National University of Sciences and Technology (NUST)
School of Electrical Engineering and Computer Science

**Faculty of Computing**

# CS 368: Reinforcement Learning

## Lab 13 & 14: Solving Atari Game Using Reinforcement Learning

## (Open Ended Lab)

**Date: 13 December 2024**

**Time: 02:00 PM – 5:00 PM**

**Instructor: Dr. Zuhair Zafar**

# Lab 13 &14: Solving Atari Games Using Reinforcement Learning

## Objectives

The goal of this lab is to apply reinforcement learning (RL) algorithms to solve the Breakout Atari Game environment from the Gymnasium library.

## Tools/Software Requirement:

Google Colab, Python, Gymnasium Library

## Introduction

Atari games have been a cornerstone of reinforcement learning research, providing complex environments with rich visual input and diverse challenges. In this lab, we focus on the game Breakout, a classic Atari game where the objective is to control a paddle to hit a ball and break bricks. Breakout poses unique challenges for reinforcement learning algorithms due to its dynamic gameplay, requiring agents to learn precise control and strategic planning.

Through this lab, you will gain hands-on experience with implementing RL algorithms, preprocessing game frames, and optimizing agent performance. Breakout's manageable complexity and visual appeal make it an ideal environment for exploring the core concepts of reinforcement learning.

## Lab Tasks

The task of this lab is to develop, train, and evaluate a reinforcement learning agent to solve the **Breakout** Atari game environment using the Gymnasium library. You will preprocess the environment, choose and implement an RL algorithm, optimize hyperparameters, and analyze the agent's performance through experimentation and the plots of learning curves and the returns per time steps.

**Deliverable:**

Please submit your notebook on LMS before the deadline **(24th December 2024, 11:59pm).**

# Lab Rubrics

| Assessment | Does not meet expectation<br><br>(1/2 marks) | Meets expectation<br><br>(3/4 marks) | Exceeds expectation<br><br>(5 marks) |
|---|---|---|---|
| **Software Problem Realization**<br><br>**(CLO1, PLO1)** | The student struggles to formulate the problem as RL and does not apply RL algorithm to solve it. There is a lack of understanding of the problem's requirements and no attempt to solve the Atari game effectively. | The student formulates the problem as RL with some guidance, applies appropriate RL algorithm with hints, and shows it's working. However, the approach might not be fully optimized or lacks a thorough justification. | The student independently formulates the given problem as RL, applies RL algorithm using SOTA libraries without guidance, and effectively solves the Atari game. The approach is fully optimized and can be applied to different Atari games. |
| **Software Tool Usage**<br><br>**(CLO4, PLO5)** | Code has syntax errors, and the implementation of the RL algorithm is incorrect or incomplete. The code is not modular and lacks comments for readability and reuse. The student shows limited ability to use gymnasium / pytorch / SOTA library functions where required. | The student has implemented the RL algorithm correctly for the given problem with minor mistakes. The code is mostly correct in terms of syntax and functionality but might not be optimized or well-structured for reuse. Some documentation is provided. The student also shows working knowledge of gymnasium and SOTA library where required. | The student has implemented the RL algorithm using SOTA library efficiently and correctly. The code is clean, modular, well-documented, and follows best practices for reproducibility and reuse. The student demonstrates full command of the gymnasium and SOTA library and its functions. |