# Lab 4: Functions of Random Variables (Chapter 3)

## Objectives

* Calculate the mean and variance of functions of random variables
* Use JMP and Excel to solve problems with normal distributions
* Solve problems regarding discrete distributions (binomial and Poisson)

## Linear Functions of Random Variables

Up to this point, we have considered distributions of one random variable. Now, we will consider statistics of functions of random variables. We will work with either a function (Y) pertaining to a constant (c) and one random variable (X) or a function (Y) combining multiple constants (c0, c1, c2…cn)and multiple random variables (X1, X2, X3…Xn). **The following table shows how to calculate the mean and variance of functions of random variables.** More information or derivations of these equations are in section 3.12 in the book.

|  |  |  |
| --- | --- | --- |
| **Function** | **Mean** | **Variance** |
|  |  |  |
|  |  |  |
|  |  | Note that if the random variables are independent, the covariance term is 0. |

## Covariance

As shown above, it is fairly straightforward to calculate statistics for independent random variables. However, **if the variables are not independent, we must consider covariance, which essentially explains dependence of one variable on another.** We can also describe the relationship between two variables using the correlation coefficient:

Basically, if the covariance is negative, the correlation between the two variables is negative (meaning if one variable decreases, the other would increase). Conversely, if the covariance is positive, the correlation is positive (if one variable increases, the other increases as well). If the covariance is 0, there is no correlation and the variables are independent.

## Non-Linear Functions of Random Variables

When the function Y is a non-linear function, the best that we can when calculating mean and variance do is consider an approximation of the function. Basically, we take where h is considered to be the approximation of Y. Then, we can say:

The right-side line bracket means we evaluate the expression at .

## Lab 4 Exercises

1. Consider . If X1 and X2 are independent random variables with μ1 = 2, μ2 = 5, σ1 = 2, σ2 = 10, find:
   1. E(Y)
   2. V(Y)
2. If X1 and X2 were not independent,
   1. What effect does a positive covariance between X1 and X2 have on the variance of Y?
   2. What effect does a negative covariance between X1 and X2 have on the variance of Y?
3. Consider . If X is a random variable, in terms of μx and σx, find:
   1. E(Y)
   2. V(Y)
4. Consider . If X1 and X2 are independent random variables, in terms of μ1, μ2, σ1 and σ2, find:
   1. E(Y)
   2. V(Y)