ME 635: Modeling and Simulation

Homework 4

Data Modeling and Numerical Methods

10/3/2022

I pledge my honor that I have abided by the Stevens Honor System

Submitted by,

Viral Panchal

1. **(20 Pts):** For the data given in ***HW4\_Problem1.txt*** ( two comma separated values), find :
   1. Coefficients for the best-fit quadratic model and the RMS error.

***Solution:***

y = a0 + a1(x) + a2(x2)

Table

Description automatically generated

*Plots:*

* 1. Find the coefficients a0 and a1 if ***ymodel = a0\*x +a1\*sinh(x)*** and the RMS error

***Solution:***

*ymodel = a0\*x +a1\*sinh(x)*

Table

Description automatically generated

*Plots:*

* 1. Find the coefficients b0 and b1 if ***ymodel = b0\*x2 +b1\*exp(x)***

***Solution:***

*ymodel = b0\*x2 +b1\*exp(x)*

**Graphical user interface, application, table, Excel

Description automatically generated**

*Plots:*

1. **(20 Pts):** For the data given in **HW4\_problem2.txt** (two comma separated values: X,Y), find:
   1. Best-fit cubic model for the entire regime (0 ≤ X ≤ 1)

***Solution:***

**Table

Description automatically generated**

*Plots:*

* 1. Two piece-wise cubic models, first fit, f1(x), is valid from 0 ≤ X ≤ 0.5 and the second fit, f2(x) is valid from: 0.5 < X ≤ 1. (Note: the point X=0.5 belongs to the first fit).
  2. For the fits determined in 3(b), Plot the two functions f1(X) and f2(X) and comment on the continuity (C0 and C1: data and slope continuity) of the two models at X = 0.5. If f2(X) is extrapolated to X = 0.5.

***Solution:***

First function from 0 – 0.5

Table

Description automatically generated

Second function from 0.5 – 1 (not including 0.5)

Table, Excel

Description automatically generated

**Plotting both the functions:**

When x = 0.5;

Chart

Description automatically generated with medium confidence

From the above plot and numerical computation, we can see that the functions do not coincide at x = 0.5. Also, they don’t have the same slope at x = 0.5. Hence, they cannot be termed as continuous.

1. **(30 Pts): For the data given in HW4\_Problem3.txt (two comma separated values: X, Y), model with two piece-wise polynomial models, a cubic function (f1(X)) to fit from 0 ≤ X ≤ 0.5 and a quartic (4th order - f2(X)) to fit from 0.5 ≤ X ≤ 1, such that f2(X) maintains both C0 and C1 continuity at X = 0.5.**

***Solution:***

Function 1: Cubic function coefficients

Graphical user interface, application, table, Excel

Description automatically generated

Plots:

Second Function: Quartic function coefficients

Graphical user interface, application, table, Excel

Description automatically generated

Table

Description automatically generated

In this, the values for df1(x) and df2(x) at x = 0.5 is almost similar and hence the slope is said to be same for both the functions. Also, the values for both the function at x=0.5 are almost same numerically and hence, the two functions can be said to be continuous which can be even verified by looking at the plot provided above.

1. **(30 Pts):** Determine polynomial interpolation, T(x) = Σ Ti Ni(x); where x = {0,..,1} and i=1...5; such that T(x=0) = T1, T(x=1) = T2, T(x=0.5) = T3, T(X=0.25)= T4 and T(x=0.75) = T5. Plot the five interpolation functions, Ni(x).

Given T1 = 100, T2 = 100, T3=160, T4=120, T5=130; Plot the temperature field, T(x) and the five interpolation functions (Ni(x), i=1…….5) Interpolation functions.

Text, letter

Description automatically generated

A piece of paper with writing

Description automatically generated with medium confidence

***Matlab Program:***

% ME635 HW04 - Q4

% Viral Panchal

close all

clear all

clc

i = 1;

N = zeros();

for x = 0:0.01:1

N\_1 = ((x-1)\*(x-0.5)\*(x-0.25)\*(x-0.75))/0.09375;

N(i,1) = N\_1;

N\_2 = ((x-0.5)\*(x-0.25)\*(x-0.75)\*(x))/0.09375;

N(i,2) = N\_2;

N\_3 = ((x - 1)\*(x-0.25)\*(x-0.75)\*(x))/0.015625;

N(i,3) = N\_3;

N\_4 = -((x - 1)\*(x - 0.5)\*(x-0.75)\*(x))/0.02344;

N(i,4) = N\_4;

N\_5 = -((x - 1)\*(x-0.5)\*(x-0.25)\*(x))/0.02344;

N(i,5) = N\_5;

N(i,6) = x;

i = i+1;

end

plot(N(:,6),N(:,1))

hold on

plot(N(:,6),N(:,2))

hold on

plot(N(:,6),N(:,3))

hold on

plot(N(:,6),N(:,4))

hold on

plot(N(:,6),N(:,5))

legend('N\_1(x)','N\_2(x)','N\_3(x)','N\_4(x)','N\_5(x)')

grid on

ylim([-0.7 1.4])

T1 = 100;

T2 = 100;

T3 = 150;

T4 = 120;

T5 = 130;

j = 1;

T = zeros();

% p = size(N,6)

for j = 1:1:size(N,1)

T(j,1) = T1\*N(j,1) + T2\*N(j,2) + T3\*N(j,3) + T4\*N(j,4) + T5\*N(j,5);

j = j+1;

end

figure

plot(N(:,6),T(:,1))

legend('T(x) = Sum(T(x)\*N\_i(x))')

grid on

***Output plots:***



