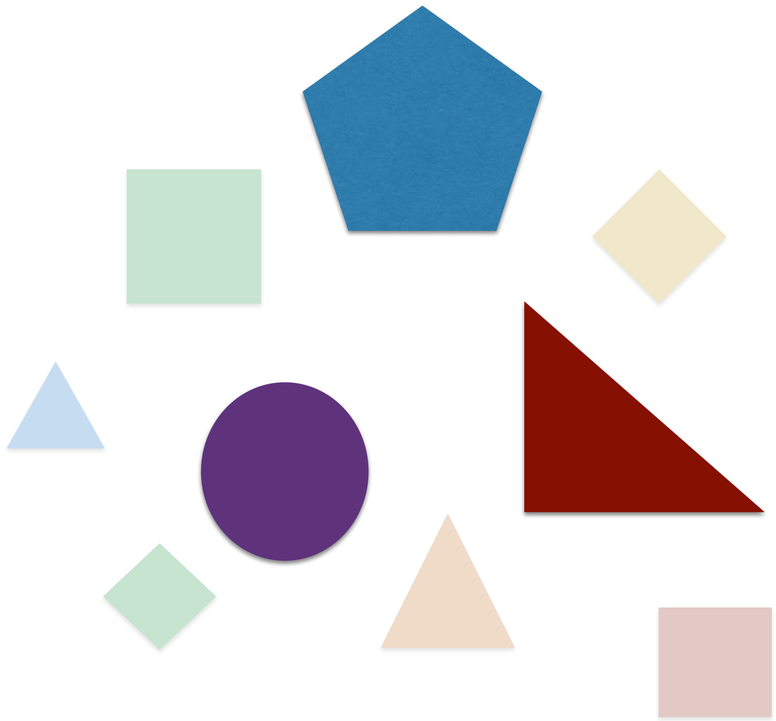


Sampling and Estimation

Point and Interval Estimates

1. Properties of Estimators
2. Confidence Intervals
3. Student's t-distribution

PREP nuggets

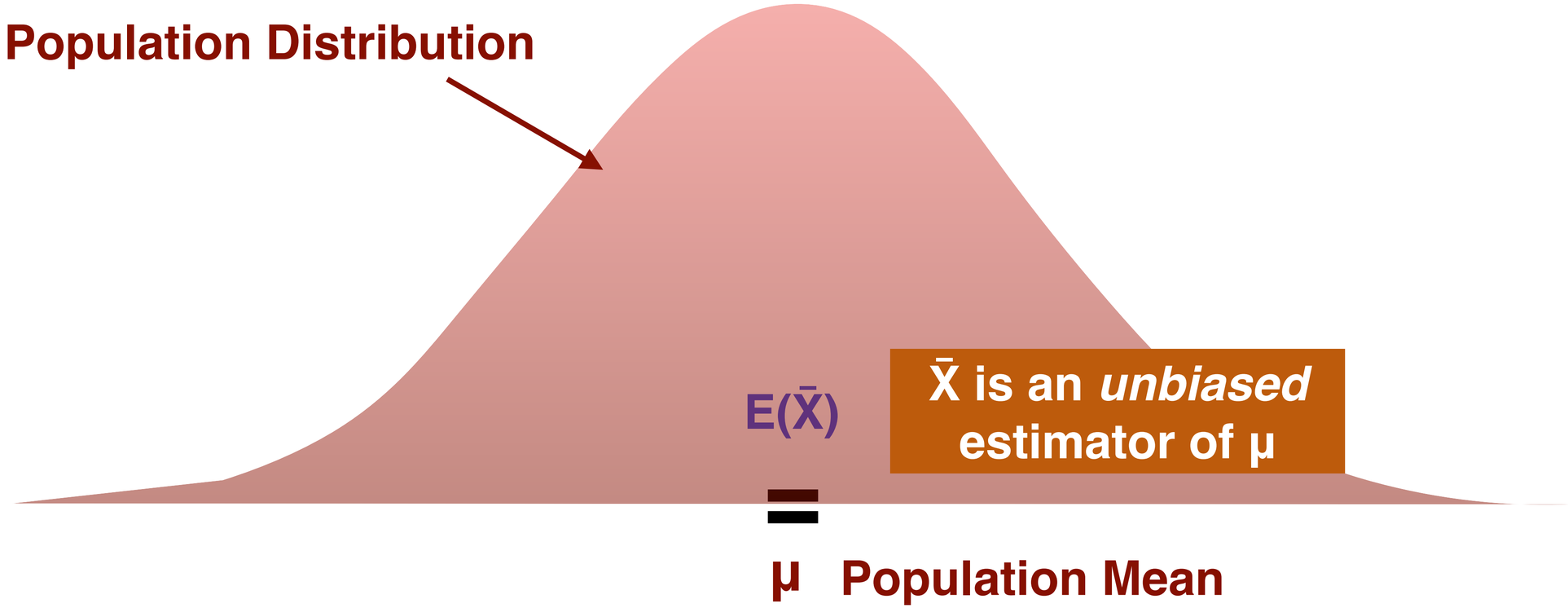
Desirable Properties of an Estimator

Consistent ***Unbiased*** ***Efficient***

Desirable Properties of an Estimator

Consistent **_Unbiased_** *Efficient*

expected value of the estimator is equal to the parameter to be estimated



PREP nuggets

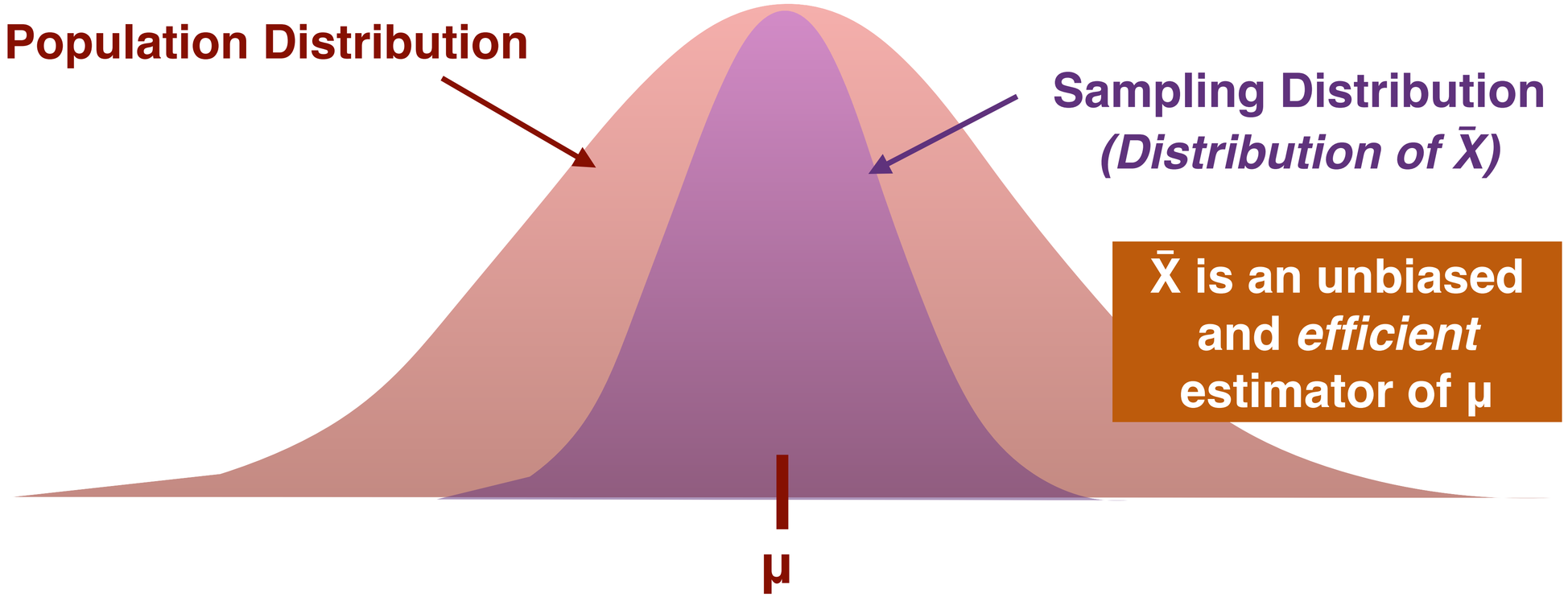
Point and Interval Estimates

1. Properties of Estimators 2. Confidence Intervals 3. Student's t-distribution

Desirable Properties of an Estimator

Consistent **Efficient** *Unbiased*

no other unbiased estimator has a sampling distribution with a smaller variance



PREP nuggets

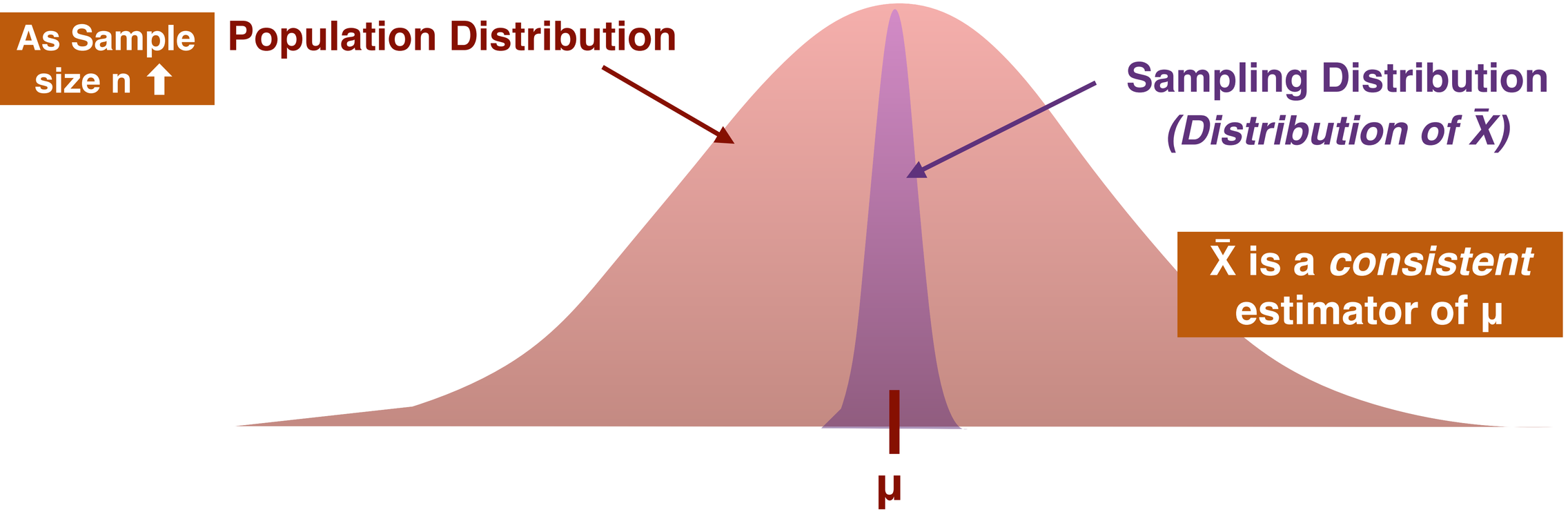
Point and Interval Estimates

1. Properties of Estimators 2. Confidence Intervals 3. Student's t-distribution

Desirable Properties of an Estimator

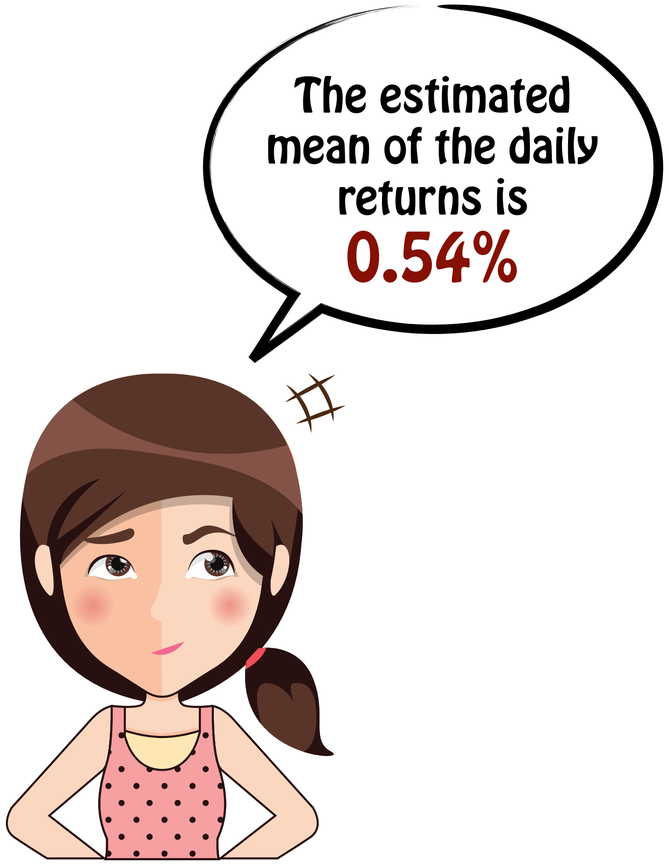
Efficient **Consistent** *Unbiased*

accuracy of the estimate increases as the sample size increases



Point Estimate

single value used to estimate population parameters



$$\frac{+2.7\%}{5} = 0.54\%$$

Not very useful!

Daily returns of XYZ stock

+1.4% +1.4% -0.8%

+1.2% +1.2% +2.1%

-0.8% -0.1%

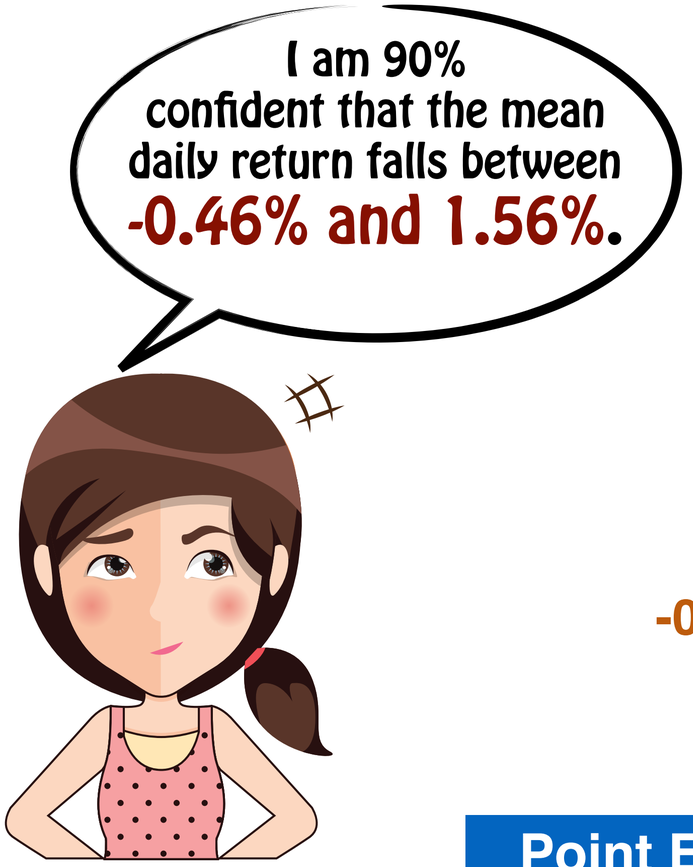
PREP nuggets

Point and Interval Estimates

1. Properties of Estimators 2. Confidence Intervals 3. Student's t-distribution

Confidence Interval

range of values in which the population parameter is expected to fall within



Point Estimate

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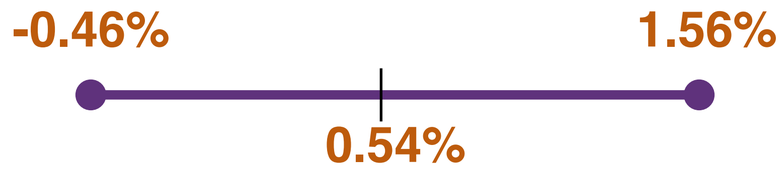


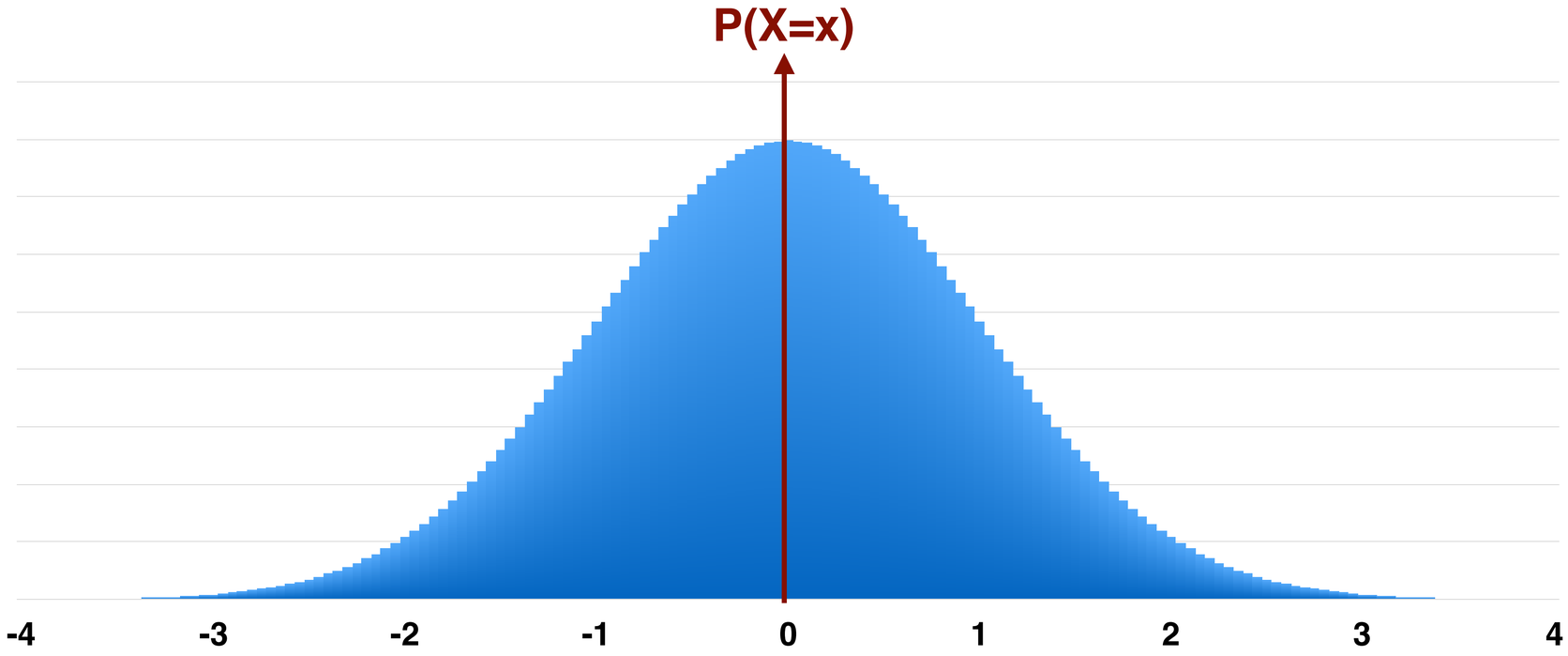
Point Estimate ± (Reliability factor x std err)

PREP nuggets

Point and Interval Estimates

1. Properties of Estimators 2. Confidence Intervals 3. Student's t-distribution

Probability Distribution



Only for Normal Distributions

z-statistics

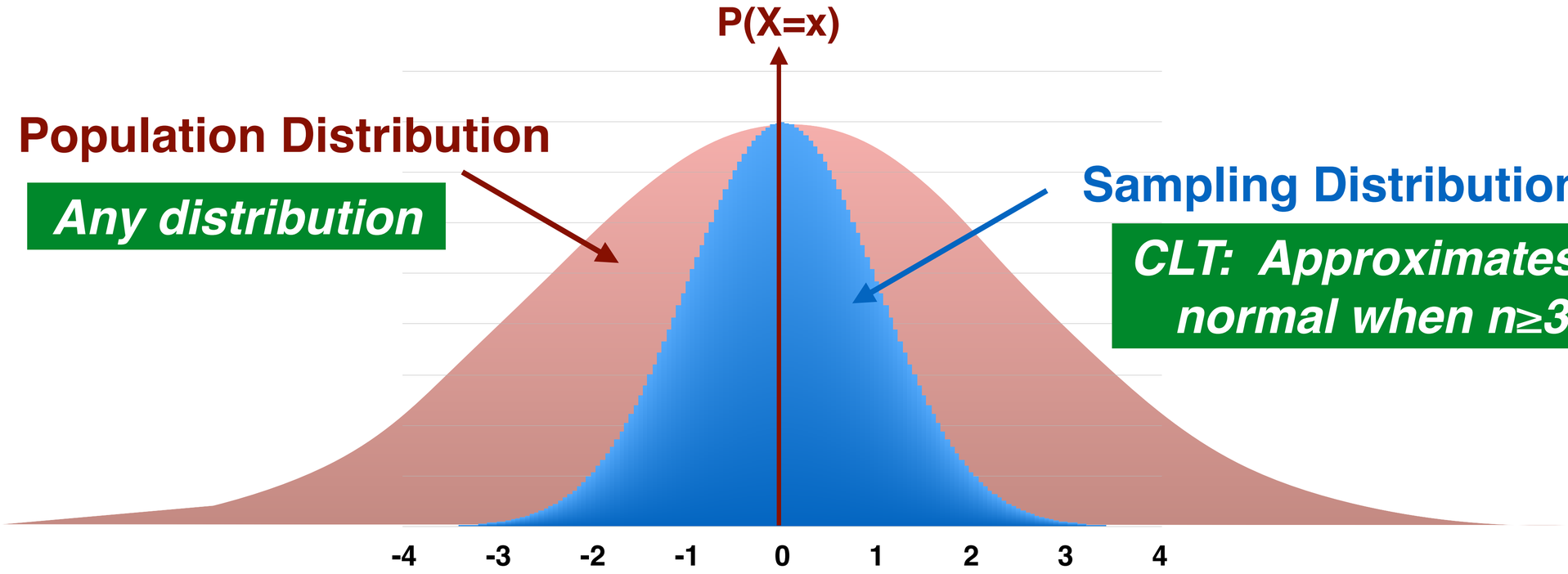
Confidence Intervals

PREP nuggets

Point and Interval Estimates

1. Properties of Estimators **2. Confidence Intervals** 3. Student's t-distribution

Probability Distribution



} *z-statistics*

Confidence Intervals

PREP nuggets

Point and Interval Estimates

1. Properties of Estimators 2. Confidence Intervals 3. Student's t-distribution

Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years which has a known standard deviation of 7.18%. She picks a sample of 50 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 95% confidence interval for the mean monthly return of the stock?

According to CLT, sampling distribution approximates to normal as n≥30.

Therefore we can use the z-statistic

95% confidence interval $\bar{X} \pm 1.96\sigma_{\bar{x}}$

Remember: Point Estimate ± (Reliability factor x std err)

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$$\sigma_{\bar{x}} = \sigma_x/\sqrt{n}$$

$$= 7.18/\sqrt{50}$$

$$= 1.02\%$$

Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years which has a known standard deviation of 7.18%. She picks a sample of 50 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

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$$\bar{X} \pm 1.96\sigma_{\bar{x}}$$

$$\sigma_{\bar{x}} = 1.02\%$$

$$95\% \text{ confidence interval} = 1.47 \pm 1.96 \times 1.02$$

$$= [-0.53, 3.47]$$

Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years which has a known standard deviation of 7.18%. She picks a sample of 50 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

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$$\bar{X} \pm 1.96\sigma_{\bar{x}}$$

$$\sigma_{\bar{x}} = 1.02\%$$

95% confidence interval = [-0.53, 3.47]

We are 95% confident that the mean monthly return falls between -0.53% and 3.47%.

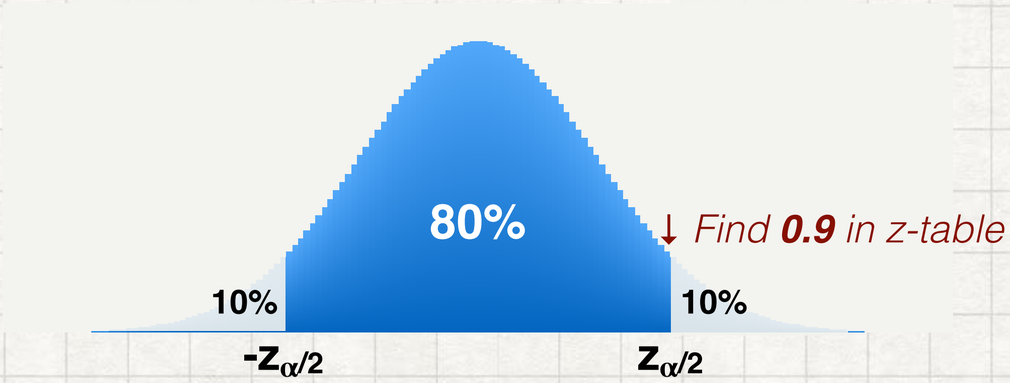
Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years which has a known standard deviation of 7.18%. She picks a sample of 50 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 80% confidence interval for the mean monthly return of the stock?

$$\bar{X} \pm z_{\alpha/2}\,\sigma_{\bar{X}}$$

α: *Level of significance* **20%**

1- α: *Degree of confidence* **80%**



Standard Normal Probabilities

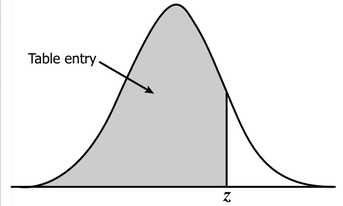


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817

Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years which has a known standard deviation of 7.18%. She picks a sample of 50 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 80% confidence interval for the mean monthly return of the stock?

$$\bar{X} \pm z_{\alpha/2}\,\sigma_{\bar{X}}$$

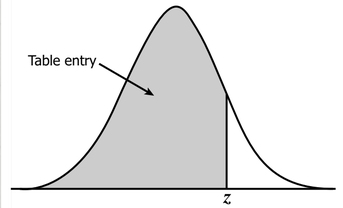
From z table

80% confidence interval = 1.47 ± 1.28 x 1.02

= [0.16, 2.78]

We are 80% confident that the mean monthly return falls between 0.16% and 2.78%.

Standard Normal Probabilities



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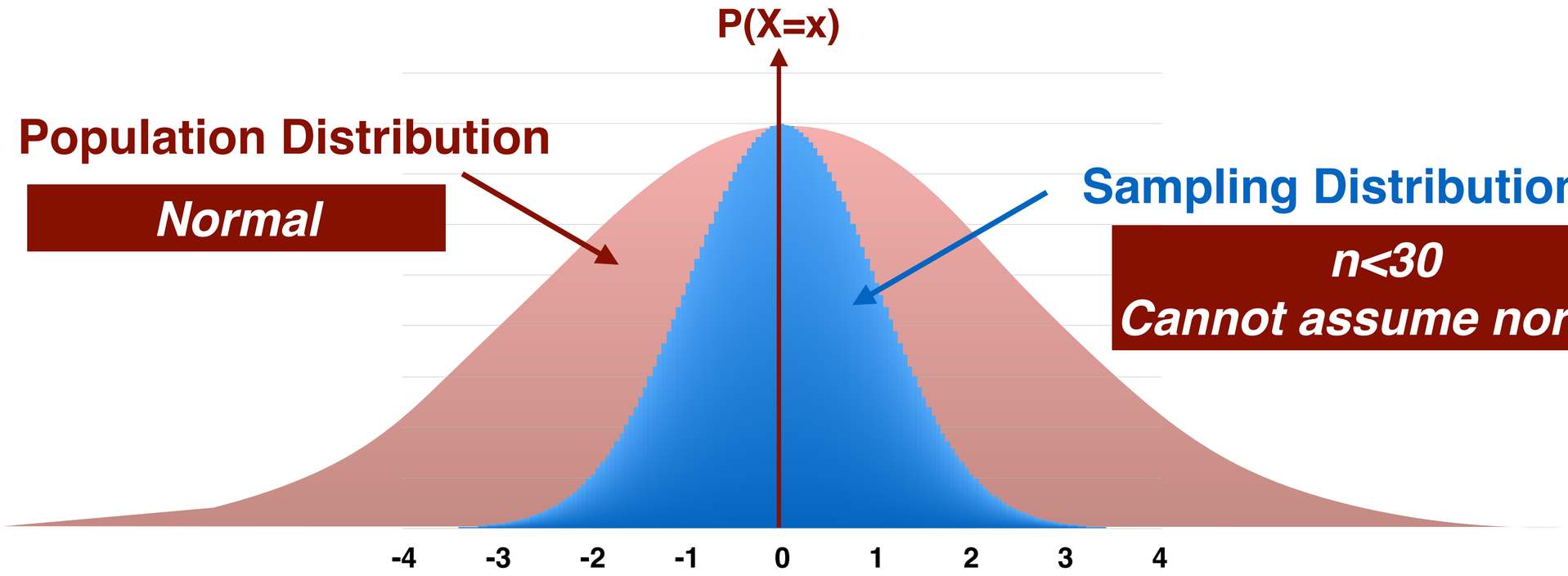
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817

Probability Distribution



Population Distribution

Normal

Sampling Distribution

n<30
Cannot assume normal

Use student's t-distribution

-1.96s — **95%** — +1.96s

-2.58s — **99%** — +2.58s

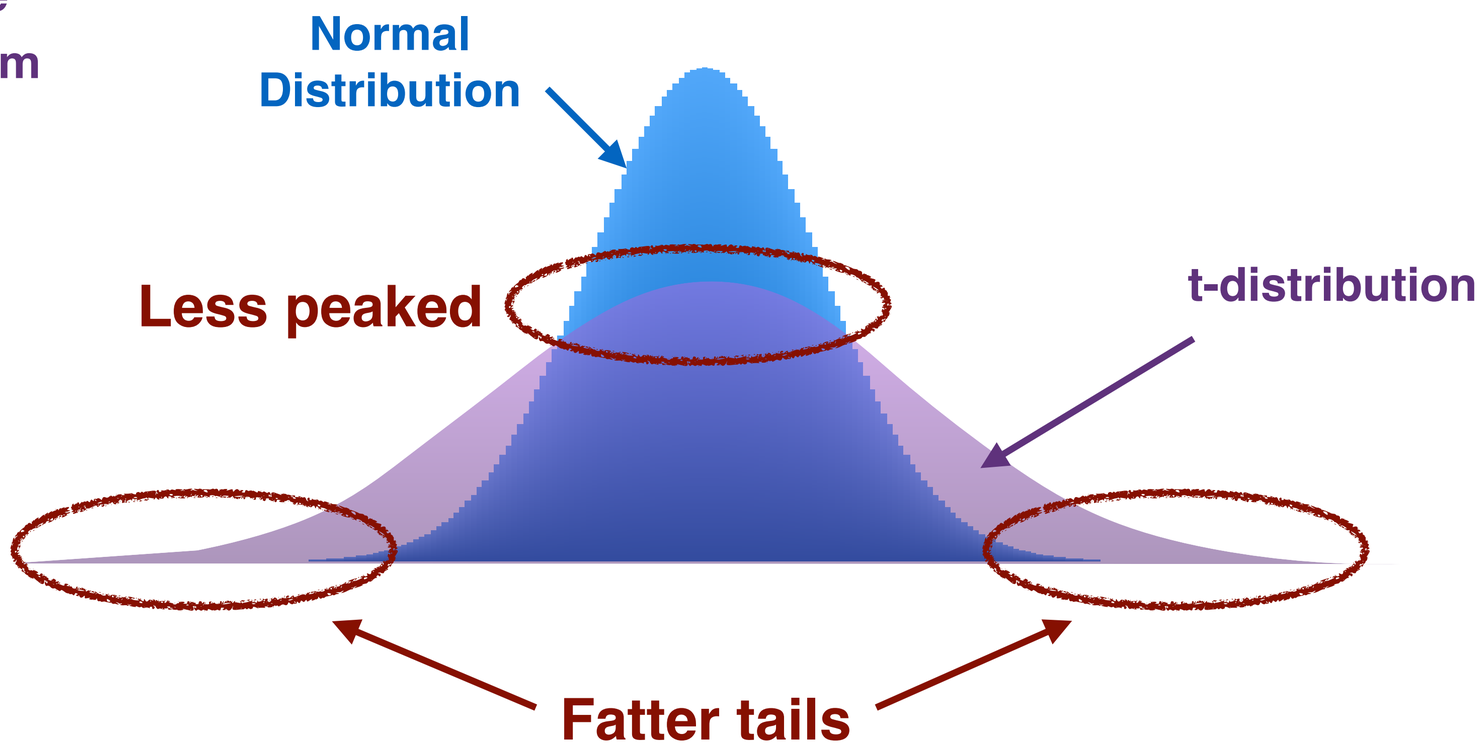
} ***z-statistics***

Confidence Intervals

Student's t-distribution

The degree to which the distribution deviates from normal is defined by

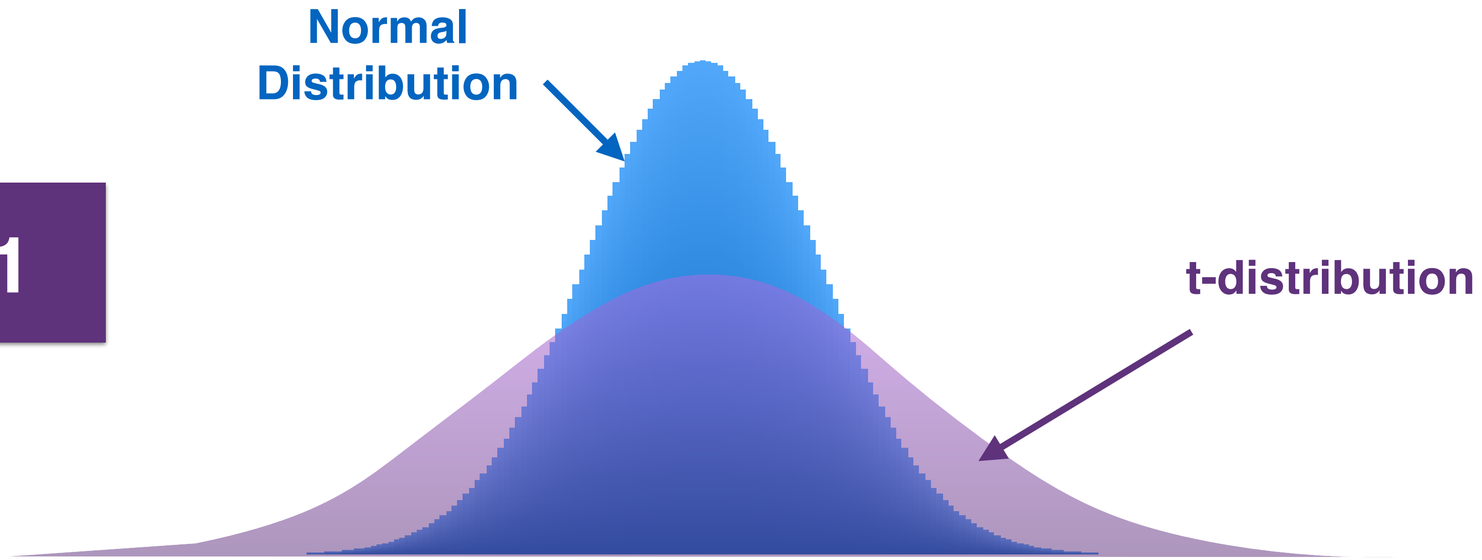
Degrees of freedom



Student's t-distribution

Degrees of freedom	1

n-1

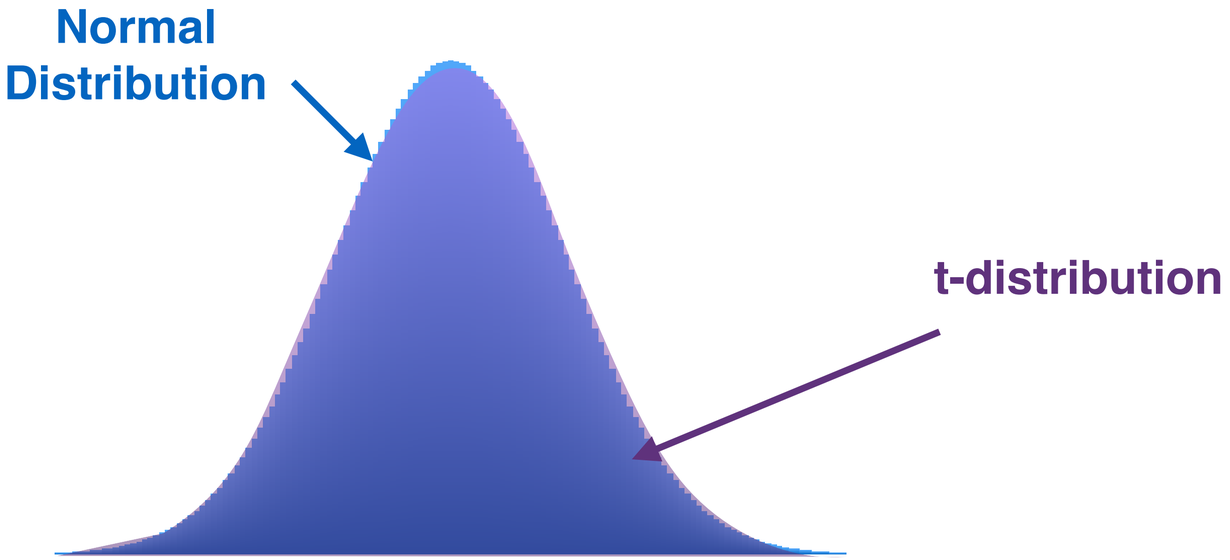


Student's t-distribution

As df → ∞
t-distribution approaches normal

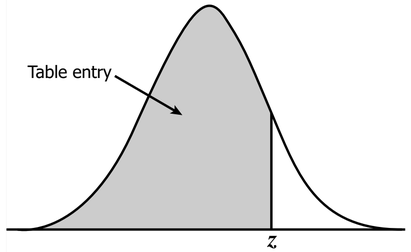
Degrees of freedom	∞

n-1



z table *use z to find probability*

Standard Normal Probabilities



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z values

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0.9	.8159	.8186	.8212	[illegible]	[illegible]	[illegible]	[illegible]	.8340	.8365	.8389
1.0	.8413	.8438	.8461	[illegible]	[illegible]	[illegible]	[illegible]	.8577	.8599	.8621
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2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817

probability

t table *use probability to find t*

t Table

probability

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	[illegible]	[illegible]	[illegible]	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	[illegible]	[illegible]	[illegible]	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

degrees of freedom

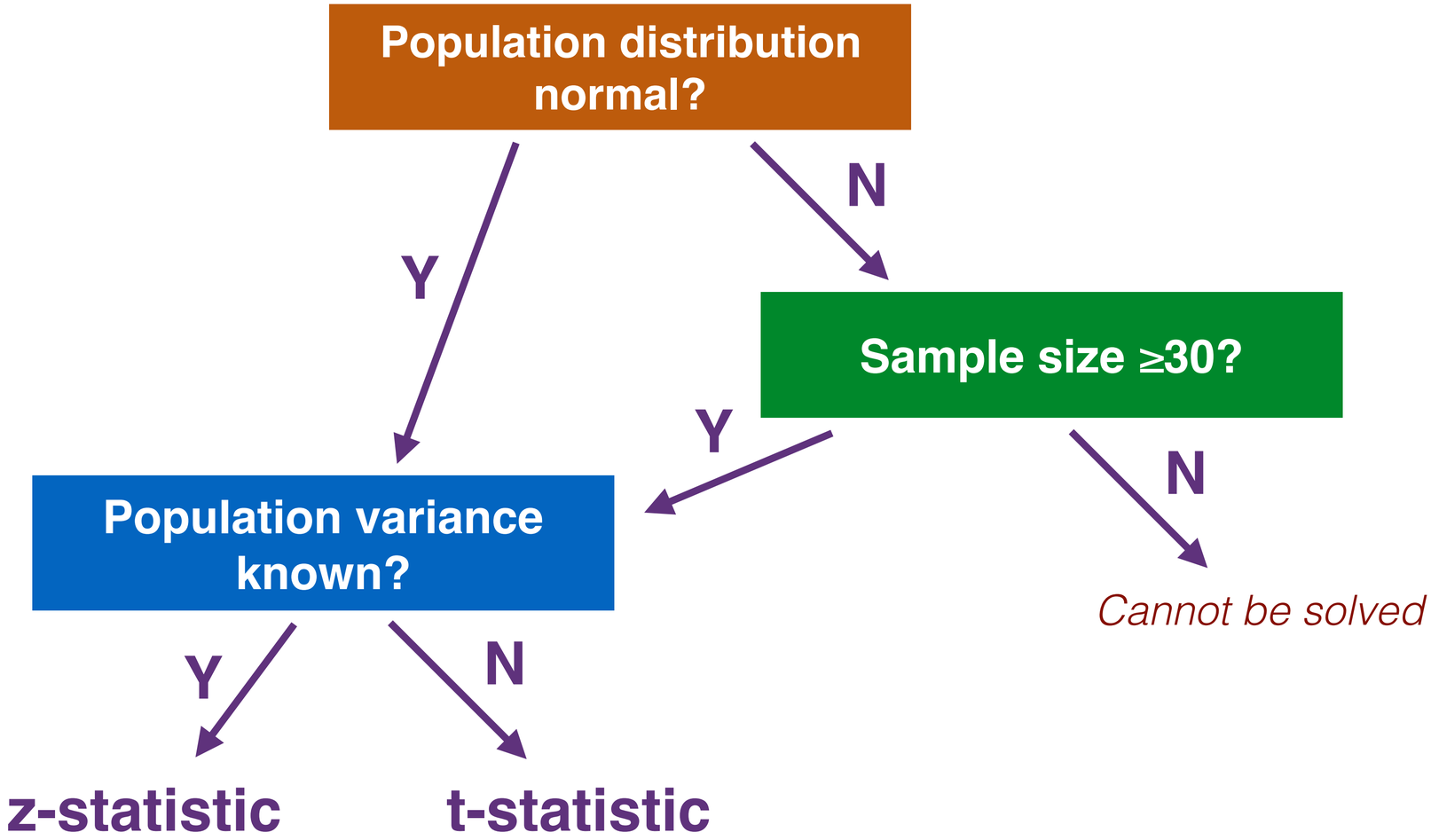
t values

PREP nuggets

Point and Interval Estimates

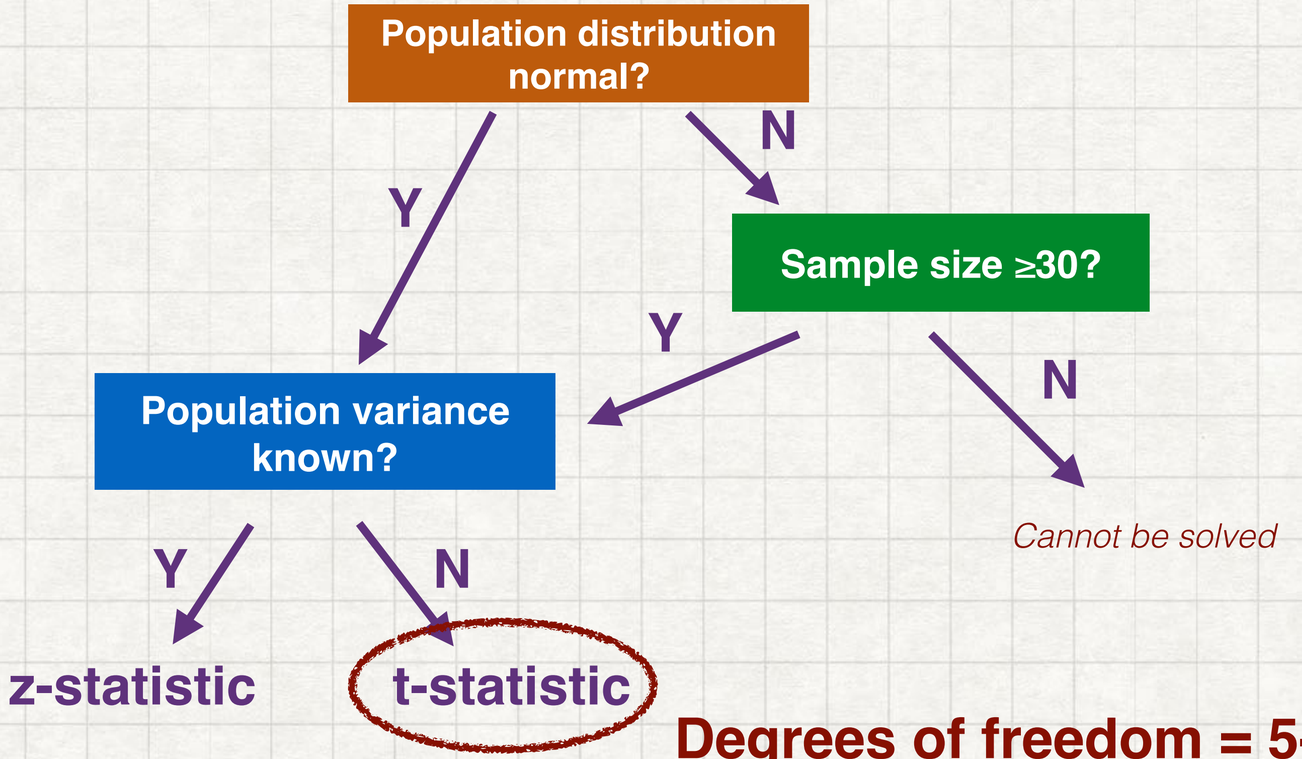
1. Properties of Estimators 2. Confidence Intervals 3. Student's t-distribution

Criteria for Selecting Test Statistic



Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years ~~which has a known standard deviation of 7.18%~~. The mean monthly return is assumed to be normal. She picks a sample of 5 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 95% confidence interval for the mean monthly return of the stock?



Degrees of freedom = 5-1 = 4

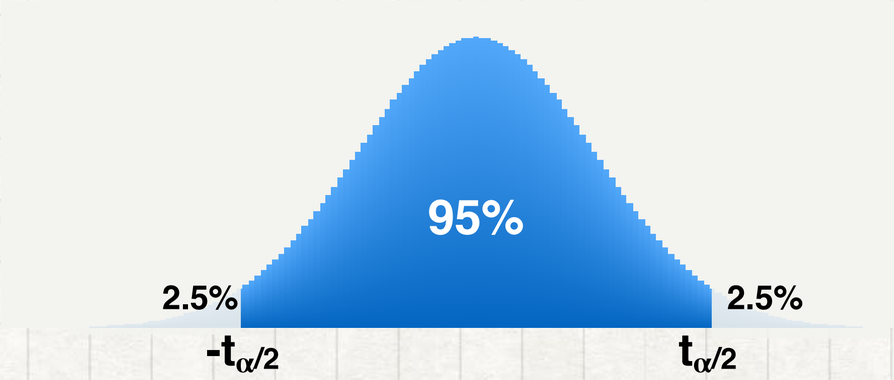
Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years ~~which has a known standard deviation of 7.18%~~. The mean monthly return is assumed to be normal. She picks a sample of 5 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 95% confidence interval for the mean monthly return of the stock?

$$\bar{X} \pm t_{\alpha/2}\, s_{\bar{X}}$$

Remember: Point Estimate ± (Reliability factor x std err)

α: *Level of significance* **5%**



t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819

Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years ~~which has a known standard deviation of 7.18%~~. The mean monthly return is assumed to be normal. She picks a sample of 5 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 95% confidence interval for the mean monthly return of the stock?

$$\bar{X} \pm t_{\alpha/2}\, s_{\bar{X}}$$

$$s_{\bar{X}} = 5.23 / \sqrt{5}$$

$$= 2.34$$

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
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13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
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Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years ~~which has a known standard deviation of 7.18%~~. The mean monthly return is assumed to be normal. She picks a sample of 5 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 95% confidence interval for the mean monthly return of the stock?

$$\bar{X} \pm t_{\alpha/2}\, s_{\bar{X}}$$

$s_{\bar{X}} = 2.34$

95% confidence interval

$= 1.47 \pm 2.776 \times 2.34$

$= [-5.08, 7.96]$

We are 95% confident that the mean monthly return falls between -5.08% and 7.96%.

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
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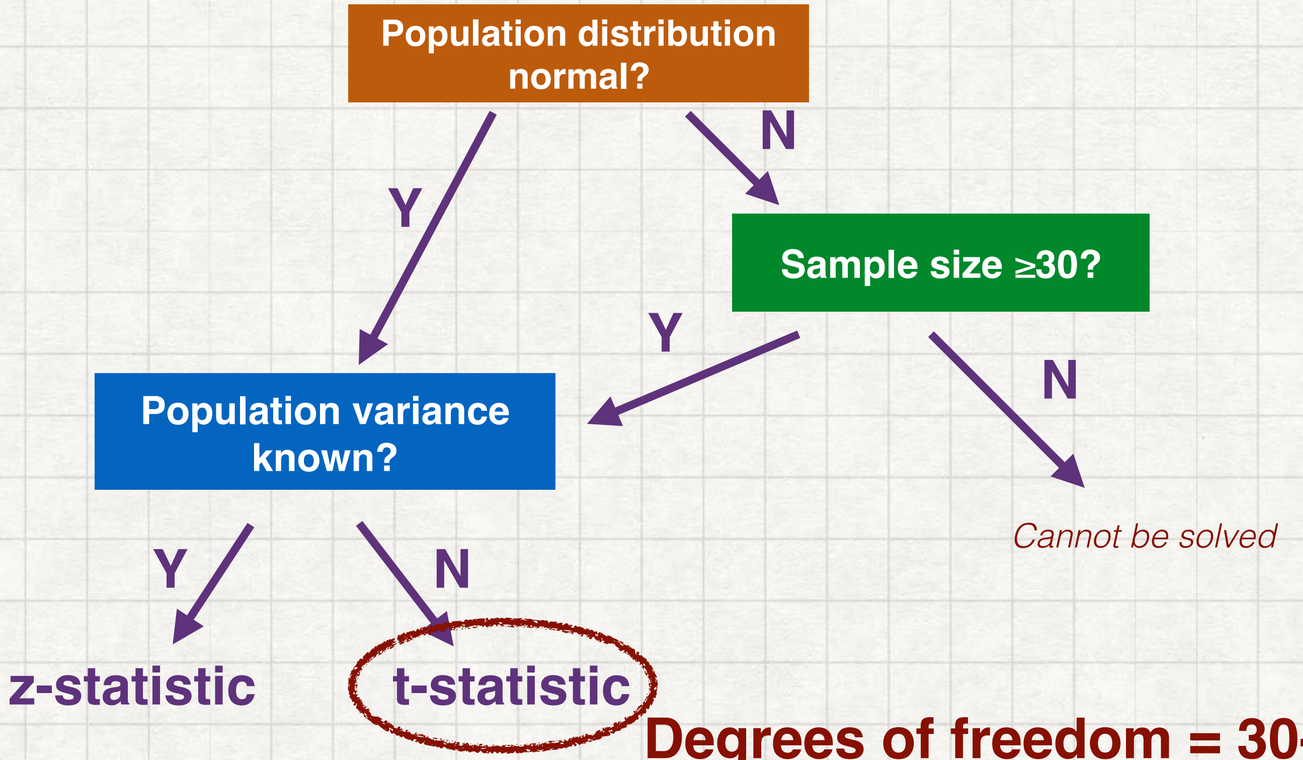
Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years ~~which has a known standard deviation of 7.18%~~. ~~The mean monthly return is assumed to be normal~~. She picks a sample of 30 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 90% confidence interval for the mean monthly return of the stock?



Degrees of freedom = 30-1 = 29

Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years ~~which has a known standard deviation of 7.18%~~. ~~The mean monthly return is assumed to be normal~~. She picks a sample of 30 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 90% confidence interval for the mean monthly return of the stock?

From the t-table, α=10% (2-tail), df=29

$t_{\alpha/2}$=1.699

$s_{\bar{X}} = 5.23 / \sqrt{30}$

$= 0.95$

Veron Foo, CFA wants to study the mean monthly return of a stock for the past 20 years ~~which has a known standard deviation of 7.18%~~. ~~The mean monthly return is assumed to be normal~~. She picks a sample of 30 random observations from the past, and found that the sample mean is 1.47% with a standard deviation of 5.23%.

What is the 90% confidence interval for the mean monthly return of the stock?

$$t_{\alpha/2}=1.699$$

$$s_{\bar{X}} = 0.95$$

$$\bar{X} \pm t_{\alpha/2}\, s_{\bar{X}}$$

$$\text{90\% confidence interval} = 1.47 \pm 1.699 \times 0.95$$

$$= [-0.14, 3.08]$$

We are 90% confident that the mean monthly return falls between -0.14% and 3.08%.

Calculating Confidence Intervals

Point Estimate ± **Reliability Factor** X **Standard Error**

Population mean μ

or

Sample mean $\bar{X}$

Select test statistic

Use criteria flow chart

Significance level α

1-Degree of Confidence

Refer z or t table

t: Degree of Freedom = n-1

z: 1.65(90%), 1.96(95%), 2.58(99%)

Population Std Dev $\sigma/\sqrt{n}$

or

Sample Std Dev $s/\sqrt{n}$

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