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1/15/17

Question 1) RANDOMIZED EXPERIMENTS vs. RANDOM SAMPLES:

The difference between randomized experimentation and random sampling is a difference between 1) how units are **allocated** to groups for study purposes and 2) how they are **selected** for sampling (see Display 1.5, *The Statistical Sleuth*, p. 9). **Randomized allocation** ensures that units are assigned to treatment groups at random. **Random sampling** ensures that every subset of a population is afforded the same chance of being selected—a crucial statistical method for securing the most representative sample measurements possible. **Only on the condition of randomized allocation can causal inferences be drawn**. If random sampling is also used in a randomized experiment for the selection of units, then inferences to populations may also be drawn.

Question 2) *Literary Digest* – POLLING EXAMPLE:

If one is interested in predicting presidential election results, the desired population of interest for such a polling survey would be the American citizenry as a whole. However, the design of the survey—which relied on info from subscribers to a literary magazine, phone number records, and auto registration records—allowed it to selectively sample from sources that poorly represented this population of interest. Indeed, in the historical context of the Great Depression, a large impact on the 1936 election results could be attributed to the ***illiterate poor***, who were not likely to subscribe to the *Literary Digest*, or to have access to novel and often expensive consumer goods like home telephones and automobiles. With the right study conditions and random selection mechanisms in place, one could potentially draw inferences to populations of *Literary Digest* readers, but little more can be determined.

Question 3) STUDY DESIGN – SCOPE of INFERENCE:

The four study designs correspond to the four quadrants of Display 1.5 in *The Statistical Sleuth* (p. 9), with differences in random vs. non-random selection and allocation of units.

Part a):

This design corresponds to the bottom right-hand quadrant of Display 1.5, where collections of available units from distinct groups are examined. **Allocation is non-randomized**, since it is up to the farmers to determine the group to which they belong—those who use the new fertilizer and those who do not. **Selection is also non-random**, insofar as sampling depends on those farmers who choose to send in the survey reporting their yield. No causal inferences or inferences to populations can be drawn.

Part b):

This design corresponds to the bottom left-hand quadrant of Display 1.5, where a group of study units is found before units are randomly assigned to treatment groups. **Allocation is randomized**, since farmers are randomly sent either the old or new fertilizer. As in Part a), **selection is non-random**, insofar as sampling remains dependent on those farmers who report their yield. No inferences to populations can be drawn, but causal inferences may or may not be drawn, depending on how one's tests for statistical significance turn out.

Part c):

This design corresponds to the upper left-hand quadrant of Display 1.5, where random samples are selected from a population before units are randomly assigned to different treatment groups. In this case, **allocation is randomized**, since the farmers are randomly sent either the old or new fertilizer. The sub-selection of fertilizer orders at the end of the season also ensures that **selection is random**. Under these study conditions, causal inferences and inferences to populations can be drawn.

Part d):

This design corresponds to the upper right-hand quadrant of Display 1.5, where random samples are selected from existing distinct populations. **Allocation is non-randomized**, since it is up to the farmers to decide whether or not to use the new fertilizer, which is offered at a discount. However, as in Part c), the sub-selection of fertilizer orders at the end of the season ensures that **selection is random**. Under these conditions, inferences to populations may or may not be drawn, but no causal inferences can be drawn.

Question 4a) FIGURES:

Figure 1: ***The UNIVARIATE Procedure – School = 0 (SMU)***

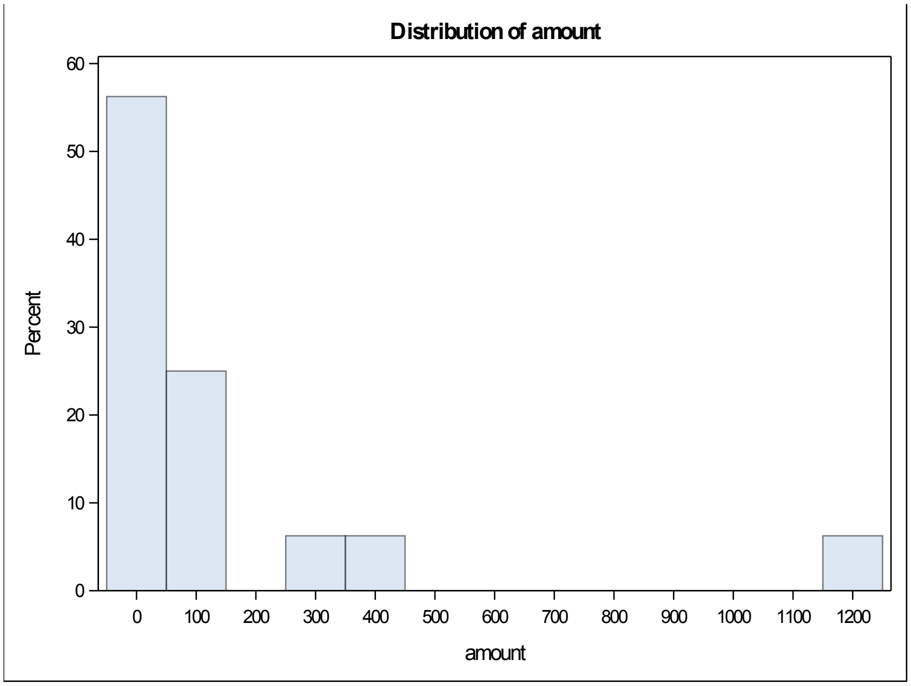


Figure 2: ***The UNIVARIATE Procedure – School = 1 (Seattle U)***

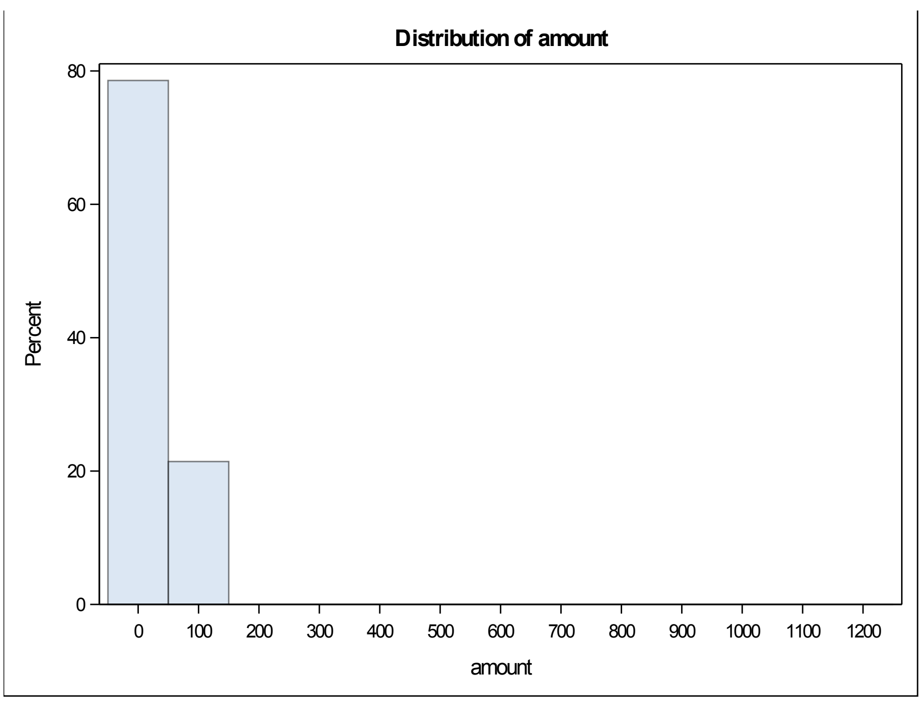


Figure 3: ***The TTEST Procedure – Variable: Amount***

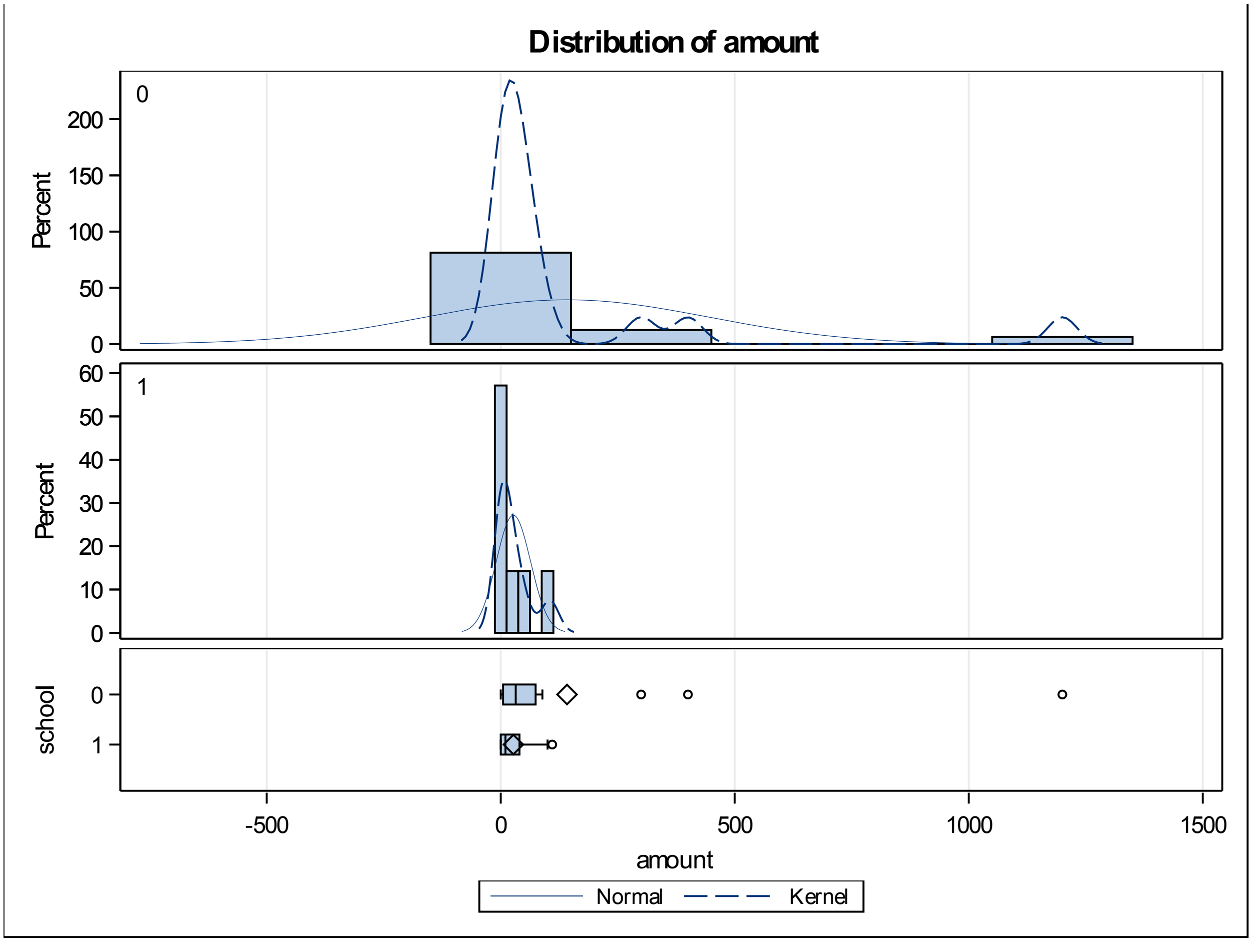


Figure 4:

school	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0		141.6	-20.5079	303.8	304.3	224.8	470.9
1		27.0000	5.7989	48.2011	36.7193	26.6198	59.1564
Diff (1-2)	**Pooled**	114.6	-53.3711	282.6	224.1	177.8	303.1
Diff (1-2)	**Satterthwaite**	114.6	-48.3948	277.6			

Figure 5:

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	28	1.40	0.1732
Satterthwaite	Unequal	15.499	1.49	0.1551

Question 4a) CONCLUSIONS:

Judging from the preliminary t-test p-value (Figure 5), the 95% confidence interval for the difference in sample means (Figure 4), the boxplot (Figure 3), and the histogram data (Figures 1 & 2), which is largely skewed in Figure 1 by the existence of extreme outliers in the set of SMU values, there is **little to no evidence with which to infer a statistically significant difference in *population* means**. Moreover, if the idea is to determine whether there are enough cash-carrying people on campus to warrant the installation of bill/coin acceptors, the random sampling should be drawn from the population that uses the vending machines, not just from classes of Business Stat students, who may or may not be representative of the broader group for which one is actually testing.

Question 4b) FIGURES:

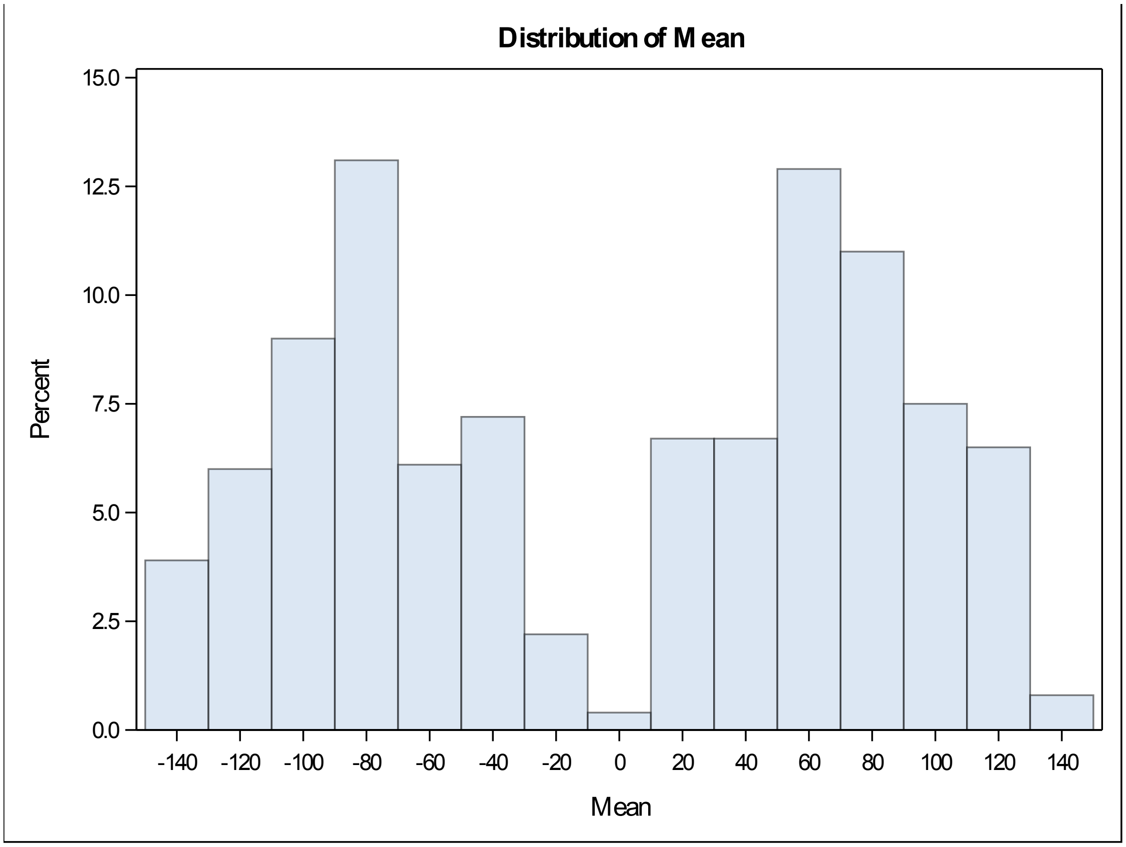
Figure 6: ***The UNIVARIATE Procedure – Variable: Mean (Permutations = 1000)***

Moments			
N	1000	Sum Weights	1000
Mean	-2.0965625	Sum Observations	-2096.5625
Std Deviation	82.765119	Variance	6850.06492
Skewness	-0.0737211	Kurtosis	-1.4670098
Uncorrected SS	6847610.43	Corrected SS	6843214.85
Coeff Variation	-3947.6581	Std Error Mean	2.61726287

Basic Statistical Measures			
Location		Variability	
Mean	-2.0966	Std Deviation	82.76512
Median	16.7232	Variance	6850
Mode	110.7411	Range	294.91071
		Interquartile Range	152.07589

Tests for Location: Mu0=0				
Test	Statistic		p Value	
Student's t	t	-0.80105	Pr > |t|	0.4233
Sign	M	25	Pr >= |M|	0.1212
Signed Rank	S	-13112	Pr >= |S|	0.1513

Figure 7: ***The UNIVARIATE Procedure – Distribution of Mean (Differences)***



Obs	Variable	Class	Method	Variances	Mean	LowerCLMean	UpperCLMean	StdDev
1	COL3	Diff (1-2)	Pooled	Equal	-123.0	-290.1	44.1458	222.9
2	COL5	Diff (1-2)	Pooled	Equal	-136.6	-302.1	28.8874	220.8
3	COL13	Diff (1-2)	Pooled	Equal	129.5	-36.8786	295.9	221.9
4	COL16	Diff (1-2)	Pooled	Equal	-128.2	-294.7	38.3334	222.1
5	COL23	Diff (1-2)	Pooled	Equal	-123.4	-290.4	43.6996	222.9
6	COL53	Diff (1-2)	Pooled	Equal	-115.1	-283.0	52.8888	224.0

…

Obs	Variable	Class	Method	Variances	Mean	LowerCLMean	UpperCLMean	StdDev
133	COL947	Diff (1-2)	Pooled	Equal	-122.0	-289.2	45.1863	223.1
134	COL953	Diff (1-2)	Pooled	Equal	-147.2	-311.4	16.9420	219.0
135	COL960	Diff (1-2)	Pooled	Equal	-123.6	-290.7	43.4021	222.8
136	COL971	Diff (1-2)	Pooled	Equal	-126.6	-293.3	40.1246	222.4
137	COL974	Diff (1-2)	Pooled	Equal	-144.7	-309.1	19.8253	219.4
138	COL985	Diff (1-2)	Pooled	Equal	-133.0	-299.0	32.9443	221.4

Question 4b) CONCLUSIONS:

One-thousand permutations were run to test the ***null-hypothesis (H_0)*** that: there is **no difference in the mean** amount of pocket cash carried by students at SMU and Seattle U: $(\mu_{SMU} - \mu_{Seattle} = 0)$.

The ***alternative-hypothesis (H_A)*** would be that: there is, in fact, a statistically significant **difference in the mean**: $(\mu_{SMU} - \mu_{Seattle} \neq 0)$.

According to Figure 7, one-hundred-thirty-eight (138) of one-thousand (1000) values were more extreme than the observed difference in sample means (114.6 →see Figure 4), creating a permutation test p-value of: (.138), which is greater than the $\propto = .05$ threshold for statistical significance.

On this basis, one would **fail to reject** (FTR) **the null-hypothesis** (H_0), determining that there is not statistically significant evidence to suggest that $(\mu_{SMU} - \mu_{Seattle} \neq 0)$ → **[p-val = .138]**.