1. $a > b > 0$, both a and b are barely above 0.
2. Underflow would cause both to be rounded to 0.
3. Want to calculate $\log(a+b)$ from $\log(a)$ and $\log(b)$.

$$
\begin{aligned}
a+b &= e^{\log(a)} + e^{\log(b)} = 1 \times \left(e^{\log(a)} + e^{\log(b)}\right) \\
&= e^{\log(a)-\log(a)}\left(e^{\log(a)} + e^{\log(b)}\right) = e^{\log(a)}e^{-\log(a)}\left(e^{\log(a)} + e^{\log(b)}\right) \\
&= e^{\log(a)}\left(e^{\log(a)-\log(a)} + e^{\log(b)-\log(a)}\right)
\end{aligned}
$$

Because of above and because log of product is sum of logs,

$$
\begin{aligned}
\log(a+b) &= \log(e^{\log(a)}) + \log(e^{\log(a)-\log(a)} + e^{\log(b)-\log(a)}) \\
\log(a+b) &= \log(a) + \log(e^{\log(a)-\log(a)} + e^{\log(b)-\log(a)})
\end{aligned}
$$

Assume $\Pr\left(x^i, y_i = 0\right) = e^{-1000}$ and $\Pr\left(x^i, y_i = 1\right) = e^{-11000}$.

$m_i =$ maximum of e^{-1000} and $e^{-11000} \; = e^{-1000}$

$\log(m_i) = -1000$

Assume $x_{i+1} = G$, $p_{G0} = 0.4$, and $p_{G1} = 0.7$.

Assume $\rho_{00} = 0.8$ ($\rho_{01} =?$).
Assume $\rho_{10} = 0.1$ ($\rho_{11} =?$).

$$\begin{aligned} log(\Pr\left(x^{i+1}, y_{i+1}\right)) &= log(m_i) + log(\sum_{y_i} exp(-log(m_i) + \\ &\quad log(\Pr\left(x^i, y_i\right)) + log(p_{x_{i+1}y_{i+1}}\rho_{y_i y_{i+1}}))) \end{aligned}$$

$$\log(\Pr\left(x^{i+1}, y_{i+1} = 0\right)) = \log(m_i) +$$

$$\log(\exp(-\log(m_i) + \log(\Pr\left(x^i, y_i = 0\right)) + \log(p_{G0}\rho_{00})) + \exp(-\log(m_i) + \log(\Pr\left(x^i, y_i = 1\right)) + \log(p_{G0}\rho_{10})))$$

$$= -1000 + \log(\exp(1000 - 1000 + \log(0.4 \times 0.8)) + \exp(1000 - 11000 + \log(0.4 \times 0.1)))$$

$$= -1000 + \log((0.4 \times 0.8) + (e^{-10000} \times 0.4 \times 0.1))$$