Interpolation

Reading Between the Lines

1

What is Interpolation ?

Given $(x_0, y_0), (x_1, y_1), \ldots\ldots (x_n, yn)$, find the value of y at a value of x that is not given.

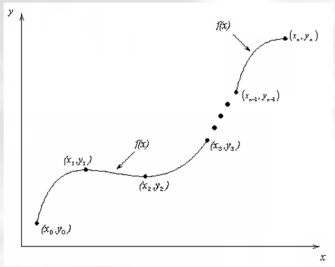


Figure Interpolation of discrete data.

2

2

APPLIED PROBLEMS

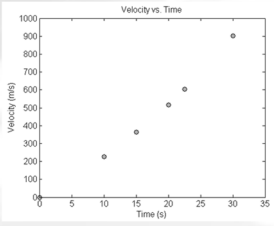
3

Fly Rocket Fly, Fly Rocket Fly

The upward velocity of a rocket is given as a function of time in table below. Find the velocity and acceleration at $t = 16$ seconds.

Table Velocity as a function of time.

t, (s)	$v(t)$, (m/s)
0	0
10	227.04
15	362.78
20	517.35
22.5	602.97
30	901.67



Velocity vs. time data for the rocket example

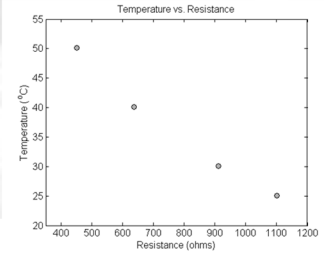
4

THERMISTOR CALIBRATION

Thermistors are based on change in resistance of a material with temperature. A manufacturer of thermistors makes the following observations on a thermistor. Determine the calibration curve for thermistor.

$$\frac{1}{T} = a_0 + a_1[\ln R] + a_2[\ln R]^2 + a_3[\ln R]^3$$

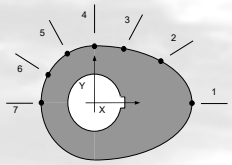
R (Ω)	T(°C)
1101.0	25.113
911.3	30.131
636.0	40.120
451.1	50.128



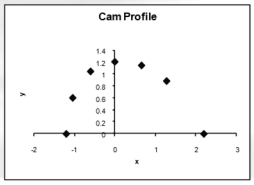
5

FOLLOWING THE CAM

A curve needs to be fit through the given points to fabricate the cam.



Point	x (in.)	y (in.)
1	2.20	0.00
2	1.28	0.88
3	0.66	1.14
4	0.00	1.20
5	–0.60	1.04
6	–1.04	0.60
7	–1.20	0.00

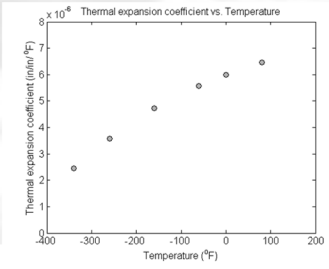


6

THERMAL EXPANSION COEFFICIENT PROFILE

A trunnion is cooled 80°F to – 108°F. Given below is the table of the coefficient of thermal expansion vs. temperature. Determine the coefficient of thermal expansion profile as a function of temperature.

Temperature (°F)	Thermal Expansion Coefficient (in/in/°F)
80	6.47×10^{-6}
0	6.00×10^{-6}
−60	5.58×10^{-6}
−160	4.72×10^{-6}
−260	3.58×10^{-6}
−340	2.45×10^{-6}



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INTRODUCTION

8

Artist named "Ye" now was born

- Snoop Dog
- Kanye Omari West
- Mr. Kimberly Noel Kardashian West
- TAFKAP

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9

A polynomial of degree n has this many zeros

- $n-2$
- $n-2$
- n
- $n+1$

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If a polynomial of degree n has more than n zeros, then the polynomial is

- oscillatory
- zero everywhere
- quadratic
- not defined

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Choose the data points

The following velocity vs time data is given. To find the velocity at $t = 14.9s$, the three time data points you would choose for second order polynomial interpolation are

Time (s)	0	15	18	22	24
Velocity (m/s)	22	24	37	25	123

- 0, 15, 18
- 15, 18, 22
- 0, 15, 22
- 0, 18, 24

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12

For interpolating many data points, higher order polynomial interpolation is generally a _____ idea.

Good

Bad

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Why is higher order interpolation a bad idea?

possible oscillatory behavior

all derivatives of the polynomial do not exist

difficult to write a program

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SPLINE INTERPOLATION

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Given n data points of y vs x for conducting quadratic spline interpolation, the x-data needs to be

equally spaced

in ascending or descending order

integers

positive

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Slope of the spline function

The following y vs. x data is given

x	1	2.25	3.7	5.1
y	4.25	6	17	15.1

The data is interpolated using linear spline interpolant. The slope of the spline function at $x = 3.7$ is _____.

- Continuous
- Discontinuous

17

A quadratic spline is made of 4 quadratics. How many unknowns do we have to find.

- 4
- 8
- 12
- 16

18

In quadratic spline interpolation (check all that apply)

- the first derivatives of the quadratics are continuous at the interior data points
- the second derivatives of the quadratics are continuous at the interior data points
- the connecting quadratics have same co-ordinate value at each of the common interior data points
- the connecting quadratics have same value of the first derivative at each of the common interior data points

19

For interpolating many data points, higher order polynomial interpolation is generally a _____ idea.

- Good
- Bad

20

A cubic spline has 5 cubics. How many unknowns do we have to find?

5

15

18

20

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LENGTH OF CURVE

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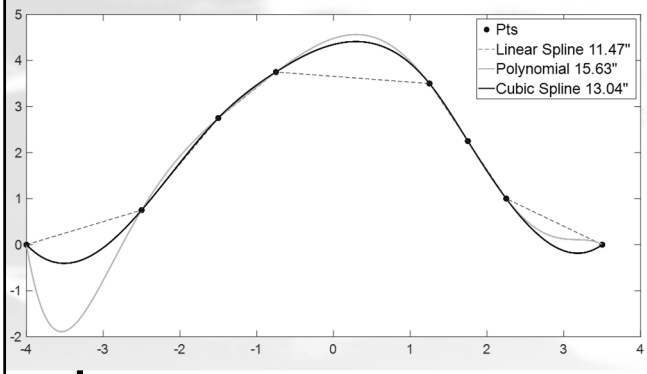
Length of interpolants



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Length of the path

A robot path on an x-y plane is found by interpolating 3 data points given below.

x	4	6	7
y	42	22	15

The interpolant is

$$y(x) = x^2 - 20x + 106, \qquad 4 \le x \le 7$$

The most accurate expression for the length of the path from $x = 4$ to $x = 7$ is

$\sqrt{(6-4)^2 + (22-42)^2} + \sqrt{(7-6)^2 + (15-22)^2}$

$\int_4^7 \sqrt{1 + (x^2 - 20x + 106)^2}\,dx$

$\int_4^7 \sqrt{1 + (2x - 20)^2}\,dx$

$\int_4^7 (x^2 - 20x + 106)\,dx$

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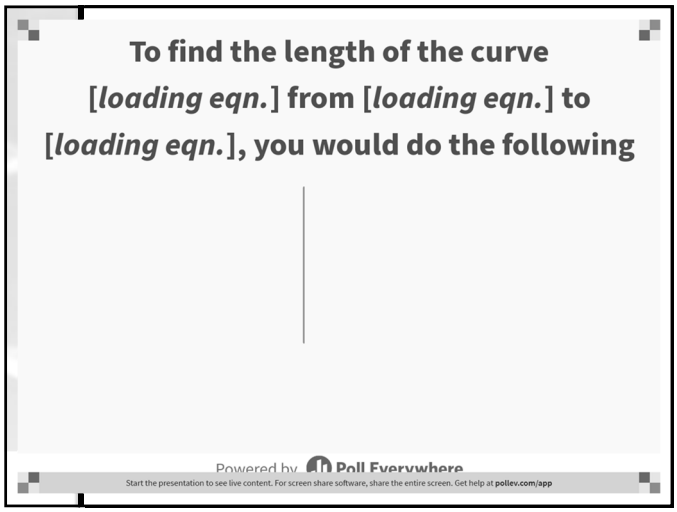
To find the length of the curve
[*loading eqn.*] from [*loading eqn.*] to
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