P346 (Computational Physics Lab)
Assignment 5
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[1]:
```
import mylibrary
import math
from matplotlib import pyplot as plt
```

Question 1

[2]:
```
#function given: log(x/2)-sin(5x/2)
f1 = lambda x: math.log(x/2) - math.sin(5*x/2)

#setting precision value to the order of -5
prec = 10**(-5)

#initial guess interval
lower_lim = 1.6
upper_lim = 2.4

#trying the method for an interval that doesn't contain the root
r,i,fxi,err = mylibrary.bisection(f1, lower_lim, upper_lim, prec)
print(r,i,fxi,err)
```

```
Missing Proper Bracketing .
```

[3]:
```
#obtaining apropriate bracket
brac1 = mylibrary.bracket(f1, lower_lim, upper_lim)
print("New bracket: " + str(brac1))
```

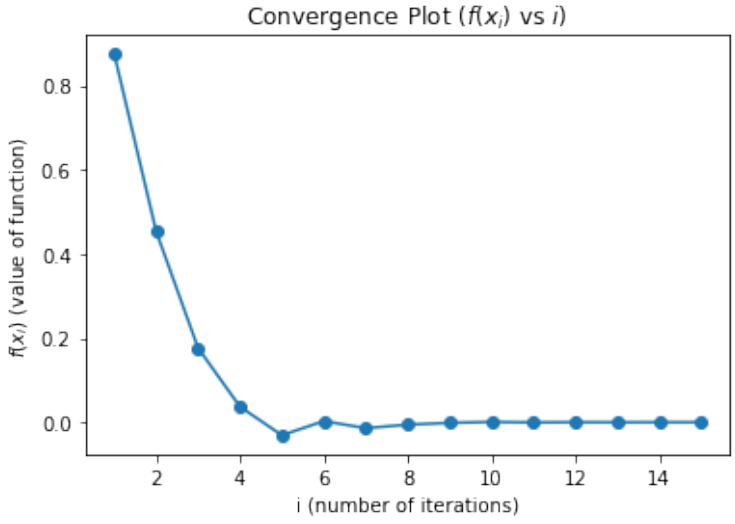
```
New bracket: (1.6, 2.6720765124999994)
```

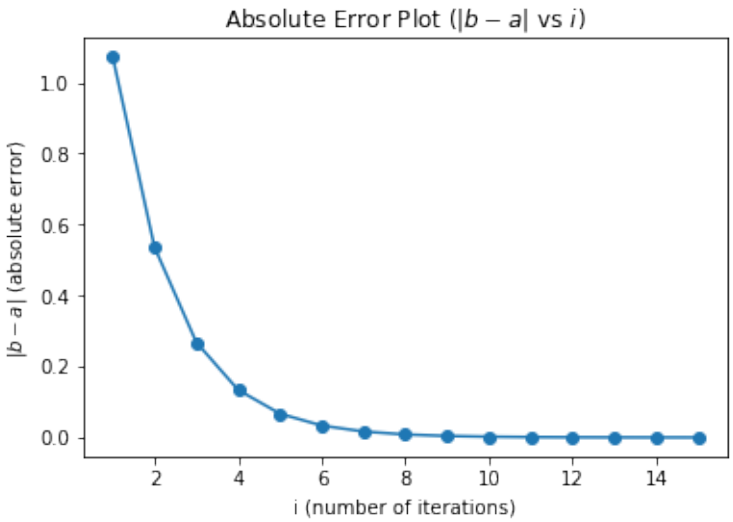
[4]:
```
#finding root using appropriate bracket
r,i,fxi,err = mylibrary.bisection(f1,brac1[0],brac1[1],prec)

#producing the table for convergence
print("Table for convergence (i vs |b-a|):")
mylibrary.showConvergenceTable(i,err)
print(f"    -> Root obtained: {r}")
```

```
Table for convergence (i vs |b-a|):
# of iterations (i)      Absolute Error (|b-a|)

         1               1.0720765124999994
         2               0.5360382562499995
         3               0.26801912812499973
         4               0.13400956406249964
```

```
5               0.06700478203124982
6               0.03350239101562513
7               0.01675119550781279
8               0.008375597753906394
9               0.004187798876952975
10               0.0020938994384764875
11               0.0010469497192384658
12               0.000523474859619455
13               0.0002617374298097275
14               0.00013086871490486374
15               6.543435745243187e-05
-> Root obtained: 2.623164330304336
```

[5]:
```
#displaying the convergence plot
plt.plot(i,fxi,'o-')
plt.xlabel("i (number of iterations)")
plt.ylabel("$f(x_i)$ (value of function)")
plt.title("Convergence Plot ($f(x_i)$ vs $i$)")
plt.show()
#displaying the absolute error plot
plt.plot(i,err,'o-')
plt.xlabel("i (number of iterations)")
plt.ylabel("$|b-a|$ (absolute error)")
plt.title("Absolute Error Plot ($|b-a|$ vs $i$)")
plt.show()
```



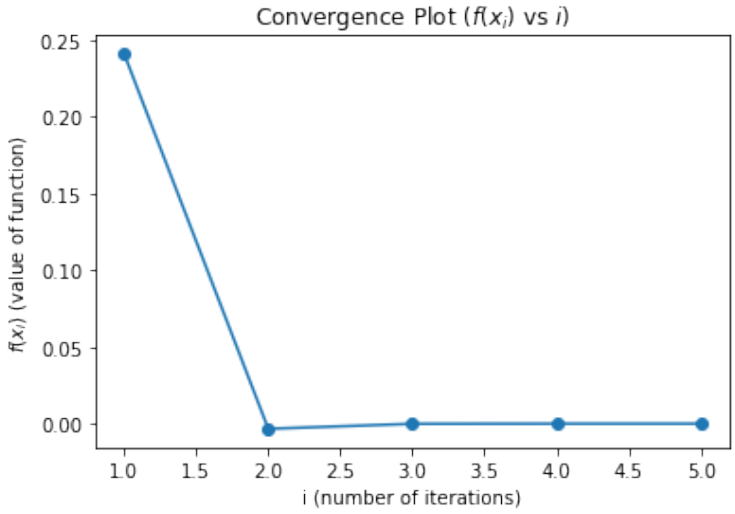


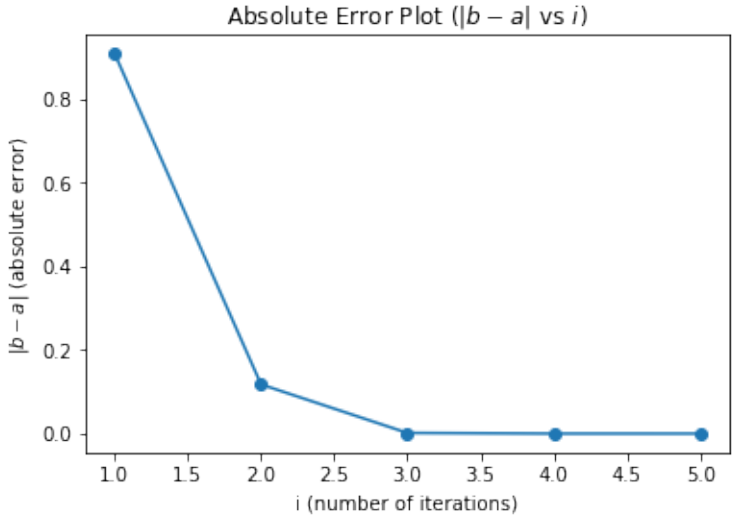
[6]:
```
#now, checking result using Regula-Falsi
r2,i2,fxi2,err2 = mylibrary.regulafalsi(f1,brac1[0],brac1[1],prec)
#print(f"    -> Regula-Falsi method: {mylibrary.
 ↪regulafalsi(f1,brac1[0],brac1[1],prec)}")

#producing the respective table for convergence
print("Table for convergence (i vs |d-c|:")
mylibrary.showConvergenceTable(i2,err2)
print()
print(f"    -> Root obtained: {r2}")
```

```
Table for convergence (i vs |d-c|:
# of iterations (i)      Absolute Error (|b-a|)

         1               0.9072548584212918
         2               0.11755051207184541
         3               0.0016203316051783823
         4               4.351403974656165e-05
         5               1.1577732772494187e-06

    -> Root obtained: 2.623140367074935
```

[7]:
```
#displaying the convergence plot
plt.plot(i2,fxi2,'o-')
plt.xlabel("i (number of iterations)")
plt.ylabel("$f(x_i)$ (value of function)")
plt.title("Convergence Plot ($f(x_i)$ vs $i$)")
plt.show()
#displaying absolute error plot
```

```
plt.plot(i2,err2,'o-')
plt.xlabel("i (number of iterations)")
plt.ylabel("$|b-a|$ (absolute error)")
plt.title("Absolute Error Plot ($|b-a|$ vs $i$)")
plt.show()
```





[8]:
```
#display both roots
print(f"Root in the given interval obtained using:")
print(f"    -> Bisection method: {r}")
print(f"    -> Regular-Falsi method: {r2}")
```

```
Root in the given interval obtained using:
```

```
    -> Bisection method: 2.623164330304336
    -> Regular-Falsi method: 2.623140367074935
```

Question 2

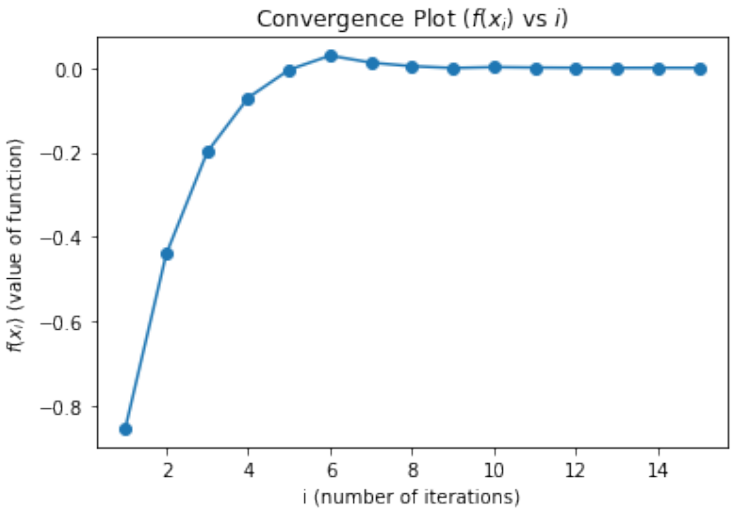
[9]:
```
#function given: -x - cos(x)
f2 = lambda x: -x-math.cos(x)
#finding bracket containing root
brac2 = mylibrary.bracket(f2, -0.5, 0.5) #guessed interval (-0.5,0.5)
print(brac2)
```

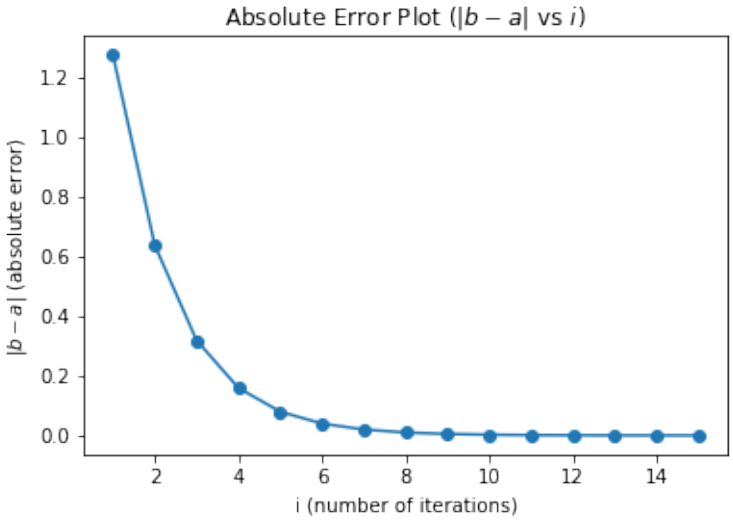
```
(-0.7762815625, 0.5)
```

[10]:
```
#finding roots using bisection, regulafalsi,
#and newton raphson, respectively
r3, i3, fxi3, err3 = mylibrary.bisection(f2, brac2[0], brac2[1], prec)
r4, i4, fxi4, err4 = mylibrary.regulafalsi(f2, brac2[0], brac2[1], prec)
r5, i5, err5 = mylibrary.newtonraphson(f2,0,prec) #initial guess set as 0

#printing roots
print("Root obtained using: ")
print(f"     -> Bisection Method: {r3}")
print(f"     -> Regula-Falsi: {r4}")
print(f"     -> Newton-Raphson: {r5}")
```

```
Root obtained using:
     -> Bisection Method: -0.7390852462100983
     -> Regula-Falsi: -0.739085123500922
     -> Newton-Raphson: -0.7390851332864619
```

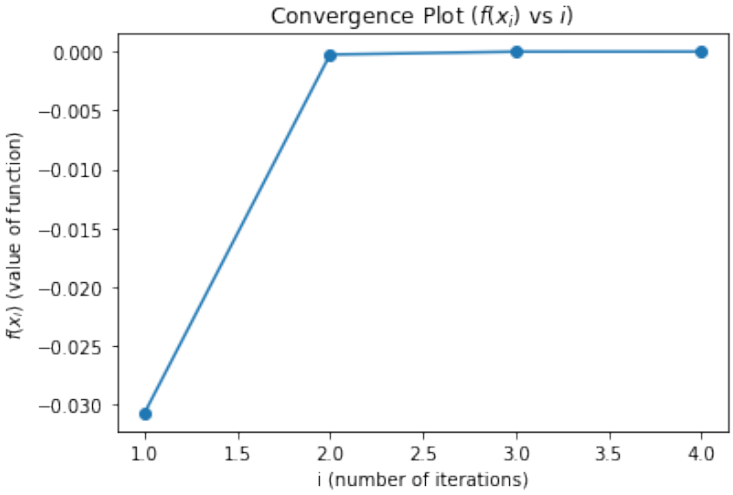
[11]:
```
#displaying the convergence plot
plt.plot(i3,fxi3,'o-')
plt.xlabel("i (number of iterations)")
plt.ylabel("$f(x_i)$ (value of function)")
plt.title("Convergence Plot ($f(x_i)$ vs $i$)")
plt.show()
#displaying absolute error plot
plt.plot(i3,err3,'o-')
plt.xlabel("i (number of iterations)")
plt.ylabel("$|b-a|$ (absolute error)")
plt.title("Absolute Error Plot ($|b-a|$ vs $i$)")
plt.show()
```

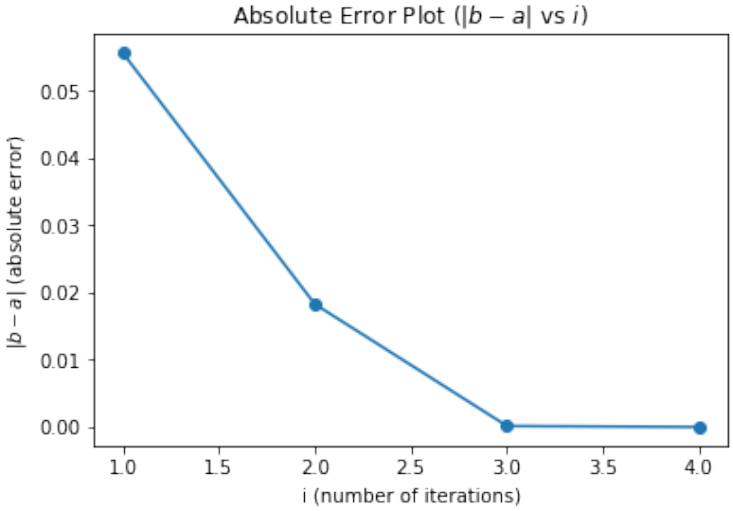




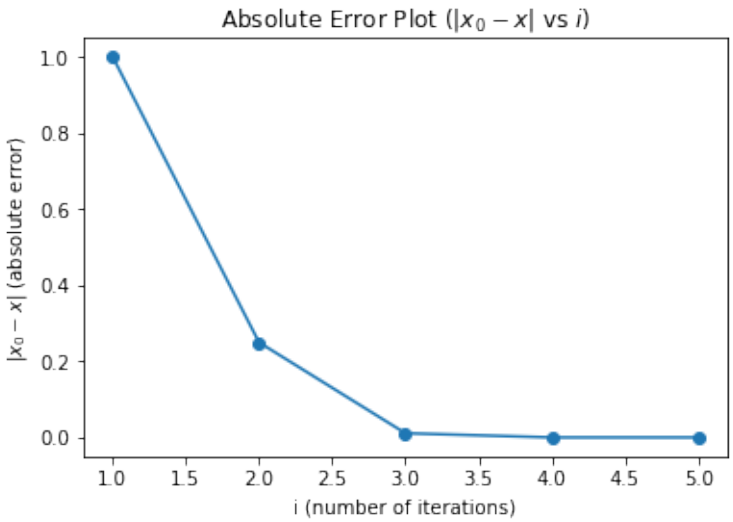
[12]:
```
#displaying the convergence plot
plt.plot(i4,fxi4,'o-')
plt.xlabel("i (number of iterations)")
plt.ylabel("$f(x_i)$ (value of function)")
plt.title("Convergence Plot ($f(x_i)$ vs $i$)")
plt.show()
#displaying absolute error plot
plt.plot(i4,err4,'o-')
plt.xlabel("i (number of iterations)")
plt.ylabel("$|b-a|$ (absolute error)")
plt.title("Absolute Error Plot ($|b-a|$ vs $i$)")
```

```
plt.show()
```





[13]:
```
#displaying absolute error plot
plt.plot(i5,err5,'o-')
plt.xlabel("i (number of iterations)")
plt.ylabel("$|x_0-x|$ (absolute error)")
plt.title("Absolute Error Plot ($|x_0-x|$ vs $i$)")
plt.show()
```



Question 3

[14]:
```
#function given: x**4 - 5*x**2 + 4
coeffs = [1, 0, -5, 0, 4]
lag_roots = mylibrary.laguerre(coeffs, 6, prec)

print("The roots of the given polynomial are:")
print(lag_roots)
```

```
The roots of the given polynomial are:
[2, 1, -1, -2]
```