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Engineering Application in Integral Calculus – Automobile Velocity

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Engineering Application in Integral Calculus –Automobile Velocity

A Mini-Project for Module 1

Project Description

This project demonstrates the following concepts in integral calculus:

1. Riemann sums
2. Definite integrals

Project description.

- Find the total distance traveled by a car by integrating the velocity function. When one is only given *data,* there are two ways to estimate the total distance – either use numerical integration and the given data, or find a polynomial regression curve to the data, and then integrate. One hopes that the two estimates are fairly close.
- Estimate when (in seconds) the total distance traveled equals a tenth of a mile.

Numerical Example

The data in the table below was taken from the *Motor Trend Magazine* the July , 1997 issue for the Mercedes – Benz SLK 230

t (s)	0	2.3	3.6	5.0	6.9	9.0	11.4
v (mph)	0	30	40	50	60	70	80

I estimated the total distance traveled, D, using Riemann sums with six subdivisions (n = 6). The result was D = 564 / 3600 ≈ 1.56667 miles. Then I fitted the velocity data with a regression polynomial of degree three (polynomials of degree one or two did not fit well data) using Matlab. I obtained the velocity function $v(t) = 0.0483t^2 - 1.2599t^2 + 15.0979t + 0.2883$.
Next, I estimated the total distance traveled using the regression polynomial.

$D \cong \frac{1}{3600}\int_0^{11.4} v(t)dt \cong 0.1572$, which is very close to the other estimate.

To estimate when (in seconds) the total distance traveled equals a tenth of a mile, I used Matlab to approximate the roots of the corresponding polynomial equation. Setting

$$\frac{1}{3600}\int_0^t v(\pi)d\pi = 0.1 \Rightarrow \int_0^t (0.0483t^3 - 1.2599t^2 + 15.0979t + 0.2883)dt = 360$$

⇨ $0.0121t^4 - 0.4100t^3 + 7.5490t + 0.2833t - 360 = 0.$

⇨ Matlab returned the *only one positive real root, t ≈ 8.5116 seconds.*

Your Assignment

1. Obtain automobile (of your choice) velocity data from Motor Trend Magazine or any other publication of your choice. The data must be time *t* as a function of velocity *v*.
2. Estimate the total distance traveled using Riemann sums.
3. Fit the velocity data with a regression polynomial of degree three using Matlab or any other software and obtained the velocity function.
4. Estimate the total distance traveled using the regression polynomial.