Introduction to Scientific Computing Lab 1

Variables and Expressions

2017

1 Objectives

After completing these exercises you will be able to:

- Create, compile and run a C program
- Create variables of different data types
- Perform calculations
- Read and write to the screen

2 Notes

Work individually

Create a directory for each week so you can come back to your codes in the future. Create files for each of the different exercises and name them in a logical manner, so `exercise1.c` for example.

When changing the source code, ensure you have **saved it before compiling** otherwise the compiler will only see the old file

When you have completed all exercises, ask a demonstrator to assess your work. They will test your code and ensure it is formatted well with good commenting, structure and variable names. This is a useful feedback mechanism, so listen to what the demonstrator has to say and their recommendations for improving your code.

In case of an error, read the compiler error. This will often tell you the line (or close to the line) where the error is occurring. Fix it, test and repeat for the errors you have. If you are getting nowhere then it can often be useful to copy the error into google, or use some keyword searches. If you are really stuck on one error then call over an assistant who will be able to point you in the right direction.

3 Evaluating the Lift of an Aerofoil

NOTE: the `math.h` reference will be useful for this exercise: `http://www.cplusplus.com/reference/cmath/`

In this exercise, you will perform some simply calculations to determine the lift, l, produced from an aerofoil shape at an angle of attack, α; see figure 1. The other force is drag, d, which we will not be calculating.

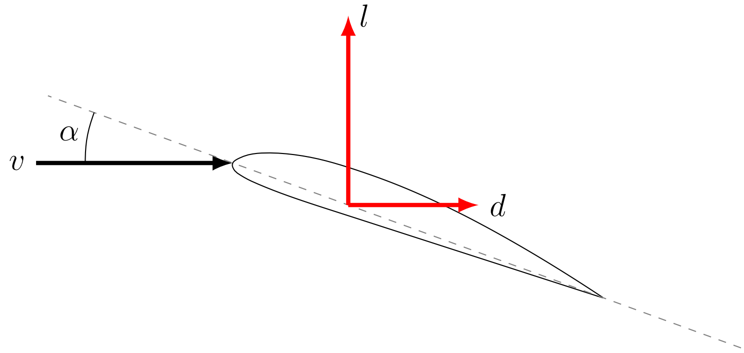

Figure 1: Forces acting on an aerofoil

The lift (per unit chord) produced by an aerofoil in inviscid flow can be approximated as:

$$l = qC_l \tag{1}$$

where $q = \frac{1}{2}\rho v^2$ is the dynamic pressure (ρ is the air density and v is the freestream velocity) and $C_l = 2\pi\alpha$ is the lift coefficient, where α is the angle the plate is inclined to the flow direction in radians.

4 Exercises

As a basis for your work, you can download the following code from Blackboard. It is called `exercise1.c` (notice that there are `??` for you to edit).

```c
#include <stdio.h>
#include <math.h>

int main() {

  /* Allocate memory */
  double dynamicPressure, velocity, density;

  /* Hard-code a value of density */
  density=??

  /* Ask user for input value of velocity and read in */
  printf("Input a value for velocity:");
  scanf("%lf", ??);

  /* Calculate the dynamic pressure */
  dynamicPressure=??

  /* Print the dynamic pressure */
  printf("The dynamic pressure is %lf", ??);

  return(0);
}
```

1. Write a program that asks the user to enter a value for freestream velocity in m/s. Hard-code a value of `1.225`kg/m^3 for ρ, calculate the dynamic pressure and output this on the screen. HINT: the `pow(<dble1>,<dble2>)` function of `math.h` maybe useful, details at `http://www.cplusplus.com/reference/cmath/pow/`.

2. Save exercise 1 as its own file (e.g. `exercise1.c`). Copy this and save it as a new file for this exercise (e.g. `exercise2.c`). Make sure you always do this for all of the exercises. Now modify the program from exercise 1 so that it asks for a value of the angle of incidence in degrees. Print this out too.

3. Modify exercise 2 to convert the value of α from degrees to radians (π can be calculated at run-time by $\pi = 4.0 \tan^{-1}(1.0)$, where C has an in-built inverse tan function: `http://www.cplusplus.com/reference/cmath/atan/`). Calculate the value for the lift coefficient C_l and output this to the screen.

4. Finally, modify exercise 3 to now calculate the total lift produced and output this to the screen.

As a check, the final answer for lift should be 67.168N if $v = 10$m/s and $\alpha = 10°$. Call over a demonstrator to check your code and mark that you have completed the exercises.

5 Next Week

Conditional statements, branching and looping.