Macao Polytechnic University

Faculty of Applied Sciences

PhD of Computer Applied Technology

Module Outline

Academic Year 2022/2023 Semester 1

Learning Module	Advanced Topics in Computer Applied Technology		**Class Code**	COMP8123	
Pre-requisite(s)	Nil				
Medium of Instruction	English			**Credit**	3
Lecture Hours	45 hrs	**Lab/Practice Hours**	0 hrs	**Total Hours**	45 hrs
Instructor	Ke Wei		**E-mail**	wke@mpu.edu.mo	
Office	A319, Chi Un Building, Main Campus		**Telephone**	8599-6452	

Description

This module is to provide students the mathematical and programming concepts, notions, and languages for the abstraction, generalization, and formalization of their ideas, methods, and approaches in common computer application technologies. This module is divided into three parts. It first introduces the fundamentals of function analysis to deal with vector spaces and approximation problems typically found in deep learning. Then, it goes through key components of functional programming in order to promote high order functions and composability, which are essential in abstraction and generalization of operations and processes. Finally, it presents the key ideas of category theory with a highly abstract view of objects and transformations in general domains. The module aims at equipping the students with the foundation and universal tools and notations for thinking, expressing, and discussing topics related to computer science and applications.

Learning Outcomes

After completing the learning module, students will be able to:

1. Describe the fundamental properties of normed spaces and of the transformations between them.
2. Study certain topological-algebraical structures and the methods by which the knowledge of these methods can be applied to analytic problems;

3. Analyze the basic results associated to different types of convergences in normed spaces;
4. Formulate and implement algorithms and operations in the functional style;
5. Abstract and generalize methods and processes using higher order functions, combinators, and monads;
6. Acquire the concept of categories and the basic constructs;
7. Apply the notions of categories and transformations in research problems and solutions.

Content

1. Functional Analysis **15.0 hours**

1.1. Metric Spaces
1.2. Normed Spaces, Banach Spaces
1.3. Inner Product Spaces, Hilbert Spaces
1.4. Fundamental Theorems for Normed and Banach Spaces
1.5. Application of Contractions
1.6. Approximation Theory

2. Functional Programming and Combinators **15.0 hours**

2.1. Haskell Fundamentals
2.2. Higher-order Functions
2.3. Lazy Evaluation
2.4. Reasoning about Programs
2.5. Monads and Effects
2.6. Lambda Calculus
2.7. Combinators

3. Category Theory **15.0 hours**

3.1. Categories and Diagrams
3.2. Monomorphisms, Epimorphisms, and Isomorphisms
3.3. Basic Constructions
3.4. Functors and F-Algebras
3.5. Natural Transformations and Adjoints
3.6. Cartesian Closed Categories
3.7. Implicit Conversions and Generic Operators

Teaching Method

Lectures, case studies, group discussion.

Attendance

Attendance requirements are governed by the “Academic Regulations Governing Doctoral Degree

Programmes of Macao Polytechnic University." Students who do not meet the attendance requirements for the module will not be permitted to sit the final examination and shall be awarded an 'F' grade.

Assessment

The learning module is graded on a 100 point scale, with 100 being the highest possible score and 50 being the passing score.

	Item	Description	Percentage
1.	Assignment	Problem solving	40%
2.	Assignment	Programming and reasoning	30%
3.	Essay	Abstraction and formalization	30%
		Total Percentage:	100%

Teaching Material(s)

Textbook(s)

No recommended textbook, the learning materials will be provided to students during the classes.

Reference

Reference book(s)

1. Erwin Kreyszig (1989): *Introductory Functional Analysis with Applications*, 1st Ed., Wiley.
2. Graham Hutton (2016): *Programming in Haskell*, 2nd Ed., Cambridge University Press.
3. Richard Bird (2014): *Thinking Functionally with Haskell*, 1st Ed., Cambridge University Press.
4. Benjamin C. Pierce (1991): *Basic Category Theory for Computer Scientists*, The MIT Press.
5. David Mertz (2015): *Functional Programming in Python*, O'Reilly Media, Inc.

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