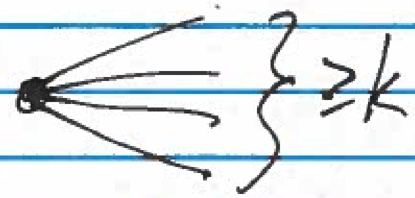
Let C be a min-cut of k edges.
Compute the probability that no edge in C is ever contracted.
A graph with n vertices and min-cut size k must have at least $kn/2$ edges.



$\geq kn$ "edge ends"
$\geq kn/2$ edges

Karger's algorithm does $n-2$ contractions, since each contraction reduces the number of vertices by 1.
Let E_i be the event that the i^{th} contraction does not contract an edge in C, for $1 \leq i \leq n-2$.

$$P(\overline{E_1}) \leq \frac{k}{kn/2} = \frac{2}{n}, \text{ so } P(E_1) \geq 1 - \frac{2}{n}$$

$$P(\overline{E_2} \mid E_1) \leq \frac{k}{k(n-1)/2} = \frac{2}{n-1}, \text{ so } P(E_2 \mid E_1) \geq 1 - \frac{2}{n-1}$$

$\vdots$

$$P(\overline{E_i} \mid E_1 \cap E_2 \cap \cdots \cap E_{i-1}) \leq \frac{k}{k(n-i+1)/2} = \frac{2}{n-i+1},$$

$$\text{so } P(E_i \mid E_1 \cap \cdots \cap E_{i-1}) \geq 1 - \frac{2}{n-i+1}$$

$$P(E_1 \cap E_2 \cap \cdots \cap E_{n-2})$$
$$= P(E_1) P(E_2 \mid E_1) P(E_3 \mid E_1 \cap E_2) \cdots P(E_{n-2} \mid E_1 \cap \cdots \cap E_{n-3})$$

$=$

$$\geq \prod_{i=1}^{n-2}\left(1-\frac{2}{n-i+1}\right) = \prod_{i=1}^{n-2} \frac{n-i-1}{n-i+1}$$

$$= \frac{\cancel{n-2}}{n}\cdot\frac{\cancel{n-3}}{n-1}\cdot\frac{\cancel{n-4}}{\cancel{n-2}}\cdot\frac{\cancel{n-5}}{\cancel{n-3}}\cdots\frac{\cancel{3}}{\cancel{5}}\cdot\frac{2}{\cancel{4}}\cdot\frac{1}{\cancel{3}}$$

$$= \frac{2}{n(n-1)} > \frac{2}{n^2}$$

so the probability of error is $< 1 - \frac{2}{n^2}$

Run Karger's algorithm $\frac{tn^2}{2}$ times, where t is a parameter to be decided, each time using independent choices of the contracted edges. At the end, output the smallest of these $tn^2/2$ cuts.

The probability that C is not output in any of these $tn^2/2$ iterations is

$$\left(1-\frac{2}{n^2}\right)^{tn^2/2} \leq \left(\frac{1}{e}\right)^t$$

When $t = 14$, this is $< 10^{-6}$

This is simpler than the most efficient deterministic algorithm based on network flow.