LESSON 5: BIONOMIAL DISTRIBUTION

Q. 2 coin flips

\# HEADS = # TAILS

? $\boxed{2}$

H	H
H	T
T	H
T	T

Q 4 coins flips

\# HEADS = # TAILS

? $\boxed{6}$

H	H	H	H
H	H	H	T
H	H	T	H
H	H	T	T
H	T	H	H
H	T	H	T
H	T	T	H
H	T	T	T
T	H	H	H
T	H	H	T
T	H	T	H
T	H	T	T
T	T	H	H
T	T	H	T
T	T	T	H
T	T	T	T

→ 6

Date...............

Q. 5 coin flips

#HEADS = #TAILS

? $\boxed{0}$

→ Answer is 0 because if we use odd no. of coins then one must be larger than the other.

Q. 5 coin flip

Exactly 1 H → $\boxed{5}$

Q. 5 coin flips

Exactly 2 H → $\boxed{10}$

$\frac{5 \cdot 4}{2} = 10$

Q. 5 coin flips 3 H → $\boxed{10}$

$\frac{5 \cdot 4 \cdot 3}{3 \cdot 2 \cdot 1} = 10$

Q. 10 coin flips 4H → $\boxed{210}$

$\frac{10 \cdot 9 \cdot 8 \cdot 7}{4 \cdot 3 \cdot 2 \cdot 1} = 210$

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Q. 10 coinflips 5 HEADS → $\boxed{252}$

$$\frac{\cancel{10}^{2}.9.\cancel{8}.7.\cancel{6}^{2}}{\cancel{5}.\cancel{4}.\cancel{3}.\cancel{2}.1} = \cancel{28} \times 9 = \cancel{3028}\ 252$$

Binomial Distribution formula

$$= \frac{n!}{k!\,(n-k)!}$$

Q 125 coins 3 HEADS → $\boxed{317,750}$

$$\frac{125 \times 124 \times 123}{3 \times 2 \times 1} = 317,750$$

2. Coin flips :-

Probabilities

$P(HEADS) = 0.5$

Q. FLIP coins 5 times

$P(\# HEADS) = 1$

$\boxed{0.15625}$

$5 \times 4 \times 3 \times 2 \times 1$ 120×0.5

60.0

$$\frac{5!}{1!\,4!} = 5 \quad 2^5 = 32 \quad = \frac{5}{32} = 0.15625$$

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Q. Flip coin 5 times $P(\# HEADS) = 3 \Rightarrow \boxed{0.3125}$

$\frac{5!}{3! \times 2!} = 10 \Rightarrow \frac{10}{32} = 0.3125$

2. Loaded coins

Q. Flip coin 3 times $P(H) = 0.8$

$P(\# HEADS = 1)$ $P(T) = 0.2$

$\downarrow$

$\boxed{0.096}$

H H H

H H T

H T H

H T T $0.8 \times 0.2 \times 0.2 = 0.032$

T H H

T H T $0.2 \times 0.8 \times 0.2$ $= 0.096$

T T H $0.2 \times 0.2 \times 0.8$

T T T

Q. Flip coin 5 times $P(H) = 0.8$

$P(\# HEADS = 4) \Rightarrow \boxed{0.4096}$

$\frac{5!}{4!\,1!} = 5 \quad (0.8)^4 \cdot (0.2)^1$

$5 \cdot (0.8)^4 \cdot (0.2)^1 = \boxed{0.4096}$

Q. Flip coin 5 times $P(H) = 0.8$

$P(\# HEADS) = 3$

$\frac{5!}{3!\,2!} = 10 \quad 10 \cdot (0.8)^3 \cdot (0.2)^2 = \boxed{0.2048}$

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Q. Flip coin 12 times $\quad P(H) = 0.8$

$P(\# \text{HEADS} = 9) \Rightarrow \boxed{0.236}$

$$\frac{12!}{9!\,3!} = \frac{\cancel{12} \times 11 \times 10}{\cancel{3 \times 2}} = 220$$

$$220 \cdot (0.8)^9 \cdot (0.2)^3 = \boxed{0.236}$$

7. Summary

1. The Binomial Distribution helps us determine the probability of a string of independent "coin flip like events".

$$P(X = x) = \frac{n!}{x!\,(n-x)!} \times p^x (1-p)^{n-x}$$

$n \rightarrow$ number of events.

$x \rightarrow$ number of successes.

$p \rightarrow$ probability of success.

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