Functions and Program Structure

EECS 2031

Function Basics (4.1)

- Functions
  - Brake large computing tasks into smaller: During the design stage try to separate small tasks that may be implemented as single function.
  - Can be reused
- Scope
  - Where the name can be used/visible?

Definition and Declaration

- Declaration (e.g., function prototype)

  returned_type function_name (list_of_arguments) ;

- Definition

  returned_type function_name (list_of_arguments)
  {
  declarations and statements
  }

- Return statement

  return *expresssion* ;

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return Statement (4.2)

- Functions use **return** statement to return the result to the caller.

  return *expression*;

- Functions can return any type: **void**, **int**, **double**, pointer (to the variable or function), etc.
- Inconsistent expressions will be cast to the returned type of the function.

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External Variables (4.3)

- **Internal variables**
  - Defined inside of the function body and exists only when the function is executed.
- **External objects**
  - External variables and function are defined outside of any function.
  - External variables may be used as a tool to communicate between functions.

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External Variables (cont.)

- Problems with external variables
  - Everyone can access the variable (like *public* variables in Java).
  - Low level of control.
  - Too many externals leads to bad program structure with too many data connections between functions (problem with modularity and reusing).
- Bottom line:
  - Avoid external variables whenever possible!

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Scope (4.4)

- Scope is a part of the program within which a declared name can be used.
- Questions of interest:
  - How to write declarations so that variables are properly declared during compilation?
  - How are declarations arranged so that all the pieces will be properly connected when program is loaded?
  - How are declarations organized so there is only one copy?
  - How external variables are initialized (so that all of them are initialize once)?

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extern Declaration

In order to use a variable in another file or before its definition.

file1.c

```
extern int size ;
extern char buff[ ] ;
```

file2.c

```
int size = SIZE ;
char buff[SIZE] ;
```

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Declaration vs. Definition

Declaration: announces the properties of a variable (type).

Definition = Declaration + Storage to be set aside.

file 1.c

extern int sp;

extern double val[ ];

file2.c

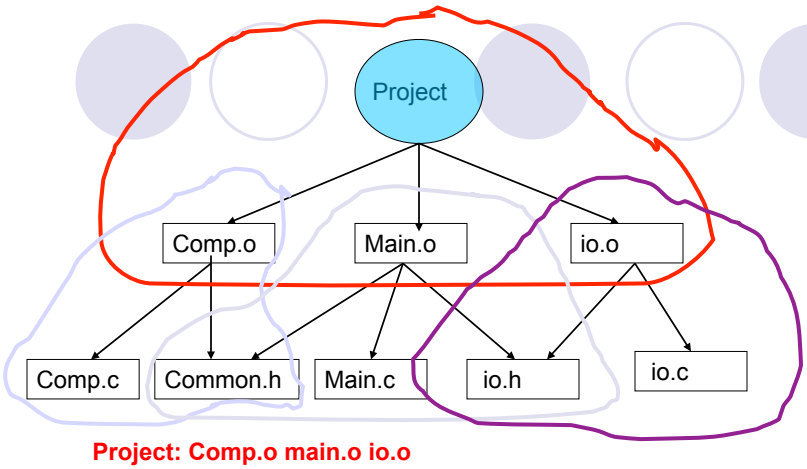
int sp = 0;

double val[MAXVAL];

Static Variables (4.6)

- **static** declaration restricts (hide) the visibility (scope) of a variable or a function.
- **Static external variables**: visible only in the source file in which they are defined.
- Example: routines in Comp.c and Main.c cannot access **buf[]** or **bufp**.
- Those variable names can be used in Comp.c and Main.c for other variables without any conflict since they are not visible outside io.c.

```
/* File io.c */

#include <stdio.h>

static char buf[BUFSIZE];
static int bufp = 0;

int getch(void) { ... }

void ungetch(int c) { ... }

/* end of file io.c */
```



Project: Comp.o main.o io.o
cc Comp.o main.o io.o –o Project

Comp.o : Comp.c Common.h
cc –c Comp.c

Main.o: Main.c Common.h io.h
cc –c Main.c

io.o: io.h io.c
cc –c io.c

cc -c: stop compiler after producing the object file, do not link.

Static Variables (cont.)

- **Static function**: its name is invisible outside of the file in which it is declared.
- *Note*: function names are normally global.
- **Static internal variable**:
  - visible only inside the function in which it is defined.
  - remains in existence (not coming and going each time the function is called).
  - provide private, permanent storage within a single function.

```
static int power
   (int base, int n) {
    ...
}
```

```
int getline(char s[]) {
    static int counter;
    int next;
    ...
}
```

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Register Variables (4.7)

- **register** declaration advises the compiler that the variable will be heavily used.
- The register variable will be placed in machine registers ⇒ smaller, faster program.
- Compilers are free to ignore the advice.
- Examples:

```
register int i;
register char c;
my_func( register long x, register unsigned y )
```

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Register Variables (cont.)

Restrictions due to underlying hardware:

- Only a few registers available.
- Only certain types are allowed.
  - Excess/disallowed declarations are treated as normal variables.
- Not possible to take address of a register var.

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Block Structure (4.8)

- Block: delimited by { and }

```
if (n > 0) {
  int i; /* declare a new i */
  for (i = 0; i < n; i++)
    ...
}
```

- **i** is initialized *each time* the block is entered.
- A **static** variable is initialized only the *first time* the block is entered.

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Block Structure (cont.)

```
int x;
int y;
...
f(double x)
{
  double y;
}
```

- The above works, but avoid that programming style!

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Initialization (4.9)

Explicit initialization

- External and static vars: must be constant expressions
- Automatic and register vars: any expressions (involving pre-defined values or function calls)

```
int x = 1;
char squote = '\'';
long day = 1000L * 60L * 60L *
   24L; /* milliseconds/day */

int binsearch( int x, int v[],
   int n )
{
   int low = 0;
   int high = n - 1;
   int mid;
   ...
}
```

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Initialization (cont.)

No explicit initialization

- External and static vars: initialized to 0.
- Automatic and register vars: undefined (garbage) initial values.

Arrays

```
int days[] = { 31, 28, 31, 30, 31, 30, 31, 31, 30, 31,
  30, 31 };  /* array of size 12 */
int months[12] = { 100, 25, 75 };  /* the rest is 0*/
char pattern = "ould";  /* same as below */
char pattern[] = { 'o', 'u', 'l', 'd', '\0' };
```

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Recursion (4.10)

- In C, a function may call itself either directly or indirectly.

```
#include <stdio.h>

/* print n in decimal */
void printd(int n)
{
   if (n < 0) {
       putchar('-');
       n = -n;
   }
   if (n / 10)
       printd(n / 10);
   putchar(n % 10 + '0');
}
```

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Recursion (cont.)

- Advantages:
  - More compact code
  - Easier to write and understand
- Disadvantage: more overhead for recursive function calls
  - Stack space
  - Parameter saving and returning

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