018 'Nuovi metodi e saperi per formare all'innovazione', Milan Italy, 2018, pp. 137–146.

[14] Syllabus Lucy - Conoscenze, abilità e competenze nel percorso di educazione all'intelligenza artificiale, 2021. URL: https://ammagamma.com/wp-content/uploads/2024/07/syllabus_lucy_giugno22-1-1.pdf.

[15] E. Zuccarini, Dalla filosofia di dennett alle reti neurali, in: AICA (Ed.), Atti Convegno Nazionale DIDAMATiCA 2020 'Smarter School for Smart Cities', Milan Italy, 2020, pp. 252–257.

[16] R. Talarico, Introduzione alle reti neurali, 2018. URL: https://www.youtube.com/playlist?list=PLWsj_wWfrevVByO9IXQ3j9SKZgUSrDUFQ.

[17] A. A. Dydrov, S. V. Tikhonova, I. V. Baturina, Artificial intelligence: Metaphysics of philistine discourses, Galactica Media: Journal of Media Studies 5 (2023) 162–178. doi:10.46539/gmd.v5i1.302.

[18] A. Mascareño, Contemporary visions of the next apocalypse: Climate change and artificial intelligence, European Journal of Social Theory 27 (2024) 352–371. doi:10.1177/13684310241234448.

[19] D. R. Moates, G. M. Schumacker, An Introduction to Cognitive Psychology, Wadsworth Pub Co, Belmont, CA, USA, 1980.