NOTE: The questions below often have more than one part. Make sure you answer all parts completely. Assume I know nothing.

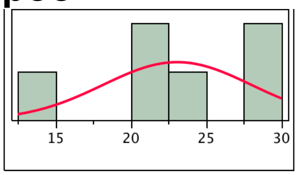
5) The Environmental Protection Agency has mandated that the ABC Widget company reduce their Pb concentration in effluent water by 40ppm compared to current concentrations. You are hired to design a sampling plan and to provide statistical tests. The client complains that sampling and analysis is expensive and that you have budgeted for way too many samples. “Au contraire”, you say (that’s French for “on the contrary”), and you go on to explain IN CONSIDERABLE DEPTH and DETAIL…(10pts)

The problem is that the EPA mandates a certain decrease (40ppm). What we really don't want to do is to commit a type II error, because that would mean that we really did meet the requirment, but were unable to detect it. We can greatly reduce our chance of making a type II error by having a large sample size (this will give us a greater power to detect the drop in Pb concentration needed).

So, although you may be paying a little more now for those extra samples, the consequences of a type II error, where you were in compliance but failed to prove it, are far more expensive (maybe $10,000 per day).

6) I want to maximize garden tomato production for making gravy. In a test next year, I set up 12 plants and apply two different fertilizers, chicken poo and veggie compost, to 6 plants each. Throughout the year, I measure the total weight of tomatoes produced by each plant. Various JMP output is below. Please state the null and alternate hypothesis then follow the proper path to reach a final conclusion. Explain each step as you go and include any assumptions that you make (each test is separated by double lines below)(10pts)

poo



Fitted Normal
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	23.0805	17.915501	28.245499
Dispersion	σ	4.921692	3.0721596	12.071011

Goodness-of-Fit Test
Shapiro-Wilk W Test

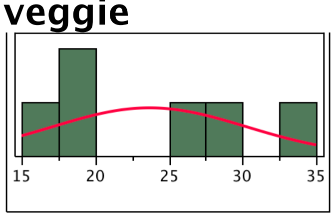
W	Prob<W
0.927709	0.5625

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

________**unpaired, 2-sample test. Poo group is normal**

---

veggie



Fitted Normal
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	23.691834	16.78429	30.599378
Dispersion	σ	6.5821512	4.1086314	16.143476

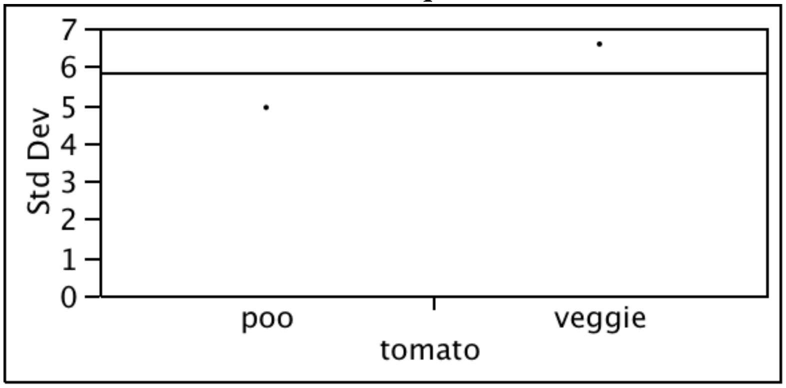
Goodness-of-Fit Test
Shapiro-Wilk W Test

W	Prob<W
0.955463	0.7842

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

________**unpaired, 2-sample test. veggie group is normal**

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
poo	6	4.921692	3.711172	3.711172
veggie	6	6.582151	5.414544	5.414544

Test	F Ratio	DFNum	DFDen	p-Value
F Test 2-sided	1.7886	5	5	0.5389

__**variances are equal. proceed to t-test with equal variances**

____

t Test
veggie-poo
Assuming unequal variances

Difference	0.6113	t Ratio	0.1822
Std Err Dif	3.3553	DF	9.259527
Upper CL Dif	8.1692	Prob > |t|	0.8594
Lower CL Dif	-6.9466	Prob > t	0.4297
Confidence	0.95	Prob < t	0.5703

________**do not use this.**

____

t Test
veggie-poo
Assuming equal variances

Difference	0.6113	t Ratio	0.1822
Std Err Dif	3.3553	DF	10
Upper CL Dif	8.0874	Prob > |t|	0.8591
Lower CL Dif	-6.8647	Prob > t	0.4295
Confidence	0.95	Prob < t	0.5705

__**2-sample t-test with equal variances. Do not reject null and conclude that there is not difference between the two treatments.**

Matched Pairs
Difference: veggie-poo

veggie	23.6918	t-Ratio	0.17339
poo	23.0805	DF	5
Mean Difference	0.61133	Prob > |t|	0.8691
Std Error	3.52577	Prob > t	0.4346
Upper 95%	9.67462	Prob < t	0.5654
Lower 95%	-8.452		
N	6		
Correlation	-0.1086		

Do not use this test

Wilcoxon Sign-Rank

	veggie-poo
Test Statistic	1.500
Prob > |z|	0.8438
Prob > z	0.4219
Prob < z	0.5781

Do not use this test

Mann-Whitney

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
poo	6	38.000	6.33333	-0.080
veggie	6	40.000	6.66667	0.080

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
40	0.08006	0.9362

Do not use this test

7) Egg production in Clown Fish is thought to be related to wave action, or the lack thereof. To test this, you set up 18 tanks, six that have a wave disturbance every 30 seconds, six that have a wave disturbance every minute, and six that are still. In each case, the number of eggs are counted. State your null and alternate hypotheses, complete the table below (the gray boxes need information) and provide a conclusion based on your results. In addition, what assumptions are you making regarding the data since you have no information about the actual data? (15pts)

Source	SS	DF	Mean Square	F
Group	375.32	2	187.66	4.76
Error	591.54	15	39.44	
Total	966.86	17	56.87	

Ho: $\mu_{still}=\mu_{30}=\mu_{1m}$
Ha: at least one mean is different

F-critical with 2dof/15dof = 3.68
Reject Ho because the calculated F=4.76 is greater than the critical value at alpha=0.05. Conclude that at least 1 mean is different. Proceed to Tukey test

Assumptions: normality, homogeneity of variance

8) a) In what circumstances is the Mann-Whitney (a.k.a. the Wilcoxon-Mann-Whitney) test used? (be complete and precise) (5pts)

Two-sample, unpaired/independent, with non-normal data or ordinal data (e.g. letter grades)

b) Why don't we use non-parametric tests all the time? Under what circumstances might it not matter if you use a parametric or non-parametric test?(5pts)

Non parametric tests are less powerfull than parametric tests for the same sample size. If the sample size is large, however, the non parametric test can provide the necessary power.

c) Why is a non-parametric test robust with respect to outliers compared to the corresponding parametric test? (5pts)

In the non parametric test, the outlier just becomes the next rank, so is no longer an outlier.

The Food and Drug Administration (FDA) is examining claims from a pharmaceutical company regarding the effectiveness of a new drug. The purpose of the drug is to lower the "bad" cholesterol in the bloodstream (LDL-low density lipoprotein), but maintain the "good" cholesterol (HDL-high density lipoprotein) at an acceptable level of 26 mg/dL. The FDA is concerned that the drug may cause HDL levels to go below 26mg/dL.

a) State the null and alternate hypotheses

see http://fox.rwu.edu/biostats/answers/errors_activity_answers.pdf

b) Discuss the implications of a Type I error from the point of view of the pharmaceutical company.

c) Discuss the implications of a Type II error from the point of view of the pharmaceutical company AND the FDA.

d) If α=0.05, calculate the Power for a sample size of 30 individuals if the sample mean is 25.8 mg/dL and do the same for a sample mean of 25.0 mg/dL. Use a standard deviation of 1.5 mg/dL for both cases.

e) Let's turn this around a bit and ask a sample size question. The FDA is critical of the above study after calculating the power. They go back to the pharmaceutical company and require them to re-run the study, with α=0.05, and a Type II error rate of β=0.10 for a HDL of 25.5 mg/dL. That is, the FDA requires that the company design an experiment that can detect an HDL 0.5 mg/dL below the minimum acceptable level 90% of the time.

What sample size is required?

Note: The idea here is to create what is called a Power Curve. Set your equations up in Excel so that you can just change one cell (the sample size) and recompute the power over and over for different sample sizes. Then make a graph of Sample Size v. Power.
Hint: =normsdist(zvalue)

Here's my example but using a different HDL level of 25.75 mg/dL:

Table 1. Cheezy screen capture of my Excel spreadsheet calculations.

null mean	26		Sample Sizes		xbar lower	z-beta	p
alternate	25.75		30		25.549	-0.7321	0
z	1.645		35		25.583	-0.6590	0
stdev	1.5		40		25.610	-0.5909	0
			45		25.632	-0.5270	0
			50		25.651	-0.4665	0
			55		25.667	-0.4090	0
			60		25.681	-0.3540	0
			65		25.694	-0.3013	0
			70		25.705	-0.2506	0
			75		25.715	-0.2016	0
			80		25.724	-0.1543	0

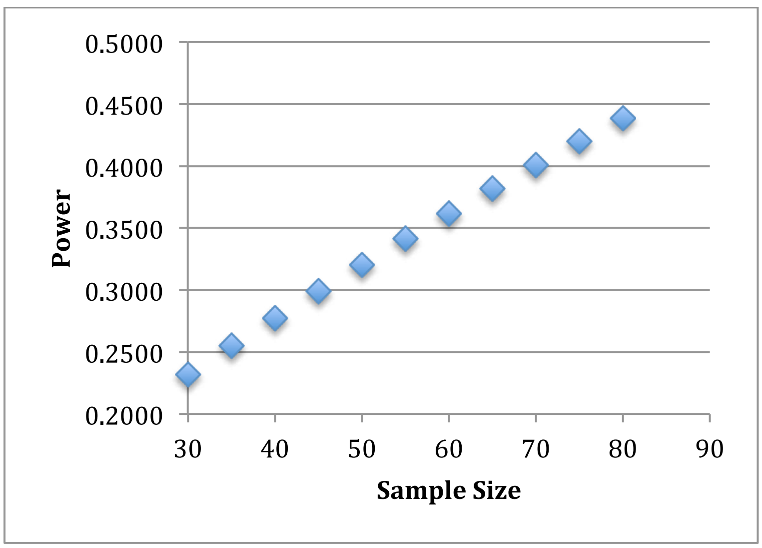


Figure 1. Power curve for pharmaceutical question to detect at HDL of 0.25 mg/dL below the minimum acceptable level of 26 mg/dL.

2) On a particular day, a couple of shellfishermen collect 834 quahogs. Their mean size is 27.86mm and the standard deviation is 11.35.

We did this one in both classes on Monday

Given that the sizes are normally distributed...

How many individuals are between 10 and 20mm? These fetch the most money.

How many individuals are greater than 40mm? These are the chowder clams and fetch the least money.

3) Dr. Byrn is collecting bugs from dirt in two different environments. In the first environment, his pit-fall traps collect 124 individuals from 7 species. In the second environment, his traps collect 96 individuals from 5 species. Which site has a higher species richness?

My favorite for species richness is Margalef, so I'll use that here.
So: First R1=(7-1)/ln(124) =1.24
Second R1=(5-1)/ln(96)=0.88
The first environment has the greater species richness

You are hired by Marge Innovera to do statistical analysis on a potentially new sub-species of Wombat, the elusive Long-Eared Wombat. Years of data collected on Wombats from Australia reveal that the average ear length of an Australian Wombat is 22.1mm. A sample of 31 Wombats (they are elusive, you only get a sample size of 31) from Tasmania is available at http://fox.rwu.edu/biostats. Your job is to see if the Long-Eared Wombat from Tasmania really exists, or if they are just natural variations of the Australian Wombats.
one-sample z-test
There is an outlier in the data. remove it.

z=(24.33-22.1)/(10.32/sqrt(30))=1.1845, p~=0.1190 from z-table.

We want to know if the "long eared" wombat exists, so a right-tailed test, p=0.1190, do not reject then null, conclude there is no long-eared wombat.

The lobster fishery in New England has been cited as a model for how to manage fisheries. Lobstermen and women, tag eggers (egg laying females) by notching the carapace. This signals to other lobster people that they have caught an egg laying female and should release her. The current minimum size limit in Maine is a carapace length of 83mm. This ensures that juveniles grow to reach adulthood. One overlooked issue is the large lobsters that live offshore. Some people view these large offshore lobsters as vital to sustaining the in-shore population, especially since nearly every in-shore lobster is caught. So, in addition to the minimum size limit, there should be a maximum size limit that leaves the top 5% of the population alone. Based on the lobster carapce length data (mm) available online at http://fox.rwu.edu/biostsats/data, what should be the maximum size limit?

1.645=(xi-79.07)/8.99
xi=93.86cm

For each question, state the null and alternate hypotheses.

1) The average price of a gallon of gasoline in RI is $3.45. It is usually perceived that gasoline is less expensive in MA than in RI. In your trip to Springfield, MA you pass 15 service stations and record the price of gasoline. Is gasoline less expensive in MA than in RI?

Answers for this section at http://fox.rwu.edu/biostats/answers/null_practice_key.pdf

2) A manufacturing process seeks an average stainless steel pin diameter of 1.2cm. Over time, the stamping and forging machines drift off that mean value. Your job is to collect daily samples of pins (30 per day) and see if the steel pins are adhering to the manufacturing specifications.

Answers for this section at http://fox.rwu.edu/biostats/answers/null_practice_key.pdf

3) Zdeno Chara says that he can shoot a hockey puck over 100 miles per hour, on average. To check the validity of his claim, he shoots 20 pucks into a radar speed trap. Is he correct?

Answers for this section at http://fox.rwu.edu/biostats/answers/null_practice_key.pdf

4) A new radical weight loss program called "eat less and move more" is under clinical trials. The trial group consists of 53 individuals who’s weight is measure before

starting the program and again after four weeks. Assuming that all the test subjects follow the program, does it result in weight loss?

Answers for this section at http://fox.rwu.edu/biostats/answers/null_practice_key.pdf

Power Calculation Practice

A study of fasting blood glucose levels in diabetic patients wishes to avoid glucose levels that are too low, as this can be immediately dangerous. The minimum acceptable mean glucose level is 65 mg/dL. For a sample of 20 patients, the mean glucose level is 55 mg/dl with a standard deviation of 15. To be on the safe side, we want an alpha of 0.01.

State the null and alternate hypotheses to get you started.

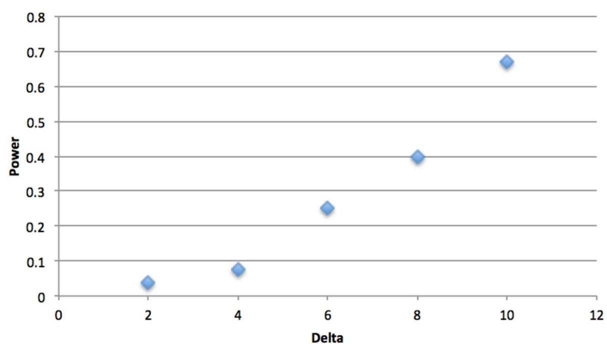
Ho: μ=65
Ha: μ<65

With 20 patients, this is a t-test problem

t-beta=10/sqrt(15^2/20)-2.539
t-beta = 0.44, so 0.30<beta<0.40 (I have a t-table that may have more alphas than yours.
So 0.60<power<0.70

Repeat this analyis assuming that the mean sample glucose level was 57, 59, 61, and 63 mg/dL. Make a graph of power v. sample mean.
(I used excel rather than redo the calculation 4 more times)
Once you get negative t-beta values, the t-table reads power, not beta. Excel can't do this.

You should get something like this. I graphed midpoints of my power



WARNING: NOTE: In case you didn't recognize it, this is a LEFT tailed test. This means that what you read from our right-tailed table is β, and Power=1-β.

WARNING this is an old example, and apparently was for a z-test at the time but I changed the sample size to t-test size and missed deleting this note. this note would apply for a z-test but not for t-tes

1. An investigator is interested in comparing the cardiovascular fitness of runners on three different courses, each of which covers 10 miles. Course 1 is flat, Course 2 has gentle inclines, and Course 3 includes steep inclines. Ten runners are involved, and their heart rates measured on each course are shown below. Assume all measures are independent.

Runner Number	*Course 1*	*Course 2*	*Course 3*
1	132	135	136
2	143	148	152
3	135	138	144
4	128	131	143
5	141	141	155
6	144	142	163
7	134	134	142
8	136	144	159
9	145	145	155
10	150	147	158

Is there a significant difference in the mean heart rates of runners on the three courses? If so, which means are different? Use $\alpha = 0.05$.

Your ANOVA table should be identical:

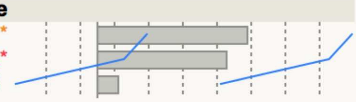
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
course	2	828.4667	414.233	7.8092	0.0021*
Error	27	1432.2000	53.044		
C. Total	29	2260.6667			

Reject the null, conclude that at least 1 mean is different. Proceed to Tukey test. You should get something like the following:

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
course 3	course 1	11.90000	3.257129	3.82422	19.97578	0.0031*
course 3	course 2	10.20000	3.257129	2.12422	18.27578	0.0112*
course 2	course 1	1.70000	3.257129	-6.37578	9.77578	0.8613



Courses 1 and 2 are not different from each other. Three is different from both 1 and 2

$\mu 1 = \mu 2 \neq \mu 3$

2) In preparation for a t-test, you are testing data for normality. You have a sample of 20 fish and are sampling tissues for mercury content. JMP calculates a skewness of 0.824 and a kurtosis of -0.942. Knowing that t-tests are pretty robust to deviations from normality, you pick alpha = 0.01. Are the data skewed? Are the data platykurtic (kurtosis too low) or leptokurtic (kurtosis too high) or mesokurtic (Goldilocks)?
skew critial from table=1.304 (do not reject null that sqrt(b1)=0

kurto critical upper=5.91, lower=1.58. kurt calculated = -0.942+3=2.059. do not reject null b2=3, mesokurtic

3) As sample of 213 Mackerals has a mean mercury concentration of 0.73ppm with a standard deviation of 0.05. The EPA says fish are safe to consume if they contain mercury concentrations less than 0.50ppm. If your alpha is 0.05 and you want a power of 0.90 will you be able to detect the difference between a population mean equal to your sample mean and the EPA limit?
- I assumed a 1-tailed test since you are only intersted in exceeding the EPA limit
detectable difference problem
delta=sqrt(0.05^2/213)(1.645+1.282)
=0.01
The needed delta is 0.23ppm (0.73-0.50) and I can detect down to 0.01ppm

4) Let's turn #3 around a bit. You are submitting a proposal to sample bluefish in Narragansett Bay for mercury content. If you want a Type I error rate of 5% and a Type II error rate of 10% how many fish do you need to catch to detect a population mean concentration more than 0.05ppm ABOVE the EPA limit.
This one needs to be solved iteratively. I'll guess n=40 at first:
n=0.05^2/0.05^2(1.684+1.303)^2
n1=9 (round up)
n2=0.05^2/0.05^2(1.860+1.397)^2
n2=11(round up)
n3=0.05^2/0.05^2(1.812+1.372)^2
n3=11(round up)

a) What is species richness?
the number of species in an environment or ecosystem

b) What is species eveness?
the distribution of individuals across species in an environment or ecosystem.

c) We discussed two indices of secies richness, the Margalef and Menhinik indices. Why do we even need these? Why not just use the number of species encountered to measure species richness?
if the sample effort (sample size) is the same, then we can use the number of species encountered. However, if the total number of individuals counted is different, then we have to adjust for the different sampling effort and use a Margalef, or Menhinik index.

1) For a biostatistic project, you need to measure acorns to test if the average size of acorns has **changed** since the 19th Century. In previous studies, it was determined that the standard deviation of acorn size is 0.28cm. You are testing your data against a 19th Century average acorn length of of 2.56cm. You REALLY need to be sure on this one so you want to make it difficult to reject the null and pick α=0.01. Consequently, you are more willing to make a Type II error than you might normally be, so you pick β=0.25.

a) State your null and alternate hypotheses

Ho: μ=2.56cm   Ha:$\mu \neq$2.56

b) A previous class estimated the mean acorn length as 2.64. How many acorns would you have to measure to detect a difference between your null and what the previous class estimated for the mean length given your choices above of Type I and Type II error rates?

sample size /detecatable difference question, 2-tailed
guess 40
n1=0.28^2/(2.64-2.56)^2(2.704+0.681)^2
n1=141
n2=0.28^2/0.08^2(2.364+0.677)^2
n2=114
my t-table only has n=80, 100, 1000, so thats about as good as I can do.

c) You now discover that you have enough money to hire a helper. If you double your sample size, from part (a) what will your new power be?
n=228
t-beta=0.08/sqrt(0.28^2/228)-2.626 (my t-table only has n=100 or 1000)
t-beta = 1.688, so 0.025<beta<0.05 or 0.95<power<0.975

d) A previous class estimated the mean acorn size as 2.64±0.07 (95% confidence interval). What sample size would you need to get the same confidence interval width?

sample size confidence interval problem. 1/2 confidence interval width =0.07 so that is d
guess 40
n1=(0.28^2*2.704)/0.07^2
n1=44
n2=(0.28^2*2.704)/0.07^2 (my t-table only has 40 and 60 so that's about the best I can do

Which test to use? All data are on the web site.
Answers are here :
http://fox.rwu.edu/biostats/answers/which_test_to_use_answers.pdf
Scenario 1.

You are testing the effect of atmospheric CO_2 concentrations on root/shoot ratios in plants. You set up two different CO_2 concentrations in two different growth chambers and have 10 plants in each growth chamber. You want to see if the CO_2 concentration has any effect on root/shoot ratios. Given the following data after 6 months of growth, perform the correct test.

Scenario 2.

Iron has been hypothesized to be a limiting nutrient for some phytoplankton in certain parts of the ocean where there is excess nitrate and phosphate. You decide to test this in the tropical Pacific, a "High Nutrient, Low Chlorophyll" (HNLC) region. You measure the concentration of diatoms before and after adding iron in different patches of the equatorial Pacific. Perform the correct test.

Scenario 3.

Compare the mean Northern Hemisphere temperature before anthropogenic global warming (1895-1904) and during (1995-2004). What should your alternate hypothesis be? What are the results?

Scenario 4.

A study of insulin effectiveness is being conducted using two slightly different insulin types. Both groups of test subjects have the same type and stage of diabetes and both are given the same diet. Does the type of insulin have an impact on the blood glucose levels?

Scenario 5.

Crop yields are important to the backyard gardener and the commercial farmer. Yields are measured in 50 1-meter quadrats. Half the quadrats are treated with Phosphastic and the other half with Nitrophostic. Is there a difference in the crop yields for the different fertilizers?

z-table practice/homework

You may assume that all the data sets involved below are normally distributed (i.e. follow a nice bell curve)

1) Find $P(z>0)$

0.50

2) Find $P(z>-1.25)$

0.8944

3) Given a P of 0.05, what is z?

1.645

4) A sample has a mean of 23.4 and a standard deviation of 4.19.

a) What percent the population is greater than 27.59? (that's $\mu+\sigma$ for those of you keeping score at home)

z=(27.59-23.4)/4.19

z=1.00, p=0.1587 (15.87)

b) What percentage of the population is greater than 31.78? (that's $\mu+2\sigma$ for those

z=2.00

p=0.0228 (2.28%)

c) What percentage of the population is less than 20.1?

z=(20.1-23.4)/4.19

z=-0.788, p=0.7852 (neg z-value do 1-table value) (78.52%)

d) What percentage of the population is greater than 11.4?

z=(11.4-23.4)/4.19

z=-2.86, p=0.9979 (99.79%)

5) The long-eared Wombat is variant of the regular Wombat. Regular adult Wombats have a mean ear length of 4.8cm with a standard deviation of 0.6. In contrast, the shortest ear recorded on the long-eared Wombat is 6.4cm. What percentage of regular Wombats have an ear longer than the shortest long-eared Wombat?

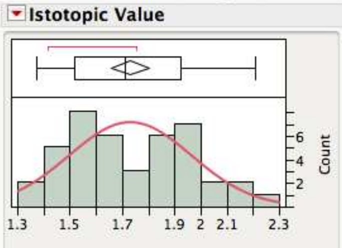
NOTE: For all hypothesis tests, use α=0.05. Name:______________

2) Does ocean circulation change during glacial and interglacial times? Carbon isotopes can tell us what water mass was present at one location in the ocean at very different times. We have data from sediments that has be separated into "glacial" and "interglacial" times. Based on the JMP output below, what would be your next step.

a) check for normality
b) check for equal variances (a.k.a. homogeneity of variance)
c) perform a 1-sample z-test
d) perform a 1-sample t-test
e) perform a 2-sample t-test with **equal variances**
f) perform a 2-sample t-test with **UNequal variances**
g) perform a 2-sample t-test with **paired** data
h) attempt a data transformation

Distributions climate=glacial

Istotopic Value



Normal(1.73189,0.23358)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	1.7318932	1.6591059	1.8046804
Dispersion	σ	0.2335754	0.1921871	0.2978474

-2log(Likelihood) = -3.96617673079248

Goodness-of-Fit Test

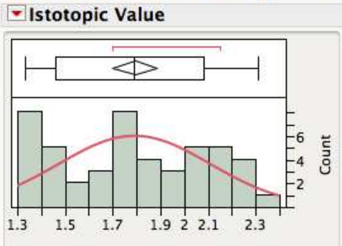
Shapiro-Wilk W Test

W	Prob<W
0.952598	0.0800

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Distributions climate=interglacial

Istotopic Value



Normal(1.79195,0.31715)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	1.7919489	1.6998581	1.8840397
Dispersion	σ	0.3171502	0.2640176	0.3972561

-2log(Likelihood) = 24.973635308573

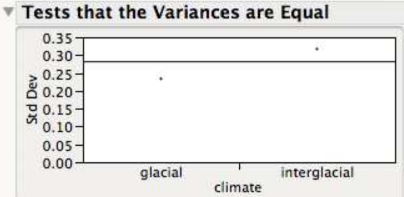
Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.932854	0.0087*

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
glacial	42	0.2335754	0.2014917	0.2014917
interglacial	48	0.3171502	0.2667322	0.2666801

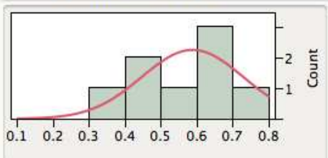
Test	F Ratio	DFNum	DFDen	p-Value
O'Brien[.5]	8.3916	1	88	0.0048*
Brown-Forsythe	4.4797	1	88	0.0371*
Levene	4.5496	1	88	0.0357*
Bartlett	3.9359	1	.	0.0473*
F Test 2-sided	1.8436	47	41	0.0480*

3) Maximizing egg production in chickens is important to both the commercial farmer and the back-yard farmer. Eight chickens fed a regular diet are tracked for two weeks and their average daily egg production is calculated. The same eight chickens are then switched to a high-protein diet and tracked for another two weeks. Based on the JMP output below, what would be your next step.

a) check for normality (the wrong normality test was done)-these are paired data
b) check for equal variances (a.k.a. homogeneity of variance)
c) perform a 1-sample z-test
d) perform a 1-sample t-test
e) perform a 2-sample t-test with **equal variances**
f) perform a 2-sample t-test with **UNequal variances**
g) perform a 2-sample t-test with **paired** data
h) attempt a data transformation

Distributions Column 1=high-protein

daily egg production



Normal(0.58863,0.14109)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	0.5886335	0.4706815	0.7065855
Dispersion	σ	0.1410874	0.0932833	0.2871512

-2log(Likelihood) = -9.63099928801258

Goodness-of-Fit Test

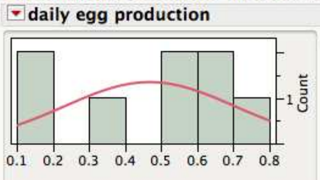
Shapiro-Wilk W Test

W	Prob<W
0.927651	0.4949

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Distributions Column 1=normal diet

daily egg production



Normal(0.46836,0.23606)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	0.4683598	0.2710055	0.665714
Dispersion	σ	0.2360638	0.1560793	0.4804541

-2log(Likelihood) = -1.39543409308699

Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.869445	0.1489

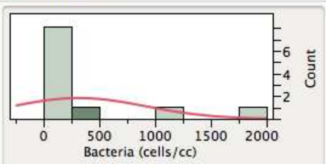
Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

4) During the summer, elevated bacterial counts sometimes cause beach closures around Narragansett Bay. Some people have hypothesized that the increases in bacteria is related to precipitation events and runoff. So, I collected samples before and after precipitation events at seven stations in upper Narragansett Bay. Based on the JMP output below, what would be your next step.

a) check for normality
b) check for equal variances (a.k.a. homogeneity of variance)
c) perform a 1-sample z-test
d) perform a 1-sample t-test
e) perform a 2-sample t-test with **equal variances**
f) perform a 2-sample t-test with **UNequal variances**
g) perform a 2-sample t-test with **paired** data
h) attempt a data transformation

Distributions timing=after precip

Column 2



Normal(317.379,597.154)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	317.37853	-83.7951	718.55217
Dispersion	σ	597.15418	417.2418	1047.9659

-2log(Likelihood) = 170.844505092264

Goodness-of-Fit Test

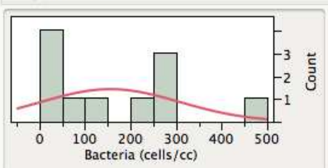
Shapiro-Wilk W Test

W	Prob<W
0.601735	<.0001*

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Distributions timing=before precip

Column 2



Normal(155.775,152.484)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	155.77479	53.334916	258.21466
Dispersion	σ	152.4836	106.54289	267.59858

-2log(Likelihood) = 140.811902250613

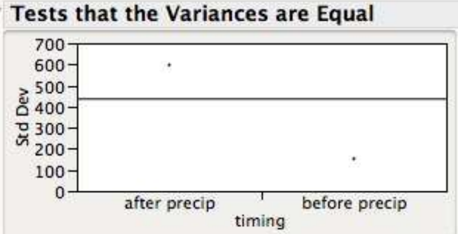
Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.880033	0.1041

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Tests that the Variances are Equal

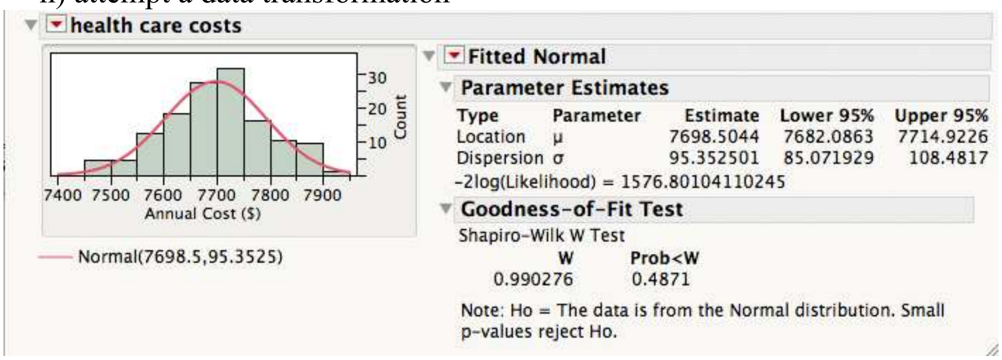


Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
after precip	11	597.1542	413.6057	299.9917
before precip	11	152.4836	132.2915	130.7179

Test	F Ratio	DFNum	DFDen	p-Value
O'Brien[.5]	1.8366	1	20	0.1905
Brown-Forsythe	0.9056	1	20	0.3526
Levene	5.0489	1	20	0.0361*
Bartlett	14.0026	1	.	0.0002*
F Test 2-sided	15.3365	10	10	0.0002*

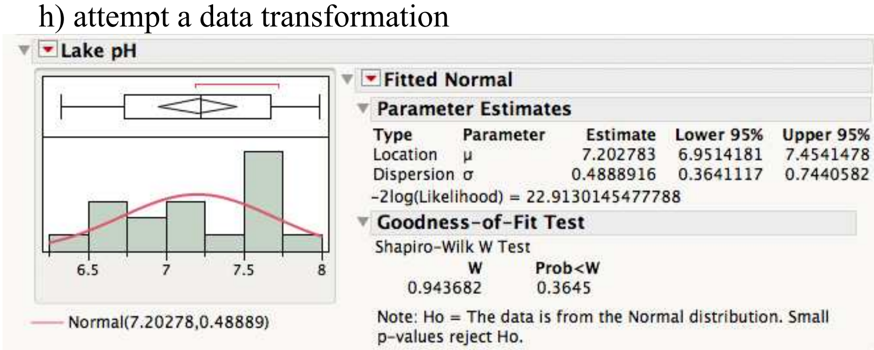
5) Do Rhode Islanders spend more per person on health care compared to the national average of $7,681 per year? You have a sample of 132 Rhode Islanders. Based on the JMP output below, what would be your next step.

a) check for normality
b) check for equal variances (a.k.a. homogeneity of variance)
c) perform a 1-sample z-test
d) perform a 1-sample t-test
e) perform a 2-sample t-test with **equal variances**
f) perform a 2-sample t-test with **UNequal variances**
g) perform a 2-sample t-test with **paired** data
h) attempt a data transformation



6) If you've taken Limnology, you know that lakes in limestone catchments have built-in pH buffering and are protected from acid rain and maintain a pH of 7. Rhode Island doesn't have any limestone and most of our lakes are in granite catchments. Are Rhode Island lakes impacted by acid rain? I sampled water from 17 lakes in RI and measured the pH. Based on the JMP output below, what would be your next step.

a) check for normality
b) check for equal variances (a.k.a. homogeneity of variance)
c) perform a 1-sample z-test
d) perform a 1-sample t-test
e) perform a 2-sample t-test with **equal variances**
f) perform a 2-sample t-test with **UNequal variances**
g) perform a 2-sample t-test with **paired** data
h) attempt a data transformation

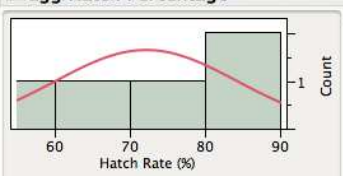


7) Does the diet fed to breeding fish impact the egg hatch rate? You set up 10 tanks, each tank has a breeding pair of Rhynefish. The fish in five tanks are fed a diet of "Skip's Finest Fish Food" and the fish in the other five tanks are fed a diet of "Dale's Delicious Delicacies". Based on the JMP output below, what would be your next step.

a) check for normality
b) check for equal variances (a.k.a. homogeneity of variance)
c) perform a 1-sample z-test
d) perform a 1-sample t-test
e) perform a 2-sample t-test with **equal variances**
f) perform a 2-sample t-test with **UNequal variances**
g) perform a 2-sample t-test with **paired** data
h) attempt a data transformation

Distributions Diet Type=Dale's

Egg Hatch Percentage



Normal(72.2302,12.0345)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	72.230183	57.287363	87.173004
Dispersion	σ	12.034512	7.2102751	34.581841

-2log(Likelihood) = 38.067170787916

Goodness-of-Fit Test

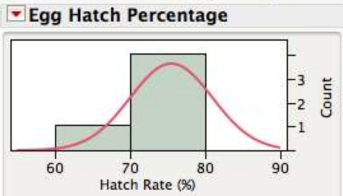
Shapiro-Wilk W Test

W	Prob<W
0.986173	0.9647

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Distributions Diet Type=Skip's

Egg Hatch Percentage



Normal(75.528,5.46948)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	75.527995	68.736737	82.319252
Dispersion	σ	5.4694808	3.2769472	15.716857

-2log(Likelihood) = 30.1812223298417

Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.826455	0.1308

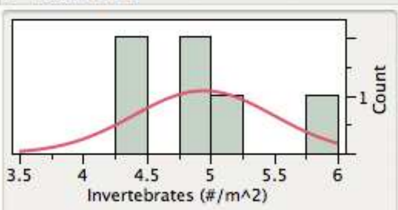
Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

8) A few years ago, a Marine Bio student was working on a research project looking at invertebrate abundances on oyster reefs, compared to abundances just off the reef. He set up "on-reef" and "off-reef" sampling sites adjacent to one another at 6 sites in the bay. Based on the JMP output below, what would be your next step.

a) check for normality (wrong normality test was done, these are paired data)
b) check for equal variances (a.k.a. homogeneity of variance)
c) perform a 1-sample z-test
d) perform a 1-sample t-test
e) perform a 2-sample t-test with **equal variances**
f) perform a 2-sample t-test with **UNequal variances**
g) perform a 2-sample t-test with **paired** data
h) attempt a data transformation

Distributions reef?=off-reef

Column 2



Normal(4.948,0.55048)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	4.948003	4.3703091	5.5256969
Dispersion	σ	0.5504806	0.3436144	1.3501163

-2log(Likelihood) = 8.86369885401394

Goodness-of-Fit Test

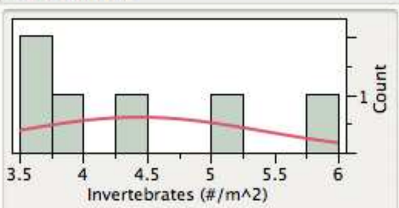
Shapiro-Wilk W Test

W	Prob<W
0.901698	0.3841

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Distributions reef?=on-reef

Column 2



Normal(4.43963,0.97379)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	4.439635	3.417705	5.4615649
Dispersion	σ	0.97379	0.6078475	2.388331

-2log(Likelihood) = 15.7085474005237

Goodness-of-Fit Test

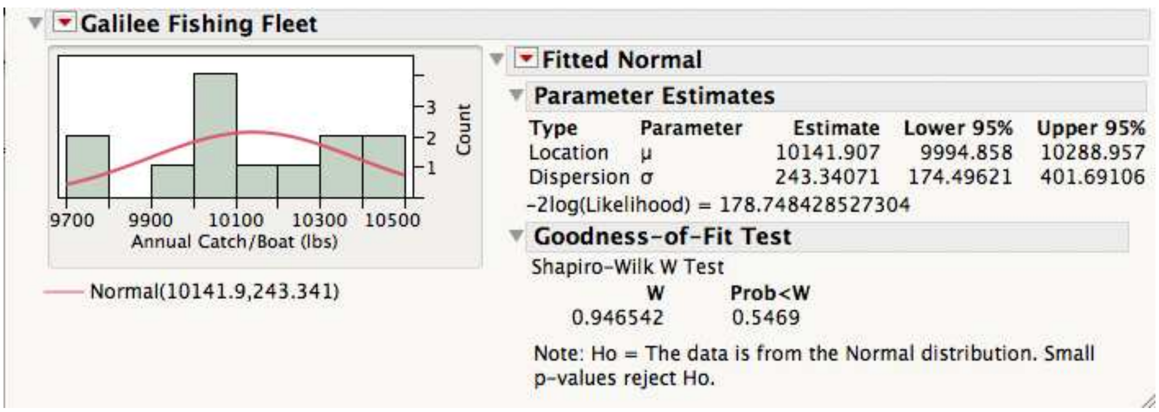
Shapiro-Wilk W Test

W	Prob<W
0.876559	0.2536

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

9) Fisheries management is a dicey problem. How to set the limits that fisherman can catch? A management strategy is designed in which if the average annual catch per boat falls below 10,000 pounds, new restrictions are imposed. For this year, 13 boats out of Galilee were tracked and their annual catch recorded. Based on the JMP output below, what would be your next step.

a) check for normality
b) check for equal variances (a.k.a. homogeneity of variance)
c) perform a 1-sample z-test
d) perform a 1-sample t-test
e) perform a 2-sample t-test with **equal variances**
f) perform a 2-sample t-test with **UNequal variances**
g) perform a 2-sample t-test with **paired** data
h) perform a Mann-Whitney non-parametric test
i) perform a Wilcoxon Signed-Rank test



10) For each of the following, would you use the "standard error" or the "standard deviation" (Please circle the correct answer).

a) Item 9 above.
(standard error) (standard deviation)

b) The percentage of individual clams greater than 43mm across
(standard error) (***standard deviation***)

c) The percentage of quahoggers that average more than 153 littlenecks per day for the season.
(standard error) (***standard deviation***)

d) You are calculating the 95% confidence interval for the average number of fairies on a the head of a pin.
(***standard error***) (standard deviation)