Arrays

Suppose I need to compute statistics on class marks?

```
int mark_student0, mark_student1, mark_student2, ...;
mark_student0 = 73;
mark_student1 = 42;
mark_student2 = 99;
...
```

- cumbersome, need hundreds of individual variables
- can't write while loop which executes for each student
- becomes unfeasible if dealing with a lot of values

Solution use an array

```
int mark[930];
mark[0] = 73;
mark[1] = 42;
mark[2] = 99;
...
```

C Arrays

- C array is a collection of variables called **array elements**.
- All array elements must be the same type.
- Array elements don't have a name
- Array elements accessed by a number called the **array index**.
- Valid array indices for array with n elements are $0 .. n-1$
- Array can have millions/billions of elements.
- Array elements must be initialized.
- Can't assign scanf/printf whole arrays.
- Can assign scanf/printf array elements.

Arrays

```
// Declare an array with 10 elements
// and initialises all elements to 0.
int myArray[10] = {0};
```

	myArray
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0

Arrays

```
// Declare an array with 10 elements
// and initialises all elements to 0.
int myArray[10] = {0};

// Put some values into the array.
myArray[0] = 3;
```

	myArray
0	3
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0

Arrays

```
// Declare an array with 10 elements
// and initialises all elements to 0.
int myArray[10] = {0};

// Put some values into the array.
myArray[0] = 3;
myArray[5] = 17;
```

	myArray
0	3
1	0
2	0
3	0
4	0
5	17
6	0
7	0
8	0
9	0

Arrays

```
// Declare an array with 10 elements
// and initialises all elements to 0.
int myArray[10] = {0};

// Put some values into the array.
myArray[0] = 3;
myArray[5] = 17;
myArray[10] = 42; // <-- Error
```

	myArray
0	3
1	0
2	0
3	0
4	0
5	17
6	0
7	0
8	0
9	0

Reading Arrays

Scanf can't read an entire array. This will read only 1 number:

```
    #define ARRAY_SIZE 42
    ...
    int array[ARRAY_SIZE];
    scanf("%d", &array);
```

Instead you must read the elements one by one:

```
    i = 0;
    while (i < SIZE) {
        scanf("%d", &array[i]);
        i = i + 1;
    }
```

Printing Arrays

printf can't print an entire array. This won't compile:

```
    #define ARRAY_SIZE 42
    ...
    int array[ARRAY_SIZE];
    printf("%d", array);
```

Instead must print the elements one by one:

```
    i = 0;
    while (i < ARRAY_SIZE) {
        printf("%d\n", array[i]);
        i = i + 1;
    }
```

Copying Arrays

Suppose we have the following:

```
int array1[5] = {1, 2, 3, 4, 5};
int array2[5];
```

Array assignment not allowed in C. This won't compile:

```
array2 = array1;
```

Instead must must copy the elements one by one:

```
i = 0;
while (i < 5) {
    array2[i] = array1[i];
    i = i + 1;
}
```

Copying Arrays

Suppose we have the following:

```
int array1[5] = {1, 2, 3, 4, 5};
int array2[5];
```

Array assignment not allowed in C. This won't compile:

```
array2 = array1;
```

Instead must must copy the elements one by one:

```
i = 0;
while (i < 5) {
    array2[i] = array1[i];
    i = i + 1;
}
```

Static Array Initialisers

Other ways to define arrays:

```
// If no size is given C counts how many elements
// you have specified to determine the size
int myArray1[] = {3,12,9,12,8,17,33,22,43,10};
int myArray2[10] = {3,12}; //The rest it padded with 0's
int myArray3[10] = {3};    //The rest is padded with 0's
//A common way to initialise the whole array to 0
int myArray4[10] = {0};    //The rest is padded with 0's
```

Each definition creates a `int` array with 10 elements.

Argument Passing: Array Variables

Array arguments are passed by reference

- The array is not copied so changes to array elements are visible the outside function
- Full explanation will have to wait until we cover pointers

Arrays as Function Arguments

```
int main(void) {
     int nums[5] = {0};
     f(nums,5);                    // pass nums as argument
     printf("%d\n", nums[0]); // what is printed?
}
void f(int nums[], int size) {
     nums[0] = 42;                 // modify argument
}
```

`printf()` ⇒ 42. Why?

Because a reference to the original copy of the array `nums` is passed to `f()`, any changes to the referenced `nums` in `f()` is reflected in the original `nums`.

Arrays as Function Arguments

Examples of how the prototypes can be declared:

```
    void f1(double ff[]);
    void f2(double ff[SIZE]);
    void f3(double ff[], int size);
```

Warning:

Notice that the size may be left unspecified.

In these cases it is up to the programmer to manage the number of elements in its array argument.

Options:

- by using a size constant
- by passing in a size variable, like in the `f3()` example

Arrays as Function Arguments

Consider the following:

```
    #define SIZE 10
    int sum1(int nums[]);
    int sum2(int nums[SIZE]);
    int sum3(int nums[], int size);

    int main(void) {
      int nums[10] = {1, 2, 3};
      sum1(nums);
      sum2(nums);
      sum3(nums, 3);
      return 0;
    }
```

Arrays as Function Arguments

The functions

- `sum1` and `sum2` uses `SIZE` to iterate through its array argument
- `sum3` uses the supplied `size` argument.

Why is `sum3` better? You can pass in arrays of different sizes, or tell the function to just sum the first 'size' elements in the array.

Beware: Don't Try to Return an Array

It might be tempting to try returning an array from a function:

```
    int[] foo(void) {
      int nums[] = {1,2,3};
      return nums;
    }
```

This looks ok but fails spectacularly!
Arrays are passed by reference, but the array is destroyed immediately after the `return` statement. Using it in the caller then becomes a run-time error!
It is possible to return dynamically allocated arrays, which we will learn later in the course.

Beware: Don't Try to Return an Array

Instead of returning an array you can pass in an array ,fill it with values.

```
int main(void){
   int numbers[SIZE];
   //foo fills the numbers array with with values
   foo(numbers,SIZE);
   //Now you can use the numbers array
   //etc
}
void foo(int nums[], int size) {
    int i = 0;
    while(i < size){
        nums[i] = 42;
    }
}
```

Arrays of Arrays

- C supports arrays of arrays.
- Useful for multi-dimensional data.

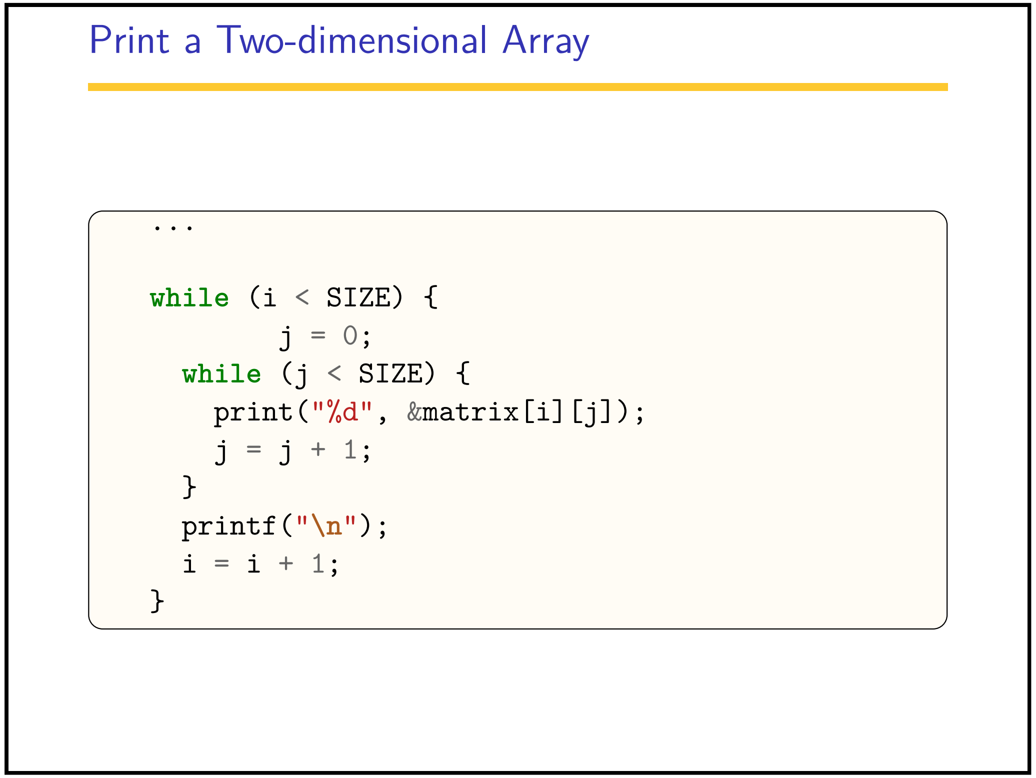
```
    int matrix[3][3] = { {1, 2, 3},
                         {4, 5, 6},
                         {7, 8, 9} };

    printf("%d\n", matrix[1][1]);
```

Read a Two-dimensional Array

```
    #define SIZE 42
    ...
    int matrix[SIZE][SIZE];
    int i, j;

    i = 0
    while (i < SIZE) {
            j = 0;
      while (j < SIZE) {
        scanf("%d", &matrix[i][j]);
        j = j + 1;
      }
      i = i + 1;
    }
```



Print a Two-dimensional Array

```
...

while (i < SIZE) {
        j = 0;
  while (j < SIZE) {
    print("%d", &matrix[i][j]);
    j = j + 1;
  }
  printf("\n");
  i = i + 1;
}
```