Module 10a – Inference for Means (continued)

Review Against All Odds: Unit 27 (Inference)

Stat Procedure Diagram – Where we are

		Descriptive Statistics (Describing Pops or Samples)		Inferential Statistics (from Samples)
	Variable Types	Display	Describe	Estimation
Univariate	categorical (nominal or ordinal)*	Bar Graph/Pie Chart	Counts/Percentages	*When binary/dichotomous:* Confidence interval for proportions
	quantitative/continuous	Histogram/Stem & Leaf Box Plot	Mean/St Dev (normal) Median/Min, Q1, Q3, Max (skewed)	Confidence interval for means
		Display	Describe	Significance Tests/Hypothesis Tests
Bivariate	2 categorical	Tables or Bar Graphs	Two-way tables/Crosstabulation	Chi-square test (for goodness of fit)
	1 categorical, 1 quant.	Bar Graphs	Comparison of means/averages	T-test (one sample/group, two samples/groups) ANOVA (two or more samples/groups)
	2 quant.	Scatterplot	Correlation Coef. (Coef. of determ)/ Regression Line	T-test for correlation
		Display	Describe	Significance Tests/Hypothesis Tests
Multivariate	Response Variable is Quant.	-	Ordinary Least Squares Regression (OLS)	F-test for overall model T-tests for each explanatory variable
	Response Variable is categorical (dichotomous)	-	Logistic Regression	Chi-square tests of significance

NOTE: Items highlighted in yellow are covered in this course.

**When a categorical variable has two categories, it is called dichotomous.*

Still focused on…
…***quantitative/continuous variables (inference)***

- Confidence Intervals (with ***unknown*** population standard deviation)

$$\overline{x} \pm t \frac{s}{\sqrt{n}}$$

- Done exactly as before except we use our *degrees of freedom* to determine the t-value for the equation.

- Degrees of Freedom (df) for confidence intervals: **n-1,** where n=number of cases in our sample

Confidence Intervals (practice)

Taken from Example 20.3 on page 459:

Calculating the average tip at a restaurant.

We randomly select 20 restaurant receipts out of all the receipts for an entire day.

Assume we know that the distribution of tips (as a percentage of the bill) is normally distributed but we don't know the population standard deviation so we substitute the **sample standard deviation,** which is given as **1.963%.**

We calculate the mean tip percentage for the **sample of 20** to be **22.21%.** Now we want to calculate the **95% confidence interval** for tips at the restaurant.

Confidence Intervals (assumptions)

Calculating a confidence interval requires making three assumptions.

1. The data are independent observations from a ***simple random sample.***

2. The distribution of the underlying population is ***relatively normal.***

3. We do NOT know the population ***standard deviation*** (so we estimate it based on the sample standard deviation)

t-distribution table (from page 701)

Confidence Level: 95%

Degrees of Freedom (df): n-1 (20-1=19)

t=2.093

Table entry for C is the critical value t^* required for confidence level C. To approximate one- and two-sided P-values, compare the value of the t statistic with the critical values of t^* that match the P-values given at the bottom of the table.

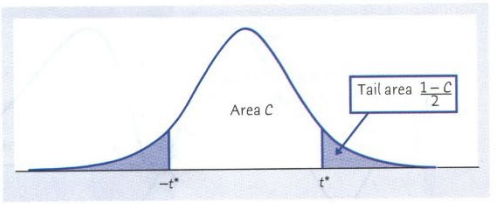

TABLE C *t* DISTRIBUTION CRITICAL VALUES

DEGREES OF FREEDOM	CONFIDENCE LEVEL C											
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9%
1	1.000	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
2	0.816	1.061	1.386	1.886	2.920	4.303	4.849	6.965	9.925	14.09	22.33	31.60
3	0.765	0.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	0.741	0.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	0.727	0.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	0.718	0.906	1.134	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	0.706	0.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	0.703	0.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	0.700	0.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	0.697	0.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	0.694	0.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	0.691	0.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	0.690	0.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	0.689	0.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	0.688	0.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	0.688	0.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	0.687	0.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	0.686	0.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	0.686	0.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	0.685	0.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	0.685	0.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	0.684	0.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	0.684	0.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	0.684	0.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	0.683	0.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	0.683	0.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	0.681	0.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	0.679	0.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	0.679	0.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	0.678	0.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	0.677	0.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.390
1000	0.675	0.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.300
z^*	0.674	0.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.291
One-sided P	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
Two-sided P	.50	.40	.30	.20	.10	.05	.04	.02	.01	.005	.002	.001

Confidence Intervals (practice)

Mean: 22.21%
Sample Std Deviation: 1.963%
Number in our sample: 20
t-value: 2.093

$$\bar{X} \pm 2.093 * \frac{s}{\sqrt{n}}$$

22.21 +/- 2.093 * [1.963/ $\sqrt{20}$]
22.21 +/- .92
21.29 (LCL) to 23.13 (UCL)

We are 95% confident that the true mean percentage tip from all patrons at the restaurant is between 21.29% percent and 23.13%