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Extended Abstract

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Digital revolution in medicine: new tools in biochemistry, molecular biology, medical science, education and research

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When you just think about it! The digital world has changed our lives in every way. Education, the days when teachers used chalk, dusters, and blackboards are almost at an end. Black has turned to white, in the form of interactive whiteboards. The white chalk is now digital ink Printed books. Over 92% of children in the United States carry backpacks that are typically loaded with heavy books that may set them up for spine strain rather than success. Now, those books are turning into e-books and audio books which thousands of them can be stored in a USB flash drive or cloud storage. They are versatile, searchable, portable and efficient, not to mention they are much easier on your back. Digital content has revolutionized the way people distribute and access information on virtually every platform. How medical Students Benefit from Learning with interactive e-books? What is the future for paper books and ebooks? The e-books market is growing!. The development of high-throughput, data-intensive biomedical research assays and technologies, such as DNA sequencing, imaging protocols, and wireless health monitoring devices, has created a need for researchers to develop strategies for analyzing, integrating and interpreting the massive amounts of data they generate. Although a wide variety of statistical methods have been designed to accommodate the 'big data' produced by these assays, experiences with the use of artificial intelligence (AI) techniques suggest that they might be particularly appropriate. In addition, the application of data-intensive biomedical technologies in research studies has revealed that humans vary widely at the genetic, biochemical, physiological, exposure and behavioral levels, especially with respect to disease processes and treatment responsiveness. This suggests that there is often a need to tailor, or 'personalize,' medicines to the nuanced and often unique features possessed by individual patients. Given how important data-intensive assays are to revealing appropriate intervention targets and strategies for personalizing medicines, AI can play an important role in the development of personalized medicines at all relevant phases of the clinical development and implementation of new personalized health products, from finding appropriate intervention targets to testing them for their utility. We describe many areas where AI can play a role in the development of personalized medicines, and argue that AI's ability to advance personalized medicine will depend critically on the refinement of relevant assays and ways of storing, aggregating, accessing and ultimately integrating the data they produce. We also point out the limitations of many AI techniques, as well as consider areas for further research. Modern biomedical science is guided, if not dominated, by many interrelated themes. Four of the most prominent and important of these themes. Personalized medicine, or the belief that health interventions need to be tailored to the nuanced and often unique genetic, biochemical, physiological, exposure and behavioral features individuals possess. The exploitation of emerging data-intensive assays, such as DNA sequencing, proteomics, imaging protocols, and wireless health monitoring devices. 'Big data' research paradigms in which massive amounts of data, say of the type generated from emerging data-intensive biomedical assays, are aggregated from different sources, harmonized, and made available for analysis in order to identify patterns that would normally not be identified if the different data points were analyzed independently. Artificial Intelligence (AI; which we consider here to include algorithms based machine learning, deep learning, neural network constructs and a wide variety of related techniques, which can be used to find relevant patterns in massive data sets. Bringing together research activities associated with these four emerging themes is not trivial, as it will require communication and participation from researchers and practitioners with a wide variety of skills and expertise, including molecular biology, genetics, pathology, informatics, computer science, statistics, clinical science, and medicine. AI will have a special role to play in this integration process if the goal is to advance personalized medicine, since it is unclear how relevant clinically-meaningful insights can be drawn from big data-generating assays that would complement or build off the insights from experts in different domains. In this light, there are a number of phases in the development of medicines, general interventions, and other products, such as diagnostics, prognostics, decision support tools, etc., where AI could have a significant impact. These different phases are emphasized in subsections of this chapter that describe and comment on recent studies leveraging AI. This chapter does not provide an exhaustive literature review of AI in medicine, however, as there are some excellent reviews for this, but rather considers the potential that AI has in developing new medicines, health devices and products. In particular, a focus on the need for greater integration across the various phases of the development of health interventions and products could result in very radical yet positive changes in the way medicine is practiced. In this sense, this chapter is as much a summary of the ways in which AI can be exploited in modern medicine as it is a vision of the future. As noted, the development of interventions and health products, as with the diagnosis and treatment of a patients, proceeds in different phases. There are various ways of defining and referring to these phases, however, and all of them point to opportunities for AI to have a substantial impact if leveraged appropriately.

Bottom Note: *This work is partly presented at EuroScicon congress on Biochemistry, Molecular Biology & Allergy* October 11 - 12, 2018 Amsterdam, Netherlands