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I pledge my honor that I have abided 10/30/24  
by the Thoms Honor System.

# SSW 345 Midterm 1uv

## Exercise 7.1

1. a)  $t_{\text{region}}$  will be 2ms. Each input image is  $2,000 \times 2,000$  pixels, or 4,000,000 pixels. Since half the image processed on each CPU, each CPU processes 2,000,000 pixels, and computing the histogram is N pixels.  
 $t_{\text{ins}} = 1 \text{ ms}$ .
- b) histogram will also be 2ms, assuming all pixels are visited. Each CPU processes half the image, taking 2ms. Due to the pardo node, we take the longer of the two CPU times, but they are the same.
- c)  $P_{L0}$  will be 0.4, since for each channel, approximately 1,600,000 pixels of the 4,000,000 pixels for each image are labeled  $L_0$ .
- d)  $P_{L1}$  will be 0.6 since for each channel, approximately 2,400,000 pixels of the 4,000,000 pixels for each image are labeled  $L_1$ .
- e)  $t_{L0}$  will be 1ms. Assuming we label 500,000 pixels as  $L_1$ , and there is a 0.6 chance each pixel is labeled  $L_1$ , we can divide 500,000 by 0.6 to get the total number pixels before the tumor is found, which is 833,333.33. Then, we multiply by 0.4, the chance of a pixel being labeled  $L_0$ , to get the number of pixels labeled  $L_0$  before tumor found, which is 333,333.33. We then multiply by 3ns, which is the time required for the CPU to label a pixel  $L_0$ , and get 1,000,000 ns or 1ms.
- f)  $t_{L_1}$  will be 2.5ms. Assuming we label 500,000 pixels as  $L_1$ , we multiply by 5ns, which is the time required for the CPU to label a pixel  $L_1$ , and get 2,500,000 ns or 2.5ms.
- g)  $t_{\text{LabelRegion}}$  leads to a case node, which has 0.4 chance of reaching the LabelZero node, and a 0.6 chance of reaching the LabelOne node. In the best case, it will go to LabelZero, with time 1ms. In the worst, it will go to LabelOne with time 2.5ms. On average, considering the the case node probabilities,  $t_{\text{LabelRegion}}$  will be  $0.4 \times 1\text{ms} + 0.6 \times 2.5\text{ms}$ , or 1.9ms.
- h)  $t_{\text{Label}}$  leads to a case node, which has 0.75 chance of reaching a split node to two LabelRegion nodes, and 0.25 chance of reaching pardo node to two LabelRegion nodes. In the worst case, it will again go to LabelOne with time 2.5ms, and in the best case, go to LabelZero, with time 1ms. On average, considering the case node probabilities,  $t_{\text{Label}}$  will be  $0.75 \times \min(1.9\text{ms}, 1.9\text{ms}) + 0.25 \times \max(1.9\text{ms}, 1.9\text{ms})$ , or 1.9ms.

$$2. \text{Fastest} = 3 \times (2\text{ms} + \min(1\text{ms}, 2.5\text{ms})) = 9\text{ms}$$

$$\text{Slowest} = 3 \times (2\text{ms} + \max(1\text{ms}, 2.5\text{ms})) = 13.5\text{ms}$$

$$\text{Average} = 3 \times (2\text{ms} + 0.75 \times \min(0.4 \times 1\text{ms} + 0.6 \times 2.5\text{ms}, 0.4 \times 1\text{ms} + 0.6 \times 2.5\text{ms}) + 0.25 \times \max(0.4 \times 1\text{ms} + 0.6 \times 2.5\text{ms}, 0.4 \times 1\text{ms} + 0.6 \times 2.5\text{ms}))$$

$$= 11.7\text{ms}$$

3. See submission for Simulink files and scope output showing best, worst, and average performance times.
4. As seen in the scope output for the simulated algorithm, the best performance time was 9ms, and the worst performance time was 13.5ms, which both match the manual estimates. The average performance time for the simulated algorithm was 11.85ms, which is slightly higher than the manually estimated average performance of 11.7ms, but this is reasonable, given the noise introduced at each node that updates process time in the simulation, along with the randomness involved when determining which path to follow at each case node.
5. The simulation execution model can be improved by indicating that each LabelRegion node leads to a case node that could either lead to the node LabelZero or LabelOne. The current iteration only depicts the first LabelRegion node leading to a case node, which for me caused confusion, as I did not know whether to assume that each LabelRegion leads to a case node, or that a different calculation would have to be made for the LabelRegion nodes that do not appear to continue. Eventually, I was able to clarify this with the professor and he told me to assume that each LabelRegion node did lead to the same case node that either could lead to LabelZero or LabelOne.