AI 361: Assignment 1

Due: Friday, September 27th, 11:59pm (FINAL – NO EXTENSION).
Submit via Moodle.
Weight: 5%

General guidelines:

What to Submit?
You will submit the assignment on Moodle before the due date. Only submit the following:

- For the written exercises, you need to supply a written or typed answer in a (.TXT, .DOC, .DOCX, .PDF, or any readable format).

Submission guidelines:

- Make sure your Name, Student Number, and UPM Email are included in a the submission files.
- Make sure you have comments. Both inline and function headers.
- Use proper/effective variable names.

Regarding the use of generative AI (aka ChatGPT)

- **Not allowed for this assignment!**

Part 1: Written exercises (Weight 0.75%) – Please refer to the reference book for the following written questions**.**

a) You are preparing a report and have to insert in it an image of size 2048 × 2048 pixels.
   I. Assuming no limitations on the printer, what would the resolution in line pairs per mm have to be for the image to fit in a space of size 5 × 5 cm?
   II. What would the resolution have to be in dpi for the image to fit in 2 × 2 inches?

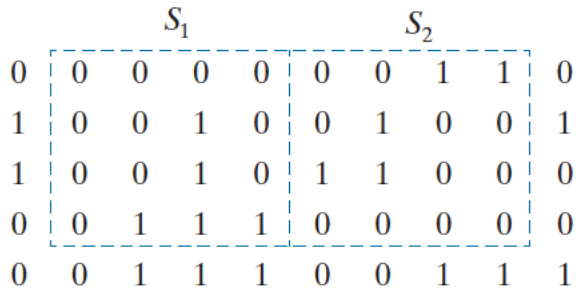
b) When discussing linear indexing in Section 2.4, we arrived at the linear index in Eq. (2-14) by inspection. The same argument used there can be extended to a 3-D array with coordinates x, y, and z, and corresponding dimensions M, N, and P. The linear index for any (x, y,z) is:

$$s = x + M(y + Nz)$$

Start with this expression and:
   I. Derive Eq. (2-15).
   II. Derive Eq. (2-16).

c) Consider the two image subsets, S1 and S2 in the following figure. With reference to Section 2.5, and assuming that V = {1}, determine whether these two subsets are:
   I. 4-adjacent.
   II. 8-adjacent.

III. m-adjacent.



Part 2: Pseudocode exercise (Weight 4.25%)

In this assignment, you are tasked with developing pseudocode for the Bilinear Interpolation algorithm, a widely used method in image processing for resizing images or scaling pixel values.

Write detailed pseudocode for performing **bilinear interpolation** on a given 2D image, where the algorithm estimates the value of a pixel at a non-integer position (x, y) using the surrounding four integer pixel values.

Requirements:

1. The input to your pseudocode should include:
    - A 2D array representing pixel values of the image.
    - The non-integer position (x, y) where interpolation needs to be performed.
2. The output should be the interpolated pixel value at the given position.
3. Ensure that your pseudocode handles boundary conditions where the interpolation point lies near the edges of the image.
4. **Clearly comment each step in the pseudocode to explain the logic behind it.**
5. **Make sure to explain how the weights for the neighboring pixels are calculated.**

Example Input:
A 4x4 image and the point (1.5, 1.5) for interpolation.

Expected Output:
The interpolated value at (1.5, 1.5).

Bonus – Weight (1%):

In addition to the standard grayscale bilinear interpolation, consider a color image where each pixel has three components (R, G, B). Your task is to extend the pseudocode you developed earlier to handle **RGB** color images.

FAQs:

- **Q:** I don't know where to start.
  - **A:** Join the office hour or send me a message on MS Teams and I will do my best to address your questions.
- **Q:** There is a bug in my code!
  - **A:** Debugging is part of the challenges we as programmers need to be patient with. Spend some time with it and if not resolved, share your code, and provide details about the issue on the MS Teams channel. Your classmates may provide some hints and I can also share feedback.
- **Q:** I don't know how to do X?
  - **A:** Approach me and I will try to guide how to do it. I may end up myself searching with you some of the questions.
- **Q:** My code isn't working.
  - **A:** It is probably a matter of more testing and debugging. Do your best and if you still cannot make it work, let me know and I will join the debugging activity.
- **Q:** You're asking us to do a bunch of things you haven't taught us!
  - **A:** I know. This is because some real-life cases will require extensive search to find a solution for. Let me know if you feel that this is overwhelming.
- **Q:** Can I email the professor with questions?
  - **A:** Of course, anytime!
- **Q:** If I submit it at 12:00am, you'll still mark it, right?
  - **A:** 11:59pm and earlier is on time. Anything after 11:59pm is late. Anything late will not be probably marked. If I find you have a legitimate cause, you will be graded according to the following rules (24 hours after deadline → assignment is marked out of 75% only, 48 hours after deadline → assignment is marked out of 50% only, 72 hours after deadline → assignment is marked out of 25% only).