Your name: Solutions

Midterm 2

Math 3080-1, Spring 2007, The University of Utah

- This is a 50-minute closed-book, closed-notes exam. You may (and probably should) use a calculator.
- You may use only your own work.
- Tables and a formula sheet are in the back. Please feel free to tear them off. The F-table is 6 pages.
- Write your name on the top of every sheet. Unnamed loose sheets will not be graded.
- Partial credit is given only to clearly-written work.
- If you don't show the details of your work, you will not receive any credit, regardless of your answer.

---

1. (15 points total) Three identical [electrical] resistors were each subjected to three different temperatures for 24 hours. Then, the resistances were computed using a standard electrical test. The data follows:

	Temp 1	Temp 2	Temp 3
	6.9	8.3	8.0
	5.4	6.8	10.5
	5.8	7.8	8.1
	4.6	9.2	6.9
	4.0	6.5	9.3
average	5.34	7.72	8.56
variance	1.248	1.217	1.898
	$\uparrow S_1^2$	$\uparrow S_2^2$	$\uparrow S_3^3$

(a) (10 points) Test the hypothesis that the three different temperatures do not alter the average resistance of a resistor. Report your P-value.

$J=5$ $I=3$

$$MSE = \frac{1.248+1.217+1.893}{3} \cong 1.454$$

$$\bar{X}_{..} = \frac{5.34+7.72+8.56}{3} = 7.20\bar{6}$$

$$MSTR = \frac{5}{2}\sum_{i=1}^{3}(\bar{X}_{i\cdot}-7.20\bar{6})^2 = \frac{5}{2}\left[(5.34-7.20\bar{6})^2+(7.72-7.20\bar{6})^2+(8.56-7.20\bar{6})^2\right]$$

$$\cong 13.949$$

$$F \cong \frac{13.949}{1.454} \cong 9.59$$

num.df $= I-1 = 2$

den.df $= I(J-1) = 12$

$0.001 < P\text{-value} < 0.01$ [probably P value ≈ 0.005 or so]

(b) (5 points) What assumptions are you envoking? Explain clearly how you might try to verify/reject your assumptions?

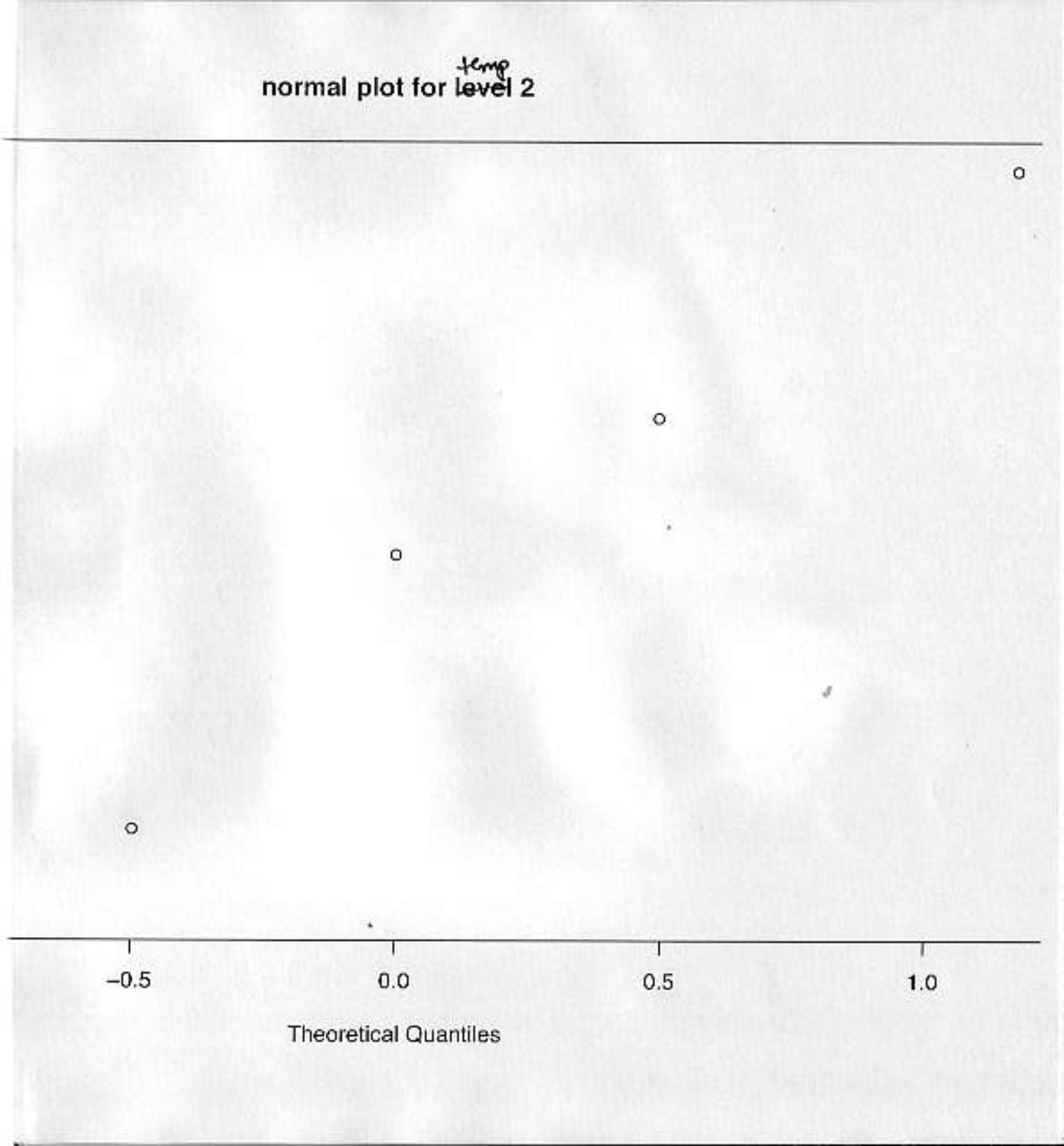
- Normal data (explain)
- Plot normal plots (explain)

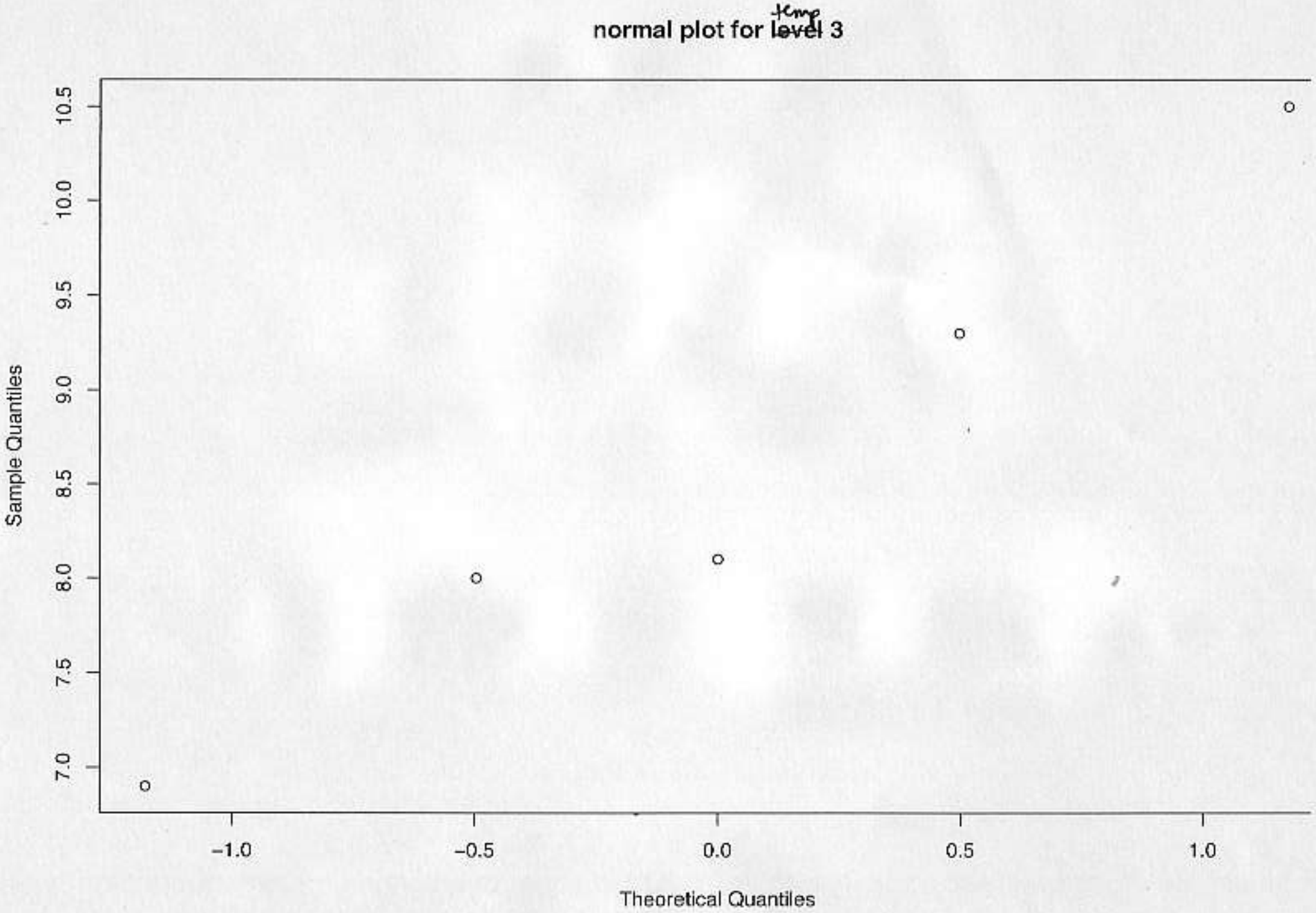
↓

included ; Temp 1 and 2 are ≈ normal

Temp 3 "would be," but

has a little glitch, it seems!


normal plot for temp level 2
−0.5
0.0
0.5
1.0
Theoretical Quantiles


normal plot for temp level 3
Sample Quantiles
Theoretical Quantiles
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
−1.0
−0.5
0.0
0.5
1.0

2. (10 points) The following is actual 1960 cancer data for 8 states in the country. The columns are:

(a) State = the state (e.g., "MD" = "Maryland.")

(b) Cig = the number of cigarettes (heads per capita) smoked.

(c) Lung = deaths (per 100,000 population) from lung cancer.

(Source: J.F. Fraumeni. "Cigarette smoking and cancers of the urinary tract: Geographic variations in the United States," *Journal of the National Cancer Institute* 41, 1205–1211.)

State	Cig (x)	Lung (y)	Cig×Lung
ME	28.92	20.94	605.5848
MD	25.91	26.48	686.0968
MA	26.92	22.04	593.3168
MI	24.96	22.72	567.0912
MN	22.06	14.20	313.2520
MS	16.08	15.60	250.8480
MO	27.56	20.98	578.2088
MT	23.75	19.50	463.1250
mean	24.52	20.3075	507.1904
variance	16.33791	15.41256	23286.25

Find the best line that explains "cig" versus "lung."

$\bar{x} = 24.52$ $\qquad \bar{y} = 20.3075$

$\overline{xy} = 507.1904$

$16.33791 = \text{var}_x = \frac{1}{7}\sum_{i=1}^{8}(x_i - \bar{x})^2$

$= \frac{1}{7}\left[\sum_1^8 x_i^2 - 2\bar{x}\sum x_i + 8(\bar{x})^2\right]$

$= \frac{1}{7}\left[\sum x_i^2 - 2(\bar{x})^2 \cdot 8 - 8(\bar{x})^2\right]$

$= \frac{1}{7}\left[8 \cdot \overline{x^2} - 8(\bar{x})^2\right]$

$= \frac{8}{7}\left[\overline{x^2} - (\bar{x})^2\right]$

$\therefore \quad \overline{x^2} - (\bar{x})^2 = \frac{7}{8} \times 16.33791 = 14.29568$

$a = \dfrac{507.1904 - (24.52 \times 20.3075)}{14.29568} \simeq 0.647$

$b = \bar{y} - a\bar{x}$

$= 4.44$

$y = 0.647x + 4.44$