MBC 638

LIVE SESSION WEEK 5

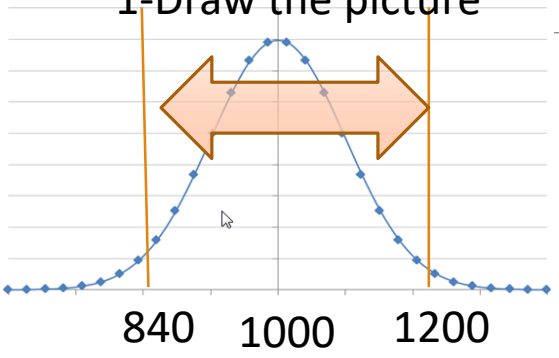
Agenda

Topic	Time	Thursday Section	Sunday Section
Introduction	5 min	9:00-9:05	6:30-6:35
Homework #2 Chapter 9 Quiz Quiz #2 Prep Review	35 min	9:05-9:40	6:35-7:10
Highlights from Week 5 Video	30 min	9:40-10:10	7:10-7:40
Breakout on Additional Example	10 min	10:10-10:20	7:40-7:50
Review of Upcoming Assignments and Open Question	10 min	10:20-10:30	7:50-8:00

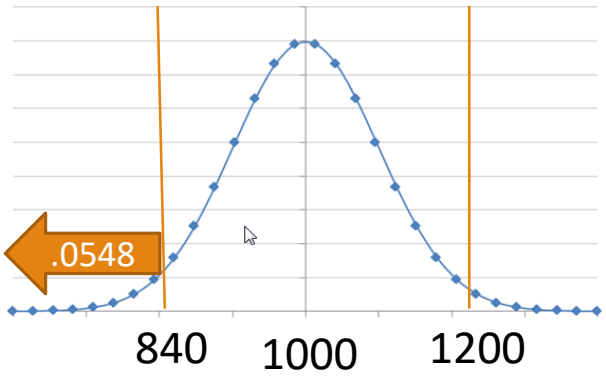
Quiz 2 Prep Question 1: Practice with Z calculations

The distribution of weekly incomes of supervisors at the ABC Company follows the normal distribution, with a mean of $1000 and a standard deviation of $100.
What percent of the supervisors have a weekly income between $840 and $1200?

1-Draw the picture



2-Think about what you are calculating related to the picture



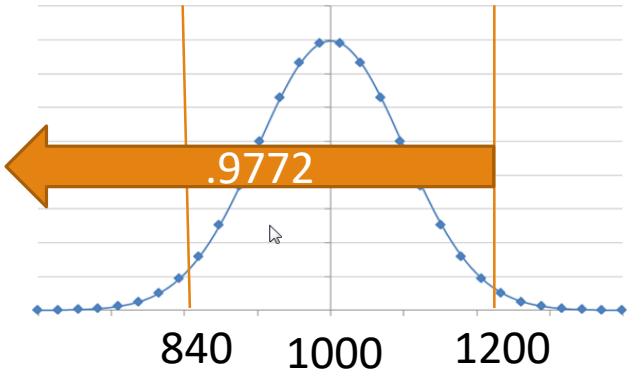
$$Z = \frac{X - \mu}{\sigma}$$

$$Z = \frac{840 - 1000}{100} = -1.6$$

Look up in tables, p = .0548

Or in Excel

=NORM.DIST(840,1000,100,TRUE)



$$Z = \frac{X - \mu}{\sigma}$$

$$Z = \frac{1200 - 1000}{100} = 2$$

Look up in tables, p = .9772

Or in Excel

=NORM.DIST(1200,1000,100,TRUE)

.9772-.0548 = .9224, so 92.24% have a weekly income between $840 and $1200

Table C Standard normal distribution (*cont*

Z	0.00	0.01	0.02
0.0	0.5000	0.5040	0.5080
0.1	0.5398	0.5438	0.5478
0.2	0.5793	0.5832	0.5871
0.3	0.6179	0.6217	0.6255
0.4	0.6554	0.6591	0.6628
0.5	0.6915	0.6950	0.6985
0.6	0.7257	0.7291	0.7324
0.7	0.7580	0.7611	0.7642
0.8	0.7881	0.7910	0.7939
0.9	0.8159	0.8186	0.8212
1.0	0.8413	0.8438	0.8461
1.1	0.8643	0.8665	0.8686
1.2	0.8849	0.8869	0.8888
1.3	0.9032	0.9049	0.9066
1.4	0.9192	0.9207	0.9222
1.5	0.9332	0.9345	0.9357
1.6	0.9452	0.9463	0.9474
1.7	0.9554	0.9564	0.9573
1.8	0.9641	0.9649	0.9656
1.9	0.9713	0.9719	0.9726
2.0	0.9772	0.9778	0.9783

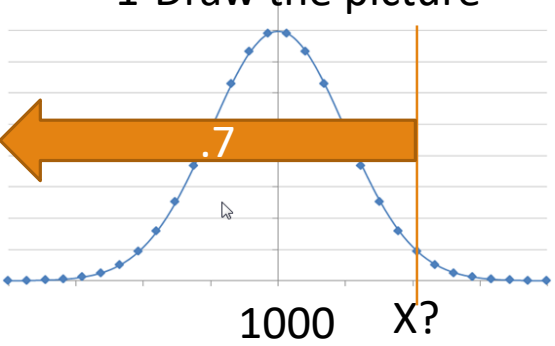
Table C Standard normal distribution

Z	0.00	0.01	0.02	0.03
–3.4	0.0003	0.0003	0.0003	0.0003
–3.3	0.0005	0.0005	0.0005	0.0004
–3.2	0.0007	0.0007	0.0006	0.0006
–3.1	0.0010	0.0009	0.0009	0.0009
–3.0	0.0013	0.0013	0.0013	0.0012
–2.9	0.0019	0.0018	0.0018	0.0017
–2.8	0.0026	0.0025	0.0024	0.0023
–2.7	0.0035	0.0034	0.0033	0.0032
–2.6	0.0047	0.0045	0.0044	0.0043
–2.5	0.0062	0.0060	0.0059	0.0057
–2.4	0.0082	0.0080	0.0078	0.0075
–2.3	0.0107	0.0104	0.0102	0.0099
–2.2	0.0139	0.0136	0.0132	0.0129
–2.1	0.0179	0.0174	0.0170	0.0166
–2.0	0.0228	0.0222	0.0217	0.0212
–1.9	0.0287	0.0281	0.0274	0.0268
–1.8	0.0359	0.0351	0.0344	0.0336
–1.7	0.0446	0.0436	0.0427	0.0418
–1.6	0.0548	0.0537	0.0526	0.0516

Quiz 2 Prep Question 1 Extended: Practice with Z calculations

The distribution of weekly incomes of supervisors at the ABC Company follows the normal distribution, with a mean of $1000 and a standard deviation of $100.
Management wants to give bonuses to those supervisors within the top 30% of weekly incomes.
What is the weekly income cut off, the lowest weekly income a supervisor can have and still receive the bonus?

1-Draw the picture



2-Think about what you are calculating related to the picture

$$Z = \frac{X - \mu}{\sigma} \qquad Z = \frac{x - 1000}{100} = ?$$

We know p = .7, what Z goes with that p value…look it up from the table = .52 or in Excel=NORM.S.INV(0.7)=.52

$$.52 = \frac{x - 1000}{100}$$

$$.52 * 100 = X - 1000$$

52 = X – 1000

52 + 1000 = X

1052 = X

$1052 is the lowest weekly income a supervisor can have and still receive a bonus

Quiz 2 Review

Highlights: Video Segment 3.5: Binomial(Discrete Data)

No set shape
Mean: μ=np, n = number of trials, p=probability of success
Variance: σ^2= n x p(1-p)

<u>A binomial experiment is an experiment which satisfies these four conditions:</u>
A fixed number of trials
Each trial is independent of the others
There are only two outcomes
The probability of each outcome remains constant from trial to trial.

You're taking a quiz with five true/false questions. You didn't study and plan to guess. What's the probability you get three questions correct?

Find P(X = 3), the probability that the number of successes is equal to three.

- n = 5
- p = 0.5

Example: Binomial Table

		p (probability of a success)						
n	*X*	0.10	0.15	0.20	…	0.40	0.45	0.50
⋮	⋮				…			
4	0	0.6561	0.5220	0.4096		0.1296	0.0915	0.0625
	1	0.2916	0.3685	0.4096		0.3456	0.2995	0.2500
	2	0.0486	0.0975	0.1536		0.3456	0.3675	0.3750
	3	0.0036	0.0115	0.0256		0.1536	0.2005	0.2500
	4	0.0001	0.0005	0.0016		0.0256	0.0410	0.0625
5	0	0.5905	0.4437	0.3277	…	0.0778	0.0503	0.0312
	1	0.3280	0.3915	0.4096		0.2592	0.2059	0.1562
	2	0.0729	0.1382	0.2048		0.3456	0.3369	0.3125
	3	0.0081	0.0244	0.0512		0.2304	0.2757	0.3125

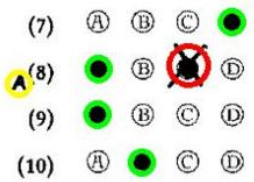
Use the tables in the back of the book or Excel to calculate probabilities for a binomial distribution for discrete data or use Excel: =binom.dist(3,5,.5,False) = .3125

Means give me the probability that I get 3 successes, out of 5 trials, when each has a probability of success of .5, and False means exactly 3 successes(True would mean all those probabilities up to and including 3 successes:1,2,3 successes all added together)

Quiz 2 Review

Highlights: Video Segment 3.5: Binomial(Discrete Data)

Another Example:



For a multiple choice test that you are guessing on, you want to know the probability you get at least 3 correct, on a test that has 5 multiple choice questions, and each has 5 choices(A,B,C,D,E).

n=5 test questions, p=.2(chance of answering correctly on each problem(1/5)), x>=3

=BINOM.DIST(3,5,0.2,FALSE)

This formula means, the probability that I get 3 questions correct, with 5 questions on the test, and 5 answers for each question so a 1/5=.2 chance of getting each correct, and false means I don't want the cumulative percent because I won't pass the test if I get 1 or 2 correct. This will give me probability of getting exactly 3 correct, then I would do the same with the probability at 4 and 5 correct and add the three probabilities together – because I want to know the probably of getting at least 3 correct, which means 3 or more correct.

=BINOM.DIST(3,5,0.2,FALSE)= .0512
=BINOM.DIST(4,5,0.2,FALSE)= .0064
=BINOM.DIST(5,5,0.2,FALSE)= .0003
.0579 or 5.79% probability that you get at least 3 correct

Or =BINOM.DIST(2,5,0.2,TRUE) means probability I get 1 or 2 correct, then subtract from 1 to get probability of 3,4,5 correct

=.9421, so 1-.9421=.0579 so 5.79% probability that you get at least 3 correct

Quiz 2 Prep Question 2:

Twenty percent of the employees of ABC Company use direct deposit and have their wages sent directly to the bank. Assume we random sample five employees. What is the probability that all five employees use direct deposit?

Solution:

n=5, trials is 5
p=.2, 20% chance they use direct deposit(yes or no)
X=5, we want to know the probability 5 employees used direct deposit
=Table B in your book, n=5,x=5,.2 column **= .0003 is the probability all 5 employees use direct deposit**

Or in Excel =BINOM.DIST(5,5,0.2,FALSE)
BINOM.DIST(successes, trials, probability, cumulative), false because we want exactly 5 successes not cumulative)

Quiz 2 Review

Table B Binomial distribution

		p								
n	X	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50
2	0	0.8100	0.7225	0.6400	0.5625	0.4900	0.4225	0.3600	0.3025	0.2500
	1	0.1800	0.2550	0.3200	0.3750	0.4200	0.4550	0.4800	0.4950	0.5000
	2	0.0100	0.0225	0.0400	0.0625	0.0900	0.1225	0.1600	0.2025	0.2500
3	0	0.7290	0.6141	0.5120	0.4219	0.3430	0.2746	0.2160	0.1664	0.1250
	1	0.2430	0.3251	0.3840	0.4219	0.4410	0.4436	0.4320	0.4084	0.3750
	2	0.0270	0.0574	0.0960	0.1406	0.1890	0.2389	0.2880	0.3341	0.3750
	3	0.0010	0.0034	0.0080	0.0156	0.0270	0.0429	0.0640	0.0911	0.1250
4	0	0.6561	0.5220	0.4096	0.3164	0.2401	0.1785	0.1296	0.0915	0.0625
	1	0.2916	0.3685	0.4096	0.4219	0.4116	0.3845	0.3456	0.2995	0.2500
	2	0.0486	0.0975	0.1536	0.2109	0.2646	0.3105	0.3456	0.3675	0.3750
	3	0.0036	0.0115	0.0256	0.0469	0.0756	0.1115	0.1536	0.2005	0.2500
	4	0.0001	0.0005	0.0016	0.0039	0.0081	0.0150	0.0256	0.0410	0.0625
5	0	0.5905	0.4437	0.3277	0.2373	0.1681	0.1160	0.0778	0.0503	0.0312
	1	0.3280	0.3915	0.4096	0.3955	0.3602	0.3124	0.2592	0.2059	0.1562
	2	0.0729	0.1382	0.2048	0.2637	0.3087	0.3364	0.3456	0.3369	0.3125
	3	0.0081	0.0244	0.0512	0.0879	0.1323	0.1811	0.2304	0.2757	0.3125
	4	0.0004	0.0022	0.0064	0.0146	0.0284	0.0488	0.0768	0.1128	0.1562
	5		0.0001	0.0003	0.0010	0.0024	0.0053	0.0102	0.0185	0.0312
6	0	0.5314	0.3771	0.2621	0.1780	0.1176	0.0754	0.0467	0.0277	0.0156
	1	0.3543	0.3993	0.3932	0.3560	0.3025	0.2437	0.1866	0.1359	0.0938
	2	0.0984	0.1762	0.2458	0.2966	0.3241	0.3280	0.3110	0.2780	0.2344
	3	0.0146	0.0415	0.0819	0.1318	0.1852	0.2355	0.2765	0.2932	0.3125
	4	0.0012	0.0055	0.0154	0.0330	0.0595	0.0951	0.1382	0.1861	0.2344
	5	0.0001	0.0004	0.0015	0.0044	0.0102	0.0205	0.0369	0.0609	0.0938
	6			0.0001	0.0002	0.0007	0.0018	0.0041	0.0083	0.0156
7	0	0.4783	0.3206	0.2097	0.1335	0.0824	0.0490	0.0280	0.0152	0.0078
	1	0.3720	0.3960	0.3670	0.3115	0.2471	0.1848	0.1306	0.0872	0.0547
	2	0.1240	0.2097	0.2753	0.3115	0.3177	0.2985	0.2613	0.2140	0.1641
	3	0.0230	0.0617	0.1147	0.1730	0.2269	0.2679	0.2903	0.2918	0.2734
	4	0.0026	0.0109	0.0287	0.0577	0.0972	0.1442	0.1935	0.2388	0.2734
	5	0.0002	0.0012	0.0043	0.0115	0.0250	0.0466	0.0774	0.1172	0.1641
	6		0.0001	0.0004	0.0013	0.0036	0.0084	0.0172	0.0320	0.0547
	7				0.0001	0.0002	0.0006	0.0016	0.0037	0.0078
8	0	0.4305	0.2725	0.1678	0.1001	0.0576	0.0319	0.0168	0.0084	0.0039
	1	0.3826	0.3847	0.3355	0.2670	0.1977	0.1373	0.0896	0.0548	0.0312
	2	0.1488	0.2376	0.2936	0.3115	0.2965	0.2587	0.2090	0.1569	0.1094
	3	0.0331	0.0839	0.1468	0.2076	0.2541	0.2786	0.2787	0.2568	0.2188
	4	0.0046	0.0185	0.0459	0.0865	0.1361	0.1875	0.2322	0.2627	0.2734
	5	0.0004	0.0026	0.0092	0.0231	0.0467	0.0808	0.1239	0.1719	0.2188
	6		0.0002	0.0011	0.0038	0.0100	0.0217	0.0413	0.0703	0.1094
	7			0.0001	0.0004	0.0012	0.0033	0.0079	0.0164	0.0313
	8					0.0001	0.0002	0.0007	0.0017	0.0039

Note: Blank entries indicate a binomial probability of less than 0.00005.

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Highlights: Video Segment 5.3:Confidence Intervals for Continuous Data

Another Statistical Inference Method

1

Drawing a conclusion about a population

Takes into account the *natural variability* in the data

...based on a sample

Reasons to sample:

- Too time consuming
- Too expensive
- May require destruction

A **confidence interval** is an estimate of a parameter consisting of an interval of numbers based on a point estimate, together with a **confidence level** specifying the probability that the interval contains the parameter.

2

How Is a Confidence Interval Useful?

3

- Estimates an unknown population parameter (e.g., mean, standard deviation, variance, proportion)
- Gives an indication of how accurate that estimate is
- Also indicates how confident we are that the results are correct

What Is a Confidence Interval?

4

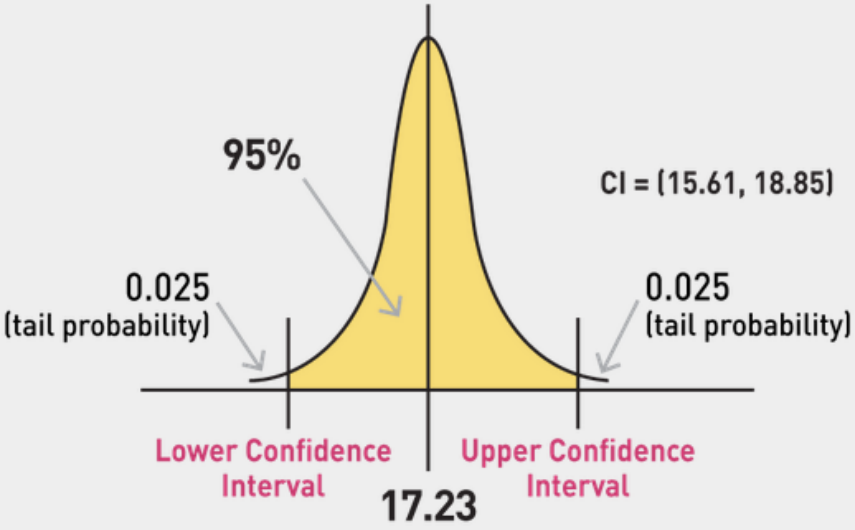
Confidence interval: a range of values (from sample data) in which we expect the population parameter to occur

Parameter estimate ± margin of error (E)

↓ $\bar{x}, s, p$ (estimates of population parameters)

Highlights: Video Segment 5.4
Confidence Interval Example

Other Ways to Interpret This CI



- The above distribution is a distribution of sample means, so the probability of the true mean being within the confidence interval is 95%.
- 95% of all $\bar{x}$s (calculated from samples) will fall into the shaded region.

Highlights: Video Segment 5.3:Confidence Intervals for Continuous Data

Confidence Interval Formulas for Mean

Boundaries of interval (two sided)	When population standard deviation is *known* (not often)	When population standard deviation is *unknown* and sample size n is *large* (≥ 30)	When population standard deviation is *unknown* and sample size n is *small* (< 30)
Upper confidence limits for μ	$U = \bar{x} + z^* \frac{\sigma}{\sqrt{n}}$	$U = \bar{x} + z^* \frac{s}{\sqrt{n}}$	$U = \bar{x} + t \frac{s}{\sqrt{n}}$
Lower confidence limits for μ	$L = \bar{x} - z^* \frac{\sigma}{\sqrt{n}}$	$L = \bar{x} - z^* \frac{s}{\sqrt{n}}$	$L = \bar{x} - t \frac{s}{\sqrt{n}}$
			$df = n - 1$

- In all cases, assume a normal distribution.
- Find z^* and t-values in Table D, p. T-11.

Margin of Error

Confidence intervals for the population mean μ take the form:

point estimate $\pm$ margin of error E

The **margin of error *E*** is a measure of the precision of the confidence interval estimate. For the *Z* interval, the margin of error takes the form $E = Z_{\alpha/2}(\sigma/\sqrt{n})$.

In our example, $E = Z_{\alpha/2}(\sigma/\sqrt{n}) = 32.9$. Therefore, the confidence interval has the form:

$$510 \pm 32.9$$

We would like our confidence interval estimates to be as precise as possible. Therefore, we would like the margin of error to be as small as possible. There are two strategies to decrease *E:*

- ***Decrease the confidence level***
- ***Increase the sample size***

Highlights: Video Segment 5.4 Confidence Interval Example

Example: Hank's Process

- Find 95% confidence interval about the mean
  - Need lower and upper limits
- Use data given by example:
  - $n = 30$
  - $\bar{x} = 17.23$
  - $s = 4.52$
- Assume $\alpha = 0.05$

When population standard deviation is *unknown* and sample size n is *large* (≥ 30)

$$U = \bar{x} + z^* \frac{s}{\sqrt{n}}$$

$$L = \bar{x} - z^* \frac{s}{\sqrt{n}}$$

$$U \,\&\, L = \bar{x} \pm z^* \frac{s}{\sqrt{n}} = 17.23 \pm (1.96) \frac{4.52}{\sqrt{30}}$$

Highlights: Video Segment 5.4 Confidence Interval Example

Confidence Interval for Hank's Process

$$U \& L = \bar{x} \pm z^* \frac{s}{\sqrt{n}} = 17.23 \pm (1.96)\frac{4.52}{\sqrt{30}}$$

- Use data given by example: $n = 30$; $\bar{x} = 17.23$; $s = 4.52$.
- Plus/minus gives margin of error above and below the parameter estimate.
- In Table D, find z^* at 95% confidence ($p = 0.95$).

=CONFIDENCE.NORM(alpha, std dev, sample size)

OR =CONFIDENCE.NORM(0.05,4.52,30)
=1.617432 (the margin or error)

=17.23(+ or –) 1.62

= 15.61 to 18.85

How to get the 1.96:
1.96 from last row of table D under 95% confidence or
enter in Excel=NORM.S.INV(0.975) or
lookup .975 inside the z table
it is .975 because you want + or – so you need to split the .05 in half which then equals 1-(.05/2) = .975

- We are 95% confident that the mean of the population (μ_{pop}) is between 15.61 and 18.85 days.

Highlights: Video Segment 5.4 Confidence Interval Example

Table D *t*-Distribution

		Confidence level				
		80%	90%	95%	98%	99%
		Area in one tail				
		0.10	0.05	0.025	0.01	0.005
		Area in two tails				
		0.20	0.10	0.05	0.02	0.01
df	1	3.078	6.314	12.706	31.821	63.657
	2	1.886	2.920	4.303	6.965	9.925
	3	1.638	2.353	3.182	4.541	5.841
	4	1.533	2.132	2.776	3.747	4.604
	5	1.476	2.015	2.571	3.365	4.032
	6	1.440	1.943	2.447	3.143	3.707
	7	1.415	1.895	2.365	2.998	3.499
	8	1.397	1.860	2.306	2.896	3.355
	9	1.383	1.833	2.262	2.821	3.250
	10	1.372	1.812	2.228	2.764	3.169
	11	1.363	1.796	2.201	2.718	3.106
	12	1.356	1.782	2.179	2.681	3.055
	13	1.350	1.771	2.160	2.650	3.012
	14	1.345	1.761	2.145	2.624	2.977
	15	1.341	1.753	2.131	2.602	2.947
	16	1.337	1.746	2.120	2.583	2.921
	17	1.333	1.740	2.110	2.567	2.898
	18	1.330	1.734	2.101	2.552	2.878
	19	1.328	1.729	2.093	2.539	2.861
	20	1.325	1.725	2.086	2.528	2.845
	21	1.323	1.721	2.080	2.518	2.831
	22	1.321	1.717	2.074	2.508	2.819
	23	1.319	1.714	2.069	2.500	2.807
	24	1.318	1.711	2.064	2.492	2.797
	25	1.316	1.708	2.060	2.485	2.787
	26	1.315	1.706	2.056	2.479	2.779
	27	1.314	1.703	2.052	2.473	2.771
	28	1.313	1.701	2.048	2.467	2.763
	29	1.311	1.699	2.045	2.462	2.756
	30	1.310	1.697	2.042	2.457	2.750
	31	1.309	1.696	2.040	2.453	2.744
	32	1.309	1.694	2.037	2.449	2.738
	33	1.308	1.692	2.035	2.445	2.733
	34	1.307	1.691	2.032	2.441	2.728
	35	1.306	1.690	2.030	2.438	2.724
	36	1.306	1.688	2.028	2.435	2.719
	37	1.305	1.687	2.026	2.431	2.715
	38	1.304	1.686	2.024	2.429	2.712
	39	1.304	1.685	2.023	2.426	2.708
	40	1.303	1.684	2.021	2.423	2.704
	50	1.299	1.676	2.009	2.403	2.678
	60	1.296	1.671	2.000	2.390	2.660
	70	1.294	1.667	1.994	2.381	2.648
	80	1.292	1.664	1.990	2.374	2.639
	90	1.291	1.662	1.987	2.368	2.632
	100	1.290	1.660	1.984	2.364	2.626
	1000	1.282	1.646	1.962	2.330	2.581
	z	1.282	1.645	1.960	2.326	2.576

Z Star

i.e. 95% confident = 1.96

Highlights: Video Segment 5.4 Confidence Interval Example

Note: The Z value is for $\frac{\alpha}{2}$

Regular Z table

Must use 1 - α/2

i.e. 95% confident,
α is .05, .05/2 = .025
1-.025 = .975
Z value = 1.96

Table C Standard normal distribution (*continued*)

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Note: T versus Z based on sample size

Highlights: Video Segment 5.6 Exercises

You are interested in how long it takes to get your food at a takeout restaurant (the time it takes from placing your order to when the food arrives). Over the next month, you decide to sample 20 times to determine the actual average. You find that *x*bar = 15.8 minutes and *s* = 2.5 minutes. Find the 95 percent confidence interval for the true mean.

When population standard deviation is *unknown* and sample size *n* is *small* (< 30)

$$U = \bar{x} + t\frac{s}{\sqrt{n}}$$

$$L = \bar{x} - t\frac{s}{\sqrt{n}}$$

$$df = n - 1$$

Df = n-1 = 20-1 = 19

Find t value look at df = 19 and under the 95% confidence level column = 2.093

$15.8 \pm 2.093(\frac{2.5}{\sqrt{20}})$

$15.8 \pm 2.093(\frac{2.5}{4.472})$

$15.8 \pm 2.093(.559)$

$15.8 \pm 1.17 = 14.63 \text{ to } 16.97$

Or in Excel use =CONFIDENCE.T(0.05,2.5,20)=1.17 then +- to 15.8 to get interval

Confidence.t(alpha, std deviation, sample)

T Table

Table D *t*-Distribution

		Confidence level				
		80%	90%	95%	98%	99%
		Area in one tail				
		0.10	0.05	0.025	0.01	0.005
		Area in two tails				
		0.20	0.10	0.05	0.02	0.01
df	1	3.078	6.314	12.706	31.821	63.657
	2	1.886	2.920	4.303	6.965	9.925
	3	1.638	2.353	3.182	4.541	5.841
	4	1.533	2.132	2.776	3.747	4.604
	5	1.476	2.015	2.571	3.365	4.032
	6	1.440	1.943	2.447	3.143	3.707
	7	1.415	1.895	2.365	2.998	3.499
	8	1.397	1.860	2.306	2.896	3.355
	9	1.383	1.833	2.262	2.821	3.250
	10	1.372	1.812	2.228	2.764	3.169
	11	1.363	1.796	2.201	2.718	3.106
	12	1.356	1.782	2.179	2.681	3.055
	13	1.350	1.771	2.160	2.650	3.012
	14	1.345	1.761	2.145	2.624	2.977
	15	1.341	1.753	2.131	2.602	2.947
	16	1.337	1.746	2.120	2.583	2.921
	17	1.333	1.740	2.110	2.567	2.898
	18	1.330	1.734	2.101	2.552	2.878
	19	1.328	1.729	2.093	2.539	2.861
	20	1.325	1.725	2.086	2.528	2.845
	21	1.323	1.721	2.080	2.518	2.831
	22	1.321	1.717	2.074	2.508	2.819
	23	1.319	1.714	2.069	2.500	2.807
	24	1.318	1.711	2.064	2.492	2.797
	25	1.316	1.708	2.060	2.485	2.787
	26	1.315	1.706	2.056	2.479	2.779
	27	1.314	1.703	2.052	2.473	2.771
	28	1.313	1.701	2.048	2.467	2.763
	29	1.311	1.699	2.045	2.462	2.756
	30	1.310	1.697	2.042	2.457	2.750
	31	1.309	1.696	2.040	2.453	2.744
	32	1.309	1.694	2.037	2.449	2.738
	33	1.308	1.692	2.035	2.445	2.733
	34	1.307	1.691	2.032	2.441	2.728
	35	1.306	1.690	2.030	2.438	2.724
	36	1.306	1.688	2.028	2.435	2.719
	37	1.305	1.687	2.026	2.431	2.715
	38	1.304	1.686	2.024	2.429	2.712
	39	1.304	1.685	2.023	2.426	2.708
	40	1.303	1.684	2.021	2.423	2.704
	50	1.299	1.676	2.009	2.403	2.678
	60	1.296	1.671	2.000	2.390	2.660
	70	1.294	1.667	1.994	2.381	2.648
	80	1.292	1.664	1.990	2.374	2.639
	90	1.291	1.662	1.987	2.368	2.632
	100	1.290	1.660	1.984	2.364	2.626
	1000	1.282	1.646	1.962	2.330	2.581
	z	1.282	1.645	1.960	2.326	2.576

Highlights: Video Segment 5.6 Confidence Interval for Discrete Data

CI Example: Candidate A Voters

- Of a sample of 300 voters, 164 want to vote for Candidate A.
- Find the 99% confidence interval for the proportion of voters planning to vote for Candidate A.

Confidence Interval for Discrete Data

For a population proportion (e.g., cosmetic defect):

$$U = p + z^* \sqrt{\frac{p(1-p)}{n}}$$

$$L = p - z^* \sqrt{\frac{p(1-p)}{n}}$$

- Upper and lower confidence limits for p
- Where:
  - p = sample proportion (e.g., percent defective)
  - n = sample size

CI Example: Candidate A Voters (cont.)

$$U \& L = p \pm z^* \sqrt{\frac{p(1-p)}{n}}$$

$$= 0.547 \pm 2.576 \sqrt{\frac{0.547(1-0.547)}{300}}$$

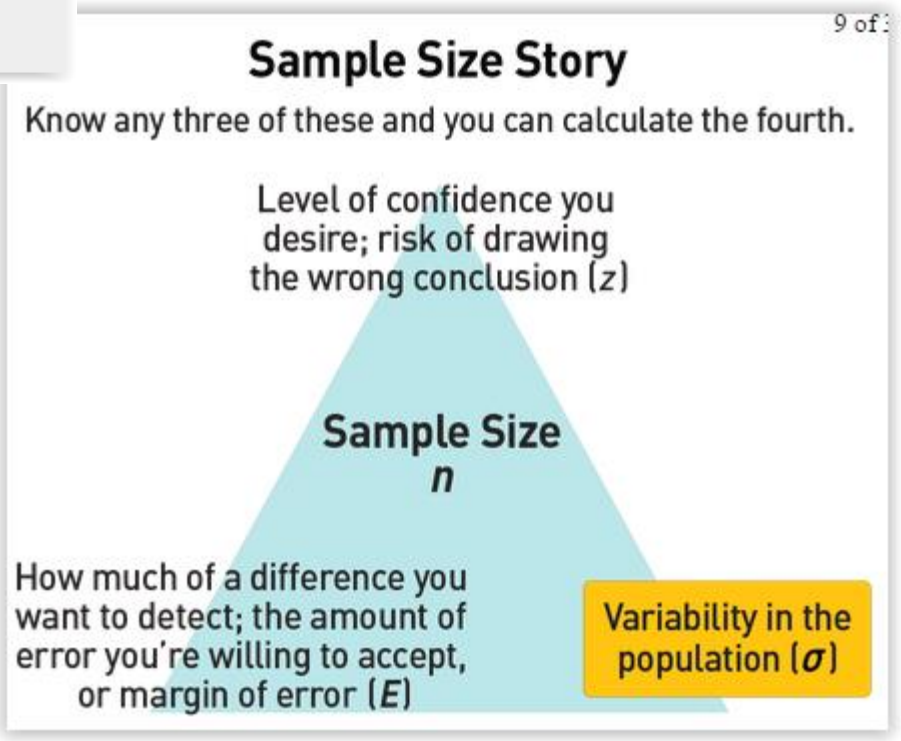
$$= 0.547 \pm 0.077$$

- p = 164/300 = 54.7%
- z^* at 99% = 2.576 (at the bottom of p. T-11)
- n = 300

We are 99% confident that the true percentage of voters for Candidate A is between 47.0% and 62.4% (i.e., $0.47 \leq \pi \leq 0.624$).

Highlights: Video Segment 5.5 Sample Size for Continuous

The only way to have both high confidence and a tight interval is to increase sample size.



Note: Sample Size Calculation for projects

Highlights: Video Segment 5.5 Sample Size for Continuous

Sample Size Formula for Continuous Data

$$n = \left(\frac{z^* \hat{\sigma}}{E} \right)^2$$

Example: Time to Complete Job

- Suppose you have collected a simple random sample of data and found the standard deviation to be three minutes.
- How many samples are needed to detect a change in job completion time after a process improvement project is implemented?
  - You are okay with a margin of error of two minutes.
  - Assume you want 95% confidence.

Example: Time to Complete Job (cont.)

$$n = \left(\frac{1.96(3)}{2} \right)^2$$

$$= 8.6 \cong 9$$

- z^* at 95% confidence = 1.96
- $\hat{\sigma} = 3$
  - Estimated population standard deviation
  - Equivalent to sample standard deviation, s
- $E = 2$

Note: ALWAYS round up

Highlights: Video Segment 5.6 Exercises

You would like to start a new business providing Internet service and need to estimate the average Internet usage of households during one week for your business plan. How many households must you select to be 95 percent sure that the sample mean is within one minute (E = 1) of the population mean? Assume a previous survey of household usage has shown that sigma = 6.95 minutes.

Sample Size Formula for Continuous Data

$$n = \left(\frac{z^* \hat{\sigma}}{E}\right)^2$$

$$n = \left(\frac{1.96 \; X \; 6.95}{1}\right)^2$$

n = 185.55, round up to a whole number for a sample

n = 186

Highlights: Video Segment 5.6 Sample Size for Discrete Data

Sample Size for Discrete Data

$$n = \frac{(z^*)^2 p(1-p)}{E^2}$$

Agenda

Topic	Time	Thursday Section	Sunday Section
Introduction	5 min	9:00-9:05	6:30-6:35
Homework #2 Chapter 9 Quiz Quiz #2 Prep Review	35 min	9:05-9:40	6:35-7:10
Highlights from Week 5 Video	30 min	9:40-10:10	7:10-7:40
Breakout on Additional Example	10 min	10:10-10:20	7:40-7:50
Review of Upcoming Assignments and Open Question	10 min	10:20-10:30	7:50-8:00

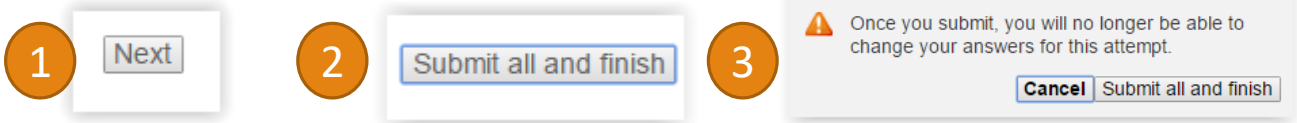
Review of Upcoming Assignments: Thursday Section

November 2018	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week #5	28	29	30	31	1	2	3
	Homework #2 DUE: **CH 9** Online Quiz **CH 11** StatTutor Expected counts in 2-way tables				Live Class #5 		
Week #6	4	5	6	7	8	9	10
	Homework #3 DUE: **CH 8** Online Quiz				Live Class #6		
Week #7	11	12	13	14	15	16	17
	Quiz #2 DUE				Live Class #7		
Week #8	18	19	20	21	22	23	24
	Homework #4 Due: 1. **CH 4** Learning Curve **Reminder:** Start reading Understanding Variation	***Live Class #8 RESCHEDULE 9PM EST***			Live Class #8 RESCHEDULE 		

1. Homework #3 due Sunday, 11/4 midnight EST in LaunchPad, Ch 8 Online Practice Quiz

2. Quiz #2 Prep file and answers are uploaded– optional

3. Quiz #2 is 5 calculation questions and 1, 10 part definitional question, due Sunday, 11/11 midnight EST, in the learning management system
   - DO NOT LEAVE ANY BLANK
   - You can not start and stop the Quiz.
   - There is a 2 hr. time limit. There is no timer, you must keep track of your own time.
   - Password for the Quiz is: TestTime101
   - At the end must click, NEXT at the bottom of the questions, then click Submit all and Finish, then click AGAIN Submit all and Finish in dialog box



4. Projects
   - Measure should be wrapping up within a week or so
   - Then Analyze should be getting started
   - Sample size calculation would be a good add to your measure/analyze phase to make sure you have enough data or to let you know your risk

Review of Upcoming Assignments: Sunday Section

November 2018	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week #5	4 Live Class #5	5	6	7 ***Homework #3 DUE:*** **CH 8** Online Quiz	8	9	10
Week #6	11 Live Class #6	12	13	14 ***Quiz #2 DUE***	15	16	17
Week #7	18 Live Class #7	19	20	21 ***Homework #4 Due:*** 1. **CH 4** Learning Curve **Reminder:** Start reading Understanding Variation	22	23	24
Week #8	25 Live Class #8	26	27	28 ***Homework #5 Due:*** 1. Problems 1-10 pg 114-116 in Understanding Variation	29	30	1

1. Homework #3 due Wednesday, 11/7 midnight EST in LaunchPad, Ch 8 Online Practice Quiz

2. Quiz #2 Prep file and answers are uploaded– optional

3. Quiz #2 is 5 calculation questions and 1, 10 part definitional question, due Wednesday, 11/14 midnight EST, in the learning management system
   - DO NOT LEAVE ANY BLANK
   - You can not start and stop the Quiz.
   - There is a 2 hr. time limit. There is no timer, you must keep track of your own time.
   - Password for the Quiz is: TestTime101
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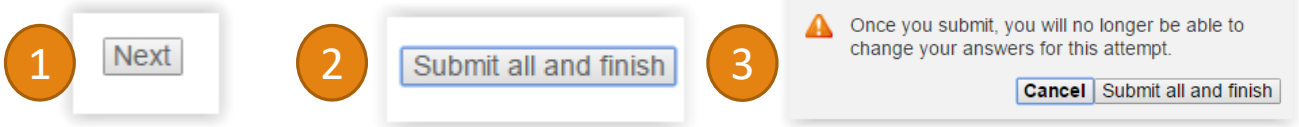

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