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**Project 8 – Numerical Integration**

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Grand Canyon University

Course number: CST - 305

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**Project 8 – Numerical Integration**

**Instructions**

The objective of this project is to create a python code that can numerically compute a Reimann integral of a function by utilizing your comprehension of the Reimann Sum for the initial part. In the subsequent part, the python code created in the first part will be utilized to determine the volume of data that can be transmitted over a network. The network should be monitored for thirty minutes with periodic recordings of the download rate (in megabytes per second) for every one-minute interval. This will enable us to construct a graph that models the region under a curve representing the rate at which large files are downloaded on a specific network.

**Part 1:**

The instructor will assign you a continuous function over the interval , which you will partition into subintervals of length 𝛥𝑥. You will then approximate the value you want to find as ∑𝑓(𝑐𝑘)𝛥𝑥 with a point in the subinterval. Write a definite integral to express the limit . Finally, evaluate the integral numerically over the given interval.

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Figure . Summation Formula

1. Graph The function over the given interval [−𝜋,𝜋]. Partition the interval into four subintervals of equal length. Then add to your sketch the rectangles associated with the Riemann sum, given that is the (a) left-hand endpoint, (b) righthand endpoint, (c) midpoint of the subinterval.

If we devide the interval [−𝜋,𝜋] into 4 section (k = 1, 2, 3, and 4), then the four subintervals will be , ,, and . From the given subintervals, we can say each point moves . Now we can find f(x) using each part of the subintervals with .

[ Left-Hand Endpoint ]

[ Mid Point ]

For calculating mid point, we have to find the point in between each interval for , ,, and . Then, it will be .

[ Right-Hand Endpoint ]

Chart, bar chart

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Figure 2. Part A Graph & Execution

1. For the function over the interval [0,1], find a formula for the Riemann sum obtained by dividing the interval [𝑎,𝑏] into n equal subintervals and using the right-hand endpoint for each . Then take a limit of these sums as 𝑛→∞ to calculate the ar ea under the curve over [𝑎,𝑏].

By using general calculation for the integral

Solve the equation by using Riemann sum by dividing the interval [𝑎,𝑏] into n equal subintervals. The Riemann sum is defined as:

When n approaches to infinity for the denominator, the value is getting closer to 0, therefore we caclulate the denomiator for n with the as 0, then we get

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Figure 3. Part B Graph & Execution

1. Find the Riemann sum from the definitive integral. . Write a Python code using the necessary libraries to plot the general solution with the highest granularity.

Solve the equation by using Riemann sum by dividing the interval [𝑎,𝑏] into n equal subintervals. The Riemann sum is defined as:

Substitute with values, then we get:

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Figure 4. Part C 1 Graph & Execution

1. For the function 𝑜𝑣𝑒𝑟 𝑡ℎ𝑒 𝑖𝑛𝑡𝑒𝑟𝑣𝑎𝑙 [−1,0], 𝑓𝑖𝑛𝑑 a formula for the Riemann sum obtained by dividing the interval [𝑎,𝑏] into 𝑛 equal subintervals and using the right-hand endpoint for each . Then take a limit of these sums as n→∞ to calculate the area under the curve over [𝑎,𝑏].

By using general calculation for the integral, if we calculate , then we get:

Solve the equation by using Riemann sum by dividing the interval [𝑎,𝑏] into n equal subintervals. The Riemann sum is defined as:

Substitute with values, then we get:

When n approaches to infinity for the denominator, the value is getting closer to 0, therefore we caclulate the denomiator for n with the as 0, then we get

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Figure 5. Part C 2 Graph & Execution

**Part 2:**

A media server streams data at a varying rate. The rate (megabytes per second) at which the server operates is recorded at 1-minute intervals for 30 minutes. Locate a content server on the Internet that stores large files and perform several downloads. As you download files, record the download rates (Mbps), and store the results in a table with 30 entries (30 min, 1-minute intervals). Define a function R(t) to represent the download rate over time t that is continuous over the interval [0, 30]. Use the software tool you developed in Part 1 to numerically calculate the amount of data downloaded over the duration of the experiment. Output the value and explain its meaning.

Table

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We have downloaded over 30 minutes interval and were able to collect 30 data download speed values. We have selected the general book pdf files for collecting data download speed, and several were able to download files from several websites. By using excel data chart, we were able to find the R(t) to represent the download rate over time t that is continuous over the interval [0, 30].

By using general calculation for the integral

Solve the equation by using Riemann sum by dividing the interval [𝑎,𝑏] into n equal subintervals. The Riemann sum is defined as:

When n approaches to infinity for the denominator, the value is getting closer to 0, therefore we caclulate the denomiator for n with the as 0, then we get

Chart, bar chart

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Figure 6. Part C 2 Graph & Execution