$$\mathbf{P}(H) =: P_{n,m}$$

$$\mathbf{P}(H \mid A) = P_{n-1,m} \qquad \mathbf{P}(H \mid A^c) = P_{n,m-1}$$

$$\mathbf{P}(A) = \frac{\binom{n+m-1}{m}}{\binom{n}{m}} = \frac{n}{n+m} \qquad \mathbf{P}(A^c) = 1 - \mathbf{P}(A) = \frac{m}{n+m}$$

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$$\mathbf{P}(H) = \mathbf{P}(H \mid A)\,\mathbf{P}(A) + \mathbf{P}(H \mid A^c)\,\mathbf{P}(A^c)$$

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A recurrence: $$P_{n,m} = \mathbf{P}(H) = \mathbf{P}(H \mid A)\,\mathbf{P}(A) + \mathbf{P}(H \mid A^{c})\,\mathbf{P}(A^{c}) = P_{n-1,m}\frac{n}{n+m} + P_{n,m-1}\frac{m}{n+m} \qquad (1 \le m < n)$$

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Boundary conditions:

$$\mathbf{P}(H) =: P_{n,m}$$

$$\mathbf{P}(H \mid A) = P_{n-1,m} \qquad \mathbf{P}(H \mid A^\complement) = P_{n,m-1}$$

$$\mathbf{P}(A) = \frac{\binom{n+m-1}{m}}{\binom{n}{m}} = \frac{n}{n+m} \qquad \mathbf{P}(A^\complement) = 1 - \mathbf{P}(A) = \frac{m}{n+m}$$

A recurrence: $$P_{n,m} = \mathbf{P}(H) = \mathbf{P}(H \mid A)\,\mathbf{P}(A) + \mathbf{P}(H \mid A^\complement)\,\mathbf{P}(A^\complement) = P_{n-1,m}\frac{n}{n+m} + P_{n,m-1}\frac{m}{n+m} \qquad (1 \le m < n)$$

Boundary conditions: $$P_{n,m} = \begin{cases} 0 & \text{if } m \ge n, \\ 1 & \text{if } 0 = m < n. \end{cases}$$