Graphs of functions

```
import math
x1=[]
y1=[]
for i in range(1,11):
    x1.append(i)
    a=math.log10(i)
    y1.append(a)

import matplotlib.pyplot as plt
plt.plot(x1, y1, label = "log n")


x2=[]
y2=[]
for i in range(1,11):
    x2.append(i)
    a=math.log(i)
    y2.append(a)

plt.plot(x2, y2, label = "ln n")

x3=[]
y3=[]
for i in range(1,11):
    x3.append(i)
    a=math.log10(i)
    b=i*a
    y3.append(b)

plt.plot(x3, y3, label = "nlog n")

x4=[]
y4=[]
for i in range(1,11):
    x4.append(i)
    a=math.log(i)
    b=i*a
    y4.append(b)

plt.plot(x4, y4, label = "nln n")



plt.xlabel('x - axis')
plt.ylabel('y - axis')
plt.legend()
```

```
print("nlogn and nlnn are are continuously increasing functions. logn
and lnn are increasing functions")
print("The shapes of the graphs of log n and ln n are similar and the
shapes of the graphs of nlogn and nlnn are similar")
```

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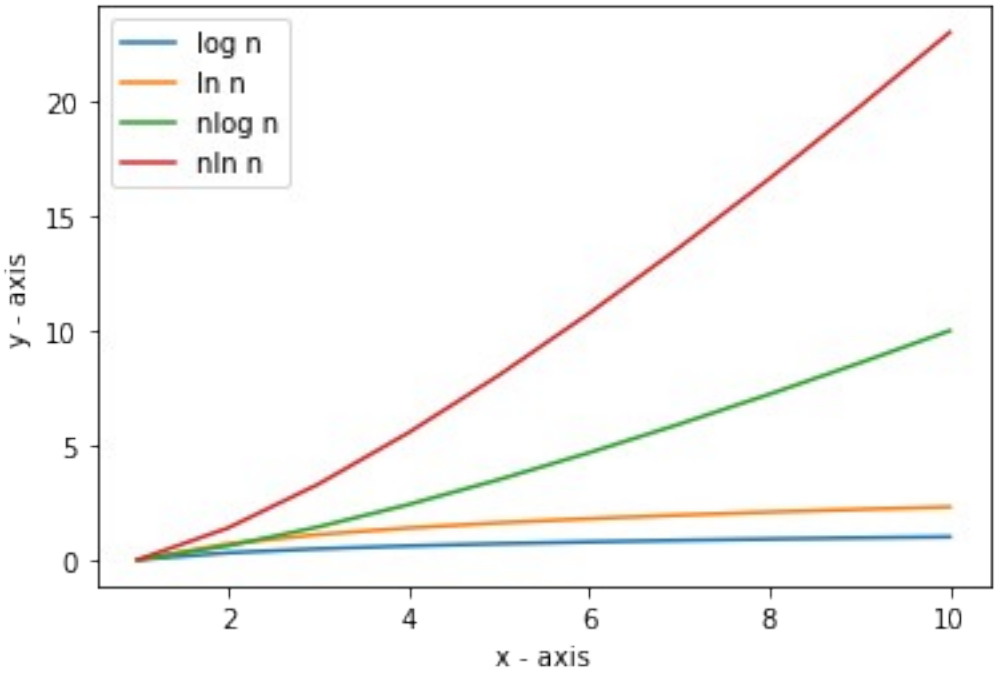
```




```
x5=[]
y5=[]
for i in range(1,21):
    x5.append(i)
    a=math.log10(i)
    b=a/i
    y5.append(b)

plt.plot(x5, y5, label = "log n/n")

x6=[]
y6=[]
for i in range(1,21):
    x6.append(i)
    a=math.log(i)
    b=a/i
    y6.append(b)
```

```
plt.plot(x6, y6, label = "ln n/n")


plt.xlabel('x - axis')
plt.ylabel('y - axis')
plt.legend()

print(" Both the functions (logn)/n and (ln n)/ n first increase,
reach a point of maxima and then decrease")
print("The shapes of the graphs of (logn)/n and (ln n)/ n are
similar")
```

```
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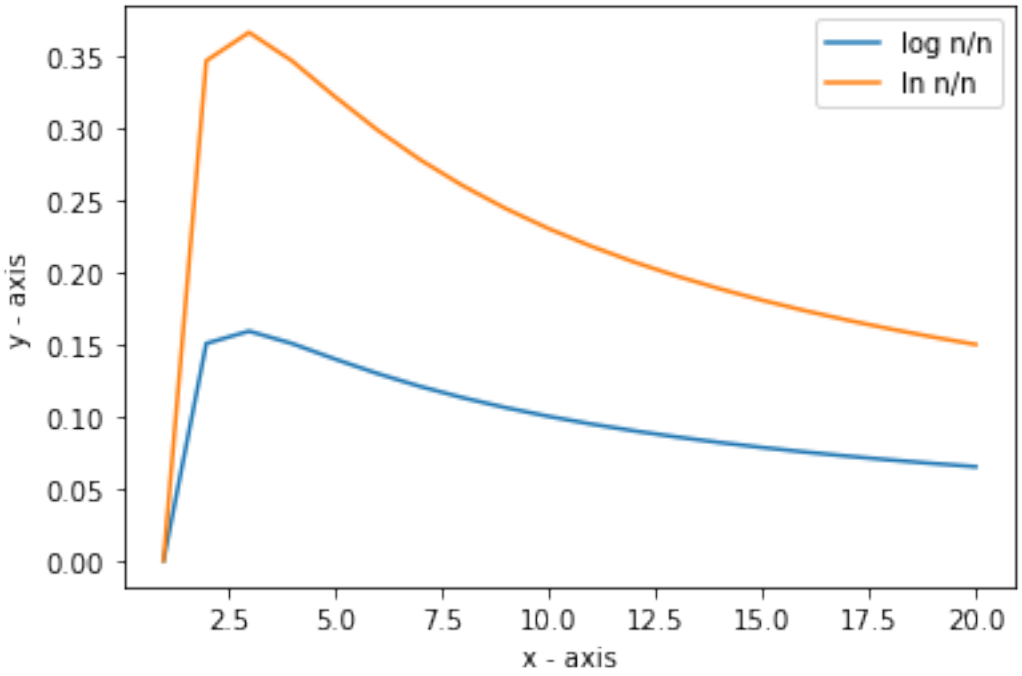
The shapes of the graphs of (logn)/n and (ln n)/ n are similar
```




```
x=[]
y=[]
for i in range(1,6):
    x.append(i)
    y.append(i)

plt.plot(x, y, label = "n")

x=[]
y=[]
for i in range(1,6):
    x.append(i)
```

```
    y.append(i*i)

plt.plot(x, y, label = "n^2")

x=[]
y=[]
for i in range(1,6):
    x.append(i)
    y.append(i*i*i)

plt.plot(x, y, label = "n^3")




plt.xlabel('x - axis')
plt.ylabel('y - axis')
plt.legend()

print("the functions n,n^2 and n^3 are continuously functions")
print("The graph of n is a straight line. The graphs of n^2 and n^3
have a similar shape for all positive integers. For all integers >=2
n<n^2<n^3 . They are all equal at n=1")
```

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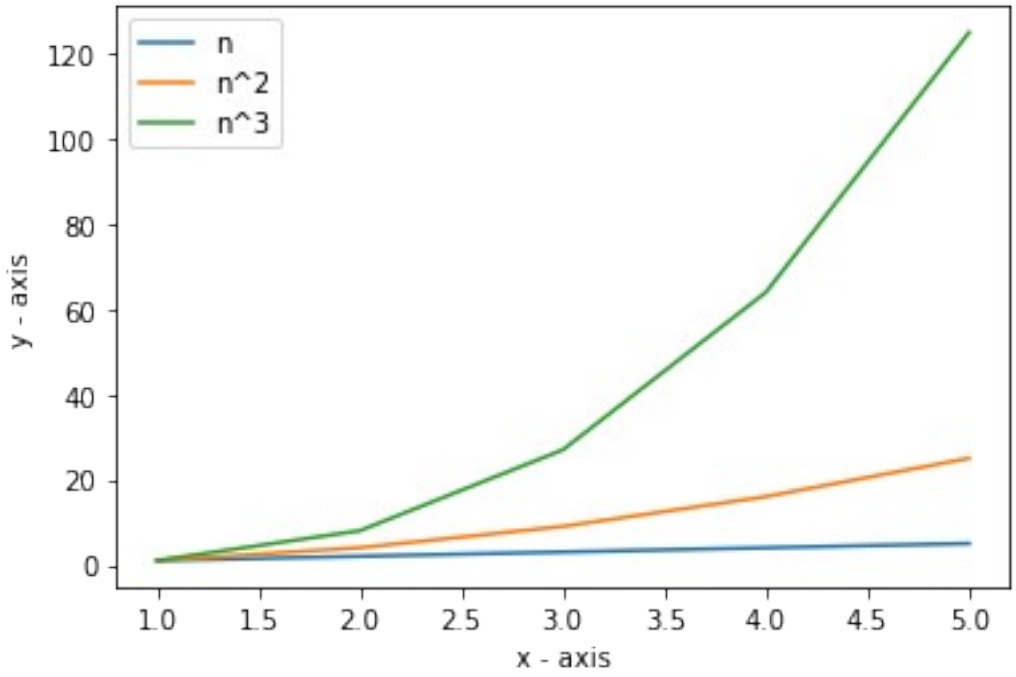


```
x=[]
y=[]
for i in range(1,21):
    x.append(i)
    y.append(i**0.5)

plt.plot(x, y, label = "n^1/2")

x=[]
y=[]
for i in range(1,21):
    x.append(i)
    y.append(i**(1/3))

plt.plot(x, y, label = "n^1/3")




plt.xlabel('x - axis')
plt.ylabel('y - axis')
plt.legend()

print("The functions n^(1/2) and n^1/3 are increasing functions. Their
graphs have a similar shape")
```

```
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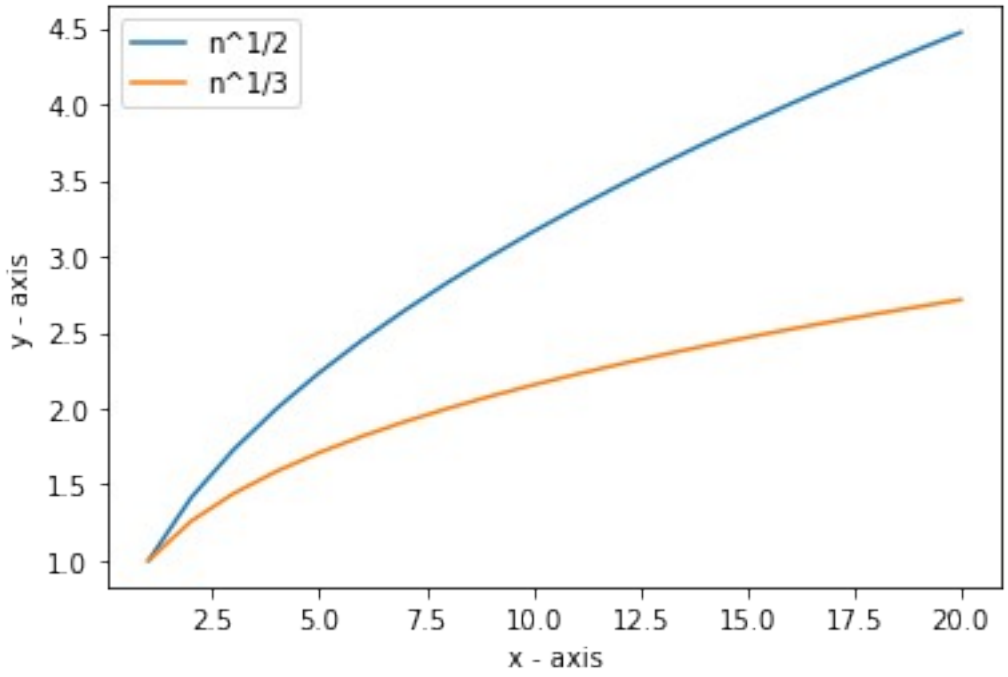
```




```
x=[]
y=[]
for i in range(1,5):
    x.append(i)
    y.append(i**i)

plt.plot(x, y, label = "n^n")

x=[]
y=[]
for i in range(1,5):
    x.append(i)
    y.append(1.5**i)

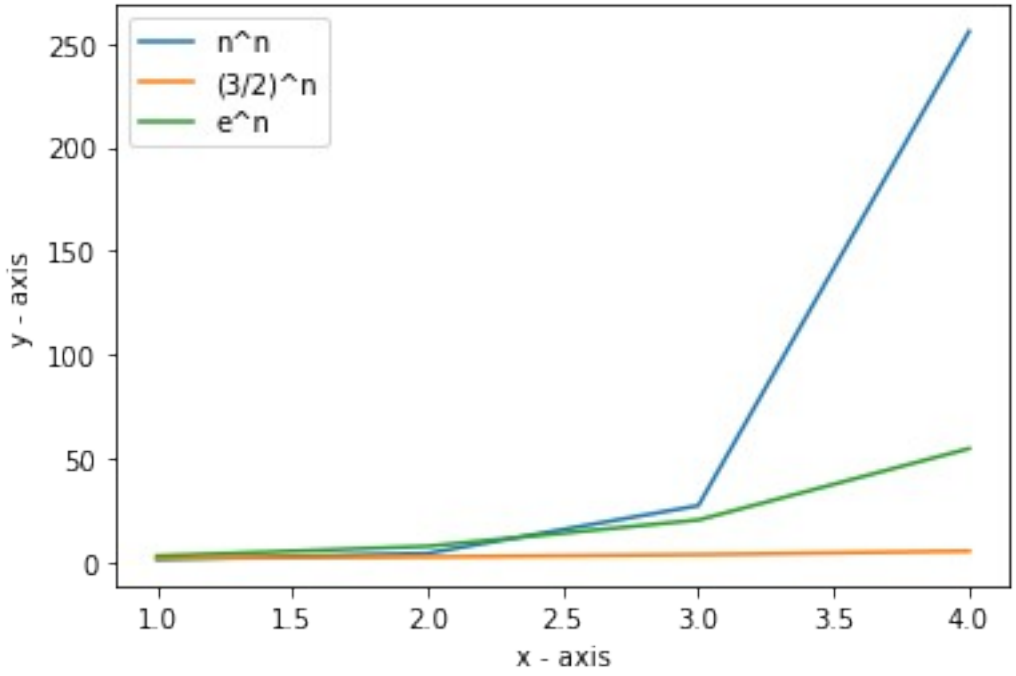
plt.plot(x, y, label = "(3/2)^n")

x=[]
y=[]
for i in range(1,5):
    x.append(i)
    y.append(math.exp(i))

plt.plot(x, y, label = "e^n")


plt.xlabel('x - axis')
plt.ylabel('y - axis')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x214ea320a30>
```




```
x=[]
y=[]
for i in range(2,11):
    x.append(i)
    y.append(math.log10(math.log10(i)))

plt.plot(x, y, label = "log logn")

x=[]
y=[]
for i in range(2,11):
    x.append(i)
    y.append(math.log(math.log(i)))

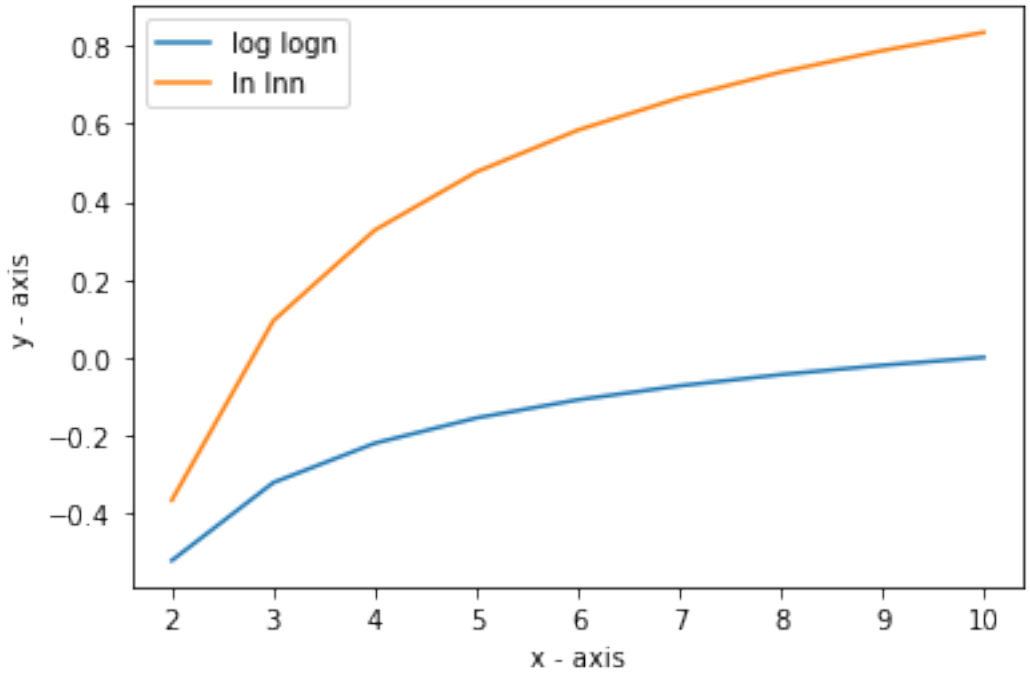
plt.plot(x, y, label = "ln lnn")



plt.xlabel('x - axis')
plt.ylabel('y - axis')
plt.legend()

print("The functions log logn and ln lnn are increasing functions and
their graphs have a similiar shape")
```

```
The functions log logn and ln lnn are increasing functions and their
graphs have a similiar shape
```




```
x=[]
y=[]
for i in range(1,21):
    x.append(i)
    y.append(1/i)

plt.plot(x, y, label = "1/n")


x=[]
y=[]
for i in range(1,21):
    x.append(i)
    y.append(2**math.log10(i))

plt.plot(x, y, label = "2^logn")

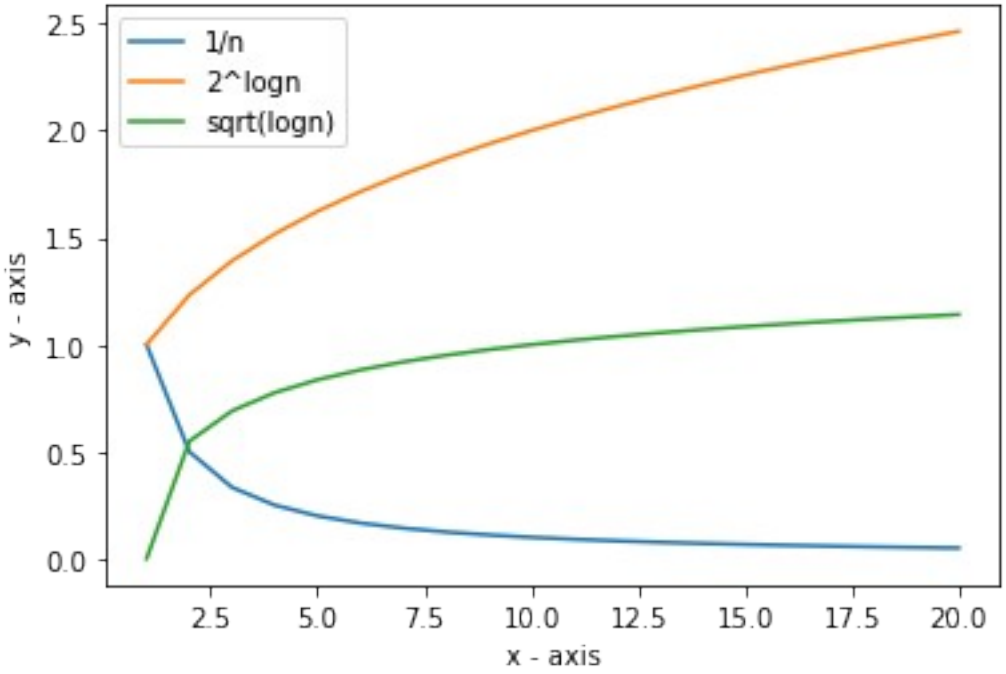
x=[]
y=[]
for i in range(1,21):
    x.append(i)
    y.append(math.log10(i)**0.5)

plt.plot(x, y, label = "sqrt(logn)")

plt.xlabel('x - axis')
plt.ylabel('y - axis')
plt.legend()
```

```
print("1/n is a decreasing function")
print("sqrt(logn) and 2^logn are increasing functions")
```

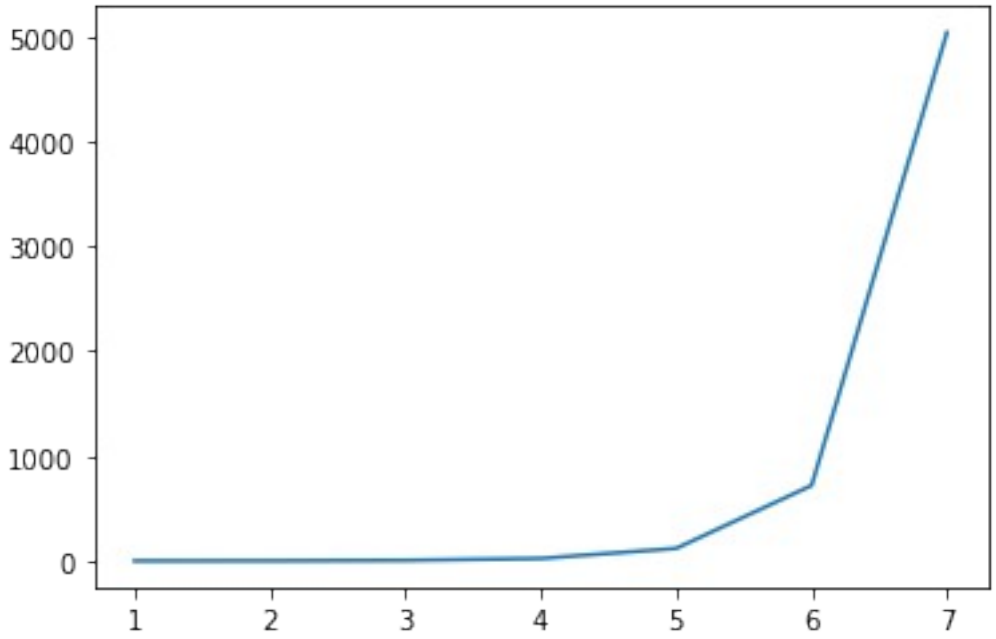
```
<matplotlib.legend.Legend at 0x214eb573400>
```




```
x=[]
y=[]
for i in range(1,8):
    x.append(i)
    y.append(math.factorial(i))

plt.plot(x, y, label = "n!")
print("n! is a strictly increasing function")
```

```
n! is a strictly increasing function
```



Binary search

```
def binarySearch(a,low,high,x):

    if high >= low:

        mid = (high + low) // 2

        if a[mid] == x:
            return mid

        elif a[mid] > x:
            return binarySearch(a, low, mid - 1, x)

        else:
            return binarySearch(a, mid + 1, high, x)
    else:
        return -1
```

Case 1: Object is present

```
a=[1,2,3,4,5,6,7,8,9,10]
x=8
index=binarySearch(a,0,len(a)-1,x)
```

```
if index!=-1:
    print("The object is present at index ",index)

else:
    print("The object is not present")
```

```
The object is present at index  7
```

Case 2: Object is not present

```
x=15
index=binarySearch(a,0,len(a)-1,x)
if index!=-1:
    print("The object is present at index ",index)

else:
    print("The object is not present")
```

```
The object is not present
```

Loop invariant property

If the element is present in the array it will be in a particular section of the array(left or right) or will not be present in the entire master array

Initialisation

Since at the beginning the entire master array is the range we can say that the loop invariant property is true.

Maintainence

Before a particular iteration if the loop invariant property is true, compare the element with mid of the array responsible in that particular iteration. Consider the next sub array accordingly based on the values of mid and element i.e. if element>mid consider the right sub array and if element < mid consider left sub array. If the element is present it will be present in that particular array or will not be present in the complete master array. This happens because the array is sorted.

Termination

At the last step we reach a point where the low=high. If element=low=high, the function returns the value of the index. If not, it returns -1 indicating that the given element is not present.