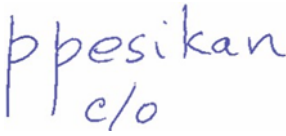


Course Outline

School:	Eng. Tech. & Applied Science
Department:	Information and Communication Engineering Technology (ICET)
Course Title:	Cloud Machine Learning
Course Code:	COMP 264
Course Hours/Credits:	42
Prerequisites:	COMP 247
Co-requisites:	N/A
Eligible for Prior Learning, Assessment and Recognition:	Yes
Originated by:	Mayy Habayeb
Creation Date:	Winter 2022
Current Semester:	Winter 2023
Approved by:	
	<hr/> Chairperson/Dean

Students are expected to review and understand all areas of the course outline.

Retain this course outline for future transfer credit applications. A fee may be charged for additional copies.

This course outline is available in alternative formats upon request.

Acknowledgement of Traditional Lands

Centennial is proud to be a part of a rich history of education in this province and in this city. We acknowledge that we are on the treaty lands and territory of the Mississaugas of the Credit First Nation and pay tribute to their legacy and the legacy of all First Peoples of Canada, as we strengthen ties with the communities we serve and build the future through learning and through our graduates. Today the traditional meeting place of Toronto is still home to many Indigenous People from across Turtle Island and we are grateful to have the opportunity to work in the communities that have grown in the treaty lands of the Mississaugas. We acknowledge that we are all treaty people and accept our responsibility to honor all our relations.

Course Description

In this course, students will be introduced to Cloud AI frameworks. Coursework will emphasize machine learning on AWS, Azure, and Google cloud. Students will gain hands-on experience by building and deploying ML applications using cloud tools and frameworks. "Machine learning operations" (ML/OPS) pipelines on the cloud and "Automated machine learning" (Auto ML) will be also explored.

Program Outcomes

Successful completion of this and other courses in the program culminates in the achievement of the Vocational Learning Outcomes (program outcomes) set by the Ministry of Colleges and Universities in the Program Standard. The VLOs express the learning a student must reliably demonstrate before graduation. To ensure a meaningful learning experience and to better understand how this course and program prepare graduates for success, students are encouraged to review the Program Standard by visiting <http://www.tcu.gov.on.ca/pepg/audiences/colleges/progstan/>. For apprenticeship-based programs, visit <http://www.collegeoftrades.ca/training-standards>.

Course Learning Outcomes

The student will reliably demonstrate the ability to:

1. Explain the definition, use cases, drivers and challenges of 'Cloud Computing'.
2. Examine the major cloud AI frameworks, available.
3. Analyze the technology stack & layers for AI applications.
4. Design, code, test and deploy a full stack AI application to Detect Objects in images utilizing cloud vendor APIs.
5. Design code, test and deploy a full stack AI application to upload images to the cloud, detect text within the images & translate the text to a different language utilizing cloud vendor APIs.
6. Examine security best practices for machine learning projects on the cloud.
7. Discuss best practices for Machine Learning operations (MLOps) pipelines on the cloud.

Essential Employability Skills (EES)

The student will reliably demonstrate the ability to*:

1. Communicate clearly, concisely and correctly in the written, spoken, and visual form that fulfills the purpose and meets the needs of the audience.
4. Apply a systematic approach to solve problems.

5. Use a variety of thinking skills to anticipate and solve problems.
9. Interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals.
11. Take responsibility for one's own actions, decisions, and consequences.

**There are 11 Essential Employability Skills outcomes as per the Ministry Program Standard. Of these 11 outcomes, the following will be assessed in this course.*

Global Citizenship and Equity (GC&E) Outcomes

N/A

Methods of Instruction

Engaging and interactive lecture content.

Lab demonstrations and tutorials.

Hands on practical lab exercises.

Interactive discussion forms and boards.

Team project.

Text and other Instructional/Learning Materials

Text Book(s):

Encyclopedia of Cloud Computing by San Murugesan; Irena Bojanova

Online ISBN: 9781118821930

Hands-On Artificial Intelligence on Amazon Web Services by Subhashini Tripuraneni, Charles Song

Publisher: Packt Publishing Release Date: October 2019 ISBN: 9781789534146

Building machine learning pipelines : automating model life cycles with TensorFlow

by Hapke Hannes, Nelson, Catherine. Publisher: O'Reilly Media, Inc Release date 2020

Data Science on AWS by Chris Fregly, Antje Barth Publisher: O'Reilly Media, Inc. Release Date: April 2021 ISBN: 9781492079392

Online Resource(s):

<https://ieeexplore-ieee-org.centennial.idm.oclc.org/servlet/opac?bknumber=7493776>

<https://learning.oreilly.com/library/view/hands-on-artificial-intelligence/9781789534146/#toc>

<https://learning.oreilly.com/library/view/data-science-on/9781492079385/>

<https://learning.oreilly.com/library/view/building-machine->

[learning/9781492053187/?sso_link=yes&sso_link_from=centennial-college](https://learning.oreilly.com/library/view/building-machine-learning/9781492053187/?sso_link=yes&sso_link_from=centennial-college)

Material(s) required for completing this course:

Indicated on course shell

Classroom and Equipment Requirements

Lab exercises will run under Linux environment.

Amazon free tier account or Amazon college student account.

Microsoft student Azure account.

Qwiklabs subscription.(optional)

Evaluation Scheme

- ◇ Test #1: Material weeks 1-6 Theory and Hands-on

- ⇒ Quizzes: Three quizzes
- ⇒ Group Project: Build a Full stack enabled AI application to solve a real business problem
- ⇒ Lab Assignments: Two lab assignments
- ⇒ Online interaction and discussion boards: Contributing to discussion board and online interaction through discussion boards.
- ⇒ Lab exercises: Attendance in lab session is required
 - 1) Sage Maker
 - 2) Airflow
 - 3) Sage Maker pipelines
 - 4) Step functions
 - 5) Aws Glue

Evaluation Name	CLO(s)	EES Outcome(s)	GCE Outcome(s)	Weight/100
Test #1	1, 2, 3, 4, 5	4, 5		20
Quizzes	1, 2, 3, 6, 7	4, 5		15
Group Project	2, 3, 4, 5	1, 4, 5, 9, 11		25
Lab Assignments	3, 4, 6, 7	1, 4, 5		20
Online interaction and discussion boards	1, 2, 6, 7	1, 11		10
Lab exercises	2, 6, 7			10
Total				100%

If students are unable to write a test they should immediately contact their professor or program Chair for advice. In exceptional and well documented circumstances (e.g. unforeseen family problems, serious illness, or death of a close family member), students may be able to write a make-up test.

All submitted work may be reviewed for authenticity and originality utilizing Turnitin®. Students who do not wish to have their work submitted to Turnitin® must, by the end of the second week of class, communicate this in writing to the instructor and make mutually agreeable alternate arrangements.

When writing tests, students must be able to produce official Centennial College photo identification or they may be refused the right to take the test or test results will be void.

Tests or assignments conducted remotely may require the use of online proctoring technology where the student's identification is verified and their activity is monitored and/or recorded, both audibly and visually through remote access to the student's computer and web camera. Students must communicate in writing to the instructor as soon as possible and prior to the test or assignment due date if they require an alternate assessment format to explore mutually agreeable alternatives.

Student Accommodation

The Centre for Accessible Learning and Counselling Services (CALCS) (<http://centennialcollege.ca/calcs>) provides programs and services which empower students in meeting their wellness goals, accommodation and disability-related needs. Our team of professional psychotherapists, social workers, educators, and staff offer brief, solution-focused psychotherapy, accommodation planning, health and wellness education, group counselling, psycho-educational workshops, adaptive technology, and peer support. Walk in for your first intake session at one of our service locations (Ashtonbee Room L1-04, Morningside Room 190, Progress Room C1-03, The Story Arts Centre Room 285, Downsview Room 105)

or contact us at calcs@centennialcollege.ca, 416-289-5000 ext. 3850 to learn more about accessing CALCS services.

Use of Dictionaries

- Any dictionary (hard copy or electronic) may be used in regular class work.

Program or School Policies

N/A

Course Policies

Late lab assignments will be accepted for 3 days after the due date has passed, subject to the following penalty structure:

A 10% penalty per day of lateness.

Lab assignments will not be accepted past the 3 day limit and will not earn any marks.

There are no extensions for discussion boards.

Attendance either on-site or virtual is required to earn lab exercises grade based on presenting results of lab execution.

College Policies

Students should familiarize themselves with all College Policies that cover academic matters and student conduct.

All students and employees have the right to study and work in an environment that is free from discrimination and harassment and promotes respect and equity. Centennial policies ensure all incidents of harassment, discrimination, bullying and violence will be addressed and responded to accordingly.

Academic Honesty

Academic honesty is integral to the learning process and a necessary ingredient of academic integrity. Forms of academic dishonesty include cheating, plagiarism, and impersonation, among others. Breaches of academic honesty may result in a failing grade on the assignment or course, suspension, or expulsion from the college. Students are bound to the College's AC100-11 Academic Honesty and Plagiarism policy.

To learn more, please visit the Libraries information page about Academic Integrity

<https://libraryguides.centennialcollege.ca/academicintegrity> and review Centennial College's Academic Honesty Module:

https://myappform.centennialcollege.ca/centennial/articulate/Centennial_College_Academic_Integrity_Module_%202/story.html

Use of Lecture/Course Materials

Materials used in Centennial College courses are subject to Intellectual Property and Copyright

protection, and as such cannot be used and posted for public dissemination without prior permission from the original creator or copyright holder (e.g., student/professor/the College/or third-party source). This includes class/lecture recordings, course materials, and third-party copyright-protected materials (such as images, book chapters and articles). Copyright protections are automatic once an original work is created, and applies whether or not a copyright statement appears on the material. Students and employees are bound by College policies, including AC100-22 Intellectual Property, and SL100-02 Student Code of Conduct, and any student or employee found to be using or posting course materials or recordings for public dissemination without permission and/or inappropriately is in breach of these policies and may be sanctioned.

For more information on these and other policies, please visit www.centennialcollege.ca/about-centennial/college-overview/college-policies.

Students enrolled in a joint or collaborative program are subject to the partner institution's academic policies.

PLAR Process

This course is eligible for Prior Learning Assessment and Recognition (PLAR). PLAR is a process by which course credit may be granted for past learning acquired through work or other life experiences. The PLAR process involves completing an assessment (portfolio, test, assignment, etc.) that reliably demonstrates achievement of the course learning outcomes. Contact the academic school to obtain information on the PLAR process and the required assessment.

This course outline and its associated weekly topical(s) may not be reproduced, in whole or in part, without the prior permission of Centennial College.

Semester: Winter 2023
 Section Code: All
 Meeting Time & Location: see my-centennial

Professor Name: see e-centennial
 Contact Information: see e-centennial
 Delivery Method: Section 001 - 004 - On-site, 401- Online

Topical Outline (subject to change):

Week	Topics	Readings/Materials	Weekly Learning Outcome(s)	Instructional Strategies	Evaluation Name and Weight	Evaluation Date
1	Course Overview. Introduction to cloud computing.	Modul#1 material. Chapter 1 Encyclopedia of Cloud Computing	Explain and discuss the definition of "Cloud computing". Examine the cloud service basic models. Examine the cloud service support models. Examine the benefits and challenges of cloud computing. List and discuss the main cloud services providers in the area of AI and machine learning. Set up a college account and carry out a quick tour of the cloud platform services that will be used in the course.	Lecture Demonstration Lab Session Class Discussion Discussion boards	Make available discussion board #1	
2	Restful API. Serverless architectures. AI Framework.	Module#2 material Section 1 -chapter 1 Hands-On Artificial Intelligence on Amazon Web Services by Tripuraneni & Song	Analyze the serverless architecture. Examine the Restful API architecture. Discuss a cloud based AI framework approach. Examine Image analysis APIs available from cloud providers.	Lecture Demonstration Lab Session Class Discussion Discussion boards	Make available Assignment #1	
3	Embedding AI capabilities into cloud applications. Serverless framework. Object detection.	Module#3 material. Section 2 -chapter 2 Hands-On Artificial Intelligence on Amazon Web Services by Tripuraneni & Song	Explain embedding AI capabilities into applications. Design an AI application to detect objects in images utilizing cloud vendor APIs Build and code the services layer: detection service, storage service. Build and code the orchestration layer. Develop and test the user interface.	Lecture Demonstration Lab Session Class Discussion Discussion boards	Quiz#3 Discussion board #1 due Make available discussion board #2	week 3
4	Detecting text within images. Translating text.	Module#4 material. Section 2 -chapter 3 Hands-On Artificial Intelligence on Amazon Web Services by	Explore language translation APIs available from cloud vendors. Design an AI application to detect text utilizing cloud vendor APIs'. Build and code the services layer: translation service, storage service, recognition service.	Lecture Demonstration Lab Session Class Discussion Discussion boards		

Week	Topics	Readings/Materials	Weekly Learning Outcome(s)	Instructional Strategies	Evaluation Name and Weight	Evaluation Date
5	Detecting and Translating Text (part#2) RESTful endpoints. Develop the front end. Deployment of a web App to the cloud.	Module#5 material. Section 2 -chapter 3 Hands-On Artificial Intelligence on Amazon Web Services by Tripuraneni & Song	Develop the Restful endpoints for the AI application. Develop the web user interface. Deploy and test the service on the local host. Deploy the AI application to the cloud using the serverless framework.	Lecture Demonstration Lab Session Class Discussion Discussion boards	Discussion board #2 due Make available project document	
6	AI/Machine Learning on the cloud	Module#6 material	Compare machine learning platforms available on the cloud. Explore the machine learning services/tools available from Amazon. Explore the machine learning services/tools available from Microsoft. Explore the machine learning services/tools available from Google.	Lecture Demonstration Lab Session Class Discussion Discussion boards	Assignment#1 due Make available discussion board #3	Week#6
7	Mid-term evaluations	N/A	N/A	Test during virtual class room session.	Midterm-test	week 7
8	Building M/L models on the cloud. Feedback loops.	Module#8 material. Chapter 12 Data Science on AWS Fregly & Antj Article: https://aws.amazon.com/getting-started/hands-on/build-train-deploy-machine-learning-model-sagemaker/ Chapter 13 "Building Machine Learning Pipelines" by Hannes Hapke and Catherine Nelson	Evaluate the concept of feedback loops and their value in machine learning. Use cloud machine Learning tool to learn a model from data. Evaluate model's performance.	Lecture Demonstration Lab Session Class Discussion Discussion boards	Lab exercise #1 Machine learning on cloud (SageMaker)	
9	Machine Learning Operations (ML/OPS)	Module#9 material. Section 3 -chapter 8 Hands-On Artificial Intelligence on Amazon Web	Describe the ML-OPS evolution over the past decade. List the main tasks that ML pipelines should contain in a cloud environment Describe and explain the machine learning	Lecture Demonstration Lab Session Class Discussion Discussion boards	Quiz#2 Discussion board #3 due Lab exercise #2 Airflow	week#9

Week	Topics	Readings/Materials	Weekly Learning Outcome(s)	Instructional Strategies	Evaluation Name and Weight	Evaluation Date
		Services by Tripuraneni & Song Chapter 10 Data Science on AWS Fregly & Antj Chapter 1 Building Machine Learning Pipelines by Hannes Hapke and Catherine Nelson	pipelines and their value in cloud environments. Explore the main pipeline packages available on the cloud: •MLflow •Apache Airflow •Amazon step function •Kubeflow •Amazon sage maker pipelines			
10	Machine Learning Operations (ML/OPS) triggers. Machine Learning Operations (ML/OPS) packages on the cloud.	Module#10 material. Section 3 -chapter 8 Hands-On Artificial Intelligence on Amazon Web Services by Tripuraneni & Song Chapter 10 Data Science on AWS Fregly & Antj Chapter 2 Building Machine Learning Pipelines by Hannes Hapke and Catherine Nelson	Compare the various trigger strategies for machine learning pipelines and their use cases. Explore the concept of step functions	Lecture Demonstration Lab Session Class Discussion Discussion boards	Lab exercise #3 Step functions	
11	Cloud security Threats. Identity and access management.	Module#11 material. Chapter 12 Data Science on AWS Fregly & Antj	Examine the most common security threat for cloud computing. Explain the concept of Identity and access management on the cloud.	Lecture Demonstration Lab Session Class Discussion Discussion boards	Make available discussion board #4 Lab exercise #4 Amazon Sage Maker pipelines	
12	Data Encryption Encryption Network isolation	Module#12 material. Chapter 12 Data Science on AWS Fregly & Antj	Differentiate between the responsibilities of the customer/developer and the cloud provider for securing data and application on the cloud. Explain the concept of compute and network isolation Describe best practices for cloud security.	Lecture Demonstration Lab Session Class Discussion Discussion boards	Assignment #2 due Quiz#3	week12
13	Governance	Module#13 material.	Explore cloud packages that are used to	Lecture	Discussion	week#13

Week	Topics	Readings/Materials	Weekly Learning Outcome(s)	Instructional Strategies	Evaluation Name and Weight	Evaluation Date
	Audit	Chapter 12 Data Science on AWS Fregly & Antj	govern data storage and applications. Describe the best practices for auditing machine learning cloud environments.	Demonstration Lab Session Class Discussion Discussion boards	board #4 due Lab exercise #5 Aws glue and pipelines	
14	Group project presentations	N/A	Package and present the project.	Presentations during onsite or virtual class sessions, Q&A.	Project presentation	week 14