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.

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.

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
```

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));
```
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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));
```
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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)
{...}
```
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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)
{...}
```
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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)
{...}
```

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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)
{...}
```

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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()
{
    List *list1 = NULL;
    add(list1, 10);
    isEmpty(list1);
}
```

list.c

```
#include "list.h"

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

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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
```

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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 $<
```
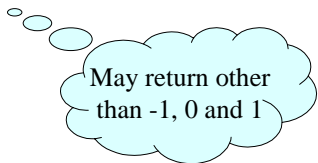
mystrcmp.c

```
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);
}
```
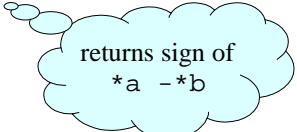
May return other than -1, 0 and 1

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