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5/7/18
CS 491

Lab 3

Similarity

3.7.10: (a)

v_4 neighbors = $\{v_3, v_5, v_6\}$
v_5 neighbors = $\{v_3, v_4, v_6\}$
Jaccard Similarity = $|\{v_3, v_5, v_6\} \cap \{v_3, v_4, v_6\}| / |\{v_3, v_5, v_6\} \cup \{v_3, v_4, v_6\}|$
= 1/2
Cosine Similarity = $|\{v_3, v_5, v_6\} \cap \{v_3, v_4, v_6\}| / \sqrt{(|\{v_3, v_5, v_6\}| * |\{v_3, v_4, v_6\}|)}$
= 1/3

4.7.4:

A phase transition in the evolution of a random graph happens at a critical point, similar to matter in physics, at which a certain number of nodes—which have already been connected into small trees—connect together to form a significant mass of nodes in the network. Adding additional nodes to the network means that the mass of nodes grows in size.

4.7.7:

Random graphs are incapable of modeling real-world graphs because of the basic assumption required in creating them, which is that edges between nodes are formed randomly. In the real-world these relationships between nodes are complex, and are not perfectly random. This makes modeling real-world graphs with random graphs imperfect.

4.7.9:

Assuming that a normal distribution governs the probability of webpages choosing their links, then the number of pages with k in-links will decrease exponentially in k, as k grows large. Assuming that a power-law distribution instead governs the probability of webpages choosing their links, then the fraction of Web pages that have k in-links is approximately proportional to $1/k^2$.

Assortativity
8.7.2: (c)

$$
A = \begin{array}{cc|ccccc|ccccc|ccccc}
 & & \multicolumn{5}{c|}{a} & \multicolumn{5}{c|}{b} & \multicolumn{5}{c}{c} \\
 & & 0 & 1 & 2 & 3 & 4 & 0 & 1 & 2 & 3 & 4 & 0 & 1 & 2 & 3 & 4 \\
\hline
a & 0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
 & 2 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & 3 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & 4 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
\hline
b & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\
 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\
 & 2 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\
 & 3 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\
 & 4 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\
\hline
c & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\
 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 \\
 & 2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & 0 \\
 & 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 \\
 & 4 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0
\end{array}
$$

$$
d = \begin{array}{cc|c}
a & 0 & 4 \\
 & 1 & 4 \\
 & 2 & 4 \\
 & 3 & 4 \\
 & 4 & 4 \\
b & 0 & 4 \\
 & 1 & 4 \\
 & 2 & 4 \\
 & 3 & 4 \\
 & 4 & 4 \\
c & 0 & 4 \\
 & 1 & 4 \\
 & 2 & 4 \\
 & 3 & 4 \\
 & 4 & 4
\end{array}
$$

$m = 15$

<u>Modularity Matrix</u>

$B = A - dd^T/2m$

Modularity = 0.255