# Challenge #1: Topology Design

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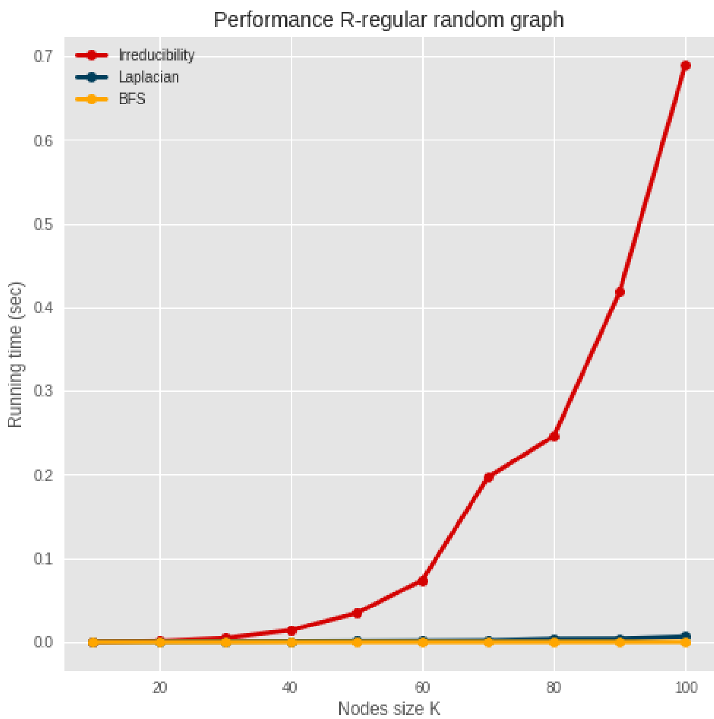
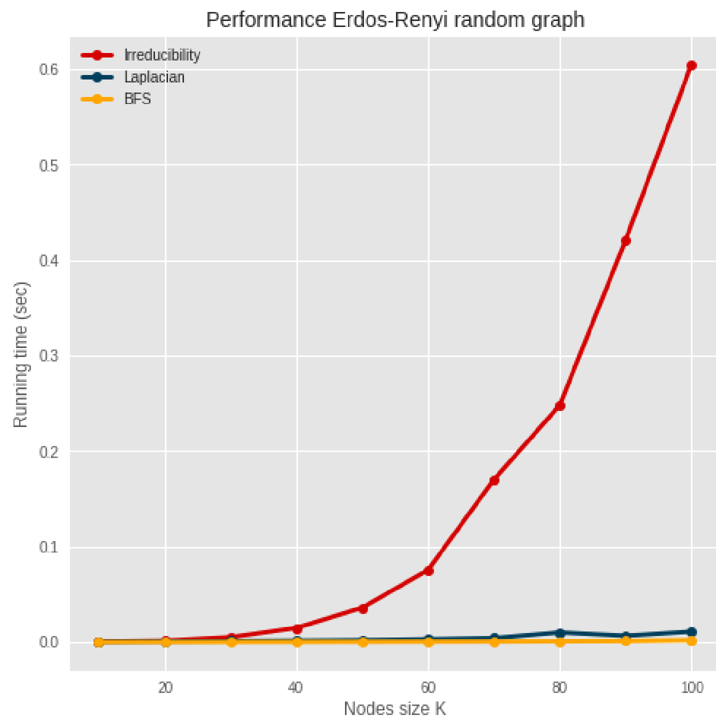
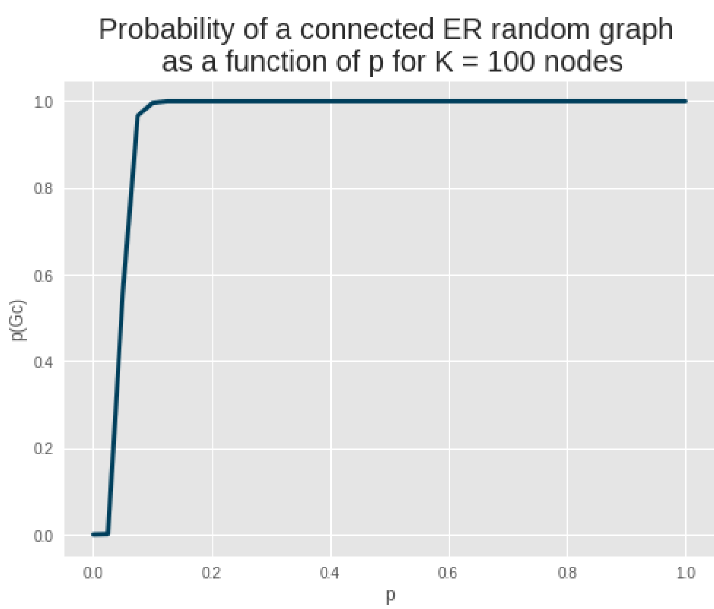
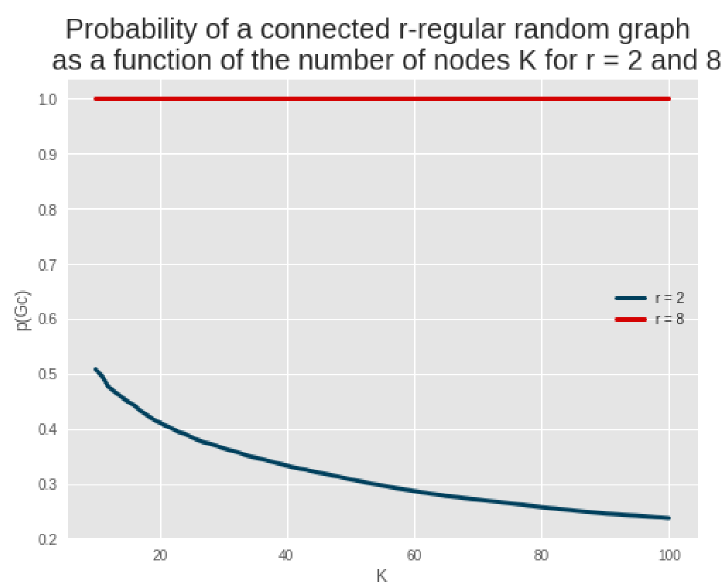
# 1 Part 1




The previous plots show the complexity with respect to the number of nodes for each of three methods used to check the connectivity of the graphs. The complexity is expressed using running time in seconds. In the first plot we consider the performance of a Erdos-Renyi graph, while in the second plot we consider the performance of a R-regular random graph. In both cases we can see that **irreducibility** method has the worst performance. Instead, the **BFS** method has the best performance like the **Laplacian** method, that has a similar trend.



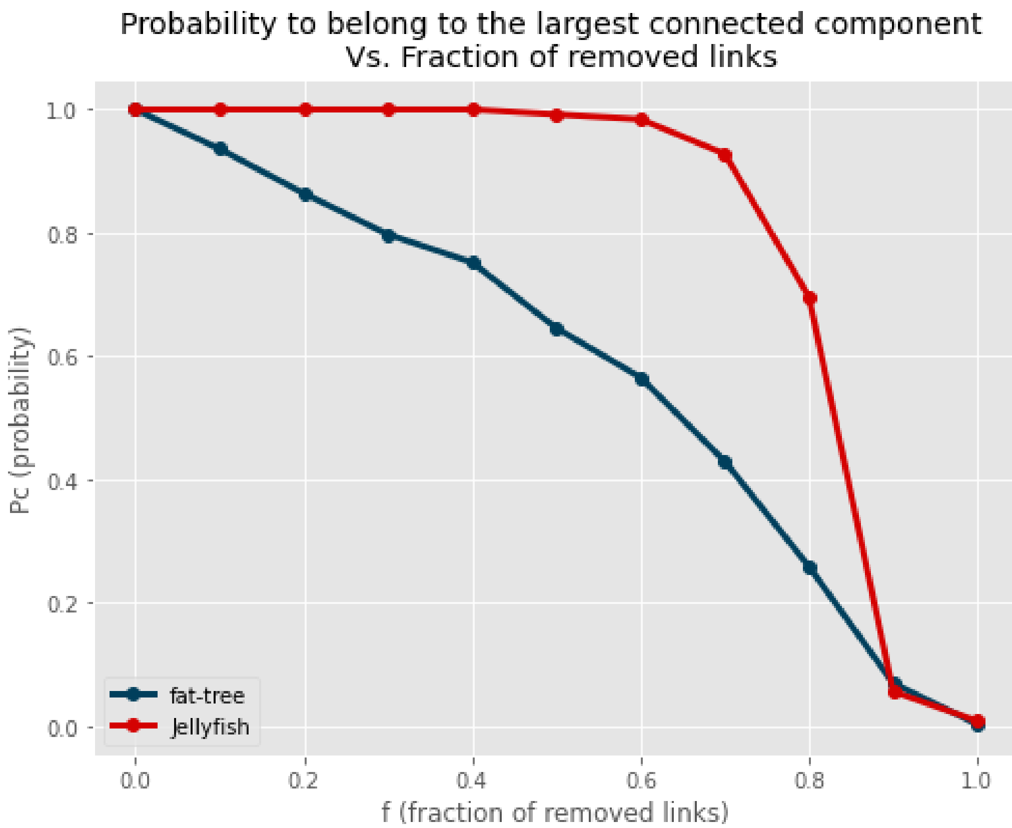




As we can observe in the first plot, if the probability that an arc is included in the graph increases, the probability to have a connected graph converges to 1. In the second plot we consider the r-regular random graph with two different values of degrees. For $r = 8$ the probability to be connected is always equal to 1 for $K \leq 100$. Instead, for $r = 2$ the probability converges to 0 as the number of nodes increases.

# 2 Part 2

In order to find $r$ as a function of $n$ so that $N$ and $S$ are the same for Jellyfish and Fat-Tree we impose that $N_{jelly} = N_{fat}$ and $S_{jelly} = S_{fat}$, where $N$ is the number of servers and $S$ is the number of switches.
We know that:
for **Fat-Tree** $N_{Fat} = \frac{n^3}{4}$ and $S_{Fat} = \frac{5n^2}{4}$
for **Jellyfish** $N_{Jelly} = S_{Jelly} \times (n - r)$
So we obtain $\frac{n^3}{4} = S_{Jelly} \times (n - r)$ and we have that $\frac{n^3}{4} = \frac{5n^2}{4} \times (n - r)$.
We solve this equation in function of $r$ and the result is: $\mathbf{r} = \mathbf{\frac{4n}{5}}$.

If we assume that $n = 10$ we have that $r = 8$ and $S = 125$.




As we can see from the plot, the probability that a generic node of the graph belongs to the largest connected component of the graph decreases as we increase the proportion of removed links, both for **Fat-Tree** and **Jellyfish**.
Hence, both topologies are highly resilient to failures but, for the same amount of resources, **Jellyfish** is more resilient; in fact the throughput of the **Fat-Tree** decreases faster than the other topology. Such random graphs as Jellyfish have higher throughput, because they have low average path lengths in comparison to symmetric topologies such as Fat-Tree.