STAT 651 Final Exam (2 hours, 15 minutes)   **May, 2014**

NAME: **Total number of Marks:**   /40

There are 9 questions in this paper, do not be deterred, they are straightforward. Read each question carefully. There are questions on <u>both</u> side of the page. The number of marks for each question are given in brackets. Be smart about how you answer. If you can't answer one question move on the to next and return to the questions you could not do after answering all the other questions! There are 7 Figures in this paper. You must submit a cheat sheet with this exam.

DO ALL TESTS IN THIS PAPER AT THE 5% LEVEL.

Rubric: This exam is a closed book exam, but you can use 4-sides of cheat sheet, normal tables, t-tables, both Wilcoxon tables, chi-square tables, scrap paper and a calculator. You can also use an English dictionary, but these must be declared to me (so I can check that there is nothing inside).

Write your solutions in the question paper.

GOOD LUCK!

Spare page.

(1) In this question we are interested in the number of children (defined as persons below the age of 16) in a household.

(a) What type of variable is the number of children in a household? [1]

(b) Sketch the distribution for the number of children in a household, giving the mean and standard deviation (guess the mean and standard deviation - give numerical values that you think are appropriate). [2]

(c) 300 households were randomly sampled and the average (sample mean) number of children per household evaluated. Sketch the distribution of the sample mean including the mean and standard error (using the numbers from part (a)).

[2]

(2) I want to estimate the proportion of Texans who are vegetarian. I know that this proportion cannot be greater than 10% of the Texan population (let's be realistic, this is Texas not South India!).

What is the minimum sample size I should use to be sure that the margin of error for the 95% confidence interval for the proportion is less than 2% (0.02)? [2]

Distributions

chocolate

Summary Statistics

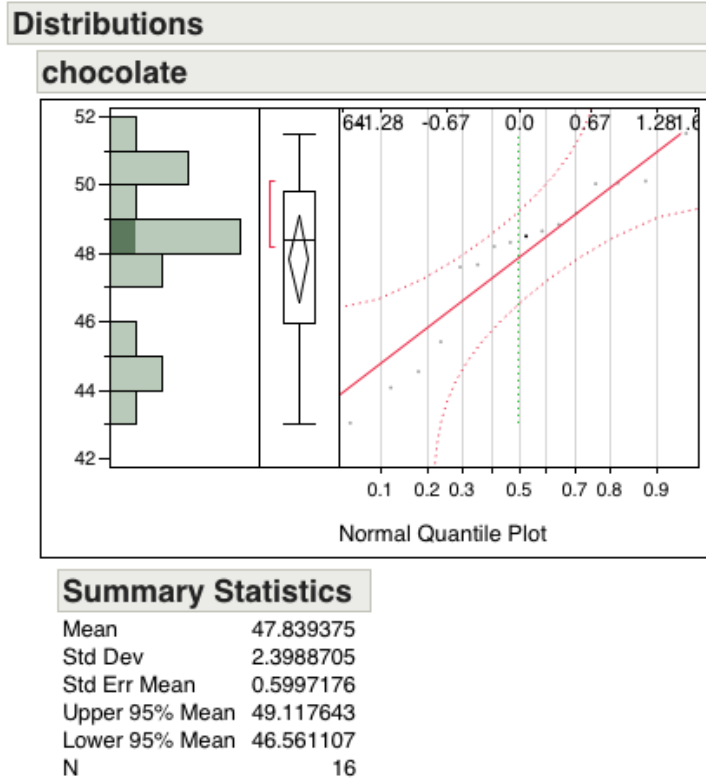|	
Mean	47.839375
Std Dev	2.3988705
Std Err Mean	0.5997176
Upper 95% Mean	49.117643
Lower 95% Mean	46.561107
N	16

Figure 1: Chocolate Data

(3) I want to know the mean weight of a chocolate bar. I collect a random sample of 16 chocolate bars. The data is summarized in Figure 1.

(a) Use the t-distribution with 15df to calculate a 99% confidence interval for the mean weight of a chocolate bar. [2]

(b) Explain why the t-distribution needs to be used instead of a normal distribution. [1]

Hypothesis test results:

p_1 : proportion of successes for population 1
p_2 : proportion of successes for population 2
$p_1 - p_2$: difference in proportions
$H_0 : p_1 - p_2 = 0$
$H_A : p_1 - p_2 \neq 0$

Difference	Count1	Total1	Count2	Total2	Sample Diff.	Std. Err.
$p_1 - p_2$	60	150	40	150	0.13333334	0.054433104

Figure 2: Two sample test for proportions in Statcrunch

(4) There has been some debate as to whether allergy shots (the treatment where patients who are allergic to a certain allergen are given small doses of it, to build up their tolerence of the allergen) work for people who suffer from food allergies.

A double blind study (where neither the doctor nor patient knows whether they are given the allergen or a placebo) was done to see whether allergy shots help to reduce the allergic reaction to foods.

300 people with food allergies were included in the study. 150 were randomly put in the placebo group and the other 150 were given the allergen. After the study each patient was asked whether their allergic reaction to food has reduced (they could answer yes or no).

The data is summarized here:

	Placebo	Given Allergen
Yes, reduction	40	60
No difference	110	90

(a) Explain why a double bind study was done rather than telling the doctor and patient the treatment group that they are in. [1]

(b) State the hypotheses of interest? [1]

(c) Using the output in Figure 2 to test the hypothesis given in (b). [2]

(d) Suppose that the treatment does not work and there is no different between taking allergy shots and the placebo. What is the BEST estimate for the proportion of people who will see a reduction in allergy when given a placebo?   [1]

(5) A child educationist wants to know whether a three old child is able to recognize letters from the alphabet.

To investigate this, the child is shown four different letters, the eductionist asks the child to point to a certain letter (for example, the child may be asked which letter is B). 14 of these multiple-choice type questions are asked. The child gets 7 questions correct out of 14 questions.
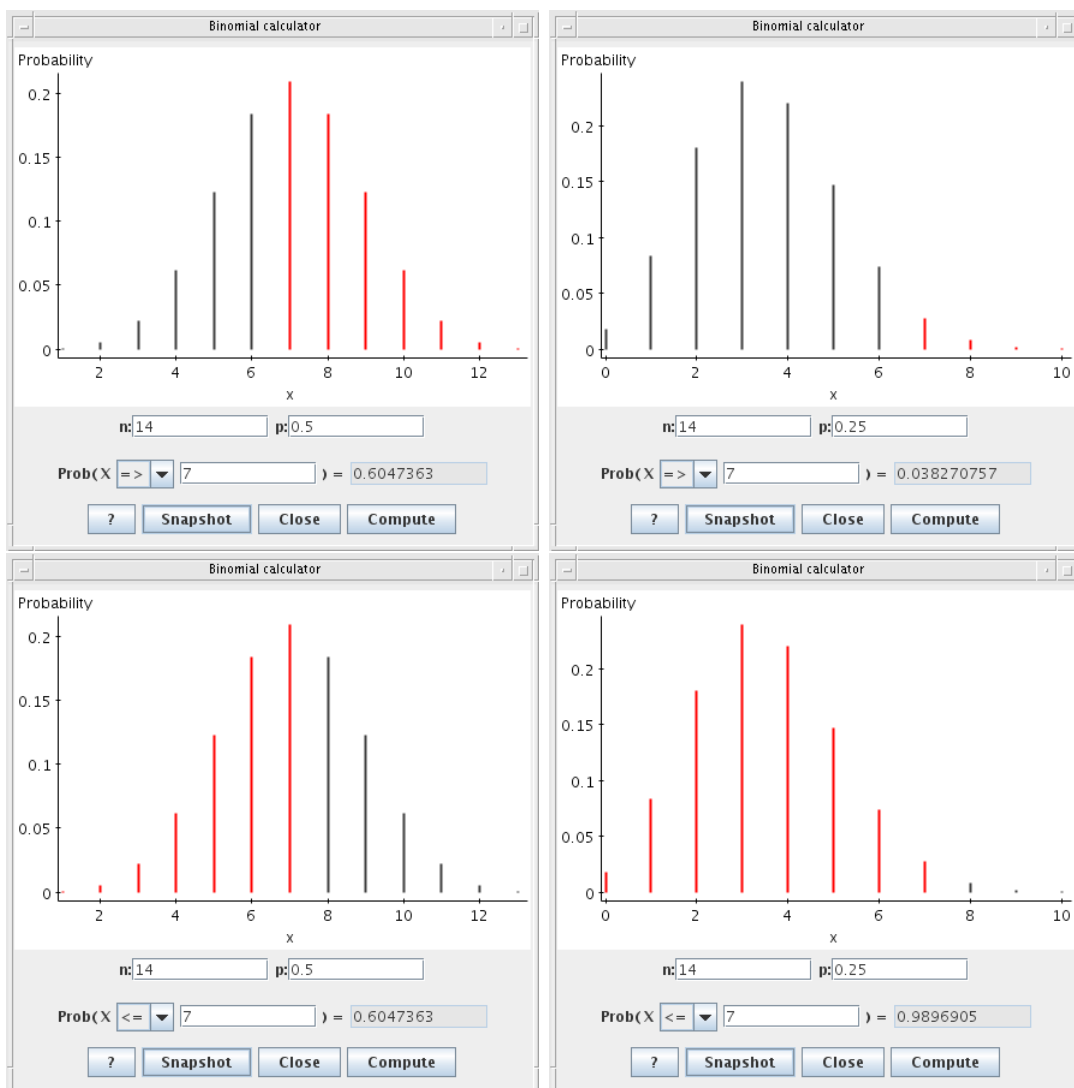

Figure 3: Binomial probabilities

(a) Suppose you want to see whether the child has some idea about his letters, what hypotheses would you test? [1]

(b) Use <u>Figure 3</u> (see previous page) to test the hypothesis in (a). [2]

(c) You do the test in Statcrunch and get the output in Figure 4. Explain why the p-value in the Statcrunch output is different to the p-value obtained in (b). [1]

Hypothesis test results:

p : proportion of successes for population

$H_0 : p = 0.25$

$H_A : p > 0.25$

Proportion	Count	Total	Sample Prop.	Std. Err.	Z–Stat	P–value
p	7	15	0.46666667	0.1118034	1.9379256	0.0263

Figure 4: Statcrunch output for one sample proportion test

(d) Which result gives the most reliable p-value. You should only answer (b), (c) or both the same? [1]

(6) Animal researchers want to know whether the type of antibody given to an calf at birth has an influence on their birth weight at 8 weeks. Each calf is given on of three treatments C, F of P. An ANOVA was done and the results are given in Figure 5

Oneway Analysis of Wt 8 centered by Igg By Igg

Oneway Analysis of Wt 8 By Igg

Oneway Anova

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Igg	2	0.000	0.000	0.0000	1.0000
Error	41	11834.540	288.647		
C. Total	43	11834.540			

Oneway Anova

Analysis of Variance

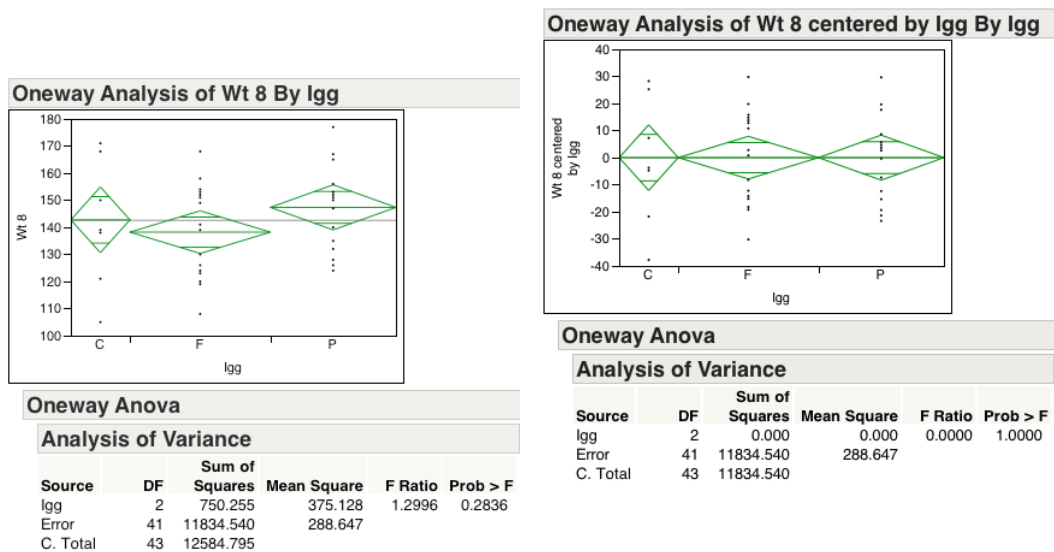| Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Igg	2	750.255	375.128	1.2996	0.2836
Error	41	11834.540	288.647		
C. Total	43	12584.795			

Figure 5: Left: ANOVA on the DATA. Right ANOVA of the residuals.

(a) State the hypotheses of interest and use Figure 5 (left plot) to obtain the results of the test. [2]

(b) Your friend explains that it is very important to consider the residuals. He does ANOVA on the residuals and is amazed to get a p-value of 1. His output is given in Figure 5 (right side plot). Using your knowledge of residuals, explain why he got this result and why it is meaningless to do an ANOVA on residuals. [1]

(c) Explain why the residuals are analysed when we do an ANOVA. [1]

(7) Anecdotal evidence suggests that wives tend to complain to their husbands more than husbands complain to their wives.

To see whether there was any evidence of this, a group of psychologists followed 6 heterosexual married couples over a period of a month and calculated the average number of times in a day the husband complained to the the wife and the number of times the wife complained to the husband. The data is summarized below.

	Wife complains to Husband	Husband complains to Wife	
Couple 1	15.5	2.3	13.2
Couple 2	2.3	1.5	0.8
Couple 3	3.6	0.8	2.8
Couple 4	0.2	3.5	-3.3
Couple 5	6.8	4.2	2.6
Couple 6	1.8	1.1	0.7

(a) What is the hypothesis of interest? [1]

(b) What test is appropriate and why? [1]

(c) Do the test and report the results. [2]

(d) How may sample size have influenced the outcome of your result? [1]

(8) Does sibling configuration have an influence on success in life?

This question was recently asked by a group of Socialogists at the University of Essex. A random sample of 1500 unrelated adults below the age of 30 were surveyed. They were asked (a) whether they were the oldest, youngest or middle sibling (only children were classed as oldest) and whether they had graduated from University or not.

	Graduates	Not Graduate	Total
Oldest	350 (58.33%) (41.18%) (23.33%)	250 (41.67%) (38.46%) (16.67%)	600 (100.00%) (40%) (40%)
Middle	250 (62.5%) (29.41%) (16.67%)	150 (37.5%) (23.08%) (10%)	400 (100.00%) (26.67%) (26.67%)
Youngest	250 (50%) (29.41%) (16.67%)	250 (50%) (38.46%) (16.67%)	500 (100.00%) (33.33%) (33.33%)
Total	850 (56.67%) (100.00%) (56.67%)	650 (43.33%) (100.00%) (43.33%)	1500 (100.00%) (100.00%) (100.00%)

Chi−Square test:

Statistic	DF	Value	P−value
Chi−square	2	15.271493	0.0005

Figure 6: The Statcrunch output

(a) Using the results in Figure 6, test whether there is an association between graduating and sibling configuration (state precisely the null and alternative).   [2]

(b) From the data what is the chance of graduating given (when)   [2]

   (i) The sibling is the oldest.

   (ii) The sibling is in the middle

   (iii) The sibling is the youngest.

(c) Using your results in (a) and (b), summarize in three lines or less, highlights of the study.   [2]
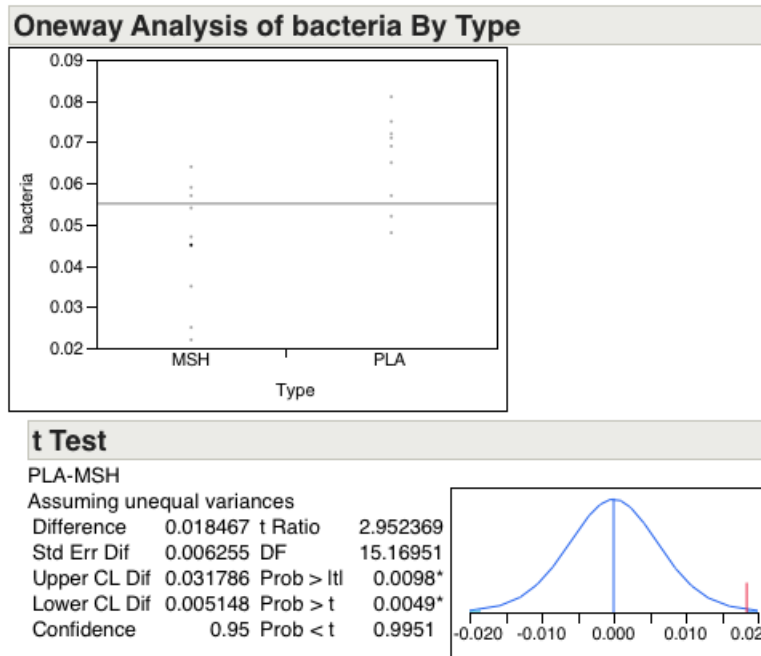
Figure 7: MSH corresponds the group given MSH and PLA corresponds to the group given the Placebo.

(9) Microbiologists want to understand whether MSH **reduces** the level of bacteria growing in a dish. The experiment was done 19 times. MSH was administered at the start of the experiment for 9 of the experiments. For the remaining 10 experiments no MSH was administered. After two days the bacteria level was measured. The output of the independent sample t-test using this data, is given in Figure 7.

(a) State the hypotheses of interest. [1]

(b) Use Figure 7 to test the hypotheses given in (a). [1]

PLEASE TURN OVER for parts (c) and (d)

(c) State an alternative statistical test that could have been used. [1]

(d) Use Figure 7 to test the hypotheses $H_0 : \mu_{PLA} - \mu_{MSA} \leq 0.01$ against
$H_A : \mu_{PLA} - \mu_{MSA} > 0.01$. [2]

probability	0.15	0.10	0.05	0.025	0.01	0.005
t^*	1.07	1.33	1.75	2.13	2.60	2.94

Table 1: Tables for a t-distribution with 15.169df