Department of Electrical, Computer, and Software Engineering
University of Auckland
COMPSYS 302 S1 2021 – Python Project (Weighting 45%)

Background

Nowadays, artificial intelligence comes into every aspect of our life. From searching recommendation systems to self-driving cars, the foundation of these applications is Neural Networks. Recently there are a lot of tools and models we can easily use for free, and it becomes core technical skills for most domains. This project will focus on designing and developing an example of AI solution based on a simple design pattern, which can be helpful to your part 4 project.

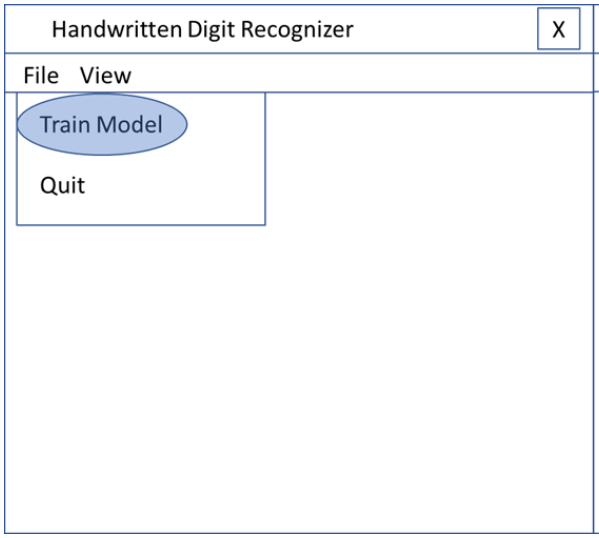
Objective

We will design and implement a tool that recognizes handwritten digits. The overall goal of this project is to get familiar with software design, GUI program and usage of basic machine learning skills. Students can find **one** partner to implement this project together. Two students will cooperate by using Github Classroom. Both students should contribute to project design and implementation. The use of Github will also be assessed as well. As you may know, there are lots of codes you can find online. However, we would suggest you **write your own code from scratch except for the recognition methods**.

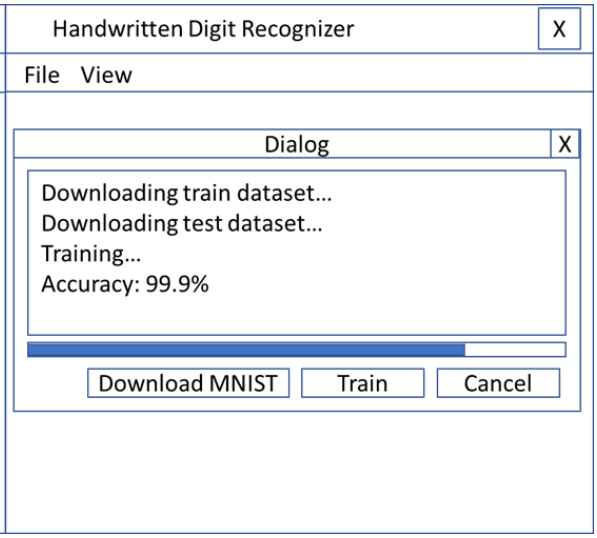
What you should develop in this project?

You should develop a SW that

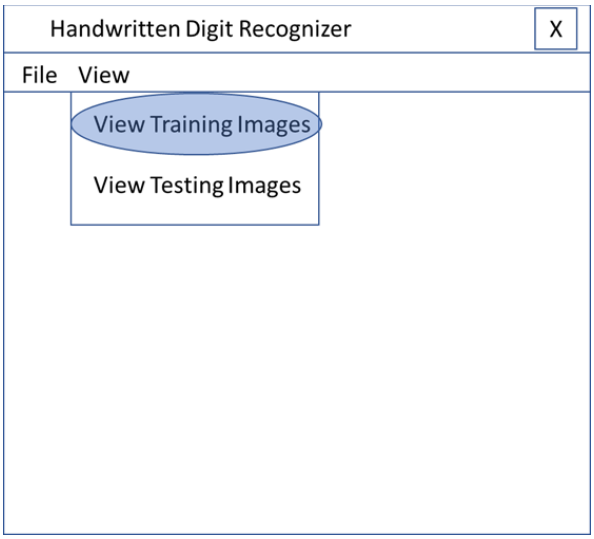
- imports MNIST dataset using torchvision.dataset (Fig. 1),
- trains a DNN (Deep Neural Network) model using train dataset for classification (Fig. 2),
- shows the progress of the training, accuracy of a model for validation dataset (Fig. 2),
- shows the train and validation dataset (a viewer) (Fig. 3),
- selects a model from the list (if you have some different models) (Fig. 4),
- provides a canvas to draw digits using a device such as a mouse on screen for testing (Fig. 4),
- classifies the handwritten digit, such as a number (0 ~ 9) using the trained model (Fig. 4),
- and shows the probability of the classified handwritten digit (Fig. 4).



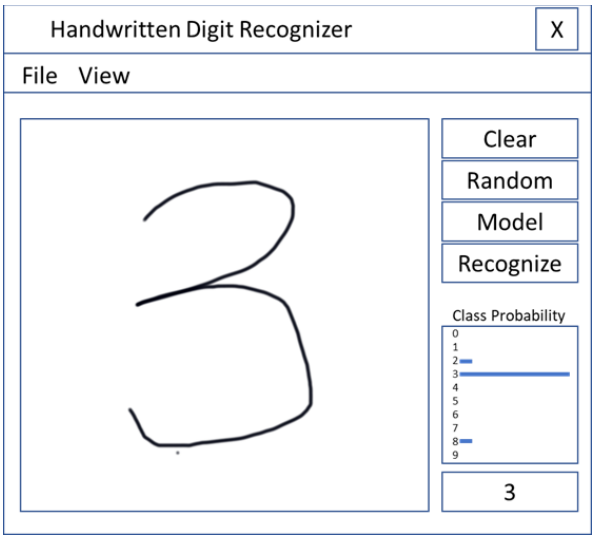
<Fig. 1>



<Fig. 2>



<Fig. 3>



<Fig. 4>

Tools / Libraries to use

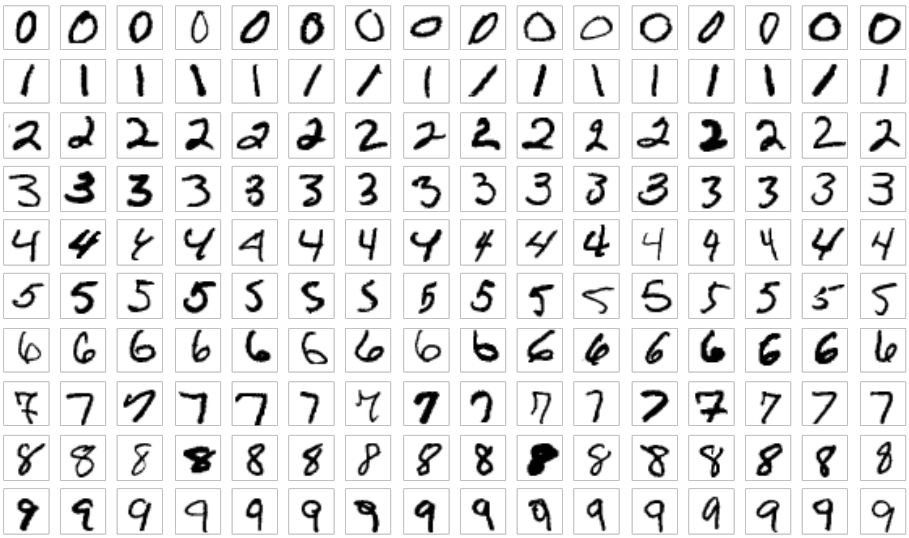
Python3
For this project, Python3.7 or above is required.

PyQt5 Python GUI
PyQt5 is a GUI widgets toolkit. It is a Python interface for Qt, one of the most powerful, and popular cross-platform GUI libraries. PyQt5 is a blend of the Python programming language and the Qt library. For tutorials, please refer to the following webpage.

- https://wiki.python.org/moin/PyQt/Tutorials

MNIST Dataset
The MNIST database of handwritten digits has a training set of 60,000 examples, and a test set of 10,000 examples. It is a subset of a larger set available from NIST. The digits have been size-normalized and centered in a fixed-size image. You can download the MNIST dataset from Canvas >> Files. For the details, please refer to the following websites.

- http://yann.lecun.com/exdb/mnist/
- https://en.wikipedia.org/wiki/MNIST_database
- https://pytorch.org/vision/0.8/datasets.html#mnist



<Fig 5. Samples of MNIST>

PyTorch for DNN
PyTorch is an open-source machine learning library based on the Torch library, used for applications such as computer vision and natural language processing, primarily developed by Facebook's AI Research lab. For the details, please refer to the following website.

- https://pytorch.org/

scikit-image
scikit-image is a collection of algorithms for image processing. But if you are comfortable to use other image manipulation libraries such as PIL or opencv, it is alright to use them. For the details, please refer to the following website.

- https://scikit-image.org/
- https://pillow.readthedocs.io/en/3.1.x/index.html
- https://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_setup/py_intro/py_intro.html

NumPy
Numpy is the fundamental package for scientific computing with Python. This library should be used for data manipulation, such as an image.

- https://numpy.org/

Code Editor (IDE)
You can use any tools that support Python. Here are the ones you can use, but you can use any tools you want, even not listed here.

- https://code.visualstudio.com/
- https://www.jetbrains.com/pycharm/

Setup Development Environment

Conda and pip will be used to set up the development environment. Detailed instructions will be covered in the lab and/or lecture.

Github

Github Classroom
Each team should create one private repository per group with the name "2021-Python-groupnumber". One student creates it and invites your teammate. Do not make two different ones.

Directory hierarchy & Code structure
Your python project is recommended to follow a structure as below.

- Name of your project (Repository)
    - requrement.txt (Version of required libraries)
    - README.md (Document for how to install and run your project)
    - scripts (Folder)
        - Your python scripts stay here

Versioning
The use of the Git versioning system via Github is compulsory and will be monitored. Steady progress from all groups is expected throughout the semester, and you should not just commit the day before everything is due.

Requirements
Please provide instruction to run your program correctly.

- Write your instruction on how to install and run your program on README.md,
- Write the details of improvements(or updates) for each version of the program on README.md
- Specify all the dependencies(libraries and versions) on requirement.txt,
- We will check the learning curve to make sure it is learning.

Assessment

This project is completed and assessed in a group as well as individually.

- Demo (10%) during labs on Wed week 6 ==> group
- Questions (5%) during labs on Wed week 6 ==> individual
- Final report (20%) by 8pm Sunday week 6 ==> individual
- Code submission (10%) by 8pm Sunday week 6 ==> group

Demo

- Worth 10%
- Type: Group
- Penalty: -2% every delay of your tern / cannot do demo after the demo session
- Important points
    - Usefulness
    - Methodology
    - Performance
    - Completeness

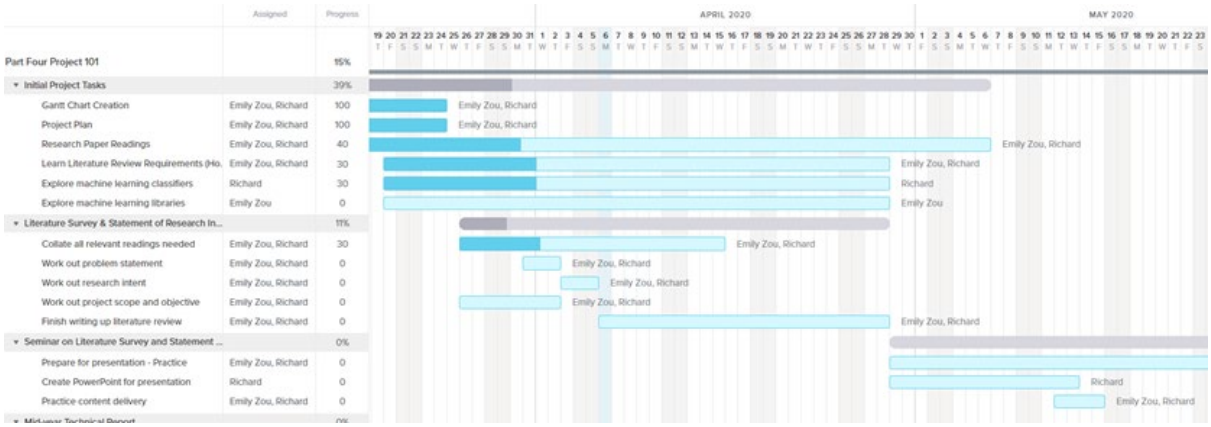
Questions

- Worth 5%
- Type: Individual
- Penalty: -2% every delay of your tern / cannot do demo after the demo session
- Important points
    - Will get full mark if you answer the first question.
    - Will have the second chance to answer for 2.5%

Final Project Report

- Worth 20%
- Type: Individual
- Penalty: -2% every 10 mins / cannot submit and 0 point after 30 mins to due
- Important points
    - We combine the design planning document and final report, which were separated in the previous years.
    - Your design should be documented in a report which is in the form of a real paper report, which is the same format for your part 4 project reports. There are a few sections that are listed below you need to cover.
    - The final report should be max 12 pages. You don't have to write a whole thesis with it. Format should be Doc or pdf.
    - You can mention your teamwork and partners here. Please show clear evidence if you complain about your partner.

- Factors
  - (1%) Introduction
    - Imagine you are running a start-up! Image Recognition Group pic.
    - If it is impossible, just show your photo. Individual photos are fine.
    - Can have a logo of your team as well.
    - This is for recognizing who you are.
    - Group name (professional names only!) and group number!
    - Put your group number, UPI, email address
  - (3%) Planning
    - Summary of literature review
    - Setup for your project, such as patterns, environment, tools, etc., and the reason to choose them
    - Gantt chart – schedule and roles (Fig. 6)



<Fig 6. Example of Gantt chart>

  - (10%) Design Software Architecture
    - Imagine you are writing an application to get fund!
    - Purpose of the system
      - Background
      - Reason to develop your recognizer
      - Benefit to society
      - The goal of your project, i.e. hand-writing recognition
    - Database and methods/model to use
      - Name of database,
      - link of the database you get ==> reference
      - Existing one or your one? How to modify it?
      - How to select and the reason?
      - How does it work?
    - System Diagram for your software
    - Explain each component of your system
    - What is the benefit of your architecture?
  - (4%) Results
    - Describe your results (details of your tool).
    - The statistical analysis: learning result, precision rate, recall rate, f1 for your model.
    - Recognition results

        - Discussion
    - (2%) Conclusion/Future Work
        - Draw your conclusion
        - Future works

Code

- Worth 10%
- Type: Group
- Penalty: -2% every 10 mins / cannot submit and 0 point after 30 mins to due
- Important points
    - You should use Git but must submit the final version as a zip file via CANVAS
- Factors
    - (3%) README file
        - Explain about your project, and versions, etc.
    - (5%) Comments
        - Explain your code, including purpose, source (if you get it from somewhere), input, output, etc.
    - (2%) Github history
        - Will check how often you worked on this project.
        - How well you did the version management.

Final Note

In this project, you are expected to do your own planning and learning. You'll be responsible for finding out how to do things yourselves. There will be content delivered in lectures to help speed this process up at the beginning, but ultimately it is your responsibility to find out what you will need. If you get stuck and need help, please ask a TA or the lecturer. **Do not leave things to the last minute**. The easiest way to fail this project is to try to start it in the last week (or night) before it's due.

Do not mistake the minimum requirements as the only requirements; if you want to do well in this course, you will need to design your project carefully and manage your time well. Do not hesitate to contact the lecturers and TAs if you are in doubt! They are available to help with concepts, troubleshooting, and debugging, but they will not write your project.

Poorly documented or implemented code, while otherwise functionally correct, may not get you full marks for the project overall. Someone else has to be able to work on your code later! Please develop consistent and good coding practices.

Due to the nature of this project, a certain level of collaboration is required within the class. As a result, it is strongly recommended that you interact with other students in the labs. Additionally, TAs will be there, and you can discuss requirements with them as well.

Academic Integrity Notice

The University of Auckland will not tolerate cheating or assisting others to cheat and views cheating in coursework as a serious offence. The work that a student submits for grading must be the student's work, reflecting his or her learning. Where work from other sources is used, it must be appropriately acknowledged and referenced. This requirement also applies to sources on the world-wide-web. **Do not copy code from other students or the internet** without attribution.