Midterm #2

10/25/2012

Instructions: The exam is divided into two parts. In Part I, your score is entirely based on your numerical answer, and not any accompanying explanation. In Part II, your grade for each question will be based primarily on your written explanation, and unsupported answers will receive no points. For both parts, you should refer to the provided probability tables as necessary. You may use a calculator, and one sheet of notes.

Part I (7 questions)

Each short question is worth 7 points. Write your answer in the space provided.

Problem 1 (7 points) Consider the following hypothesis test:

$$H_0 : \mu = 40$$
$$H_1 : \mu \neq 40$$

You collect the following data: $\overline{x} = 40.5$, $\sigma = 2$, and $n = 64$. What is the p-value of the test?

Problem 2 (7 points) Consider the following hypothesis test:

$$H_0 : \mu = 100$$
$$H_1 : \mu > 100$$

You collect the following data: $\overline{x} = 104$, $\sigma = 21$, and $n = 49$. What is the p-value of the test?

Problem 3 (7 points) Referring back to problem 2, interpret the P-value *in plain English*. What does it tell you?

Problem 4 (7 points) Consider the following hypothesis test:

$$H_0 : \mu = 150$$
$$H_1 : \mu > 150$$

Suppose that σ is known to be 12. You wish to test your hypotheses with a 1% chance of Type I error. You are about to collect a sample of size 144. What is the probability of type II error if, in reality, $\mu = 154$?

Problem 5 (7 points) Consider the following hypothesis test:

$$H_0 : \mu = 40$$
$$H_1 : \mu \neq 40$$

Suppose that σ is known to be 10. You wish to test your hypotheses with a 5% chance of Type I error. You are about to collect a sample of size 36. What is the probability of type II error if, in reality, $\mu = 39$?

Problem 6 (7 points) Consider the following hypothesis test:

$$H_0 : \mu = 230$$
$$H_1 : \mu < 230$$

Suppose that σ is known to be 4. You determine that type I error is very costly, and so you wish to test your hypotheses with a 0% chance of Type I error. You are about to collect a sample of size 225. What is the probability of type II error if, in reality, $\mu = 200$?

Problem 7 (7 points)

$$H_0 : \mu = 63$$
$$H_1 : \mu \neq 63$$

Suppose that σ is known to be 9, and you will have access to data from a sample of size $n = 100$. You determine that type II error is very costly, and so you design a test with a 0% chance of type II error. What is the probability of type I error for this test? Suppose that, in reality, $\mu = 62$, although you don't know this.

Part II (3 questions)

Questions 8, 9, and 10 are worth 15, 25, and 10 points, respectively. Thoroughly support all of your answers. Credit will not be given without complete explanations.

Problem 8 (15 points) A researcher runs a regression of monthly crime rate (CRIME) on number of police (POLICE), where CRIME is measured as the number of felonies reported per 100,000 people committed that month, and POLICE is the number of policemen in active duty in the state that month. The researcher uses a data set of 6 years worth of state-level observations (one observation is the crime rate and the number of police in a given state in a given month), and obtains the following results:

Regression	**Statistics**
Multiple R	.321827
R Square	.14816
Adjusted R Square	.121732
Standard error	6.653
Observations	3,600

	coefficients	Standard error	t stat	P-value	Lower 95%	Upper 95%
Intercept	41.3546	12.5760	3.2884	.0005038	16.70704	66.00496
POLICE	4.2849	1.0746	3.9874	3.3395 E-005	2.1786	6.3911

a. Interpret the regression results. What is the relationship between number of police and the crime rate? Is number of police a statistically significant variable in explaining variation in the crime rate?

b. Do these results cause you to conclude that police cause crimes? If not, what alternative explanations are there for the regression results? How would you more accurately measure the impact of hiring more police on the crime rate?

Problem 9 (25 points) In a 2003 paper in the *American Law and Economics Review*, Katz, Levitt, and Shustorovich study the deterrent effects of the death penalty and poor prison conditions on crime rates. They are interested in testing two hypotheses:

1. The death penalty deters crime
2. Poor prison conditions deter crime

Their data set consists of 2050 observations, where each observation is a collection of information from one state in one year. Their measurement of prison conditions is the number of deaths per 1,000 prisoners that occur in a year. They have access to the following data:

- CRIMERATE: violent crime per 100,000 residents (mean: 356)
- PRISON_DEATHS: prison deaths per 1,000 prisoners (mean: 3.1)
- EXECTUIONS: executions per 1,000 prisoners (mean: .11)
- PRISONERS: prisoners per 100,000 residents (mean: 126)
- INCOME: real per capita income (mean: 13,724)
- UNEMPLOYMENT: unemployment rate (mean: 3.37)
- BLACK: fraction of the state that is black (mean: .11)
- URBAN: fraction of the state that lives in urban areas (mean: .72)
- YOUNG: fraction of the state that is 24 years or younger (mean: .42)

The researchers consider the following linear regression model:

$$\begin{aligned} CRIMERATE = \beta_0 &+ \beta_1 * PRISON\_DEATHS + \beta_2 * EXECUTIONS + \beta_3 * PRISONERS \\ &+ \beta_4 * INCOME + \beta_5 * UNEMPLOYMENT + \beta_6 * BLACK + \beta_7 * URBAN \\ &+ \beta_8 * YOUNG + \epsilon \end{aligned}$$

a. What sign do you expect β_1, β_2, ..., β_8 to have, and why? Give 8 separate answers. You may use the next page if necessary.

The researchers run a regression of violent crime on the other 8 variables, and obtain the following results:

variable	coefficients	standard error	t-stat	P-value
Intercept	324	123.1	2.63	.0085
Prison deaths/1,000 prisoners	-3.4	1.5	-2.27	.024
Executions/1,000 prisoners	-4.1	3.0	-1.37	.172
Prisoners/100,000 residents	.21	.27	.78	.436
Real per capita income	.42	.16	2.63	.008
Unemployment rate	-.15	.08	1.875	.061
Fraction black	37.1	16.1	2.30	.021
Fraction urban	-7.3	6.9	1.06	.290
fraction under 24	2.6	10.2	.255	.799

b. Which variables are significant predictors of the crime rate and which are not?

c. Is there more evidence to say that the death penalty deters crime or that poor prison conditions deter crime?

Problem 10 (10 points) A friend shows you the following headline:

> "A new poll of likely voters in Nevada shows that Obama has 50% support and Romney has 48%. The poll's margin of error is +/- 4.5%."

a. Your friend asks you for clarification. Is Obama winning in Nevada? Use statistical concepts studied in Eco 391 to explain to your friend, *in plain English*, what is going on.

b. Some polls have larger margins or error than others. What is one factor that determines the size of margin of error? Explain.