A. M. E. C. E. A<br>MAIN EXAMINATION

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AUGUST - DECEMBER 2018 TRIMESTER<br>FACULTY OF COMMERCE<br>DEPARTMENT OF ACCOUNTING AND FINANCE<br>ODEL PROGRAMME

## CMS 311: BUSINESS STATISTICS

Date: DECEMBER 2018 Duration: 2 Hours
INSTRUCTIONS: Answer Question ONE and ANY OTHER TWO Questions
Q1. i) In each of the 4 races, the democrats have $60 \%$ chance of winning. Assuming that the races are independent of each other, what is the probability that:
a) The Democrats will win 0 races, 1 race, 2 races, 3 races, or 4 races?
(9 marks)
b) The Democrats will win at least 1 race.
(3 marks)
c) The Democrats will win a majority of the races. (3 marks)
ii) A discrete random variable (RV) has the following Probability Distribution:

|  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :---: |
| $X$ | 1 | 2 | 4 | 5 | 8 |  |
| $\operatorname{Pr}(\mathrm{x})$ | 0.20 | 0.25 |  | $?$ | 0.30 |  |

Required:
d) Find the $\operatorname{Pr}(4)$
e) Find the $((\operatorname{Pr}(x)=2)$ or $(\operatorname{Pr}(x)=4))$.
f) Find the $\operatorname{Pr}(x \leq 4)$
g) Find the $\operatorname{Pr}(x<4)$
h) The Regional Chairman of the Muscular Dystrophy Association is typing to estimate the amount each caller will pledge during the annual MDA telethon. Using data gathered over the past 10 years, she has computed the following probabilities of various pledge amounts. Draw a graph illustrating this probability distribution:
(3 marks)

| Dollar pledge | 25 | 50 | 75 | 100 | 125 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Probability | 0.45 | 0.25 | 0.15 | 0.10 | 0.05 |

Q2. a) The scores on an aptitude test required for entry into a certain job position have a mean of 500 and a standard deviation of 120 . If a random sample of 36 applicants has a mean of 546 , is there evidence that their mean score is different from the mean that is expected from all applicants? ( 10 marks)
b) The training department of a company wishes to determine if there is any difference in the performance between the workers that have completed a training program and those that have not completed the program. A sample of 100 trained workers reveals an average output of 74.3 parts per hour with a sample standard deviation of 16 parts per hour. A sample of 100 who have not been trained has an average output of 69.7 parts per hour with a standard deviation of 18 parts per hour. Is there evidence of a difference in output between the two groups? Write a $95 \%$ confidence interval estimate of the difference.
(10 marks)
Q3. i) The table below shows the political affiliation of American voters and the proportion favouring or opposing the death penalty within the 6 categories defined by three values of party affiliation and 2 opinions.

|  | Death Penalty Opinion |  |
| :--- | :--- | :--- |
| Party | Favour | Oppose |
| Republican | 0.26 | 0.04 |
| Democrat | 0.12 | 0.24 |
| Other | 0.24 | 0.01 |

a) What is the probability that a randomly chosen voter favours the death penalty?
(5 marks)
b) What is the Probability that a different randomly chosen voter is a Republican?
ii) Identical computer components are shipped in boxes of 5. About15\% of components have defects. Boxes are tested in a random order.
a) What is the probability that a randomly selected box has only nondefective components?
b) Whatistheprobabilitythatatleast8ofrandomlyselected10 boxes have only non-defective components?
c) What is the distribution of the number of boxes tested until a box without defective components is found?

Q4. Suppose that the voting population in Utopia is 300 million and $60 \%$ of the voting population intend to vote for Melinda McNulty in the next election. We take a random sample of size 100 from the same voting population and ask each
person chosen whether they will vote for Melinda McNulty in the next election or not. Let $X$ be the number of yes' in our sample. The possible values of $X$ (The number of successes) are $0,1,2,3, \cdots, 100 . n=100, p=0.6, q=1-p=0.4$. You may use your calculator to calculate the following:
a) What is $P(x=60)$ ?
(4 marks)
b) What is $P(x \leq 20)$ ?
c) What is $P(x>70)$ ?
d) What is $P(x<50)$ ?

## CMS 311 BUSINESS STATISTICS FORMULAE

## PARAMETERS

- Population mean $=\mu=\left(\Sigma X_{i}\right) / N$
- Population standard deviation $=\sigma=\operatorname{sqrt}\left[\Sigma\left(X_{i}-\mu\right)^{2} / N\right]$
- Population variance $=\sigma^{2}=\Sigma\left(X_{i}-\mu\right)^{2} / N$
- Variance of population proportion $=\sigma P^{2}=P Q / n$
- Standardized score $=Z=(X-\mu) / \sigma$


## Statistics

Unless otherwise noted, these formulas assume simple random sampling.

- Sample mean $=x=\left(\Sigma x_{i}\right) / n$
- Sample standard deviation $=s=\operatorname{sqrt}\left[\Sigma\left(x_{i}-x\right)^{2} /(n-1)\right]$
- Sample variance $=s^{2}=\Sigma\left(x_{i}-x\right)^{2} /(n-1)$
- Variance of sample proportion $=S_{p}^{2}=p q /(n-1)$


## Counting

- $n$ factorial: $n!=n$ * $(n-1)$ * $(n-2)$ *... * 3 * 2 * 1 . By convention, $0!=1$.
- Permutations of $n$ things, taken $r$ at a time: ${ }_{n} P_{r}=n!/(n-r)$ !
- Combinations of $n$ things, taken $r$ at a time: ${ }_{n} \mathrm{Cr}_{r}=n!/ r!(n-r)!={ }_{n} P_{r} / r$ !


## Probability

- Rule of addition: $\mathrm{P}(\mathrm{A} \cup \mathrm{B})=\mathrm{P}(\mathrm{A})+\mathrm{P}(\mathrm{B})-\mathrm{P}(\mathrm{A} \cap \mathrm{B})$
- Rule of multiplication: $P(A \cap B)=P(A) P(B \mid A)$
- Rule of subtraction: $P\left(A^{\prime}\right)=1-P(A)$


## Random Variables

In the following formulas, $X$ and $Y$ are random variables, and $a$ and $b$ are constants.

- Expected value of $X=E(X)=\mu_{x}=\Sigma\left[x_{i}{ }^{*} P\left(x_{i}\right)\right]$
- Variance of $X=\operatorname{Var}(X)=\sigma^{2}=\Sigma\left[x_{i}-E(x)\right]^{2} * P\left(x_{i}\right)=\Sigma\left[x_{i}-\mu_{x}\right]^{2} P P\left(x_{i}\right)$
- Normal random variable $=z$-score $=z=(X-\mu) / \sigma$
- Chi-square statistic $=X^{2}=\left[(n-1) * s^{2}\right] / \sigma^{2}$
- f statistic $=f=\left[s_{1}{ }^{2} / \sigma_{1}{ }^{2}\right] /\left[s_{2}{ }^{2} / \sigma_{2}{ }^{2}\right]$
- Expected value of sum of random variables $=E(X+Y)=E(X)+E(Y)$
- Expected value of difference between random variables $=E(X-Y)=E(X)-E(Y)$


## Sampling Distributions

- Mean of sampling distribution of the mean $=\mu_{\mathrm{x}}=\mu$
- Mean of sampling distribution of the proportion $=\mu_{\mathrm{p}}=\mathrm{P}$
- Standard deviation of proportion $=\sigma_{p}=\operatorname{sqrt}[P *(1-P) / n]=\operatorname{sqrt}(P Q / n)$
- Standard deviation of the mean $=\sigma_{x}=\sigma /$ sqrt( $n$ )
- Standard deviation of difference of sample means $=\sigma_{d}=\operatorname{sqrt}\left[\left(\sigma_{1}{ }^{2} / n_{1}\right)+\left(\sigma_{2}{ }^{2} /\right.\right.$ $\mathrm{n}_{2}$ ) ]


## Standard Error

- Standard error of proportion $=\mathrm{SE}_{\mathrm{p}}=\mathrm{S}_{\mathrm{p}}=\operatorname{sqrt}\left[\mathrm{p}^{*}(1-\mathrm{p}) / \mathrm{n}\right]=\operatorname{sqrt}(\mathrm{pq} / \mathrm{n})$
- Standard error of difference for proportions $=\mathrm{SE}_{\mathrm{p}}=\mathrm{S}_{\mathrm{p}}=\operatorname{sqrt}\{\mathrm{p} \text { * (1-p })^{*}\left[\left(1 / \mathrm{n}_{1}\right)\right.$ $\left.\left.+\left(1 / \mathrm{n}_{2}\right)\right]\right\}$
- Standard error of the mean $=\mathrm{SE}_{\mathrm{x}}=\mathrm{Sx}_{\mathrm{x}}=\mathrm{s} / \mathrm{sqrt}(\mathrm{n})$
- Standard error of difference of sample means $=S E_{d}=S_{d}=\operatorname{sqrt}\left[\left(s_{1}{ }^{2} / n_{1}\right)+\left(s^{2} /\right.\right.$ n2) ]
- Standard error of difference of paired sample means $=\mathrm{SE}_{\mathrm{d}}=\mathrm{S}_{\mathrm{d}}=\left\{\operatorname{sqrt}\left[\left(\Sigma\left(\mathrm{d}_{\mathrm{i}}-\right.\right.\right.\right.$

$$
\left.\left.d)^{2} /(n-1)\right]\right\} / \operatorname{sqrt}(n)
$$

## Discrete Probability Distributions

- Binomial formula: $\mathrm{P}(\mathrm{X}=\mathrm{x})=\mathrm{b}(x ; n, P)={ }_{\mathrm{n}} \mathrm{C}_{\mathrm{x}}{ }^{*} \mathrm{P}^{\mathrm{x}}$ * $(1-\mathrm{P})^{\mathrm{n}-\mathrm{x}}={ }_{\mathrm{n}} \mathrm{C}_{\mathrm{x}}{ }^{*} \mathrm{P}^{\mathrm{x}}{ }^{*} \mathrm{Q}^{\mathrm{n}-\mathrm{x}}$
- Mean of binomial distribution $=\mu_{\mathrm{x}}=\mathrm{n}$ * $P$
- Variance of binomial distribution $=\sigma_{x}{ }^{2}=n^{*} P^{*}(1-P)$
- Negative Binomial formula: $\mathrm{P}(\mathrm{X}=\mathrm{x})=\mathrm{b}^{*}(x ; r, P)=\mathrm{x}-1 \mathrm{C}_{\mathrm{r}-1}$ * $\mathrm{P}^{*}(1-\mathrm{P})^{\mathrm{x}-\mathrm{r}}$
- Mean of negative binomial distribution $=\mu_{x}=r Q / P$
- Variance of negative binomial distribution $=\sigma_{x^{2}}=r * Q / P^{2}$
- Poisson formula: $\mathrm{P}(x ; \mu)=\left(\mathrm{e}^{-\mu}\right)\left(\mu^{x}\right) / \mathrm{x}$ !
- Mean of Poisson distribution $=\mu_{x}=\mu$
- Variance of Poisson distribution $=\sigma_{x}{ }^{2}=\mu$

Multinomial formula: $P=\left[n!/\left(n_{1}!{ }^{*} n_{2}!{ }^{*} \ldots n_{k}!\right)\right]^{*}\left(p_{1} n_{1}{ }^{*} p_{2}{ }^{n_{2}}{ }^{*} \ldots{ }^{*} p_{k}{ }^{n_{k}}\right)$
*END*

