Probability Distributions

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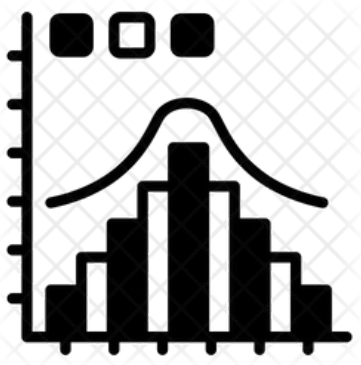

Binomial Distribution

- Binomial experiment, which has the following properties:
  - Fixed number of n trials.
  - Each trial is an independent event.
  - Only two outcomes are possible (Success and Failure).
  - Probability of success (p) for each trial is constant.
  - A random variable Y= the number of successes.

Multinomial Distribution

- A multinomial experiment is almost identical with one main difference: a binomial experiment can have two outcomes, while a multinomial experiment can have multiple outcomes.
- Example: You roll a die ten times to see what number you roll. There are 6 possibilities (1, 2, 3, 4, 5, 6), so this is a multinomial experiment.
- If you rolled the die ten times to see how many times you roll a three, that would be a binomial experiment (3 = success, 1, 2, 4, 5, 6 = failure).
- A binomial experiment will have a binomial distribution. A multinomial experiment will have a multinomial distribution.

Multinomial Distribution

- Three card players play a series of matches. The probability that player A will win any game is 20%, the probability that player B will win is 30%, and the probability player C will win is 50%.
- If they play 6 games, what is the probability that player A will win 1 game, player B will win 2 games, and player C will win 3?
- Use the following formula to calculate the odds

Multinomial Distribution

$$P = \frac{n!}{(n_1!)(n_2!)\ldots(n_x!)} P_1^{n1} P_2^{n2} \ldots P_x^{nx}$$

- where:

  n = number of events

  n1 = number of outcomes, event 1

  n2 = number of outcomes, event 2

  n3 = number of outcomes, event x

  p1 = probability event 1 happens

  p2 = probability event 2 happens

  px = probability event x happens

Example:

- Using the data from the question, we get:

  n = 12 (6 games total).

  n1 = 1 (Player A wins).

  n2 = 2 (Player B wins).

  n3 = 3 (Player C wins).

  p1 = 0.20 (probability that Player A wins).

  p2 = 0.30 (probability that Player B wins).

  p3 = 0.50 (probability that Player C wins).

$$\Pr(A = 1, B = 2, C = 3) = \frac{6!}{1!2!3!}(0.2^1)(0.3^2)(0.5^3) = 0.135$$

Example:

- We want to determine what is the probability that, after 12 games, player 1 will have 7 wins, player 2 will have 2 wins and the remaining games will finish in draw.
- For that, suppose that the probability that Player 1 wins is 0.4, Player 2 is 0.35 and the tie has probability 0.25

Variable	Value
n	12
x1	7
x2	2
x3	3
p1	0.4
p2	0.35
p3	0.25

Example:

- Replacing that in the formula shown above:

$$p(X = k) = \frac{12!}{7!2!3!}0.4^7 \cdot 0.35^2 \cdot 0.25^3 = 0.0248$$

- Therefore, the probability of this specific outcome in this chess tournament is approximately 2.5%.

Thank you

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