Assignment 1 ME5102

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January 26, 2019

Problem 6: Newton-Raphson method

Given the equation

$$e^{0.3x} ln(x) = x + 2$$

We can write it as

$$y = e^{0.3x} ln(x) - x - 2$$

Finding the derivative

$$y' = 0.3e^{0.3x} ln(x) + \frac{e^{0.3x}}{x} - 1$$

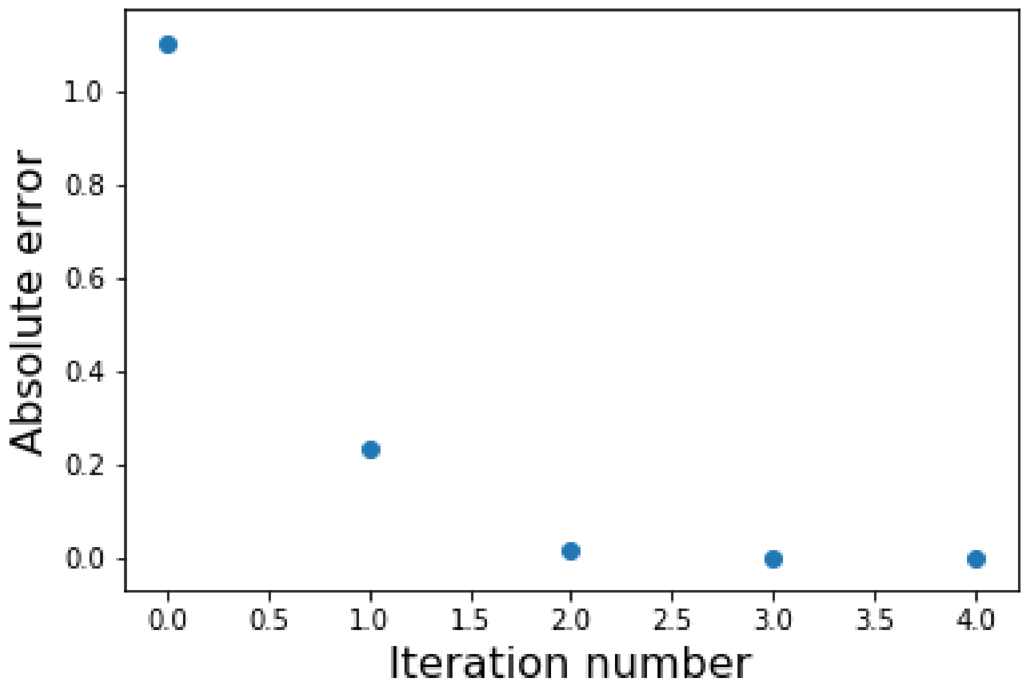
Performing iteration with the below equation taking x=6 as the initial guess

$$x_{i+1} = x_i - \frac{f_i}{f_i'}$$

```
In [19]: import numpy as np
         import matplotlib.pyplot as plt
         from astropy.table import Table, Column
         import math

         x=6
         y=np.exp(0.3*x)*np.log(x)-2-x
         lx = []
         ly = []
         error = []
         exact = []
         i = 0
         itera = []
         while y > 0.00001:
                 y=np.exp(0.3*x)*np.log(x)-2-x
                 dy=0.3*np.exp(0.3*x)*np.log(x)+(1/x)*np.exp(0.3*x) - 1
                 xn = x - (y/dy)
                 lx.append(x)
                 x = xn
```

```
        ly.append(y)
        i = i+1
print("x = ",x)

# exact solution 4.89389362525
for x in range(i):
        exact.append(4.89389362525)
        itera.append(x)

for x in range(i):
        error.append(abs(lx[x]-exact[x]))
# potting the points
plt.scatter(itera, error, marker='o')
plt.ylabel('Absolute error', fontsize=16)
plt.xlabel('Iteration number', fontsize=16)
plt.show()
t = Table([itera, error], names=('Iteration number', 'Absolute error'))
print(t)
```

```
x =  4.89389362525
```



```
Iteration number    Absolute error
---------------- -----------------
               0     1.10610637475
               1     0.23512441327
               2   0.0129258473651
               3 4.13628589619e-05
               4 4.28117985507e-10
```

Problem 5: Trapezoidal Method

```
In [3]: from astropy.table import Table, Column
        import matplotlib.pyplot as plt
        import numpy as np

        a=0
        b=2
        ival=[]
        hval=[]
        no = []
        exact = []
        error =[]
        def calculate(n):
                h=(b-a)/n
                hval.append(h)
                A=0
                for x in range(n):
                        A=A+0.5*h*(1/(1+x*h*x*h) + 1/(1+(x*h+h)*(x*h+h)))
                return(A)

        for x in range(1,11):
                ival.append(calculate(30*x))


        for x in range(1,11):
                no.append(x)
                exact.append(1.1071487177943273)
        # exact solution   1.1071487177943273

        for x in range(10):
                error.append(abs(ival[x]-exact[x]))

        t = Table([no , hval, ival, exact , error], names=('No','h', 'IntegralApprox' , ' Integr
        print(t)

        slope, intercept = np.polyfit(np.log(hval), np.log(error), 1)
```

```python
print("\n Slope of the log-log curve is: ",slope)

plt.scatter(np.log(hval), np.log(error))
plt.ylabel('log(h)', fontsize=16)
plt.xlabel('log(error)', fontsize=16)
# function to show the plot
plt.show()
```

```
 No         h          IntegralApprox  IntegralExact        Error
--- ---------------- -------------- -------------- -----------------
  1  0.0666666666667  1.10708946485  1.10714871779 5.92529394907e-05
  2  0.0333333333333  1.10713390337  1.10714871779 1.48144200054e-05
  3  0.0222222222222  1.10714213351  1.10714871779  6.5842843413e-06
  4  0.0166666666667  1.10714501412  1.10714871779 3.70367924885e-06
  5  0.0133333333333  1.10714634743  1.10714871779 2.37036049411e-06
  6  0.0111111111111  1.10714707171  1.10714871779 1.64608589537e-06
  7 0.00952380952381  1.10714750842  1.10714871779 1.20937024217e-06
  8 0.00833333333333  1.10714779187  1.10714871779 9.25924618533e-07
  9 0.00740740740741   1.1071479862  1.10714871779 7.31595066972e-07
 10 0.00666666666667   1.1071481252  1.10714871779 5.92592197535e-07

 Slope of the log-log curve is:  1.99996185283
```