**CS1 – Actuarial Statistics**

Chapters:

1. Probability Distributions
2. Generating Functions
3. Joint Distributions
4. Conditional Expectation
5. Central Limit Theorem
6. Sampling and Statistical Inference
7. Point Estimation
8. Confidence Intervals
9. Hypothesis Testing
10. Data Analysis
11. Linear Regression
12. Multiple Linear Regression
13. Generalised Linear Models
14. Bayesian Statistics
15. Credibility Theory
16. Empirical Bayes Credibility Theory
17. **Probability Distributions**

***\*Important Background:*** *For those who aren’t aware, we define a set to be a collection of things that make up something. For example the set of numbers that can be observed on the throw of a dice would be the numbers from 1 through to 6. Mathematically, we would define this set to be S = {1,2,3,4,5,6}. Similarly, we could define a set of Countries such as S = {England, Germany, France,…}. Sets do not have to be numerical in nature but we will mostly come across numerical sets in our studies of this subject.*

***\*Important Background:*** *We define a population to be the whole of whatever is being observed. For example, if people in the whole world are being observed then every single person would make up the population. If one person were to be left out then we would call all the remaining people the sample of the population. Similarly, if all the people in the world made up the population then all females would be a sample of the population. Finally, if all the females in the world were the population then all females from England would be a sample of that population.*

***\*Important Background:*** *The very bare-bones understanding of probability, in a mathematical sense, is that we calculate:*

* 1. **Uniform Distribution**

The Uniform Distribution is a distribution that describes events that are **all** equally likely to occur. For example, if we have a dice that has no significant impurities (meaning that it is not heavier on one side and all sides are straight and of the same size) then it would be reasonable to believe that the chances of the dice landing on a 4 is exactly the same as it landing on a 1.

Relating this to our understanding of probability, the chance of a dice landing on a 4 would be 1/6 since there is only one way the dice could land on a 4 and there are 6 total possible outcomes. If this were a strange dice that had the number 4 on two of the sides then the probability of the dice landing on a 4 would be 2/6 since there would be 2 ways that the dice could land on a 4.

Let the random variable X be defined by X(i) = i, (i = 1,2,3,…,k) (meaning that X can take any **one** value between 1 and whatever K is).

Under the Uniform Distribution, the probability of X being any one of those observations is  
 **P(X = x) = 1/k (x = 1,2,3,…,k)**

Moments:   
µ = E[X] = ∑ X P(X = x)

= 1 (1/k) + 2 (1/k) + 3 (1/k) + … + k (1/k)

= (1/k) (1 + 2 + 3 + … + k)

= (1/k) (k (1 + k) / 2)

µ = (1 + k) / 2

E[X2] = ∑ X2 P(X = x)

= 12 (1/k) + 22 (1/k) + 32 (1/k) + … + k2 (1/k)

= (1/k) (12 + 22 + 32 + … + k2 )

= (1/k)

=

Now,

σ2 = E[X2] - E[X] 2 = -

= -

= -

=

=

=

=

σ2 =

Finally, regarding our example to do with the probabilities of the roll of a dice, we can see that our random variable X can take any value between 1 and 6, hence our k = 6.

Because of this, the expected value of a roll of dice would be  
E[X] = = = = 3.5  
with a variance of   
σ2 = = = = 2.9167

* 1. **Bernoulli Distribution**
  2. **Binomial Distribution**
  3. **Geometric Distribution**
  4. **Negative Binomial Distribution**
  5. Hypergeometric Distribution
  6. Poisson Distribution

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13. **Bayesian Statistics**
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15. **Empirical Bayes Credibility Theory**