Types of Discrete Random Variables

Discrete Random Variables

Random variable-variable whose numeric value is determined by the outcome of a random experiment
Discrete random variables-random variable which has a countable number of possible outcomes
Continuous random variable-random variable that can assume any value on a continuous segment(s) of the real number line
Probability distribution- model which describes a specific kind of random process

Expected value

$$E(X) = \mu = \sum [x_i * P(X = x_i)]$$

x = data value
P(X=x_i) = probability when equal to the value of x

Variance of a discrete random variable

$$\sigma^2 = \sum [{x_i}^2 * P(x = x_i)] - \mu^2$$

x = data value
P(x=x_i) = probability when equal to the value of x
μ= mean

Standard deviation of a discrete random variable

$$\sigma = \sqrt{\sum [{x_i}^2 * P(x = x_i)] - \mu^2}$$

x = data value
P(x=x_i) = probability when equal to the value of x
μ= mean

Variance- weighted average of the squared deviations about the mean

Binomial

Binomial distribution-arises from experiments in which there is a fixed number of repeated trials, having only two outcomes and one of the outcomes is counted
Binomial experiment-is a random experiment which satisfies all the following conditions:
1. There are only 2 outcomes on each trial of the experiment. One of the outcomes is usually referred to as a success, and the other as a failure
2. The experiment consists of n identical trials as describes earlier
3. He probability of success on any one trial is denoted by p and does not change from trial to trial. Note that the probability of a failure is 1-p and also does not change from trial to trial
4. Trials are independent
5. The binomial random variable is the count of the number of successes in n trials

Probability for the binomial distributions

$$P(X = x|n,p) = {}_nC_x\, p^x (1-p)^{n-x}$$

n = number of trials
x = number of success in trial
p = probability of success

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Excel: =binomdist(x, n,σ,1 or 0)
True(1) = when x ≤?
False (0) = when x = ?

Example:
Want probability x > 5 n=200 p=.02
=1-binomdist(5,200,0.02,1)

Want probability x =3 n=200 p=0.2
=binomdist(3,200,0.2,0)

Expected value (mean): of a binomial random variable
E(X) = μ = n*p

Variance of binomial random variable
$\sigma^2 = np(1-p)$

Standard deviation of binomial random variable
$\sigma = \sqrt{np(1-p)}$

Poisson

Poisson distribution- similar to binomial except does not have fixed number of trials, but uses a fixed interval of time or space where number of "successes" are recorded
1. "Successes" occur one at a time
2. The occurrence of a "success" in any interval is independent of the occurrence of a "success" in any order interval

$$P(X) = \frac{\lambda^X e^{-\lambda}}{X!} \text{ for } X = 0,1,2,3,...$$

where:

$\lambda = long - run\ average$

$e = 2.718282...$ (the base of natural logarithms)

$\lambda = mean$

Var(x) = λt = E(x)

Excel: = poisson (x, λt, 0 or 1)
True(1) = when x ≤?
False (0) = when x = ?

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Example:
Want probability that x ≥5, λ=2 t=2
= 1-poisson(4,4,1)

Want probability x < 3 λ=2 t=2
=poisson(2,4,1)

Hypergeometric

Hypergeometric-a random experiment which satisfies all of the following conditions:
1. Only 2 outcomes in each trial, success and failure
2. N identical trials
3. Trials are dependent
4. Populations are finite in which the total number of successes and failures are known

Like binomial but without replacement

$$P(x) = \frac{\left(C_x^X\right)\left(C_{n-x}^{N-X}\right)}{C_n^N}$$

$$\mu = \frac{X \cdot n}{N}$$

$$\sigma^2 = \frac{X(N-X)n(N-n)}{N^2(N-1)}$$

$$\sigma = \sqrt{\sigma^2}$$

Excel:
=hypgeomdist (number of successes in sample, number in sample, number of successes in population, number of population)

Example:
8 black balls, 9 red balls
What is the probability that when you draw 7 balls from the urn, you draw 4 black balls (without replacement)?
=hpygeomdist(4,8,7,17)

10 black balls, 7 red balls
What is the probability that when you draw 4 balls from the urn, you draw no more than 1 black balls?
=hypgeomdist(1,10,4,17) + hypgeomdist(0,10,4,17)

Games of Chance

Find the probability of winning * how much you would win
Find the probability of losing * how much you would lose

Then (probability of winning*how much would win) – (probability of losing*how much would lose)