

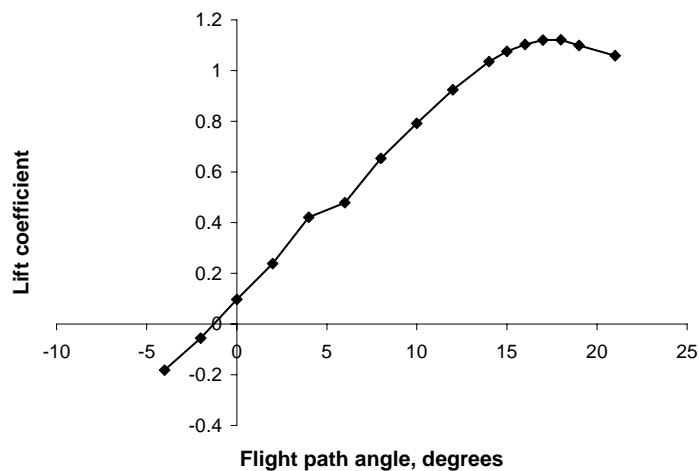
Monday 01 December

Programming Assignment 10: due Wednesday 3 December

Final Exam: **Wed 10 Dec 10:00 AM 621 BEH**

### Class Activity 27:

Wind tunnels are used in the aviation industry to determine the functional characteristics of



accurately scaled models of aircraft before building full scale versions. One important functional characteristic is the *lift coefficient* as a function of the angle of climb (flight path angle). A typical data set from a wind tunnel is shown here.

Mathematical models that describe the aircraft behavior under various circumstances are developed from data such as this. This is the basis of flight simulators that are used to train pilots before they ever actually fly the plane.

Such models need to determine the lift coefficient as a function of flight path angle for angle values that lie between the data points. One method of doing this is *linear interpolation*. Given the x-coordinate that lies between two known data points  $(x_1, y_1)$  and  $(x_2, y_2)$ , the estimated y-coordinate is given by

$$y = y_1 + (x - x_1)(y_2 - y_1) / (x_2 - x_1)$$

which is obtained from straight-forward manipulation of the equation of a line.

Class Activity 26 asked you to design a program using an array of  $(x, y)$  data points. For example,

```
double xydata[MAXPTS][2];
```

would declare an array of data points. The first index corresponds to the data point number. The second index corresponds to whether it is the x-data point value or the y-data point value. For example,

```
xydata[0][0] first data point, x value  
xydata[3][1] fourth data point, y value  
xydata[5][1] sixth data point, y value  
xydata[9][0] tenth data point, x value
```

An alternative way to think about an (x,y) data set is to use two one-dimensional arrays for the data. For example,

```
double xpts[MAXPTS];  
double ypts[MAXPTS];
```

would declare two one dimensional arrays of data points. The name refers to the particular type of value and the index to the data point number. For example,

```
xpts[0]    first data point, x value  
ypts[3]    fourth data point, y value  
ypts[5]    sixth data point, y value  
xpts[9]    tenth data point, x value
```

## Class Activities

**Restructure your solution to Class Activity 26 to use one-dimensional arrays to handle the (x,y) data set rather than a two-dimensional array.**

- 1) Design a subprogram that uses linear interpolation to find the y-coordinate corresponding to a specified x-coordinate given the *value* of the x-coordinate and the (x,y) data set for interpolation.

Things to consider: what information does the function need to work? what information results from the function working correctly? what type of function is this? how does this information impact the function parameter list? what is an appropriate name for this function? what happens if the x-coordinate lies outside the data range?

- 2) The data for the above graph is in the file `liftdata.dat` on `get12`. You can retrieve the file and look at it. The data is in (angle, lift) pairs, one pair per line, in ascending angle order. Design a subprogram that will ask the user for the file name to read, open the file, and read an *unknown* number of (x,y) pairs from the file. The subprogram should return the contents of the data file as a single matrix of (x,y) data point pairs and the number of data points in the file.

Things to consider: what information does the function need to work? what information results from the function working correctly? what type of function is this? how does this information impact the function parameter list? what is an appropriate name for this function?

- 3) Design a program that will read the data file `liftdata.dat`, ask the user for an angle, determine whether the angle is within the range of the data, and if so, determine the corresponding lift for the angle.

**Turn in a program listing and screen output.**