

External and static variables

- **External variable**: declared outside the body of a function
- **File scope**: visible from the point of the declaration to the end of the file.
- **Static storage duration**: through the duration of the program.
- External/global variables have file scope and static storage duration.

Example

```
#include <stdio.h>

int nextvalue()
{
    static int i = 0;
    i++;
    return i;
}

int main()
{
    int i;
    for(i = 10; i > 0; i--) {
        printf("%d\n", nextvalue());
    }
    return 0;
}
```

```
output:
1
2
3
4
5
6
7
8
9
10
```

static variables

```
static int i;
```

```
void f(void)
{
    static int j;
}
```

- static used outside a block means that the variable is only visible in the file in which it is declared
- static used in a block means that the variable lives beyond the duration of the block, and is initialized only once.

extern

filea.c

```
extern int i;

void f(void) {
    i++;
}
```

fileb.c

```
int i = 0;
extern void f(void);
void g(void) {
    f();
    printf("%d\n", i);
}
```

- informs the compiler that `i` is an `int` variable, but doesn't cause it to allocate space.

typedef

- You can define new types using typedef.
- You have already seen the effects of typedef

```
typedef unsigned int size_t;
```

- Example

```
struct personrec {  
    char name[20];  
    int age;  
};  
typedef struct personrec Person;  
Person *p = malloc(sizeof(Person));
```

typedef

- You can define new types using typedef.
- You have already seen the effects of typedef

```
typedef unsigned int size_t;
```

- Example

```
typedef struct {  
    char name[20];  
    int age;  
} Person;  
  
Person *p = malloc(sizeof(Person));
```

Header files

- When you begin to split up your C program into multiple files, you need header files to store function and type declarations.

main.c

```
void add(int);  
int isEmpty();  
extern List head;  
int main()  
{  
    add(10);  
    isEmpty();  
    head = NULL;  
}
```

list.c

```
List *head = NULL;  
int isEmpty()  
{...}  
void add(int v)  
{...}  
void remove(int v)  
{...}
```

list.h

```
struct node {  
    int value;  
    struct node * next;  
};  
typedef struct node List;  
extern List *head;  
int isEmpty(int);  
void add(int);  
void remove(int)
```

main.c

```
#include "list.h"  
  
int main()  
{  
    add(10);  
    isEmpty();  
    head = NULL;  
}
```

list.c

```
#include "list.h"  
List *head = NULL;  
int isEmpty()  
{...}  
void add(int v)  
{...}  
void remove(int v)  
{...}
```

list.h

```
struct node {
    int value;
    struct node * next;
};
typedef struct node List;
List *head = NULL;
int isEmpty();
void add(int);
void remove(int)
```

Wrong!

main.c

```
#include "list.h"

int main()
{
    add(10);
    isEmpty();
}
```

list.c

```
#include "list.h"

int isEmpty()
{...}
void add(int v)
{...}
void remove(int v)
{...}
```

Wrong!

main.c

```
#include "list.c"

int main()
{
    add(10);
    isEmpty();
}
```

list.c

```
List *head = NULL;
int isEmpty()
{...}
void add(int v)
{...}
void remove(int v)
{...}
```

list.h

```
struct node {
    int value;
    struct node * next;
};
typedef struct node List;

int isEmpty(List *, int);
void add(List *, int);
void remove(List *, int)
```

Allows more
than one List
to be used

main.c

```
#include "list.h"

int main()
{
    add(10);
    isEmpty();
}
```

list.c

```
#include "list.h"

int isEmpty(List *h)
{...}
void add(List *h, int v)
{...}
void remove(List *h, int v)
{...}
```

Protecting header files

- Compilation errors may result if a header file is included more than once.
- This causes a problem if the header file defines types.
- Use preprocessor directives to selectively compile.
#ifndef LIST_H
#define LIST_H
...(contents of the header file)
#endif

Makefiles

- Makefiles were originally designed to support separate compilation of C files.

```
CFLAGS= -g -Wall
```

```
all : switch1 switch2 switch3
```

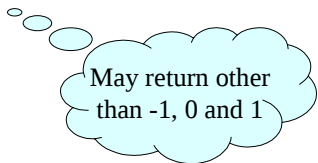
```
switch1 : reverse.o switch1.o
gcc ${CFLAGS} -o switch1 $^
switch2 : reverse.o switch2.o
gcc ${CFLAGS} -o switch2 $^
switch3 : reverse.o switch3.o
gcc ${CFLAGS} -o switch3 $^
%.o : %.C
gcc ${CFLAGS} -c $<
```

mystrcmp.c

```
int main(int argc, char **argv)
{
    char *result;
    if (argc != 3) {
        fprintf(stderr, "Usage: %s string1 string2\n", argv[0]);
        exit(1);
    }
    switch (mystrcmp(argv[1], argv[2])) {
        case -1: result = "less than"; break;
        case 0:  result = "equal to"; break;
        case 1:  result = "greater than"; break;
        default: result = "causing a problem comparing to"; break;
    }
    printf("%s is %s %s\n", argv[1], result, argv[2]);
    return 0;
}
```

mystrcmp.c (continued)

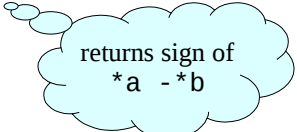
```
int mystrcmp (const char *a, const char *b)
{
    while (*a && *b && *a == *b) {
        a++; b++;
    }
    return (*a - *b);
}
```



May return other
than -1, 0 and 1

mystrcmp.c (return -1,0, or 1)

```
int mystrcmp (const char *a, const char *b)
{
    while (*a && *b && *a == *b) {
        a++; b++;
    }
    if (*a < *b)
        return -1;
    else if (*a > *b)
        return 1;
    else /* a same as b */
        return 0;
}
```



returns sign of
*a - *b