Math 124: Using the t-table to find P-values

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There are fewer P-values in a t-table then in the normal distribution table we have used earlier. The method we use is to put bounds on the P-value. First we find the appropriate row in the table corresponding whatever degrees of freedom we have. Then we find t_{left}, with upper tail probability p_{left}, and t_{right}, with upper tail probability p_{right}, from the table such that $t_{\text{left}} < t < t_{\text{right}}$. We may then conclude that $p_{\text{left}} >$ P-value $> p_{\text{right}}$.

Recall that how you get your P-value depends on the form of the alternative hypothesis. This document discusses null and alternative hypotheses in the context of two sample problems (but the methodology remains the same for the one sample problems).

Testing against the two sided alternative

We will use the two sided test in the following examples

$$H_0 : \mu_1 - \mu_2 = 0 \text{ vs } H_A : \mu_1 - \mu_2 \neq 0$$

the P-value will be given by $2P\left(T > |t|\right)$

Example 1.1

Let df = 21 and suppose the value of the t statistic is $t = 2.05$.

From the t-table we find that

$$1.721 < 2.05 < 2.080$$

converting to P-values

$$0.05 > P(T > 2.05) > 0.025$$

multiplying through by 2 yields

$$0.1 > 2P(T > 2.05) > 0.05$$

and so we can reasonably say that $0.05 <$ P-value < 0.1

Example 1.2

Let df = 16 and suppose the value of the t statistic is $t = 0.321$.

One thing to note is that because the t-distribution is symmetric about 0, 50% of the area under the curve is above 0. Therefore from the t-table we find that

$$0 < 0.321 < 0.690$$

converting to P-values

$$0.5 > P(T > 0.321) > 0.25$$

multiplying through by 2 yields

$$1 > 2P(T > 0.321) > 0.5$$

and so we can reasonably say that $0.5 <$ P-value < 1.

Example 1.3

Let df = 25 and suppose the value of the t statistic is $t = -4.01$.

Now we know that

$$-4.01 < -3.725$$

multiplying both sides by -1 leads to

$$3.725 < 4.01$$

converting to P-values

$$0.0005 > P(T > 4.01)$$

multiplying through by 2 yields

$$0.001 > 2P(T > 4.01)$$

and so we can reasonably say that $0.001 >$ P-value.

Testing against the greater than alternative

We will use the following one sided test in the following examples

$$H_0 : \mu_1 - \mu_2 \leq 0 \text{ vs } H_A : \mu_1 - \mu_2 > 0$$

so any P value we compute will be given by $P\left(T > t\right)$

Example 2.1

Let df $= 31$ and suppose the value of the t statistic is $t = 2.56$. Firstly we must choose a row of the t-table to use since $df = 31$ is not in the table. To be conservative pick the largest df that is in the table but smaller than df you want (in this case we pick the row $df = 30$). This approach will give us slightly wider confidence intervals and we will be slightly less likely to reject the null hypothesis.

From the t-table we find that

$$2.457 < 2.56 < 2.750$$

converting to P-values

$$0.01 > P(T > 2.56) > 0.005$$

and so we can reasonably say that $0.005 <$ P-value < 0.01.

Example 2.2

Let df $= 11$ and suppose the value of the t statistic is $t = -0.75$.

Note that because the t-distribution is symmetric about 0, the following holds

$$P\left(T > -0.75\right) = 1 - P(T < -0.75) = 1 - P(T > 0.75)$$

From the t-table we find that

$$0.697 < 0.75 < 0.876$$

converting to P-values

$$0.25 > P(T > 0.75) > 0.20$$

multiply through by -1

$$-0.25 < -P(T > 0.75) < -0.20$$

then add 1 to each side

$$0.75 < 1 - P(T > 0.75) < 0.8$$

and so

$$0.75 < P(T > -0.75) < 0.8$$

and so we may state that $0.75 <$ P-value < 0.8

Testing against the less than alternative

We will use the following one sided test in the following examples

$$H_0 : \mu_1 - \mu_2 \geq 0 \text{ vs } H_A : \mu_1 - \mu_2 < 0$$

and so the P-value will be given by $P(T < t)$

Example 3.1

Let df = 8 and suppose the value of the t statistic is $t = -1.97$.

Observe that

$$-2.306 < -1.97 < -1.86$$

multiply through by -1 to give

$$1.86 < 1.97 < 2.306$$

converting to p-values from the t-table

$$0.05 > P(T > 1.97) > 0.025$$

and so we may reasonably conclude that $0.025 <$ P-value $< .05$