An Introduction to Artificial Intelligence and Machine Learning in Addictions & Mental Health

The concept of machines having human-like intelligence created the notion of artificial intelligence (AI) in the 1950s (Copeland, 2016). Since then, machine learning, a subfield of AI, has provided the most practical implementation of AI where computers can learn without being explicitly programmed (Copeland, 2016). This is done with sophisticated computer algorithms that extract information and patterns from data, and use this information to make predictions.

Even though the idea of AI dates back to the 1950s, it is only within the last decade that machine learning has become such a powerful tool (Copeland, 2016). This is because:

1. We now have access to large amounts of data from which the machine learning algorithms may 'learn'.
2. Computational power and efficiency have improved significantly due to supercomputers and graphical processing units, allowing complicated algorithms to run quickly.
3. We can now address complicated problems by using artificial neural networks, a machine learning tool.

Types of Machine Learning

There are three categories of machine learning algorithms (Appenzeller, 2017).

	Definition	*Sub-category*	*Examples*
Supervised Learning	• 'Learn' from a test set of known data. • Test sets have inputs & labelled outputs. (Example: An image of a handwritten letter as input & the correct letter as output). • After training using the test set data, new images of writing are analyzed to determine what is written. • Used in most currently-available applications.	**Classification** Predict discrete value (a category)	• Handwriting recognition • Facial recognition • Email spam filter
		Regression Predict continuous quantity (a number)	• Predict housing prices given house size • Determine the form of media that contributes most to sales
Unsupervised Learning	• Does not require a test set of data as input. • Goal is to categorize the data based on the properties of the data itself.	**Clustering** Divide data into groups based on similarities	• Cluster social media users into groups for targeted advertising
		Dimension Reduction Decrease number of variables (data) for easier analysis	• Isolate one person's voice from a noisy audio recording

	Definition	Sub-category	Examples
Reinforcement Learning	• Train function using a reward for positive outcomes & a penalty for negative outcomes.	-	• Chess-playing algorithms reward moves associated with a win & penalize moves associated with a loss • Penalize self-driving cars for decisions leading to collisions during training

Artificial Neural Networks

Artificial neural networks are a tool used in machine learning that may be used in supervised, unsupervised, and reinforcement learning. Neural networks allow for the combination of difficult formulas and functions to describe complex data sets, and are particularly useful when the connection between input and output is not intuitive. Artificial neural networks are designed with layers of 'neurons': an input layer of neurons is followed by multiple, hidden layers of neurons, which ends in a final output layer. A neuron in one layer is connected to all neurons in the adjacent layers (Tzeng & Ma, 2005). The term 'deep learning' refers to the many layers in the neural network (Copeland, 2017).

Each input-layer neuron receives a piece of the input data. For example, in the handwriting recognition problem discussed above, each neuron receives data about the brightness of a pixel. As the data moves through each layer, the relative importance of each piece of data (neuron) is weighed to gain new insights and recognize patterns. For example, processing data by hidden neurons may reveal patterns such as loops and lines, which correspond to different features of a letter or number (Sanderson, 2017). Each neuron in the output layer represents a potential answer or output; for example, a letter or number. When the data reaches the final, output layer, the neuron corresponding to the correct answer is chosen.

Machine Learning in Addictions and Mental Health*

Predictions from health records

Researchers have used machine learning to predict the risk of suicide attempts using health records (Walsh, Riberio & Franklin, 2017). Machine learning used health records containing suicide codes to predict future suicide attempts with a significant improvement over the near-chance accuracy of traditional methods.

* The application of machine learning to health care raises ethical considerations regarding the privacy and security of patient and user data. A discussion of these ethical considerations lies outside the scope of this document.

Diagnostic imaging

Machine learning has been applied to diagnostic imaging in many areas of health care. Researchers at the University of Alberta are using machine learning and functional magnetic resonance imaging (fMRI) images to diagnose the presence of schizophrenia and symptom severity (Gheiratmand et al., 2017).

Determining mental health via social media

The large amounts of data produced via social media provide many applications for machine learning. Facebook has recently implemented AI that can identify posts containing suicidal thoughts and flags these posts for human moderation (Constine, 2017). A new study has also examined Instagram accounts to screen for depression in users (Reece & Danforth, 2017). The algorithm determined that depressed users posted photos that tended to be darker and feature fewer people. The model offers significant improvements on previously reported rates of false depression diagnosis.

Factors leading to addiction

The computer company IBM is trying to combat the opioid crisis by using machine learning to identify factors that lead to addiction (Wei, 2017). This includes looking at initial opioid prescriptions and things like opioid class, quantity of drug prescribed, and related medical procedures. The goal is to be able to create patient-specific guidelines on prescribing opioids.

REFERENCES

Appenzeller, T. (2017, July 7). The AI revolution in science. *Science Magazine*. Retrieved from http://www.sciencemag.org/news/2017/07/ai-revolution-science

Constine, J. (2017, November 27). Facebook rolls out AI to detect suicidal posts before they're reported. *TechCrunch*. Retrieved from https://techcrunch.com/2017/11/27/facebook-ai-suicide-prevention/

Copeland, M. (2016, July 29). What's the difference between artificial intelligence, machine learning, and deep learning?. *Nvidia*. Retrieved from https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/

Gheiratmand, M., Rish, I., Cecchi, G. A., Brown, M. R. G., Greiner, R., Polosecki, P. I., … Dursun, S. M. (2017). Learning stable and predictive network-based patterns of schizophrenia and its clinical symptoms. *npj Schizophrenia*, *3*, 1-12.

Reece, A. G., & Danforth, C. M. (2017). Instagram photos reveal predictive markers of depression. *EPJ Data Science*, *5*, 1-12.

Sanderson, G. [3blue1brown]. (2017, October 5). *But what *is* a neural network?* [Video file]. Retrieved from https://www.youtube.com/watch?v=aircAruvnKk

Tzeng, F-Y., Ma, K-L. (2005). Opening the black box – Data driven visualization of neural networks. *VIS 05. IEEE Visualization, 2005*., 383-390. Retrieved from: http://ieeexplore.ieee.org/document/1532820/

Walsh, C. G., Ribeiro, J. D., & Franklin, J. C. (2017). Predicting risk of suicide attempts over time through machine learning. *Clinical Psychological Science*, *5*, 457-469.

Wei, D. (2017, August 9). Combating the opioid epidemic with machine learning. *IBM Research*. Retrieved from https://www.ibm.com/blogs/research/2017/08/combating-the-opioid-epidemic-with-machine-learning/

This overview provides an introduction to AI with select applications and is not intended to be comprehensive.

For more information about this document, contact Knowledge Exchange, Provincial Addiction and Mental Health, Alberta Health Services at researchpartnership@ahs.ca.