

Course Overview

Introduction à l'apprentissage automatique – GIF-4101 / GIF-7005

Professor: Christian Gagné

Week 1



UNIVERSITÉ
LAVAL

Introduction to Machine Learning

- GIF-4101: Optional course in computer engineering, computer science, statistic, mathematic-informatic, software engineering, mechanical engineering, geomatics engineering, etc.
 - Requirements
 - STT-2920 – Probabilités pour ingénieurs (or equivalent)
 - MAT-2930 – Algèbre linéaire appliqué (or equivalent)
- GIF-7005: graduate course, professional Master's in Computer Science – Artificial Intelligence, Master's and PhD in Electrical Engineering, Computer Science
 - Open to students from other Master's and PhD programs (sciences and engineering)
 - No official requirements, but must have basic knowledge in:
 - Linear algebra
 - Probability and statistics
 - Calculus
 - Algorithms and programming

Course organization

- Theoretical content presented in video capsules
 - Slides (PDF) and video capsules available each week
- Hybrid synchronous presence period, Wednesday from 9:00 to 10:20 AM
 - In person at VCH-3820 (106 places available, seat reservation required)
 - Simultaneous broadcast on Zoom
 - Recording of sessions for later listening
 - Explanations, technical presentations, answers to the questions
- Practical work
 - 5 homeworks done in the PAX environment (Jupyter notebooks)
 - Undergraduate students: homeworks in teams of 2
 - Graduated students: individual
 - A project in teams of 3 to 5 students
 - In teams of 3 to 5 students (mixed groups allowed)
 - Narrated presentation (e.g. slides in video with voice-over)
 - Work realised on Python with scikit-learn and PyTorch libraries

Evaluations

Work	Date	Time	Weighting
Homework 1	September 29, 2021	5:00 PM	8 %
Homework 2	October 13, 2021	5:00 PM	8 %
Homework 3	November 10, 2021	5:00 PM	8 %
Homework 4	November 24, 2021	5:00 PM	8 %
Homework 5	December 8, 2021	5:00 PM	8 %
Project	December 17, 2021	5:00 PM	20 %

	Date	Time	Weight.	Format
Partial exam	November 3, 2021	8:30 to 10:20 AM	25 %	Online multiple-choice test
Final exam	December 15, 2021	8:30 to 10:20 AM	15 %	Development questions

Grades scales

- GIF-4101 (Undergraduates): pass at **50 %**

A+: [100, 90]	A: [90, 85]	A-: [85, 80]
B+: [80, 76]	B: [76, 72]	B-: [72, 68]
C+: [68, 64]	C: [64, 60]	C-: [60, 56]
D+: [56, 53]	D: [53, 50]	E: [50, 0]

- GIF-7005 (Graduates): pass at **60 %**

A+: [100, 90]	A: [90, 85]	A-: [85, 80]
B+: [80, 76]	B: [76, 72]	B-: [72, 68]
C+: [68, 64]	C: [64, 60]	E: [60, 0]

- **Introduction (2h)**: types of learnings; optimization; regularization; generalization; methodology.
- **Parametric methods (6h)**: discriminating functions; Bayes theorem; parametric methods; maximum likelihood estimation; bias/variance trade-off; multivariate methods; mixture models; linear regression; multivariate regression.
- **Nonparametric methods (3h)**: density functions; kernel density estimation; nearest neighbors classification; distance measures.
- **Linear discriminants (3h)**: gradient descent; multiclass classification; Perceptron algorithm; least squares method; logistic regression.
- **Kernel methods (3h)**: kernel function; maximization of geometric margins; wide margin discrimination; examples of other kernel methods.
- **Multilayer Perceptron (3h)**: neural networks models; backpropagation algorithm.

- **Deep learning (6h)**: representation learning; deep learning techniques; example of applications.
- **Ensemble methods (3h)**: majority voting; error correction codes; mixture of experts; Bagging; Boosting; decision trees; random forests.
- **Model preprocessing and configuration (3h)**: principal component analysis; greedy forward/backward features selection; heterogeneous data; missing variables; imputation; cross validation; hyper-parameters optimization.
- **Clustering (3h)**: K-means algorithm; expectation-maximization algorithm; hierarchical clustering; manifold learning; multidimensional scaling.
- **Conception and analysis of learning experiments (3h)**: plan of experiment; confusion matrix; ROC curves; Bootstrap; error estimation; statistical tests; algorithms comparison.

For those not fluent in French

- The course can be followed entirely in English, for students not sufficiently comfortable with French
 - English version of the slides
 - Video lectures in English will also be recorded and made available along the semester
 - Statements of assignments and exams are provided in English
 - Answers to assignments and exams, discussions on the forum, project proposal and presentations can be made in English
- Wednesday morning sessions
 - General explanations given in French, request for repeating in English can be made
 - Questions can be asked and will then be answered in English

- Several references available for further study
 - No book is required this year
 - Most of the references are available in digital format

📖 Ethem Alpaydin. *Introduction to Machine Learning*. 4th edition, MIT press, 2020.

📖 Christopher M. Bishop, *Pattern Recognition and Machine Learning*. Springer, 2006.

<https://www.microsoft.com/en-us/research/people/cmbishop/prml-book/>

📖 Trevor Hastie, Robert Tibshirani et Jerome Friedman. *The elements of statistical learning: data mining, inference, and prediction*. 2nd edition, Springer, 2009.

<https://web.stanford.edu/~hastie/ElemStatLearn/>

📖 Ian Goodfellow, Yoshua Bengio et Aaron Courville. *Deep Learning*. MIT press, 2016.

<http://www.deeplearningbook.org/>

📖 Andriy Burkov. *The Hundred-Page Machine Learning Book en français*. 2019.

<http://themlbook.com/wiki/doku.php>

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- Course assistance:
 - Questions and discussions of general interest on the subject matter and evaluations:
PAX course forum
 - More specific or personal considerations: email the professor

- monPortail site: <https://sitescours.monportail.ulaval.ca/ena/site/accueil?idSite=131222>
 - Course overview
 - Slides
 - Grades for homeworks and exams
- PAX's website: <https://pax.ulaval.ca/GIF-4101-7005/A21/>
 - Homeworks (Jupyter notebook)
 - Discussion forum
- YouTube channel:
https://www.youtube.com/channel/UCkMXqYn0zhI1RseU0gq8_Xw
 - Video capsules