Problem 2 (a)

N = 4 : H H A A

$$\mathbb{P}(N=4) = \underbrace{p_H^2 p_A^2}_{\text{east1 wins 4 games}} + \underbrace{(1-p_H)^2(1-p_A)^2}_{\text{east8 wins 4 games}}$$

N = 5 : H H A A H

$$\mathbb{P}(N=5) = \underbrace{\binom{2}{1}(1-p_H)p_H^2 p_A^2}_{\text{east1 loses 1 Home}} + \underbrace{\binom{2}{1}(1-p_A)p_H^3 p_A}_{\text{east1 loses 1 Away}} + \underbrace{\binom{2}{1}p_H(1-p_H)^2(1-p_A)^2}_{\text{east8 loses 1 Home}} + \underbrace{\binom{2}{1}p_A(1-p_H)^3(1-p_A)}_{\text{east8 loses 1 Away}}$$

N = 6 : H H A A H A

$$\mathbb{P}(N=6) = \underbrace{\binom{3}{2}(1-p_H)^2 p_H p_A^3}_{\text{east1 loses 2 Home}} + \underbrace{(1-p_A)^2 p_H^3 p_A}_{\text{east1 loses 2 Away}} + \underbrace{\binom{3}{1}\binom{2}{1}(1-p_H)(1-p_A)p_H^2 p_A^2}_{\text{east1 loses 1 Home 1 Away}} + \underbrace{\binom{3}{2}p_H^2(1-p_H)(1-p_A)^3}_{\text{east8 loses 2 Home}} + \underbrace{p_A^2(1-p_H)^3(1-p_A)}_{\text{east8 loses 2 Away}} + \underbrace{\binom{3}{1}\binom{2}{1}p_H p_A(1-p_H)^2(1-p_A)^2}_{\text{east8 loses 1 Home 1 Away}}$$

N = 7 : H H A A H A H

$$\mathbb{P}(N=7) = \underbrace{(1-p_H)^3 p_H p_A^3}_{\text{east1 loses 3 Home}} + \underbrace{(1-p_A)^3 p_H^4}_{\text{east1 loses 3 Away}} + \underbrace{\binom{3}{1}\binom{3}{1}(1-p_H)^2(1-p_A)p_H^2 p_A^2}_{\text{east1 loses 2 Home 1 Away}} + \underbrace{\binom{3}{1}\binom{3}{1}(1-p_H)(1-p_A)^2 p_H^3 p_A}_{\text{east1 loses 1 Home 2 Away}} + \underbrace{p_H^3(1-p_H)(1-p_A)^3}_{\text{east8 loses 3 Home}} + \underbrace{p_A^3(1-p_H)^4}_{\text{east8 loses 3 Away}} + \underbrace{\binom{3}{1}\binom{3}{1}p_H^2 p_A(1-p_H)^2(1-p_A)^2}_{\text{east8 loses 2 Home 1 Away}} + \underbrace{\binom{3}{1}\binom{3}{1}p_H p_A^2(1-p_H)^3(1-p_A)}_{\text{east8 loses 1 Home 2 Away}}$$