A Review of C Language

C++ Object Oriented Programming
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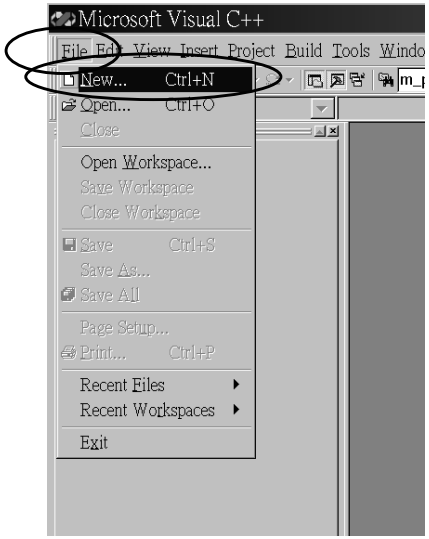
Modified from www.**c**se.**c**uhk.edu.hk/~**csc**2520/tuto/**csc**2520_tuto01.**ppt**

Contents

Visual C++ 6.0



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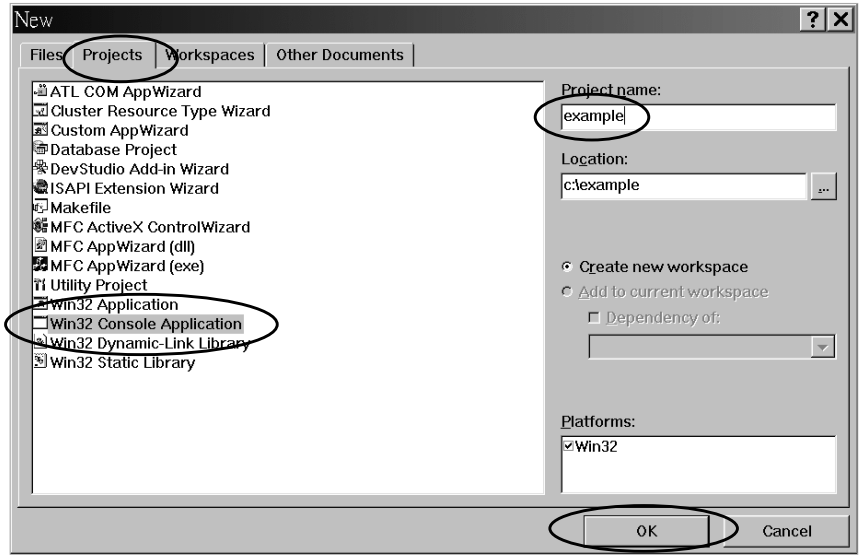

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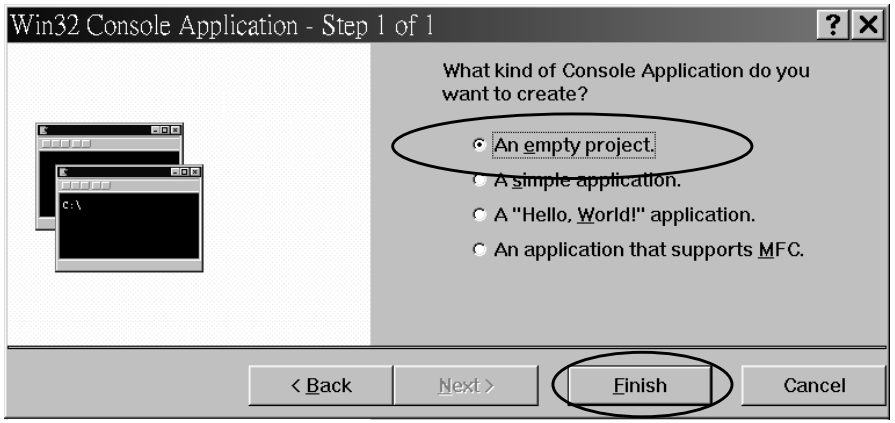

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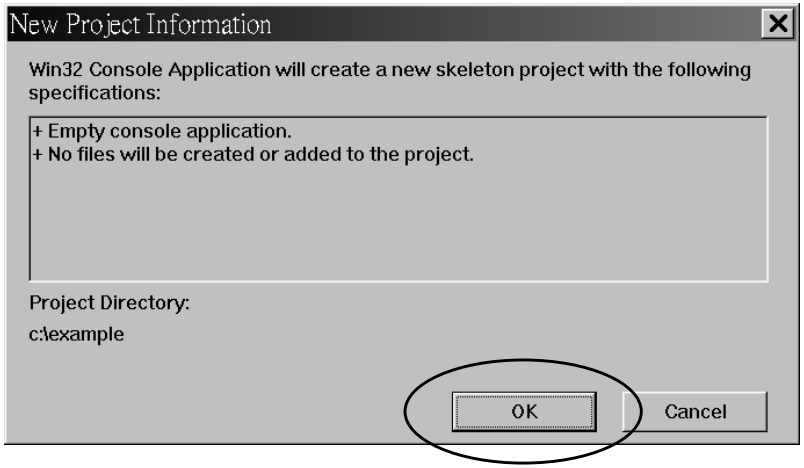

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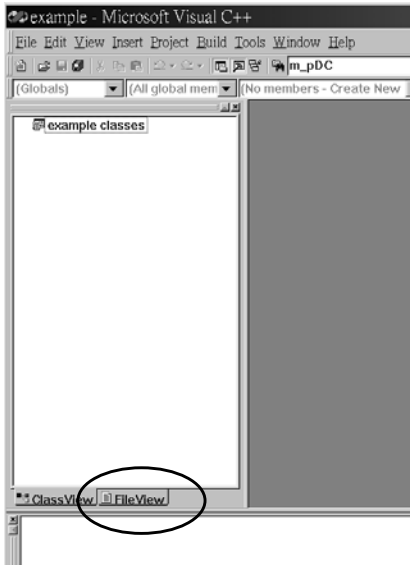

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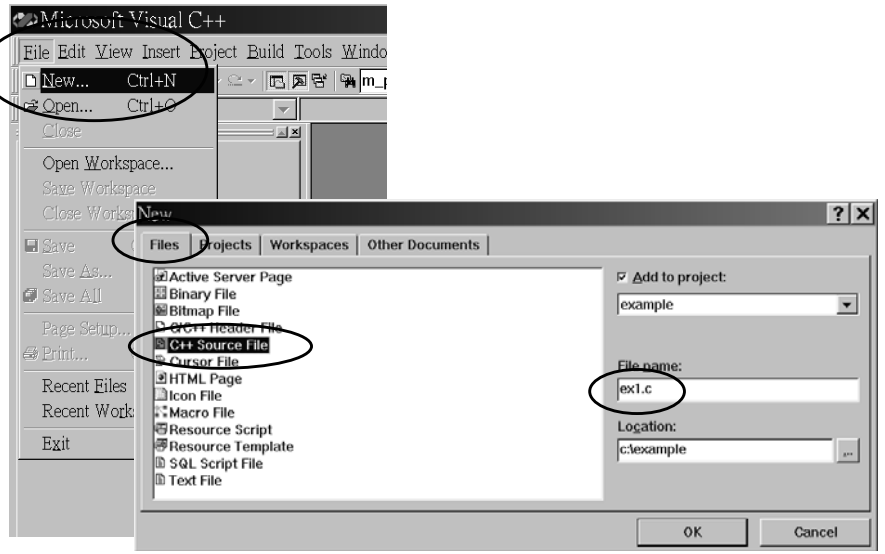

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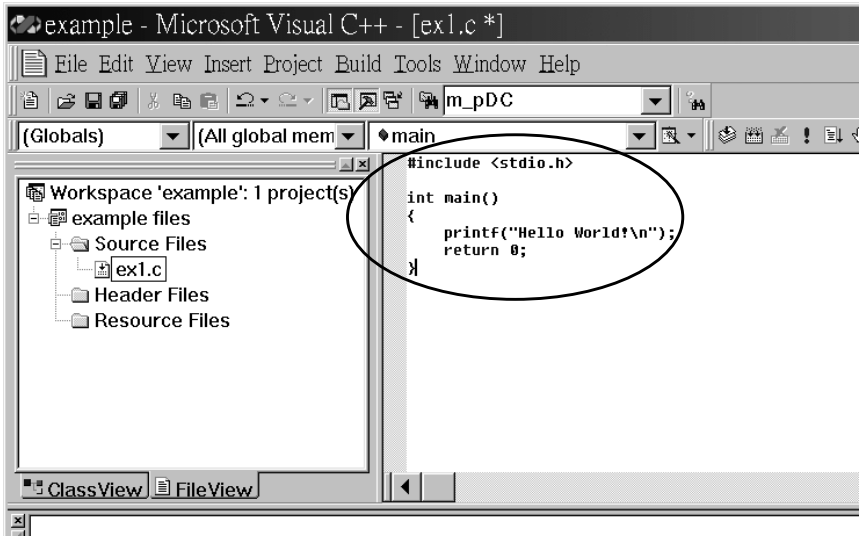

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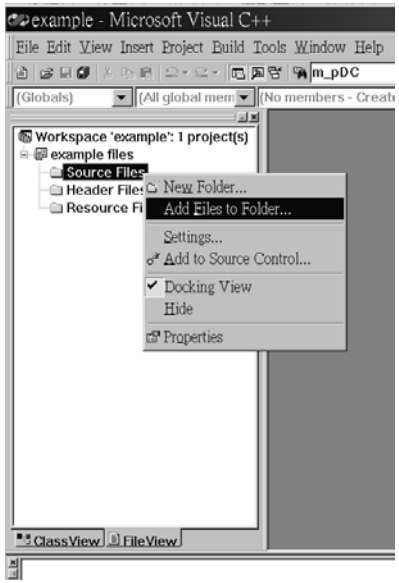

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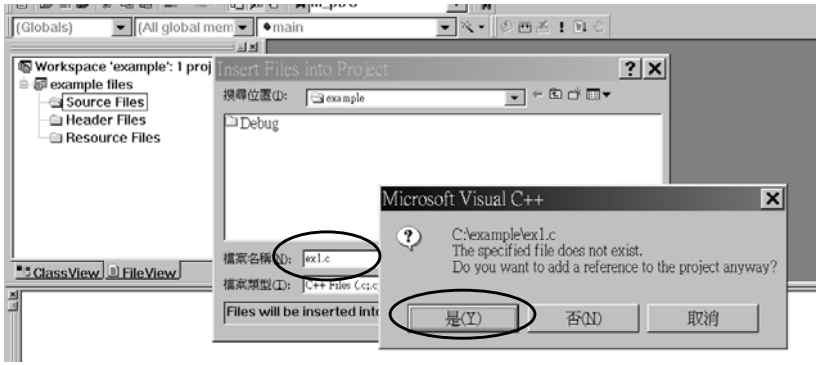

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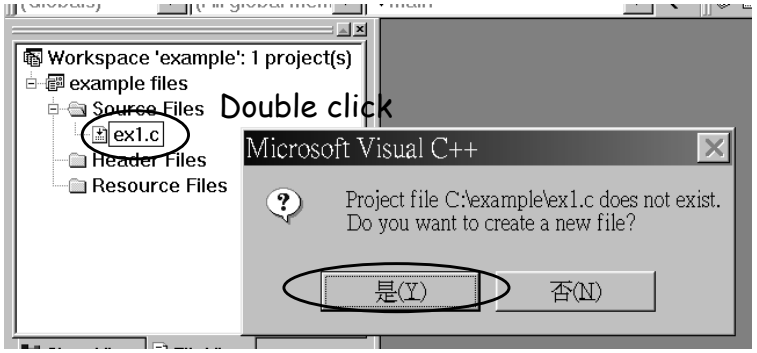

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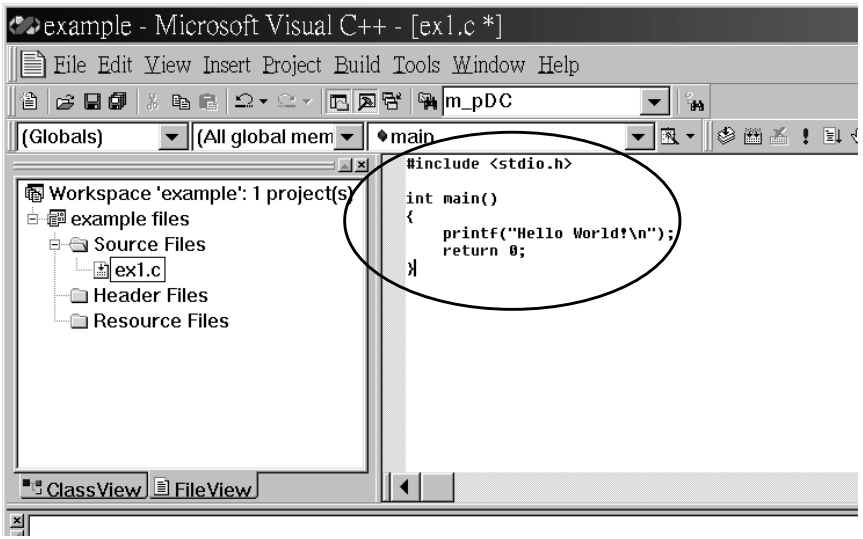
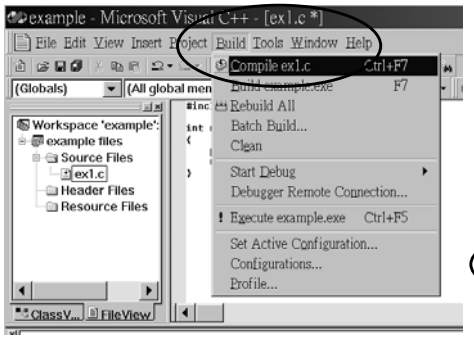
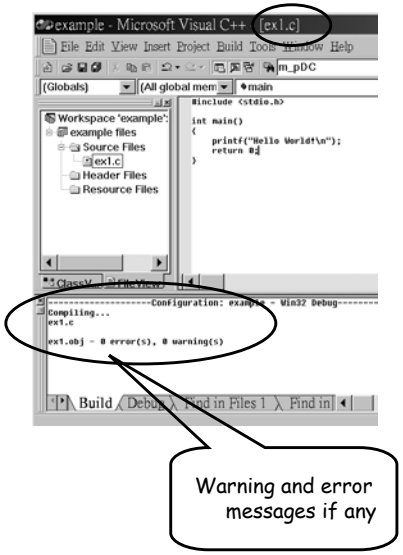


Visual C++ 6.0

✧ Compile a single source file

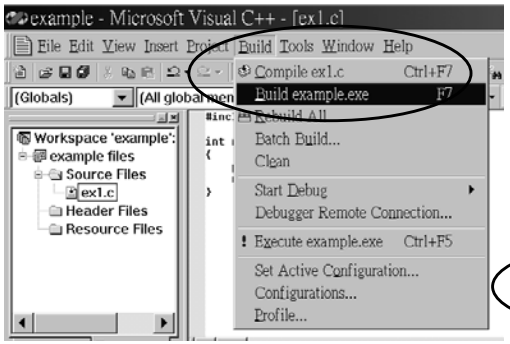


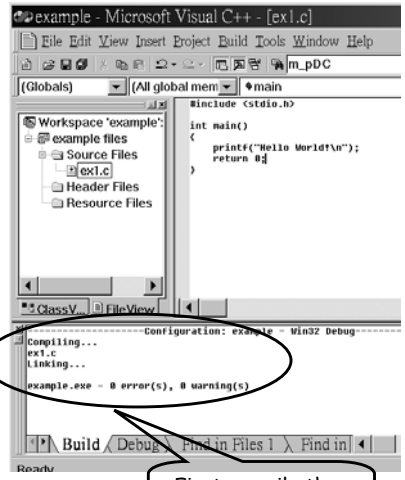


Warning and error messages if any

Visual C++ 6.0

✧ Build the whole project

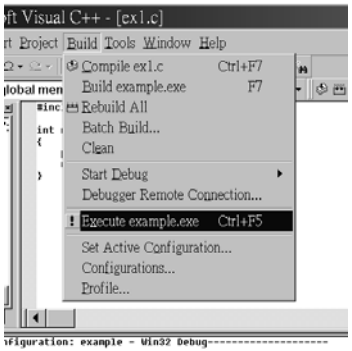


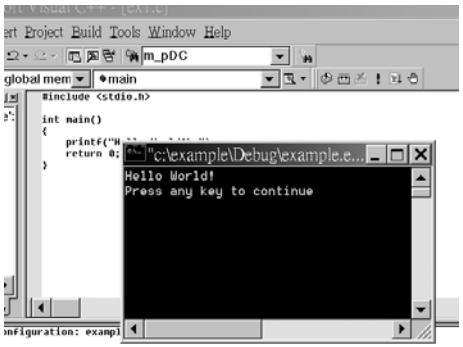


First compile then link

Visual C++ 6.0

✧ Execute





✧ .exe file is located in the "Debug" directory in debug configuration

✧ .exe file is located in the "Release" directory in release configuration

Visual C++ Command-Line Compiler

- Download at:
  - http://msdn.microsoft.com/visualc/vctoolkit2003/
- Install the toolkit
- Configure environment:
  - Set PATH=<the toolkit directory>\bin;%PATH%
  - Set INCLUDE=<the toolkit directory>\include;%INCLUDE%
  - Set LIB=<the toolkit directory>\lib;%LIB%

Visual C++ Command-Line Compiler

- Compile and Build

  > **cl foo.c**

  or

  > cl foo1.c foo2.c –OUT:foo.exe

- Compile

  > cl –c foo.c

- Link

  > link foo1.obj foo2.obj –OUT:foo.exe

Contents

- C Development Environment
- **Basic Procedural Programming Concepts**
- Functions
- Pointers and Arrays
- Strings
- Basic I/O
- Memory Allocation
- File Operation
- Reading the Command Line

Basic Programming Concepts

- Controlling the CPU+Memory+I/O to obtain your computational goals
- Memory: provides storages for your data
  - Constants: 1, 2, 'A', "a string"
  - Variables: int count;
- CPU: provides operations to data
  - Data movement: count = 1;
  - Arithmetic or Boolean expressions: 2 * 4
  - Testing and control flow: if statement, for loop, while loop, function
- I/O: FILE, stdin, stdout, printf(), scanf(), getc(), …

Programming Concepts (cont'd)

Procedural programming basics

- **Step 1**: represent your data in terms of variables
  basic types: char, int, float, double
  user defined types: struct…link lists, trees,…

  (Here are what you learned in **Data Structure**)
- **Step 2**: figure out how to transform the original data to the desired result that you want to see with the primitive operations a computer provides: ex. search, sort, arithmetic or logic computations,…

  (Here is what you learned in **Algorithm**)

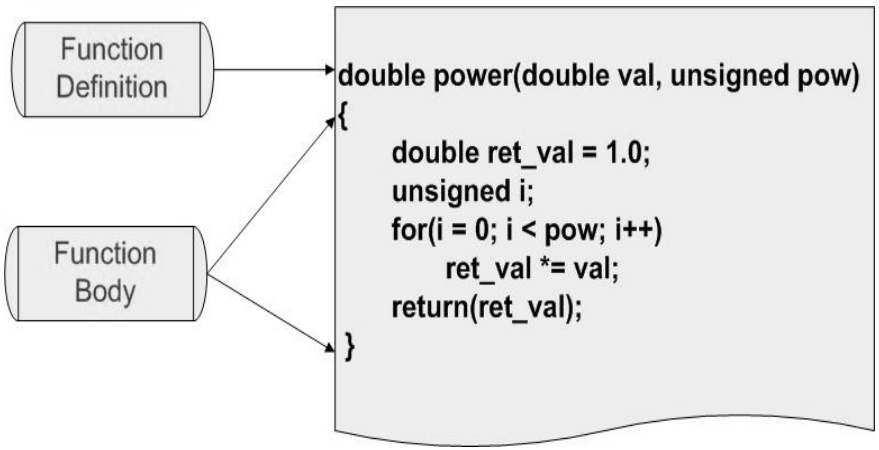
Programming Concepts (cont'd)

- Additional Requirements
  - **Structural Programming**: if statement, switch-case statement, iteration structure, function, block … (forbidden commands: goto, break…)
  - **Modularization**: function and file
  - **Functional testing / Unit testing**: assertion, unit testing routines, functional testing routines

Contents

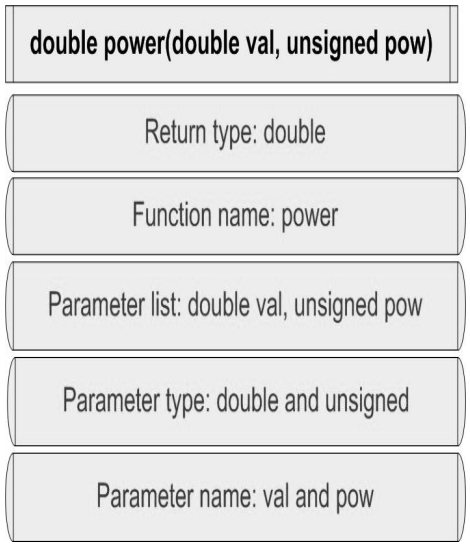
Function Basic

- A simple function compute the value of val^{pow}



Function Definition

- The first line of the function, contains:
  - Return data type
  - Function name
  - Parameter list, for each Parameter, contains:
    - Parameter data type
    - Parameter name

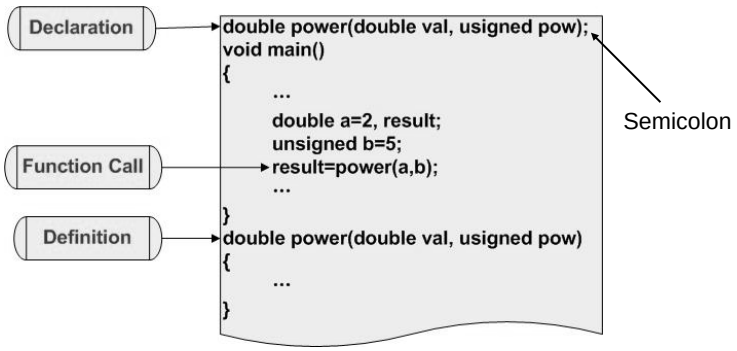


Function Body

- Function Body is bounded by a set of curly brackets
- Function terminates when:
  - "return" statement is reached or
  - the final closing curly bracket is reached.
- Function returns value by:
  - "return(ret_val);" statement, the ret_val must be of the same type in function definition;
  - Return automatically when reaching the final closing curly bracket , the return value is meaningless.

Function Declaration & Function Call

- Function can be called only after it is declared, a simple skeletal program:



Function Call

- Function can be called at any part of the program after the declaration:
  - The return value of a function can be assigned to a variable of the same type.
  - Example: result = power(2, 5);
    - Compute the value of 2^5 =32 and assign the value to the variable "result", equals to "result=32".

Function Parameter

- C is “called by value”
  - The function receives copies of values of the parameters
  - Example:
    - Print “a=10” and “x=314.159”

```
float circlearea(int x);
float pi=3.14159;
void main()
{
        float result, a=10;
        result=circlearea(a);
        printf( “a=%d” ,a);
}
float circlearea(int x)
{
        float y;
        y = pi*x*x; x=y;
        printf( “x=%d” ,x);
        return y;
}
```

a will not change

x is changed

Function Variable Scope

- Limited in the function
- Created each time when called
- Example,
  - pi: whole program
  - result, a: main
  - x,y: circlearea

```
float circlearea(int x);
float pi=3.14159;
void main()
{
        float result, a=10;
        result=circlearea(a);
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float circlearea(int x)
{
        float y;
        y = pi*x*x; x=y;
        printf( “x=%d” ,x);
        return y;
}
```

Global variable

Local variable

Local variable

Contents

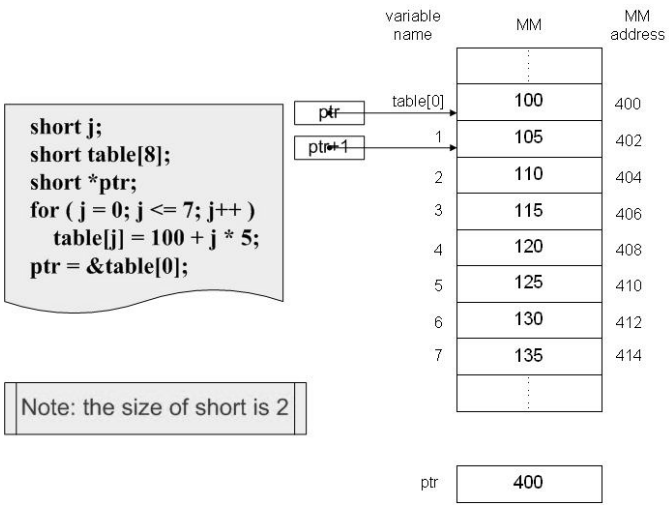
Basic Pointer Operations

- Declaration: with asterisk *.
  - int *ip; (declare a variable of integer address type)
- Generation: with “address-of” operator &.
  - int i = 5; ip = &i; (ip points to the address of i)
- Retrieve the value pointed to by a pointer using the “contents-of” (or “dereference”) operator, *.
  - printf("%d\n", *ip); (equals to “printf("%d\n", i); ”)
  - *ip=10; (equals to “i=10”)

Pointers and Arrays

- Pointers do not have to point to single variables. They can also point at the cells of an array.
  - int *ip; int a[10]; ip = &a[3];
- An array is actually a pointer to the 0-th element of the array
  - int *ip; int a[10]; ip = a; (equals to “ip = &a[0]”)
  - a[5]=10; is equivalent to *(a+5)=10;
- Pointers can be manipulated by “+” and “-”.
  - int *ip; int a[10]; ip = &a[3];
  - The pointer “ip-1” points to a[2] and “ip+3” points to a[6];

Pointers and Arrays: Example



Additional Information

- Pointer is a variable too, the content of a pointer is the address of the memory.
- Pointers can also form arrays, and there can be a pointer of pointer.

  int * pt[10];

  int ** ppt; (viewed as int * * ppt;)

  ppt = &pt[0] (or ppt = pt);

Contents

String basic

- Strings in C are represented by arrays of characters.
- The end of the string is marked with the *null character*, which is simply the character with the value 0. (Also denoted as '\0');
- The string literals:
  - char string[] = "Hello, world!";
  - we can leave out the dimension of the array, the compiler can compute it for us based on the size of the initializer (including the terminating \0).

Note:

char string[]; is illegal

string = "Hello, world!"; is illegal

String handling

- Standard library <string.h>
- For details, please refer to manual: such as MSDN

strcat,strncat	Append string
strchr,strrchr	Find character in string
strcpy,strncpy	Copy string
strcmp, strncmp	Compare string
strlen	Return string length
strstr	Find substring

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Contents

Char I/O

- "getchar": getchar returns the next character of keyboard input as an int.
- "putchar": putchar puts its character argument on the standard output (usually the screen).

```
#include <ctype.h>
/* For definition of toupper */
#include <stdio.h>
/* For definition of getchar, putchar, EOF */
 main()
 {  int ch;
    while((ch = getchar()) != EOF)
        putchar(toupper(ch));
 }
```


String I/O

- "printf": Generates output under the control of a *format string*
- "scanf": Allows *formatted reading* of data from the keyboard.

Format Specification

- Basic *format specifiers* for printf and scanf:
  - %d print an int argument in decimal
  - %ld print a long int argument in decimal
  - %c print a character
  - %s print a string
  - %f print a float or double argument
  - %o print an int argument in octal (base 8)
  - %x print an int argument in hexadecimal (base 16)

Contents

Allocating Memory with “malloc”

- Is declared in <stdlib.h>
  - void *malloc(size_t size);
- Returns a pointer to *n* bytes of memory
  - *char *line = (char *)malloc(100);*
- Can be of any type;
  - Assume “date” is a complex structure;
  - *struct date *today =*
    *(struct date *)malloc(sizeof(struct date));*
- Return null if failed

Freeing Memory

- Memory allocated with *malloc* lasts as long as you want it to.
- It does not automatically disappear when a function returns, but remain for the entire duration of your program.
- Dynamically allocated memory is deallocated with the *free* function.
  - *free(line); free(today);*
  - fail if the pointer is null or invalid value

Reallocating Memory Blocks

- Reallocate memory to a pointer which has been allocated memory before (maybe by *malloc*)
  - void *realloc(void *memblock, size_t size);
  - *today_and_tomorrow = realloc(today, 2*sizeof(date));*

Contents

File Pointers

- C communicates with files using a extended data type called a file pointer.
  - FILE *output_file;
- Common file descriptors:
  - “stdin”: The standard input. The keyboard or a redirected input file.
  - “stdout”: The standard output. The screen or a redirected output file.
  - “stderr”: The standard error. The screen or a redirected output file.

Open and Close

- Using *fopen* function, which opens a file (if exist) and returned a file pointer
  - fopen("output_file", "w");
- Using *fclose* function, which disconnect a file pointer from a file
- Access character:
  - “r”: open for reading;
  - “w”: open for writing;
  - “a”: open for appending.

File I/O

- Standard library <stdio.h>
- For details, please refer to manual: such as MSDN

putchar, putc	Put a character to a file
getchar, getc	Get a character from a file
fprintf	Put formatted string into a file.
fscanf	Take data from a string of a file.
fputs	Put a string into a file
fgets	Get a string from a file

Contents

Input From the Command Line

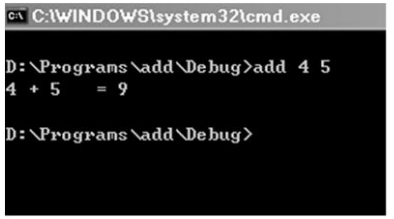
- C's model of the command line of a sequence of words, typically separated by whitespace.
- A program with command arguments:
  - int main(int argc, char *argv[]) { ... }
  - “argc” is a count of the number of command-line arguments.
  - “argv” is an array (“vector”) of the arguments themselves.

Ex.

sort file1 file2 file3

Example

```
#include <stdio.h>
#include <stdlib.h>
main(int argc, char *argv[])
{
      int a = atoi(argv[1]);
      int b = atoi(argv[2]);
      int sum = a + b;
      printf("%s + %s  = %d\n",argv[1],argv[2],sum);
}
```



argc = 3

argv[0] = “add”

argv[1] = “4”

argv[2] = “5”