Networks and Complexity

Solution 5-9

This is an example solution from the forthcoming book Networks and Complexity.
Find more exercises at https://github.com/NC-Book/NCB

Ex 5.9: Shapers [3]

I play an augmented reality game, that has ca. $5 \cdot 10^5$ players worldwide. Through the game I have made many friends and I regularly meet with 20 of them in the real world. Among these friends is a group of ca. 7 people, which know each other well and meet weekly. Among the rest only two know meet each other in real life. Part of the game is to pass virtual items around that behave like physical objects, i.e. to give an item to a player the two of you must meet in the real world. Often items need to reach a specific target person. It is therefore interesting to ask how many times an item has to be handed over to reach its destination. In other words, what is average path length in the network where nodes are players and links represent physical meetings.

Solution

The first step to the solution is to estimate the clustering coefficient. Without any additional information we can only work with my personal experiences. First let's ask how many friendship links exist between my friends. We know that I have one pair of friends who meet each other, so that's one. There is also the group of 7 people, who all meet each other mutually. This gives us another $7 \cdot 6/2 = 21$ links between my friends for a total of $f = 22$. Using the reasoning from Ex. 5.6 we can estimate the clustering coefficient as

$$c = \frac{2f}{k(k-1)} \tag{1}$$

where $k = 20$ is the number of the friends I meet. This yields a clustering coefficient of $c \approx 0.12$. We can now compute $1 - c \approx 0.88$ and use this to estimate the average path length

$$D = \log_{0.88 \cdot 20}(0.88 \cdot 5 \cdot 10^5) \approx 4.5 \tag{2}$$

so we should typically be able to get an item to the target person who needs to have it within a few hops. All of this assumes of course that I am an average player (which isn't far from the truth).