COURSE SYLLABUS

COURSE TITLE:	**Machine Learning Methods in Health Science**		
COURSE CODE:	CHEP 898	**TERM:**	2026 Winter
COURSE CREDITS:	3	**DELIVERY:**	In person
CLASS SECTION: **CLASS LOCATION:** **CLASS TIME:** **WEBSITE:**	CRN 26905 HLTH 2334 Tuesday 13:00- 15:50 pm	**START DATE:** **LAB LOCATION:** **LAB TIME:**	January 6th, 2025

Course Description

- This course bridges the gap between data science techniques, biostatistics, and health research, equipping students with advanced tools to analyze complex health data. The course covers both the theoretical and practical aspects of machine learning. Through hands-on experience with R programming language, supervised and unsupervised machine learning techniques, and data visualization, students will learn to process and interpret large datasets to uncover insights into disease patterns, public health trends, and causal relationships. The course is designed to provide students with the theoretical knowledge and practical application of data science techniques. This will prepare learners to tackle health science challenges with modern data-driven approaches.

Prerequisites

- CHEP/PUBH 805, or a graduate-level Statistics Course.
- To request permission to take this course, please submit an override request with one of the instructors as approver: https://jira.usask.ca/servicedesk/customer/portal/7/create/291
    - On your ticket request, please explain how you meet the course prerequisites and how you hope the course can further your learning and research needs.
    - Please include CHEP graduate program administrator, Stephanie Kehrig, on the approval request ticket
- Interested Faculty and Researchers are invited to contact the instructors with content questions, or Stephanie.Kehrig@usask.ca on registration processes.

Enrollment Limit

15

Land Acknowledgement

We acknowledge our shared connection to the land and recognize that Indigenous and Métis peoples on Treaty 6 Territory and all Indigenous peoples have been and continue to be stewards for social justice, equity, and land-based education. In the spirit of reconciliation may we all strive to learn and support the work of Indigenous communities as allies.

Artificial Intelligence

This course will follow the general USask Guidelines about AI for Educators and Students (https://leader ship.usask.ca/initiatives/ai/index.php). The University has developed high level guidance based on the European Network for Academic Integrity (ENAI) recommendations. The

principles are descriptions of USask intentions for, and beliefs about, the use of AI. They include 4 categories:

- Ethical and Responsible Use
- Literacy
- Tool Use
- Change and Innovation

AI Rules for this course

In general, our opinion is that you should be exploring these tools, what they can do, and how you can integrate them into your work. These tools are great for editing, formatting, generating ideas, and writing very basic code. USask faculty and students have access to Microsoft Co-Pilot (https://teaching.usask.ca/learning-technology/tools/microsoft-copilot.php). It's critical that when you use these tools you are very aware of bias and that you intervene to correct the text. Here are our general rules for AI in this course.

1. You can use AI tools for any or all parts of the work.
2. If you do you must cite your work (as above).
   2.1. Acknowledge AI tools: "All persons, sources, and tools that influence the ideas or generate the content should be properly acknowledged" (p. 3). Acknowledgement may be done in different ways, according to context and discipline, and should include the input to the tool.
   2.2. Do not list AI tools as authors: Authors must take responsibility and be accountable for content and an AI tool cannot do so.
   2.3. Recognize limits and biases of AI tools: Inaccuracies, errors, and bias are reproduced in AI tools in part because of the human produced materials used for training.
3. If you do you must include a 250 word reflective essay about the experience as part of your self-evaluation.
4. Be very careful with reference. Many of these tools just make up random references.
5. We will not use tools like GPTZero to detect whether you have used AI tools or not. We are making an agreement to be honest with each other here. This is a small class. We have that luxury.

Contact Information

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Learning Outcomes

1. Understand the basics of data wrangling and data management in epidemiology and health science
2. Gain proficiency in using Git and GitHub for version control.
3. Learn to leverage high-performance computing resources for epidemiologic data analysis.
4. Explore various machine learning techniques and their applications in epidemiology and health science
5. Compare and contrast traditional epidemiological analysis methods with machine learning approaches.

Readings/Textbooks

There is not one textbook for this course. We will use various components of different open-access resources.

- R for Data Science (2e). 2024. Hadley Wickham, Mine Çetinkaya-Rundel, and Garrett Grolemund. https://r4ds.hadley.nz/
- An Introduction to Statistical Learning with Applications in R (2e). 2024. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. https://www.statlearning.com/
- Learn Tidymodels. https://www.tidymodels.org/learn/
- The Elements of Statistical Learning: Data Mining, Inference, and Prediction (2e). 2009, Trevor Hastie, Robert Tibshirani and Jerome Friedman. https://hastie.su.domains/ElemStatLearn/

Other Required Materials

Use of a statistical software program (R) is required for this course. You will also be asked to install other software including PostGRES (SQL) and Git.

Dataset

In this course we will use the CanPath Student Dataset that provides students the unique opportunity to gain hands-on experience working with CanPath data. The CanPath Student Dataset is a synthetic dataset that was manipulated to mimic CanPath's nationally harmonized data but does not include or reveal actual data of any CanPath participants.

The CanPath Student Dataset is available to instructors at a Canadian university or college for use in an academic course, at no cost. CanPath will provide the Student Dataset and a supporting data dictionary.

- Large sample size (Over 40,000 participants)
- Real-world population-level Canadian data
- Variety of areas of information allowing for a wide range of research topics
- No cost to faculty
- Potential for students to apply for real CanPath data to publish their findings

General Class Schedule

Week	Date	Topic	Data Work
1	January 6	Intro to Data Science (Intro to Machine/Statistical learning)	Data Wrangling and Visualization
2	January 13	Data Visualization and Version Control/Github	HappyGitwithR
3	January 20	Regression - Linear Regression and Optimization	Linear Regression
4	January 27	Classification - Logistic Regression and KNN	Logistic Regression and KNN
5	February 3	Unsupervised learning - PCA	Principal Component Analysis
6	February 10	Unsupervised learning - Clustering	Clustering Methods
7	February 17	Reading Week	
8	February 24	Validation - Cross Validation + Bootstrapping	Cross Validation + Bootstrapping – Applications with Linear Regression
9	March 3	Ensemble Methods - Random Forest	Causal Quartet + Causal Forest
10	March 17	Causal Inference – Causal Forest	Causal Forest + Matching
11	March 24	Ensemble Methods – Artificial Neural Networks	Artificial Neural Networks
12	March 31	Ensemble Methods – Transformers/Self-Supervised Learning	Artificial Neural Networks Part 2
13	April 7	Scientific Computing	Scientific Computing + Full ML Implementation

- Subject to change depending on speed

Attendance and Participation

Attendance and participation and reading ahead are critical to this course. There will a lot of time for discussion and working on assignments allocated in this course but reading ahead is a critical aspect of the learning process.

Assignment Grading Scheme

	Assignment	Grade %	Due Date
1	Data Wrangling and Visualization	10%	January 19, 2026
2	Github	5%	January 26, 2026
3	Unsupervised learning	15%	February 9, 2026
4	Independent Analysis - Part 1	10%	February 23, 2026
5	Supervised learning	15%	March 9, 2026
6	Causal Forest	10%	March 23, 2026
7	Artificial Neural Network	15%	April 6, 2026
8	Scientific Computing	5%	April 20, 2026
9	Independent Analysis – Part 2	15%	April 20, 2026
	Total	**100%**	

Assignment Descriptions

1. Data Wrangling and Visualization

Value: 10% of final grade
Due Date: See Course Schedule
Type: This assignment will have students work with fundamental skills of data science and submit via an RMarkdown file.
Description: In this assignment you will complete a data wrangling assignment that will involve data cleaning, descriptive statistics, understanding missing data, and joining datasets together.

2. Github

Value: 5% of final grade
Due Date: See Course Schedule
Type: This assignment will have students work version control systems and submit their assignment to their own Github repository.
Description: In this assignment you will create a Github account, install Git on your local computer, create a Github repository and commit and push your work to that Github repository.

3. Unsupervised Learning

Value: 15% of final grade
Due Date: See Course Schedule
Type: This assignment will have students understand the basic approaches to unsupervised learning.
Description: In this assignment you will apply and compare different methods for unsupervised learning on a large health administrative dataset.

4. Independent Analysis 1

Value: 10% of final grade
Due Date: See Course Schedule
Type: This assignment will have students conduct the first part of an independent data science workflow
Description: This is part 1 of the independent analysis. You will need to find a dataset, develop an analysis plan to include the major components of the course (ie., Github, Scientific Computing), and conduct descriptive statistics and data wrangling on your chosen dataset.

5. Supervised Learning

Value: 15% of final grade
Due Date: See Course Schedule
Type: This assignment will have students understand the supervised learning approaches
Description: In this assignment you will apply and compare different methods for supervised learning on a large health administrative dataset, and will use bootstrap and cross-validation techniques.

6. Causal Forest

Value: 10% of final grade
Due Date: See Course Schedule
Type: This is a code-based assignment where you conduct a Random Forest analysis.
Description: In this analysis you will complete a Random Forest analysis using the Can Path student dataset. You will need to run the analysis, conduct detailed hyperparameter tuning, and conduct model comparisons.

7. Artificial Neural Networks

Value: 15% of final grade
Due Date: See Course Schedule
Type: This is a code-based assignment where you conduct an artificial neural network analysis.

Description: In this analysis you will complete a machine learning based artificial neural network using the Can Path student dataset.

8. Scientific Computing/Big Data

Value: 5% of final grade
Due Date: See Course Schedule
Type: This is a code-based assignment where you will learn to use an HPC.
Description: In this assignment you will use the USask Plato High Performance Computing to run a large scale machine learning on a large (~1GB) dataset.

9. Independent Analysis 15%

Value: 15% of final grade

Due Date: See Course Schedule
Type: This assignment will have students conduct the second and final part of an independent data science workflow.
Description: This is part 2 (final part) of the independent analysis. You will need to conduct a complete analysis including data wrangling, missing data handling, and apply at least 2 different machine learning methods to your data.

Self-Evaluation

Value: 0% of final grade (Formative Evaluation)
Due Date: See Course Schedule
Type: Written report (200 words)
Description: Complete the student self-evaluation form. This is **required** for **each** assignment where you use AI.

Submitting Assignments

All assignments should be submitted to the appropriate place in Canvas or Github. All assignments are due at 5pm (CST) on the due date. Please don't stay up until midnight to get the work done. Remember there are no late penalties so just take an extra day if you need and get some sleep.

Late and Missing Assignments

There is no penalty for late assignments. However, because many assignments have two parts, it is critical to the first assignment of the sections in around the due date. Missing assignments that are not submitted by the end of the course will receive a grade of zero.

Readings

1. Breiman L. Statistical Modeling: The Two Cultures, Statistical Science https://projecteuclid.org/journals/statistical-science/volume-16/issue-3/Statistical-Modeling--The-Two-Cultures-with-comments-and-a/10.1214/ss/1009213726.full https://ledaliang.github.io/journalclub/_static/breiman2001/Presentation.pdf
2. Bi Q, Goodman KE, Kaminsky J, Lessler J. What is Machine Learning? A Primer for the Epidemiologist. Am J Epidemiol. 2019 Dec 31;188(12):2222-2239. doi: 10.1093/aje/kwz189. PMID: 31509183.
3. Serghiou S, Rough K. Deep Learning for Epidemiologists: An Introduction to Neural Networks. Am J Epidemiol. 2023 Nov 3;192(11):1904-1916. doi: 10.1093/aje/kwad107. PMID: 37139570.
4. Wiemken TL, Kelley RR. Machine Learning in Epidemiology and Health Outcomes Research. Annu Rev Public Health. 2020 Apr 2;41:21-36. doi: 10.1146/annurev-publhealth-040119-094437. Epub 2019 Oct 2. PMID: 31577910.

5. Fuller D, Buote R, Stanley K. A glossary for big data in population and public health: discussion and commentary on terminology and research methods. J Epidemiol Community Health. 2017 Nov;71(11):1113-1117. doi: 10.1136/jech-2017-209608. Epub 2017 Sep 16. PMID: 28918390.

Additional readings will be provided using material from the online course material.

University of Saskatchewan Grading System (for graduate courses)

The following describes the relationship between literal descriptors and percentage scores for courses in the College of Graduate Studies and Research:

90-100 Exceptional: A superior performance with consistent strong evidence of

- a comprehensive, incisive grasp of subject matter;
- an ability to make insightful, critical evaluation of information;
- an exceptional capacity for original, creative and/or logical thinking;
- an exceptional ability to organize, to analyze, to synthesize, to integrate ideas, and to express thoughts fluently;
- an exceptional ability to analyze and solve difficult problems related to subject matter.

80-89 Very Good to Excellent: A very good to excellent performance with strong evidence of

- a comprehensive grasp of subject matter;
- an ability to make sound critical evaluation of information;
- a very good to excellent capacity for original, creative and/or logical thinking;
- a very good to excellent ability to organize, to analyze, to synthesize, to integrate ideas, and to express thoughts fluently;
- a very good to excellent ability to analyze and solve difficult problems related to subject matter.

70-79 Satisfactory to Good: A satisfactory to good performance with evidence of

- a substantial knowledge of subject matter;
- a satisfactory to good understanding of the relevant issues and satisfactory to good familiarity with the relevant literature and technology;
- a satisfactory to good capacity for logical thinking;
- some capacity for original and creative thinking;
- a satisfactory to good ability to organize, to analyze, and to examine the subject matter in a critical and constructive manner;
- a satisfactory to good ability to analyze and solve moderately difficult problems.

60-69 Poor: A generally weak performance, but with some evidence of

- a basic grasp of the subject matter;
- some understanding of the basic issues;
- some familiarity with the relevant literature and techniques;
- some ability to develop solutions to moderately difficult problems related to the subject matter;
- some ability to examine the material in a critical and analytical manner.

<60 Failure: An unacceptable performance.

Program Requirements

- Percentage scores of at least 70% are required for a minimal pass performance in undergraduate courses taken by graduate students;
- Percentage scores of at least 70% are required for a minimal pass performance for each course which is included in a Ph.D. program;
- Percentage scores of at least 70% are required for a minimal pass performance in all courses used toward JSGS Public Policy and Public Administration programs and all core courses for Master of Public Health students, whether included in a Ph.D. program or a Master's program;
- For all other graduate courses, percentage scores of at least 60-69% are required for a minimal pass performance for each course which is included in a Master's program, provided that the student's Cumulative Weighted Average is at least 70%;
- Graduate courses for which students receive grades of 60-69% are minimally acceptable in a Postgraduate Diploma program, provided that the Cumulative Weighted Average is at least 65%;
- Students should seek information on other program requirements in the Course & Program Catalogue and in academic unit publications.

Access and Equity Services (AES)

Access and Equity Services (AES) is available to provide support to students who require accommodations due to disability, family status, and religious observances. Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Access and Equity Services (AES) if they have not already done so. Students who suspect they may have disabilities should contact AES for advice and referrals at any time. Those students who are registered with AES with mental health disabilities and who anticipate that they may have responses to certain course materials or topics, should discuss course content with their instructors prior to course add / drop dates. Students who require accommodations for pregnancy or substantial parental/family duties should contact AES to discuss their situations and potentially register with that office. Students who require accommodations due to religious practices that prohibit the writing of exams on religious holidays should contact AES to self-declare and determine which accommodations are appropriate. In general, students who are unable to write an exam due to a religious conflict do not register with AES but instead submit an exam conflict form through their PAWS account to arrange accommodations. Any student registered with AES, as well as those who require accommodations on religious grounds, may request alternative arrangements for mid-term and final examinations by submitting a request to AES by the stated deadliness. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by AES. For more information or advice, visit https://students.usask.ca/health/centres/access-equity-services.php, or contact AES at 306-966-7273 (Voice/TTY 1-306-966-7276) or email aes@usask.ca.

Academic Integrity

The University of Saskatchewan is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Student Conduct & Appeals section of the University Secretary Website and avoid any behavior that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University. All students should read and be familiar with the Regulations on Academic Student Misconduct (https://governance.usask.ca/student-conduct-appeals/academic-misconduct.php) as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals (https://governance.usask.ca/student-conduct-appeals/non-academic-misconduct.php) For more information on what academic integrity means for students see the Academic

Integrity section of the University Library Website at: https://library.usask.ca/academic-integrity.php You are encouraged to complete the Academic Integrity Tutorial to understand the fundamental values of academic integrity and how to be a responsible scholar and member of the USask community - https://libguides.usask.ca/AcademicIntegrityTutorial There are also valuable resources on the Integrity Matters website: https://academic-integrity.usask.ca/

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Student Supports

Academic Support for Students

Visit the Learning Hub to learn how the University Library supports undergraduate and graduate students. Attend online or in-person workshops, review online resources or book 1-1 appointments for help with * First year experience * Research * Study strategies and skills * Writing * Math and Statistics

Teaching, Learning and Student Experience

Teaching, Learning and Student Experience (TLSE) provides developmental and support services and programs to students and the university community. For more information, see the students' website http://students.usask.ca.

Financial Support

Any student who faces unexpected challenges securing their food or housing and believes this may affect their performance in the course is urged to contact Student Central https://students.usask.ca/student-central.php.

Aboriginal Students' Centre

The Aboriginal Students' Centre (ASC) is dedicated to supporting Indigenous student academic and personal success. The ASC offers personal, social, cultural and some academic supports to Métis, First Nations, and Inuit students. The ASC is in the Gordon Oakes Red Bear Students Centre, which is an intercultural gathering space that brings Indigenous and non-Indigenous students together to learn from, with and about one another in a respectful, inclusive, and safe environment. Visit https://students.usask.ca/indigenous/index.php or students are encouraged to visit the ASC's Facebook page https://www.facebook.com/aboriginalstudentscentre/

International Student and Study Abroad Centre

The International Student and Study Abroad Centre (ISSAC) supports student success and facilitates international education experiences at USask and abroad. ISSAC is here to assist all international undergraduate, graduate, exchange, and English as a Second Language students in their transition to the University of Saskatchewan and to life in Canada. ISSAC offers advising and support on matters that affect international students and their families and on matters related to studying abroad as University of Saskatchewan students. Visit https://students.usask.ca/international/issac.php for more information.