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1 Power Laws

1.1

(a) → not scale-free, because the plot is curved, therefore $\log p_k$ does not depend linearly on $\log k$.
(b) → scale-free, because $\log p_k$ depends linearly on $\log k$ (the plot is approximately a straight line).

1.2

$\log_{10} p_k \sim -\gamma \cdot log_{10} k \Rightarrow \gamma = -\frac{\log_{10} p_k}{\log_{10} k}$. Sample several points on the graph and estimate the values in those points, then plug them in the formula:

- $k = 10$, $p_k = 10^{-2} \Rightarrow \gamma = 2$
- $k = 2$, $p_k = 10^{-1} \Rightarrow \gamma = 3.321$
- $k = 50$, $p_k = 10^{-3} \Rightarrow \gamma = 1.765$

We can estimate γ to be around 2.

1.3

$\gamma = 1 + N[\sum_{i=1}^{N} \ln \frac{K_i}{K_{min} - \frac{1}{2}}] = 1.756$, $\sigma = 0.16913$ (values calculated using a Python script. See 4-1.ipynb).

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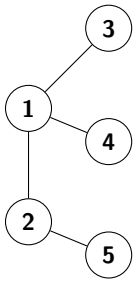
2 Configuration Model

2.1

$k = (4, 1, 1)$: One node has degree 4, yet there are only 3 nodes in total. This is impossible without forming self-loops or multiple edges.

2.2

$k = (3, 2, 1, 1, 1)$:



2.3

$k = (3, 3, 1, 1)$: Impossible. There are 4 nodes, and 2 of them have degree 3. Therefore, both of these two nodes would each have to be connected to all 3 others respectively, so the remaining two nodes must have at least degree 2, which is not the case.

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3 Network Measures of Real Graphs

3.1

largest_comps returns two different largest connected components:
Diameter of largest_component 1 = 1
Diameter of largest_component 2 = 1

3.2

Node ID = 2332, Degree = 1098

3.3

Number of triangles = 3501542

3.4

Average local clustering coefficient = 0.22099020936535468

3.5

3.6