t Test vs Z Test

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Z Test or T Test ?

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Z Test or T Test ?

Sample Size > 30

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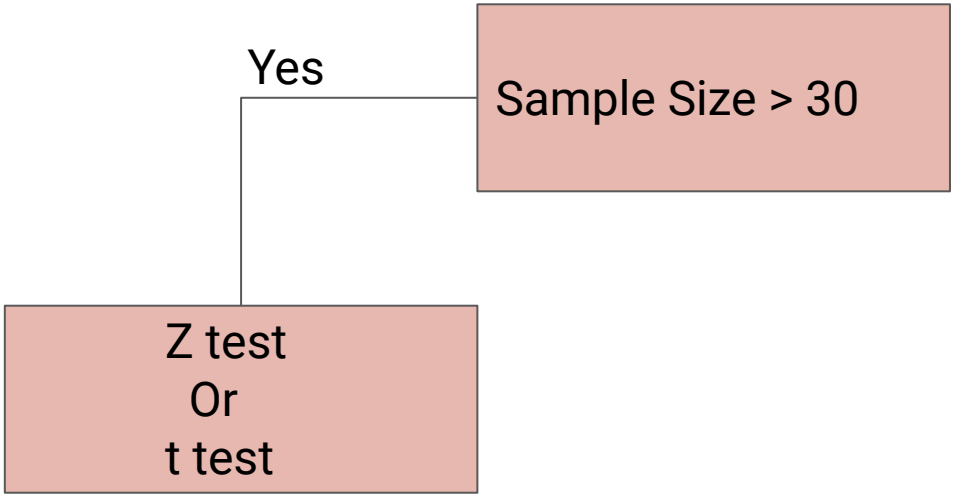
Z Test or T Test ?



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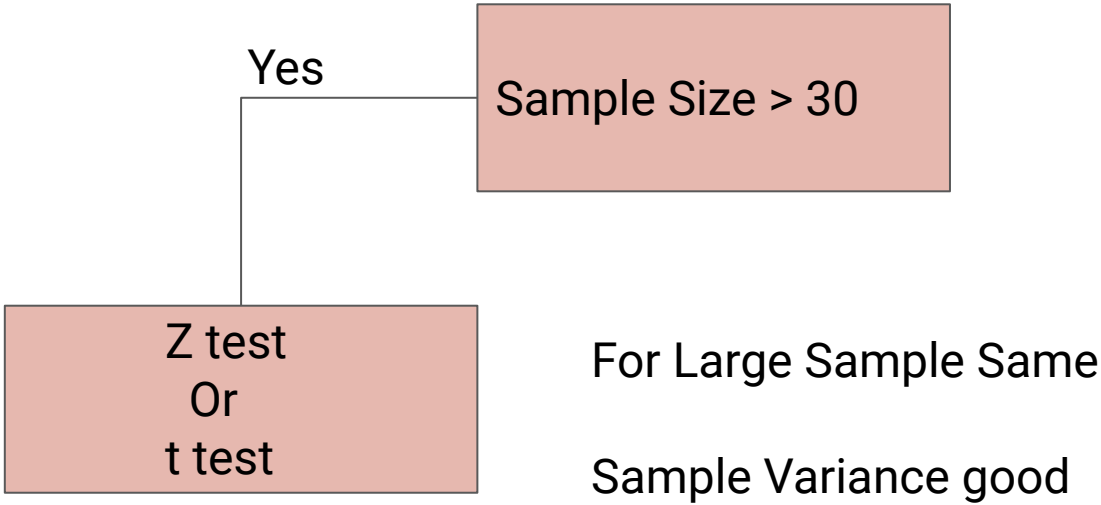
Z Test or T Test ?



For Large Sample Same

Sample Variance good estimator of Population Variance

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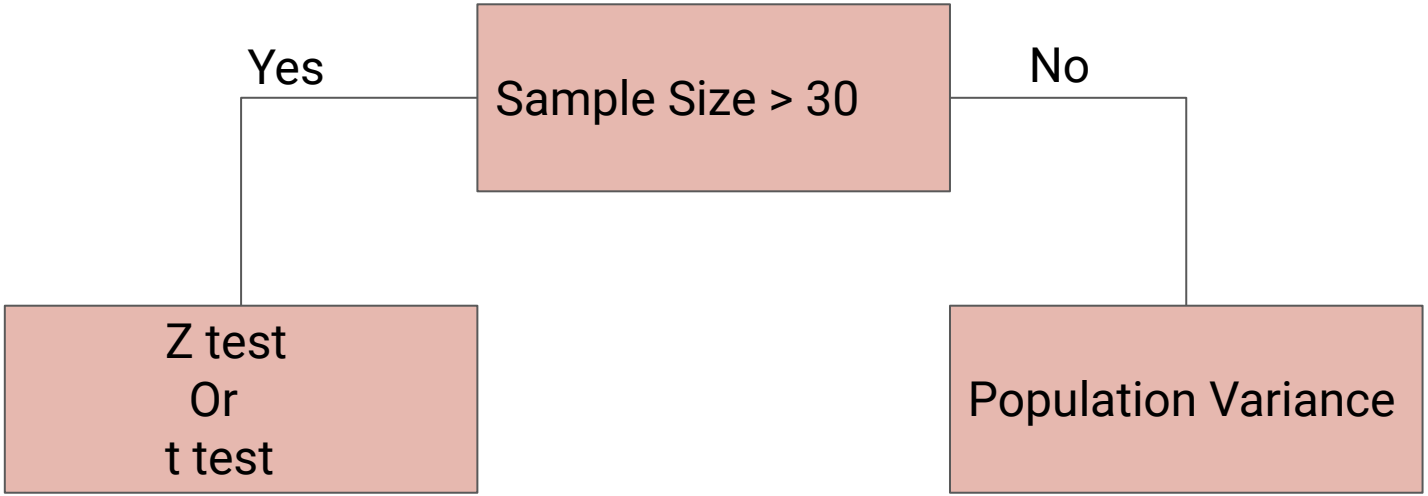
Z Test or T Test ?



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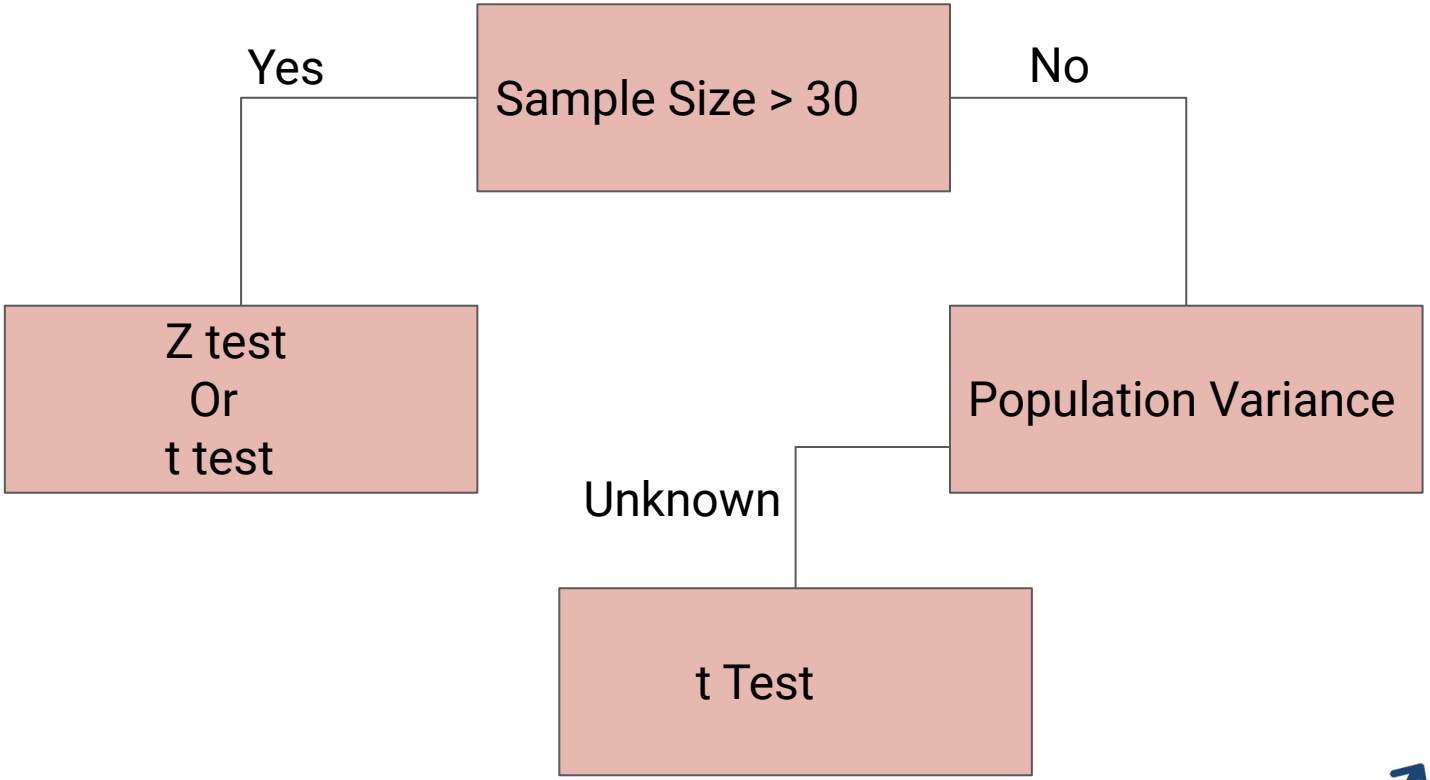
Z Test or T Test ?



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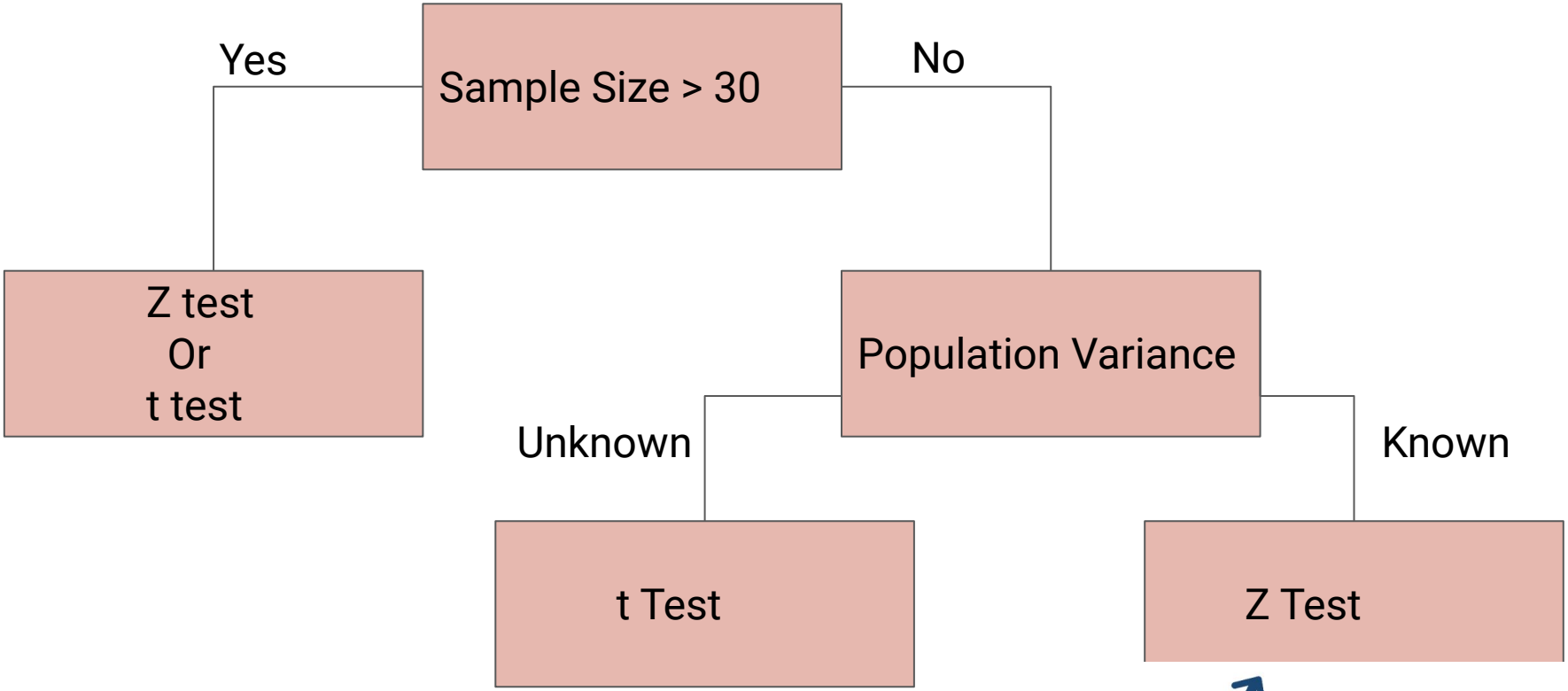
Z Test or T Test ?



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Paired t Test

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Paired t Test

A paired t-test is used when we are interested in the difference between two variables for the same subject.

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Paired t Test

A paired t-test is used when we are interested in the difference between two variables for the same subject.

Ex: Recovery of Covid Patients before and after hydroxychloroquine drugs

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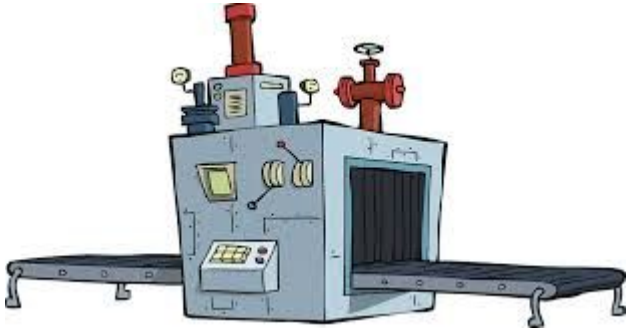
Paired t Test

A paired t-test is used when we are interested in the difference between two variables for the same subject.

Ex: Improvement in Production after using advanced manufacturing machine.



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Paired t Test

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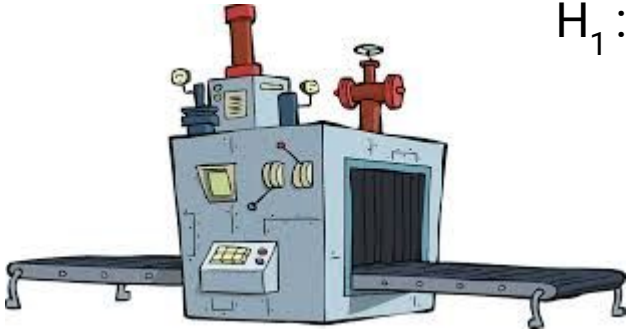
Ex: Improvement in Production after using advanced manufacturing machine.



H_0 : Production doesn't improve

H_1 : Production does improve

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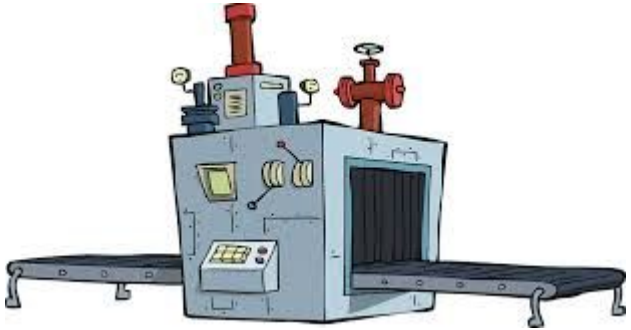
Paired t Test

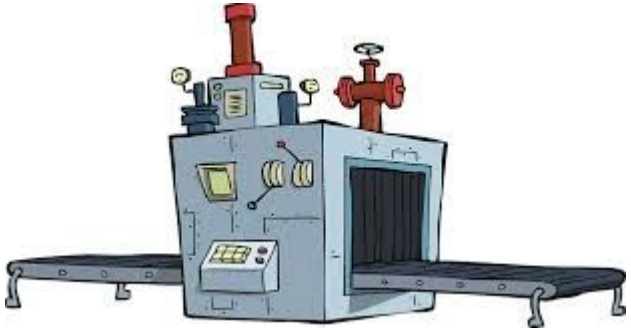
Ex: Improvement in Production after using advanced manufacturing machine.



Day
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0

Paired t Test

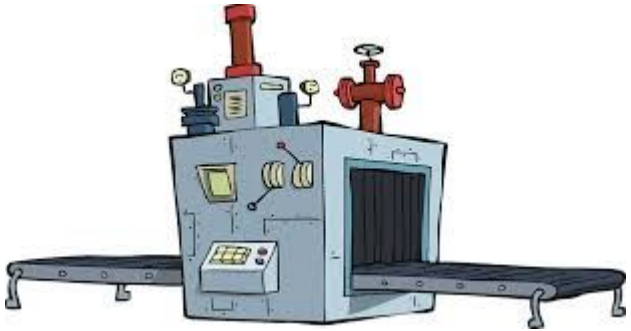
Ex: Improvement in Production after using advanced manufacturing machine.



Day	Before Production
1.0	1800
2.0	2100
3.0	1600
4.0	2200
5.0	1900
6.0	2400
7.0	1700
8.0	2100
9.0	2300
10.0	1800
11.0	1400
12.0	1600
13.0	1600
14.0	1900
15.0	1800
16.0	2000
17.0	1200
18.0	2200
19.0	1500
20.0	1700

Paired t Test

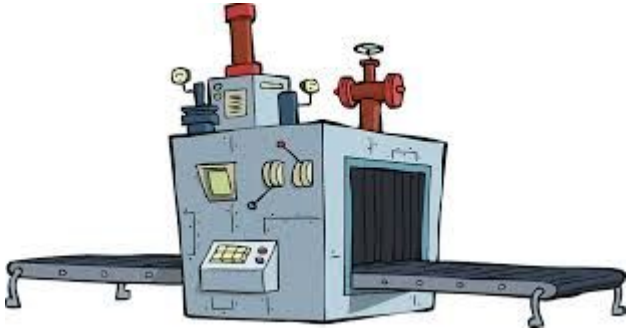
Ex: Improvement in Production after using advanced manufacturing machine.



Day	Before Production	After Production
1.0	1800	2200
2.0	2100	2500
3.0	1600	1700
4.0	2200	2400
5.0	1900	1600
6.0	2400	2900
7.0	1700	2000
8.0	2100	2300
9.0	2300	1900
10.0	1800	2000
11.0	1400	1500
12.0	1600	1500
13.0	1600	1800
14.0	1900	2600
15.0	1800	1800
16.0	2000	2400
17.0	1200	1800
18.0	2200	2500
19.0	1500	1900
20.0	1700	1600

Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.



Day	Before Production	After Production	Difference
1.0	1800	2200	400
2.0	2100	2500	400
3.0	1600	1700	100
4.0	2200	2400	200
5.0	1900	1600	-300
6.0	2400	2900	500
7.0	1700	2000	300
8.0	2100	2300	200
9.0	2300	1900	-400
10.0	1800	2000	200
11.0	1400	1500	100
12.0	1600	1500	-100
13.0	1600	1800	200
14.0	1900	2600	700
15.0	1800	1800	0
16.0	2000	2400	400
17.0	1200	1800	600
18.0	2200	2500	300
19.0	1500	1900	400
20.0	1700	1600	-100

Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.

$$t_{calc} = \frac{\bar{d}}{s_d / \sqrt{n}}$$

Day	Before Production	After Production	Difference
1.0	1800	2200	400
2.0	2100	2500	400
3.0	1600	1700	100
4.0	2200	2400	200
5.0	1900	1600	-300
6.0	2400	2900	500
7.0	1700	2000	300
8.0	2100	2300	200
9.0	2300	1900	-400
10.0	1800	2000	200
11.0	1400	1500	100
12.0	1600	1500	-100
13.0	1600	1800	200
14.0	1900	2600	700
15.0	1800	1800	0
16.0	2000	2400	400
17.0	1200	1800	600
18.0	2200	2500	300
19.0	1500	1900	400
20.0	1700	1600	-100

Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.

$$t_{calc} = \frac{\bar{d}}{s_d / \sqrt{n}}$$

$\bar{d}$ → Mean of difference observed
S_d → Standard deviation of difference observed
n → Sample Size

Day	Before Production	After Production	Difference
1.0	1800	2200	400
2.0	2100	2500	400
3.0	1600	1700	100
4.0	2200	2400	200
5.0	1900	1600	-300
6.0	2400	2900	500
7.0	1700	2000	300
8.0	2100	2300	200
9.0	2300	1900	-400
10.0	1800	2000	200
11.0	1400	1500	100
12.0	1600	1500	-100
13.0	1600	1800	200
14.0	1900	2600	700
15.0	1800	1800	0
16.0	2000	2400	400
17.0	1200	1800	600
18.0	2200	2500	300
19.0	1500	1900	400
20.0	1700	1600	-100

Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.

$$t_{calc} = \frac{\bar{d}}{s_d / \sqrt{n}}$$

$\bar{d}$ → 205
S_d → 283.72
n → 20

Day	Before Production	After Production	Difference
1.0	1800	2200	400
2.0	2100	2500	400
3.0	1600	1700	100
4.0	2200	2400	200
5.0	1900	1600	-300
6.0	2400	2900	500
7.0	1700	2000	300
8.0	2100	2300	200
9.0	2300	1900	-400
10.0	1800	2000	200
11.0	1400	1500	100
12.0	1600	1500	-100
13.0	1600	1800	200
14.0	1900	2600	700
15.0	1800	1800	0
16.0	2000	2400	400
17.0	1200	1800	600
18.0	2200	2500	300
19.0	1500	1900	400
20.0	1700	1600	-100

Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.

$$t_{calc} = \quad 3.231$$

Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.

$$t_{calc} = \quad 3.231$$

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

Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.

$$t_{calc} = \quad 3.231$$

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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Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.

$$t_{calc} = \quad 3.231$$

P value would be between 0.001 and 0.005.

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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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Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.

$$t_{calc} = \quad 3.231$$

P value would be between 0.001 and 0.005.

Exact P value = 0.004

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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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

Paired t Test

Ex: Improvement in Production after using advanced manufacturing machine.

$$t_{calc} = \quad 3.231$$

P value would be between 0.001 and 0.005.

Exact P value = 0.004

P value < 0.05

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
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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

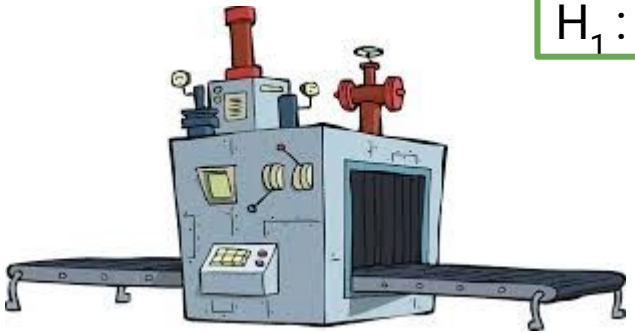
Paired t Test

A paired t-test is used when we are interested in the difference between two variables for the same subject.

Ex: Improvement in Production after using advanced manufacturing machine.

H_0 : Production doesn't improve

H_1 : Production does improve



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Thank You!