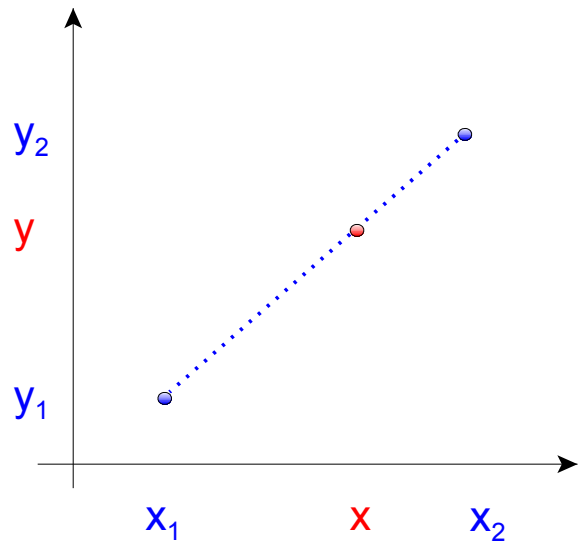# Interpolation

"Reading Between the Lines"

▶ Outline
- Defninition of Linear Interpolation
- Linear interpolation in MATLAB
- Concept of Cubic Spline interpolation
- Cubic spline interpolation in MATLAB

What is Interpolation?

One Approach to Linear Interpolation

Given: $(x1, y1)$ $(x2, y2)$, x
Find: y

$$y = mx + b$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}, \quad b = y_1 - mx_1 = y_2 - mx_2$$

$$\Downarrow$$

$$y = \frac{y_2 - y_1}{x_2 - x_1} x + \left(y_1 - \frac{y_2 - y_1}{x_2 - x_1} x_1 \right)$$

$$\Downarrow$$

$$y = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1) + y_1$$

Linear Interpolation in MATLAB

Using the "interp1" Function

- ▸ y = interp1(x_i, y_i, x)
  - Interpolates the data (x_i, y_i) to estimate the value of y at x
  - x_i ⇒ vector of independent values
  - y_i ⇒ corresponding vector of dependent values
  - x ⇒ data point where we want the dependent variable (y)

Beyond Linear Interpolation

Polynomial Interpolation

- ▸ Fit a polynomial to the data.
  - • If we have n data points, what order polynomial should we use?

- ▸ Use the polyfit function to get coefficients

- ▸ Using the "polyval" function:
  - • P(x) = polyval(coeff, x)
    - – coeff ⇒ vector of polynomial coefficients
    - – x ⇒ scalar, vector, or matrix that contains points at which the polynomial is to be evaluated.

- ▸ Example: Polynomial interpolation

Beyond Linear Interpolation

Using Cubic Splines

- ▶ How to deal with accuracy issue?
  - Higher order polynomials get too "wiggly"

- ▶ Use piece-wise polynomial interpolation
  - Cubic splines

- ▶ y = spline(x_i, y_i, x)
  - x_i, y_i, x, y are defined as before