Introduction to Scientific Computing

Indian Institute of Technology, Madras

Assignment 6

Maximum Marks: 100

Assigned: May 6, 2024
Deadline: **May 21**, 2024

General Instructions

- You are expected to use the VM for this assignment. Create a directory in your home directory called `assignment_6`. Use this directory to work on the assignment.
- For second question, create a bash file called `question_2.sh` in the `assignment_6` directory. This bash file should contain the necessary code or commands to solve the respective question.
- We will be using an evaluation script to assess and evaluate your submission. Therefore, kindly ensure that the naming convention (as mentioned in usage section of each question) is strictly adhered to, and that the output which you get from running a script, matches the structure of the sample output.
- For submission, upload the MD5 checksum of the `assignment_6` directory on Moodle. You can use the following command. Make sure that you are in `HOME` directory for this command to work as intended.

```
find ./assignment_6/* -exec md5sum {} \; | cut -f 1 -d " " | md5sum
```

- After submitting the MD5 checksum on Moodle, **do not** update any file(s). Doing so will change your checksum, and your submission will not be evaluated.
- You are free to read through various resources. However, please ensure that you cite your sources to avoid plagiarism. Any detected instances of plagiarism will result in penalties.
- Please contact your assigned TA for any doubts or queries regarding this assignment.
- The **soft deadline** for this assignment is **11:59 PM** on **May 22**, 2024. Submissions after this deadline will face a linearly increasing penalty of 15 marks per late day.
- The **hard deadline** for this assignment is **11:59 PM** on **May 24**, 2024. Submissions after this deadline will not be evaluated.

[30 marks] 1. **Treasure Hunt II**

Context Treasure Hunt is back, this time, more fun!! Arceus, the legendary Pokemon, took refuge in Sinnoh mountains, after its creation, Giratina is caught by the PokeMaster - you.

Task

[– marks] (a) This time, you are tasked in searching for the Arceus - hill by hill, mountain by mountain, and when you spot it, don't hesitate to throw a Master Ball, and there, you conquer the whole world!!

[– marks] (b) You are given a shell binary (script.sh.x). Run it in your home directory. The result will be a cpp file (question_2.cpp), which is committed and branched multiple times, similar to how Arceus has multiple hideouts and tunnels for escape.

[30 marks] (c) You can search for Arceus by traversing these branches and nodes. Once you found the Legendary Arceus, immediately merge the commit to the HEAD of the MASTER branch, just as you would catch Arceus using the Master Ball. The result ? The Pokemon world and hence the treasure hunt - is yours.

Note that when you get to the right version of the file, you will see the clear ASCII picture of Arceus, whereas the rest of them would show its illusions!!

Usage:

```
$ ./script.sh.x
```

[40 marks] 2. **Image Processing**

In image processing, a kernel is a small matrix used for transforming an image. This is achieved by *convolving* the image with the kernel matrix.

Consider a 3×3 kernel which is a matrix A_{ij} that will operate on an image as follows: For a pixel located at (m, n) the value of the pixel $P_{m,n}$ in the image, the new value is given by the following formula:

$$P^{\text{new}}_{m,n} = \sum_{i=0,j=0}^{i=2,j=2} A_{ij} P^{\text{old}}_{m-1+i,n-1+j}$$

You have been given two images, the original Lena as well as a distorted version of her.

[15 marks] (a) By taking up kernels for at least two different image operations (such as brightness change, contrast change, gamma correction, motion blur, edge detection, etc.), illustrate how the image is modified.

[15 marks] (b) Can you reduce the noise in the second image using any of the kernels above? Why does it work / not work?

[10 marks] (c) Having worked with Fourier Transforms in the previous assignment, can you figure out a way to filter noise from the image by manipulating its values in the frequency domain? How does this perform against the kernel method above? Can you comment on the nature of noise that would be suitable for these various methods?

For the boundary pixels, you can either skip them or consider a periodic boundary condition as you wish. You can also try padding the image.

[30 marks] 3. **Reflection:**

- Write a LaTeX report (named `<roll_number>_A6.pdf`), which contains your observations and the overall conclusion you got from performing the tasks above. Upload the same on Moodle.
- Your PDF report should contain the old and the modified images for illustrating the kernel operations.
- Make sure you provide in the report - the branch, and the node in which you caught the Arceus!
- Avoid repeating the same point multiple times in the report.
- Make use of math expressions effectively whenever possible.
- As and when possible, write your points in ordered or unordered bullet points. Images/ Screenshots of intermediate steps are appreciated.
- Remember that the more details you project in the report, the more marks you will be reflected with.

[10 marks] (a) Task 1

[20 marks] (b) Task 2