TECH 646 Analysis of Research in Industry and Technology

Ch. 14 Sampling
Appendix 14a: Determining Sample Size

Lecture note based on the text book and supplemental materials:
Cooper, D.R., & Schindler, P.S., *Business Research Methods* (12 th edition), McGraw-Hill/Irwin

Paul I-Hai Lin, Professor of ECET
http://www.etcs.pfw.edu/~lin
A Core Course for M.S. In Technology
Purdue University Fort Wayne

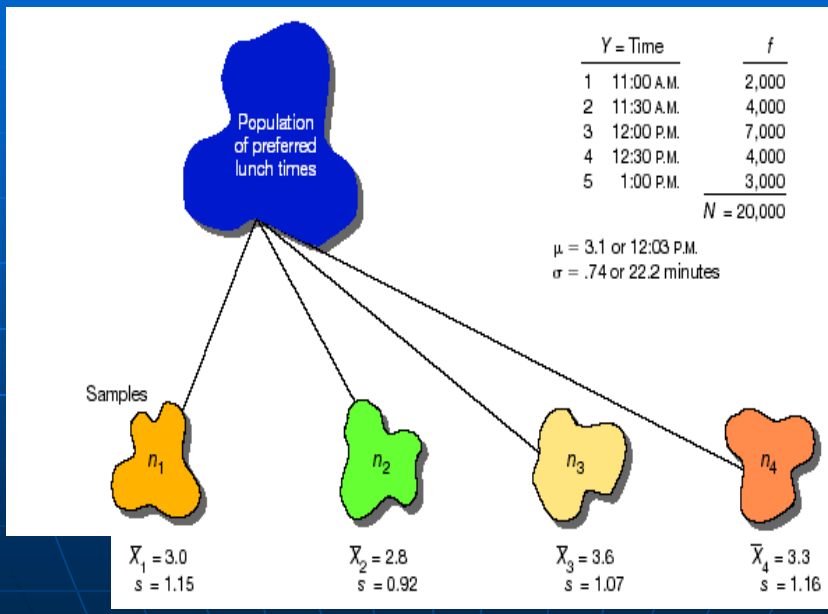
1

Appendix 14a

Determining Sample Size
Metro U. Dinning Club Study

2

Random Samples of Preferred Lunch Times



	Y = Time	f
1	11:00 A.M.	2,000
2	11:30 A.M.	4,000
3	12:00 P.M.	7,000
4	12:30 P.M.	4,000
5	1:00 P.M.	3,000
		$N = 20{,}000$

$\mu = 3.1$ or 12:03 P.M.
$\sigma = .74$ or 22.2 minutes

3

Increasing Precision

	Reducing the Standard Deviation by 50%	Quadrupling the Sample
$\sigma_{\bar{X}} = \frac{s}{\sqrt{n}}$	$\sigma_{\bar{X}} = \frac{.74}{\sqrt{10}} = .234$	$\sigma_{\bar{X}} = \frac{.8}{\sqrt{25}} = .16$
	$\sigma_{\bar{X}} = \frac{.37}{\sqrt{10}} = .117$	$\sigma_{\bar{X}} = \frac{.8}{\sqrt{100}} = .08$

where
$\sigma_{\bar{X}}$ = standard error of the mean
s = standard deviation of the sample
n = sample size

Increasing Precision

- Sample data (n1)
- Unbiased Estimator – the sample standard deviation from sample n:

$$\sigma_{\bar{X}} = {}^{s}/_{\sqrt{n}}$$

Where:

s = standard deviation of the sample n1

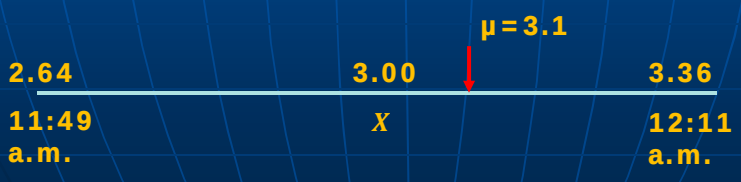
n1 = 10, $\overline{X1}$= 3.0, s1 = 1.15

$\sigma_{\bar{X}} = {}^{s}/_{\sqrt{n}}$ = 1.15/$10^{0.5}$ = 0.36

5

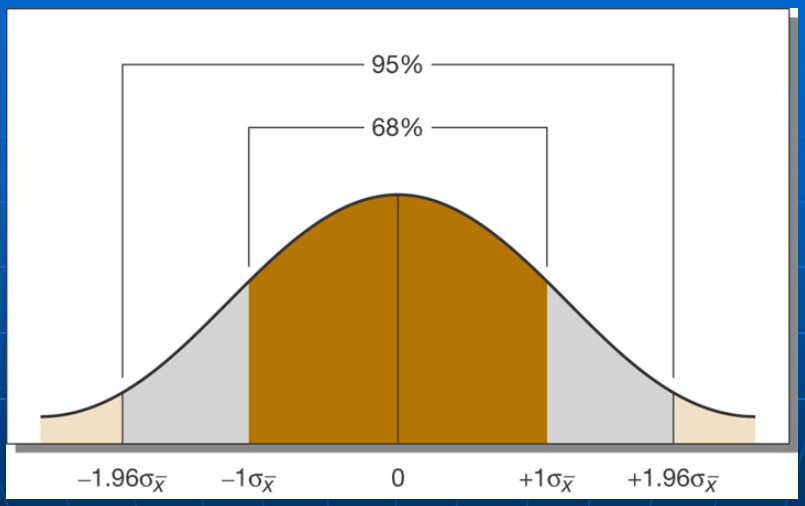
Increasing Precision

- μ - predicted to be 3.0 or 12:00 noon (the mean of n1) ±0.36
- Would expect to find the true μ between 2.64 and 3.36 – between 11.49 a.am. and 12:11 p.m.
- If 2 = 11:30 a.m. and 0.64 = (19.2 min); 2.64 = 11:49 a.m.
- From Exhibit 141-1, we know that population average μ = 3.1, or 12.03 p.m.; and have 68% confidence in this estimate (± Z or 68% of the area under the normal curve, see next slide)



6

Confidence Levels and the Normal Curve



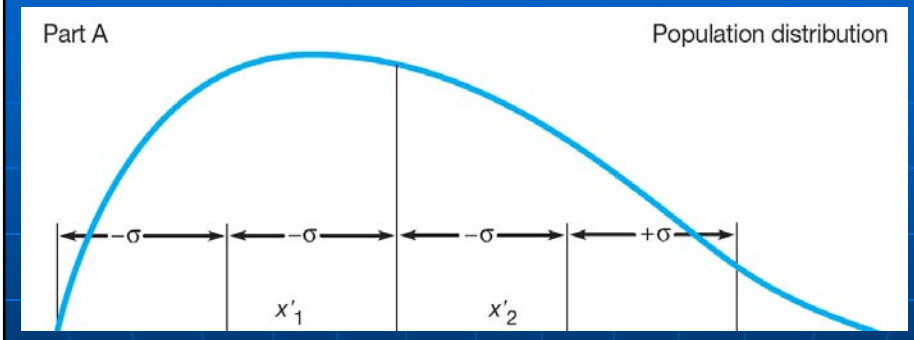
Improve confidence to 95%: true mean increases to ±0.7 = 0.36 x (±1.96) (from 2.64 => 2.3; 3.36 => 3.7 OR from 11:39 a.m. to 12:21 p.m.

7

Standard Errors

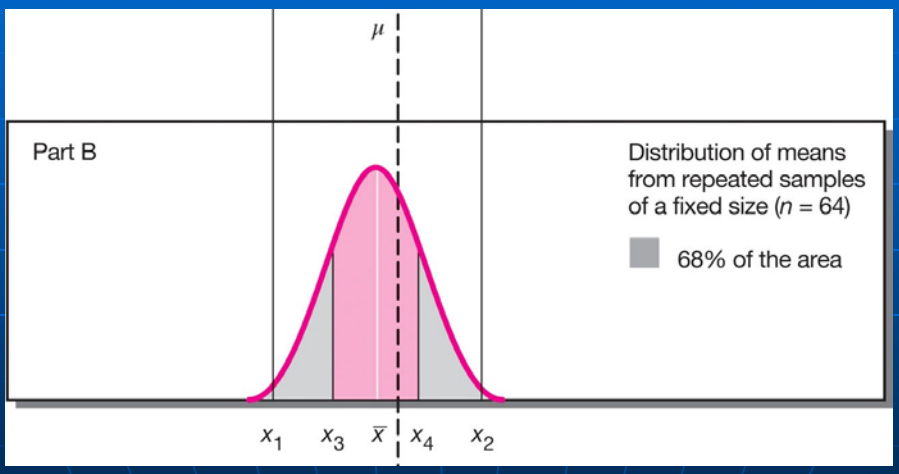
Standard Error (Z score)	*% of Area*	*Approximate Degree of Confidence*
1.00	*68.27*	*68%*
1.65	*90.10*	*90%*
1.96	*95.00*	*95%*
3.00	*99.73*	*99%*

Metro U. Dinning Club Study
Central Limit Theorem



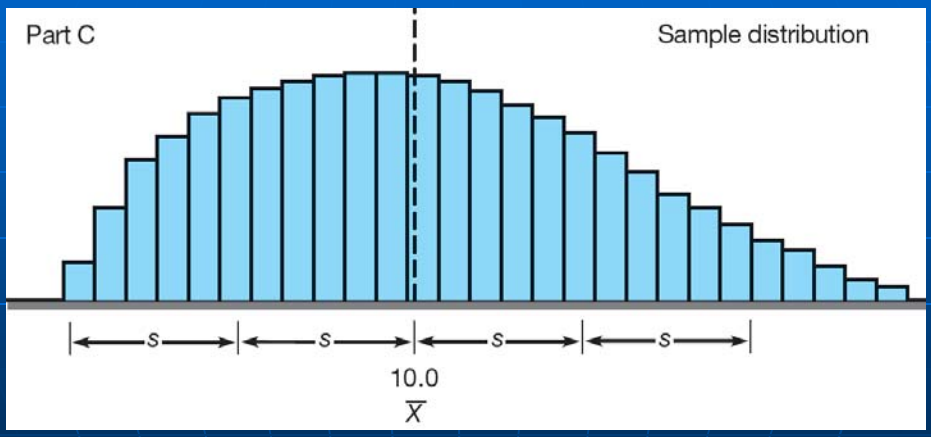
9

Central Limit Theorem



10

Central Limit Theorem



11

Estimates of Dinning Visits

Confidence	Z score	% of Area	Interval Range (visits per month)
68%	1.00	68.27	9.48-10.52
90%	1.65	90.10	9.14-10.86
95%	1.96	95.00	8.98-11.02
99%	3.00	99.73	8.44-11.56

12

Calculating the Sample Size for Questions Involving Means

1. The precision desired and how to quantify it:
   a. The confidence level we want with our estimate.
   b. The size of the interval estimate.
2. The expected dispersion in the population for the investigative question used.
3. Whether a finite population adjustment is needed.

13

Metro U Sample Size for Means

Steps	*Information*
Desired confidence level	95% (z = 1.96)
Size of the interval estimate	± .5 meals per month
Expected range in population	0 to 30 meals
Sample mean	10
Standard deviation	4.1
Need for finite population adjustment	No
Standard error of the mean	.5/1.96 = .255
Sample size	$(4.1)^2/ (.255)^2 = 259$

Metro U Sample Size for Population

Steps	*Information*
Desired confidence level	95% (z = 1.96)
Size of the interval estimate	± .10 (10%)
Expected range in population	0 to 100%
Sample proportion with given attribute	30%
Sample dispersion	Pq = .30(1-.30) = .21
Finite population adjustment	No
Standard error of the proportion	.10/1.96 = .051
Sample size	$.21/ (.051)^2 = 81$

Appendix 14a: Key Terms

- Central limit theorem
- Confidence interval
- Confidence level
- Interval estimate
- Point estimate
- Proportion

16