NUS SOC Summer Workshop 2024

Artificial Intelligence of Things

Cloud, Security, IoT & AI

Course Information

Pre-requisites:

- Which year of study is appropriate for your topic?

Year 2 and above

- What background and programming languages are required for your topic?

Python and JavaScript

- What do you think is attractive/unique about your topic?

This topic provides students with a unique opportunity to learn and integrate three important skills of the future economy, namely software engineering, IoT development and machine learning.

Learning content and Teaching

- What will be covered during "trial" lectures?

Topic 1 – Overview of Artificial Intelligence of Things

- Pervasive computing paradigm.
- Introduction to Internet of Things (IoT).
- Overview of IoT architecture and IoT system design.
- Introduction to Artificial Intelligence (AI).
- Overview of implementing AI with machine learning.
- Artificial Intelligence of Things (AIoT) – The whole is greater than the sum of the parts.

Topic 2 – Single-board Microcontroller (I)

- Overview of single-board microcontrollers.
- Overview of the micro:bit.
- Technical characteristics and features of micro:bit.
- Programming micro:bit with JavaScript.
- Working with micro:bit onboard sensors.

- What will be covered during the “advanced” seminars?

Topic 3 – Single-board Microcontroller (II)

- Working with micro:bit computational and communication capabilities.
- Basic electronic component concepts.
- How to work with external peripherals via the micro:bit’s edge connector.
- What is an Analogue to Digital Converter.
- How to write and read analogue and digital values to/from the micro:bit.
- Programming peripherals directly with micro:bit’s pins, and indirectly with edge connector breakout board.

Topic 4 – Single-board Computer (I)

- Overview of the Raspberry Pi single-board computer.
- General purpose programming with Python on Raspberry Pi.
- Basic Raspberry Pi GPIO programming using digital signal (I).

Topic 5 – Single-board Computer (II)

- Basic Raspberry Pi GPIO programming using digital signal (II).
- Basic Raspberry Pi GPIO programming using analogue signal.
- Working with other external devices.
- UART communication with Raspberry Pi over GPIO pins.
- BLE communication with Raspberry Pi.
- Using Raspberry Pi to control micro:bit devices with BLE and radio.
- Working with Raspberry Pi’s advanced interfaces.

Topic 6 – IoT Backend Integration

- What is Service-Oriented Architecture.
- What is RESTful web service.
- How to create RESTful web service in Python with Flask-RESTful.

- How to test RESTful web service in Postman.
- How to consume RESTful web service in Python.
- Persisting the data to a relational database.
- What is Publish-Subscribe messaging architecture.
- What is Message Queuing Telemetry Transport (MQTT).
- What is MQTT broker.
- How to create MQTT publisher and subscriber clients in Python with Eclipse Paho.

Topic 7 – IoT Data Preprocessing

- Basic data structures in Python and their limitations.
- How to use Python SciPy data science libraries to perform common data analytics tasks easily.
- Basic numerical processing using NumPy.
- Data preparation and exploration using Pandas.
- Data visualisation using Matplotlib.

Topic 8 – Machine Learning for IoT Data (I)

- Regression analysis – Simple linear regression, multiple linear regression
- Classification (I) – Decision tree
- How to apply supervised learning to IoT sensor data.

Topic 9 – Machine Learning for IoT Data (II)

- Classification (II) – Logistic regression
- Clustering – Partitioning methods
- How to apply unsupervised learning to IoT sensor data.

Topic 10 – Computer Vision

- Introduction to Computer Vision Tasks – Object Localization, Detection, Recognition and Segmentation.
- Introduction to Deep Learning for Image Recognition
- Working with the Raspberry Pi camera module.
- Image Recognition Using TensorFlow and Keras
- Image Recognition Using OpenCV

- What will students be doing for the project work? How do you intend to split students into project groups?

  The project involves the conceptualization, design and implementation of a smart AIoT system. The deliverable must demonstrate both elements of IoT and AI.

  The group size of the project is 4 students. The project involves IoT hardware development and thus students working on the hardware development will need to meet up physically. The recommended group configuration is 2 students on hardware development, and 2 students on software development and AI.

- Do you have any recommendations for references (books) where students can study to prepare for this topic beforehand?

  Students are encouraged to self-learn the Python programming language if they are not familiar with it. Please refer to the official Python tutorial on this website – https://docs.python.org/3/tutorial/.

- Apart from a laptop/computer, is there any other equipment/software required for this topic?

  The course requires a set of IoT equipment based on micro:bit and Raspberry Pi. This would be issued to each group of students during the workshop. As this course focuses on IoT, it is important for students to hands-on with the IoT hardware. The hardware is also required for the group project.