Project 2

Computer Vision (CSI4116-01)

Spring, 2021

Due date : 12th May, 23:55

Task 1

Face Recognition

Overview

[Recognize faces using Eigenfaces]

You are given two face datasets, “train” and “test”.

You have to run PCA to recognize the faces in the ”test”.

The assignment consists of 3 steps.

1) Select the number of principal components you use for this data.
2) Reconstruct all images in the training set using the number of PCs.
3) Recognize images in the test dataset using a simple nearest neighbor algorithm.

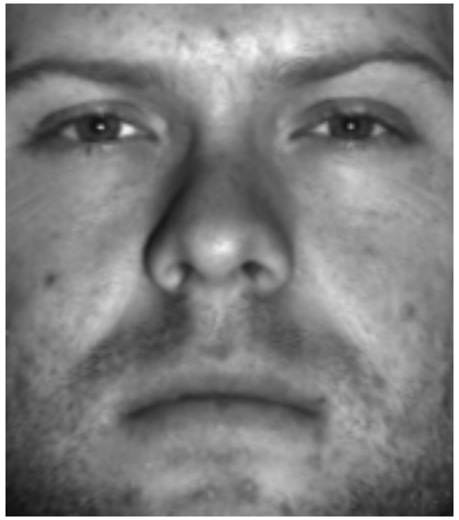
Dataset

Two datasets are provided for this problem

- **faces_training** : a face database of 39 people
- **faces_test** : 5 faces to be recognized

Filename : faceXX.pgm / testXX.pgm

- XX indicates the identity number of the image.


data example

Step1: Principal Components Selection

1. Using SVD algorithm, compute principal components of the 'train' dataset.

2. Given a percentage of the variance as an input, select the number of principal components you use for this data.
   - e.g., given 0.80, the smallest d such that $\frac{\sum_{i=1}^{d} \lambda_i}{\sum_i \lambda_i} \geq 80\%$

*** You don't have to implement the unit variance part in the SVD algorithm.

Step1: Principal Components Selection

[Implementation Detail]

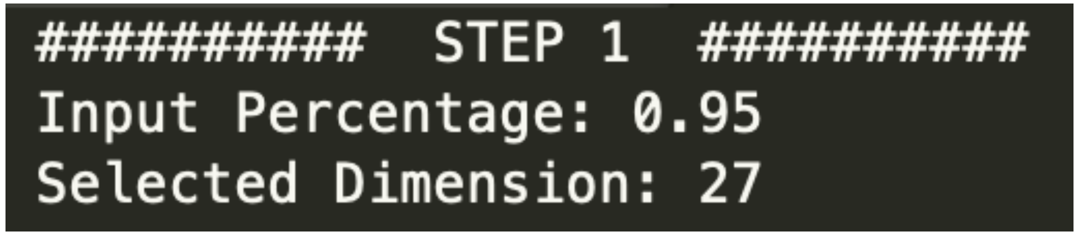
1. The percentage of the variance is given as a command line option
2. Output the selected dimension to the 'output.txt' file.

Input Example

```
$ python 201XXXXXXX.py 0.95
```

The percentage of the variance is the float value (0,1)
You don't have to consider the case coming from inappropriate inputs

Output Example



```
##########  STEP 1  ##########
Input Percentage: 0.95
Selected Dimension: 27
```

The percentage given as an input
Selected PCs number

Step2: Image Reconstruction

1. Reconstruct all images in the training set using the selected number of principal components(step1). Then save the reconstructed images.

2. Compute the reconstruction error between original images and reconstructed images.

   Reconstruction error : Mean Squared Error

$$\frac{1}{n}\sum_{i=1}^{n}(y_i - t_i)^2$$

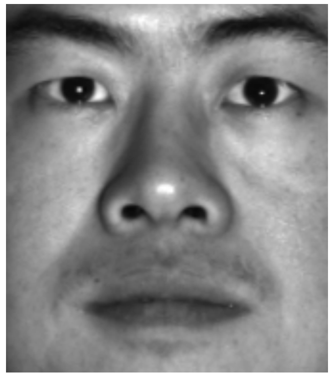
Step2: Image Reconstruction

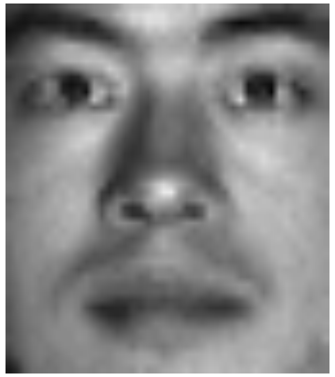
[Implementation Detail]

1. Save the reconstructed image as a format of ‘201XXXXXXX/faceXX.pgm’ (same with the original file).

2. Output the reconstruction loss of each train image to the ‘output.txt’ file.

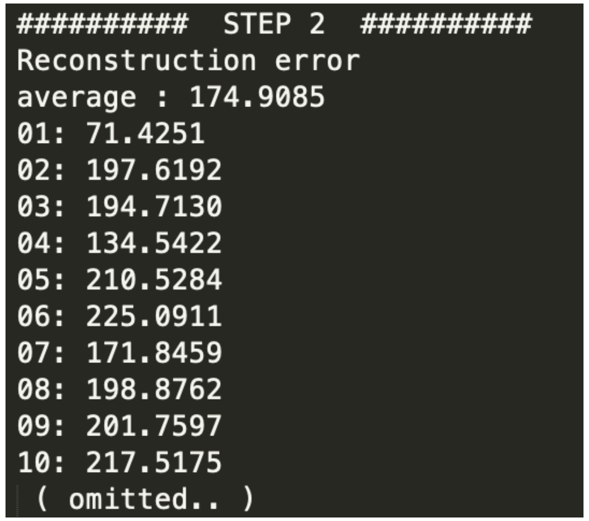
Output Sample (face02.pgm)


Original


Reconstructed

Reconstructed image size is equal to the original image size

Output Example


```
##########  STEP 2  ##########
Reconstruction error
average : 174.9085
01: 71.4251
02: 197.6192
03: 194.7130
04: 134.5422
05: 210.5284
06: 225.0911
07: 171.8459
08: 198.8762
09: 201.7597
10: 217.5175
 ( omitted.. )
```

Step3: Face Recognition

1. Recognize images in the test dataset using a simple nearest neighbor algorithm. We'll use 'l2 distance'. (Compute distance between two vectors.)

   l2 distance(Euclidean distance) :

$$d(\mathbf{p},\mathbf{q}) = d(\mathbf{q},\mathbf{p}) = \sqrt{(q_1-p_1)^2+(q_2-p_2)^2+\cdots+(q_n-p_n)^2}$$

$$= \sqrt{\sum_{i=1}^{n}(q_i-p_i)^2}.$$

2. Find the closest identity of each image in the test dataset among the identities in the train dataset.

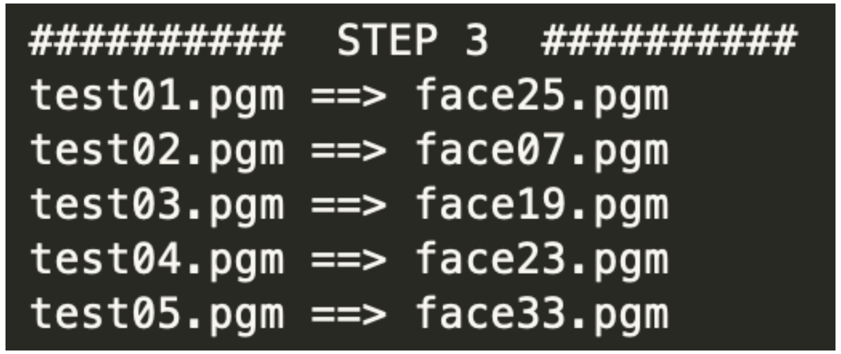
(https://en.wikipedia.org/wiki/Euclidean_distance)

Step3: Face Recognition

[Implementation Detail]

1. Output the identity number for each image in the test dataset to the 'output.txt' file.

Output Example



```
##########  STEP 3  ##########
test01.pgm ==> face25.pgm
test02.pgm ==> face07.pgm
test03.pgm ==> face19.pgm
test04.pgm ==> face23.pgm
test05.pgm ==> face33.pgm
```

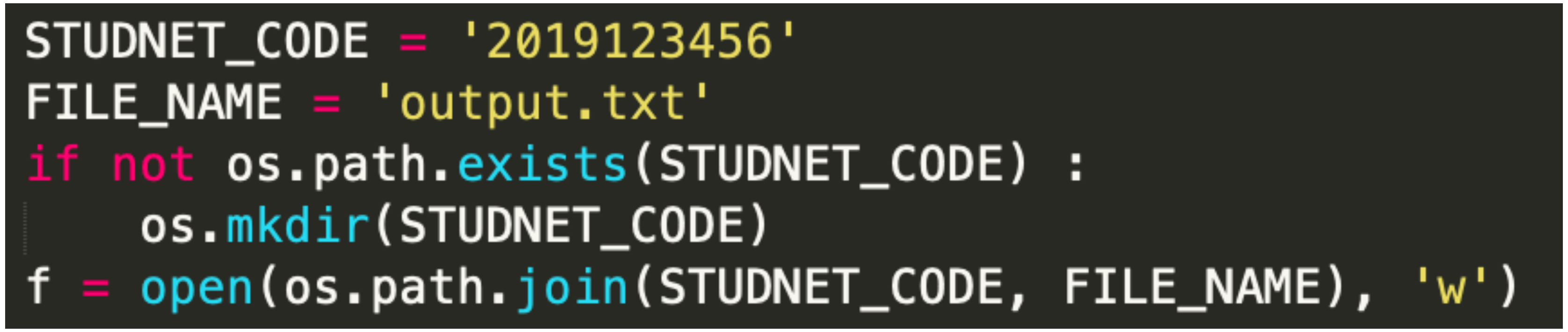
[test image name] ➔ [corresponding train image name]
We have to find the most nearest face among data in train datasets. You don't have to consider the case where there are several faces which have same l2 distance.

Submission

- Deliverables : 201XXXXXXX.py (Your student ID)
  - You don’t have to include your result files.
  - But your python code **must** output the required files in the ‘201XXXXXXX’ directory after running your code.

Submission

- After running your code, your code must output the ’output.txt’ file and ‘faceXX.pgm’ image files in the ‘201XXXXXXX’(your student ID) directory.



```
STUDNET_CODE = '2019123456'
FILE_NAME = 'output.txt'
if not os.path.exists(STUDNET_CODE) :
    os.mkdir(STUDNET_CODE)
f = open(os.path.join(STUDNET_CODE, FILE_NAME), 'w')
```

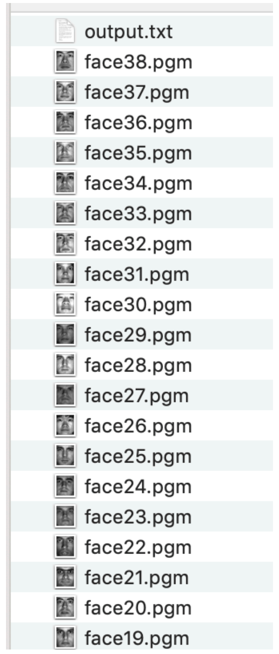
Directions

- You cannot use other external libraries except
  - numpy
  - opencv for image reading and writing

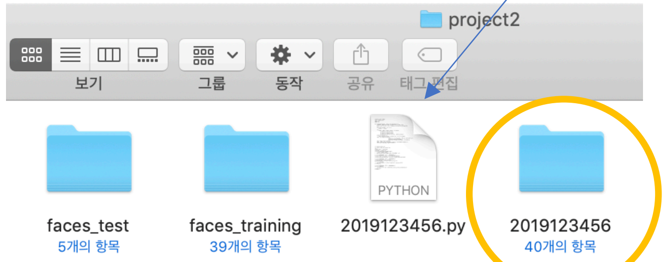
  - import glob
  - import os
  - import sys

- If you use other external libraries, you will get 0 point.

Output


```
output.txt
face38.pgm
face37.pgm
face36.pgm
face35.pgm
face34.pgm
face33.pgm
face32.pgm
face31.pgm
face30.pgm
face29.pgm
face28.pgm
face27.pgm
face26.pgm
face25.pgm
face24.pgm
face23.pgm
face22.pgm
face21.pgm
face20.pgm
face19.pgm
```
…

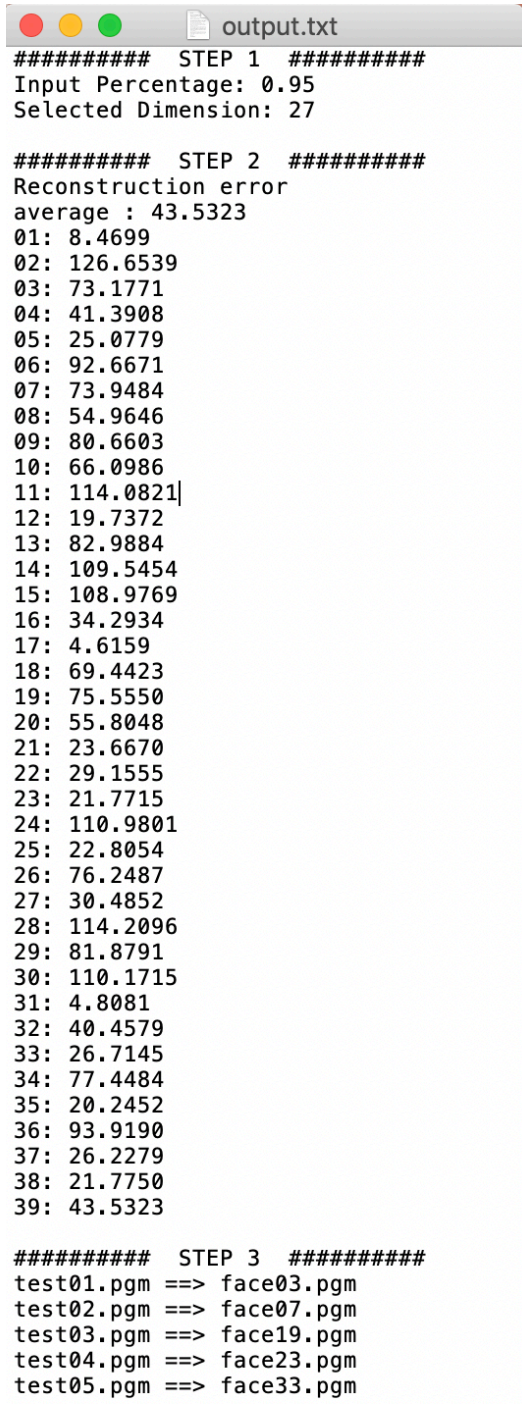
your code is here!



your output!

When you run your python code, 201XXXXXXX(your student ID) directory is made and in the directory, 'output.txt', 'faceXX.pgm' (1~39) must be included.

The overall format of 'output.txt' is on the right side.
The output values change according to the input percentage values. So just use the right capture for formatting reference.
We will grade scores based on the 'output.txt' file and images. So comply with the given output format.


output.txt

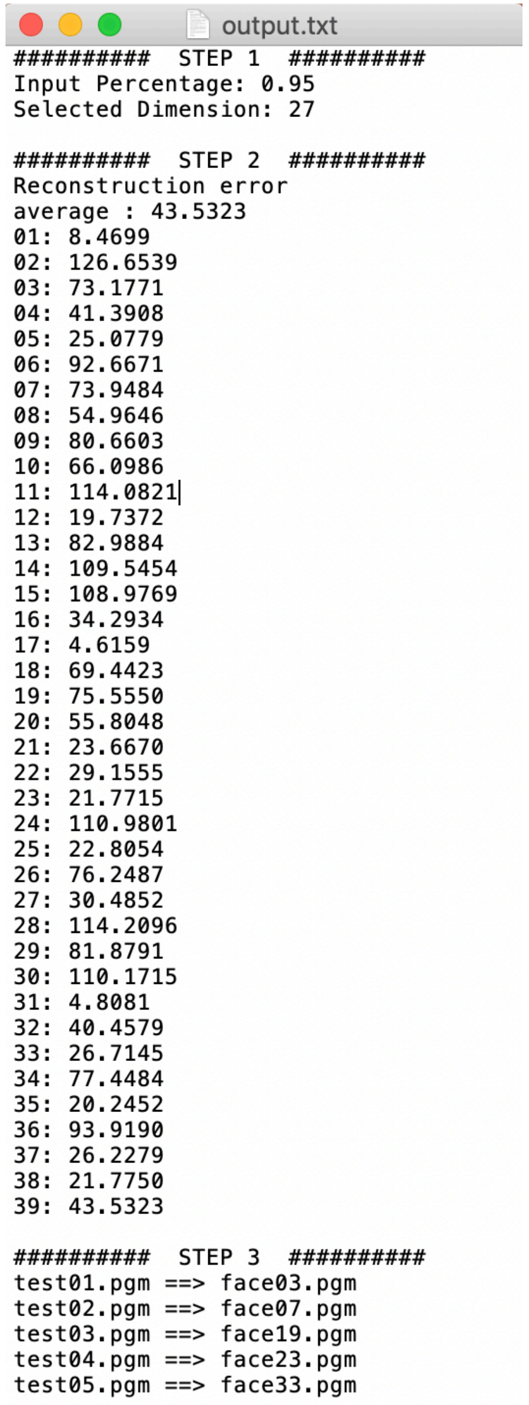
```
##########  STEP 1  ##########
Input Percentage: 0.95
Selected Dimension: 27

##########  STEP 2  ##########
Reconstruction error
average : 43.5323
01: 8.4699
02: 126.6539
03: 73.1771
04: 41.3908
05: 25.0779
06: 92.6671
07: 73.9484
08: 54.9646
09: 80.6603
10: 66.0986
11: 114.0821
12: 19.7372
13: 82.9884
14: 109.5454
15: 108.9769
16: 34.2934
17: 4.6159
18: 69.4423
19: 75.5550
20: 55.8048
21: 23.6670
22: 29.1555
23: 21.7715
24: 110.9801
25: 22.8054
26: 76.2487
27: 30.4852
28: 114.2096
29: 81.8791
30: 110.1715
31: 4.8081
32: 40.4579
33: 26.7145
34: 77.4484
35: 20.2452
36: 93.9190
37: 26.2279
38: 21.7750
39: 43.5323

##########  STEP 3  ##########
test01.pgm ==> face03.pgm
test02.pgm ==> face07.pgm
test03.pgm ==> face19.pgm
test04.pgm ==> face23.pgm
test05.pgm ==> face33.pgm
```

Output

All the numbers in the output.txt example is just for reference.
The numbers don't have to match.
You must follow the format of the given output.txt


output.txt

```
##########  STEP 1  ##########
Input Percentage: 0.95
Selected Dimension: 27

##########  STEP 2  ##########
Reconstruction error
average : 43.5323
01: 8.4699
02: 126.6539
03: 73.1771
04: 41.3908
05: 25.0779
06: 92.6671
07: 73.9484
08: 54.9646
09: 80.6603
10: 66.0986
11: 114.0821
12: 19.7372
13: 82.9884
14: 109.5454
15: 108.9769
16: 34.2934
17: 4.6159
18: 69.4423
19: 75.5550
20: 55.8048
21: 23.6670
22: 29.1555
23: 21.7715
24: 110.9801
25: 22.8054
26: 76.2487
27: 30.4852
28: 114.2096
29: 81.8791
30: 110.1715
31: 4.8081
32: 40.4579
33: 26.7145
34: 77.4484
35: 20.2452
36: 93.9190
37: 26.2279
38: 21.7750
39: 43.5323

##########  STEP 3  ##########
test01.pgm ==> face03.pgm
test02.pgm ==> face07.pgm
test03.pgm ==> face19.pgm
test04.pgm ==> face23.pgm
test05.pgm ==> face33.pgm
```

Grading Environment & Directions

- Language : Python
- We grade your score in Linux(Ubuntu 16.04)
- Python3 (>= 3.5.2)

- data type float 64

- This is an individual project
- You should follow the input/output format

- Never copy code
- You will get 0 points if you cheat

- If you have a question, upload on the Q&A board of LearnUS.

Grading Policy

- Total 100 pts
- Details
  - Implementation
    - step1 : 30 pts
    - step2 : 30 pts (output.txt 15 pts + output images 15 pts)
    - step3 : 30 pts
    - get input & generate output(format) : 10 pts
    - We will grade implementation scores based on the 'output.txt' file and images. So comply with the given output format.

Task 2
back propagation

Overview

[implement backpropagation]

Use MNIST dataset, Google Colab and provided skeleton code to implement backpropagation

For this assignment you have implement :

* Forward Propagation
* Back Propagation
* Update the gradient

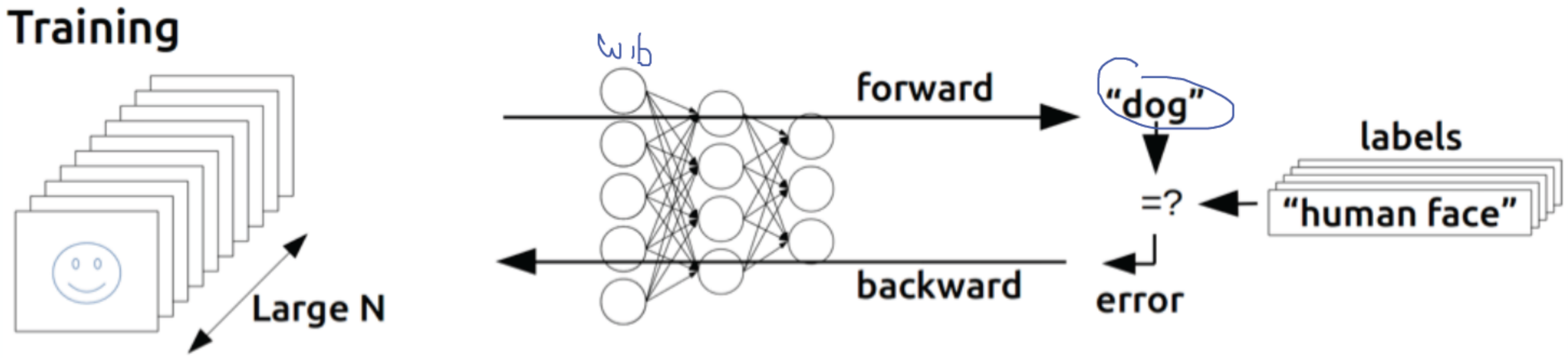
Dataset

- MNIST dataset

- You can refer to the tutorial file for explanation for how to use pytorch and google colab

data example

Backpropagation (1974, 1982 by Paul Werbos, 1986 by Hinton)



https://devblogs.nvidia.com/parallelforall/inference-next-step-gpu-accelerated-deep-learning/

Backpropagation

Implement

Step 1. forward pass
Step 2. backward pass
Stpp 3. weight update

based on given skeleton code.

Fill in the blank spaces of skeleton code file and
use google colab to run the code.

Refer Lecture 12 (week 6) and Lecture 12 – backpropagation (week 7)

Directions

- You cannot use other function except
  - torch.add
  - torch.mul
  - torch.transpose
  - torch.mm

- If you use other external libraries, you will get 0 point.

Submission

- Deliverables : 201XXXXXXX_task2.ipynb (Your student ID)

  You can download your code as ipynb file in google colab.
  (File – Download – Download .ipynb)

** Yon can’t change given skeleton code.

Grading Policy

- Total 100 pts
- Details
    - Implementation

forward propagation	25 pts
back propagation	50 pts
gradient update	25 pts

Final Submission

- Deliverables :

  You must submit two files

  201XXXXXXX.py (Your student ID)

  201XXXXXXX_task2.ipynb (Your student ID)

Grading Policy

- Total 200 pts
    - Task1 100 pts
    - Task2 100 pts

Due Date

- 12th May, 23:55

- We'll receive late submission for 1 weeks.
- However, 20% reduction of total score is applied for each additional day.