Note that \( d + e = 1 \) and thus, \( \gamma \) satisfies the following equation

\[
\sum_{j=1}^{4} p_{(j)} = \frac{n_{(1)}}{\gamma} + \frac{n_{(2)}}{2\lambda d + \gamma} + \frac{n_{(3)} + n_{(4)}}{2\lambda + \gamma} = 1.
\]

We can solve for \( \gamma \) by taking the real roots of the cubic equation

\[
\gamma^3 + A \gamma^2 + B \gamma + C = 0,
\]

where \( A = 2\lambda (1 + d) - N \), \( B = 2\lambda \times [-n_{(1)} - n_{(2)} - d (N - n_{(3)}) + 2\lambda d] \) and \( C = -4\lambda^2 n_{(1)} d \).

To solve for \( \gamma \), take the sum of the positive roots for each \( \hat{p}_{(j)} \).