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EDITORIAL

Artificial Intelligence and Medicine: "times are a'changing"

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In the early 70s a seminal article introduced Artificial Intelligence (AI) in medicine[(1)]. Less than a decade later, a highly confrontational paper stated: "The most profoundly depressing of all ideas about the future of the human species is the concept of artificial intelligence"[(2)]. While a lot of progress happened since those early times, AI is still the cause of intense discussions. The decision to write about AI in this editorial, is certainly not an attempt to join this endless battle, but only to share our concerns about the risks of promoting AI, and its correlated sister areas: Machine Learning (ML) and Deep Learning (DL), as being mature technologies that are ready to revolutionize medicine and healthcare. It is undeniable (given the growing evidence) that those technologies are indeed extremely powerful and can disrupt current *status quo* in certain areas (e.g. image analysis and genomics analysis), but they are certainly not a panacea, not yet.

First introduced more than five decades ago, the evolution of those techniques applied to medical use-cases is parallel to improved processing power and storage capabilities at decreased costs, and an unprecedented wealth of data[(3)] being generated out of scientific and clinical systems (e.g. electronic health records, picture archiving and communication system, and omics). In reality, most of the conceptual foundations in this area are not new, but the combination of those advancements is helping the theoretical models finally become usable technologies, commodities even.

Translating science into practice is a big challenge that involves addressing generalization, regulatory, commercial and implementation issues. As in any device, drug or procedure the principle of "do no harm" must apply to AI technologies. New drugs need to go over well-defined approval process, an equivalent process is not available today for AI[(4)]. Most AI methods (ML and DL included) depend on the human annotations and the strategy for training, which ultimately means quality of the dataset used for the learning process. Works quite well for medical images, where the data quality is usually good to excellent. ML algorithms can be trained with datasets containing controlled human annotations, for instance radiology findings annotated specifically for this purpose. The quality of those annotations is a critical factor to define the accuracy of any proposed model, therefore a more standardized set of annotations produce better results. Another approach is to use plain EHR data as training datasets, higher volumes tend to compensate for increased variance. In those cases, the quality of the data derived from those systems can dramatically affect the precision of AI/ML/DL algorithms. The sad news is that even determining (quantifying) the quality of EHR systems data is still an unresolved problem[(5)], but it is clear that incomplete and noisy data can lead to bad results[(6)].

In the past few years some new expressions began to be increasingly used: big data and personalized medicine[(7)]. It is difficult to determine causality, but those novel areas are helping AI to resurge, as can be observed by the growth in publications [Fig. 1]. Figure 1 also shows that AI progress seem to influenced by the debut of new terms, like: "EHR systems" in the 90s, "precision medicine" and "big data" less than decade ago.

In summary, it is clear that AI/ML/DL are powerful enablers of a more targeted, evidence-based and intelligent medicine. Those are wonderful tools that can dramatically help healthcare become more efficient, affordable and accessible[(8)]. In reality, for certain uses in radiology and genomics, ML methods are the gold standards. But, at least for the foreseeable future, the human brain is still the main hub and master of this complex system, and definitely getting more and more powerful with the help of AI.

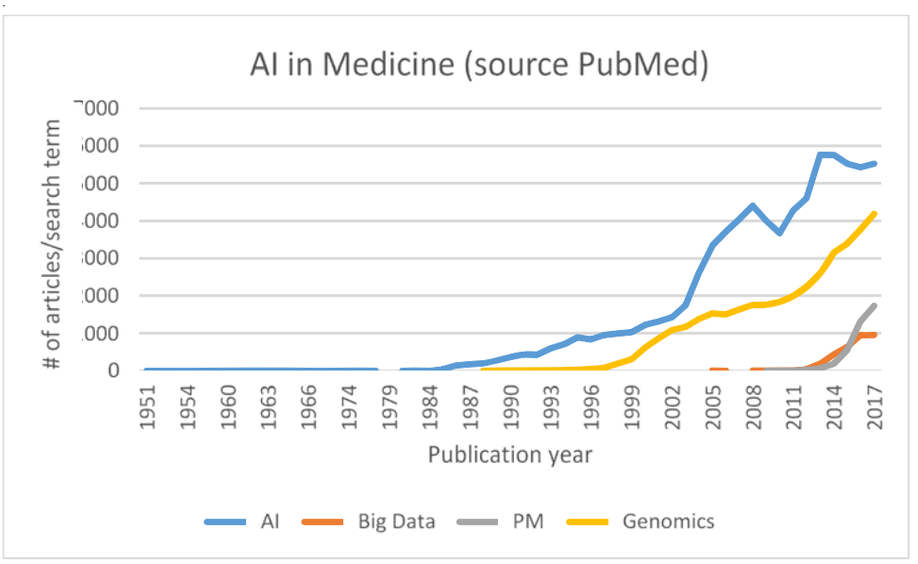

Figure 1 – Number of publications per year, using the following terms: Artificial Intelligence, Big Data, Precision Medicine and Genomics. The terms were present in the title or abstract of the publication. Queries were executed on PubMed (August 2018).

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