The Ladder Exercise–exploiting nonlinearities

In this Minitab session, we will learn which ladder is best for estimating the height of the building–the long ladder (30') or the short ladder (24'). We assume that variation in the estimation of θ, the angle between the ladder and the ground, does not depend on the angle itself. In practice, though, the angle for the long ladder is close to 45^o; many students choose 45^o as their answer and estimates for that angle have less variation. The "best" should have the least variation.

After clicking on the Minitab icon, click in the **Worksheet 1** window and enter the following two columns of data in the first two columns of the worksheet. Label the columns appropriately (i.e., 'Shallow Angle', 'Steep Angle') in the cells provided above the worksheet columns.

Shallow Angle	Steep Angle
45	70
50	67
40	75
48	60
45	70
55	70
45	70
45	80
60	75
50	75
45	70
50	70
55	75

We now need to convert the estimated angle to an estimated height. Minitab has a calculator that can be used with the pull down menu **Calc**. Since your guess was in degrees, and Minitab's sine function expects the input column to be in radians, be sure to nest the **Radians** function inside the **Sine** function. You can also use **Command Line Editor** under the **Edit** menu and enter:

```
let c3=30*sin(radians(c1))
let c4=24*sin(radians(c2))
describe c1-c4
```

Press the **Submit Commands** button and two new columns will be created in your data sheet; summary descriptive statistics will appear in the **Session window**.

Inspect the output in the session window–is the variability in angle estimates the same? Is the variability in height estimates the same? Which method produces the height estimate with the least variation? Generate histograms of c3 and c4 to help in your decision; refer to the balance example for notes to ensure that the histograms are displayed on the same horizontal and vertical scales.