# Activity 10 - Robustness

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The results are in the Table 1. There, $f_c$ is the relative[1] number of nodes that have to be removed from the network for it to lose its giant component. It is calculated using the Equation 1. "-" values are fields which are not appliable for the particular network.

For directed networks, the values $f_{c,in}, f_{c,out}, f_{c,directed}$ are provided. They are similar to $f_c$: $f_{c,in}, f_{c,out}$ use $\langle k_{in}^2 \rangle$ and $\langle k_{out}^2 \rangle$ instead of $\langle k^2 \rangle$, respectively; $f_{c,di}$ is calculated according to the Equation 2.

In the Equation 2, one chose to use max because one considers the network to be disconnected when both the "in" and "out" network are disconnected. Such choice doesn't matter much because, for all networks, both $f_{c,in}, f_{c,out}$ are very close.

$$f_c = 1 - \frac{1}{\frac{\langle k^2 \rangle}{\langle k \rangle} - 1} \tag{1}$$

$$f_{c,di} = \max\{f_{c,in}, f_{c,out}\} \tag{2}$$

Table 1: networks and their properties.

| network | $\langle k \rangle$ | $\langle k_{in}^2 \rangle$ | $\langle k_{out}^2 \rangle$ | $\langle k^2 \rangle$ | $f_c$ | $f_{c,in}$ | $f_{c,out}$ | $f_{c,di}$ |
|---|---|---|---|---|---|---|---|---|
| internet | 6.340 | - | - | 240.100 | 0.973 | - | - | - |
| www | 4.600 | 1546.000 | 482.400 | - | - | 0.997 | 0.990 | 0.997 |
| power grid | 2.670 | - | - | 10.300 | 0.650 | - | - | - |
| mobile phone calls | 2.510 | 12.000 | 11.700 | - | - | 0.736 | 0.727 | 0.736 |
| email | 1.810 | 94.700 | 1163.900 | - | - | 0.981 | 0.998 | 0.998 |
| science collaboration | 8.080 | - | - | 178.200 | 0.953 | - | - | - |
| actor network | 83.710 | - | - | 47353.700 | 0.998 | - | - | - |
| citation network | 10.430 | 971.500 | 198.800 | - | - | 0.989 | 0.945 | 0.989 |
| e. coli metabolism | 5.580 | 535.700 | 396.700 | - | - | 0.989 | 0.986 | 0.989 |
| portein interactions | 2.900 | - | - | 32.300 | 0.901 | - | - | - |

[1] Relative to the number of nodes of the network.