Arrays

Topics

- Arrays
  - Array Parameters
  - Typical Array Operations
- main − closer look

Arrays

- We typically encounter groups of similar items
  - Eggs in an egg carton
  - Apartments in an apartment building
- It is easier to manage the group rather than each individual alone
- Each object in the set is the same
- The overall set has a size

Arrays

- An array is a collection of values of all identical type
- Logically (between the programmer and the outside world) these values are also related to each other.
- The collection has a variable name
- Each item in the collection has a subscript that defines its position within the collection

Example

- An array for assignment 1 grades: will be float, and each entry represents someone's grade of assignment 1
- The first entry represents the grade of the first student in the roster.
- The compiler will let you assign, for example, the second entry to the balance of someone's bank account − they are all float numbers. This is a logical error on your part.

Array Declaration

- Syntax:
  ```
  type arrayname[ size ];
  ```
- `type` referred to as the data type for all array elements
- `arrayname` is the variable name for the entire collection
- `size` is the number of elements allowed in the collection
  - indexes from `0` to `size-1`

Arrays

- Example:
  - `int grades[ 5 ];`

Arrays

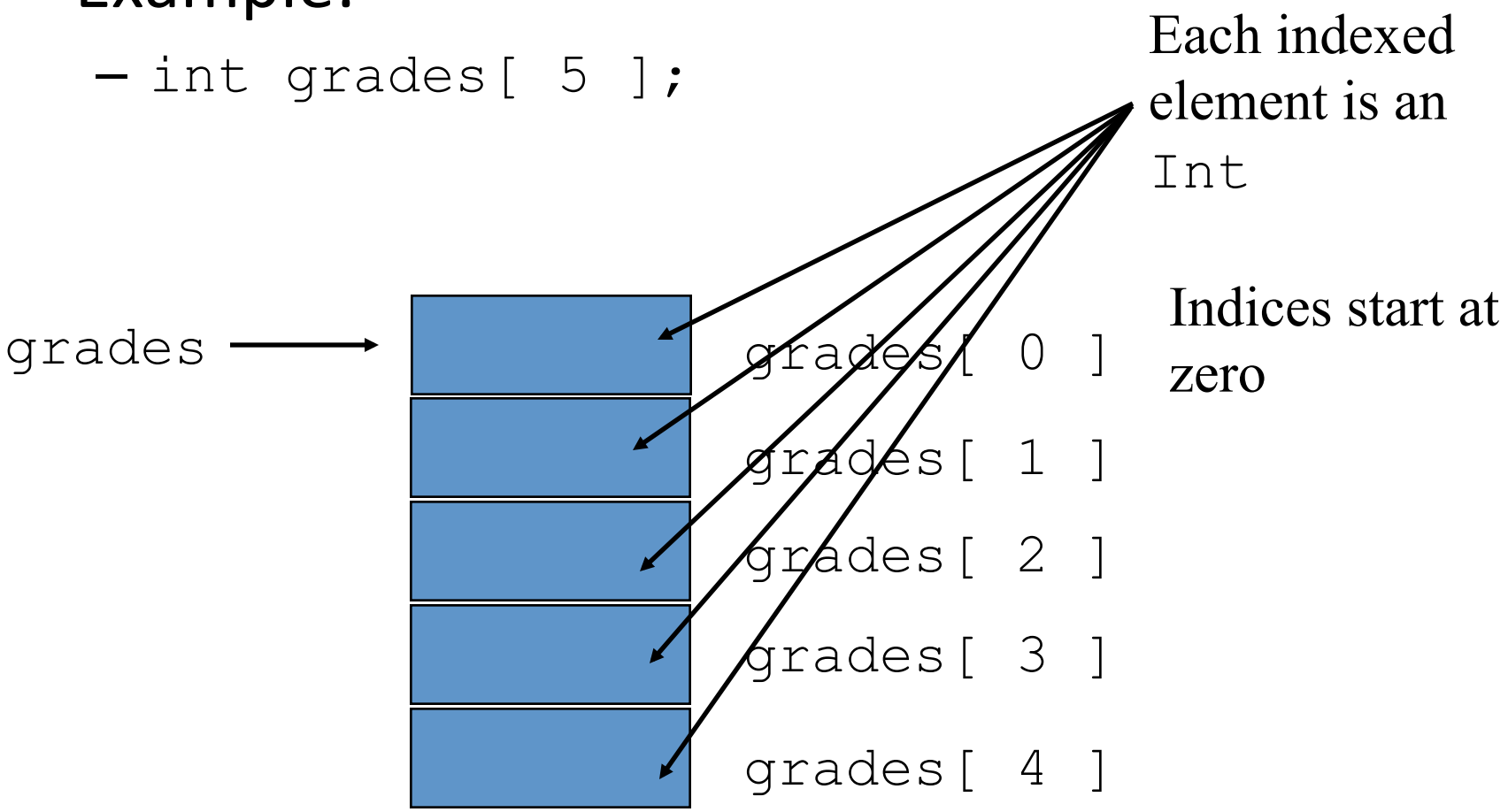
- Example:
  - `int grades[ 5 ];`

  Here we have the variable name grades, and the size of the array is 5. The first element of grades is located at location 0, the second element at location 1, … and the 5^{th} element is at location (in programming we call it index) 4.

  0 to 4 is 5 elements.

Arrays

- Example:
  - `int grades[ 5 ];`



Exercise

- int x[7]
  - How many elements are in x?
  - What is the data type of x[2]?
  - What is the index of the last element in x?
  - What is the index of the first element in x?

Exercise - Answers

- int x[7]
  - How many elements are in x? 7
  - What is the data type of x[2]? int, as is the data type of every element in x
  - What is the index of the last element in x? 6
  - What is the index of the first element in x? 0
- We pay special attention to the address of the last element. Why? We'll learn in a few slides

Arrays

- Arrays are an ordered list

  `grades[ 1 ]` precedes `grades[ 10 ]`

  `grades[ 10 ]` precedes `grades[ 11 ]`
- Arrays are stored contiguously in one block
- Each index is a literal in its own right, e.g. grades[n], n can be a variable calculated through a math expression. This is where the fun is.
- `[ ]` Is used to declare and access arrays

Arrays

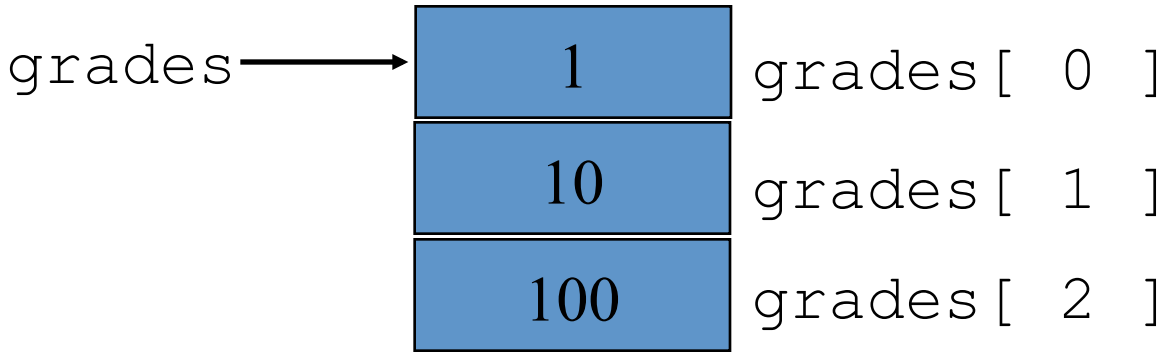
- Example:

```
int grades[3];  //declare
grades[0] = 1;  // assign first element to 1
grades[1] = 10; // assign second to 10
grades[2] = 100; // assign third to 100
```

Arrays

- Example:

```
int grades[3];
grades[0] = 1;
grades[1] = 10;
grades[2] = 100;
```

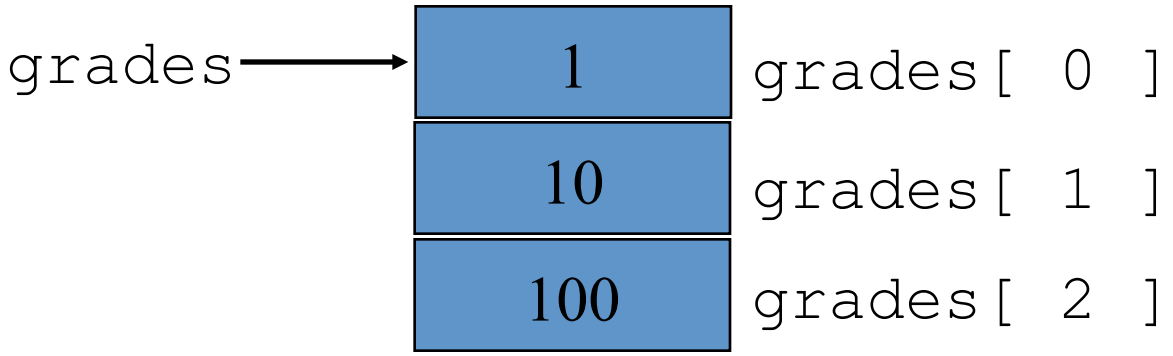


Arrays

- Example:

```
int grades[3];
grades[0] = 1;
grades[1] = 10;
grades[2] = 100;
```

Don't confuse declaration syntax with element access



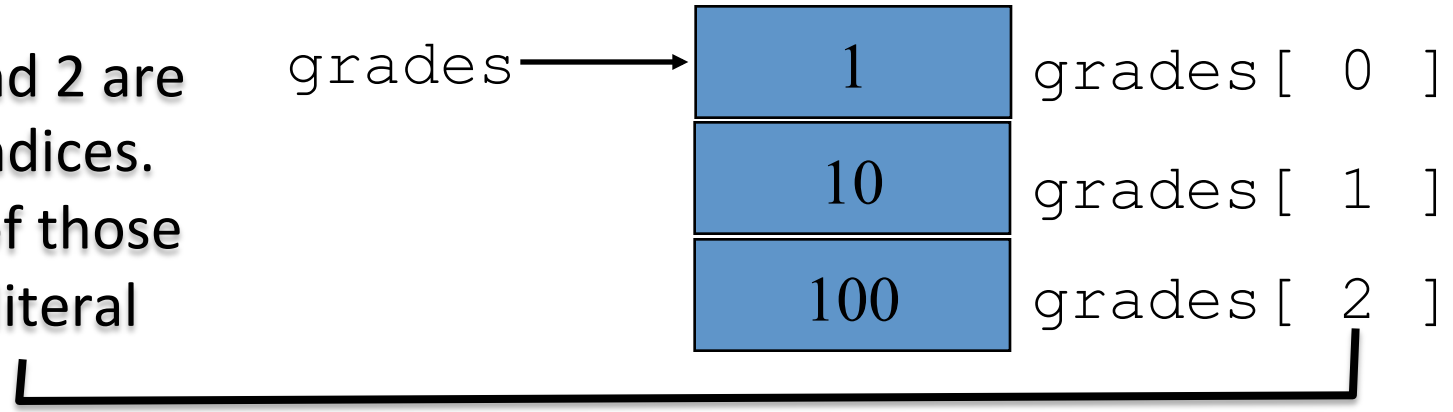
Arrays

- Example:

```
int grades[3];
grades[0] = 1;
grades[1] = 10;
grades[2] = 100;
```

Don't confuse declaration syntax with element access

0, 1 and 2 are the indices. Each of those is a literal



Array Initialization

- Like other variables, arrays can be initialized when they are declared
- Generally, it's a good idea to define constants for array size

```
const int SIZE=3;
int grades[SIZE];
grades[0] = 1;
grades[1] = 10;
grades[2] = 100;
```

Array Initialization

- Alternative ways to initialize:

```
const int SIZE=3;
int grades[SIZE];
grades[0] = 1;
grades[1] = 10;
grades[2] = 100;
```

```
const int SIZE=3;
int grades[SIZE]={1,10,100};
```

Array Iteration

- `for` loops are often used with arrays
  - In the loop, Array index (`i` below)should not be a fixed constant

```
const int SIZE=3;
int a[SIZE]={1,10,100};//initialize here
                       // helps in testing

for (int i=0; i<SIZE; i++) {
  printf( "a[%d] = %d\n", i, a[i] );
}
```

Important Considerations

- Don’t exceed array bounds. It is a fatal run-time error to do so…
- Typically, bounds errors come on the last iteration going over the edge
- You are forewarned!

Arrays Demo!

```
#include <stdio.h>

void sort( int a[], int size );
void dump( int a[], int size );

int main( ) {

/* An array is a whole set of like values. When you declare an array, you must use square brackets and provide a fixed, constant size.  You cannot use a variable to declare its size.  All of the elements of the array are the same; they will be int
   */
        int array[ 10 ];
        int amount;
        int data;
        int i;

        printf( "How many values do you want to enter? (<10,please)" );
        scanf( "%d", &amount );

        /* Arrays lead to lots of looping as you walk the set of values.
         */
        for (i = 0; i < amount; i++) {
                printf( "Enter a value: " );
                scanf( "%d", &data );
                array[ i ] = data;
        }

        /*
          You can pass a whole array to a function.  When you do, you must also send a companion parameter which states how big the array is, because the function has no other way of knowing unless you supply it.
           */
        sort( array, amount );
        dump( array, amount );
        return( 0 );
}
void sort( int a[], int size ) {
        int i, j, temp;
        for (i = 0; i < size; i++) {
                for (j = 0; j < size; j++) {
                  //Get one pair of values ordered correctly…
                        if (a[i] < a[j]) {
                                temp = a[i];
                                a[i] = a[j];
                                a[j] = temp;
                        }
                }
        }
}
void dump( int a[], int size ) {
        int i;
        for (i = 0; i < size; i++) {
                printf( "a[ %d ] = %d\n", i, a[i] );
        }
}
```

Summarizing Arrays Demo!

- Arrays let you work with groups of data
- Carefully track array size!
- Don’t reinvent the wheel − use code from the demo for future with adjustments as needed

Arrays As Function Arguments

- Like any other *value*, array **elements** can be passed to functions

```
void print_value( int i ); //some function

const int SIZE=3;
int a[SIZE]={1,10,100}; //array

for (int i=0; i<SIZE; i++) {
  print_value( a[ i ] );
//a[i] is an int and can be passed to print_value
}
```

Arrays As Function Arguments

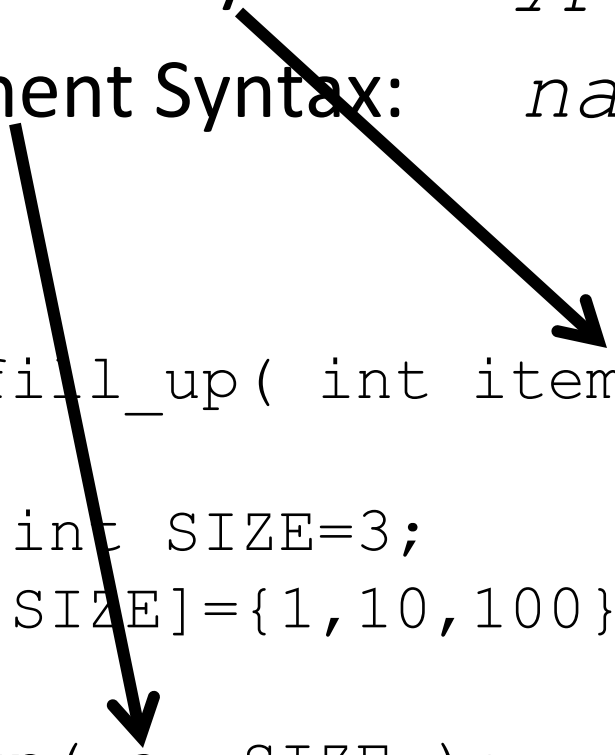
- The whole array can also be a parameter in a function
- Arrays are passed to functions as array arguments
- If a function changes element value, these changes will be seen by the caller

Arrays As Function Parameters

- Parameter Syntax: *`type name[]`*
  - *`Need [] to stress its an array`*
- Argument Syntax: *`name`*
  - *`Prototype knows name is an array`*
  - *`Hence do not use []`*

Arrays As Function Parameters

- Parameter Syntax: *type name[]*
- Argument Syntax: *name*



```
void fill_up( int items[], int length );

const int SIZE=3;
int a[SIZE]={1,10,100};

fill_up( a, SIZE );
```

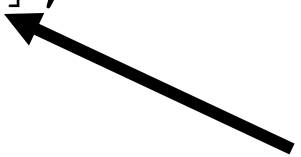
Arrays As Function Parameters

- Parameter Syntax: *type name[]*
- Argument Syntax: *name*

```
void fill_up( int items[], int length );

const int SIZE=3;
int a[SIZE]={1,10,100};

fill_up( a, SIZE );
```



No Index Value

Observations

- Since the array parameter definition lacks array size value, it is always A good idea to pass the size of the array as an extra argument

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- Since the array parameter definition lacks array size value, it is a good idea to pass the size of the array as an extra argument

```
void fill_up( int items[], int length );

int a[5], b[10];

fill_up( a, 5 );
fill_up( b, 10 );
```

Observations

- Since the array parameter definition lacks array size value, it is always a good idea to pass the size of the array as an extra argument

```
void fill_up( int items[], int length );

int a[5], b[10];

fill_up( a, 5 );
fill_up( b, 10 );
```

Function can be called with arrays of various sizes

Observations

- When arrays are passed to functions, elements changed by the function are visible to the caller
- This is kinda pass-by-reference
  - No copies of the individual elements are made
  - Changes to any elements will be permanent, hence seen by the caller
  - We will cover pass by reference in the next unit

`const` Array Arguments

- If you know the function will not change the array values, use `const` modifier

`const` Array Arguments

- If you know the function will not change the array values, use `const` modifier

```
void print(const int items[],int length);
```

Typical Array Operations

- Searching
- Sorting

Revisiting Arrays Demo!

```
#include <stdio.h>

void sort( int a[], int size );
void dump( int a[], int size );

int main( ) {

/* An array is a whole set of like values. When you declare an array, you must use square brackets and provide a fixed, constant size.  You cannot use a variable to declare its size.  All of the elements of the array are the same; they will be int
   */
        int array[ 10 ];
        int amount;
        int data;
        int i;

        printf( "How many values do you want to enter? (<10,please)" );
        scanf( "%d", &amount );

        /*  Arrays lead to lots of looping as you walk the set of values.
         */
        for (i = 0; i < amount; i++) {
                printf( "Enter a value: " );
                scanf( "%d", &data );
                array[ i ] = data;
        }

        /*
          You can pass a whole array to a function.  When you do, you must also send a companion parameter which states how big the array is, because the function has no other way of knowing unless you supply it.
           */
        sort( array, amount );
        dump( array, amount );
        return( 0 );
}
void sort( int a[], int size ) {
        int i, j, temp;
        for (i = 0; i < size; i++) {
                for (j = 0; j < size; j++) {
                  //Get one pair of values ordered correctly…
                        if (a[i] < a[j]) {
                                temp = a[i];
                                a[i] = a[j];
                                a[j] = temp;
                        }
                }
        }
}
void dump( int a[], int size ) {
        int i;
        for (i = 0; i < size; i++) {
                printf( "a[ %d ] = %d\n", i, a[i] );
        }
}
```

Arrays Summary

- Arrays
  - Array Parameters
  - Typical Array Operations

- Read the book section on arrays.

Important Reminders

- When declaring an initializing arrays:
  - Size may be omitted
  - Size, if provided may not have to match the number of elements initialized
  - If you provide a size, but initialize less elements, the rest will default to 0 or 0.0
- C will go past an array last element without throwing a runtime exception; hence you could be reading or working with garbage
- In fact C will go before arrays first element without throwing a runtime exception
- Array index must be int

main – closer look…

`main( )` – Officially

- Officially, `main( )` can accept parameters:

```
int main( int argc, char * arg[])
```

  - You know argc is an int
  - But what is char * arg[]?
  - It's an array of type char
  - We will cover char and strings in a later unit

main Arguments

- Although many of our examples up until now have avoided it, you can pass data back and forth to your `main( )` function
  - Data returned from the `main( )` function is passed back to the operating system
  - Data sent to the `main( )` function comes from the operating system

Returning From `main( )`

- Officially, `main( )` is supposed to return int

```
int main( )
```

- By convention, a return value of zero indicates “everything is OK”
- Any other value returned would be interpreted by the operating system to indicate some kind of error
  - This an FYI

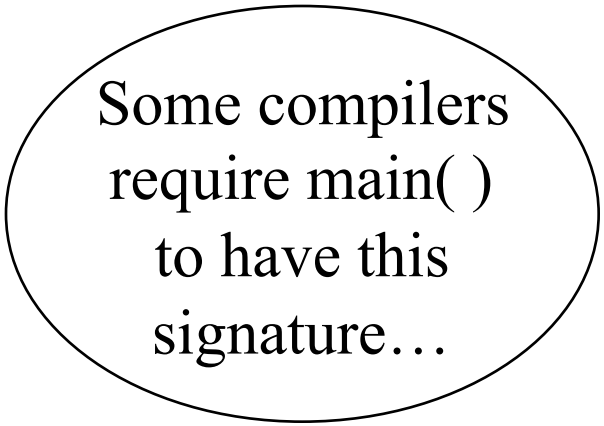
FYI- Passing Data To `main( )`

- Officially, `main( )` can accept parameters
- These parameters come from the command-line which is used to call your program
- `main( )` gets passed an array of cstring known as `argv`
  - These are text from the actual command line broken up into space-separated words
- `main( )` gets an `int` known as `argc`
  - This value tells you how big the array of `argv` is

Passing Data To `main( )`

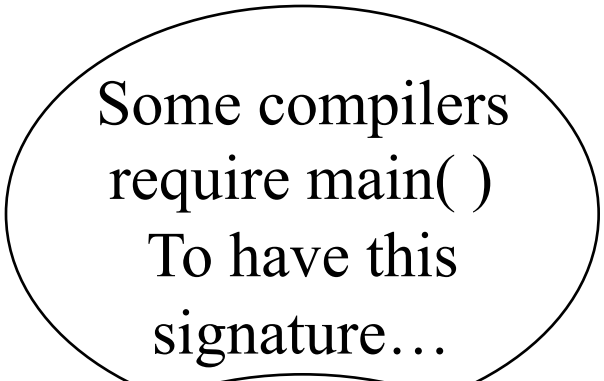
- Officially, `main( )` Can Accept Parameters

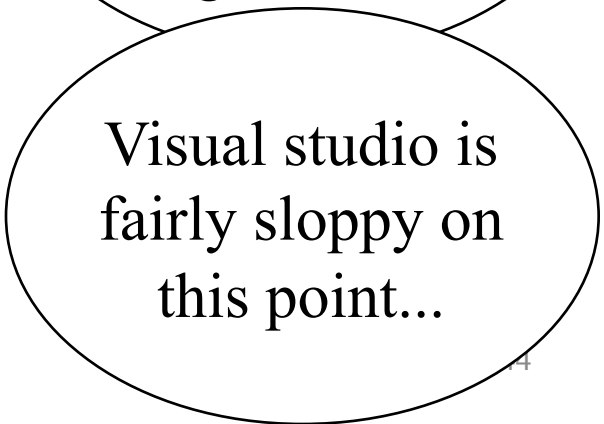
```
int main( int argc, char * argv[])
```



Passing Data To `main( )`

- Officially, `main( )` Can Accept Parameters
  - `int main( int argc, char * argv[])`





FYI - Background

- Whether you start your program in visual studio or by double-clicking in windows explorer or by typing into A DOS box, you always get the chance to send command-line arguments

FYI - Examples

- For A Program Named `foo.exe`:
  DOS> `foo param1 param2`

Examples

- For A Program Named `foo.exe`:
  DOS> `foo param1 param2`

argc

argv

Examples

- For A Program Named `foo.exe`:
  DOS> `foo param1 param2`

argc 3

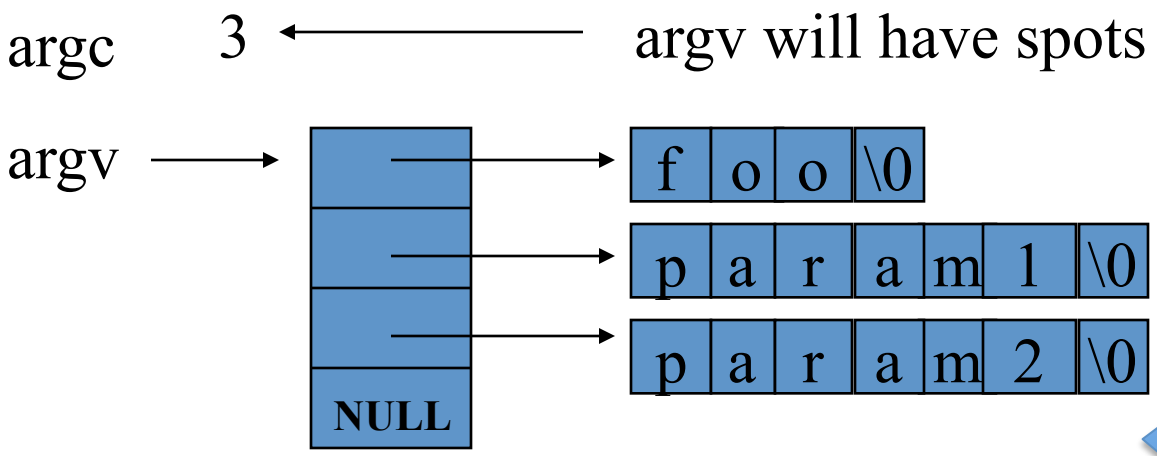
argv

Examples

- For A Program Named `foo.exe`:
  DOS> `foo param1 param2`

Examples

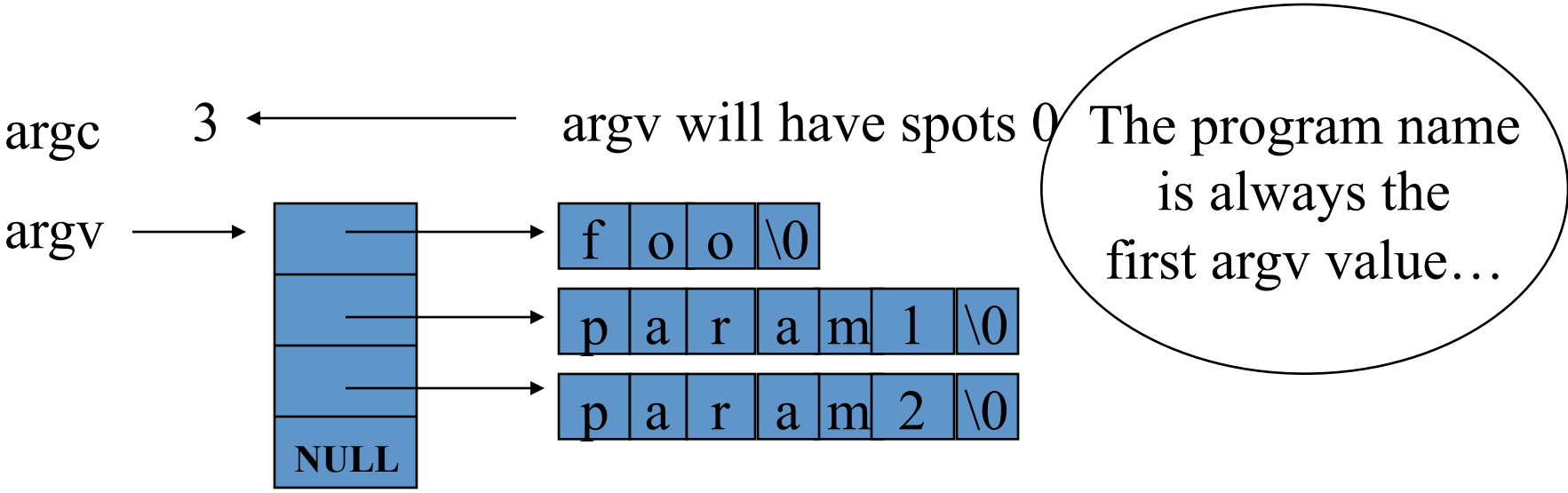
- For A Program Named `foo.exe`:
  DOS> `foo param1 param2`



We did not cover arrays yet, so this may look gibberish. You may ignore it

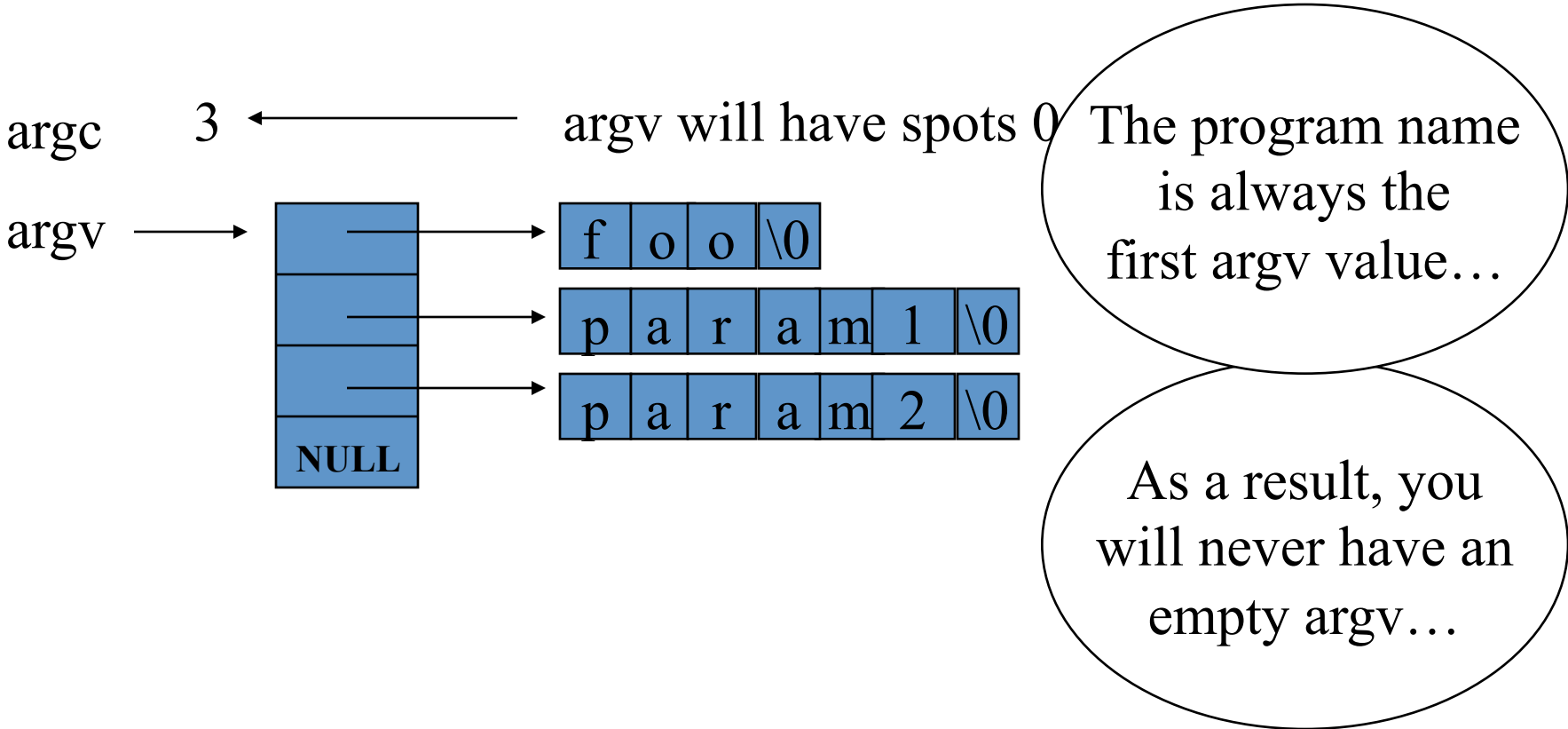
Examples

- For A Program Named `foo.exe`:
  DOS> `foo param1 param2`



Examples

- For A Program Named `foo.exe`:
  DOS> `foo param1 param2`



FYI Demo

```
#include <stdio.h>

int main( int argc, char ** argv ) {
	int counter;
	printf( "Here are your command line arguments...\n" );
	printf( "When you run from inside Visual Studio,\n" );
	printf( "there won't be any arguments besides the\n" );
	printf( "program name, unless you change your project\n" );
	printf( "settings, as shown in the powerpoint slides for this unit...\n" );
	/* The command line arguments are passed as array of c-string */
	for (counter = 0; counter < argc; counter++) {
		printf( "%d. %s\n", counter, argv[counter] );
	}
	getchar();
	return( 0 );
}
```

FYI - Setting Command-Line Arguments

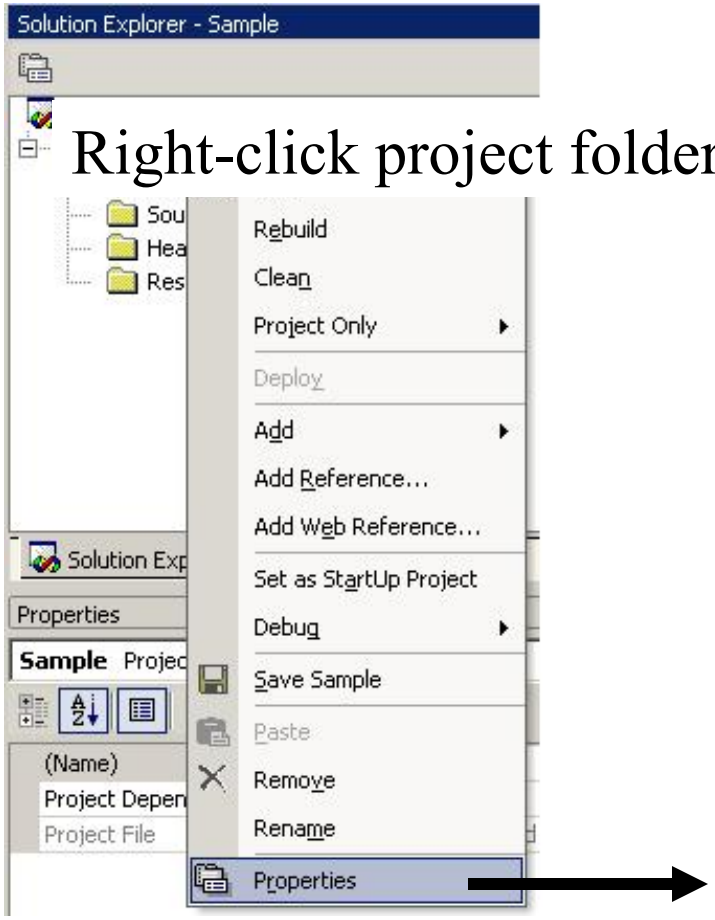
- When working with the DOS> prompt, you type in the command-line arguments yourself

Setting Command-Line Arguments - FYI

- When working with visual studio, whether from debug or release versions, you can coax visual studio into supplying command-line arguments to your programs

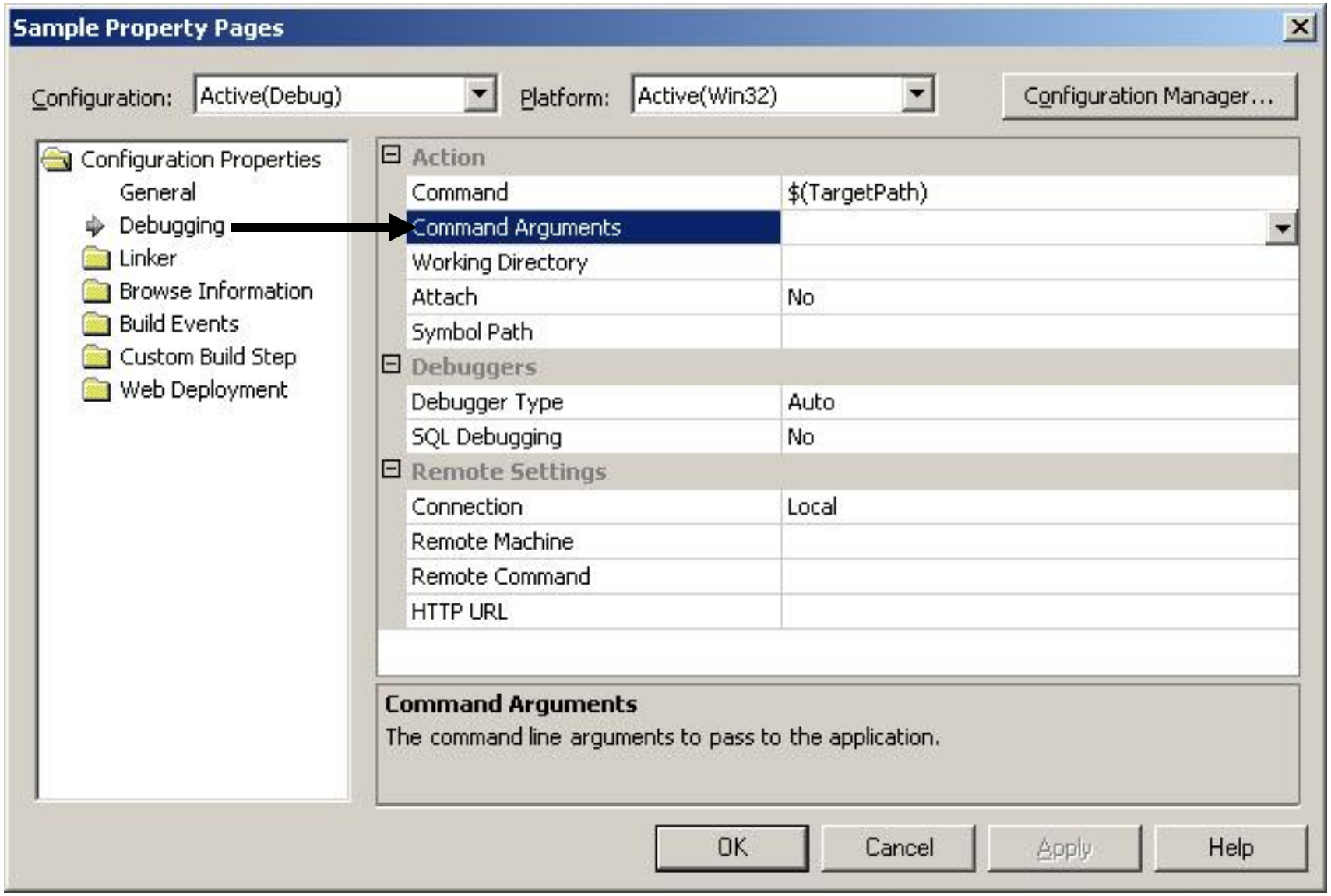
Setting Command-Line Arguments - FYI

- Visual Studio .NET



Right-click project folder, then Properties

FYI


Sample Property Pages
Configuration: Active(Debug)
Platform: Active(Win32)
Configuration Manager...
Configuration Properties
General
Debugging
Linker
Browse Information
Build Events
Custom Build Step
Web Deployment
Action
Command
$(TargetPath)
Command Arguments
Working Directory
Attach
No
Symbol Path
Debuggers
Debugger Type
Auto
SQL Debugging
No
Remote Settings
Connection
Local
Remote Machine
Remote Command
HTTP URL
Command Arguments
The command line arguments to pass to the application.
OK
Cancel
Apply
Help