DSC8016: DEEP LEARNING FOR COMPUTER VISION

Effective Term
Semester A 2026/27

Part I Course Overview

Course Title
Deep Learning for Computer Vision

Subject Code
DSC - Data Science
Course Number
8016

Academic Unit
Data Science (DS)

College/School
College of Computing (CC)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
SDSC8016 Deep Learning for Computer Vision

Exclusive Courses
Nil

Part II Course Details

Abstract

This course provides students with an extensive exposure to deep learning. Topics include shallow and deep neural networks, activation functions and rectified linear unit, construction of deep neural networks and matrix representations including deep convolutional neural networks and Transformer, computational issues including backpropagation, automatic differentiation, and stochastic gradient descent, complexity analysis, approximation analysis including universality of approximation, design of deep neural network architectures and programming according to various applications including computer vision tasks such as detection, segmentation and low-level vision, generative models such as VAE, GAN, Diffusion models and adversarial robustness.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Understand the basic ingredients of deep learning and constructing deep neural networks by matrix representations	20	x		
2	State clearly computer vision application domains and the properties of deep neural networks with various architecture applied in computer vision	20	x	x	
3	Conduct complexity analysis and approximation analysis of deep learning methods	30	x	x	x
4	Apply deep learning algorithms to typical datasets, design new algorithms from theoretical understanding of complexity and approximation, and solve some practical problems in data science by deep learning algorithms	30	x	x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Learning through teaching is primarily based on lectures.	1, 2, 3, 4	39 hours in total

2	Take-home assignments	Learning through take-home assignments is primarily based on interactive problem solving and hand-on computer exercises allowing instant feedback.	1, 2, 3, 4	after class
3	Project	Students will tackle a defined a computer vision problem in deep learning in a group manner, develop a solution, and synthesize findings into a written report. Conclude the project with a presentation that showcases both the process and the outcome, with continuous guided support from the instructor to ensure clarity and effectiveness of learning.	1, 2, 3, 4	after class

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Hand-in assignments	1, 2, 3, 4	20	These are skills based assessment to enable students to demonstrate the basic concepts, methods and algorithms of deep learning, and applications of deep learning algorithms in some applications.	Yes
2	Project	1, 2, 3, 4	40	The projects provide students chances to demonstrate their achievements on deep learning methods learned in this course.	Yes

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

Exam: Administer an exam focused on assessing the comprehension of basic concepts, fundamental theories, various neural network architectures, and their applications to datasets.

Assessment Rubrics (AR)

Assessment Task

Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to learn the basic concepts, apply methods and algorithms of deep learning, and develop applications of deep learning algorithms.

Excellent

A+, A, A-

Good

B+, B

Marginal

B-, C+, C

Failure

F

Assessment Task

Project (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to demonstrate the understanding of the basic concepts, fundamental theory, deep learning methods, and applications of computer vision with deep learning algorithms to some datasets.

Excellent

A+, A, A-

Good

B+, B

Marginal

B-, C+, C

Failure

F

Assessment Task

Exam (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to understand and apply the fundamental theory, deep neural network architectures, and deep learning algorithms in computer vision.

Excellent

A+, A, A-

Good

B+, B

Marginal

B-, C+, C

Failure

F

Assessment Task

Assignments (Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to learn the basic concepts, apply methods and algorithms of deep learning, and develop applications of deep learning algorithms.

Excellent

A+, A, A-

Good

B+, B, B-

Fair

C+, C, C-

Marginal

D

Failure

F

Assessment Task

Project (Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to demonstrate the understanding of the basic concepts, fundamental theory, deep learning methods, and applications of computer vision with deep learning algorithms to some datasets.

Excellent

A+, A, A-

Good

B+, B, B-

Fair

C+, C, C-

Marginal

D

Failure

F

Assessment Task

Exam (Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to understand and apply the fundamental theory, deep neural network architectures, and deep learning algorithms in computer vision.

Excellent

A+, A, A-

Good

B+, B, B-

Fair

C+, C, C-

Marginal

D

Failure

F

Part III Other Information

Keyword Syllabus

- Review of neural networks: activation functions, sigmoidal functions and rectified linear unit.
- Construction of deep neural networks and matrix representations: fully connected networks represented by full matrices, deep convolutional neural networks represented by convolutional matrices, deep recursive neural networks represented by structured matrices, and pooling and Transformer.
- Computational issues: backpropagation and automatic differentiation, overfitting and the role of rectified linear unit in deep learning, non-convex optimization and saddle problems in training deep neural networks.underfitting, gradient vanishing
- Complexity analysis: regularization for deep learning, learning ability in terms of the number of hidden neurons and depth of the deep neural networks.
- Computer Vision Application: Classification, Detection, Segmentation, Generation, Low-level Vision, Recognition.
- Generative Models: VAE, GAN, Flow-based Models and Diffusion Models
- Network Architectures: CNN, ResNet, Transformer
- Adversarial Robustness: Adversarial Attacks, Adversarial Defense
- Design of deep neural network architectures and programming according to various applications of deep learning.

Reading List

Compulsory Readings

	Title
1	Lecture slides and other related material

Additional Readings

	Title
1	Understanding deep learning by Prince, Simon JD. MIT press, 2023.
2	Deep learning by Goodfellow, Ian, et al. Cambridge: MIT press, 2016.