```
>
```

Normal and *t* Distributions

```
> restart;
> with(plots);
Warning, the name changecoords has been redefined
```

[*animate*, *animate3d*, *animatecurve*, *changecoords*, *complexplot*, *complexplot3d*, *conformal*, *contourplot*, *contourplot3d*, *coordplot*, *coordplot3d*, *cylinderplot*, *densityplot*, *display*, *display3d*, *fieldplot*, *fieldplot3d*, *gradplot*, *gradplot3d*, *implicitplot*, *implicitplot3d*, *inequal*, *listcontplot*, *listcontplot3d*, *listdensityplot*, *listplot*, *listplot3d*, *loglogplot*, *logplot*, *matrixplot*, *odeplot*, *pareto*, *pointplot*, *pointplot3d*, *polarplot*, *polygonplot*, *polygonplot3d*, *polyhedra_supported*, *polyhedraplot*, *replot*, *rootlocus*, *semilogplot*, *setoptions*, *setoptions3d*, *spacecurve*, *sparsematrixplot*, *sphereplot*, *surfdata*, *textplot*, *textplot3d*, *tubeplot*]

```
> with(stats);
```

[*anova*, *describe*, *fit*, *importdata*, *random*, *statevalf*, *statplots*, *transform*]

```
> with(statevalf);
```

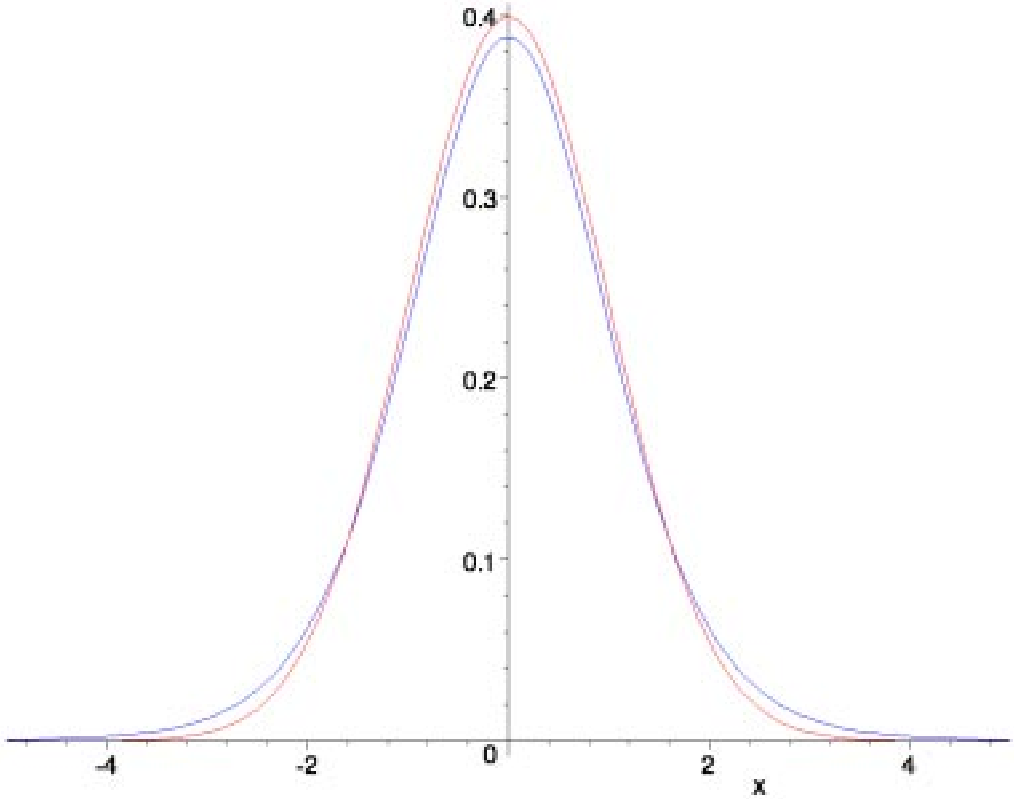
[*cdf*, *dcdf*, *icdf*, *idcdf*, *pdf*, *pf*]

```
> with(pdf);
```

[β, *cauchy*, *chisquare*, *exponential*, *fratio*, γ, *laplaced*, *logistic*, *lognormal*, *normald*, *studentst*, *uniform*, *weibull*]

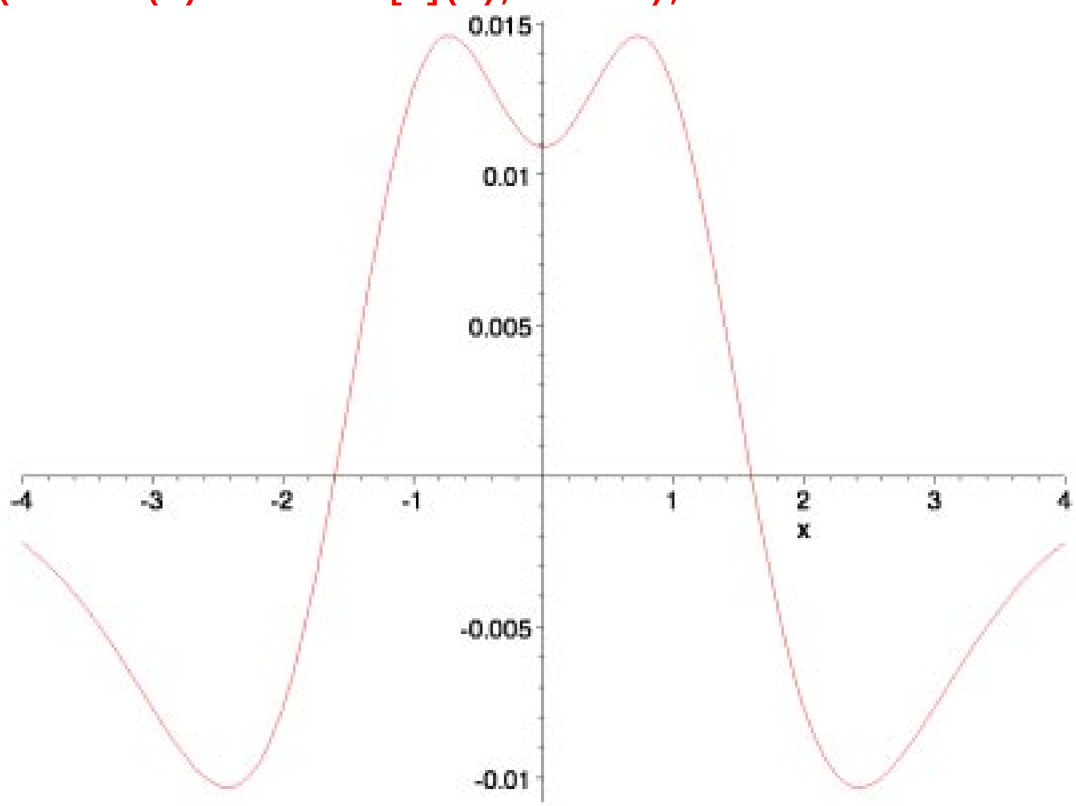
We first wish to compare the normal distribution (red) with the *t* distribution with 9 degrees of freedom (blue).

```
> p0:=plot(normald(x),x=-5..5,color=red):
  p1:=plot(studentst[9](x),x=-5..5,color=blue):
  display(p0,p1);
```



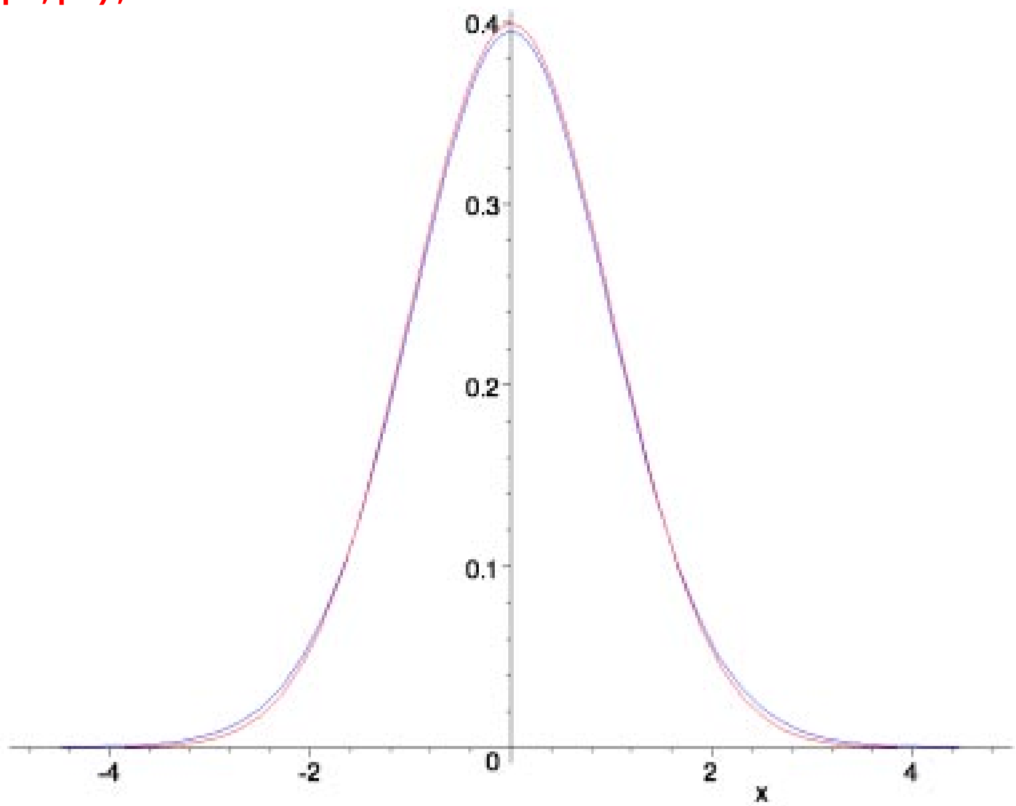
We see the normal curve is higher in the middle but lower on the extremes. Let's compute the difference of the curves.

```
> plot(normald(x)-studentst[9](x),x=-4..4);
```



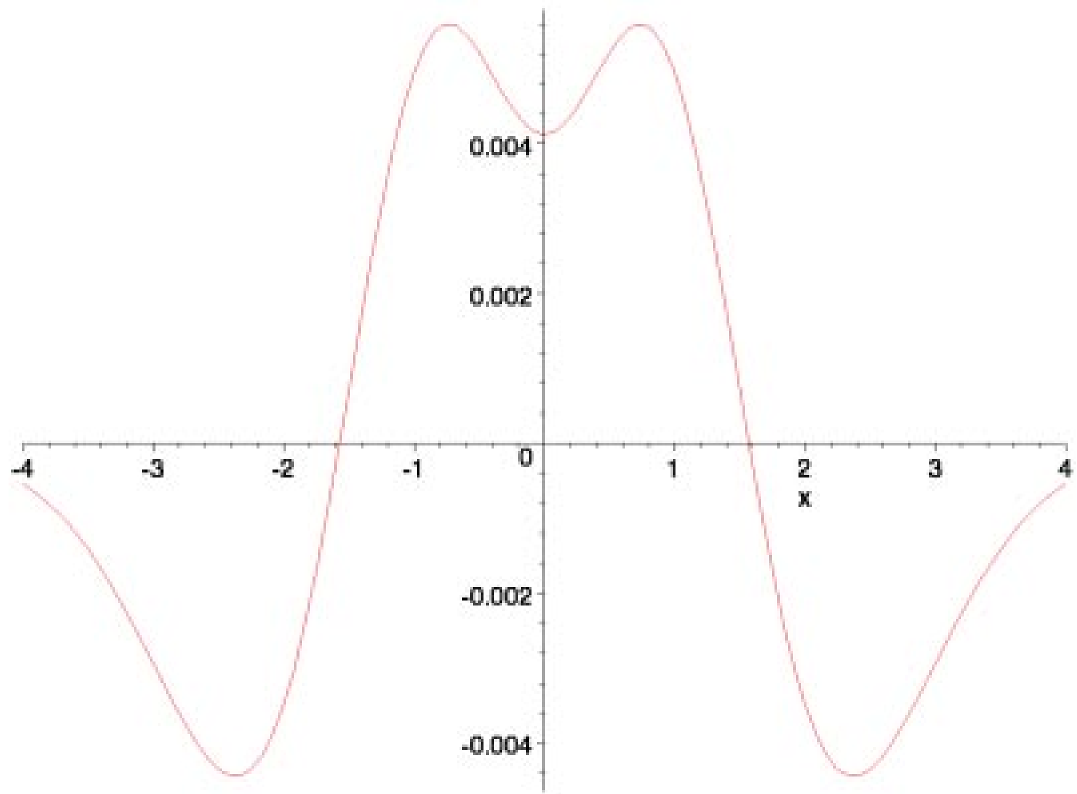
Next let's compare the normal distribution (red) with the *t* distribution with 24 degrees of freedom (blue), which we would often use when $n = 25$.

```
p0:=plot(normald(x),x=-5..5,color=red):
p2:=plot(studentst[24](x),x=-5..5,color=blue):
display(p0,p2);
```



We have the same relationship as before, but the curves are much closer. Let's again compute the difference of the curves.

```
> plot(normald(x)-studentst[24](x),x=-4..4);
```



With this small difference, you can see why we often, for convenience sake, use z instead of t for large populations (when n is greater than or equal to 25). What is the total accumulated absolute error in using t instead of z when $n = 25$?

```
> dif:=abs(normald(x)-studentst[24](x));
```

$$dif := \left| \mathrm{normald}(x) - studentst_{24}(x) \right|$$

```
> int(dif,x=-infinity..infinity);
```

$$\int_{-\infty}^{\infty} \left| \mathrm{normald}(x) - studentst_{24}(x) \right| dx$$

```
> evalf(%);
```

$$.02618338748$$

This is pretty small. Let's see what happens when $n = 30$.

```
> dif:=abs(normald(x)-studentst[29](x));
```

$$dif := \left| -\mathrm{normald}(x) + studentst_{29}(x) \right|$$

```
> int(dif,x=-infinity..infinity);
```

$$\int_{-\infty}^{\infty} \left| -\mathrm{normald}(x) + studentst_{29}(x) \right| dx$$

```
> evalf(%);
```

$$.02169647044$$

This total accumulated absolute error will keep getting smaller as n increases.

```
>
```