Machine Learning

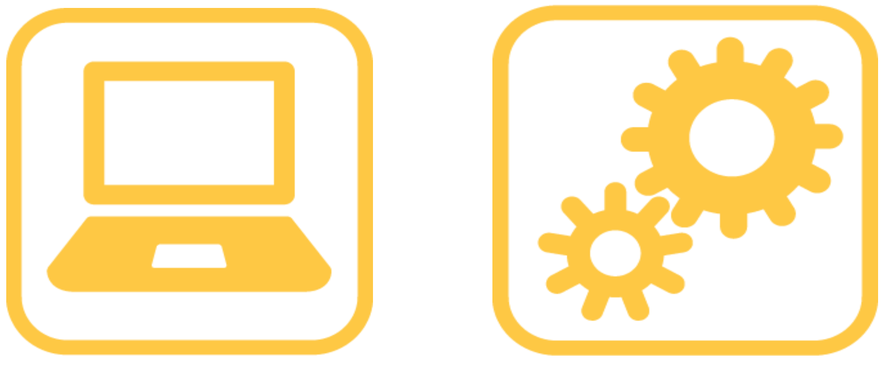
Innovations in Addiction and Mental Health Research

What is Machine Learning?

Machine learning advances research and applications by collecting and analyzing data in improved and novel ways.

Artificial Intelligence (AI)

- Concept of machines having human-like intelligence and learning autonomously from data to perform tasks.



Machine Learning (ML)

- A subfield of AI, where computers can learn without being programmed.
- Learns from previous data to develop models capable of making predictions on unseen data.

Progress stems from advances in computing such as:

- Increased ability to extract and process large datasets.
- Increased computational power and efficiency.
- Innovation of artificial neural networks, which allow large and complex data to be analyzed.

Types of Machine Learning

Supervised Learning

- Aims to make predictions about unseen and unlabeled data.
- Most machine learning applications function via supervised learning.

Unsupervised Learning

- An algorithm recognizes undefined existing patterns from the data.

Reinforcement Learning

- Algorithm provides probabilities for correct (good) or incorrect (bad) decisions/output.
- With the help of this reward feedback, agents are able to learn the behavior and improve it.

Integration Across Addiction & Mental Health (AMH)

Data Types and Research Examples

Medical Images

- A valuable tool for predicting prognosis and response to treatment.

Example:
- Analysis of fMRI data can detect clinical depression symptoms that respond differently to certain treatments.

Biological & Physiological Sensors

- Wearable sensor technology has made mass data collection possible, leading to advancements in mental health monitoring.

Example:
- Combining sensory information with smartphone usage and sleep data can predict low and high stress users.

Social Media & Text Messages

- ML algorithms can use social media platforms, text messages, and other digital data to find trends, identify risk, and triage service.

Example:
- Kids' Help Phone analyzes initial text messages to determine if the user is at risk of self-harm.

Assessments & Surveys

- ML innovations in computerized adaptive testing (CAT) aim to reduce the amount of questions required to capture valid and reliable data.

Example:
- Promising CAT work has been developed to help diagnose major depressive disorder, anxiety, suicidality, and mental health status in youth.

Electronic Health Records

- Provide a rich dataset and powerful resources for predicting mental health outcomes in patients.

Example:
- Diagnosis, medication, and lab measurements can be used by ML to predict patient outcomes, assess risk, or support psychiatric diagnosis.
- Unstructured data such as observational notes can also be used to improve outcomes.

Other Data Types

- Genetic and genomic data tools can help personalize treatments, provide precision therapies, and detect early mental illness or recurrence of illness.
- Speech and facial recordings can help detect mental illness by recognizing audible symptoms.

AMH Domains & Innovations

Conditions most commonly addressed in AMH machine learning include Alzheimer's Disease, depression, schizophrenia, self-harm/suicide, and substance use.

Domain	Innovation
Detection & Diagnosis 	• Improving diagnostic screening tools. • Predicting future diagnosis of a patient based on past diagnosis. • Differentiating between mental illnesses that have similar symptoms. • Developing risk models to identify predisposition for mental illness.
Prognosis, Treatment, & Support 	• Predicting long-term patient outcomes. • Decreasing wait times for high-risk service users. • Providing individually-tailored treatment recommendations. • Selecting patients most likely to benefit from high-cost or time-intensive services.
Research & Clinical Administration 	• Improving resource allocation by considering patient risk status and individual factors. • Sharing research methods via data sharing or participant selection. • Extracting mental health symptoms from sources like clinical notes or administrative databases.
Public Health 	• Assessing mental health of specific and broader populations. • Monitoring health outcomes during or after events, such as COVID-19. • Creating risk models for system delivery, and anticipating financial and service issues.

The Alberta Context: Current Work in Machine Learning + AMH

Early diagnosis of bipolar disorder

Distinguishes first-episode bipolar disorder patients from healthy controls using cognitive tests and ML.

Detecting Parkinson's disease

ML model that can detect Parkinson's disease from digitized handwriting samples.

Diagnosing depression more accurately

Uses social, personal, and health records, as well as genetic and MRI data, to diagnose depression more precisely.

References

Canadian Agency for Drugs and Technology in Health (CADTH) and Mental Health Commission of Canada (MHCC). (2021). *Artificial intelligence and machine learning in mental health services: An environmental scan*. https://www.cadth.ca/artificial-intelligence-and-machine-learning-mental-health-services-environmental-scan

Chomiak, T., Rasiah, N. P., Molina, L. A., Hu, B., Sains, J. S., & Füzesi, T. (2021). A versatile computational algorithm for time-series data analysis and machine-learning models. *npj Parkinsons Disease, 7*(97), 1-6. https://doi.org/10.1038/s41531-021-00240-4

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

D'Mello, S. K. (2016). Automated mental state detection for mental health care. In: Luxton, D. D. (Ed), *Artificial intelligence in behavioral and mental health care* (pp.117-136). Elsevier Academic Press.

Eichstaedt, J. C., Smith, R. J., Merchant, R. M., Ungar, L. H., Crutchley, P., Preoțiuc-Pietro, D., Asch, D. A., & Schwartz, H. A. (2018). Facebook language predicts depression in medical records. *Proceedings of the National Academy of Sciences*, *115*(44), 11203-11208. https://doi.org/10.1073/pnas.1802331115

Gao, S., Calhoun, V. D., & Sui, J. (2018). Machine learning in major depression: from classification to treatment outcome prediction. *CNS Neuroscience and Therapeutics, 24*(11), 1037-1052. https://doi.org/10.1111/cns.13048

Gibbons, R. D., Hooker, G., Finkelman, M. D., Weiss, D. J., Pilkonis, P. A., Frank, E., Moore, T., & Kupfer, D. J. (2013). The computerized adaptive diagnostic test for major depressive disorder (CAD-MDD): a screening tool for depression. *The Journal of clinical psychiatry, 74*(7), *669-674.* https://doi.org/10.4088/JCP.12m08338

Gibbons, R. D., Weiss, D. J., Pilkonis, P. A., Frank, E., Moore, T., Kim, J. B., & Kupfer, D. J. (2014). Development of the CAT-ANX: A computerized adaptive test for anxiety. *The American Journal of Psychiatry, 171*(2), 187-194. *https://doi.org/10.1176/appi.ajp.2013.13020178*

Gibbons, R. D., Weiss, D. J., Frank, E., & Kupfer, D. (2016). Computerized adaptive diagnosis and testing of mental health disorders. *Annual Review of Clinical Psychology, 12,* 83-104. https://doi.org/10.1146/annurev-clinpsy-021815-093634

Gibbons, R. D., Kupfer, D., Frank, E., Moore, T., Beiser, D. G., & Boudreaux, E. D. (2017). Development of a computerized adaptive test suicide scale-The CAT-SS. *Journal of Clinical Psychology, 78*(9), 1376-1382. https://doi.org/10.4088/JCP.16m10922

Gibbons, R. D., Kupfer, D. J., Frank, E., Lahey, B. B., George-Milford, B. A., Biernesser, C. L., Porta, G., Moore, T. L., Kim, J. B., & Brent, D. A. (2020). Computerized adaptive tests for rapid and accurate assessment of psychopathology dimensions in youth. *Journal of the American Academy of Child and Adolescent Psychiatry, 59*(11), *1264-1273.* https://doi.org/10.1016/j.jaac.2019.08.009

Gupta, A. (2018). *Detecting crisis: An AI solution*. Crisis Text Line. https://www.crisistextline.org/blog/2018/03/28/detecting-crisis-an-ai-solution/

Menger, V., Scheepers, F., & Spruit, M. (2018). Comparing deep learning and classical machine learning approaches for predicting inpatient violence incidents from clinical text. *Applied Sciences, 8*(6), 981. https://doi.org/10.3390/app8060981

Ringeval, F., Schuller, B., Valstar, M., Cummins, N., Cowie, R., Tavabi, L., Schmitt, M., Alisamir, S., Amiriparian, S., Messner, E-M., Song, S., Liu, S., Zhao, Z., Mallol-Ragolta, A., Ren, Z., Soleymani, M., & Pantic, M.. (2019). AVEC 2019 workshop and challenge: State-of-mind, detecting depression with AI, and cross-cultural affect recognition. *arXiv*. https://doi.org/10.48550/arXiv.1907.11510

Spasic, I., & Nenadic, G. (2020). Clinical text data in machine learning: Systematic review. *JMIR Medical Informatics*, *8*(3), e17984. https://doi.org/10.2196/17984

Standing Senate Committee on Social Affairs, Science and Technology. (2017). *Challenge ahead: Integrating robotics, artificial intelligence and 3D printing technologies into Canada's healthcare systems*. https://sencanada.ca/content/sen/committee/421/SOCI/reports/RoboticsAI3DFinal_Web_e.pdf

Technology.org. (2021). *Researchers craft AI based tool that detects bipolar disorder at earlier stages*. https://www.technology.org/2021/03/31/researchers-craft-ai-based-tool-that-detects-bipolar-disorder-at-earlier-stages/

University of Alberta. (2021). *Researchers hope AI can help diagnose depression more accurately*. https://www.ualberta.ca/folio/2021/04/researchers-hope-ai-can-help-diagnose-depression-more-accurately.html

Wang, Y., Iyengar, V., Hu, J., Kho, D., Falconer, E., Docherty, J. P., & Yuen, G. Y. (2017). Predicting future high-cost schizophrenia patients using high-dimensional administrative data. *Frontiers in Psychiatry, 8,* 114. https://doi.org/10.3389/fpsyt.2017.00114

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