Radiology meets artificial intelligence

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The media and even radiology presentations are filled with Cassandraesque statements on the sunset of radiology. These oracular pronouncements are based on artificial intelligence's (AI) recent success in solving complex tasks (Watson for Jeopardy; Google for Go). Machine learning algorithms (MLs), a subcategory of AI, excel in "pattern" identification; when applied to images, this ability overlaps that of radiologists.

Headline-grabbing quotes, such as, "the role of the radiologist will be obsolete in five years"[1] are the result of simplistic extrapolation of early achievements. This "role" is a narrow, somewhat uninformed view of radiologists' contribution to patient care. Google's vice president of health offers an interesting counterpoint to this notion, stating, "there literally have to be thousands of algorithms to even come close to replicating what a radiologist can do on a given day. It's not going to be all solved tomorrow."[2] This reflects a more informed understanding of MLs, and it also raises the important question, "who will make sense of hundreds to thousands of MLs relevant to radiology's care of patients?" Radiologists have this golden opportunity, which in turn has given rise to the catchphrase, "radiologists won't be replaced by AI, but by radiologists who use AI."

The perceived "role" noted above should prompt not only the radiologists, but the entire radiologic team, to take a proactive, encompassing role in delivering diagnostic and therapeutic patient care, preferably as an integrated service. Predictions of future human behavior in times of rapid change can become exaggerated. In the case of AI, the exponential increase in computing power is assumed to directly translate into an exponential increase in human, business and economic capabilities and productivity. An exponential pattern is unlikely. Change in complex systems occurs not in a smooth line, but rather in a step-like pattern known as punctuated equilibrium.[3] Not surprisingly, when such "punctuations" first appear, linear extrapolations can become quite extravagant. Nevertheless, AI, especially in the form of machine learning, clearly will impact radiology, and will do so positively.

Machine learning as noted by one of its founders, Arthur Samuel in the 1950s, is defined as giving computers the ability to learn a task without being directly programmed to solve that task.[4] The solution to the task is generated, not by software code specific to that task, but rather by code that learns how to solve the problem posed by the task. Machine learning is a powerful technique, with many variations and applications. Diagnostic radiology must certainly understand and use MLs to accelerate improvements in offering accurate, integrated diagnostic information.

First of all, MLs should not be feared; running from them is not an option. MLs will even

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be fun, because machine learning outputs can create extremely interesting "images." It is helpful to view machine learning as families of algorithms that can solve different classes of problems (diagnostic, therapeutic, etc.). Radiologists will need to acquire skill, experience, and knowledge in how and when to choose appropriate machine learning programs to solve diagnostic or treatment problems. It is useful to know that machine learning's value is primarily in making predictions based on previous data. MLs will expand radiology's range of information services. Such an expansion was exemplified by a machine learning algorithm based on chest CT images that successfully evaluated overall health and mortality risk in individuals older than age 60.[5] Why would this work? Many patients have comorbidities that are recorded in electronic medical records or radiology reports in just a few words. Actual chest CT images, however, reveal these comorbidities in a rich informational image format. MLs can integrate such variegated image data better than the human mind can integrate a list of words, such as diffuse lung disease, emphysema, enlarged heart and aorta, vascular calcification, abnormal mediastinal masses, bone lesions, etc.

MLs will evolve from detecting abnormalities, to characterizing them to interpreting them in light of broader clinical and pathologic information. They will add further intelligence to imaging based screening for breast, lung and prostate cancer. MLs will make radiology teams more accurate, a key source of value. Both diagnostic and interventional radiologists should embrace MLs, by melding this new form of expertise with their knowledge domains, skillsets and judgement abilities.

While an oversimplification, this melding can be at the data science level, at the radiology workflow level and at radiology's operational level. At the data science level, mathematical innovations in neural networks will be critical in ensuring the accuracy of MLs. MLs, once tested for accuracy and reliability, will be applied to image acquisition, image processing, image analytics, and image interpretation, i.e., the workflow level as represented in the components of radiology's value chain.[6]
At UCLA, at the workflow level, MLs already accurately analyze, interpret and quantitatively measure drug treatment effects in pulmonary fibrosis. This type of machine learning measurement of changes on lung CTs in response to treatment precedes the human visual system's ability to describe them even qualitatively.

MLs can also be employed in the analysis of and the running of large-scale radiologic operations involving everything from patient access to enriching the final report, such as in pulmonary fibrosis. MLs will increase efficient use of our high-cost capital equipment, an imperative for cost reduction. MLs could streamline MR protocols by reducing acquisition of duplicate information. They can be used in improving safety by X-ray dose optimization or by assessing risk of contrast media reactions. UCLA is looking into using MLs to improve operations such as reducing wait times for patients. For MLs to be widely adopted, tools to measure their accuracy and value (cost in dollars, time, etc.) need to be developed. Our department has already developed methods to measure machine learning clinical accuracy.

MLs should be seen as knowledge tools to be understood, adopted and utilized by all members of radiology teams to produce better, faster, safer and less expensive diagnostic and therapeutic services. Used intelligently, MLs will increase radiology's value to patients, as well as raise quality, both of which are essential in the current healthcare environment.[7] Don't worry, be happy and befriend machine learning! R

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