CS301 Computer Architecture Mid-semester Examination

13th December 2020

- Marks: 25
- Duration: 4 hours
- You are allowed to refer to the textbook and videos.
- You are NOT allowed to discuss amongst yourselves. Plagiarism will be treated severely.

Question

You have started an Artificial Intelligence company that does a lot of high definition image analysis and classification. One basic operation that is performed very frequently during image processing is "convolution". If your company can somehow perform convolution faster, you can gain a huge upper-hand over the competing companies. How will you achieve this? Your modifications can be to the hardware or the software or both.

Brief description of convolution in image processing: The input image 'I' is described by a 2-D array of pixels, with each pixel as a single integer value for the sake of simplicity. To perform an image processing operation (such as edge detection), we use a kernel 'w', which is a 3×3 matrix of integer values. Each pixel of the transformed image 'T' is given by,

$$T[x][y] = \sum_{i=0}^{2} \sum_{j=0}^{2} w[i][j] \times I[x+i-1][y+j-1]$$

- Hint: start by analyzing how this convolution operation will behave as it is executed by the processor design you have studied in this course. Find out where a lot of time is being spent, and try to optimize accordingly.
- Please gather your thoughts and then write coherently. The marks you receive is directly determined by how much the evaluator understands! (Verbal explanation of answers at a later point in time will not be entertained)
- Think of it this way -- you are pitching this idea to an investor for your company. You have to give a great description of your solution if you want to convince him to invest in your company.
- Think freely. Be creative.
- You can submit multiple ideas if you come up with them.
- For each idea that you come up with, give a detailed description of your design.
- For every design decision you make, explain the rationale behind it.