
SCIENCE EDUCATION AND ARTIFICIAL INTELLIGENCE – A CHATBOT ON MAGIC AND QUANTUM COMPUTING AS AN EDUCATIONAL TOOL

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Abstract

Artificial Intelligence (AI) has entered the realm of higher education and has become an impressive emerging field. Since AI is starting also to be applied to Science Education, here an essay is provided while the opportunities of AI in a particular case of Science Education are reviewed and assessed, namely a chatbot on Quantum Computing, another awesome emerging field. Indeed, Quantum Computing is based on a set of principles that are difficult to understand by the general population, so the ultimate goal of such a chatbot is to learn a few complex concepts in this field and to increase public understanding and awareness of Science. Actually, AI is starting also to be applied to Science Communication, even though progress is not so advanced as in learning.

Magic tricks based on mathematical principles are especially well suited to teach difficult concepts, like those related to Quantum Science. They are used to explain entanglement, quantum cryptography, the superposition principle, and other quantum-related concepts – along with other physical and chemical core elements like Entropy.

Developing a chatbot is not especially difficult (e.g., with Botpress, Watson, Dialogflow, Manybot, etc.). One may build either scripted, intelligent, or application bots. Indeed, the first ones are those that are easiest to create, and correspond to the first phase of the current project. Intelligent bots understand natural spoken language and correspond to a second phase in this project. In general, Bots are connected to a real-world messaging service, like Facebook Messenger, Twitter, Telegram, Slack, etc.

Introduction

Machine learning, chatbots, learning personalization, and other artificial intelligence (AI)-related concepts have entered the realm of higher education. AI may be used to enhance

and power education, and augmented human intelligence (rather than taking decisions on its own) is an emerging field. AI is starting also to be applied to Science Communication, even though progress is not so advanced as in learning.

EU's Horizon 2020 initiative has pointed out that there are fewer students interested in STEM areas. Since magic is deeply related with the latest technological and scientific discoveries, it is a good vehicle for getting more interest into science and technology from young students. In fact, technical issues like turning up a lamp were already presented as a magic trick in the 19th century as a magical fact: the illusionist (Robert Houdin) claimed he turned up a candle. At that time people did not have electricity at their homes, so they were not used to lamps and it seemed to be something magical (i.e., impossible within natural behaviour). It is also part from the popular culture that magicians use mirrors to get surprising effects – another use of Science for conjuring.

On Magic, Science, and AI

Magic, the Science of Deception and Illusion, is much related to Psychology and Behavioural Sciences, and is actually a field of interest for consciousness studies. For that reason, Artificial Intelligence may be a useful tool to build up new magic tricks – and the opposite too: magic may be used to create artificial intelligence agents. Here a few, relevant sources on the use of AI in the field of intersection of Magic and Science are pinpointed.

A recent paper (Zaghi-Lara et al., 2019) by a team of neuroscientists and a magician showed how magic tricks played to deep neural networks untangles human deception. In such a paper, it was shown that humans and machine often behave oppositely regarding a particular magic trick.

Moreover, a few years ago, a leading Science of Magic research group (McOwan, Queen Mary Univ. London) developed new magic tricks using AI techniques (McMillan, 2014), thus creating new card magic apps for smartphones that are slightly different, more “intelligent”, than commonplace tricks performed by conjurors. The same group published another paper (Williams & McOwan, 2017) involving intelligent search of the Internet to create new magic tricks.

Literature on magic, illusion and AI is scarce, but nice examples may be found every now and then, for instance, blurring the line between human tasks and automation (Primlani, 2019). A nice paper (Sharkey & Sharkey, 2006) also deals with this issue: deception as an integral part of AI and robotics (on automata and their relationship with conjuring).

AI has been compared (probably in an unjustified way) negatively (Doctorow, 2019), where AI itself is perceived like a magic trick: “amazing until it goes wrong, then revealed as a cheap and brittle effect”.

Indeed, the current wealth of AI apps for pattern recognition, mimicking creativity (e.g., emulating someone’s paintings, songs, or literature) may yield to new forms of impossibility in magic performances. Moreover, AI may be used as an (obscure) excuse to justify the illusion of impossibility: for instance, in the trick entitled “Instant Personality Test” (Messina, 2020), AI is seemingly used for guessing someone’s personality, which makes the trick stronger than ever.

Even cheap new tricks are sold involving use of the two “magical” words “Artificial Intelligence” (Smiffys, 2016). And one must not forget magic performed by robots (an updated version of automata playing magic tricks in the 19th century) (Rosenbluth, 2018).

On Quantum Mechanics and Quantum Computing

Quantum Mechanics is based on a set of principles that are difficult to understand by the general population. Several games based on mathematical tricks have been created to pinpoint the key aspects of Quantum Science. Currently, their online versions are being created – that result into a scripted chatbot, later to become an intelligent one.

Playing cards are quite useful because black and red cards may represent values 0 and 1 for qubits (and bits, of course). This allows to present the Superposition Principle in Quantum Mechanics, leading to a metaphoric Schrödinger’s Card. Further, entanglement has also been tackled, using card magic Gilbreath’s First Principle. Card magic may thus be used to provide a learning path to quantum gates used in quantum computing. Similar games are used to explain in a plain way quantum cryptography, using hints about the use of De Bruijn’s extension to Gilbreath’s Principle as applied to Quasycrystals in order to understand it.

Those techniques have been used to explain Quantum concepts in Science workshops, talks, and fairs for a few years, and have verified their usefulness in formal and informal educational environments. This has led to use of Magic in University teaching and Public Understanding of Science. Moreover, Magic has been used as a tool for professional development, because Magic improves communication, theatrical and rationale skills, which are of utmost importance in Higher Education.

Magic has been successfully used in Higher Education, especially to enhance experiments related to key areas of chemistry, but also in physics and biomedicine. Not only does Magic

provide the illusion of impossibility, but it does also enhance the reality of teaching and learning.

On Science Communication and AI

Dealing with the area of intersection of Magic, Science and Education follows the main purpose to use Magic and Illusionism to increase public awareness and understanding of Science. Use is made also of scientific concepts and rationale to explain either superficially or in depth magical effects. Moreover, Magic is dealt with to improve teachers' professional skills and to develop new developments in university education.

Such an innovative and research effort in this field has allowed to enter the realm of formal and non-formal education at all levels, from children education to high school students, up to higher education. Experience shows that magic provides increased learning opportunities and leads to a more inclusive education, because of learning being made more attractive.

Experience with workshops and shows at schools, universities, street level and stage theatres has led to consider magic as a very relevant tool to cohesionate communities, especially suitable for underprivileged environments. Moreover, the public is far more engaged with science if it is presented in an attractive way.

Magic is also used in mentally handicapped people through a therapeutic activity. Moreover, magic is currently used with hospital patients along with other entertainer volunteers.

Finally, there is another social impact of magic: as a very relevant tool for communication skills and for personal development – namely that of shy individuals.

Artificial Intelligence plays a relevant role in Science communication (yet less important than in personalized and online learning): it may allow researchers to digest the enormous amount of scientific information created by scholarly journals. One does not longer have the time needed to keep with publications and bibliographic references of likely interest, so probably a bot may do much better to curate content. Moreover, artificial intelligence may help in science communication in a way similar it will do in general communication and publishing.

For instance, a recent paper (Zandan, 2017) has tackled the way people will communicate in the future, by considering “hybrid thinking” and an interplay between human and cyber intelligence. AI writing bots have been proposed to revolutionize science journalism, even substituting the very journalists, and AI may lead to bots writing real news stories about

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science discoveries. Actually, AI algorithms are already summarizing scientific research papers and automatically turning them into simple press releases and news stories. Indeed, one the main drawbacks (or advantages) of AI is that it will have no emotional or heated responses.

Mundane tasks are likely to be carried out by machines letting scientists focus on bigger questions of research and development and contribute to supporting science journalism. Moreover, there are already examples of AI taking care of routinely tasks of creating movie trailers or science videos, thus helping scientists to become better communicators (and fulfilling the new challenges of disseminating original research). Finally, AI can expedite scientific communication and eradicate bias from the publishing process: the current publishing models has created an opportunity for predatory journals and publishers that should be solved – AI may help in the reviewing process and the assessment of quality and high standards.

Conclusions

As far as higher education is concerned, magic has been successfully use to enhance experiments related to key areas of chemistry. Classical magic tricks have been also adapted to teach and enhance learning of complex concepts related to physics, chemistry and biomedicine.

Besides the aforementioned game on Quantum Computing, a modified version of a classical card trick has been developed to explain entropy – as a measure of disorder and as a non-observable thermodynamical property in Nature, since entropy is linked to the arrow of time. Indeed both games carry a large amount of deception and surprise.

Mystery brings about a strong impact on participants, while causing them to know about awesome science and difficult concepts. And indeed, secrecy provides a continued anchor with Science – and an extrapolation of the learning process. Artificial Intelligence fosters interaction and impact with students and citizens, so a Chatbot is very convenient and justified – thus being developed to further enhance the user experience towards Science.

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