

Watson

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Abstract

If Sir Arthur Conan Doyle created Sherlock Holmes as the character who excelled at everything, then why did he create Dr. John Watson? One response is that even the best of us are better with a partner who can compensate for our weaknesses and provide diverging perspectives that stimulate out-of-the-box thinking. Similarly, IBM's supercomputer Watson is among a new wave of artificial intelligences that can complement human skill sets, with applications in a wide variety of fields. Demonstrating promise as a physician's partner, Watson has found recent implementations in the healthcare system, particularly in treatment recommendations for different cancers and in research of therapeutic gene targets in patients. While Watson has many hurdles to overcome before it will see widespread uptake, the early studies that document its successful applications in healthcare are cause for excitement about the future of artificial intelligence in medicine.

Sherlock Holmes, the fictional private investigator created by Sir Arthur Conan Doyle, was a true Renaissance man.¹ The depiction of Holmes' unparalleled deductive reasoning is known to reflect the diagnostic acumen of Joseph Bell, one of Doyle's own medical school preceptors.¹⁻³ Doyle's reason for creating a second character, Dr. John Watson, to act as Holmes' partner and biographer may be elucidated by John Donne's quote "no man is an island."⁴ Doyle created a partnership that transcended the individual abilities of both Joseph Bell and Sherlock Holmes. Holmes benefitted from a counterpart who complemented his skill set, and in Dr. Watson he frequently found fresh perspectives: in the original canon, Dr. Watson is described as "a conductor of light" who was able to enhance Holmes' own genius.⁵ Hence, while Watson is by no means the protagonist of Doyle's most famous works, he remains a critical component of the dyad. Without him, Holmes is woefully incomplete. In the same ways that Dr. Watson contributed to Holmes' ability to solve a mystery, a supercomputer named Watson is learning how to help modern doctors treat disease.

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Watson has been in development by International Business Machines (IBM) Corporation since 2010. IBM's Watson is actually named after the corporation's first CEO, Thomas J. Watson, but there are uncanny parallels to be drawn between Doyle's detective duo and the partnership between physicians and Watson – for instance, the concept that even the best of us benefit from an ally who can compensate for our weaknesses. Though creative minds are finding ways to implement this technology in healthcare, IBM's original conception actually focussed on several applications predating the concept of AI in medicine. Watson succeeded IBM's previous supercomputer, Deep Blue, a world-class chess machine built with the singular objective of defeating the best human chess player alive – a feat considered the "holy grail" for computer scientists at the time.⁶ In 1977, Deep Blue, combining the wisdom of grandmaster chess experts with technological advances like multiprocessing technology, defeated World Champion chess grandmaster Garry Kasparov.⁷ In the match, Deep Blue's "massively parallel search" system was able to evaluate an average of 126 million positions per second.⁷ Deep Blue was a huge step for artificial intelligence, but was never applied outside of chess. It did, however, represent the possibility that unprecedented computing power could outcompete human beings in certain tasks that rely on logic-based decision making, and such tasks are inherent in medicine.

Following Deep Blue's success, Watson transcends existing artificial intelligence technology with advances in computational linguistics and natural language processing. Watson has been dubbed a deep question-answering (DeepQA) technology, for its ability to analyze text passages and provide scored responses indicating the strength of the evidence supporting each answer.⁸ DeepQA relies on semantic technology, which is the ability of a software to encode and categorize meaning separately from other types of data. This serves as the interface between humans, who are linguistically complex, and machines, which traditionally are not.⁹ In addition to its myriad of existing applications in areas like consumer profiling and solving algorithm-based problems faced by big business, Watson is projected to increase its functionality and field of application with the recent announcement that Deep Learning will be incorporated as a new service in the supercomputer. Deep Learning is a subtype of machine learning in which machines can "learn" as they work through datasets, by changing their internal parameters as they operate to improve performance in real-time.¹⁰ This novel technology is anticipated to provide a lower barrier to entry for scientists, developers, and business analysts by making high-throughput computing more accessible, affordable, and versatile.¹¹ Increasing utility and availability of digital imaging, as well as the digitization of health records, are among the current advances in healthcare which are expected to benefit greatly from Deep Learning and DeepQA.¹²

Moreover, Watson is gradually gaining recognition in a number of other non-medical spheres. In 2011, it won a highly publicized game of Jeopardy against legendary players Ken Jennings and Brad Rutter.¹³ Watson has also seen recent applications in a suite of commercial settings including Fortune 1000 companies, agricultural equipment, insurance agencies, and guide dog training programs. It has even been in a Superbowl commercial with Jon Hamm. In its first forays into medicine, Watson has garnered recognition as a companion to oncologists in the Watson for Oncology (WFO) program developed through a collaboration between IBM and the Memorial Sloan Kettering Cancer Centre.¹⁴ In a recent trial including patients with breast, lung, and colorectal cancers, WFO made treatment recommendations which had a 73% concordance with an expert multidisciplinary tumor board.¹⁴ As Watson iteratively learns to weigh patient nuances and co-morbidities, it has the capacity to become a very precise tool for assisting doctors in evidence-based treatment recommendations.^{15,16} Watson is also gaining application in the era of genomic medicine – its ability to process published data orders of magnitude faster than a human being can assist in determining actionable therapeutic gene targets in patients.^{17,18}

One of the key tasks of doctors, and one in which we can be outperformed by machines, is a domain in which Watson excels: keeping up to date with a seemingly infinite ebb of new research and creating a differential diagnosis along with reasoned likelihood of each, from a patient's presentation. However, Watson remains imperfect, with potential to make off-target errors. For instance, in its infamous Jeopardy debut, Watson responded “Toronto” to a question for which the answer was “Chicago” – not a trivial error in the context of patient care, where a similar error can have life-threatening consequences.¹⁹ In addition to issues of consistency, AI faces criticisms surrounding information confidentiality.²⁰ This serves to caution us against relying too heavily on artificial intelligence and failing to mediate it with our own human faculties of reason. However, the emerging evidence suggests that Watson and its derivatives will make valuable partners for physicians, either confirming their clinical suspicions or suggesting differential diagnoses that were not originally considered – striking role similarities between IBM's Watson and Doyle's Dr. Watson.^{14,16}

The landscape of medicine is changing, and Watson is certainly not the only technology jockeying for a position in this new market. Competing technologies are currently being developed and produced by Microsoft, Google, Intel, and a growing number of other companies. Each bears the reminder that even the best of us are better with help – similar to how the abilities of Sir Arthur Conan Doyle's Sherlock Holmes were enhanced by those of Dr. Watson. It is clear that patient outcomes and hospital efficiency can be improved when physicians work in partnership with artificial intelligence.²¹ In the decades to come we can expect to reach new frontiers in healthcare, and the proficiency of computers will make it all look elementary.

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