

## Project 3 Report:

1)

- a. Yes, I believe the degree distribution is consistent with that of a small world graph. This is indicated by the shape of the histogram, as it peaks relatively early, meaning that the majority of vertices have a relatively small number of connections. Being a small world graph means that each node has few connections but is also closely connected to every other node. The degree distribution confirms that there are relatively low numbers of connections for each node, but it does not concretely say whether the nodes are widely connected to one-another, although it does suggest it.
- b. The highest degree node in each graph is about 4-5x higher than the majority of other nodes. Even so, I would not classify these as supernodes. My reasoning is that the degree of the nodes increases at a linear

rate. There is no big jump in degrees. If we look at the average degree, not taking into account how many nodes belong to each degree, the average is almost exactly  $n/2$ , with  $n$  being the highest degree. This makes these large nodes look much more normal. It is hard to draw an arbitrary line when the degrees continuously increases from 1 to  $n$ . Therefore, the highest node does not make it a supernode.

- 2) For a small world graph, there should be one very large component with minimal other components, and certainly not any other large components. This is because for a small world graph, nearly all components (or ideally all of them) should be connected to one-another.
- 3) Yes, the results support my hypothesis. For each graph, there is one component significantly larger than any others. In addition, there are very few other components. This means that the large majority of nodes are connected to each other. Furthermore, when the degree distribution is taken into consideration on top of this, it absolutely

points to a small world graph. That is, a large majority of nodes in the graph are connected to one-another and each node also has a relatively low number of direct connections (edges).

Graphs:

#### Degree Distribution for 0.95

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-----  
Degree 0: * * * * * (86)  
Degree 1: * * * * * (110)  
Degree 2: * * * * * (100)  
Degree 3: * * * * * (105)  
Degree 4: * * * * * (147)  
Degree 5: * * * * * (177)  
Degree 6: * * * * * (126)  
Degree 7: * * * * * (169)
```

Degree 8: \* \* \* \* \* (445)  
 Degree 9: \* \* \* \* \* (204)  
 Degree 10: \* \* \* \* \* (185)  
 Degree 11: \* \* \* \* \* (125)  
 Degree 12: \* \* \* \* \* (170)  
 Degree 13: \* \* \* \* \* (164)  
 Degree 14: \* \* \* \* \* (122)  
 Degree 15: \* \* \* \* \* (96)  
 Degree 16: \* \* \* \* \* (88)  
 Degree 17: \* \* \* \* \* (84)  
 Degree 18: \* \* \* \* \* (66)  
 Degree 19: \* \* \* \* \* (69)  
 Degree 20: \* \* \* \* \* (62)  
 Degree 21: \* \* \* \* \* (41)  
 Degree 22: \* \* \* \* (20)  
 Degree 23: \* \* \* (18)  
 Degree 24: \* \* \* (17)  
 Degree 25: \* \* \* (19)  
 Degree 26: \* \* \* \* (21)  
 Degree 27: \* \* \* (15)  
 Degree 28: \* \* \* (17)  
 Degree 29: \* \* (13)  
 Degree 30: \* \* (10)  
 Degree 31: \* \* \* \* (23)  
 Degree 32: \* (9)  
 Degree 33: \* \* \* (16)  
 Degree 34: \* \* (13)  
 Degree 35: \* \* (12)  
 Degree 36: \* \* (10)  
 Degree 37: \* (5)  
 Degree 38: (3)  
 Degree 39: (0)  
 Degree 40: (2)

Degree 41: (1)

Degree 42: (1)

### Degree Distribution for 0.925

-----  
Degree 0: \* \* \* \* \* (31)

Degree 1: \* \* \* \* \* \* \* (45)

Degree 2: \* \* \* \* \* \* \* (44)

Degree 3: \* \* \* \* \* \* \* \* \* (57)

Degree 4: \* \* \* \* \* \* \* \* \* \* (69)

Degree 5: \* \* \* \* \* \* \* \* \* \* \* \* (81)

Degree 6: \* \* \* \* \* \* \* \* \* \* \* \* \* \* (90)

Degree 7: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (115)

Degree 8: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (118)

Degree 9: \* (147)

Degree 10: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (109)

Degree 11: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (88)

Degree 12: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (89)

Degree 13: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (110)

Degree 14: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (90)

Degree 15: \* (121)

Degree 16: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (99)

Degree 17: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (104)

Degree 18: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (104)

Degree 19: \* (120)

Degree 20: \* (156)

Degree 21: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (105)

Degree 22: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (102)

Degree 23: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (95)

Degree 24: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (77)

Degree 25: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (72)

Degree 26: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (68)

Degree 27: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (61)

Degree 28: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (62)

Degree 29: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (72)

Degree 30: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (61)

Degree 31: \* \* \* \* \* \* \* \* (41)

Degree 32: \* \* \* \* \* (33)  
Degree 33: \* \* \* (19)  
Degree 34: \* \* \* (19)  
Degree 35: \* \* \* \* \* (28)  
Degree 36: \* \* (11)  
Degree 37: \* \* \* (15)  
Degree 38: \* \* \* (16)  
Degree 39: \* \* \* (17)  
Degree 40: \* (9)  
Degree 41: \* \* (11)  
Degree 42: \* (7)  
Degree 43: \* \* (12)  
Degree 44: \* \* (14)  
Degree 45: \* (7)  
Degree 46: \* (6)  
Degree 47: \* (9)  
Degree 48: \* (6)  
Degree 49: \* \* (10)  
Degree 50: \* \* \* (18)  
Degree 51: \* (6)  
Degree 52: \* (8)  
Degree 53: \* (9)  
Degree 54: \* (9)  
Degree 55: \* \* (13)  
Degree 56: \* \* (13)  
Degree 57: \* \* (12)  
Degree 58: \* (9)  
Degree 59: \* (6)  
Degree 60: \* (5)  
Degree 61: \* (5)  
Degree 62: (3)  
Degree 63: \* (5)  
Degree 64: (3)  
Degree 65: (2)  
Degree 66: (2)  
Degree 67: (3)  
Degree 68: (2)

Degree 69: (0)

Degree 70: (0)

Degree 71: (1)

### Degree Distribution for 0.9

-----  
Degree 0: \* \* (14)

Degree 1: \* \* \* \* \* (25)

Degree 2: \* \* \* \* \* (28)

Degree 3: \* \* \* \* \* (25)

Degree 4: \* \* \* \* \* \* \* (40)

Degree 5: \* \* \* \* \* \* \* \* (49)

Degree 6: \* \* \* \* \* \* \* \* (48)

Degree 7: \* \* \* \* \* \* \* \* \* (56)

Degree 8: \* \* \* \* \* \* \* \* \* \* (74)

Degree 9: \* \* \* \* \* \* \* \* \* (52)

Degree 10: \* \* \* \* \* \* \* \* \* \* \* \* \* (87)

Degree 11: \* \* \* \* \* \* \* \* \* \* \* (67)

Degree 12: \* \* \* \* \* \* \* \* \* \* \* (64)

Degree 13: \* \* \* \* \* \* \* \* \* \* \* \* \* (80)

Degree 14: \* \* \* \* \* \* \* \* \* \* \* (65)

Degree 15: \* \* \* \* \* \* \* \* \* (49)

Degree 16: \* \* \* \* \* \* \* \* \* \* (52)

Degree 17: \* \* \* \* \* \* \* \* \* \* \* (61)

Degree 18: \* \* \* \* \* \* \* \* \* \* \* \* \* \* (91)

Degree 19: \* \* \* \* \* \* \* \* \* \* \* \* \* \* (80)

Degree 20: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (121)

Degree 21: \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* (117)

Degree 22: \* \* \* \* \* \* \* \* \* \* \* \* \* (70)

Degree 23: \* \* \* \* \* \* \* \* \* \* \* \* \* \* (73)

Degree 24: \* \* \* \* \* \* \* \* \* \* \* \* \* (68)

Degree 25: \* \* \* \* \* \* \* \* \* \* \* \* \* (68)

Degree 26: \* \* \* \* \* \* \* \* \* \* \* \* \* (59)

Degree 27: \* \* \* \* \* \* \* \* \* \* \* \* \* \* (72)

Degree 28: \* \* \* \* \* \* \* \* \* \* \* \* \* \* (67)

Degree 29: \* \* \* \* \* \* \* \* \* \* \* \* \* \* (73)

Degree 30: \* \* \* \* \* \* \* \* \* \* \* \* \* (67)

Degree 31: \* \* \* \* \* (65)  
Degree 32: \* \* \* \* \* (77)  
Degree 33: \* \* \* \* \* (67)  
Degree 34: \* \* \* \* \* (51)  
Degree 35: \* \* \* \* \* (65)  
Degree 36: \* \* \* \* \* (51)  
Degree 37: \* \* \* \* \* (50)  
Degree 38: \* \* \* \* \* (55)  
Degree 39: \* \* \* \* \* (49)  
Degree 40: \* \* \* \* \* (50)  
Degree 41: \* \* \* \* \* (37)  
Degree 42: \* \* \* \* \* (52)  
Degree 43: \* \* \* \* \* (37)  
Degree 44: \* \* \* \* \* (34)  
Degree 45: \* \* \* \* \* (36)  
Degree 46: \* \* \* \* \* (27)  
Degree 47: \* \* \* \* \* (25)  
Degree 48: \* \* \* \* \* (20)  
Degree 49: \* \* (14)  
Degree 50: \* \* \* \* (22)  
Degree 51: \* \* (12)  
Degree 52: \* (9)  
Degree 53: \* \* (12)  
Degree 54: \* \* (12)  
Degree 55: \* \* (14)  
Degree 56: \* \* (10)  
Degree 57: \* \* (10)  
Degree 58: \* (7)  
Degree 59: \* (7)  
Degree 60: \* (9)  
Degree 61: \* (6)  
Degree 62: \* \* (11)  
Degree 63: \* \* (11)  
Degree 64: \* (8)  
Degree 65: \* (7)  
Degree 66: \* (7)  
Degree 67: \* (6)



Degree 68: \* (6)  
Degree 69: \* (6)  
Degree 70: \* (8)  
Degree 71: \* (5)  
Degree 72: \* \* (11)  
Degree 73: \* (6)  
Degree 74: \* (6)  
Degree 75: \* (9)  
Degree 76: \* (7)  
Degree 77: (2)  
Degree 78: \* (9)  
Degree 79: \* (6)  
Degree 80: \* (9)  
Degree 81: \* (6)  
Degree 82: \* \* (10)  
Degree 83: \* (9)  
Degree 84: \* (9)  
Degree 85: \* (5)  
Degree 86: (3)  
Degree 87: \* (7)  
Degree 88: (3)  
Degree 89: (4)  
Degree 90: (2)  
Degree 91: (3)  
Degree 92: (3)  
Degree 93: (3)  
Degree 94: (2)  
Degree 95: (3)  
Degree 96: (2)  
Degree 97: \* (6)  
Degree 98: (4)  
Degree 99: (1)  
Degree 100: (1)  
Degree 101: (3)  
Degree 102: (1)  
Degree 103: (1)  
Degree 104: (1)

#### **Component Size for 0.95**

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**Comp size 1: 86**

**Comp size 2: 18**

**Comp size 3: 8**

**Comp size 4: 4**

**Comp size 5: 1**

**Comp size 6: 1**

**Comp size 7: 1**

**Comp size 30: 1**

**Comp size 88: 1**

**Comp size 2888: 1**

**Total number of components: 3186**

#### **Component Size for 0.925**

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**Comp size 1: 31**

**Comp size 2: 4**

**Comp size 3: 4**

**Comp size 4: 3**

**Comp size 3123: 1**

**Total number of components: 3186**

#### **Component Size for 0.9**

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**Comp size 1: 14**

**Comp size 2: 3**

**Comp size 3: 3**

**Comp size 6: 1**

**Comp size 3151: 1**

**Total number of components: 3186**