DeVry University Spring 2005

Math 230: Applied Calculus II Matlab Assignment #4A

Due Friday Week #11 (5/20/05)

Title: A Fourier Series Approximation

Objectives: To practice calculating Fourier coefficients,
To review Matlab's graphing capabilities,
To study some matrix (rather than array) arithmetic.

Instructions:

(1) You are given the following periodic modified **triangle wave**. It is described for one period $0 \leq x \leq 2\pi$ and repeats both before and afterwards.

$$f(t) = \begin{cases} \frac{2t}{\pi} & 0 \leq t \leq \frac{\pi}{2} \\ -\frac{2t}{\pi} + 2 & \frac{\pi}{2} \leq t \leq \pi \\ 3 - \frac{3t}{\pi} & \pi \leq t \leq \frac{3\pi}{2} \\ \frac{3t}{\pi} - 6 & \frac{3\pi}{2} \leq t \leq 2\pi \end{cases}$$

(2) Use any method you wish to plot the given function through three periods from 0 to 6π.

(3) Construct two arrays: one of integers from 1 to 1000 and one a list of 1000 values (using **linspace**) from 0 to 6π.

(4) Next determine the Fourier coefficients for the given function using the following integral formulas:

$$\mathbf{a_0} = \frac{1}{2\pi}\int_0^{2\pi} f(t)\,dt,\ \mathbf{a_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\cos(nt)\,dt \text{ and } \mathbf{b_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\sin(nt)\,dt.$$

(5) Now, construct two new arrays 1000 elements long. The first should contain all the values a_n and the second should contain the values b_n. You can store a_0 separately.

(6) Use matrix multiplication to create a matrix where the first row is an array from 0 to 6π, the second row is the same length but from 0 to 12π, the third row is the same length but from 0 to 18π,..., and the final row has the same number of values but ranges from 0 to 6000π. (*Hint*: See the sample code)

(7) Use the **diag** function in Matlab to convert each array of Fourier coefficients into a matrix. Multiply the first by the sine of the matrix created in the previous step, the second by the cosine of the same matrix and then add the two together.

(8) Use the **sum** function to add the first 5 rows in the resulting matrix, add the constant term a_0 and plot the result.

(9) Then, sum the first 20 rows in the matrix, add the constant term and plot the result.

(10) Afterwards, sum all rows in the matrix, add the term a_0 and plot the result.

(11) Finally, attempt the same construction for the full matrix but sum the sine terms separately, plotting the result, and sum the cosine (and constant) terms separately and plot the result.

(12) **Note:** Sample code is provided in a separate file. It shows a similar arrangement for two distinct functions: a square wave and a sawtooth function.

DeVry University Spring 2005

Math 230: Applied Calculus II Matlab Assignment #4B

Due Friday Week #11 (5/20/05)

Title: A Fourier Series Approximation

Objectives: To practice calculating Fourier coefficients,
To review Matlab's graphing capabilities,
To study some matrix (rather than array) arithmetic.

Instructions:

(1) You are given the following periodic modified **triangle wave**. It is described for one period $0 \le x \le 2\pi$ and repeats both before and afterwards.

$$f(t) = \begin{cases} \frac{4t}{\pi} & 0 \le t \le \frac{\pi}{2} \\ -\frac{4t}{\pi} + 4 & \frac{\pi}{2} \le t \le \pi \\ 5 - \frac{5t}{\pi} & \pi \le t \le \frac{3\pi}{2} \\ \frac{5t}{\pi} - 10 & \frac{3\pi}{2} \le t \le 2\pi \end{cases}$$

(2) Use any method you wish to plot the given function through three periods from 0 to 6π.

(3) Construct two arrays: one of integers from 1 to 1000 and one a list of 1000 values (using **linspace**) from 0 to 6π.

(4) Next determine the Fourier coefficients for the given function using the following integral formulas:

$$\mathbf{a_0} = \frac{1}{2\pi}\int_0^{2\pi} f(t)\,dt,\ \mathbf{a_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\cos(nt)\,dt \text{ and } \mathbf{b_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\sin(nt)\,dt.$$

(5) Now, construct two new arrays 1000 elements long. The first should contain all the values a_n and the second should contain the values b_n. You can store a_0 separately.

(6) Use matrix multiplication to create a matrix where the first row is an array from 0 to 6π, the second row is the same length but from 0 to 12π, the third row is the same length but from 0 to 18π,..., and the final row has the same number of values but ranges from 0 to 6000π. (*Hint*: See the sample code)

(7) Use the **diag** function in Matlab to convert each array of Fourier coefficients into a matrix. Multiply the first by the sine of the matrix created in the previous step, the second by the cosine of the same matrix and then add the two together.

(8) Use the **sum** function to add the first 5 rows in the resulting matrix, add the constant term a_0 and plot the result.

(9) Then, sum the first 20 rows in the matrix, add the constant term and plot the result.

(10) Afterwards, sum all rows in the matrix, add the term a_0 and plot the result.

(11) Finally, attempt the same construction for the full matrix but sum the sine terms separately, plotting the result, and sum the cosine (and constant) terms separately and plot the result.

(12) **Note:** Sample code is provided in a separate file. It shows a similar arrangement for two distinct functions: a square wave and a sawtooth function.

DeVry University Spring 2005

Math 230: Applied Calculus II Matlab Assignment #4C

Due Friday Week #11 (5/20/05)

Title: A Fourier Series Approximation

Objectives: To practice calculating Fourier coefficients,
To review Matlab's graphing capabilities,
To study some matrix (rather than array) arithmetic.

Instructions:

(1) You are given the following periodic modified **triangle wave**. It is described for one period $0 \le x \le 2\pi$ and repeats both before and afterwards.

$$f(t) = \begin{cases} \frac{6t}{\pi} & 0 \le t \le \frac{\pi}{2} \\ -\frac{6t}{\pi} + 6 & \frac{\pi}{2} \le t \le \pi \\ 2 - \frac{2t}{\pi} & \pi \le t \le \frac{3\pi}{2} \\ \frac{2t}{\pi} - 4 & \frac{3\pi}{2} \le t \le 2\pi \end{cases}$$

(2) Use any method you wish to plot the given function through three periods from 0 to 6π.

(3) Construct two arrays: one of integers from 1 to 1000 and one a list of 1000 values (using **linspace**) from 0 to 6π.

(4) Next determine the Fourier coefficients for the given function using the following integral formulas:

$$\mathbf{a_0} = \frac{1}{2\pi}\int_0^{2\pi} f(t)\,dt,\ \mathbf{a_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\cos(nt)\,dt \text{ and } \mathbf{b_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\sin(nt)\,dt.$$

(5) Now, construct two new arrays 1000 elements long. The first should contain all the values a_n and the second should contain the values b_n. You can store a_0 separately.

(6) Use matrix multiplication to create a matrix where the first row is an array from 0 to 6π, the second row is the same length but from 0 to 12π, the third row is the same length but from 0 to 18π,..., and the final row has the same number of values but ranges from 0 to 6000π. (*Hint*: See the sample code)

(7) Use the **diag** function in Matlab to convert each array of Fourier coefficients into a matrix. Multiply the first by the sine of the matrix created in the previous step, the second by the cosine of the same matrix and then add the two together.

(8) Use the **sum** function to add the first 5 rows in the resulting matrix, add the constant term a_0 and plot the result.

(9) Then, sum the first 20 rows in the matrix, add the constant term and plot the result.

(10) Afterwards, sum all rows in the matrix, add the term a_0 and plot the result.

(11) Finally, attempt the same construction for the full matrix but sum the sine terms separately, plotting the result, and sum the cosine (and constant) terms separately and plot the result.

(12) **Note:** Sample code is provided in a separate file. It shows a similar arrangement for two distinct functions: a square wave and a sawtooth function.

DeVry University Spring 2005

Math 230: Applied Calculus II Matlab Assignment #4D

Due Friday Week #11 (5/20/05)

Title: A Fourier Series Approximation

Objectives: To practice calculating Fourier coefficients,
To review Matlab's graphing capabilities,
To study some matrix (rather than array) arithmetic.

Instructions:

(1) You are given the following periodic modified **triangle wave**. It is described for one period $0 \le x \le 2\pi$ and repeats both before and afterwards.

$$f(t) = \begin{cases} \frac{8t}{\pi} & 0 \le t \le \frac{\pi}{2} \\ -\frac{8t}{\pi} + 8 & \frac{\pi}{2} \le t \le \pi \\ 5 - \frac{5t}{\pi} & \pi \le t \le \frac{3\pi}{2} \\ \frac{5t}{\pi} - 10 & \frac{3\pi}{2} \le t \le 2\pi \end{cases}$$

(2) Use any method you wish to plot the given function through three periods from 0 to 6π.

(3) Construct two arrays: one of integers from 1 to 1000 and one a list of 1000 values (using **linspace**) from 0 to 6π.

(4) Next determine the Fourier coefficients for the given function using the following integral formulas:

$$\mathbf{a_0} = \frac{1}{2\pi}\int_0^{2\pi} f(t)\,dt,\ \mathbf{a_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\cos(nt)\,dt \text{ and } \mathbf{b_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\sin(nt)\,dt.$$

(5) Now, construct two new arrays 1000 elements long. The first should contain all the values a_n and the second should contain the values b_n. You can store a_0 separately.

(6) Use matrix multiplication to create a matrix where the first row is an array from 0 to 6π, the second row is the same length but from 0 to 12π, the third row is the same length but from 0 to 18π,..., and the final row has the same number of values but ranges from 0 to 6000π. (*Hint*: See the sample code)

(7) Use the **diag** function in Matlab to convert each array of Fourier coefficients into a matrix. Multiply the first by the sine of the matrix created in the previous step, the second by the cosine of the same matrix and then add the two together.

(8) Use the **sum** function to add the first 5 rows in the resulting matrix, add the constant term a_0 and plot the result.

(9) Then, sum the first 20 rows in the matrix, add the constant term and plot the result.

(10) Afterwards, sum all rows in the matrix, add the term a_0 and plot the result.

(11) Finally, attempt the same construction for the full matrix but sum the sine terms separately, plotting the result, and sum the cosine (and constant) terms separately and plot the result.

(12) **Note:** Sample code is provided in a separate file. It shows a similar arrangement for two distinct functions: a square wave and a sawtooth function.

DeVry University Spring 2005

Math 230: Applied Calculus II Matlab Assignment #4E

Due Friday Week #11 (5/20/05)

Title: A Fourier Series Approximation

Objectives: To practice calculating Fourier coefficients,
To review Matlab's graphing capabilities,
To study some matrix (rather than array) arithmetic.

Instructions:

(1) You are given the following periodic modified **triangle wave**. It is described for one period $0 \le x \le 2\pi$ and repeats both before and afterwards.

$$f(t) = \begin{cases} \frac{10t}{\pi} & 0 \le t \le \frac{\pi}{2} \\ -\frac{10t}{\pi} + 10 & \frac{\pi}{2} \le t \le \pi \\ 4 - \frac{4t}{\pi} & \pi \le t \le \frac{3\pi}{2} \\ \frac{4t}{\pi} - 8 & \frac{3\pi}{2} \le t \le 2\pi \end{cases}$$

(2) Use any method you wish to plot the given function through three periods from 0 to 6π.

(3) Construct two arrays: one of integers from 1 to 1000 and one a list of 1000 values (using **linspace**) from 0 to 6π.

(4) Next determine the Fourier coefficients for the given function using the following integral formulas:

$$\mathbf{a_0} = \frac{1}{2\pi}\int_0^{2\pi} f(t)\,dt,\ \mathbf{a_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\cos(nt)\,dt \text{ and } \mathbf{b_n} = \frac{1}{\pi}\int_0^{2\pi} f(t)\sin(nt)\,dt.$$

(5) Now, construct two new arrays 1000 elements long. The first should contain all the values a_n and the second should contain the values b_n. You can store a_0 separately.

(6) Use matrix multiplication to create a matrix where the first row is an array from 0 to 6π, the second row is the same length but from 0 to 12π, the third row is the same length but from 0 to 18π,..., and the final row has the same number of values but ranges from 0 to 6000π. (*Hint*: See the sample code)

(7) Use the **diag** function in Matlab to convert each array of Fourier coefficients into a matrix. Multiply the first by the sine of the matrix created in the previous step, the second by the cosine of the same matrix and then add the two together.

(8) Use the **sum** function to add the first 5 rows in the resulting matrix, add the constant term a_0 and plot the result.

(9) Then, sum the first 20 rows in the matrix, add the constant term and plot the result.

(10) Afterwards, sum all rows in the matrix, add the term a_0 and plot the result.

(11) Finally, attempt the same construction for the full matrix but sum the sine terms separately, plotting the result, and sum the cosine (and constant) terms separately and plot the result.

(12) **Note:** Sample code is provided in a separate file. It shows a similar arrangement for two distinct functions: a square wave and a sawtooth function.