A FIRST LOOK AT ARRAYS

Today

- How we can use arrays to hold sets of related data.
- Common patterns of handing data:
  - Finding the largest element
  - Summing up elements
  - Counting elements with some feature.
- You should read these notes in conjunction with the program in `arrays.cpp`

What is an array?

- You can think of an array as a set of variables which are grouped together, all using the same identifier.
- Just as

  `int a;`

  declares an integer variable with the name `a`, then

  `int b[5];`

  declares an *array* of 5 integers, with the name `b`.
- The square brackets `[ ]` are the crucial bit of syntax, telling the compiler it is dealing with an array.

- Whereas

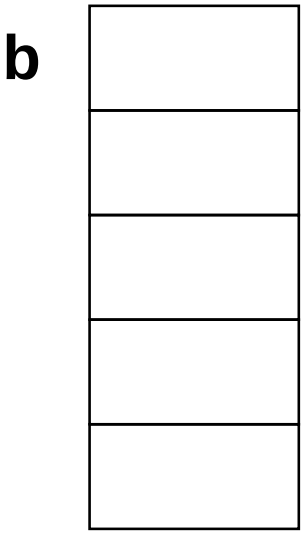
  `int a;`

  reserves space for one integer in memory and associates the name `a` with it:

the declaration

```
int b[5];
```

reserves space for five integers in memory right next to one another.



- Elements of the array `b` are just integers, and we can do exactly the same things to them that we can do to integers.
- The only difference is how we *address* them.
- While we can assign a value to `a` by:

  ```
  a = 5;
  ```

  To do the same to one of the *elements* of `b`, we have to specify which element it is. For example:

  ```
  b[1] = 5;
  ```

- Thus all of the following are legal operations:

```
b[1] += 2;
b[2] =  7 % 3;
b[3] =  b[2] - 5;
b[4] =  b[1]/b[3];
```

- One thing to be careful of is the limits on the *index*, that is the number inside the square brackets `[ ]`.
- The first element of an array always has index 0.
- So the first element of `b` is:

  `b[0]`

  and, since `b` has 5 elements, the last element of `b` is:

  `b[4]`.
- Every C++ programmer forgets this from time to time.

- Arrays are useful when you want to store lost of data in memory.
- If I want to use 3 integers in my progran, I'll just declare 3 different variables.
- If I want to use 30,000 integers in my program, it is a lot easier to use an array.
- Arrays also go very nicely with `for` loops.
- For example, here is code from `arrays.cpp` which reads information from a file, and puts part of it into two different arrays.
- The arrays are `diseases[]` and `ages[]`

```
for(counter = 0; counter < 7 ; counter++)
    {
        infile >> idNumber;          // Read data in from
        infile >> age;               // file.
        infile >> disease;
        infile >> zipCode;

        // Store disease and age data in arrays

        diseases[counter] = disease;
        ages[counter]     = age;

        printRecord();               // Print data
    }
```

- Once the information is in the array, we can do all kinds of stuff with it.
- We can, for example, print out the values in reverse order:

```
cout << endl << "Diseases in reverse order" << endl;

for(counter = 6; counter >= 0;  counter--)
    {
        cout << diseases[counter] << endl;
    }
```

- Another thing we can do is to count up how many times we find some value in the array.
- The value we are looking for is in the variable `disease`

```
for(counter = 0; counter < 7;  counter++)
   {
     if(diseases[counter] == disease)
       {
         numberOfDiseases += 1;
       }
   }
```

- This is one common pattern of using a loop to *summarize* some information.

- A slightly different summarization would be look look for oldest patient. (The patient with the largest age.)
- We collect the largest age in the variable `oldest`:

```
int oldest = 0;

for(counter = 0; counter < 7;  counter++)
   {
     if(ages[counter] > oldest)
       {
         oldest = ages[counter];
       }
   }
```

- We could also store the value of `counter` that corresponds to the highest age, and then we could look at other aspects of the oldest patient.

- A third, and final summarization is to add up, and then compute the average of, the patient ages:

```
int sumOfAges = 0;

for(counter = 0; counter < 7;  counter++)
   {
     sumOfAges += ages[counter];
   }

cout << endl << "Average age is ";
cout << endl << sumOfAges / 7.0 << endl;
```

- We divide by 7.0 in order to force the result to be a decimal fraction.
- If we didn;t do this, we would be dividing one integer by another, and we'd get an integer result.

Variable precision

- This last example has us printing out a decimal fraction.
- In order to print out decimal fractions neatly, we can specifcy how many decimal places we want to print out.
- In this example:

```
cout.setf(ios::fixed, ios::floatfield);
cout.precision(2);

cout << endl << "Average age is ";
cout << endl << sumOfAges / 7.0 << endl;
```

- The first two lines tell `cout` to print floating point numbers (in other words decimal fractions) with fixed width, and to use two decimal places.

Constants

- One thing to notice with all of these arrays is that we have been writing 7, the size of the array, a lot.
- What would happen if we decided we now needed the array to hold 10 elements?
- Well, we'd have to make lots of changes.
- Each change gives us the chance to make a mistake.
- There is a way to reduce the number of changes, and that is to use a *constant*.

- We define a constant using the keyword `const`:

```
const int LENGTH = 7;
```

- By convention we give a constant a name that is all capitals.
- We can then use `LENGTH` wherever we need the number 7:

```
int diseases[LENGTH];

for(counter = 0; counter < LENGTH; counter++)
   {
     sumOfAges += ages[counter];
   }
```

and so on.

Summary

- In this lecture we talked about four things.
- First we briefly introduced arrays.
- (We will talk about arrays a lot more in the future).
- Second we talked about some common patterns of programming.
- Third we talked about formatting output, in particular controlling the precision of numbers.
- Finally we talked about constants.