Linda Mei

P&S - Project 2 Formula Sheet

**Set Operations**

Intersection :

and

Union :

and

Complement :

De Morgan’s Laws:

**Chapter 1**

Mean Formula:

Variance Formula:

Standard Deviation Formula:

*s used for sample, σ (sigma) used for population.*

**Chapter 2**

Axioms 1-3:

*S is the sample space. A is in S (subset). P(A) is the probability of A.*

Axiom 1:

Axiom 2:

Axiom 3 (summing up events):

*are pairwise mutually exclusive events. Can be written as a finite sequence.*

rule (extended rule for ):

m elements and n elements form pairs.

*Can apply rule to sets; extended rule for permutations:*

Permutations (order matters):

*ordering distinct objects taken at a time*

*Factorial Note: and*

Partition distinct objects into distinct groups:  
*Each object appears in exactly one group, rearrangement within a group doesn’t count*

Combinations (order doesn’t matter):

*number of combos objects taken at a time*

Conditional Probability (probability of A given B has occurred):

Rewritten (\*similar to Bayes’ Theorem):

Dependent vs. Independent:

*Two events A and B are independent if any one of the following holds. Otherwise, the events are dependent:*

The Multiplicative Law of Probability (can find the intersection of 3+ events):

*The probability of the intersection of two events A and B is*

*If A and B are independent, then*

The Additive Law of Probability (can find union of 3+ events):

*The probability of the union of two events A and B is*

*If A and B are mutually exclusive events,*

Solve the Odds of an Event Not Happening (Theorem 2.7):

*Hard to directly solve the probability ? Solve the odds of the event NOT happening .*

The Law of Total Probability:

*Note: Assume is a partition of S*

such that for always

Bayes’ Rule:

*Used to make probability statements when event B hasn’t been observed but event A has.*

*Assume that is a partition of S such that such that for always, then*

or

or

**Chapter 3**

Probability Mass Function (Probability Distribution or PMF):

*Sum of the probabilities of all sample points in S that are assigned the value y.*

*The following also mean PMF:*

*[ = number of ways of selecting y for a value, = number of sample points in S]*

For any PMF, the following has to be true:

1. , probability has to be between 0 and 1.
2. , all values of must add to 1 when summed up.

Discrete Random Variable:

*Think of this as the “average”, the sum of the random variables multiplied by the PMF.*

Mean and Variance of Random Variable Y:

Standard Deviation of Random Variable Y:

*The standard deviation of Y is the positive square root of V(Y).*

PMF for Binomial Distribution (success or fail):

*\*Probability of Failure in a Binomial Experiment:*

and

for all other

*Use combination ( means “n Choose y”):*

|  |  |
| --- | --- |
| p = probability of success | n = number of trials |
| q = probability of failure (sometimes given) | y = number of successes |

Binomial Distribution Mean and Variance:

Geometric Distribution (count how many fails carried out until success):

where

|  |  |
| --- | --- |
| q = 1 – p (failure) | y = # of total trials (including success) |
| p = success probability | Y = y ⬄ y – 1 mean failures minus success |

Geometric Distribution Expected (Mean) and Variance:

Geometric Distribution (spelled out):

A success occurs on/before the nth trial

A success occurs before the nth trial

A success occurs on/after the nth trial

A success occurs after the nth trial

Hypergeometric Distribution PMF (# of successes without replacement from a sample size):

\*When and is too large use binomial PMF

= # of ways of selecting the Type I items from available

= # of ways of selecting the Type II items from the available

= # of ways of selecting items (this is our sample space)

|  |  |  |
| --- | --- | --- |
| Total *cards* = N | Num of *red cards* = r | Total *cards* – *red cards* = N - r |
| Total *cards* selected = n | Num of *red cards we want* = y | Remaining choices = N - y |
|  |  |  |

Hypergeometric Distribution Expected Mean and Variance Formulas:

Poisson Distribution (successes that occur independently in a continuous time at a continuous rate):

where

Poisson Distribution Expected (Mean) and Variable and :

*= rate at which successes occur*

Tchebysheff’s (Chebyshev’s) Theorem (how much values are in the interval around the average):

random variable, mean , finite variance , then for any constant

or

for , at least of data values lie k standard deviations of the mean

where

**Chapter 4**

Cumulative Distribution Function of Random Variable Y:

\*Distribution function (CDF), big F

for

1. Starts at 0:
2. Ends at 1:

Probability Density Function of Random Variable Y:

\*Density function (PDF), little f (derivative of F)

1. Non-negative: for this follows as is nondecreasing
2. Integrates to 1: this follows as

Interval Probability of Random Variable Y (find the probability in the range):

1. for all
2. area under the graph (everything sums up to 1)

Expected Value (Mean) of Random Variable Y (provided integral exists):

Variance of Random Variable Y:

Expected Value of a Function (provided integral exists)

Theorem 4.5:

*is the expected of a constant*

Uniform Distribution Probability Mass Function (PMF)

Uniform Distribution Expected

Uniform Distribution Variance

**Chapter 5**

Bivariate (Joint) Probability Mass Function (PMF) – Discrete Random Variables

must sum up to 1 and and are both discrete (2 variables)

*can be thought of like tables for rows and columns*

Theorem 5.1

If and are discrete random variables with joint probability function , then

Bivariate (Joint) Probability Distribution Function (PDF) – Any Random Variables

*Jointly continuous random variables where is the joint probability density function and is the joint distribution function*

= density, = distribution

Marginal Probability Function (MPF)

Marginal Density Function (MDF)

Conditional Discrete Probability Function

Conditional Distribution Function (interested in the “at least” while something is preset)

Conditional Density Function

are independent random variables if true

Theorem 5.4

*(p: marginal probability functions) are independent random variables if true*