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SilverSky Insights:

The impact of *AI* on *Diagnostics*

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The impact of AI on Diagnostics

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What is AI?

Through improving transistor technology, computer processing capability has doubled around every two years over recent decades. Although this phenomenon, known as Moore's Law, may slow[i], these capacity advances, together with shrinking costs for convenient data cloud storage, mean that we can use computers to do more than ever before. This has brought us to realistic functional artificial intelligence (AI). General public understanding of this area may be limited, but alongside fears surrounding job redundancies and science fictional robotic takeovers, a general optimism that AI will improve lives exists[ii].

As opposed to natural intelligence displayed by humans, AI is intelligence demonstrated by machines, which we can exploit to enable computers to conduct tasks that would otherwise require human intellect. Commonly, we are asking computers to trawl through buckets of vast amounts of connected and somewhat organized data, recognize patterns (some of which we may even not be aware of) and then look for deviations from the norm. In doing so, we are learning that machines can process huge data volumes increasingly more efficiently, faster and more cheaply. The potential for machines to do our work better and then actually learn themselves how to further improve processes, known as deep learning, inspires great possibilities.

Not surprisingly then, AI is being adopted across a broad range of industries, from passport control to fraud detection, and is likely to remain one of the hottest topics of 2019[iii] and beyond.

AI in healthcare

AI is already widely employed across the health sector, from technology to manage fitness to robots performing repetitive laboratory tasks or complex surgery. Consumer wearables can facilitate rapid treatment for patients with heart disease through early detection of minor episodes, and safe independent living for the elderly through detection of inactivity or falls. Exploiting widespread mobile phone ownership, Babylon's Rwandan subsidiary babyl, for example, is also utilizing AI to deliver healthcare to individuals beyond the westernized world[iv]. The involvement of technology giants highlights both the clinical and financial potential in this area. For example, IBM's Watson for Health[v] can store and rapidly review vast amounts of medical information regarding symptoms, treatments and responses from journals and case studies.

The goal is to help healthcare systems to utilize global data and apply powerful analysis for impact on areas including efficiency, decision-making and coordination. Likewise, Google's DeepMind Health[vi] focuses on healthcare system support centered around the construction of learning algorithms into human brain-like neural networks. CEO Demis Hassabi expresses their ambitious mission "to solve intelligence and then to use that to solve everything else"[vii]

How can AI improve diagnostics (Dx)?

Among the most disruptive of healthcare applications is the potential for AI to predict or at least diagnose disease to enable preventative or rapid treatment, respectively. The aim is to detect conditions both *more accurately and earlier* than medical professionals are capable of, which would clearly deliver both *better clinical outcome* alongside *time and cost savings.*

One aspect of AI Dx is to create algorithms to replicate current diagnostic tools, such as reading medical scans. Two years ago, in February 2017, researchers at Stanford had already trained a deep learning algorithm on over 129,000 dermatological images and reported AI classification of cancerous skin lesions on par with expert dermatologists[viii]. They predicted future mobile apps which will offer image analysis outside the clinic at low cost. Likewise, deep learning algorithms have shown high sensitivity and specificity for the detection of diabetic retinopathy and macular edema from retinal fundus photographs, when compared to manual analysis[ix].

A breakthrough last year, in 2018, was Poplin *et al.*'s intelligent algorithm, trained on retinal images and medical information from almost 300,000 patients, which learned how to associate retinal features with cardiovascular risk factors (such as age and blood pressure) and thus predict cardiovascular risk from retinal images *beyond doctors' ability*[x]. While exciting, as expressed in the proceeding Nature Editorial[xi], such studies are still young and require full description of computational methods and data material, replication and rigorous testing in large trials before wider acceptance and ultimately routine adoption. This article cites the AI model that detected breast cancer from slide images better than doctors but points out that this was only the case when examinations were time-limited. While AI methodology was quicker, with no time restriction, human analysis was comparable and actually outperformed the computer for difficult-to-detect cases[xii].

What are the challenges for AI in Dx?

Dependable data:

Again, as across the entire AI field, Dx algorithms are obviously dependent on *reliability, availability* and *quality of data*. Regarding *reliability*, it is essential that markers are empirically stable and robust manifestations of the condition to be diagnosed. Serving as an example, vocal diagnostics promises to detect disease at an early stage through a highly convenient, non-invasive method of voice recording.





While long recognized that speech can be affected by psychological conditions, it is crucial to define representative acoustic markers that provide good separation from controls. The Parkinsons Voice Initiative[xiii] is researching voice-based tests that could be scalable, quick and cost-effective, and thus revolutionize disease screening, drug trial recruitment and treatment monitoring. A spin-off from Humboldt University musicology and mathematics departments, PeakProfiling, in collaboration with Charité Berlin, is also using sound analysis of human voice recordings to detect medical and psychological conditions. CEO Claudio Hasler explained that, among an indefinite number of speech features, the major challenge is to find those that give high specificity and sensitivity (personal communication). The team examines simple features, such as talking speed or pitch, as well as complex digital markers that may not yet be somatically understood, in search of biomarkers that are explainable, prevalent and consistent across individuals with a particular disorder. In pilot studies looking at ADHD-specific vocal acoustic patterns, initial analyses of over 1000 patients identified single, and combinations of, acoustic markers with high sensitivity and specificity[xiv]. Excitingly, results of full trials will be collected by the end of April.

With the current background of privacy concerns and data protection regulations, accessing and sharing data threatens to restrict the *availability* of mass information needed to train AI algorithms comprehensively. One can surmise that legal frameworks could be developed to allow data access and sharing across institutions and geographical regions to ensure wide collection of information alongside data protection for individuals. Interestingly, increasing numbers of research groups and startups are taking a novel approach using a blockchain system (as used for Bitcoin) for individuals to efficiently donate medical data, such as medical scans, genetic profiles and hospital records, while retaining control[xv]. Blockchain acts as a series of switches that guide data flow between researchers and participants who can give or revoke access via an online portal that relies on blockchain to secure cloud data storage.

Digitalization of microscopic tissue sections with modern slide scanners and digital storage has enabled quick and remote access for computerized Dx. Radiomics is similarly quantifying features from CT, PET or MR scans to further characterize disease, especially cancer[xvi]. Whilst one would hope that, in the future, deep learning tools would be able to decipher data from various sources and in variable forms, AI Dx based on images in particular is clearly dependent on data *quality*. This can greatly restrict the volume of usable information for AI training as centers may only be confident or capable of using their own data. For now, to guarantee safety, tool certification will also likely remain conditional on data of a specified quality (see below) and overseeing by clinicians.

Accurate algorithms:

The success of AI Dx, again as for AI in other areas, depends on computer program performance. This initially placed a heavy demand on data scientists to create precise algorithms, pull data, specify searches and come up with best solutions. As time progresses, more products simplifying the writing of algorithms are becoming available, enabling operators with lower levels of IT expertise, such as medical research scientists and doctors, to engage in this field. However, whoever the designer, the potential introduction of human bias into AI algorithms and machines is a recognized concern[xvii].

Building in either human error or prejudice is ideally avoided or certainly minimized. At least if known, bias should be acknowledged and documented for future reference and progression.

Validated tools:

The best way to deliver AI diagnostic tools fit for clinical use is for them not only to be trained on broad, high quality datasets, but also be endorsed in controlled, published research studies. This leads to the question of how algorithms can be tested in clinical trials when there appears to be a lack of AI algorithms gaining the certification needed. The first medical device to perform AI diagnosis gained FDA clearance in April 2018[xviii]. IDx-DR is a software program that uses an algorithm to analyze retinal images for detection of greater than mild retinopathy in diabetes. It was the first authorized device that does not require clinical interpretation of images or results, making it applicable for non-eye specialist personnel. More than mild retinopathy was recognized 87.4% of the time with the tool and not more than mild retinopathy 89.5% of the time. However, certification was dependent on a long list of exclusions and categorization as a novel, low-medium risk device, with designation necessitating intensive FDA interaction and guidance, and dependent on recognition as a breakthrough technology with significant advantages over existing alternatives. Gaining certification for emerging novel AI Dx tools may represent a major challenge.

The future for AI Dx

Careful development of useful traditional and deep learning algorithms trained on good quality and high quantity data must be demonstrated in the field of diagnosis. There are increasing reports of advances in AI Dx, whether using images for cancers, including breast[xix], gastrointestinal[xx] and colorectal[xxi], PET scans for Alzheimer disease[xxii], sleep heart rhythm disruptions for mental illnesses[xxiii] or speech abnormalities for depression[xxiv]. Only the first step of AI research is to establish efficient and accurate diagnosis as recognized by current medical understanding. Claudio Hasler from PeakProfiling believes that the key advantage of this technology will be the future discovery of connections between condition-specific features. Dr. Armin Piehler, clinical pathologist and AI expert, explains that they can already obtain medical information from heterogeneous and extensive datasets that would have been difficult to spot even with the trained eye of a specialist. This facilitates detection of diseases before they are clinically evident. An exponential increase in understanding and linking of early and subtle disease-related changes from intelligent algorithms learning from themselves would allow leaps in disease prediction and treatment. However, algorithms must be incorporated into Dx carefully and responsibly to unravel true and relevant connections and thus deliver long term clinical benefits.

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DxPx Partner Perspective


Prof. Dr. Wolfgang Kaminski (CMO Sonic Healthcare Germany and Bioscientia) and Dr. Peter Wieloch (Medical Director CT and Head diagnostics2market, Bioscientia)

Bioscientia specializes in offering up-to-date laboratory services and is also pioneering the development of algorithm/ AI based IVD mass-screening tools.

Resources and financial investment are key

Utilizing the increasing availability of computer based expert systems, members of the company's medical team with both laboratory and coding experience took the opportunity to systematically explore computer programs. As a result, they are currently developing prototypic algorithms that will support doctors in highly effective disease-screening. W. Kaminski and P. Wieloch believe they benefit from their tool designers being clinicians with medical domain expertise. Taking a modular building approach will allow for the use of available, specialized AI elements. As the algorithms are developed by experienced medical experts, introduced bias can be better estimated and documented. Regarding quality as well as quantity of data, the clinical laboratory is in the fortunate position of having access to mega-scale levels of biomaterials, which have been directly obtained from patients in compliance with current data protection regulations and warrant the required level of patient protection. Importantly, the data from their German laboratory network are both digitalized and structured. Prof. Kaminski and Dr. Wieloch believe that this challenging but exciting work will result in final doctor-trained working algorithms. Future decision support systems will operate as highly effective disease screening services. A team comprising a medical professional and AI will perform more accurately than one of human staff but only due to the absence of potential human factors such as fatigue or reduced level of alertness. Kaminski and Wieloch foresee the potential for enormous benefit for millions of individuals in the early diagnosis of malignomas and rare disorders, as well as emerging highly prevalent diseases.

The DxPx conference in Düsseldorf on November 18th, 2019 provides a platform for meeting C-level executives involved in AI Dx. Participate to learn more about this technology and form partnerships to drive developments for the benefit of patients!
www.dxpx-conference.com





[i] https://www.technologyreview.com/s/601441/moores-law-is-dead-now-what/
[ii] https://www.sage.com/en-us/news/press-releases/2017/11/survey-reveals-nearly-50-percent-of-consumers-have-no-idea-what-artificial-intelligence-is-about/
[iii] https://www.forbes.com/sites/bernardmarr/2018/12/03/5-important-artificial-intelligence-predictions-for-2019-everyone-should-read/#6c3cbc5b319f
[iv] https://www.mobihealthnews.com/content/health-20-applications-change-world
[v] https://www.ibm.com/watson/health/index-1.html
[vi] https://deepmind.com/applied/deepmind-health/
[vii] The Times 2018 https://www.thetimes.co.uk/article/demis-hassabis-interview-the-brains-behind-deepmind-on-the-future-of-artificial-intelligence-mzk0zhsp8
[viii] https://www.nature.com/collections/ksgfknntbs
https://www.nature.com/articles/nature21056.epdf?referrer_access_token=RcIKxkNHJfvxwTkuTW4lPNRgN0jAjWel9jnR3ZoTv0NXpMHRAJy8Qn10ys2O4tuPxB4B9GCLPvFTfGPu3BrO0euO-oKmEt01tc_3Bad0Edx-p21z_GXJAeVxTVS6U_o7mmt1TxNO3XcR6ZK9ofxEEeFaRl3oGpNMQBIFWEz9lVYs1gWvSGHUzq1_WTPh2nfp3Rx8zKAPHxpbvedE5qWe3w7F8nyvpmzbjlR_EbOOvaY%3D&tracking_referrer=www.wired.co.uk
[ix] https://jamanetwork.com/journals/jama/fullarticle/2588763
[x] https://www.nature.com/articles/s41551-018-0195-0
[xi] https://www.nature.com/articles/d41586-018-03067-x
[xii] https://jamanetwork.com/journals/jama/fullarticle/2665774
[xiii] http://www.parkinsonsvoice.org/vision.php
[xiv] WPA XVII World Congress of Psychiatry in 2017 https://www.peakprofiling.com/uploads/6/6/7/5/66753005/wpaconference_-_abstract_-_dr._eike_ahlers_-_charité_berlin.pdf
[xv] https://www.nature.com/magazine-assets/d41586-018-02641-7/d41586-018-02641-7.pdf
[xvi] https://www.nature.com/collections/ksgfknntbs
[xvii] https://www.ft.com/content/ccaf069e-22d2-11e8-8138-569c3d7ab0a7
[xviii] https://www.fda.gov/newsevents/newsroom/pressannouncements/ucm604357.htm
[xix] https://link.springer.com/article/10.1007/s10278-018-0154-z
[xx] http://ascopubs.org/doi/abs/10.1200/JCO.2018.36.15_suppl.e16239
[xxi] http://ascopubs.org/doi/abs/10.1200/JCO.2018.36.15_suppl.e15601
[xxii] https://pubs.rsna.org/doi/abs/10.1148/radiol.2018180958
[xxiii] https://medibio.com.au/science/
[xxiv] https://www.psychologytoday.com/us/blog/the-future-brain/201810/mit-creates-ai-predicts-depression-speech

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