Neural and Genetic Computing
CISC/CMPE 452/COGS 400
Fall 2021

Grading Scheme

Grade Categories	Grade
Assignments	**45%**
Assignment 1: A Basic ANN Development	10
Assignment 2: Supervised Learning in Multilayer ANN	15
Assignment 3: Unsupervised Learning	10
Assignment 4: Literature Review Report (2 unique papers each) with code download from published work (individual) (7 marks), data download and preprocessing and implementing a baseline model (group) (3 marks) (see OnQ for requirements)	10
Group Project (bonus 2 marks for exceptional work)	**25%**
Code implementation (Individual unique deep learning model + compiled)	10
Group project report (problem, solution, model description, data preprocessing flow diagram, results with charts and discussion) (individual + compiled) (see OnQ for requirements)	10
Recorded group talk (narrated PowerPoint) and demo (individual + compiled)	5
Quizzes	**30%**
Written Quiz 1	10%
Written Quiz 2	10%
Written Quiz 3	10%

Grading Method
A *"numbers in, letters out"* method will be used. Marks will be posted as numerical percentage. The final course numerical grade will be converted to a letter grade based on Arts and Science Grading Scheme.

Late Policy
Late submissions will be accepted after the due date until the end date on OnQ but 2 marks will be subtracted for each day past the due date. For special accommodations, students MUST CONTACT welfare services

Calculator Policy
Calculators can be used during quizzes, tests and examinations which have the basic calculating functions required by most Arts and Science courses. For this purpose, the use of the **Casio 991** series calculator is permitted and is the **only approved calculator for Arts and Science students**. This calculator can be bought from the Queen's Campus Bookstore, Staples and other popular suppliers of school and office supplies.

Check the school website for standard information about the following:
(https://www.cs.queensu.ca/students/undergraduate/syllabus/year2021-22.php)

- **Turnitin Statement**
- **Academic Integrity**
- **Copyright of Course Materials**
- **Accessibility Statement**
- **Accommodations Statement and Academic Considerations for Extenuating Circumstances**
  - ***No accommodation will be given for time zone*** as students are expected to attend the classes in person.
- **Statement of the Location and Timing of Final Examinations**

Weekly Syllabus - Academic Dates < Queen's University (queensu.ca)
(Holidays Oct 11-15 inclusive)

Week 1: Introduction to ANN
Topics
Introduction to biological neurons and the evolution of Artificial Neural Network (ANN) models. Example of an ANN model applied to human cognition. General architecture and concepts behind ANN and its application in machine learning.
Readings
>Textbook Chapter 1 and additional online material.

Activities
- Introduction forum
- Read published work on image analysis, text analysis and numeric or hybrid data analysis

Week 2: Learning Algorithms and Applications of ANN
Topics
Learning algorithms for different machine learning applications such as classification, clustering, associations, predictions, image processing and compression, and dimensionality reduction. Evaluation criteria and validation of ANN.
Readings
>Textbook Chapter 1 and/or additional online material.

Activities
- Research paper forum, categories: text cognition, visual cognition, speech cognition, classification, clustering, memory models, pattern recognition, prediction
- Formative Assessment: Research paper review
- Summative Assessment: Individual assignment #1 posted

Week 3: Supervised Learning in Single Layer ANNs
Topics
Learning algorithms in Perceptrons and Adaline using simple feedback learning, error correction, Q-learning, and Pocket algorithms.
Readings
>Textbook Chapter 2 and/or additional online material.

Activities
- Summative Assessment: Individual assignment #1 due (simple on ANN development)

Week 4: Supervised Learning in Multilayer ANNs

Topics

Supervised learning using back propagation. Engineering ANNs, design techniques for choice of layers and parameters including momentum and decay.

Readings

Textbook Chapter 3 and/or additional online material.

Activities

- Summative Assessment: Written Quiz 1 - All materials covered during weeks 1-3 inclusive
- Summative Assessment: Individual Assignment #2 posted due in 1.5 weeks (backpropagation)

Week 5: Other Supervised Learning in ANNs and Deep Learning Models

Topics

Supervised learning in recurrent, Radial Basis Function, adaptive networks, polynomial networks and network pruning algorithms for adaptive networks. Introduction to Deep Learning models (CNN, RNN, Attention, Transformer).

Readings

Textbook Chapter 4 and/or additional online material.

Activities

- Formative: Project group formation and title selection (based on literature review of relevant papers with published code and dataset)

Week 6: Unsupervised Learning in ANNs

Topics

Hamming network, maxnet, simple competitive learning and Kohonen network, K-means clustering, Learning Vector Quantizers (LVQ).

Readings

Textbook Chapter 5 and/or additional online material.

Activities

- Formative Assessment: Project group formed and title selected. Project work discussion and report progress on the discussion forum – each member should post in the group forum a list of 2 references relevant to the model to implement and should be unique from other group members.
- Summative Assessment: Assignment #2 due
- Summative Assessment: Individual Assignment #3 posted due in 1.5 weeks (unsupervised learning)

Week 7: Unsupervised Learning in ANNs (cont…)

Topics

Counter-propagation networks, Adaptive Resonance Theory (ART), Self -Organizing Map (SOM), Neocognitron, Principal Component Analysis (PCA).

Readings

Textbook Chapter 5 and/or additional online material.

Activities

- Summative Assessment: Assignment #4 posted (literature review and data preprocessing) (see OnQ for detail).

Week 8: Discrete Associative Memory Models
Topics
Hebbian Learning or reinforcement learning, Auto and Hetero Association Models, Discrete Hopfield networks, Lyapunov energy function.
Readings
Textbook Chapter 6 and/or additional online material.
Activities
- Summative Assessment: Assignment #3 due
- Written Quiz 2 – All materials covered during weeks 4-7 inclusive

Week 9: Continuous Associative Memory Models
Topics
Continuous Hopfield networks, Brain-State-in-a-Box (BSB), Boltzmann machine, hetero association models, Bidirectional Associative Memory (BAM).
Readings
Textbook Chapter 6 and/or additional online material.
Activities
- Formative Assessment: Submit project summary (project abstract, group members, data selected, models to be implemented listed by group members with additional processing of the same dataset if needed, list of references based on APA format, evaluation method for each model) on the forum.
- Summative Assessment: Assignment #4 due

Week 10: Genetic Algorithm and Simulated Annealing
Topics
Evolutionary computing, genetic algorithm and simulated annealing as optimization algorithms for ANN.
Readings
Textbook Chapter 8 and/or additional online material.
Activities
- Formative: Project work discussion and report progress on the discussion forum.

Week 11: Cutting Edge Research in ANN and Deep Learning Applications
Topics
Cutting edge research presentations on ANN.
Readings
Online material.
Activities
- Formative Assessment: Report about individual project work progress on the project group discussion forum. Recorded demo due next week.

Week 12: Project Discussion and Presentations
Topics
Presentations of group projects. Submit recorded presentation by the group (see additional instructions on OnQ).
Readings

Papers relevant to the group work.

Activities

- Summative Assessment: Submit recorded demo, program code for project and the final report (see OnQ for details)
- Written Quiz 3 – All materials covered during weeks 8-11 inclusive