

Sample Exam 1

Full Name: _____ ID/Email: _____

- This is an 80 minute exam. There are 5 problems, one of which is for the graduate section only.

The exam is worth a total of 42 points for the undergraduate section and 52 points for the graduate section.

- You may use *one* physical page of personal notes and a standard scientific calculator. (You may *not* share these items with anyone else.)
- *Write all answers in the spaces provided.* If you require more space to write your answer, you may use the back side of the page.
- You are not allowed to communicate with anyone except the instructor or proctors before you submit this exam.

Useful Abbreviations:

CI = confidence interval

SE = standard error

E = expected value

Var = variance

Cov = covariance

df = degrees of freedom

ML = maximum likelihood LRT = likelihood ratio test L = log-likelihood

RR = relative risk

H_0 = the null hypothesis of a test H_a = the alternative hypothesis of a test

- The relationship between coffee drinking and myocardial infarction (MI) was studied in young women, aged 30–49. This retrospective study included 487 cases hospitalized for the occurrence of a MI. Nine hundred eighty patients hospitalized for some other acute condition were selected as controls. Data for consumption of five or more cups of coffee, stratified by smoking status were:

Nonsmokers			Smokers		
Cups per day	MI	Controls	Cups per day	MI	Controls
≥ 5	14	49	≥ 5	138	134
< 5	75	381	< 5	260	416

- Compute both conditional odds ratios as well as the marginal odds ratio. Give approximate 95% confidence intervals for the conditional odds ratios. [10 pts]

- Do you think that stratification on smoking status was important in this study? Explain. [2 pts]

2. The Chinese Mini-Mental Status Test (CMMS) is a test consisting of 114 items to identify people with Alzheimer's disease and senile dementia among people in China. An extensive clinical evaluation was performed, whereby participants were interviewed by psychiatrists and nurses and a definitive diagnosis of dementia was made. The table below shows the results.

CMMS score	Non-demented	Demented	Total
0-5	0	2	2
6-10	0	1	1
11-15	3	4	7
16-20	9	5	14
21-25	16	3	19
26-30	18	1	19
Total	46	16	62

Suppose that a cutoff value of ≤ 20 on the test is used to identify people with dementia.

- (a) Estimate the sensitivity of the test. [3 pts]

- (b) Estimate the specificity of the test. [3 pts]

- (c) The *positive predictive value (PPV)* is the probability that someone who tests positive actually has the disease. Suppose the prevalence of dementia is 5% in this population. Use this, together with the estimated sensitivity and specificity, to estimate the PPV. [4 pts]

3. The following table gives results for a study comparing surgery and radiation therapy for treating cancer of the larynx.

Therapy	Outcome	
	Successful	Unsuccessful
Radiation	3	15
Surgery	2	21

Use an appropriate test for $H_0 : \theta = 1$ against $H_a : \theta > 1$, where θ is the odds ratio for success of radiation versus surgery. Give the P -value. [10 pts]

4. The following table classifies a sample of psychiatric patients according to their diagnosis and whether they are prescribed drugs as part of their treatment.

Diagnosis	Drugs	No Drugs
Schizophrenia	150	13
Neurosis	18	19
Personality Disorder	47	52

Compute an appropriate test statistic of the null hypothesis that drug prescription is independent of diagnosis. State the asymptotic distribution of this statistic under the null hypothesis of independence. [10 pts]

GRADUATE SECTION ONLY

5. Let X_1, X_2, \dots, X_n be independent random variables. Suppose X_t has a Poisson distribution with mean $t\lambda$, where λ is unknown.

(a) Find the ML estimator $\hat{\lambda}$. [3 pts]

(b) Find an expression for approximating $\text{Var}(\hat{\lambda}^2)$. [3 pts]

(c) Give an approximate 95% confidence interval for the parameter $\theta = \lambda^2$ for a data set in which $n = 15$ and $\sum_{t=1}^n X_t = 22$. [4 pts]