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CSE13S
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WRITEUP

my_sin(x):

```
isaac@isaac-VirtualBox:~/cse13s/asgn2$ ./mathlib-test -s
 x           sin          Library       Difference
 -           ------         -------       ----------
 0.0000      0.000000000      0.000000000   0.000000000000
 0.1571      0.156434465      0.156434465   0.000000000000
 0.3142      0.309016994      0.309016994   0.000000000000
 0.4712      0.453990500      0.453990500  -0.000000000000
 0.6283      0.587785252      0.587785252   0.000000000000
 0.7854      0.707106781      0.707106781   0.000000000000
 0.9425      0.809016994      0.809016994  -0.000000000000
 1.0996      0.891006524      0.891006524  -0.000000000000
 1.2566      0.951056516      0.951056516   0.000000000000
 1.4137      0.987688341      0.987688341   0.000000000000
 1.5708      1.000000000      1.000000000   0.000000000000
 1.7279      0.987688341      0.987688341  -0.000000000000
 1.8850      0.951056516      0.951056516  -0.000000000000
 2.0420      0.891006524      0.891006524  -0.000000000000
 2.1991      0.809016994      0.809016994   0.000000000000
 2.3562      0.707106781      0.707106781   0.000000000000
 2.5133      0.587785252      0.587785252   0.000000000000
 2.6704      0.453990500      0.453990500  -0.000000000000
 2.8274      0.309016994      0.309016994  -0.000000000000
 2.9845      0.156434465      0.156434465  -0.000000000000
 3.1416      0.000000000      0.000000000   0.000000000000
 3.2987     -0.156434465     -0.156434465   0.000000000000
 3.4558     -0.309016994     -0.309016994   0.000000000000
 3.6128     -0.453990500     -0.453990500   0.000000000000
 3.7699     -0.587785252     -0.587785252  -0.000000000000
 3.9270     -0.707106781     -0.707106781  -0.000000000000
 4.0841     -0.809016994     -0.809016994  -0.000000000000
 4.2412     -0.891006524     -0.891006524  -0.000000000000
 4.3982     -0.951056516     -0.951056516   0.000000000000
 4.5553     -0.987688341     -0.987688341   0.000000000000
 4.7124     -1.000000000     -1.000000000   0.000000000000
 4.8695     -0.987688341     -0.987688341   0.000000000000
 5.0265     -0.951056516     -0.951056516  -0.000000000000
 5.1836     -0.891006524     -0.891006524  -0.000000000000
 5.3407     -0.809016994     -0.809016994  -0.000000000000
 5.4978     -0.707106781     -0.707106781   0.000000000000
 5.6549     -0.587785252     -0.587785252   0.000000000000
 5.8119     -0.453990500     -0.453990500   0.000000000000
 5.9690     -0.309016994     -0.309016994   0.000000000000
 6.1261     -0.156434465     -0.156434465  -0.000000000000
 6.2832     -0.000000000     -0.000000000  -0.000000000000
```

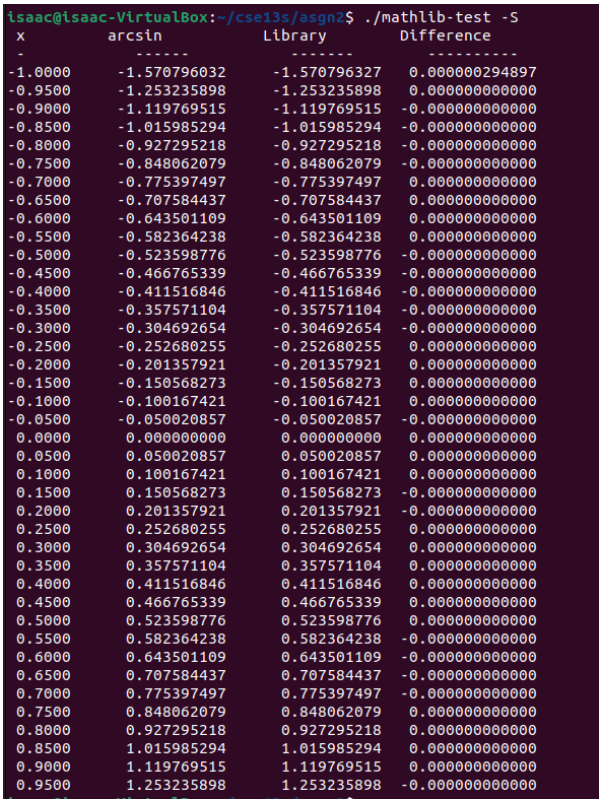
Discussion: My sin(x) and cos(x) functions were both accurate to the library versions for all the decimal places checked. There are no comments on the differences in output since the outputs are the same to the 12th decimal place. Sin(x) was the first function I got to work and after that, the rest were easier since they are implemented similarly to sin(x).

my_cos(x):

```
isaac@isaac-VirtualBox:~/cse13s/asgn2$ ./mathlib-test -c
 x            cos           Library        Difference
 -            ------        -------        ----------
 0.0000      1.000000000     1.000000000   0.000000000000
 0.1571      0.987688341     0.987688341   0.000000000000
 0.3142      0.951056516     0.951056516  -0.000000000000
 0.4712      0.891006524     0.891006524   0.000000000000
 0.6283      0.809016994     0.809016994   0.000000000000
 0.7854      0.707106781     0.707106781  -0.000000000000
 0.9425      0.587785252     0.587785252  -0.000000000000
 1.0996      0.453990500     0.453990500   0.000000000000
 1.2566      0.309016994     0.309016994   0.000000000000
 1.4137      0.156434465     0.156434465  -0.000000000000
 1.5708     -0.000000000     0.000000000  -0.000000000000
 1.7279     -0.156434465    -0.156434465  -0.000000000000
 1.8850     -0.309016994    -0.309016994   0.000000000000
 2.0420     -0.453990500    -0.453990500   0.000000000000
 2.1991     -0.587785252    -0.587785252   0.000000000000
 2.3562     -0.707106781    -0.707106781  -0.000000000000
 2.5133     -0.809016994    -0.809016994  -0.000000000000
 2.6704     -0.891006524    -0.891006524  -0.000000000000
 2.8274     -0.951056516    -0.951056516  -0.000000000000
 2.9845     -0.987688341    -0.987688341   0.000000000000
 3.1416     -1.000000000    -1.000000000   0.000000000000
 3.2987     -0.987688341    -0.987688341   0.000000000000
 3.4558     -0.951056516    -0.951056516  -0.000000000000
 3.6128     -0.891006524    -0.891006524  -0.000000000000
 3.7699     -0.809016994    -0.809016994  -0.000000000000
 3.9270     -0.707106781    -0.707106781  -0.000000000000
 4.0841     -0.587785252    -0.587785252   0.000000000000
 4.2412     -0.453990500    -0.453990500   0.000000000000
 4.3982     -0.309016994    -0.309016994   0.000000000000
 4.5553     -0.156434465    -0.156434465   0.000000000000
 4.7124     -0.000000000    -0.000000000  -0.000000000000
 4.8695      0.156434465     0.156434465  -0.000000000000
 5.0265      0.309016994     0.309016994  -0.000000000000
 5.1836      0.453990500     0.453990500   0.000000000000
 5.3407      0.587785252     0.587785252   0.000000000000
 5.4978      0.707106781     0.707106781   0.000000000000
 5.6549      0.809016994     0.809016994   0.000000000000
 5.8119      0.891006524     0.891006524  -0.000000000000
 5.9690      0.951056516     0.951056516  -0.000000000000
 6.1261      0.987688341     0.987688341  -0.000000000000
 6.2832      1.000000000     1.000000000  -0.000000000000
```

Discussion: Cos(x) was also accurate to the 12th decimal place. This function was implemented identically to how I implemented sin(x) but I changed the starting point for three variables.

my_arcsin(x):



```
isaac@isaac-VirtualBox:~/cse13s/asgn2$ ./mathlib-test -S
 x         arcsin          Library         Difference
 -         ------          -------         ----------
-1.0000    -1.570796032    -1.570796327    0.000000294897
-0.9500    -1.253235898    -1.253235898    0.000000000000
-0.9000    -1.119769515    -1.119769515   -0.000000000000
-0.8500    -1.015985294    -1.015985294   -0.000000000000
-0.8000    -0.927295218    -0.927295218   -0.000000000000
-0.7500    -0.848062079    -0.848062079   -0.000000000000
-0.7000    -0.775397497    -0.775397497    0.000000000000
-0.6500    -0.707584437    -0.707584437    0.000000000000
-0.6000    -0.643501109    -0.643501109    0.000000000000
-0.5500    -0.582364238    -0.582364238    0.000000000000
-0.5000    -0.523598776    -0.523598776   -0.000000000000
-0.4500    -0.466765339    -0.466765339   -0.000000000000
-0.4000    -0.411516846    -0.411516846   -0.000000000000
-0.3500    -0.357571104    -0.357571104   -0.000000000000
-0.3000    -0.304692654    -0.304692654   -0.000000000000
-0.2500    -0.252680255    -0.252680255    0.000000000000
-0.2000    -0.201357921    -0.201357921    0.000000000000
-0.1500    -0.150568273    -0.150568273    0.000000000000
-0.1000    -0.100167421    -0.100167421    0.000000000000
-0.0500    -0.050020857    -0.050020857   -0.000000000000
 0.0000     0.000000000     0.000000000    0.000000000000
 0.0500     0.050020857     0.050020857    0.000000000000
 0.1000     0.100167421     0.100167421    0.000000000000
 0.1500     0.150568273     0.150568273   -0.000000000000
 0.2000     0.201357921     0.201357921   -0.000000000000
 0.2500     0.252680255     0.252680255    0.000000000000
 0.3000     0.304692654     0.304692654    0.000000000000
 0.3500     0.357571104     0.357571104    0.000000000000
 0.4000     0.411516846     0.411516846    0.000000000000
 0.4500     0.466765339     0.466765339    0.000000000000
 0.5000     0.523598776     0.523598776    0.000000000000
 0.5500     0.582364238     0.582364238   -0.000000000000
 0.6000     0.643501109     0.643501109   -0.000000000000
 0.6500     0.707584437     0.707584437   -0.000000000000
 0.7000     0.775397497     0.775397497   -0.000000000000
 0.7500     0.848062079     0.848062079    0.000000000000
 0.8000     0.927295218     0.927295218    0.000000000000
 0.8500     1.015985294     1.015985294    0.000000000000
 0.9000     1.119769515     1.119769515    0.000000000000
 0.9500     1.253235898     1.253235898   -0.000000000000
```

Discussion: My implementation for arcsin(x) was accurate for all values of x except for the first value x = -1. I first assumed it was because I used a float instead of a double at some point in the code but that was not true. I implemented arcsin(x) through the method of this piazza post https://piazza.com/class/l8ahj4fji3i4om/post/155 . I discovered that through this method the approximation begins to diverge as x -> 1 and -1. This is why the data is not accurate at x = -1.

my_arccos(x):

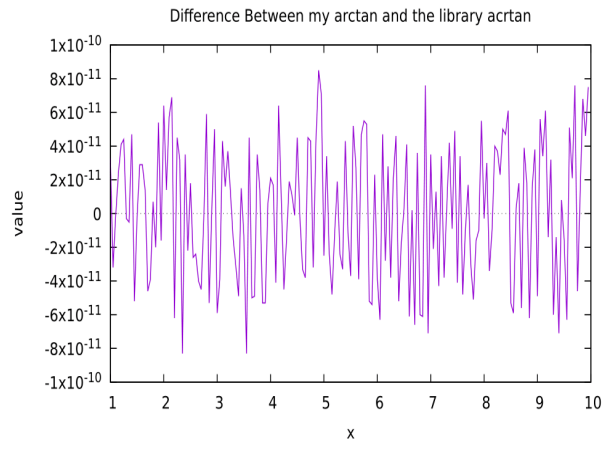
```
isaac@isaac-VirtualBox:~/cse13s/asgn2$ ./mathlib-test -C
 x         arccos           Library        Difference
 -         ------           -------        ----------
-1.0000     3.141592359      3.141592654  -0.000000294897
-0.9500     2.824032224      2.824032224  -0.000000000000
-0.9000     2.690565842      2.690565842   0.000000000000
-0.8500     2.586781621      2.586781621   0.000000000000
-0.8000     2.498091545      2.498091545   0.000000000000
-0.7500     2.418858406      2.418858406   0.000000000000
-0.7000     2.346193823      2.346193823  -0.000000000000
-0.6500     2.278380764      2.278380764  -0.000000000000
-0.6000     2.214297436      2.214297436  -0.000000000000
-0.5500     2.153160565      2.153160565  -0.000000000000
-0.5000     2.094395102      2.094395102  -0.000000000000
-0.4500     2.037561666      2.037561666   0.000000000000
-0.4000     1.982313173      1.982313173   0.000000000000
-0.3500     1.928367430      1.928367430   0.000000000000
-0.3000     1.875488981      1.875488981   0.000000000000
-0.2500     1.823476582      1.823476582   0.000000000000
-0.2000     1.772154248      1.772154248  -0.000000000000
-0.1500     1.721364600      1.721364600   0.000000000000
-0.1000     1.670963748      1.670963748   0.000000000000
-0.0500     1.620817184      1.620817184  -0.000000000000
 0.0000     1.570796327      1.570796327   0.000000000000
 0.0500     1.520775470      1.520775470   0.000000000000
 0.1000     1.470628906      1.470628906  -0.000000000000
 0.1500     1.420228054      1.420228054   0.000000000000
 0.2000     1.369438406      1.369438406   0.000000000000
 0.2500     1.318116072      1.318116072   0.000000000000
 0.3000     1.266103673      1.266103673   0.000000000000
 0.3500     1.213225223      1.213225223  -0.000000000000
 0.4000     1.159279481      1.159279481  -0.000000000000
 0.4500     1.104030988      1.104030988  -0.000000000000
 0.5000     1.047197551      1.047197551   0.000000000000
 0.5500     0.988432089      0.988432089   0.000000000000
 0.6000     0.927295218      0.927295218   0.000000000000
 0.6500     0.863211890      0.863211890   0.000000000000
 0.7000     0.795398830      0.795398830   0.000000000000
 0.7500     0.722734248      0.722734248  -0.000000000000
 0.8000     0.643501109      0.643501109  -0.000000000000
 0.8500     0.554811033      0.554811033  -0.000000000000
 0.9000     0.451026812      0.451026812  -0.000000000000
 0.9500     0.317560429      0.317560429   0.000000000000
```

Discussion: I implemented arccos(x) by subtracting pi/2 by my implementation of arcsin(x). This causes it to diverge at x = -1 for the same reason arcsin(x) did.

my_arctan(x):

```
isaac@isaac-VirtualBox:~/cse13s/asgn2$ ./mathlib-test -T
 x         arctan          Library         Difference
 -         ------          -------         ----------
1.0000     0.785398163     0.785398163   0.000000000033
1.0500     0.809783573     0.809783573  -0.000000000032
1.1000     0.832981267     0.832981267  -0.000000000001
1.1500     0.855052737     0.855052737   0.000000000024
1.2000     0.876058051     0.876058051   0.000000000041
1.2500     0.896055385     0.896055385   0.000000000044
1.3000     0.915100701     0.915100701  -0.000000000003
1.3500     0.933247529     0.933247529  -0.000000000005
1.4000     0.950546841     0.950546841   0.000000000047
1.4500     0.967046993     0.967046993  -0.000000000052
1.5000     0.982793723     0.982793723  -0.000000000002
1.5500     0.997830184     0.997830184   0.000000000029
1.6000     1.012197011     1.012197011   0.000000000029
1.6500     1.025932411     1.025932411   0.000000000014
1.7000     1.039072260     1.039072260  -0.000000000046
1.7500     1.051650213     1.051650213  -0.000000000039
1.8000     1.063697822     1.063697822   0.000000000007
1.8500     1.075244653     1.075244653  -0.000000000020
1.9000     1.086318398     1.086318398   0.000000000054
1.9500     1.096944990     1.096944990  -0.000000000016
2.0000     1.107148718     1.107148718   0.000000000064
2.0500     1.116952325     1.116952325   0.000000000014
2.1000     1.126377117     1.126377117   0.000000000057
2.1500     1.135443052     1.135443052   0.000000000069
2.2000     1.144168834     1.144168834  -0.000000000062
2.2500     1.152571997     1.152571997   0.000000000045
2.3000     1.160668986     1.160668986   0.000000000032
2.3500     1.168475229     1.168475229  -0.000000000083
2.4000     1.176005207     1.176005207   0.000000000035
2.4500     1.183272521     1.183272521  -0.000000000022
2.5000     1.190289950     1.190289950   0.000000000018
2.5500     1.197069507     1.197069507  -0.000000000026
2.6000     1.203622493     1.203622493  -0.000000000024
2.6500     1.209959544     1.209959544  -0.000000000040
2.7000     1.216090675     1.216090675  -0.000000000045
2.7500     1.222025323     1.222025323  -0.000000000003
2.8000     1.227772386     1.227772386   0.000000000059
2.8500     1.233340258     1.233340258  -0.000000000053
2.9000     1.238736859     1.238736859   0.000000000003
2.9500     1.243969674     1.243969674   0.000000000050
3.0000     1.249045772     1.249045772  -0.000000000059
3.0500     1.253971841     1.253971841  -0.000000000039
3.1000     1.258754205     1.258754205   0.000000000043
3.1500     1.263398854     1.263398854   0.000000000016
3.2000     1.267911458     1.267911458   0.000000000037
3.2500     1.272297395     1.272297395   0.000000000012
3.3000     1.276561762     1.276561762  -0.000000000015
3.3500     1.280709394     1.280709394  -0.000000000031
3.4000     1.284744885     1.284744885  -0.000000000049
```

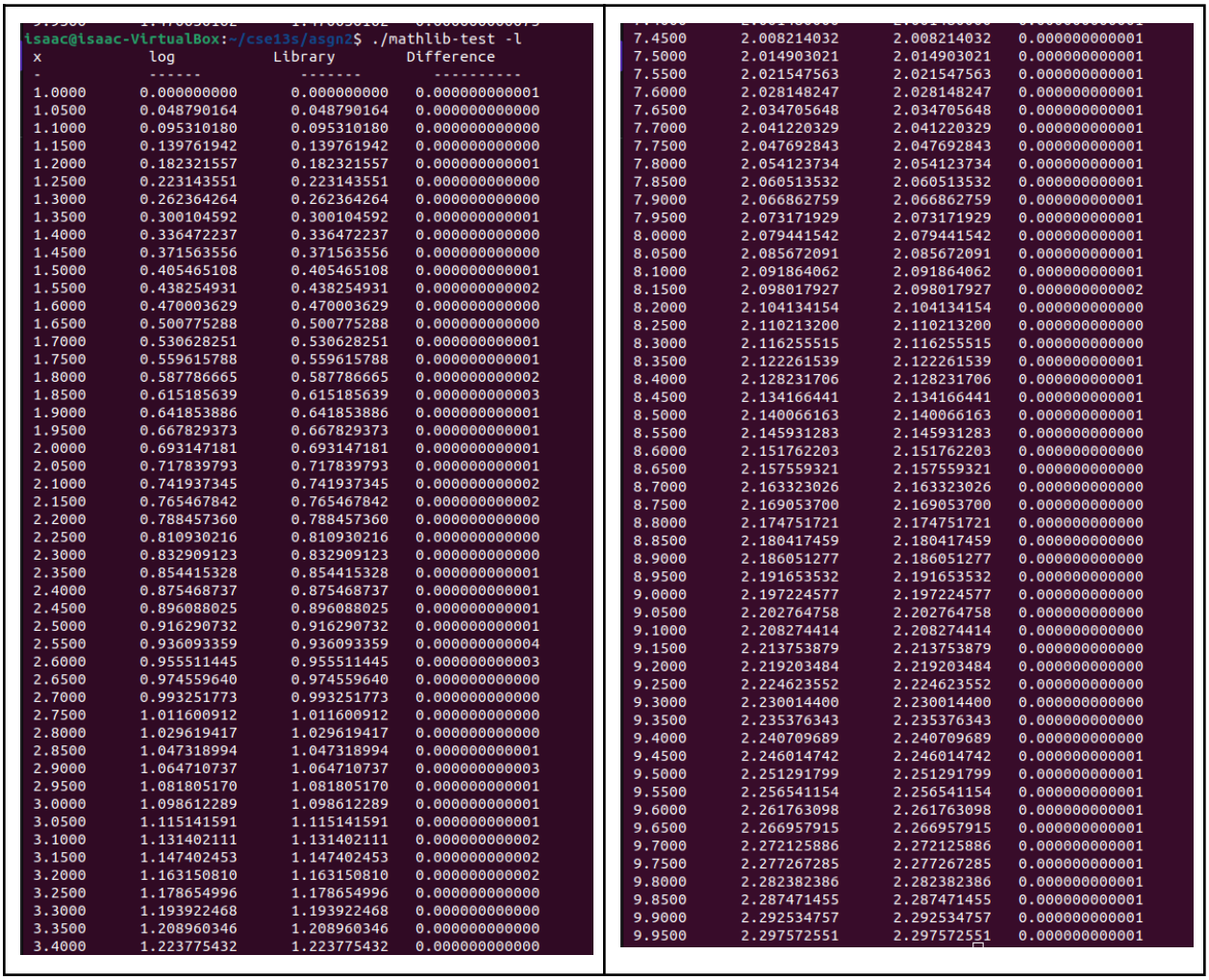
```
7.4500     1.437365674     1.437365674   0.000000000049
7.5000     1.438244794     1.438244794  -0.000000000041
7.5500     1.439112473     1.439112473   0.000000000034
7.6000     1.439968931     1.439968931  -0.000000000048
7.6500     1.440814382     1.440814382  -0.000000000009
7.7000     1.441649037     1.441649037   0.000000000017
7.7500     1.442473099     1.442473099  -0.000000000030
7.8000     1.443286769     1.443286769  -0.000000000051
7.8500     1.444090239     1.444090239  -0.000000000016
7.9000     1.444883701     1.444883701  -0.000000000010
7.9500     1.445667339     1.445667339   0.000000000055
8.0000     1.446441332     1.446441332  -0.000000000003
8.0500     1.447205858     1.447205858   0.000000000030
8.1000     1.447961088     1.447961088  -0.000000000034
8.1500     1.448707189     1.448707189  -0.000000000009
8.2000     1.449444326     1.449444326   0.000000000040
8.2500     1.450172658     1.450172658   0.000000000037
8.3000     1.450892341     1.450892341   0.000000000023
8.3500     1.451603528     1.451603528   0.000000000050
8.4000     1.452306368     1.452306368   0.000000000047
8.4500     1.453001005     1.453001005   0.000000000061
8.5000     1.453687582     1.453687582  -0.000000000053
8.5500     1.454366238     1.454366238  -0.000000000059
8.6000     1.455037109     1.455037109   0.000000000003
8.6500     1.455700327     1.455700327   0.000000000018
8.7000     1.456356021     1.456356022  -0.000000000056
8.7500     1.457004320     1.457004320   0.000000000039
8.8000     1.457645345     1.457645345   0.000000000018
8.8500     1.458279219     1.458279219  -0.000000000062
8.9000     1.458906061     1.458906061   0.000000000015
8.9500     1.459525985     1.459525985   0.000000000038
9.0000     1.460139106     1.460139106  -0.000000000049
9.0500     1.460745534     1.460745534   0.000000000056
9.1000     1.461345378     1.461345378   0.000000000034
9.1500     1.461938744     1.461938744   0.000000000061
9.2000     1.462525736     1.462525736  -0.000000000014
9.2500     1.463106456     1.463106456   0.000000000032
9.3000     1.463681003     1.463681003  -0.000000000060
9.3500     1.464249476     1.464249476  -0.000000000014
9.4000     1.464811969     1.464811969  -0.000000000071
9.4500     1.465368576     1.465368576   0.000000000008
9.5000     1.465919388     1.465919388  -0.000000000016
9.5500     1.466464496     1.466464496  -0.000000000063
9.6000     1.467003986     1.467003986   0.000000000051
9.6500     1.467537946     1.467537946   0.000000000021
9.7000     1.468066459     1.468066459   0.000000000076
9.7500     1.468589609     1.468589609  -0.000000000046
9.8000     1.469107475     1.469107475   0.000000000013
9.8500     1.469620138     1.469620138   0.000000000068
9.9000     1.470127675     1.470127675   0.000000000046
9.9500     1.470630162     1.470630162   0.000000000075
```



Discussion: The values for arctan(x) that I was getting were off to the 11th decimal place. I implemented arctan(x) through the simpler method of using arcsin(x/ square root(x^2 + 1). I plotted the difference between my arctan(x) and the library version of arctan(x) seen on the left. I figured that the inaccuracy was from the multiple function calls in my implementation. I call arcsin(x) and a square_root function which may cause inaccuracies along the lines.

my_log(x):

Discussion: My log(x) function was accurate to the 12th decimal place. Some values were accurate for all the decimal places checked. I figure that the inaccuracy is caused by the same reason arctan(x) was inaccurate. I call the Exp(x) function which does e^x. This call may cause inaccuracies along the line.



```
isaac@isaac-VirtualBox:~/cse13s/asgn2$ ./mathlib-test -l
 x            log           Library        Difference
 -            ---           -------        ----------
 1.0000    0.000000000    0.000000000    0.000000000001
 1.0500    0.048790164    0.048790164    0.000000000000
 1.1000    0.095310180    0.095310180    0.000000000000
 1.1500    0.139761942    0.139761942    0.000000000000
 1.2000    0.182321557    0.182321557    0.000000000001
 1.2500    0.223143551    0.223143551    0.000000000000
 1.3000    0.262364264    0.262364264    0.000000000000
 1.3500    0.300104592    0.300104592    0.000000000001
 1.4000    0.336472237    0.336472237    0.000000000000
 1.4500    0.371563556    0.371563556    0.000000000000
 1.5000    0.405465108    0.405465108    0.000000000001
 1.5500    0.438254931    0.438254931    0.000000000002
 1.6000    0.470003629    0.470003629    0.000000000000
 1.6500    0.500775288    0.500775288    0.000000000000
 1.7000    0.530628251    0.530628251    0.000000000001
 1.7500    0.559615788    0.559615788    0.000000000001
 1.8000    0.587786665    0.587786665    0.000000000002
 1.8500    0.615185639    0.615185639    0.000000000003
 1.9000    0.641853886    0.641853886    0.000000000001
 1.9500    0.667829373    0.667829373    0.000000000001
 2.0000    0.693147181    0.693147181    0.000000000001
 2.0500    0.717839793    0.717839793    0.000000000001
 2.1000    0.741937345    0.741937345    0.000000000002
 2.1500    0.765467842    0.765467842    0.000000000002
 2.2000    0.788457360    0.788457360    0.000000000000
 2.2500    0.810930216    0.810930216    0.000000000000
 2.3000    0.832909123    0.832909123    0.000000000000
 2.3500    0.854415328    0.854415328    0.000000000001
 2.4000    0.875468737    0.875468737    0.000000000001
 2.4500    0.896088025    0.896088025    0.000000000001
 2.5000    0.916290732    0.916290732    0.000000000001
 2.5500    0.936093359    0.936093359    0.000000000004
 2.6000    0.955511445    0.955511445    0.000000000003
 2.6500    0.974559640    0.974559640    0.000000000000
 2.7000    0.993251773    0.993251773    0.000000000000
 2.7500    1.011600912    1.011600912    0.000000000000
 2.8000    1.029619417    1.029619417    0.000000000000
 2.8500    1.047318994    1.047318994    0.000000000001
 2.9000    1.064710737    1.064710737    0.000000000003
 2.9500    1.081805170    1.081805170    0.000000000001
 3.0000    1.098612289    1.098612289    0.000000000001
 3.0500    1.115141591    1.115141591    0.000000000001
 3.1000    1.131402111    1.131402111    0.000000000002
 3.1500    1.147402453    1.147402453    0.000000000002
 3.2000    1.163150810    1.163150810    0.000000000002
 3.2500    1.178654996    1.178654996    0.000000000000
 3.3000    1.193922468    1.193922468    0.000000000000
 3.3500    1.208960346    1.208960346    0.000000000000
 3.4000    1.223775432    1.223775432    0.000000000000
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 7.4500    2.008214032    2.008214032    0.000000000001
 7.5000    2.014903021    2.014903021    0.000000000001
 7.5500    2.021547563    2.021547563    0.000000000001
 7.6000    2.028148247    2.028148247    0.000000000001
 7.6500    2.034705648    2.034705648    0.000000000001
 7.7000    2.041220329    2.041220329    0.000000000001
 7.7500    2.047692843    2.047692843    0.000000000001
 7.8000    2.054123734    2.054123734    0.000000000001
 7.8500    2.060513532    2.060513532    0.000000000001
 7.9000    2.066862759    2.066862759    0.000000000001
 7.9500    2.073171929    2.073171929    0.000000000001
 8.0000    2.079441542    2.079441542    0.000000000001
 8.0500    2.085672091    2.085672091    0.000000000001
 8.1000    2.091864062    2.091864062    0.000000000001
 8.1500    2.098017927    2.098017927    0.000000000002
 8.2000    2.104134154    2.104134154    0.000000000000
 8.2500    2.110213200    2.110213200    0.000000000000
 8.3000    2.116255515    2.116255515    0.000000000000
 8.3500    2.122261539    2.122261539    0.000000000001
 8.4000    2.128231706    2.128231706    0.000000000001
 8.4500    2.134166441    2.134166441    0.000000000001
 8.5000    2.140066163    2.140066163    0.000000000001
 8.5500    2.145931283    2.145931283    0.000000000000
 8.6000    2.151762203    2.151762203    0.000000000000
 8.6500    2.157559321    2.157559321    0.000000000000
 8.7000    2.163323026    2.163323026    0.000000000000
 8.7500    2.169053700    2.169053700    0.000000000000
 8.8000    2.174751721    2.174751721    0.000000000000
 8.8500    2.180417459    2.180417459    0.000000000000
 8.9000    2.186051277    2.186051277    0.000000000000
 8.9500    2.191653532    2.191653532    0.000000000000
 9.0000    2.197224577    2.197224577    0.000000000000
 9.0500    2.202764758    2.202764758    0.000000000000
 9.1000    2.208274414    2.208274414    0.000000000000
 9.1500    2.213753879    2.213753879    0.000000000000
 9.2000    2.219203484    2.219203484    0.000000000000
 9.2500    2.224623552    2.224623552    0.000000000000
 9.3000    2.230014400    2.230014400    0.000000000000
 9.3500    2.235376343    2.235376343    0.000000000000
 9.4000    2.240709689    2.240709689    0.000000000000
 9.4500    2.246014742    2.246014742    0.000000000001
 9.5000    2.251291799    2.251291799    0.000000000001
 9.5500    2.256541154    2.256541154    0.000000000001
 9.6000    2.261763098    2.261763098    0.000000000001
 9.6500    2.266957915    2.266957915    0.000000000001
 9.7000    2.272125886    2.272125886    0.000000000001
 9.7500    2.277267285    2.277267285    0.000000000001
 9.8000    2.282382386    2.282382386    0.000000000001
 9.8500    2.287471455    2.287471455    0.000000000001
 9.9000    2.292534757    2.292534757    0.000000000001
 9.9500    2.297572551    2.297572551    0.000000000001
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