# 7. Curve Fitting

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## 7.1 Exercises

**Exercise 7.1** Given the data below.

| $x$ | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $f(x)$ | 2 | 5 | 7 | 8 |

Estimate $f(2.5)$ using third–order Lagrange interpolating polynomial. ■

**Exercise 7.2** The following data is provided for the velocity, $v$ of an object as a function of time, $t$.

| $t$(s) | 20 | 24 | 28 | 32 | 36 |
|---|---|---|---|---|---|
| $v$(m/s) | 112.0 | 121.9 | 129.7 | 135.7 | 140.4 |

**i.** Construct Newton interpolating polynomial for the given data.

**ii.** Estimate $v(30)$ by using your answer in i.

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**Exercise 7.3** Given the data

| $x$ | 1 | 2 | 2.5 | 3 | 4 |
|---|---|---|---|---|---|
| $f(x)$ | 1 | 5 | 7 | 8 | 2 |

**i.** Fit this data with quadratic splines.

**ii.** Use the result in i. to estimate the value of $f$ at $x = 2.8$ and $x = 3.5$.

**Exercise 7.4** Dynamic viscosity of water, $\mu$ is related to temperature $T$ in the following manner.

| $T$ | 1 | 2 | 2.5 | 3 | 4 |
|---|---|---|---|---|---|
| $\mu$ | 1 | 5 | 7 | 8 | 2 |

Predict $\mu$ at $T = 2.34°C$ using Lagrange interpolation that fit all the given data.

**Exercise 7.5** The atmospheric pressure, $p$ as a function of height, $h$ can be modeled by an exponential function of the form $p(h) = b\exp(-nh)$, where $b$ and $n$ are constants. The values of pressure measured at different height are presented in the following table.

| $h$(m) | 0 | 5000 | 10000 | 15000 | 20000 |
|---|---|---|---|---|---|
| $p$(Pa) | 100000 | 47500 | 22600 | 10800 | 5100 |

**i.** Use a linear spline to estimate the atmospheric pressure at a height of 14000 m and 700 m.

**ii.** Use quadratic spline to estimate the atmospheric pressure at a height of 3500 m and 7000 m.

**Exercise 7.6** Develop quadratic splines for $52 \leq x \leq 82$. Then $f(61)$.

| $x$ | 22 | 42 | 52 | 82 | 100 |
|---|---|---|---|---|---|
| $f(x)$ | 4181 | 4179 | 4186 | 4199 | 4217 |

**Exercise 7.7** Given the data from astronomical observations of a type variable star called a *Cepheid variable* and represent variations in its apparent magnitude with time:

| Time, $t$ | 0.0 | 0.2 | 0.5 | 0.8 |
|---|---|---|---|---|
| Apparent magnitude, $f(t)$ | 0.302 | 0.185 | 0.106 | 0.093 |

Estimate $f(0.45)$ by using

**i.** Newton interpolating polynomial

**ii.** Lagrange interpolation method

**iii.** Linear spline interpolation

**iv.** Quadratic spline interpolation

**Exercise 7.8** The following table gives the times of sunset in hours and minutes at 40° latitude for 4 days in the year 2017.

| Date | May 1 | May 29 | June 26 | July 24 |
|---|---|---|---|---|
| Time of Sunset | 18 hr 53 m | 19 hr 19 m | 19 hr 32 m | 19 hr 21 m |

Estimate the time of sunset on 27 May by using

**i.** Newton interpolating polynomial

**ii.** Lagrange interpolation method

**iii.** Linear spline interpolation

**iv.** Quadratic spline interpolation

**Exercise 7.9** The saturation concentration of dissolved oxygen in water as a function of temperature and chloride concentration is listed in the following table.

| $T, ^\circ C$ | Dissolved Oxygen (mg/L) Concentration of Chloride (g/L) | | |
|---|---|---|---|
| | $C = 0\text{g/L}$ | $C = 10\text{g/L}$ | $C = 20\text{g/L}$ |
| 0 | 12.50 | 11.25 | 10.70 |
| 5 | 11.89 | 10.87 | 9.83 |
| 10 | 10.65 | 10.10 | 9.05 |
| 15 | 9.89 | 9.65 | 8.77 |
| 20 | 9.25 | 8.80 | 8.02 |
| 25 | 8.70 | 8.05 | 7.67 |
| 30 | 8.35 | 7.27 | 6.89 |

Estimate the dissolved oxygen level for $T = 8.5^\circ C$ with chloride $10\text{g/L}$ by using

**i.** Third order Newton interpolating polynomial

**ii.** Third order Lagrange interpolation method

**iii.** Linear spline interpolation (by using the chosen data in i. & ii.)

**iv.** Quadratic spline interpolation (by using the chosen data in i. & ii.)

**Exercise 7.10** The data below is the experimental result for the thermal resistance of a transistor tabulated for air velocity from 0 to 900 FPM.

| Air Velocity | Thermal Resistance |
|---|---|
| 0 | 373.0 |
| 150 | 156.1 |
| 300 | 113.6 |
| 450 | 93.1 |
| 600 | 81.5 |
| 750 | 73.7 |
| 900 | 67.2 |

Interpolate the data given to estimate the thermal resistance for 485 FPM by using

**i.** Third order Newton interpolating polynomial

**ii.** Third order Lagrange interpolation method

**iii.** Linear spline interpolation (by using the chosen data in i. & ii.)

**iv.** Quadratic spline interpolation (by using the chosen data in i. & ii.)

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**Exercise 7.11** The data in the table below recorded the price of gasoline (USD) in England for selected six months from year 2000 until 2004.

| Year | Selected Month | | | | | |
|---|---|---|---|---|---|---|
| | Jan | Mar | May | July | Sep | Nov |
| 2000 | 1.301 | 1.541 | 1.498 | 1.593 | 1.582 | 1.555 |
| 2001 | 1.472 | 1.447 | 1.729 | 1.482 | 1.531 | 1.263 |
| 2002 | 1.139 | 1.241 | 1.421 | 1.412 | 1.422 | 1.448 |
| 2003 | 1.473 | 1.748 | 1.542 | 1.524 | 1.728 | 1.535 |
| 2004 | 1.592 | 1.766 | 2.009 | 1.939 | 1.891 | 1.801 |

Estimate the price of gasoline in April 2004 by using

**i.** Third order Newton interpolating polynomial

**ii.** Third order Lagrange interpolation method

**iii.** Linear spline interpolation (by using the chosen data in i. & ii.)

**iv.** Quadratic spline interpolation (by using the chosen data in i. & ii.)

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**Exercise 7.12** You were performed an experiment and the following values of heat capacity, $c$ at various temperature $T$ for a gas were determined.

| $T$ | -50 | -30 | 0 | 60 |
|---|---|---|---|---|
| $c$ | 1270 | 1280 | 1350 | 1480 |

Estimate the temperature of the gas when its heat capacity reach 1000 by using

**i.** Inverse Newton interpolation method

**ii.** Inverse Lagrange interpolation method

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**Exercise 7.13** The following data define the sea–level concentration of dissolved oxygen of fresh water as a function of temperature.

| $T\,(^\circ\mathrm{C})$ | 8 | 16 | 24 | 32 |
|---|---|---|---|---|
| $o(\mathrm{mgL}^{-1})$ | 10.893 | 9724 | 8.989 | 8.210 |

What is the respective temperature if the sea-level concentration of dissolved oxygen is 8.5 $\mathrm{mgL}^{-1}$? Perform your estimation by using

**i.** Inverse Newton interpolation method

**ii.** Inverse Lagrange interpolation method

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**Exercise 7.14** In a chemical reaction, the concentration level of a product at time, $t$ was measured every half an hour. The results of this experiment are tabulated in the table below.

| Time, $t$ | 0 | 0.5 | 1.5 | 2 |
|---|---|---|---|---|
| Concentration Level | 0 | 0.23 | 0.50 | 0.67 |

What is the time taken when the concentration level of the product reach 0.60? Perform your estimation by using

**i.** Inverse Newton interpolation method

**ii.** Inverse Lagrange interpolation method

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**Exercise 7.15** The shear stresses, in kilopascal (kPa), of five specimens taken at various depths in a day stratum are listed below.

| Depth (m) | 1.9 | 3.1 | 4.0 | 5.2 |
|---|---|---|---|---|
| Shear stress (kPa) | 10.5 | 15.8 | 19.6 | 24.7 |

Estimate the depth in meter if the shear stress is 17 kilopascals by using

**i.** Inverse Newton interpolation method

**ii.** Inverse Lagrange interpolation method

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**Exercise 7.16** The measured data for velocity of a parachute against time is as in the following table.

| Time (s) | 1 | 3 | 7 | 11 |
|---|---|---|---|---|
| Measured velocity (cm/s) | 800 | 2310 | 3090 | 3940 |

Estimate the time taken if the velocity of the parachutist recorded is 3000 cm/s by using

**i.** Inverse Newton interpolation method

**ii.** Inverse Lagrange interpolation method

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