

Probability Distributions

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Definitions

- **Random Variable:** a variable that has a single numerical value that is determined by the chance of an outcome of an experiment.
- **Probability Distribution:** A table, graph, or formula that shows all the possible outcomes and their probabilities.

Probability Distribution Example

500 tickets are sold for a raffle at \$10 each. There will be one \$1000 grand prize and two \$200 other prizes given. Write down the probability distribution table.

Discrete vs. Continuous

- **Discrete:** A random variable is discrete if it has a finite number of outcomes or a countable number of outcomes.
- **Continuous:** A variable is continuous if it is not discrete.

Two Requirements

Let x be a discrete random variable. Then

1. $\sum P(x) = 1$

2. $0 \leq P(x) \leq 1$

Expected Value

- Expected Value: $\mu = \sum xP(x)$

If the experiment is run many many times, then it is very likely that the average value of x will be very close to the expected value.

Example of Expected Value

- A coin toss where **0** represents landing heads and **1** represents landing tails has expected value **0.5**. If I flip a coin many many times then the average outcome is likely to be **0.5** (half heads and half tails).

Standard Deviation

Standard Deviation: $\sigma = \sqrt{\sum (x - \mu)^2 P(x)}$

The standard deviation measures an average distance from the mean if the experiment is run many many times.

Insurance

- The insurance bet in 21 involves placing a bet, say **\$10**. If the dealer has a 10, Jack, Queen, or King, the dealer pays the player **\$20**. If not the dealer takes the **\$10**.
 - Suppose you have a 10 and a King and the dealer has an Ace showing. Should you buy insurance?
 - Suppose you have a 3 and a 7 and your friend has an 8 and an Ace and the dealer has an Ace showing. Should you buy insurance?

Example

- Find and interpret the expected value and standard deviation for the random variable that represents the outcome of tossing a six-sided die.

1-Var Stats(L1,L2)

Example

- Find the expected value and standard deviation for the raffle example:

500 tickets are sold for a raffle at \$10 each. There will be one \$1000 grand prize and two \$200 other prizes given. Write down the probability distribution table.

Example

- A contractor has figured that bidding on a contract costs her \$700. There is a 5% chance that she will win the contract and make a \$10000 profit on the project and there is a 1% chance that she will win and establish a long term working relationship with the client resulting in a total of \$100,000 profit. Find and interpret the expected value and standard deviation.

Definition of Binomial Distribution

Binomial Distribution: The distribution of the result of an experiment with

- A fixed number of trials, n
- The trials are independent
- Each trial results in success or failure
- The probability of success, p , is the same for each trial.

Binomial Distribution Example

- Suppose 22% of the population is angry about the economy. If 20 randomly selected people are surveyed, what is the probability that the number who are angry about the economy is
 - Exactly 5 are angry?
 - Exactly 6 are angry?
 - At most 4 are angry?

2nd VARS (DISTR):

A: $P(=x)$

`binompdf(n,p,x)`

B: $P(\leq x)$

`binomcdf(n,p,x)`

Binomial Distribution Example

Two percent of the world population has Down's Syndrome. If 300 randomly selected people are surveyed, what is the probability that the number who have Down's Syndrome is

- Exactly 6?
- Less than 5?
- At least 7?

2nd VARS (DISTR):

A: $P(=x)$

$\text{binompdf}(n,p,x)$

B: $P(\leq x)$

$\text{binomcdf}(n,p,x)$

Binomial Distribution Statistical Significance

47% of all high school students have had sex. Greenville High has a new sex ed. program. It reports that of the 50 students surveyed only 20 had sex.

Find the probability that 20 or fewer out of 50 students selected from all high schools have had sex. Is this statistically significant?

2nd VARS (DISTR):

A: $P(=x)$

$\text{binompdf}(n,p,x)$

B: $P(\leq x)$

$\text{binomcdf}(n,p,x)$

Binomial Distribution Statistical Significance

37% of California residents are Hispanic. A company with 25 workers employs only 6 Hispanics. Is this statistically significant? Hint: Find the probability of employing 6 or fewer out of 25.

2nd VARS (DISTR):

A: $P(=x)$

$\text{binompdf}(n,p,x)$

B: $P(\leq x)$

$\text{binomcdf}(n,p,x)$

Binomial Distribution Statistical Significance

Only 42% of CCC algebra students pass. Of the 65 LTCC algebra students, 38 of them passed. Is this statistically significant? Hint: Find the probability that at least 38 of 65 CCC students will pass.

2nd VARS (DISTR):

A: $P(=x)$

$\text{binompdf}(n,p,x)$

B: $P(\leq x)$

$\text{binomcdf}(n,p,x)$