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New Course Proposal Form

The following information is required for all new course proposals. To facilitate the review/approval process, please use the headings below (and omit the italicized explanations below each heading).

1. **Program: Graduate Program in Health – Health Management and Health Data Analytics**

2. **Course Number:** HLTH 6270

3. **Credit Value:** 3.0

4. **Long Course Title:** Machine Learning for Health

5. **Short Course Title:** Machine Learning for Health

6. **Effective Session:** Fall 2022

7. **Calendar (Short) Course Description:**
   This course will introduce the fundamental concepts and principles of machine learning and its application in healthcare. We will explore machine learning approaches, health cases in relation to machine learning, and best practices for designing, building, and evaluating machine learning applications in healthcare. Opportunities and challenges that machine learning present for health and society will be covered.

8. **Expanded Course Description:**
   The following describes the (1) course topics (2) course learning objectives, and a description of experiential education (EE) and/or technology-enhanced learning activities.

   a) course topics/theories

   1. Healthcare and Decision Making
   2. Analytics Building Blocks: Descriptive, Predictive and Prescriptive Analytics
   3. Statistical Analysis and Machine Learning
   4. Linear and Logistic Regression
   5. Integrated development Environments for Machine Learning
   6. Neural Networks
   7. Support Vector Machine
   8. Unsupervised Learning
   9. Dimensionality Reduction
   10. Evaluations of Machine Learning Applications in Healthcare
   11. AI deployment

   b) Course learning objectives

   1) Depth and breadth of knowledge
   - 1- Demonstrate understanding of the key concepts underlying Machine Learning
   - 2- Engage with multiple Machine Learning techniques

   2) Knowledge of methodologies
   - 1- Demonstrate critical understanding of the technological advancements in Machine Learning in Healthcare
   - 2- Grasp the fundamentals of the algorithms related to Machine Learning

3 Application of knowledge
1- Employ critical analytics skills
2- Conduct research of print, electronic, and visual resource texts

4) Communications skills
1- Work collaboratively and ethically with others
2- Effectively research, develop, present, and give peer feedback on Machine Learning projects in Healthcare
3- Write rigorous reports

5) Awareness of limitations of knowledge
1- Understand the limits of Machine Learning in Healthcare
2- Understand the ethical limitations of Machine Learning in Healthcare

6) Autonomy and professional capacity
1- Develop a disciplined and rigorous practice

c) Description of experiential education (EE) and/or technology-enhanced learning activities.

The course will contain classroom-focused EE that exposes students to concrete machine learning activities in the form of lab exercises and case studies. Students will be required to reflect on both and will be asked to submit at the end of each session a writeup to answer specific questions related to the concepts and theories being covered in the course. In addition, guest lecturers will be invited to the class to interact with the students about concrete Machine Learning applications in Healthcare. Lab exercises will allow student to achieve the following learning outcomes:

1- Engage with multiple Machine Learning techniques
2- Grasp the fundamentals of the algorithms related to Machine Learning
3- Employ critical Machine Learning skills
4- Analyze, discuss, and communicate clearly in a range of Machine Learning problems and solutions in healthcare
5- Work collaboratively and ethically with others
6- Effectively research, develop, present, and give peer feedback on Machine Learning applications in healthcare
7- Meet deadlines and develop a rigorous discipline

Case studies consist of real-life situation that demands Machine Learning based solutions, students need to work in group to find the different Machine Learning approaches that can be used to address the problem, and to choose one approach based on a clear rationale.

In both case studies and lab exercises, student will work collaboratively in groups; they will be able to present their findings in class and submit the results for correction and feedback.

Special computer labs will not be required for this course. Free self-install software will be used to enable students to continuously have access to machine learning capacity at home and work independently. Weka, Anaconda, and Jupyter are examples of such integrated development environments. The first lab would be dedicated to installation and use of the software.

9. Course Learning Outcomes

After completion of the course students will be able to:

1- Apply theoretical and practical knowledge of Machine Learning in Healthcare
2- Apply practical knowledge of available Machine Learning software
3- Assess Health outcomes using Machine Learning techniques
4- Choose appropriate Data Visualization tools
5- Evaluate Machine Learning Applications in Healthcare
6- Analyze, discuss, and communicate clearly in a range of Machine Learning related problems and solutions in healthcare

10. Rationale

With Machine Learning and Artificial Intelligence applications thriving in the healthcare domain, professionals working in the healthcare industry are faced with both opportunities and challenges. This course introduces the principles of Machine Learning and their applications in healthcare.

This course equips students with in-depth understanding on the data use and Machine Learning techniques as well as with skills needed in the domain. It contributes to furthering the students critical thinking, data skills, Machine Learning skills, technological innovation, presentation skills, group work, EE experience; all of which are core to the program objectives and prepare students to fill a need for data analytics skills in the healthcare system.

The course aligns with the faculty educational objectives to provide students with excellent educational experience via up-to-date content using cutting edge technologies, as well as providing students with marketable skills.

This course, along with another new course on Data Visualization constitute two of the new field-specific courses in the new field in health management and health data analytics in the Graduate Program in Health. These two analytics-oriented courses are unique to the program and complement existing health management and knowledge utilization courses already approved in the program.

The Graduate Program in Health's learning outcomes are included in Appendix X.

11. Evaluation:

Please supply a detailed breakdown of course requirements, including the type and percentage value of each assignment. The expectation is that course assignments can normally be accomplished within the course period. If applicable, details regarding expectations and corresponding grading requirements with respect to attendance and participation should be provided.

Assignment	**Percentage value**
Reflection (eClass Discussion forum / Journal)	10%
Lab exercises (Lab assignments)	25%
Term paper (research paper)	25%
Project (report 30% and presentation 10%)	40%

12. Integrated Courses:

N.A.

13. Crosslisted Courses:

N.A.

14. Faculty Resources:

Faculty members qualified to teach this course: Christo El Morr and Serban Dinca
Frequency with which you expect this course to be offered: Approximately every second year.

We have several health informatics faculty members with the School equipped to teach at the graduate and undergraduate levels. Offering this course in alternate years will not detract from the School's ability to continue to have full-time faculty deliver undergraduate health informatics courses. The addition of this area to our graduate program will also help alleviate currently high supervision loads

experienced by SHPM faculty members in the health policy and equity area and allow us to share faculty supervision resources more equitably across the School.

15. Physical Resources:

The lab already in place in HNE B02 is adequate to run the labs related to this course. No additional physical resources are needed.

16. Bibliography and Library Statement:

Please provide an appropriate and up-to-date bibliography in standard format. A statement from the University librarian responsible for the subject area certifying that adequate library resources are available for the new course must be provided.

1. Healthcare and Decision Making
2. Analytics Building Blocks: Descriptive, Predictive and Prescriptive Analytics
3. Statistical Analysis and Machine Learning
4. Linear and Logistic Regression
5. Integrate development Environments for Machine Learning
6. Neural Networks
7. Support Vector Machine
8. Unsupervised Learning
9. Dimensionality Reduction
10. Evaluations of Machine Learning Applications in Healthcare
11. AI deployment

Session 1: Healthcare and Decision Making

El Morr, C., Ginsburg, L., Nam, S., & Woollard, S. (2017). Assessing the Performance of a Modified LACE Index (LACE-rt) to Predict Unplanned Readmission After Discharge in a Community Teaching Hospital. *Interact J Med Res, 6*(1), e2. doi:10.2196/ijmr.7183

Khalifa, M., & Zabani, I. (2016). Utilizing health analytics in improving the performance of healthcare services: A case study on a tertiary care hospital. *Journal of Infection and Public Health, 9*(6), 757-765. doi:https://doi.org/10.1016/j.jiph.2016.08.016

Al Hamouche, V. (2014). Making Quality Control Decisions in Radiology Department: A Decision Support System for Radiographers' Performance Appraisal Using PACS. In M. Christo El (Ed.), Research Perspectives on the Role of Informatics in Health Policy and Management (pp. 48-61). Hershey, PA, USA: IGI Global.

Session 2: Building Blocks

Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). *Data Mining: Practical Machine Learning Tools and Techniques*: Elsevier Science.

Santos, R. S., Malheiros, S. M., Cavalheiro, S., & de Oliveira, J. M. (2013). A data mining system for providing analytical information on brain tumors to public health decision makers. *Comput Methods Programs Biomed, 109*(3), 269-282. doi:10.1016/j.cmpb.2012.10.010

Rose Business Technologies. (2013, February 7, 2013). Descriptive Diagnostic Predictive Prescriptive Analytics Retrieved from http://www.rosebt.com/blog/descriptive-diagnostic-predictive-prescriptive-analytics

Khalifa, M. (2015). Developing an Emergency Physician Productivity Index Using Descriptive Health Analytics. *Stud Health Technol Inform, 213*, 167-170.

Wagenen, J. V. (2017). 3 Big Data Trends in Healthcare Using Predictive Analytics. https://healthtechmagazine.net/article/2017/11/predicting-analytics-3-big-data-trends-healthcare

Safaee, M. M., Scheer, J. K., Ailon, T., Smith, J. S., Hart, R. A., Burton, D. C., . . . Ames, C. P. (2018). Predictive modeling of length of hospital stay following adult spinal deformity correction: Analysis of 653 patients with an accuracy of 75% within 2 days. *World Neurosurg*. doi:10.1016/j.wneu.2018.04.064

Chalmers, E., Hill, D., Zhao, V., & Lou, E. (2015). Prescriptive analytics applied to brace treatment for AIS: a pilot demonstration. *Scoliosis, 10*(Suppl 2), S13. doi:10.1186/1748-7161-10-s2-s13

Rose Business Technologies. (2013, February 7, 2013). Descriptive Diagnostic Predictive Prescriptive Analytics Retrieved from http://www.rosebt.com/blog/descriptive-diagnostic-predictive-prescriptive-analytics

Session 3: Statistical Analysis and Machine Learning

Nevo, D. (2014). *Making sense of data through statistics - An introduction*: Legerity Digital Press.

Badillo, S., Banfai, B., Birzele, F., Davydov, II, Hutchinson, L., Kam-Thong, T., . . . Zhang, J. D. (2020). An Introduction to Machine Learning. *Clin Pharmacol Ther, 107*(4), 871-885. doi:10.1002/cpt.1796

Jamthikar, A., Gupta, D., Saba, L., Khanna, N. N., Araki, T., Viskovic, K., . . . Suri, J. S. (2020). Cardiovascular/stroke risk predictive calculators: a comparison between statistical and machine learning models. *Cardiovasc Diagn Ther, 10*(4), 919-938. doi:10.21037/cdt.2020.01.07

Session 4: Linear Regression and Logistic Regression

Misra, D. P., Zimba, O., & Gasparyan, A. Y. (2021). Statistical data presentation: a primer for rheumatology researchers. *Rheumatology International, 41*(1), 43-55. doi:10.1007/s00296-020-04740-z

Monahan, J. F. (2008). *A Primer on Linear Models*: CRC Press.

Session 5: Integrate development Environments for Machine Learning

Grolemund, G., & Wickham, H. (2016). *R for Data Science* (1 ed.): O'Reilly Media, Inc.

Ohri, A. (2017). *Python for R Users* (1 ed.): Wiley.

Session 6: Neural Networks

Neural networks in healthcare : potential and challenges. (2006). Hershey, PA: Idea Group Pub.

Xie, X., Li, X., Wan, S., & Gong, Y. (2006). Mining X-Ray Images of SARS Patients. In G. J. Williams & S. J. Simoff (Eds.), *Data Mining: Theory, Methodology, Techniques, and Applications* (pp. 282-294). Berlin, Heidelberg: Springer Berlin Heidelberg.

Raeisi Shahraki, H., Bemani, P., & Jalali, M. (2017). Classification of Bladder Cancer Patients via Penalized Linear Discriminant Analysis. *Asian Pac J Cancer Prev, 18*(5), 1453-1457. doi:10.22034/apjcp.2017.18.5.1453

Session 7: Support Vector Machine

Sun, X., Su, S., Zuo, Z., Guo, X., & Tan, X. (2020). Modulation Classification Using Compressed Sensing and Decision Tree-Support Vector Machine in Cognitive Radio System. *Sensors (Basel), 20*(5). doi:10.3390/s20051438

Farhadian, M., Shokouhi, P., & Torkzaban, P. (2020). A decision support system based on support vector machine for diagnosis of periodontal disease. *BMC Res Notes, 13*(1), 337. doi:10.1186/s13104-020-05180-5

Session 8: Unsupervised Learning

Jain, V., & Chatterjee, J. M. (2020). *Machine Learning with Health Care Perspective: Machine Learning and Healthcare*: Springer International Publishing.

Cleophas, T. J. M., & Zwinderman, A. H. (2020). *Machine Learning in Medicine -- a Complete Overview*: Springer.

Session 9: Dimensionality Reduction

Jain, V., & Chatterjee, J. M. (2020). *Machine Learning with Health Care Perspective: Machine Learning and Healthcare*: Springer International Publishing.

Cleophas, T. J. M., & Zwinderman, A. H. (2020). *Machine Learning in Medicine -- a Complete Overview*: Springer.

Session 10: Evaluations of Machine Learning Applications in Healthcare

Kelly, C. J., Karthikesalingam, A., Suleyman, M., Corrado, G., & King, D. (2019). Key challenges for delivering clinical impact with artificial intelligence. *BMC Medicine, 17*(1), 195. doi:10.1186/s12916-019-1426-2

Sidey-Gibbons, J. A. M., & Sidey-Gibbons, C. J. (2019). Machine learning in medicine: a practical introduction. *BMC Med Res Methodol, 19*(1), 64. doi:10.1186/s12874-019-0681-4

Tohka, J., & Gils, M. (2020). Evaluation of machine learning algorithms for Health and Wellness applications: a tutorial. *ArXiv, abs/2008.13690*.

Session 11: AI deployment

Carlile, M., Hurt, B., Hsiao, A., Hogarth, M., Longhurst, C. A., & Dameff, C. (2020). Deployment of artificial intelligence for radiographic diagnosis of COVID-19 pneumonia in the emergency department. *Journal of the American College of Emergency Physicians Open, 1*(6), 1459-1464. doi:https://doi.org/10.1002/emp2.12297

Campion, A., Hernandez, M. G., Jankin, S. M., & Esteve, M. (2020). Managing Artificial Intelligence Deployment in the Public Sector. *Computer, 53*(10), 28-37. doi:10.1109/MC.2020.2995644

He, M., Li, Z., Liu, C., Shi, D., & Tan, Z. (2020). Deployment of Artificial Intelligence in Real-World Practice: Opportunity and Challenge. *The Asia-Pacific Journal of Ophthalmology, 9*(4). Retrieved from https://journals.lww.com/apjoo/Fulltext/2020/08000/Deployment_of_Artificial_Intelligence_in.5.aspx

Session 12: Presentations

Students' in-class project presentations.

Please submit completed forms and required supporting documentation by email to the Coordinator, Faculty Governance – fgsgovrn@yorku.ca