GiantBook Report

Results

The following table summarises the results. It shows the average number of random connections needed before the emergence of the giant component (“Giant”), the disappearance of the last isolated individual (“Isolated”), and when the network becomes connected (“Connected”).

N	R	Giant	(stddev)	Isolated	(stddev)	Connected	(stddev)
100	100	7.07×10^1	5.74	2.56×10^2	5.88×10^1	2.57×10^2	5.78×10^1
1000	100	6.96×10^2	1.76×10^1	3.71×10^3	$5.96\ 10^2$	$3.71\ 10^3$	$5.93\ 10^2$
10000	100	6.93×10^3	5.60×10^1	4.93×10^4	5.36×10^3	4.93×10^4	5.36×10^3
100000	100	6.92×10^4	1.79×10^2	6.13×10^5	7.06×10^4	6.13×10^5	$7.06\ 10^4$
1000000	10	6.92×10^5	2.78×10^2	7.42×10^6	7.81×10^5	7.42×10^6	7.81×10^5
10000000	10	6.93×10^6	1.72×10^3	8.15×10^7	3.09×10^6	8.15×10^7	3.09×10^6

The first thing that happens is the emergence of the giant component, which happens at a time linear to N. Also, two of the events seem to happen simultaneously: non-isolated and connected, which happen at time linear to N as well.

Implementation details

The implemented union-find data type is inspired by WeightedQuickUnionUF.java
from Sedgewick andWayne: Algorihthms, 4th ed..
Four methods were added to the book’s above mentioned data type:
- maxComponentSize() which returns the biggest component’s size;
- isOneComponent(), which returns true if there’s only one big component;
- noIsolatedNodes(int p, int q) which keeps track of the non isolated nodes through a HashSet;
- noIsolated() which returns true if there are no isolated components left.

Assuming we never run out of memory or heap space, if we would let our algorithm for detecting the emergence of a giant component run for 24 hours, it could compute the answer for N = 48,930,017.
It took 1.729 seconds for one round R through a one million nodes network:
1,000,000 nodes / 1.729 seconds = 578,368 nodes per second
84,600 * 578,368 = 48,930,017 N

Discussion

We defined the giant component to have size at least αN for $\alpha = 1/2$. The choice of constant is important; choosing 1/10 or 9/10 changes the experiment completely because the average number of operations for giant component to emerge change from 52,685 to 127,834 for N = 100,000 and R = 10.