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HW10

# Part 1.1

**9.2.1)**

**a –** cos (theta) = (u \* v) / (||u|| \* ||v||)

A and B -> cos(theta) = **(3.06\*2.68 + 500α\*320α + 6β\*4β) / (sqrt(3.06^2 + (500α)^2 + (6β)^2) \* sqrt(2.68^2 + (320α)^2 + (4β)^2))**

A and C -> cos(theta) = **(3.06\*2.92 + 500α\*640α + 6β\*6β) / (sqrt(3.06^2 + (500α)^2 + (6β)^2) \* sqrt(2.92^2 + (640α)^2 + (6β)^2))**

B and C -> cos(theta) = **(2.68\*2.92 + 320α\*640α + 4β\*6β) / (sqrt(2.68^2 + (320α)^2 + (4β)^2) \* sqrt(2.92^2 + (640α)^2 + (6β)^2))**

**b –** α = β = 1, theta = arccos(cos(theta)

A and B -> theta = arccos((3.06\*2.68 + 500\*320 + 6\*4) / (sqrt(3.06^2 + (500)^2 + (6)^2) \* sqrt(2.68^2 + (320)^2 + (4)^2))) = **0.132 degrees**

A and C -> theta = arccos((3.06\*2.92 + 500\*640 + 6\*6) / (sqrt(3.06^2 + (500)^2 + (6)^2) \* sqrt(2.92^2 + (640)^2 + (6)^2))) = **0.175 degrees**

B and C -> theta = arccos((2.68\*2.92 + 320\*640 + 4\*6) / (sqrt(2.68^2 + (320)^2 + (4)^2) \* sqrt(2.92^2 + (640)^2 + (6)^2))) = **0.282 degrees**

**c –** α = 0.01, β = 0.5

A and B -> theta = arccos((3.06\*2.68 + 500\*0.01\*320\*0.01 + 6\*0.5\*4\*0.5) / (sqrt(3.06^2 + (500\*0.01)^2 + (6\*0.5)^2) \* sqrt(2.68^2 + (320\*0.01)^2 + (4\*0.5)^2))) = **7.743 degrees**

A and C -> theta = arccos((3.06\*2.92 + 500\*0.01\*640\*0.01 + 6\*0.5\*6\*0.5) / (sqrt(3.06^2 + (500\*0.01)^2 + (6\*0.5)^2) \* sqrt(2.92^2 + (640\*0.01)^2 + (6\*0.5)^2))) = **7.452 degrees**

B and C -> theta = arccos((2.68\*2.92 + 320\*0.01\*640\*0.01 + 4\*0.5\*6\*0.5) / (sqrt(2.68^2 + (320\*0.01)^2 + (4\*0.5)^2) \* sqrt(2.92^2 + (640\*0.01)^2 + (6\*0.5)^2))) = **14.26 degrees**

**d -** α = 1/486, β = 1/5.33

A = [3.06, 500 \* 1/486, 6 \* 1/5.33] = [3.06, 1.028, 1.125]

B = [2.68, 0.658, 0.75]

C = [2.92, 1.316, 1.125]

A and B -> theta = arccos((3.06\*2.68 + 1.028\*0.658 + 1.125\*0.75) / (sqrt(3.06^2 + (1.028)^2 + (1.125)^2) \* sqrt(2.68^2 + (0.658)^2 + (0.75)^2))) = **6.072 degrees**

A and C -> theta = arccos((3.06\*2.92 +1.028\*1.316 + 1.125\*1.125) / (sqrt(3.06^2 + (1.028)^2 + (1.125)^2) \* sqrt(2.92^2 + (1.316)^2 + (1.125)^2))) = **5.373 degrees**

B and C -> theta = arccos((2.68\*2.92 + 0.658\*1.316 + 0.75\*1.125) / (sqrt(2.68^2 + (0.658)^2 + (0.75)^2) \* sqrt(2.92^2 + (1.316)^2 + (1.125)^2))) = **10.82 degrees**

**9.2.3)**

**a –** A: 4, B: 2, C: 5

Avg = 11/3 -> norm = comp - avg

Normalized: **A: 0.33, B: -1.66, C: 1.33**

**b –** I assume since it normalized the ratings, the components should be normalized as well:

|  |  |  |  |
| --- | --- | --- | --- |
| Feature | A | B | C |
| Processor Speed | 0.17 | -0.21 | 0.03 |
| Disk Size | 14 | -166 | 154 |
| Main-Memory Size | 0.67 | -1.33 | 0.67 |

User Profile:

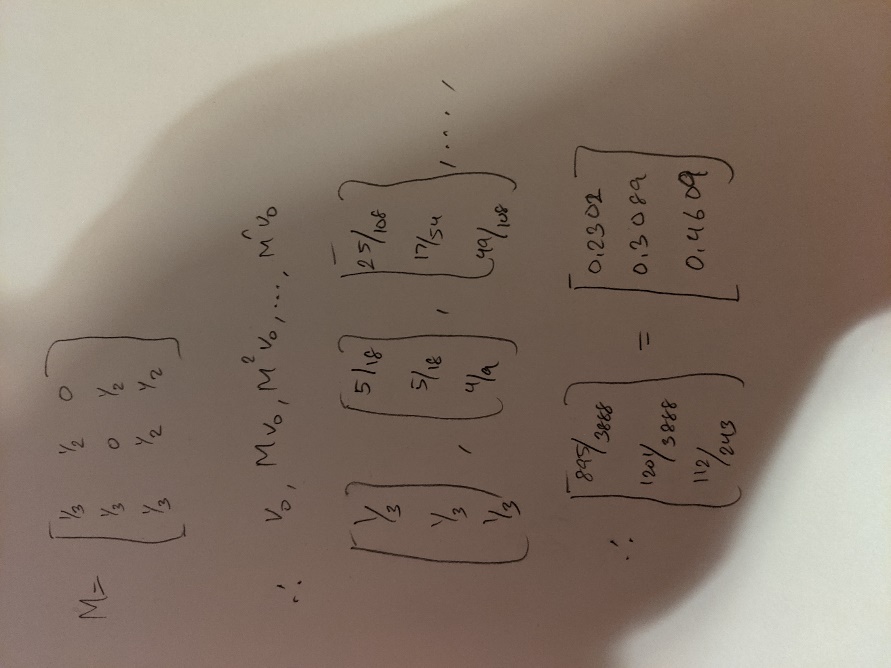
Processor Speed: (0.33 \* 0.17 + -1.66 \* -0.21 + 1.33 \* 0.03) / 3 = **0.1482**

Disk Size: (0.33 \* 14 + -1.66 \* -166 + 1.33 \* 153) / 3 = **161.223**

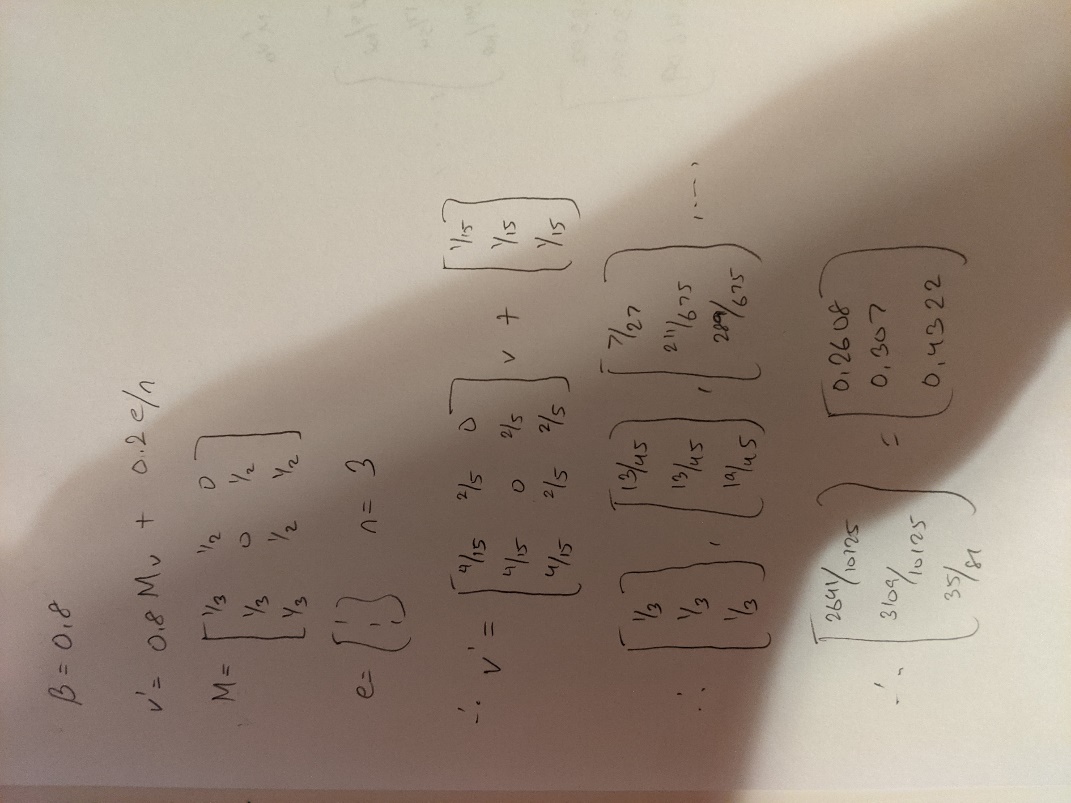
Memory-Size: (0.33 \* 0.67 + -1.66 \* -1.33 + 1.33 \* 0.67) / 3 = **1.106**

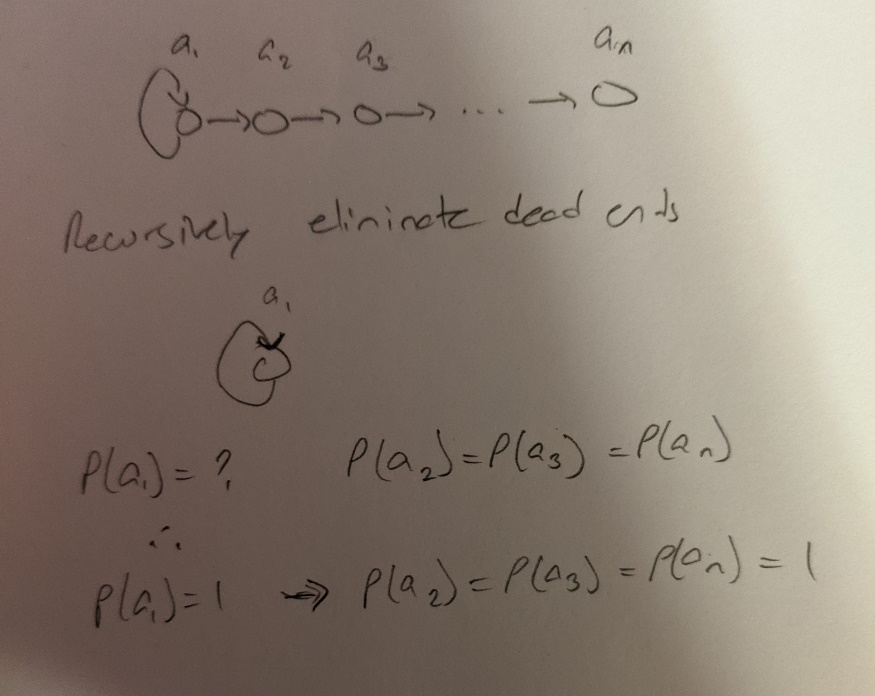
# Part 1.2

**5.1.1)**

  
**PageRank of A, B, C are 0.2302, 0.3089, and 0.4609 respectively**

**5.1.2)**

**PageRank of A, B, C are 0.2608, 0.307, and 0.4322 respectively.**  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  


**5.1.6)**

**The PageRank for each node would be 1.**

**Part 1.3**

**a)** Normalized degree centralityFor graph a:

Node 1: **1/4**

Node 2: **3/4**

Node 3: **2/4**

Node 4: **4/(5-1) = 4/4 = 1**

Node 5: **2/4**

For graph b:

Node 1: **2/4**

Node 2: **3/4**

Node 3: **2/4**

Node 4: **2/4**

Node 5: **3/4**

**b)** Normalized closeness centrality

Graph a:

Node 1: **4/(1+2+2+2) = 4/7**

Node 2: **4/(1+1+1+2) = 4/5**

Node 3: **4/(1+1+2+2) = 4/6**

Node 4: **4/(1+1+1+1) = 4/4 = 1**

Node 5: **4/(1+1+2+2) = 4/6**

Graph b:

Node 1: **4/(1+1+2+2) = 4/6**

Node 2: **4/(1+1+1+2) = 4/5**

Node 3: **4/(1+1+2+2) = 4/6**

Node 4: **4/(1+1+2+2) = 4/6**

Node 5: **4/(1+1+1+2) = 4/5**

**c)** Normalized betweenness centrality

Graph a:

Node 1: **No shortest path go through node 1, thus: 0\*2(undirected) / (2 \* (4 choose 2) = 0/12 = 0**

Node 2: **(1)\*2/12 = 2/12**

Node 3: **0/12**

Node 4: **(3+1)\*2/12 = 8/12**

Node 5: **0/12**

Graph b:

Node 1: **(1)\*2/12 = 2/12**

Node 2: **(1+1)\*2/12 = 4/12**

Node 3: **0/12**

Node 4: **(1)\*2/12 = 2/12**

Node 5: **(2)\*2/12 = 4/12**