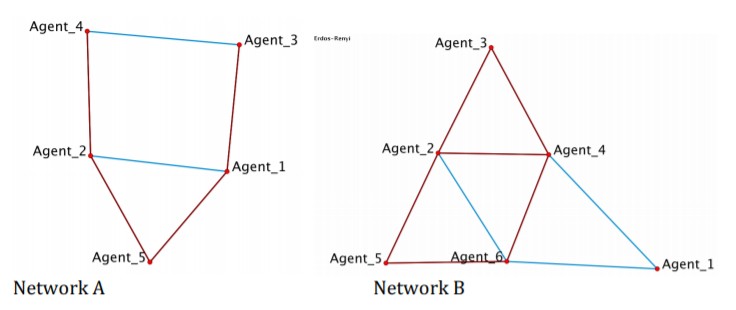
**Assignment 3**

**Guan Yue Wang**



**1 Adjacency Matrix**

Network A

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 |
| 1 | 0 | 1 | 1 | 0 | 1 |
| 2 | 1 | 0 | 0 | 1 | 1 |
| 3 | 1 | 0 | 0 | 1 | 0 |
| 4 | 0 | 1 | 1 | 0 | 0 |
| 5 | 1 | 1 | 0 | 0 | 0 |

Network B

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 2 | 0 | 0 | 1 | 1 | 1 | 1 |
| 3 | 0 | 1 | 0 | 1 | 0 | 0 |
| 4 | 1 | 1 | 1 | 0 | 0 | 1 |
| 5 | 0 | 1 | 0 | 0 | 0 | 1 |
| 6 | 1 | 1 | 0 | 1 | 1 | 0 |

**2 Degree Centralities**

Network A

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | Sum | n-1 | **Degree** |
| 1 | 0 | 1 | 1 | 0 | 1 | 3 | 4 | **3/4** |
| 2 | 1 | 0 | 0 | 1 | 1 | 3 | 4 | **3/4** |
| 3 | 1 | 0 | 0 | 1 | 0 | 2 | 4 | **2/4** |
| 4 | 0 | 1 | 1 | 0 | 0 | 2 | 4 | **2/4** |
| 5 | 1 | 1 | 0 | 0 | 0 | 2 | 4 | **2/4** |

Network B

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | Sum | n-1 | **Degree** |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 5 | **2/5** |
| 2 | 0 | 0 | 1 | 1 | 1 | 1 | 4 | 5 | **4/5** |
| 3 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 5 | **2/5** |
| 4 | 1 | 1 | 1 | 0 | 0 | 1 | 4 | 5 | **4/5** |
| 5 | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 5 | **2/5** |
| 6 | 1 | 1 | 0 | 1 | 1 | 0 | 4 | 5 | **4/5** |

**3 Geodesic**

Network A

|  |  |  |
| --- | --- | --- |
| From | To | Geodesic |
| 1 | 2 | (1,2) |
| 1 | 3 | (1,3) |
| 1 | 4 | (1,2,4) (1,3,4) |
| 1 | 5 | (1,5) |
| 2 | 3 | (2,1,3) (2,4,3) |
| 2 | 4 | (2,4) |
| 2 | 5 | (2,5) |
| 3 | 4 | (3,4) |
| 3 | 5 | (3,1,5) |
| 4 | 5 | (4,2,5) |

Network B

|  |  |  |
| --- | --- | --- |
| From | To | Geodesic |
| 1 | 2 | (1,4,2) (1,6,2) |
| 1 | 3 | (1,4,3) |
| 1 | 4 | (1,4) |
| 1 | 5 | (1,6,5) |
| 1 | 6 | (1,6) |
| 2 | 3 | (2,3) |
| 2 | 4 | (2,4) |
| 2 | 5 | (2,5) |
| 2 | 6 | (2,6) |
| 3 | 4 | (3,4) |
| 3 | 5 | (3,2,5) |
| 3 | 6 | (3,2,6) (3,4,6) |
| 4 | 5 | (4,2,5) (4,6,5) |
| 4 | 6 | (4,6) |
| 5 | 6 | (5,6) |

**4 Betweenness**

Network A

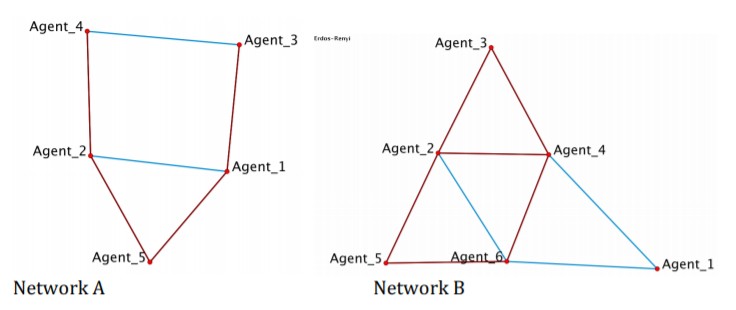
|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| From | To | Geodesic | 1 | 2 | 3 | 4 | 5 |  |
| 1 | 2 | (1,2) | 0 | 0 | 0 | 0 | 0 |
| 1 | 3 | (1,3) | 0 | 0 | 0 | 0 | 0 |
| 1 | 4 | (1,2,4) (1,3,4) | 0 | 0.5 | 0.5 | 0 | 0 |
| 1 | 5 | (1,5) | 0 | 0 | 0 | 0 | 0 |
| 2 | 3 | (2,1,3) (2,4,3) | 0.5 | 0 | 0 | 0.5 | 0 |
| 2 | 4 | (2,4) | 0 | 0 | 0 | 0 | 0 |
| 2 | 5 | (2,5) | 0 | 0 | 0 | 0 | 0 |
| 3 | 4 | (3,4) | 0 | 0 | 0 | 0 | 0 |
| 3 | 5 | (3,1,5) | 1 | 0 | 0 | 0 | 0 |
| 4 | 5 | (4,2,5) | 0 | 1 | 0 | 0 | 0 |
| Sum | | | 1.5 | 1.5 | 0.5 | 0.5 | 0 | Numerator |
| (n-1)(n-2)/2 = 6 | | | 6 | 6 | 6 | 6 | 6 | Denominator |
| Betweenness | | | 0.25 | 0.25 | 0.08 | 0.08 | 0 | Betweenness |

Network B

|  |  |  |
| --- | --- | --- |
| From | To | Geodesic |
| 1 | 2 | (1,4,2) (1,6,2) |
| 1 | 3 | (1,4,3) |
| 1 | 4 | (1,4) |
| 1 | 5 | (1,6,5) |
| 1 | 6 | (1,6) |
| 2 | 3 | (2,3) |
| 2 | 4 | (2,4) |
| 2 | 5 | (2,5) |
| 2 | 6 | (2,6) |
| 3 | 4 | (3,4) |
| 3 | 5 | (3,2,5) |
| 3 | 6 | (3,2,6) (3,4,6) |
| 4 | 5 | (4,2,5) (4,6,5) |
| 4 | 6 | (4,6) |
| 5 | 6 | (5,6) |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| From | To | Geodesic | 1 | 2 | 3 | 4 | 5 | 6 |  |
| 1 | 2 | (1,4,2) (1,6,2) | 0 | 0 | 0 | 0.5 | 0 | 0.5 |
| 1 | 3 | (1,4,3) | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 4 | (1,4) | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 5 | (1,6,5) | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 6 | (1,6) | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 3 | (2,3) | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 4 | (2,4) | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 5 | (2,5) | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 6 | (2,6) | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 4 | (3,4) | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 5 | (3,2,5) | 0 | 1 | 0 | 0 | 0 | 0 |
| 3 | 6 | (3,2,6) (3,4,6) | 0 | 0.5 | 0 | 0.5 | 0 | 0 |
| 4 | 5 | (4,2,5) (4,6,5) | 0 | 0.5 | 0 | 0 | 0 | 0.5 |
| 4 | 6 | (4,6) | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 6 | (5,6) | 0 | 0 | 0 | 0 | 0 | 0 |
| Sum | | | 0 | 2 | 0 | 2 | 0 | 2 | Numerator |
| (n-1)(n-2)/2 = 10 | | | 10 | 10 | 10 | 10 | 10 | 10 | Denominator |
| Betweenness | | | 0 | 0.2 | 0 | 0.2 | 0 | 0.2 | Betweenness |

**5. Closeness**



Network A

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | Sum | n-1 | **closeness (n-1)/sum** |
| 1 |  | 1 | 1 | 2 | 1 | 5 | 4 | **4/5** |
| 2 | 1 |  | 2 | 1 | 1 | 5 | 4 | **4/5** |
| 3 | 1 | 2 |  | 1 | 2 | 6 | 4 | **4/6** |
| 4 | 2 | 1 | 1 |  | 2 | 6 | 4 | **4/6** |
| 5 | 1 | 1 | 2 | 2 |  | 6 | 4 | **4/6** |

Network B

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | Sum | n-1 | **closeness (n-1)/sum** |
| 1 |  | 2 | 2 | 1 | 2 | 1 | 8 | 5 | **5/8** |
| 2 | 2 |  | 1 | 1 | 1 | 1 | 6 | 5 | **5/6** |
| 3 | 2 | 1 |  | 1 | 2 | 2 | 8 | 5 | **5/8** |
| 4 | 1 | 1 | 1 |  | 2 | 1 | 6 | 5 | **5/6** |
| 5 | 2 | 1 | 2 | 2 |  | 1 | 8 | 5 | **5/8** |
| 6 | 1 | 1 | 2 | 1 | 1 |  | 6 | 5 | **5/6** |

**6. Influence**

Network A

Agent 1 and 2 have the greater influence as they have the greatest degree, betweenness, closeness centrality scores.

Network B

Agent 2, 4, 6 have the greater influence as they have the greatest degree, betweenness, closeness centrality scores.

**7. Network Density**

Network A

Possible links = 5 choose 2 = 5!/(2!3!) = 10

Actual edges = 6

Network Density = 6/10 = 60%

Network B

Possible links = 6 choose 2 = 6!/(2!4!) = 15

Actual edges = 9

Network Density = 9/15 = 60%

**8. Diameter**

Diameter is based on the longest geodesic in the network.

Referring to question 3, we know both network A and B have diameter 3

Python Code and Output (actual files are attached as additional documents):



