

**Neural and Genetic Computing**  
**CISC/CMPE 452/COGS 400**  
**Fall 2022**

**Grading Scheme**

Grade Categories	Grade
<b>Assignments</b>	<b>35%</b>
Coding Assignment 1: A Basic ANN Development	5
Assignment 2: Supervised Learning in Multilayer ANN	15
Assignment 3: Unsupervised Learning with PCA	15
<b>Project Group + Individual work (bonus 2 marks for exceptional work)</b>	<b>35%</b>
Recorded group talk (narrated PowerPoint) and execution demo	8
Individual literature Review Report (2 unique papers each) with a comparison table of all papers reviewed (features, pros and cons)	5
Individual deep learning model (no MLP)	12
Individual report (model description, additional data preprocessing, data flow diagram and snapshot, experimental setup with training/testing details, results with charts, observations and discussion of result with reasoning)	6
Group project report (problem, list of models implemented, data description and general data preprocessing, comparative results obtained with the state-of-the-art result, observations and suggested future work for improvements)	4
<b>Quizzes</b>	<b>30%</b>
Written Quiz 1	15%
Written Quiz 2	15%

**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**

Assignments must be submitted by the posted due date. Late submissions will be accepted until the posted end date on OnQ. 1% will be subtracted from the total course mark for each day past the due date.

**Accommodations**

For any special accommodations, students MUST upload approved official accommodation letters on OnQ through assignment submission (details on OnQ). Without approved letters NO accommodation will be provided.

**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](https://www.cs.queensu.ca/students/undergraduate/syllabus/year2021-22.php) 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 \(queensu.ca\)](https://www.queensu.ca/academic-dates)  
(Holidays Oct 10-14 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