

Exercise : Stopping Distance 1

Stopping distance is an important measure in evaluation the overall safety of a vehicle. The data in the table are a sample of 12 trials for the stopping distance when decelerating from 60 mph to 0 mph for the 2007 Dodge Charger. Test at $\alpha = 0.05$ level of significance the claim that the 2007 Dodge charger has a stopping distance of less than 150 feet.

Stopping Distance in feet					
146.9	147.2	144.1	139.1	139.1	139.1
153.9	143.6	143.4	146.6	144.2	146.6

Step 1

State the hypotheses and identify the claim

The claim is that the actual stopping distance is less than 150 feet. This will be a one-tailed test to the left. Remember that the null hypothesis always contains the equal sign.

$$H_0: \mu = 150$$

$$H_1: \mu < 150 \text{ (claim)}$$

Step 2

Compute the test value

$$t = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}}$$

$$\bar{X} = 144.48$$

$$s = 4.26$$

$$n = 12$$

$$t = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{144.48 - 150}{\frac{4.26}{\sqrt{12}}} = -4.489$$

Step 3

<i>v</i>	<i>α</i>						
	0.40	0.25	0.10	0.05	0.025	0.01	0.005
1	0.325	1.000	3.078	6.314	12.706	31.821	63.657
2	0.289	0.816	1.886	2.920	4.303	6.965	9.925
3	0.277	0.765	1.638	2.353	3.182	4.541	5.841
4	0.271	0.741	1.533	2.132	2.776	3.747	4.604
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032
6	0.265	0.718	1.440	1.943	2.447	3.143	3.707
7	0.263	0.711	1.415	1.895	2.365	2.998	3.499
8	0.262	0.706	1.397	1.860	2.306	2.896	3.355
9	0.261	0.703	1.383	1.833	2.262	2.821	3.250
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169
11	0.260	0.697	1.363	1.796	2.201	2.718	3.106
12	0.259	0.695	1.356	1.782	2.179	2.681	3.055
13	0.259	0.694	1.350	1.771	2.160	2.650	3.012
14	0.258	0.692	1.345	1.761	2.145	2.624	2.977

The P-value < 0.005 (calculator gives 0.000459)

Step 4

Make the decision to reject or not reject the null hypothesis.

P-value < α = 0.05

Thus, our decision should be **to reject the null hypothesis**.

Step 5

Summarize the results.

There is enough evidence to support the claim (H_1)
that a 2007 Dodge Charger has a stopping distance of
less than 150 feet.

Exercise: Teacher Salaries

According to the 2016 World Almanac, the two states with the lowest average public-school teacher pay for the 2013-2014 school year were Mississippi and South Dakota. Suppose random samples of 45 teachers were drawn from each state. The sample mean for Mississippi was \$42,187. Suppose the population standard deviation for Mississippi is \$4300. The sample mean for South Dakota was \$40,023. Suppose the population standard deviation for South Dakota is \$4500.

At $\alpha = 0.10$ level of significance, is there a difference in the means of public-school teacher salaries for the two states?

Assign Groups

In order to conduct a test about the difference between means we will need to assign the groups that are being studied. In this example we will assign the teachers from Mississippi to Group 1 and the teachers from South Dakota to Group 2.

Mississippi (Group 1)

$$\bar{X} = 42187$$

$$\sigma = 4300$$

$$n = 45$$

South Dakota (Group 2)

$$\bar{X} = 40023$$

$$\sigma = 4500$$

$$n = 45$$

At $\alpha = 0.10$ level of significance, **is there a difference** in the means of public-school teacher salaries for the two states?

State Hypotheses

Step 1

State the hypotheses and identify the claim.

The claim is that there is a difference for the two states.

Remember that the null hypothesis always contains the equal sign.

The alternative hypothesis then will be that the means are not equal. The claim belongs in the alternative hypothesis.

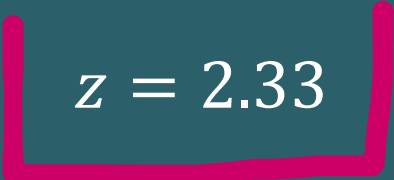
$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2 \text{ (claim)}$$

Compute the test value

$$z = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

$$z = \frac{(42187 - 40023) - (0)}{\sqrt{\frac{4300^2}{45} + \frac{4500^2}{45}}}$$


$$z = 2.33$$

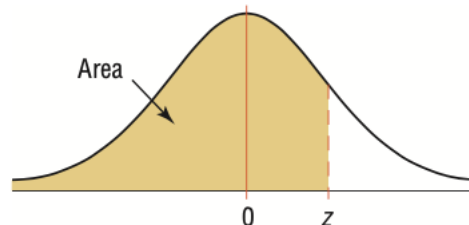
Find the P-value

Cumulative Standard Normal Distribution

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
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

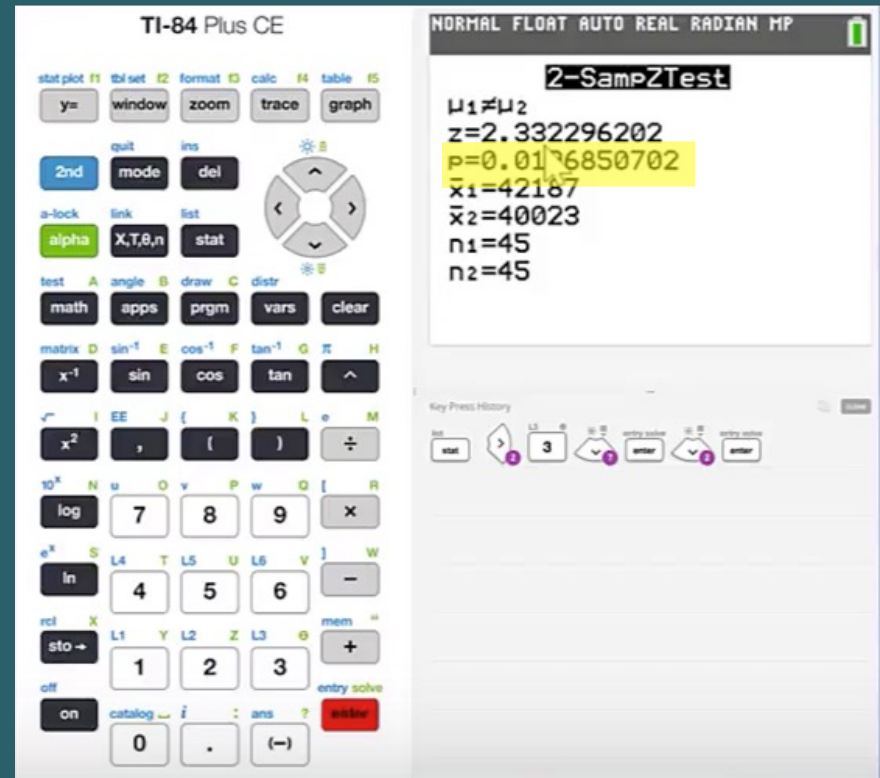
For z values greater than 3.49, use 0.9999.

$P = 0.0198$



Find the P-Value (calculator)

The P-value is
0.0197



Decision

The P-value is 0.0197

Recall that the rule for using the P-value in hypothesis testing is that if the **P-value is less than α , we should reject the null hypothesis.**

The P-value of 0.0197 is less than our significance level of 0.10

In this case we should reject the null hypothesis.

Conclusion

Our conclusion is that at $\alpha = 0.10$ level of significance **there is enough evidence to support the claim** that there exists a difference in the means of public-school teacher salaries for the two states.

Exercise: Stopping Distance 2

Stopping distance is an important measure in evaluating the overall safety of a vehicle. The data below are for samples of 20 trials for the stopping distance when decelerating from 60 miles per hour to 0 miles per hour for the 2016 Dodge Charger and a 2016 Chevrolet Caprice. At $\alpha = 0.05$ level of significance, test the claim that the stopping distance of the 2016 Dodge Charger is less than that of the 2016 Chevrolet Caprice.

Data:

Dodge Charger: $\bar{X}_1 = 125.681 \text{ ft}$; $s_1 = 1.822 \text{ ft}$

Chevrolet Caprice: $\bar{X}_2 = 130.738 \text{ ft}$, $s_2 = 1.598 \text{ ft}$

Measures

Let's begin by letting the Dodge Charger samples represent group number 1. The measures for Group 1 are the following:

$$\bar{X}_1 = 125.681 \text{ ft}$$

$$s_1 = 1.822 \text{ ft}$$

Let the Chevrolet Caprice samples represent group number 2. The measures for Group 2 are the following:

$$\bar{X}_2 = 130.738 \text{ ft}$$

$$s_2 = 1.598 \text{ ft}$$

Step 1

Step 1

State the hypotheses and identify the claim.

The claim is that the stopping distance of the 2016 Dodge Charger is less than that of the 2016 Chevrolet Caprice.

The claim will be in the alternative hypothesis.

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 < \mu_2 \text{ (claim)}$$

Step 2

Compute the test value.

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$t = \frac{(125.681 - 130.738) - (0)}{\sqrt{\frac{1.822^2}{20} + \frac{1.598^2}{20}}}$$


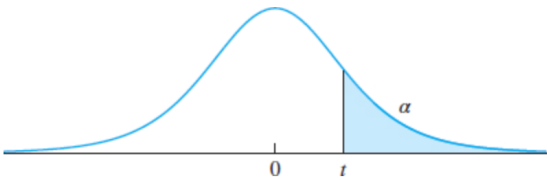

$$t = -9.332$$

TABLE A.3 Upper percentage points for the Student's *t* distribution



v	α								
	0.40	0.25	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
1	0.325	1.000	3.078	6.314	12.706	31.821	63.657	318.309	636.619
2	0.289	0.816	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.277	0.765	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.271	0.741	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.265	0.718	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.263	0.711	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.262	0.706	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.261	0.703	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.260	0.697	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.259	0.695	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.259	0.694	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.258	0.692	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.258	0.691	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.258	0.690	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.257	0.689	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.257	0.688	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.257	0.688	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.257	0.687	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.257	0.686	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.256	0.686	1.321	1.717	2.074	2.508	2.819	3.505	3.792

One-tailed test: The P-value is < 0.0005

Steps 4 and 5

$$\underline{P\text{-value} < \alpha = 0.05}$$

Our decision should be to **reject the null hypothesis**.

Since we decided to reject the null hypothesis, our conclusion is that **there is enough evidence to support the claim** that the stopping distance of the 2016 Dodge Charger is less than that of the 2016 Chevrolet Caprice.