Trapezoidal Method

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1 Trapezoidal Method

Trapezoidal Rule is a rule that evaluates the area under the curves by dividing the total area into smaller trapezoids rather than using rectangles. This integration works by approximating the region under the graph of a function as a trapezoid, and it calculates the area.

$$I = \int_a^b f(x)dx$$

$$I \approx \frac{h}{2}\left(y_0 + y_n + 2\sum_{k=1}^{n-1} y_k\right)$$

$$h = \frac{b-a}{n}$$

$n \rightarrow$ number of segments

$h \rightarrow$ step size

1.1 Implementation

We define `trapezoidal_method` function, the function takes five inputs, first input is the function to integrate, second and third input are the start and the end of the interval of integration, fourth input is the number of segments, last input is `plot_function` which equals false by default, returns a plot to the function if true

[1]:
```
# import needed packages

import numpy as np

def trapezoidal_method(f, start, end, number_of_segments, plot_function = 
 ↪False):

    h = (end - start) / number_of_segments

    x_data = np.linspace(start, end, number_of_segments + 1)

    y_data = []
```

```
    for i in x_data:
        y_data.append(f(i))


    integration = 0.5 * h * (y_data[0] + y_data[-1] + 2 * sum(y_data[1:-1]))

    if plot_function == False:

        return integration


    if plot_function == True:

        data = []

        for i in range(len(x_data)):
            data.append((x_data[i], y_data[i]))

        p1 = plot(f, (x, start, end), fill = True, fillcolor = 'grey')
        p2 = list_plot(data, color = 'red')
        p3 = list_plot(data, plotjoined = True,  color = '#ff9898')

        return integration, p1 + p2 + p3
```

1.2 Test with an example

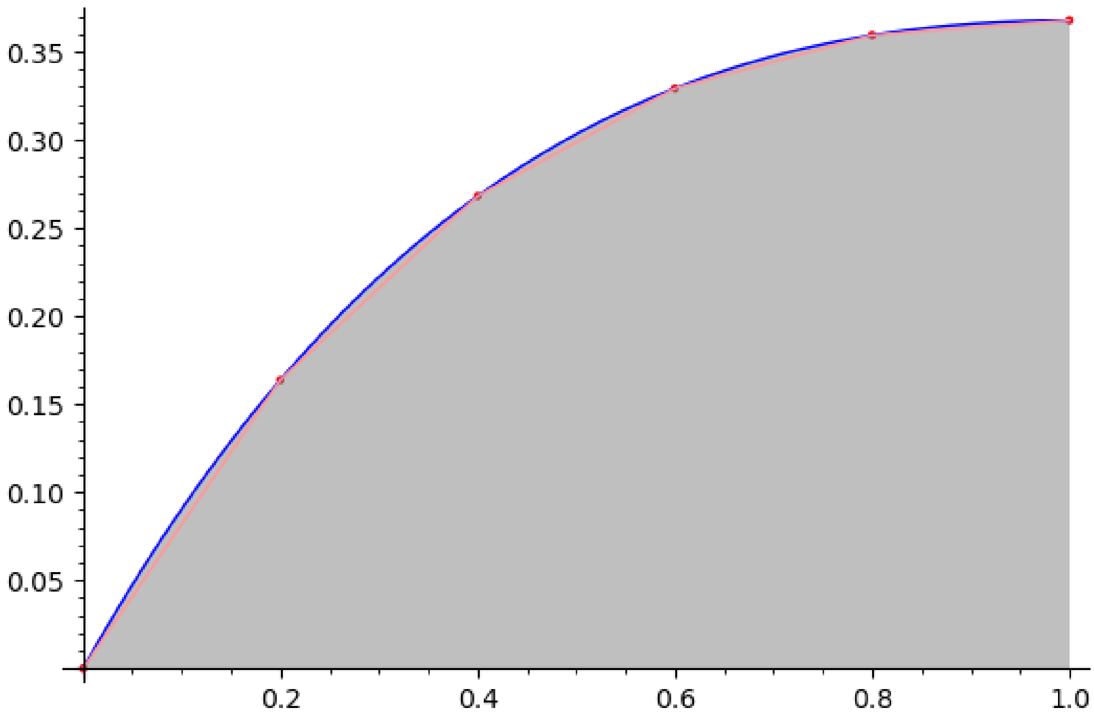
Evaluate the following integral using the trapezoidal rule. Use 5 segments.

$$\int_0^1 xe^{-x}dx$$

[2]:
```
f(x) = x * exp(-x)
```

[3]:
```
solution, graph = trapezoidal_method(f, 0, 1, 5, plot_function = True)
print(f"The definite integral value is {solution}, the exact value is {f.
 ↪integrate(x, 0, 1).n()}")
show(graph)
```

```
The definite integral value is 0.260912808513153, the exact value is
0.264241117657115
```


0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.2
0.4
0.6
0.8
1.0