n pairs, let weights be 0.8, 0.1, 0.1

$$\Rightarrow p\left((N_{true}, M_{true}, m_{true}), \text{data} \right) =$$

$$= \left| \frac{1}{n} \sum_{i=1}^{n} \left(0.8 (U_{0i} - 0.5) + 0.1 (U_{1i} - 0.5) + 0.1 (U_{2i} - 0.5) \right) \right|$$

where $U_{ij} \overset{iid}{\sim} \text{Unif}[0,1]$

$$= \left| 0.8 * \left[\frac{1}{n} \sum_{i=1}^{n} U_{0i} - 0.5 \right] + 0.1 * \left[\frac{1}{n} \sum_{i=1}^{n} U_{1i} - 0.5 \right] + 0.1 * \left[\frac{1}{n} \sum_{i=1}^{n} U_{2i} - 0.5 \right] \right|$$

$$= \left| 0.8 * N\left(\frac{1}{2}, \sigma^2 = \frac{1/12}{n} \right) + 0.1 * N\left(\frac{1}{2}, \sigma^2 = \frac{1/12}{n} \right) + 0.1 * N\left(\frac{1}{2}, \sigma^2 = \frac{1/12}{n} \right) - 0.5 \right| =$$

$$= \left| N\left(\frac{1}{2},\ \sigma^2 = (0.64 + 0.01 + 0.01)\ \frac{1/12}{n} \right) - 0.5 \right|$$

$$= \left| N\left(\mu = \frac{1}{2},\ \sigma^2 = 0.66 * \frac{1/12}{n} \right) - 0.5 \right|$$

$H_0 ::= (N_{est}, M_{est}, m_{est})$ are the true parameters

$$\mathbb{P}(P_{theoretical} > P_{obs} \mid H_0) =$$

$$= \mathbb{P}\left(\left| \sqrt{\frac{0.66}{12 * n}} \cdot Z \right| > P_{obs} \right)$$

$Z \sim N(0,1)$

$$= \mathbb{P}\left(Z > \sqrt{\frac{12 * n}{0.66}}\ P_{obs} \right) + \mathbb{P}\left(Z < -\sqrt{\frac{12 * n}{0.66}}\ P_{obs} \right)$$

$$= 2 * \left(1 - \Phi\left(\sqrt{\frac{12 * n}{0.66}}\ P_{obs} \right) \right)$$

When $n = 100$ (i.e. my case):

P_value for $(N = 1000, M = 1000, m = 0.1)$ = 0.39

P_value for $(N = 1000, M = 1000, m = 0.3)$ = 0.0028