$$V_t = e^{-r(T-t)} E_t^Q [\Phi(S(T)) \mid S(t) = S]$$

$$\Phi(S_T) = 1_{S_T \geq K}$$

$$\Rightarrow \quad E_t^Q [\Phi(S(T)) \mid S(t) = S]$$

$$= E_t^Q [1_{S_T \geq K} \mid S(t) = S]$$

$$S_T = S \cdot \exp\left((r - \tfrac{\sigma^2}{2})t + \sigma W_t^Q\right)$$

$$S_T \geq K$$

$$\Rightarrow \quad S \exp\left((r - \tfrac{\sigma^2}{2})t + \sigma W_t^Q\right) \geq K$$

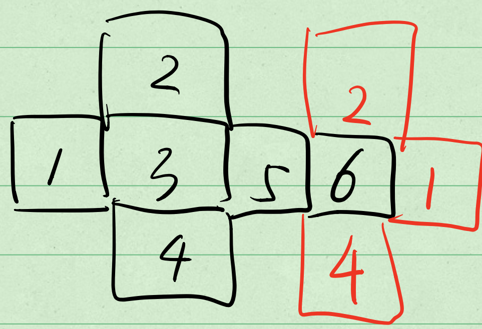
$$\Rightarrow \quad (r - \tfrac{\sigma^2}{2})t + \sigma W_t^Q \geq \ln(K/S)$$

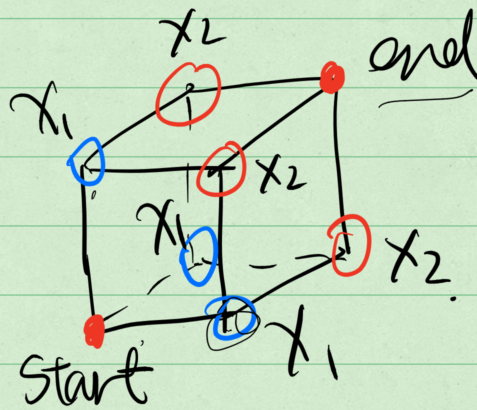
$$\Rightarrow \quad W_t^Q \geq \frac{1}{\sigma}\left[\ln(K/S) - (r - \sigma^2/2)t\right] \overset{\text{def}}{=} A$$

$$E_t^Q [1_{S_T \geq K} \mid S(t) = S]$$

$$= 1 - \varphi(A)$$

$$\Rightarrow V_t = e^{-r(T-t)} \cdot \left[1 - \varphi\left(\frac{1}{\sigma}(\ln(K/S) - (r - \sigma^2/2)t)\right)\right]$$





$$
\begin{cases}
E[Blue] = \frac{2}{3} E[Red] + \frac{1}{3} \cancel{E[Start]} + 1 \\
E[Red] = \frac{2}{3} E[Blue] + \frac{1}{3} E[end] + 1 \\
\cancel{E[Start] = E[Blue] + 1} \\
E[end] = E[Red] + 1
\end{cases}
$$

$$
3B = 2R + (B+1) + 3
$$

1 $3R = 2B + (R+1) + 3$

$$\begin{cases} 2B = 2R + 4 \\ 2R = 2B + 4 \end{cases} \qquad \begin{cases} B = R + 2 \\ R = B + 2 \end{cases}$$

$B = \frac{2}{3}R + 1$

$R = \frac{2}{3}B + \frac{1}{3}E + 1 \Rightarrow$

$E = R + 1$

$$\begin{cases} 3B = 2R + 3 \\ 2R = 2B + 4 \end{cases}$$

$3B = 2B + 7$

$B = 7$

$R = 9$

$E = 10$.