Fast percolation

Reminder

Percolation is the study of the global connection behaviour of a network when removin a certain fraction of its nodes, measured in the (relative) size of the larges connected component.

- Goal: learn a way of informed percolation which optimally disconnects a network (remove minimum amount of nodes with maximum effect)
- Useful for preventing desease spreading, or to find critical nodes in the network

Setting up a model

We attach to each node a Bernoulli random variable of failure:

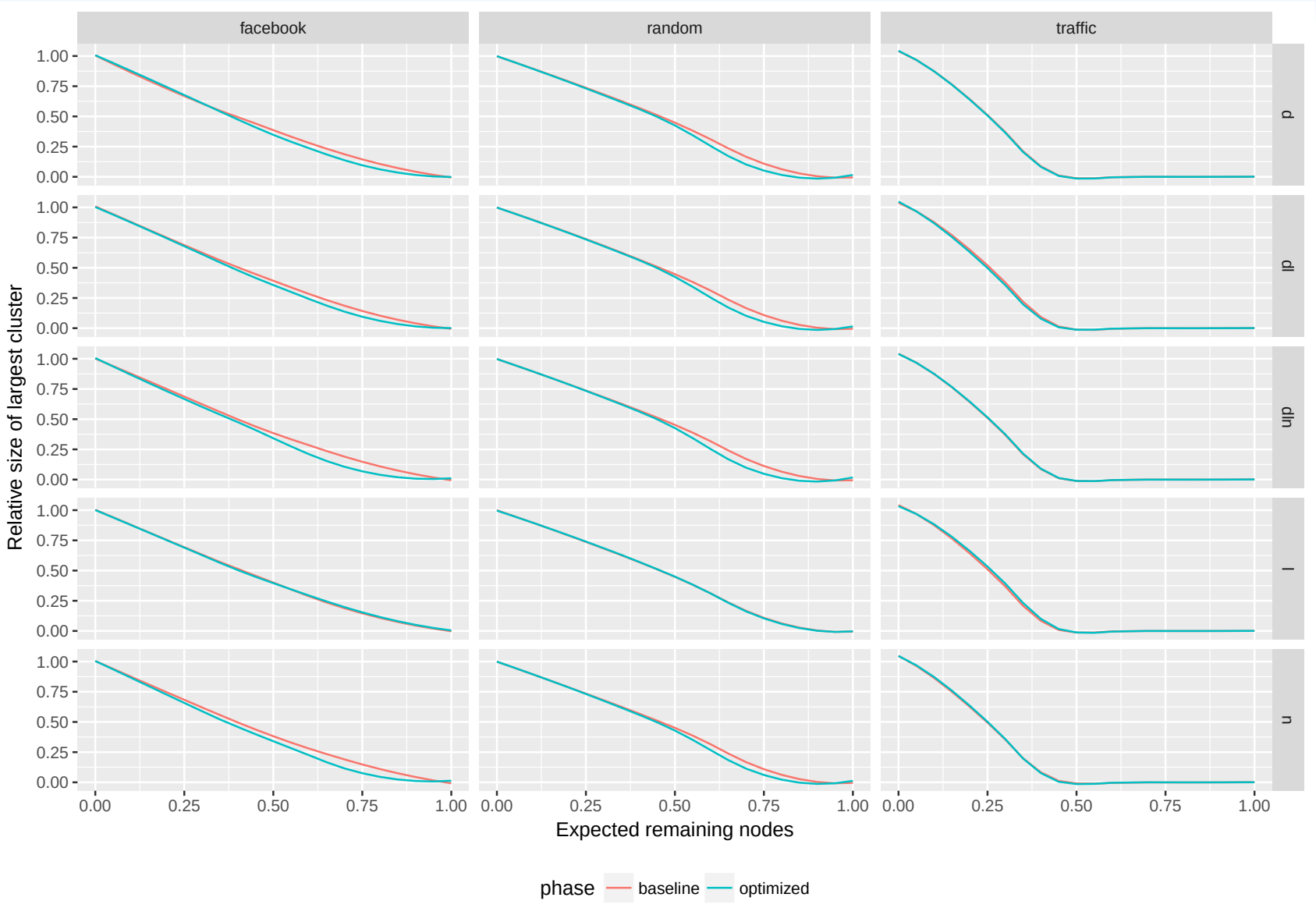
$$\hat{\mathbf{p}}_i = \sigma(\mathbf{w}^T \cdot \mathbf{info}_i)$$

$$\mathbf{Fail}_i(\varphi) \sim \text{Bernoulli}\left(\hat{\mathbf{p}}_i \frac{\varphi}{\frac{1}{n}\sum_i \hat{\mathbf{p}}_i}\right)$$

where σ is the logistic function, **info** is a vector of local information (eg., degree), and **w** the weighting of this information (a logistic model, sort of).
The value φ varies in $[0; 1]$ and describes the expected fraction of failing nodes. The individual probabilities are scaled accordingly.

- Minimize the area under the percolation curve with respect to the weights **w**
- This involves sampling the curves (several times) at each parameter evaluation
- This is expensive, so I used simulated annealing – it requires the least amount of evaluations of the loss function
- Compare some different network types:

	Facebook		Traffic		Random	
	Train	Test	Train	Test	Train	Test
Vertices	572	347	7388	13389	2000	2000
Edges	3192	2519	10591	21246	5000	5000
Density	0.0195	0.0419	0.0004	0.0002	≈ 0.0025	


facebook
random
traffic
p
dl
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n
Relative size of largest cluster
Expected remaining nodes
0.00
0.25
0.50
0.75
1.00
phase
baseline
optimized