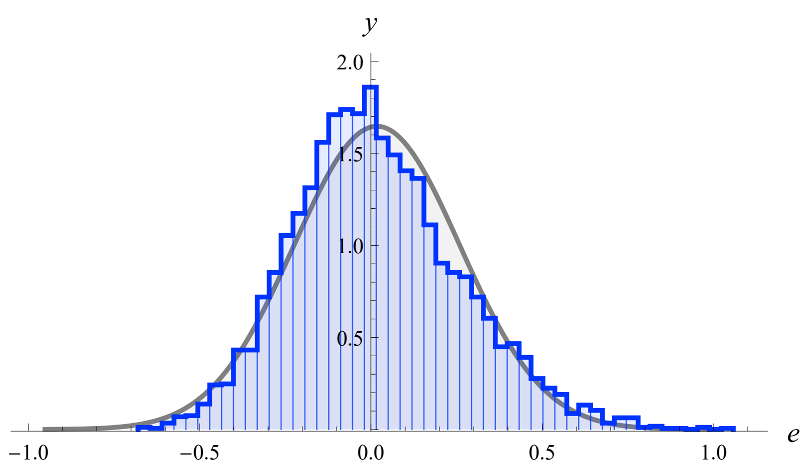
Name: Rufus Petrie

HW6 Problem 6: Seismology study

Part (A): Bootstrap Results

```
sample = differences;
Clear[ss]; Remove[f];
f[ss_] := 1 / Mean[ss];
observed = f[sample]
results = Table[f[RandomResample[sample]], {5000}];
BootstrapSummary[results, observed, ConfidenceLevel → 0.95]
```

```
2.82111
```




```
Bootstrap Error Distribution when t=2.82111:

   Bootstrap Bias:               0.0175031
   Bootstrap SE:                 0.24217
   Bias as Percent of SE:        7.22762%
   95.% Basic Bootstrap CI:      [2.28203,3.23675]
   95.% Normal Approx. CI:       [2.32897,3.27826]
```

Part (B): Bootstrap Confidence Interval

```
BootstrapCI1[sample, f, ConfidenceLevel → 0.95,
 BootstrapResamples → 5000]
```

```
{2.39806, 3.34751}
```

Part (C): Estimated Standard Error

```
Sqrt[2.821114381667734`^2 / 136]
```

```
0.241909
```

Yes, the bootstrap SE from part a equals 0.2422, while large sample theory predicts that the SE will equal approximately 0.2419, which seem relatively close.

Part (D): Discussion

From part A, we get an observed lambda value of 2.821. Based off of the bootstrapping procedures, we get a 95% basic bootstrap confidence interval of [2.282,3.236] and a 95% normally approximated bootstrap confidence interval of [2.328,3.278]. From Efron's improved bootstrap confidence interval method, we see an interval of [2.398,3.347], which has both higher upper and lower extremes than the other confidence intervals. Furthermore, we see that our results seem consistent because our estimated standard error is fairly close to the one that we estimated in part A. In conclusion, these results suggest that the distribution of intermittent times between earthquakes for this data set is best estimated by an exponential distribution with lambda close to 2.821, and we can be fairly positive that this parameter truly lies between roughly 2.4 and 3.35.

HW6 Problem 7: Tree growth study

Part (A): Summary Statistics

	Sample Size	*Mean of ΔHeight*	*SD of ΔHeight*	*Mean of ΔDiameter*	*SD of ΔDiameter*	*Sample Correlation*
Fertilizer	36	38.289	7.981	5.291	1.438	0.609
No Fertilizer	36	23.578	8.525	2.782	1.237	0.864

Part (B): Difference in heights confidence interval

```
{h1, w1} = Transpose[pairs1];
{h2, w2} = Transpose[pairs2];
```

```
PooledTCI[h1, h2]
PooledTCI[w1, w2]
```

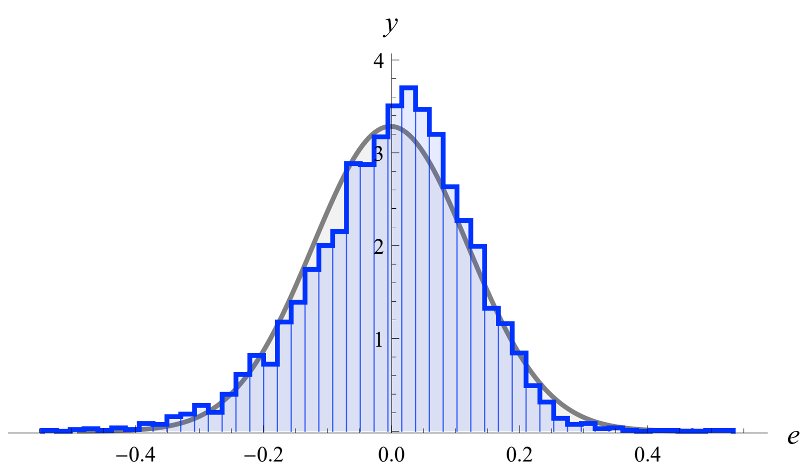
Confidence Level:	Confidence Interval:	Sampling Distribution:
0.95	{10.8294, 18.5928}	StudentT(df=70)

Part (C): Difference in diameters confidence interval

Confidence Level:	Confidence Interval:	Sampling Distribution:
0.95	{1.87853, 3.13964}	StudentT(df=70)

Part (D): Bootstrap Summary

```
samples = {pairs1, pairs2};
Clear[ss]; Remove[f];
f[ss_] := Module[{x1, y1, x2, y2},
   {x1, y1} = Transpose[First[ss]];
   {x2, y2} = Transpose[Last[ss]];
   Correlation[x1, y1] / Correlation[x2, y2]];
observed = f[samples];
results = Table[f[Map[RandomResample, samples]], {5000}];
BootstrapSummary[results, observed, ConfidenceLevel → 0.95]
BootstrapCI2[samples, f, ConfidenceLevel → 0.95,
 BootstrapResamples → 5000]
```




```
Bootstrap Error Distribution when t=0.704449:

   Bootstrap Bias:               -0.00172823
   Bootstrap SE:                 0.121424
   Bias as Percent of SE:        1.4233%
   95.% Basic Bootstrap CI:      [0.492512,0.964977]
   95.% Normal Approx. CI:       [0.46819,0.944164]

{0.439878, 0.914424}
```

Part (E): Discussion

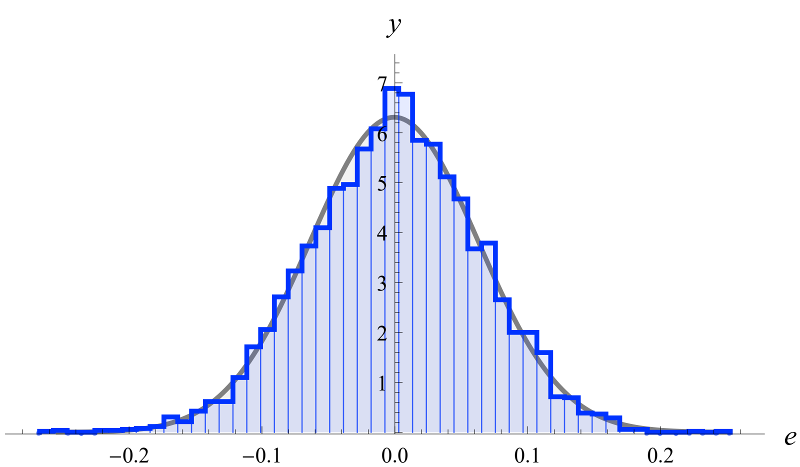
From our summary statistics, we see fairly compelling evidence that the fertilized led to an overall increase in both height and diameter growth. The standard deviatiations stayed roughly constant, but the fertilized trees saw an increase in both height and diameter growth. We also see that the correlation between height growth and diameter growth changed, which may imply that either the fertilizer helped to change the proportions of the trees, or the correlation in height change and diameter changed lessened because of the accelerated position in the trees' life cycles. From part B and C, we see that fertilized trees experienced an increased growth of somewhere in the range of [10.8294,18.5928] in terms of height and [1.87853,3.13964] in terms of width with 95% confidence. From our bootstrap analysis, we see a 0.704 ratio between the correlations of the fertilized and unfertilized trees' height/diameter growth correlations. We see a 95% basic bootstrap confidence interval of [0.492,0.964], a 95% approximately normal boostrap confidence interval of [0.468,0.944], and an Efron boostrap confidence interval of [0.439,0.914]. From these results, we can conclude that fertilized seems to produce robust growth results in trees. Additionally, the fertilized seems to alter the proportions of height growth as compared with diameter growth. This could be due to the fertilized affecting the trees' proportions, or the trees simply experiencing a different amount of growth later in their life cycles.

HW6 Problem 8: Visual perception study

Part (A): Bootstrap Results

```
samples = {times1, times2};
Clear[ss]; Remove[f];
f[ss_] := Module[{diff, nn, nz},
   diff = Flatten[Outer[Subtract, First[ss], Last[ss]]];
   nn = Length[Select[diff, Negative]];
   nz = Length[Select[diff, (# == 0) &]];
   N[(nn + 0.50 * nz) / Length[diff]]];
observed = f[samples]
results = Table[f[Map[RandomResample, samples]], {5000}];
BootstrapSummary[results, observed, ConfidenceLevel → 0.95]
```

```
0.638095
```




```
Bootstrap Error Distribution when t=0.638095:

   Bootstrap Bias:              -0.000500408
   Bootstrap SE:                0.0632035
   Bias as Percent of SE:       0.791741%
   95.% Basic Bootstrap CI:     [0.519056,0.763597]
   95.% Normal Approx. CI:      [0.514719,0.762472]
```

Part (B): Bootstrap Confidence Interval

```
BootstrapCI2[samples, f, ConfidenceLevel → 0.95,
 BootstrapResamples → 5000]
```

```
{0.506463, 0.75463}
```

Part (C): Discussion

From our bootstrap results, we see an observed T value of 0.638. We see a 95% basic bootstrap confidence interval of [0.519,0.763] and a 95% normally approximated bootstrap confidence interval of [0.514,0.762]. Furthermore, Efron's method gives a boostrap confidence interval of [0.506,0.754]. From these results, we can safely conclude that is a correlation between roughly 0.5 and 0.75 of the time that it takes somebody to recognize a solid object both in the absense of visual information and with visual information. This results suggests that people rely upon nonvisual sensory perception to identify solid objects even when they have visual information of the object.