ENGG1003 - Monday Week 6

Interpolation, Assignment 1 and Mid-term quiz

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Lecture overview

1. Interpolation
2. Assignment 1
3. Mid-term quiz

The story so far

- variables and data types
- arrays (using `numpy`)
- plotting (using `matplotlib`)
- flow control
  - `if`
  - `while`
  - `for`
- functions

Most of ENGG1003 from here uses these elements of Python to solve Engineering problems

1) Interpolation

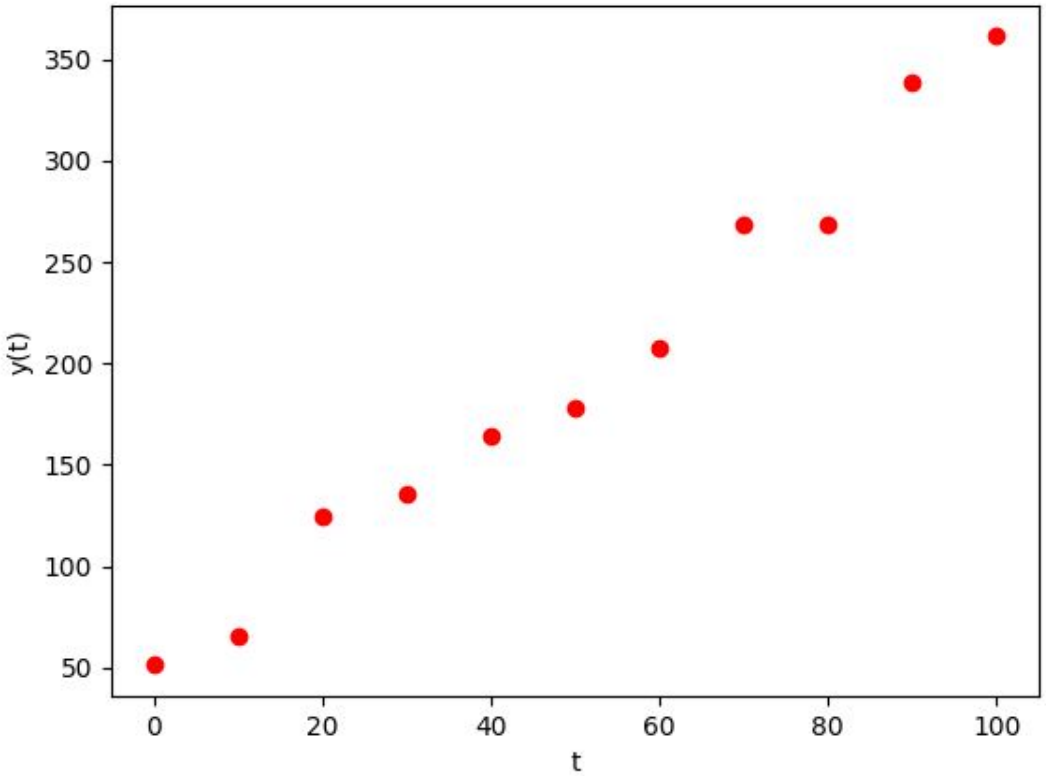
Two common forms of *curve-fitting* in Engineering applications:

1. *interpolation*
   - today's lecture
2. *regression*
   - considered in detail later in ENGG1003

- we now demonstrate both curve-fitting methods applied to the same dataset

Curve-fitting dataset

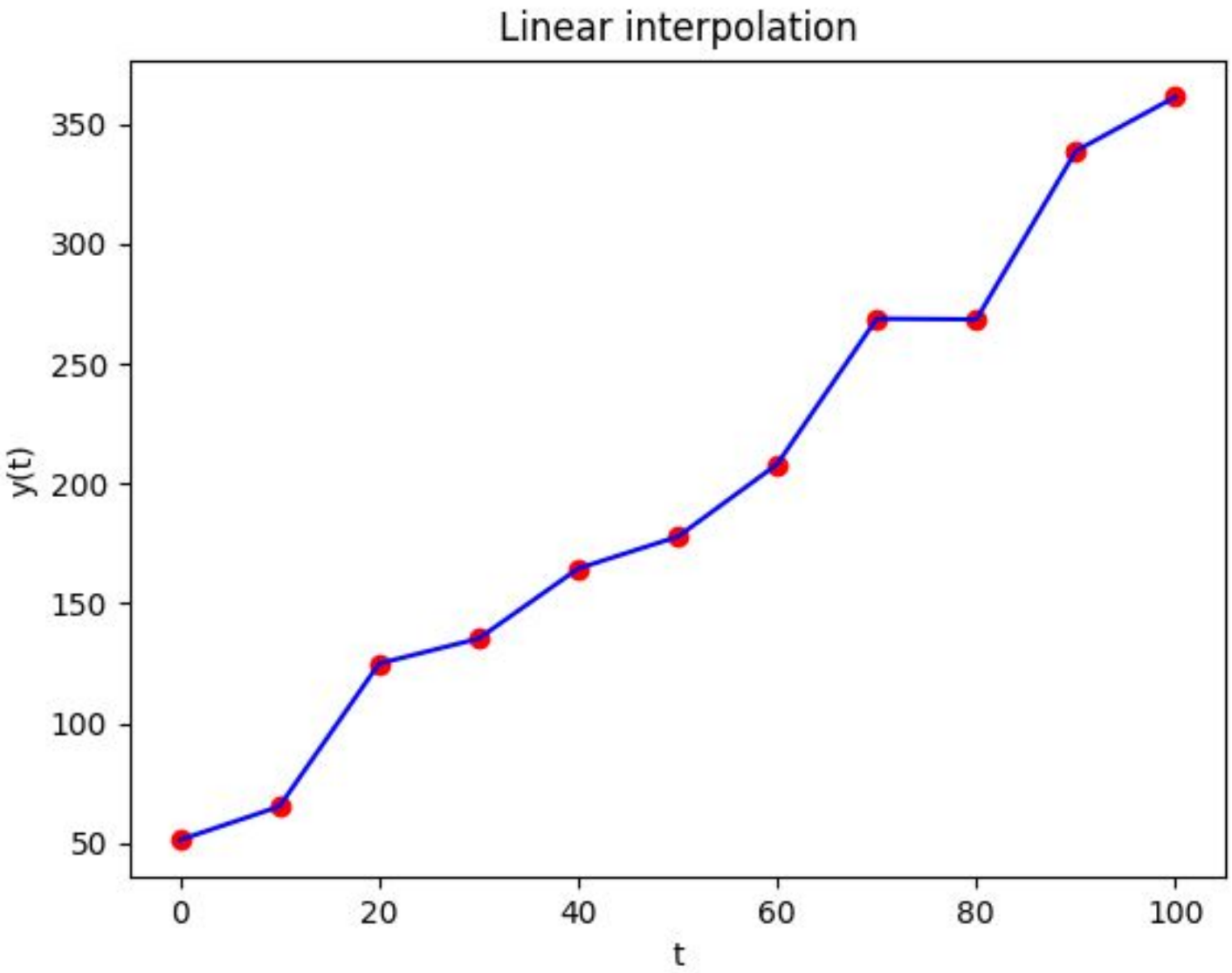
`Week6Mon.py`



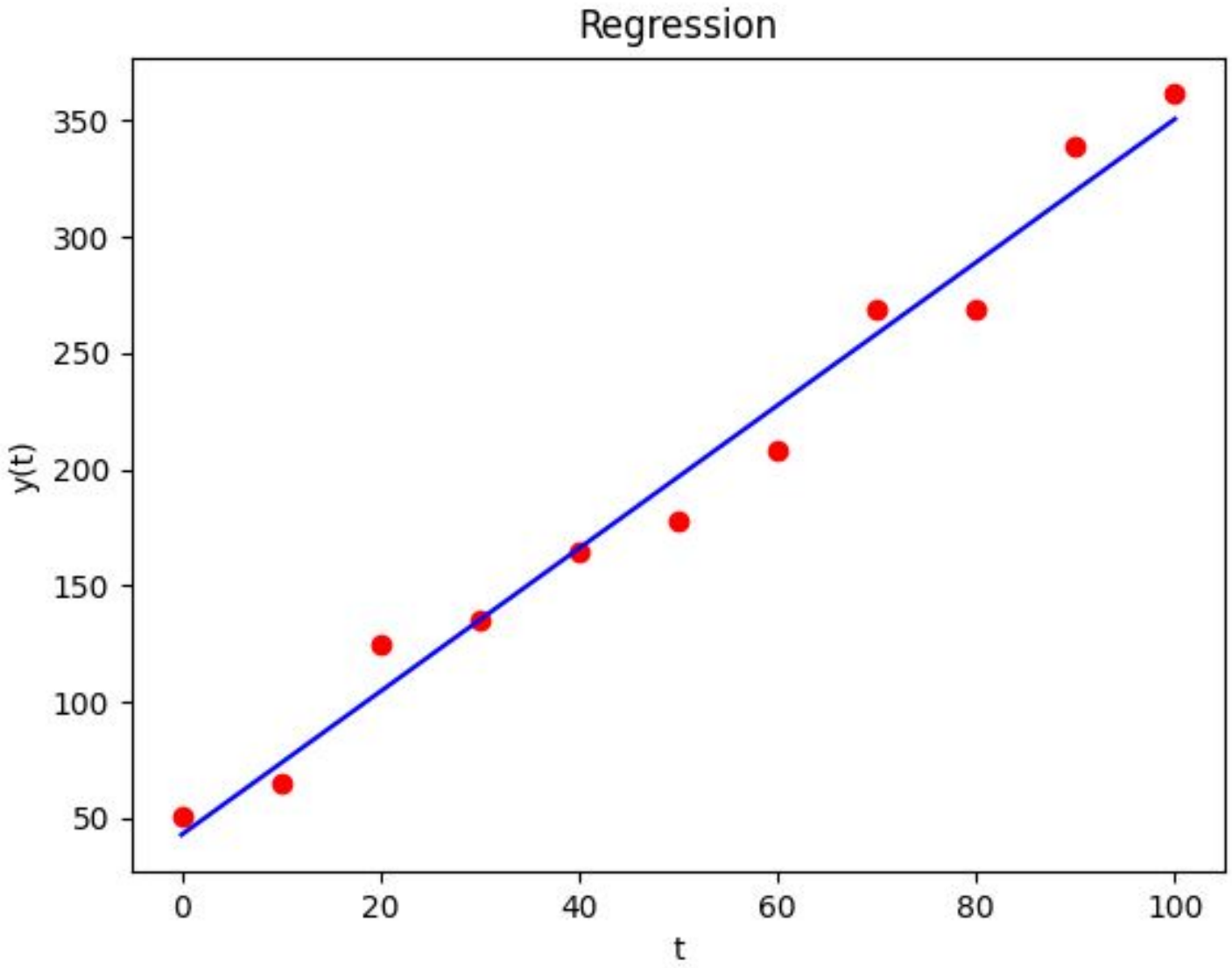
- 11 pairs of data points $(t_i, y_i), i = 0, 1, 2, \ldots, 10$

  $(0, 51.29), (10, 65.24), (20, 124.89), \ldots, (100, 361.32)$

Interpolation



Regression



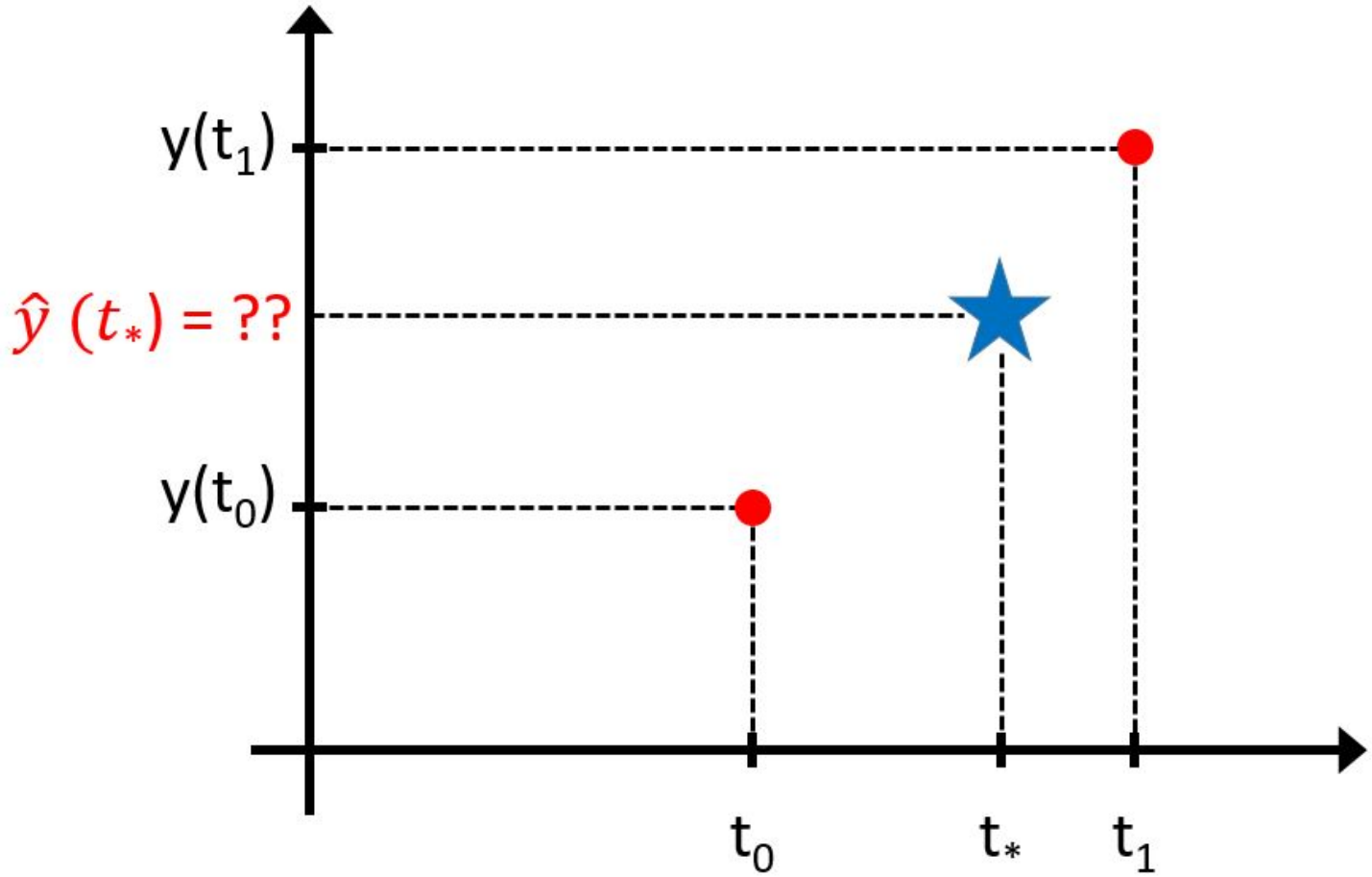
Interpolation vs. regression

- **interpolation:** joining the dots
  - obtain value of y at some intermediate point
- **regression:** fitting a straight line
  - when there's "too much data", simplify
  - here, simplifying to a straight line
  - we return to choosing "best" straight line later in ENGG1003
  - no more regression in this lecture
- both interpolation & regression involve creating a function (blue line) from data (red dots)

Functions

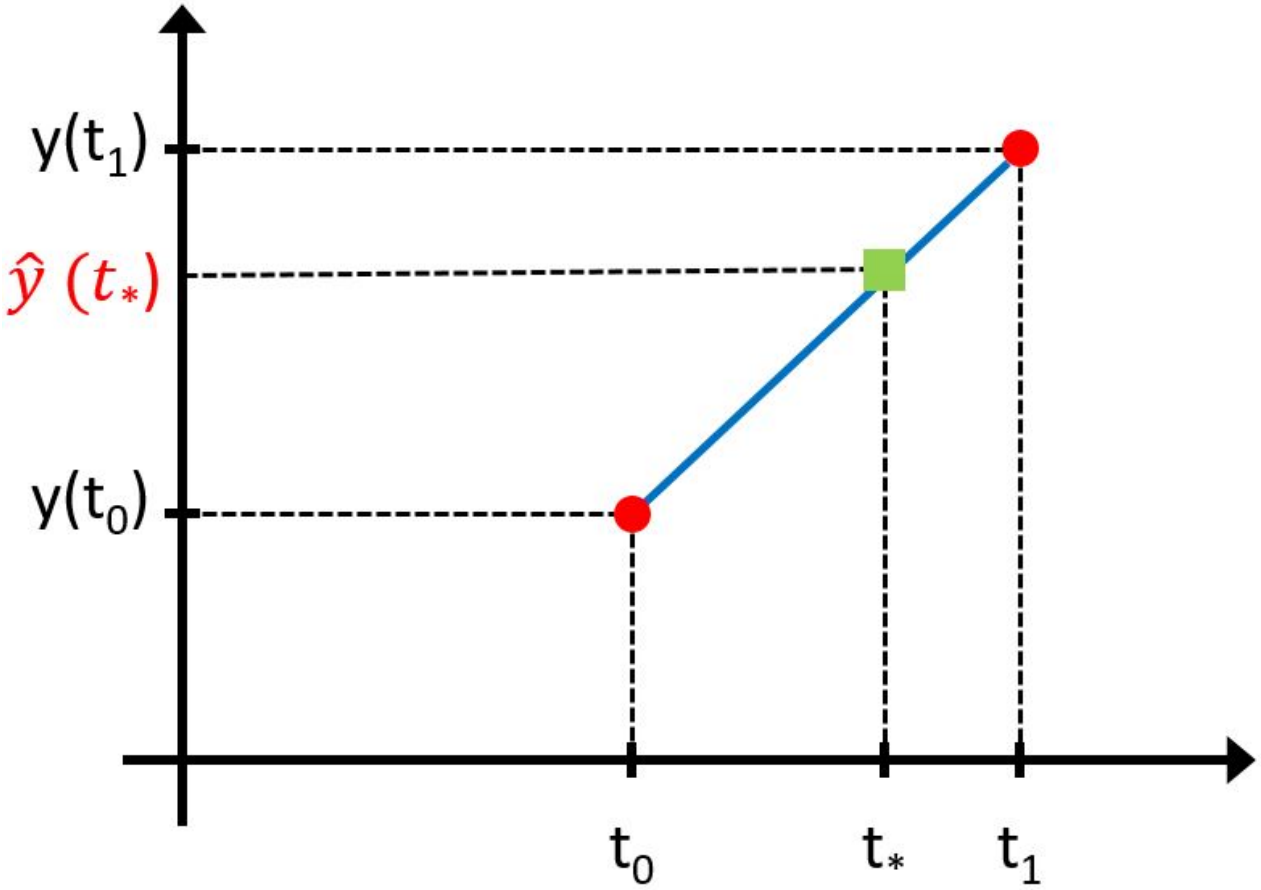
- review mathematical functions: week 5 Monday lecture, page 3
- function f takes data point t and returns $y = f(t)$

The interpolation problem



Given: data points $(t_0, y(t_0))$ & $(t_1, y(t_1))$ and $t_\star$
Calculate: interpolated value $\hat{y}(t_\star)$

Linear interpolation



- interpolated value $\hat{y}(t_\star)$ lies on straight line connecting $(t_0, y(t_0))$ & $(t_1, y(t_1))$

Linear interpolation using `interp1d`

- `interp1d` function from `scipy.interpolate`
- `pip install scipy` at console first
- call to `interp1d` returns a function
- use the function in console
- live demo

Linear interpolation in Python

Week6MonLinear.py

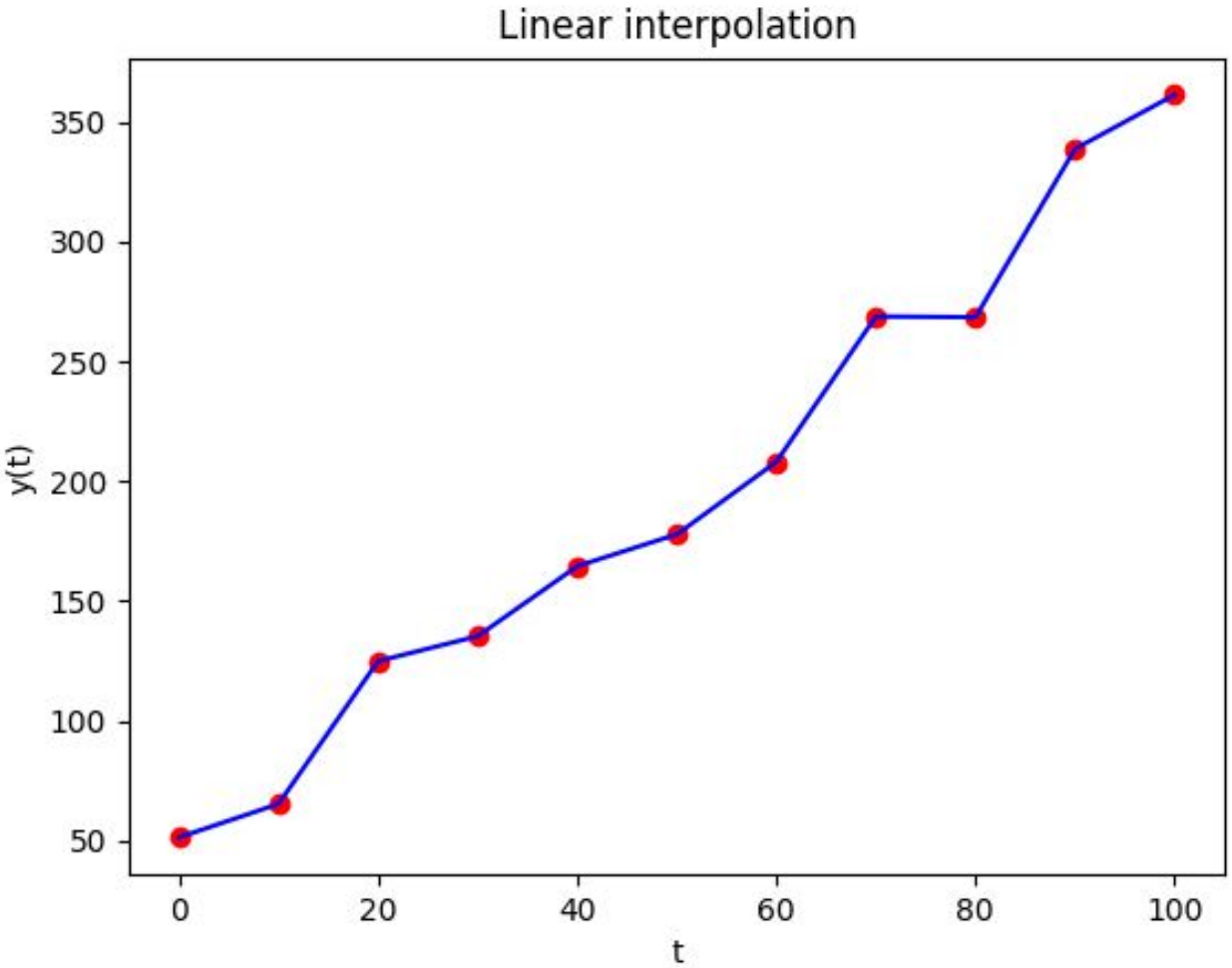
```
1  import numpy as np
2  import matplotlib.pyplot as plt
3  from scipy.interpolate import interp1d
4
5  # seed random number generator to reproduce lecture results
6  np.random.seed(27101967)
7
8  N = 11
9  t = np.linspace(0,100,11)              # 0,10,20,...,100
10 tnew = np.linspace(0,100,100*N)        # 0,0.1,0.2,...,100
11 n = np.random.uniform(-25,25,N)        # noise on linear function
12
13 m = 3                                  # gradient
14 b = 50                                 # intercept
15 y = m*t + b + n                    # dataset is straight line + noise
```

Linear interpolation in Python (ctd.)

```
# INTERPOLATION
f = interp1d(t, y)

# PLOT RESULTS
plt.plot(t, y, 'ro')
plt.xlabel('t')
plt.ylabel('y(t)')
plt.plot(tnew, f(tnew), 'b')
plt.title('Linear interpolation')
plt.show()
```

Linear interpolation



- "stitches together" straight line segments

Beyond linear interpolation

Problem: slopes of adjacent straight lines change abruptly at data points

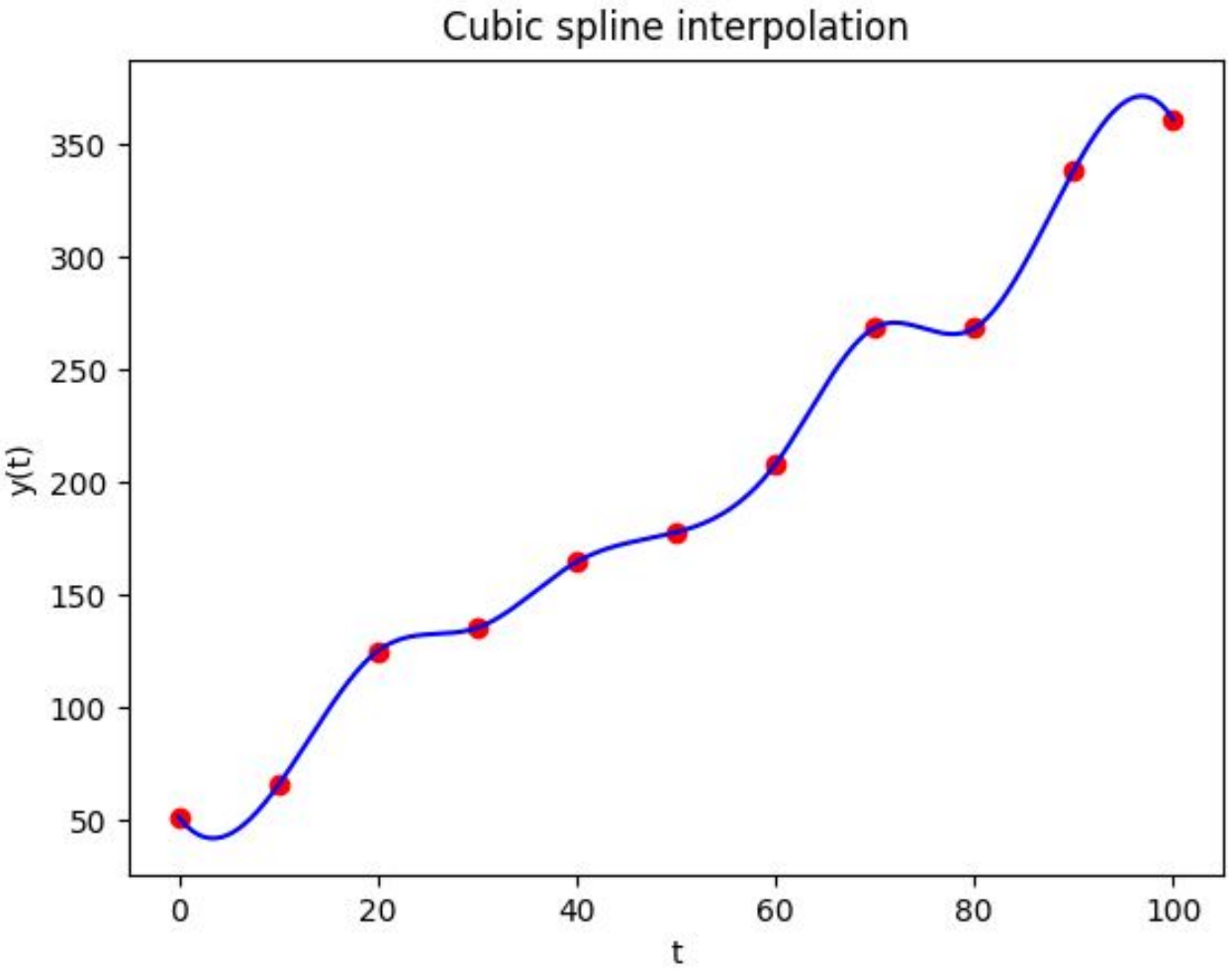
Cubic splines

- degree 1 is linear, degree 2 is parabola, degree 3 is cubic
- we're hiding lots of maths here, but we can use Python to implement without needing that maths
- maths is interesting!

Cubic spline in Python code

- half page code
- `Week6MonCubic.py`
- live demo

Cubic spline interpolation



- "stitches together" *cubic* polynomials

2) Assignment 1

- key dates: out, due date for submission
- counts for 20% of course grade
- how assessed: in lab, week 7 (after recess)
- the basic ideas behind the lab
- this weeks 2-hr face-face lab:
  - get started on the assignment
  - there isn't a week 6 lab sheet: assignment in place of work sheet

3) Mid-term quiz

- Thursday 1 April, 4–5pm
  - during scheduled lecture time
  - but there will not be any Zoom or YouTube livestream on 1 April
- 40-minute quiz
- open-book
- quiz will appear on BB at 4:10 pm
- counts for 15% of course grade
- what you'll be asked

- what you can do to prepare for the quiz
  - read THIS csv— can get started now!
  - you'll be asked to write Python code to do some calculations on a specified column
  - enter your results into BB
  - cut-and-paste code into BB
- can practice NOW in BB
- demo to class in lecture

Lecture summary

- Interpolation
  - linear interpolation
    - straight line "join the dots"
  - cubic spline interpolation
    - smoothly connects data points
- Assignment 1
  - xxx
- Mid-term quiz
  - xxx