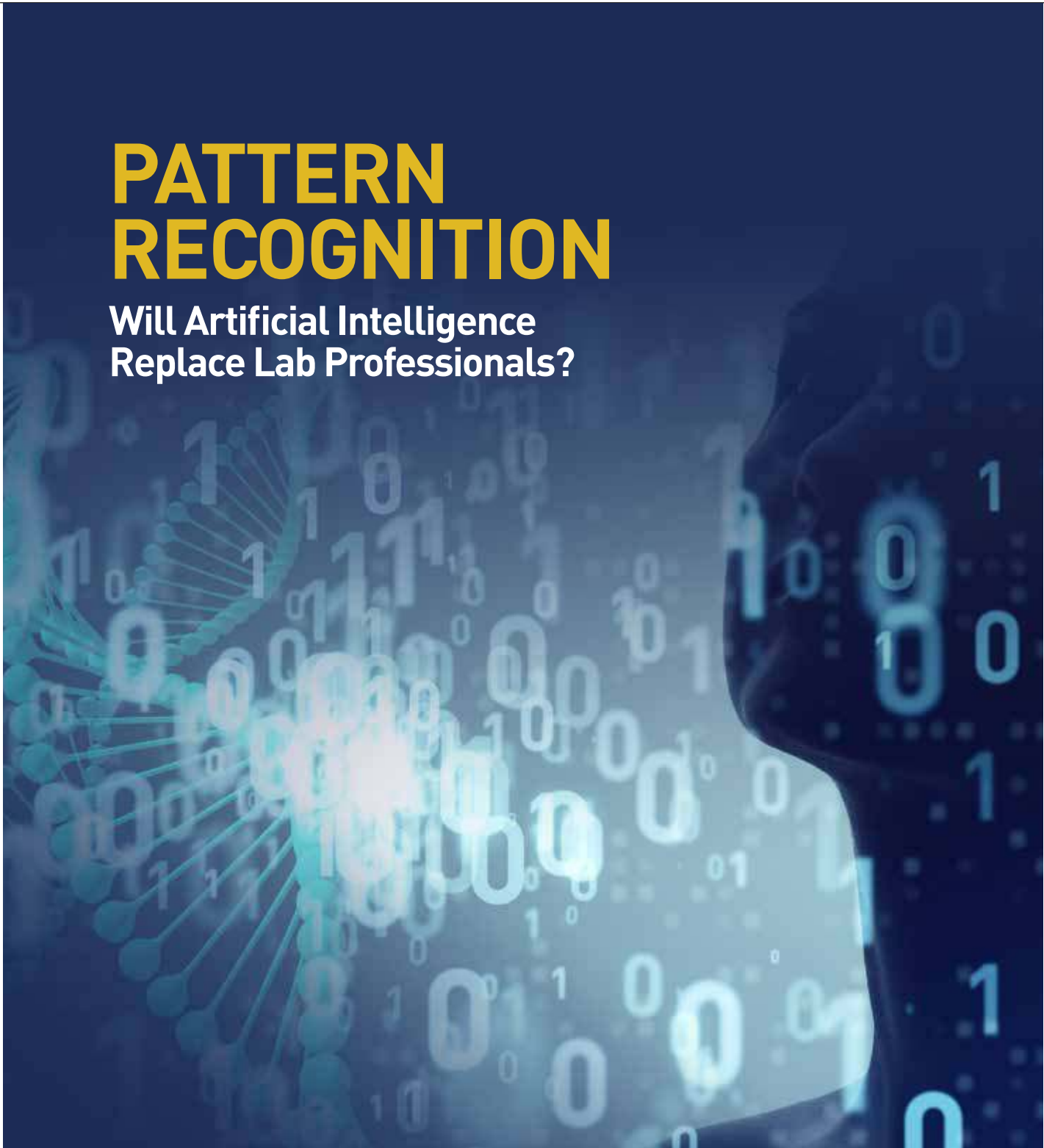


PATTERN RECOGNITION

Will Artificial Intelligence Replace Lab Professionals?



Three years ago, the International Symposium on Biomedical Imaging hosted a contest called the Cancer Metastases in Lymph Nodes Challenge 2016. Teams of researchers from around the world competed to create the best deep learning algorithm for detecting metastatic breast cancer. >>

They built their systems using a training dataset of 270 whole-slide images, some with and some without nodal metastases as verified by immunohistochemical staining. Next, they tested their systems using a second dataset of 129 whole-slide images.

The results were amazing. Seven algorithms achieved greater discrimination than a panel of 11 pathologists in a simulation exercise. The pathologists spent two hours evaluating 129 slides, on average, mimicking a typical clinical workflow. In another task, the algorithms' performance was comparable to an expert pathologist with unlimited time constraints, who spent 30 hours to process the 129 slides – an infeasible amount of time in real practice.¹ Researchers from Harvard Medical School and the Massachusetts Institute of Technology created the winning algorithm. Combining their system's predictions with a human pathologist's calls reduced the human error rate by about 85 per cent.²

Artificial intelligence (AI) is a computerized system that can process large quantities of data with advanced computing power and perform intelligent tasks like learning and pattern recognition. AI may seem like science fiction, but it is already part of our lives. For example, when contacting online customer service, we are likely chatting with an AI bot. Apple Music recommends songs based on our listening history. Car manufacturers are road testing autonomous vehicles on Canadian highways³ and pilots use AI systems to fly planes.

It's no surprise that health care is one of the main areas where AI promises to make a significant impact since it generates mountains of data and humans are imperfect. Medical laboratory technologists and pathologists are prone to fatigue and cannot process data as quickly as computers. Studies have found differences in interpretation between pathologists using standard evaluation methods, even for those with considerable training and experience. For example, for some types of breast cancer, the rate of diagnostic agreement can be as low as 48 per cent.⁴

AI systems that can analyze more parameters, process data faster and serve up intelligent insights for consideration could streamline clinical workflows and improve patient outcomes. Physicians could make better decisions on patient care, such as determining optimal treatment approaches, avoiding misdiagnoses and limiting unnecessary procedures.³

To understand the magnitude of AI's potential in pathology, consider this AI developed by researchers at the Stanford University School of Medicine. They trained a deep learning algorithm to identify nearly 10,000 traits – significantly more than the several hundred pathologists typically assess – using 2,186 whole-slide images of lung cancer tissue. The samples were from The Cancer Genome Atlas database, which also contained grade, stage and survival data. Then the researchers tested the algorithm using 294 whole-slide images of lung cancer from a separate dataset, the Stanford Tissue Microarray Database. Their AI system produced better survival predictions than pathologists using standard methods to classify cancer stage and grade. It also accurately distinguished between adenocarcinoma and squamous cell carcinoma, two types of lung cancer that are notoriously difficult for pathologists to tell apart when examining regular tissue culture slides.^{5,6}

AI is not ready yet for prime time in medical labs. In Canada and the United States, AI tools are just beginning to appear as research projects. St. Michael's Hospital (St. Mike's), part of the Unity Health Toronto network, is a busy urban hospital with a blood bank and a trauma centre. The medical lab processes about six million tests annually. Several departments are

The introduction of AI in the daily workflow of the medical lab will take place in phases, not all at once.

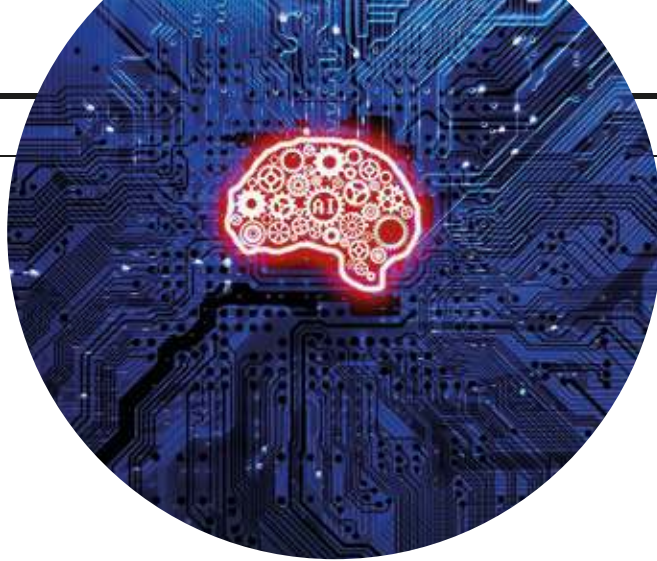


In the first phase, we'll have simple algorithms helping clinicians order and maybe interpret tests and make diagnostic suggestions. This will happen within five years. The next phase – where more advanced algorithms analyze data sets and make definitive diagnoses and recommend treatment plans – will be further out in the future.



– Dr. Tron, MD, FRCPC, Medical Lab Chief and Medical Director, St. Michael's Hospital





collaborating to create an algorithm for improving the prediction of patient flow through the emergency department. “If we can better predict the volume of patients coming to the ER, we can optimize staffing and resources,” says Victor Tron, MD, FRCPC, Chief and Medical Director of the medical lab at St. Mike’s. “It’s early days, but the exciting part about AI is taking various datasets, including our lab data, and getting them to speak to each other effectively. The less we work in silos, the better our patient outcomes will be.” Dr. Tron is also working on developing additional AI tools through collaborations at the Biomedical Zone, an innovation hub at Ryerson University. St. Mike’s staff pathologist Corwyn Rowsell, MD, FRCPC, FACP, is working on an AI tool for processing whole-slide images of pathology slides. He is working with machine learning experts at the University of Toronto and Huron Digital Pathology, a whole-slide scanning company based in St. Jacobs, Ontario.

Children’s Mercy Hospital in Kansas City, Missouri, is a pediatric hospital that provides comprehensive treatments for patients from birth to 21 years of age. The medical lab processes about 1.25 million tests each year. The lab staff are working on a project that harnesses machine learning to flag patterns in patients’ blood. “Our goal is to develop intelligent systems to help us minimize the risk of anemia from too many blood draws while aiding clinicians to order the right test at the right time,” says John David Larkin Nolen, MD, PhD, MSPH, a clinical pathologist at Children’s Mercy Hospital. He and his team are also starting to develop tools to add smart critical alerts to electronic medical records that are relevant not just for patients but also for providers.

The introduction of AI in the daily workflow of the medical lab will take place in phases, not all at once. “In the first phase, we’ll have simple algorithms helping clinicians order and maybe interpret tests and make diagnostic suggestions. This will happen within five years,” says Dr. Tron. “The next phase – where more advanced algorithms analyze data sets and make definitive diagnoses and recommend treatment plans – will be further out in the future.”

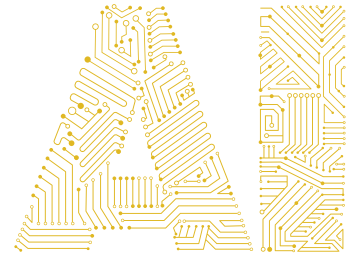
To understand the magnitude of AI’s potential in pathology, consider this AI developed by researchers at the Stanford University School of Medicine.

They trained a deep learning algorithm to identify nearly

10,000 traits

significantly more than the several hundred pathologists typically assess – using

2,186 whole-slide images of lung cancer tissue.



What’s in a Name

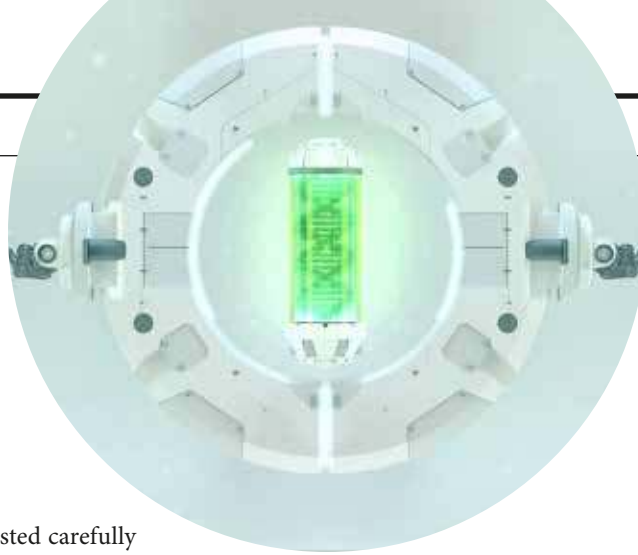
“I often tell my students not to be misled by the name ‘artificial intelligence’ – there is nothing artificial about it. AI is made by humans, intended to behave by humans, and, ultimately, to impact human lives and society.”
Fei-Fei Li, Co-Director, Stanford University Human-Centered AI Institute.

The Future of AI in Pathology

“AI will not replace pathologists. Pathologists who use AI will replace those that don’t,” said David Louis, MD, Pathologist-in-Chief, Massachusetts General Hospital and Benjamin Castleman Professor of Pathology, Harvard Medical School, during a panel discussion called “The Future of AI in Pathology in Lab Medicine” that took place at the World Medical Innovation Forum in April 2018.

Watch and listen to the recorded session on YouTube.





Like any new lab tool, AI will need to be tested carefully before, during and after it is implemented to ensure it performs well. A high degree of accuracy is essential for test results that inform diagnoses and treatment decisions that have a serious impact on peoples' lives. "We strive to do the right test for the right patient at the right time, so anything that changes that relationship should be heavily scrutinized," says Dr. Nolen. "You can see this in the slow adoption of digital pathology that has finally reached a meaningful growth curve."

Will AI replace lab technologists in the future? Experts say that is highly unlikely to happen. But the role will shift from focusing on processing samples and reporting results to providing insights. "AI will be a diagnostic assist, not a replacement for lab technologists," says Dr. Tron. "It will help them become more efficient, freeing them up to take on responsibilities that are traditionally performed by other medical professions, such as analyzing cases. We would love to see our lab technologists doing more in the hospital, helping clinicians with ordering and interpreting tests."

Dr. Nolen agrees. "Clinicians' windshields are way too cluttered today and the lab test menu is evolving rapidly. When I get calls about tests, it's not so much about how to order a test, it's what test should they order and what should they do with the result," he says. "Lab tests will still be our primary responsibility, but AI will allow us to automate the more repetitive tasks, focus on the interpretation of results and become more involved in patient care. The role of lab technologists will evolve from running and reporting tests, to becoming information stewards."

AI also will not replace human decision-making in health care. "Certain tasks might be achieved by AI, like accurately diagnosing a skin lesion or ear infection via an algorithm," writes Eric Topol, MD, a cardiologist, founder and director of the Scripps Research Translational Institute, and author of the book *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*. "But for medicine as a whole, we will never tolerate lack of oversight by human doctors and clinicians across all conditions, all the time."⁷

"Humans will still make the ultimate decisions on patient care," Dr. Nolen says. "AI will be another tool, sitting in the background and giving a tap on the shoulder to say, 'Consider this.'"⁸



Intrigued about advancements in the medical laboratory?

Visit go.csmls.org/Summer2019 to access related content.

REFERENCES

- ▶ ¹Ehteshami Bejnordi B, Veta M, Johannes van Diest P, et al. *Diagnostic Assessment of Deep Learning Algorithms for Detection of Lymph Node Metastases in Women With Breast Cancer*. *JAMA*. 2017;318(22):2199–2210. doi:10.1001/jama.2017.14585
- ▶ ²Wang D, Khosla A, Gargeya R, et al. *Deep Learning for Identifying Metastatic Breast Cancer*. Eprint arXiv: 1606.05718. Accessed March 27, 2019 at <https://arxiv.org/abs/1606.05718>
- ▶ ³Lam P. *Ontario allows public road testing of autonomous cars — without someone behind the wheel*. *CBCNews.com*. January 22, 2019. Accessed March 27, 2019 at <https://www.cbc.ca/news/canada/kitchener-waterloo/automated-vehicles-autonomous-ontario-pilot-driver-1.4988392>
- ▶ ⁴Topol E. *Doctors and Patterns. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*. New York, NY: Basic Books, Hachette Book Group; c2019:126.
- ▶ ⁵Yu KH, Zhang C, Berry GJ, et al. Predicting non-small cell lung cancer prognosis by fully automated microscopic pathology image features. *Nature Communications*. 2016;7:12474. Published 2016 Aug 16. doi:10.1038/ncomms12474
- ▶ ⁶Conger K. *Computers trounce pathologists in predicting lung cancer type, severity*. *Stanford Medicine News Center*; August 16, 2016. Accessed March 31 at <http://med.stanford.edu/news/all-news/2016/08/computers-trounce-pathologists-in-predicting-lung-cancer-severity.html>
- ▶ ⁷Topol E. *The Skinny on Deep Learning. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*. New York, NY: Basic Books, Hachette Book Group; c2019:87.
- ▶ ⁸Topol E. *Deep Liabilities. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*. New York, NY: Basic Books, Hachette Book Group; c2019:89.



JANE LANGILLE
Health and Medical Writer
Special to *CJMLS*