

# COVID-19 pandemic and artificial intelligence: challenges of ethical bias and trustworthy reliable reproducibility?

Casimir Kulikowski ,<sup>1</sup> Victor Manuel Maojo<sup>2</sup>

**To cite:** Kulikowski C, Maojo VM. COVID-19 pandemic and artificial intelligence: challenges of ethical bias and trustworthy reliable reproducibility? *BMJ Health Care Inform* 2021;**28**:e100438. doi:10.1136/bmjhci-2021-100438

Received 01 July 2021  
Accepted 17 September 2021

Rapid vaccine breakthroughs for the SARS-CoV-2 viral pandemic have been enabled by genomics-based designs and biomedical informatics-driven experimentation relying on many algorithmic and artificial intelligence (AI) methods. Great hopes expressed about informatics for the humanitarian amelioration of pandemics internationally depend on data analytics and AI for predicting COVID-19 spread and public health prevention measures, diagnoses and treatments. Yet, bioinformatics-enabled vaccine development has turned out to be the only truly indispensable technological work-around compensating for the tragic worldwide shortcomings in pandemic responses and insufficiencies in epidemiological genomics data infrastructures.<sup>1</sup>

Any AI in a healthcare informatics system must target recommendations and actions to individual patients and this requires high-quality relevant data to be extracted and prioritised from heterogeneous mixes of statistics, for which much more sophisticated and reproducible methods of semantic annotation, knowledge-based design and cross-validation are needed than commonly used today. These need to build on experience with multiple methods of expert-knowledge representation and inference beyond purely data-driven machine learning. Especially important is to identify high-risk or vulnerable subpopulations to avoid biased misapplication of machine learning and other AI techniques that could exacerbate healthcare inequalities during the COVID-19 pandemic and beyond.<sup>2</sup> Natural language analysis has become a major enabling breakthrough for extracting information from the literature and from big data sources, such as electronic health records, laboratory tests, public databases and others. Combined with

image analysis, there are initial prototypes and great expectations reported for tracking the COVID-19 pandemic.<sup>3</sup> Yet, unfortunately, machine learning methodologies for producing personalised diagnostics and therapeutics are still largely fragile, unexplainable and often insufficiently reproducible.<sup>4</sup> Serious medical actions cannot be algorithmically and automatically taken without review and integration with final decision-making judgments of human experts, who draw not only on their experiences in interpreting statistical data subjectively but are also required to take clinical and legal responsibility for the ethical treatment of patients.<sup>5</sup> Expert professionals cannot be totally replaced by algorithmic or AI 'Chatbots', so admired for efficiency in business or entertainment IT. And even in these less ethically challenged fields, automated software rarely truly satisfies the needs of customers. An extensive review of AI machine learning methods for predictive modelling of COVID-19 infections from lung CT images concluded that a majority of models were at risk of being biased, leading to unreliable results, noting that: 'In their current reported form, none of the machine learning models included in this review are likely candidates for clinical translation for the diagnosis/prognosis of Covid-19'.<sup>6</sup>

The above conclusions coincide with the authors' experience in biomedical AI over many decades.<sup>7</sup> Better and thoroughly tested and evaluated models are needed to explain human-machine reasoning under risk and uncertainty. Because the rapid onset of the COVID-19 pandemic required correspondingly urgent responses, most COVID-related AI tools did not undergo comprehensive evaluations, including for those for ethical use, although history has shown this to be essential for clinical systems. An urgent



© Author(s) (or their employer(s)) 2021. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

<sup>1</sup>Department of Computer Science, Rutgers University, New Brunswick, New Jersey, USA

<sup>2</sup>Artificial Intelligence, Universidad Politecnica de Madrid, Madrid, Spain

**Correspondence to**  
Dr Casimir Kulikowski;  
kulikows@cs.rutgers.edu

undertaking to make the current predominantly data-driven AI methods (eg, deep learning) clinically usable is to develop innovative advanced cognitive models that are humanely explainable, and ethically driven knowledge-and-experience-based. The COVID-19 pandemic reinforces lessons that for AI to be effective, unbiased and reliably trustworthy for patient care in clinical epidemiological settings, novel AI approaches are urgently needed. These will have to be highly problem focused,<sup>8</sup> so the best expert judgments can exploit specific clinical phenotypes from precision medicine developments to interactively, securely, and in clearly explained ways take advantage of the latest computational techniques of structured, indexed data and knowledge base design.

In summary, AI has been key in producing computational genomic analyses and techniques essential for the exceptionally rapid development of COVID-19 vaccines, but expectations that it will play a substantial role in clinically helping handle the current pandemic remain premature, largely based on inadequately tested early prototypes. Lessons learnt during the present COVID-19 pandemic will all have to be critically reviewed and completely new, human-interactive and humanely tested AI developed beyond current data-analytical insights, so the world can respond more effectively with unbiased ethical responsibility to pandemics in the future.

**Contributors** Each author contributed equally to the writing of this article.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Provenance and peer review** Commissioned; externally peer reviewed.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

#### ORCID iD

Casimir Kulikowski <http://orcid.org/0000-0002-0625-1666>

#### REFERENCES

- 1 Kulikowski CA. Pandemics: Historically “slow learning curve” leading to biomedical informatics and vaccine breakthroughs. *Yearb Med Inform* 2021;30:290–301.
- 2 Leslie D, Mazumder A, Peppin A, *et al*. Does “AI” stand for augmenting inequality in the era of covid-19 healthcare? *BMJ* 2021;372:n304.
- 3 Cury RC, Megyeri I, Lindsey T, *et al*. Natural language processing and machine learning for detection of respiratory illness by chest CT imaging and tracking of COVID-19 pandemic in the US. *Radiol Cardiothorac Imaging* 2021;3:e200596.
- 4 Roberts M, Driggs D, Thorpe M, *et al*. Common pitfalls and recommendations for using machine learning to detect and prognosticate for COVID-19 using chest radiographs and CT scans. *Nat Mach Intell* 2021;3:199–217.
- 5 Grote T, Berens P. On the ethics of algorithmic decision-making in healthcare. *J Med Ethics* 2020;46:205–11.
- 6 Wynants L, Van Calster B, Collins GS, *et al*. Prediction models for diagnosis and prognosis of covid-19: systematic review and critical appraisal. *BMJ* 2020;369:m1328.
- 7 Maojo V, Crespo J, García-Remesal M, *et al*. Biomedical ontologies: toward scientific debate. *Methods Inf Med* 2011;50:203–16.
- 8 Larson EJ. *The Myth of Artificial Intelligence: Why Computers Can't Think the Way We do*. Cambridge: Bellknap-Harvard University Press, 2021.