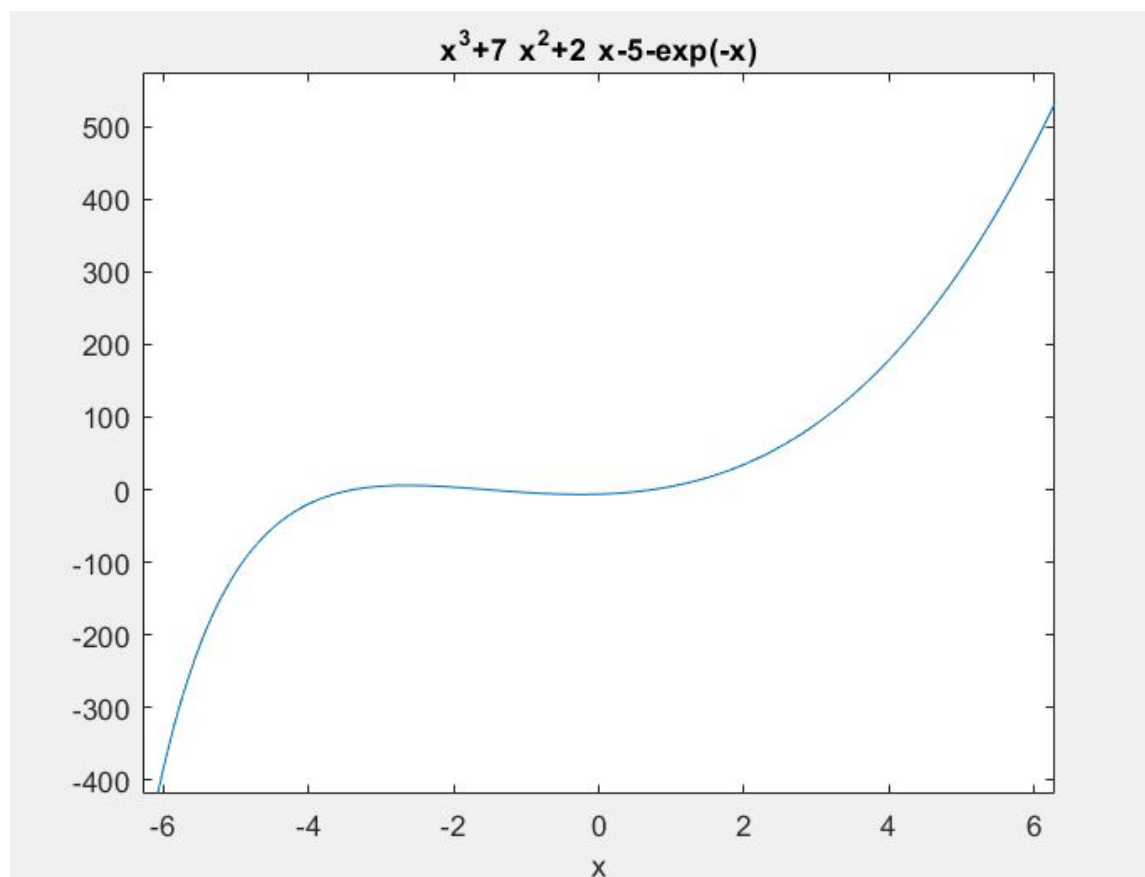


Jack Weissenberger Problem Set 1: Solutions of Equations in One Variable

Below are the output of my_fzero function and MatLab's fzero function which are trying to find the zeros of the graph below. When comparing the two functions with the starting points $\{-3, -2, -1, 0\}$, each of the functions was able to come up with a correct and the same zero but each used different method. My my_fzero function used Newton's method the vast majority of the time and bisection a few times. MatLab's fzero used interpolation for every calculation. My my_fzero actually used less iterations for every example. I think this is because the derivative of the function was already calculated and saved a lot of time for the algorithm. Also my calculation of the took less iterations each time than fzeros. my_fzero does take less iterations each time but it is limited by the fact that you need to know the derivative of the function and it doesn't work every time like interpolation and falls back on bisection with I predicts a zero outside the interval. MatLab's fzero is definitely more robust and handels a much wider set of functions and errors, it also does not require a derivative of the original function. It does seem to be slower overall though than my_fzero.



```
>> fzero(f, -3, optimset('display', 'iter'))
```

Search for an interval around -3 containing a sign change:

Func-count	a	f(a)	b	f(b)	Procedure
1	-3	4.91446	-3	4.91446	initial interval
3	-2.91515	5.4316	-3.08485	4.22383	search
5	-2.88	5.59865	-3.12	3.88309	search
7	-2.83029	5.79066	-3.16971	3.34321	search
9	-2.76	5.97878	-3.24	2.45725	search
11	-2.66059	6.09165	-3.33941	0.940328	search
13	-2.52	5.9812	-3.48	-1.79111	search

Search for a zero in the interval [-2.52, -3.48]:

Func-count	x	f(x)	Procedure
13	-3.48	-1.79111	initial
14	-3.48	-1.79111	interpolation
15	-3.3806	0.214576	interpolation
16	-3.39123	0.0174624	interpolation
17	-3.39217	-2.53046e-05	interpolation
18	-3.39216	2.26852e-08	interpolation
19	-3.39216	2.84217e-14	interpolation
20	-3.39216	-3.55271e-15	interpolation

Zero found in the interval [-2.52, -3.48]

ans =

-3.3922

```
>> my_fzero(f, df, -3)
```

Finding Interval

	a	b	f(a)	f(b)
1	-3.00e+00	-3.00e+00	4.91e+00	4.92e+00
2	-3.00e+00	-3.00e+00	4.89e+00	4.94e+00
3	-3.01e+00	-2.99e+00	4.86e+00	4.96e+00
4	-3.01e+00	-2.99e+00	4.81e+00	5.02e+00
5	-3.03e+00	-2.97e+00	4.68e+00	5.12e+00
6	-3.06e+00	-2.94e+00	4.42e+00	5.31e+00
7	-3.13e+00	-2.87e+00	3.81e+00	5.63e+00
8	-3.25e+00	-2.75e+00	2.25e+00	6.01e+00
9	-3.51e+00	-2.75e+00	-2.49e+00	6.01e+00

Findind Zero

	x	f(x)	Method
1	-3.51e+00	-2.49e+00	Newton
2	-3.40e+00	-2.24e-01	Newton
3	-3.39e+00	-2.48e-03	Newton
4	-3.39e+00	-3.16e-07	Newton

ans =

-3.3922

```
>> fzero(f, -2, optimset('display', 'iter'))
```

Search for an interval around -2 containing a sign change:

Func-count	a	f(a)	b	f(b)	Procedure
1	-2	3.61094	-2	3.61094	initial interval
3	-1.94343	3.22875	-2.05657	3.97589	search
5	-1.92	3.06595	-2.08	4.12142	search
7	-1.88686	2.83169	-2.11314	4.32111	search
9	-1.84	2.49316	-2.16	4.59037	search
11	-1.77373	2.00218	-2.22627	4.94217	search
13	-1.68	1.28961	-2.32	5.37396	search
15	-1.54745	0.262326	-2.45255	5.82988	search
16	-1.36	-1.18445	-2.45255	5.82988	search

Search for a zero in the interval [-1.36, -2.45255]:

Func-count	x	f(x)	Procedure
16	-1.36	-1.18445	initial
17	-1.54449	0.239275	interpolation
18	-1.51348	-0.00190289	interpolation
19	-1.51373	-1.00231e-06	interpolation
20	-1.51373	1.71685e-12	interpolation
21	-1.51373	0	interpolation

Zero found in the interval [-1.36, -2.45255]

ans =

-1.5137

```
>> my_fzero(f, df, -2)
```

Finding Interval

	a	b	f(a)	f(b)
1	-2.00e+00	-2.00e+00	3.62e+00	3.60e+00
2	-2.00e+00	-2.00e+00	3.63e+00	3.59e+00
3	-2.01e+00	-1.99e+00	3.66e+00	3.56e+00
4	-2.01e+00	-1.99e+00	3.71e+00	3.51e+00
5	-2.03e+00	-1.97e+00	3.81e+00	3.40e+00
6	-2.06e+00	-1.94e+00	4.02e+00	3.18e+00
7	-2.13e+00	-1.87e+00	4.40e+00	2.73e+00
8	-2.25e+00	-1.75e+00	5.08e+00	1.79e+00
9	-2.51e+00	-1.49e+00	5.96e+00	-1.92e-01

Findind Zero

	x	f(x)	Method
1	-2.00e+00	3.61e+00	Bisection
2	-1.74e+00	1.78e+00	Bisection
3	-1.74e+00	1.78e+00	Newton
4	-1.51e+00	-3.59e-02	Newton
5	-1.51e+00	4.33e-06	Newton
6	-1.51e+00	5.33e-14	Newton

ans =

-1.5137

```
>> fzero(f, -1, optimset('display', 'iter'))
```

Search for an interval around -1 containing a sign change:

Func-count	a	f(a)	b	f(b)	Procedure
1	-1	-3.71828	-1	-3.71828	initial interval
3	-0.971716	-3.89381	-1.02828	-3.53853	search
5	-0.96	-3.96523	-1.04	-3.46288	search
7	-0.943431	-4.06492	-1.05657	-3.35475	search
9	-0.92	-4.20318	-1.08	-3.19959	search
11	-0.886863	-4.39309	-1.11314	-2.97591	search
13	-0.84	-4.64987	-1.16	-2.65163	search
15	-0.773726	-4.98791	-1.22627	-2.17882	search
17	-0.68	-5.41151	-1.32	-1.48659	search
19	-0.547452	-5.88989	-1.45255	-0.474539	search
21	-0.36	-6.29279	-1.64	0.981086	search

Search for a zero in the interval [-0.36, -1.64]:

Func-count	x	f(x)	Procedure
21	-1.64	0.981086	initial
22	-1.46736	-0.359941	interpolation
23	-1.51369	-0.000259144	interpolation
24	-1.51373	3.46591e-07	interpolation
25	-1.51373	-2.77112e-13	interpolation
26	-1.51373	0	interpolation

Zero found in the interval [-0.36, -1.64]

ans =

-1.5137

```
>> my_fzero(f, df, -1)
```

Finding Interval

	a	b	f(a)	f(b)
1	-1.00e+00	-9.99e-01	-3.71e+00	-3.72e+00
2	-1.00e+00	-9.97e-01	-3.70e+00	-3.74e+00
3	-1.01e+00	-9.93e-01	-3.67e+00	-3.76e+00
4	-1.01e+00	-9.85e-01	-3.62e+00	-3.81e+00
5	-1.03e+00	-9.69e-01	-3.52e+00	-3.91e+00
6	-1.06e+00	-9.37e-01	-3.31e+00	-4.10e+00
7	-1.13e+00	-8.73e-01	-2.88e+00	-4.47e+00
8	-1.25e+00	-7.45e-01	-1.97e+00	-5.12e+00
9	-1.51e+00	-4.89e-01	-2.12e-02	-6.05e+00
10	-2.02e+00	-4.89e-01	3.76e+00	-6.05e+00

Findind Zero

	x	f(x)	Method
1	-2.02e+00	3.76e+00	Newton
2	-1.44e+00	-5.50e-01	Newton
3	-1.51e+00	2.19e-03	Newton
4	-1.51e+00	1.48e-08	Newton

ans =

-1.5137

```
>> fzero(f, 0, optimset('display', 'iter'))
```

Search for an interval around 0 containing a sign change:

Func-count	a	f(a)	b	f(b)	Procedure
1	0	-6	0	-6	initial interval
3	-0.0282843	-6.07968	0.0282843	-5.90992	search
5	-0.04	-6.10967	0.04	-5.86953	search
7	-0.0565685	-6.14912	0.0565685	-5.80928	search
9	-0.08	-6.199	0.08	-5.7178	search
11	-0.113137	-6.25791	0.113137	-5.57571	search
13	-0.16	-6.31841	0.16	-5.34885	search
15	-0.226274	-6.35965	0.226274	-4.97497	search
17	-0.32	-6.3331	0.32	-4.33658	search
19	-0.452548	-6.13649	0.452548	-3.20463	search
21	-0.64	-5.57142	0.64	-1.11795	search
23	-0.905097	-4.28942	0.905097	2.88155	search

Search for a zero in the interval [-0.905097, 0.905097]:

Func-count	x	f(x)	Procedure
23	0.905097	2.88155	initial
24	0.905097	2.88155	interpolation
25	0.647494	-1.02216	interpolation
26	0.714946	-0.115849	interpolation
27	0.723235	0.00106971	interpolation
28	0.723159	-5.55442e-06	interpolation
29	0.723159	-2.63826e-10	interpolation
30	0.723159	-4.44089e-16	interpolation
31	0.723159	-4.44089e-16	interpolation

Zero found in the interval [-0.905097, 0.905097]

ans =

0.7232


```
>> my_fzero(f, df, 0)
```

```
Finding Interval
```

	a	b	f(a)	f(b)
1	-1.00e-03	1.00e-03	-6.00e+00	-6.00e+00
2	-3.00e-03	3.00e-03	-6.01e+00	-5.99e+00
3	-7.00e-03	7.00e-03	-6.02e+00	-5.98e+00
4	-1.50e-02	1.50e-02	-6.04e+00	-5.95e+00
5	-3.10e-02	3.10e-02	-6.09e+00	-5.90e+00
6	-6.30e-02	6.30e-02	-6.16e+00	-5.78e+00
7	-1.27e-01	1.27e-01	-6.28e+00	-5.51e+00
8	-2.55e-01	2.55e-01	-6.36e+00	-4.79e+00
9	-5.11e-01	5.11e-01	-5.99e+00	-2.62e+00
10	-1.02e+00	1.02e+00	-3.57e+00	5.08e+00

```
Findind Zero
```

	x	f(x)	Method
1	0.00e+00	-6.00e+00	Bisection
2	5.12e-01	-2.61e+00	Bisection
3	5.12e-01	-2.61e+00	Newton
4	7.59e-01	5.22e-01	Newton
5	7.24e-01	1.11e-02	Newton
6	7.23e-01	5.51e-06	Newton
7	7.23e-01	1.35e-12	Newton

```
ans =
```

```
0.7232
```