Hypergeometric

Let R be created by sampling n_1 points from X and n_2 points from X. For the Forbes measure we then get:

$$\begin{aligned}
|R| &= n_1 + n_2 \\
FDR &= n_2/(n_1 + n_2) \\
|R \cap Q| &\sim HG(|X|, |X \cap Q|, n_1) + HG(\left|\bar{X}\right|, \left|\bar{X} \cap Q\right|, n_2) \\
E(\frac{|R \cap Q|}{|R|\,|Q|}) &= \frac{n_1 \, |X \cap Q| \,/\, |X| + n_2 \left|\bar{X} \cap Q\right| / \left|\bar{X}\right|}{|Q|\,(n_1 + n_2)} \\
&= (1 - FDR)\frac{|X \cap Q|}{|X|\,|Q|} + FDR\frac{\left|\bar{X} \cap Q\right|}{\left|\bar{X}\right|\,|Q|}
\end{aligned}$$

I.e: the expected Forbes measure for R and Q is a weighted linear combination of the forbes similarity between X and Q and $\bar{X}$ and Q. But independent of the size of R.

For Jaccard we get:

$$\begin{aligned}
|R \cap Q| &\sim HG(|X|, |X \cap Q|, n_1) + HG(\left|\bar{X}\right|, \left|\bar{X} \cap Q\right|, n_2) \\
E(|R \cap Q|) &= HG(|X|, |X \cap Q|, n_1) + HG(\left|\bar{X}\right|, \left|\bar{X} \cap Q\right|, n_2) \\
\frac{|R \cap Q|}{|R \cup Q|} &= \frac{|Q| + |R| - |Q \cup R|}{|Q \cup R|} \\
\frac{|R \cap Q|}{|R \cup Q|} &\sim \frac{|R \cap Q|}{|Q| + |R| - |R \cap Q|}
\end{aligned}$$

Notes

$$\begin{aligned}
f(x) &= (x)/(N - x) \\
f'(x) &= ((N - x) + x)/(N - x)^2 \\
f'(x) &= ((N)/(N - x)^2
\end{aligned}$$