System Software Experiment 1
Lecture 11: Storage Classes
spring 2018

Jinkyu Jeong (jinkyu@skku.edu)
Computer Systems Laboratory
Sungyunkwan University
http://csl.skku.edu
Scope Rules

• Identifiers are accessible only within the block in which they are declared.

• Those are unknown outside of the block!
Storage Classes

- Auto
- Register
- Extern
- Static
Memory Allocation

- **Auto**
- **Dynamic Allocation** (ex. malloc)
- **Extern**
- **Static**
Auto

• Declared by default
• Allocated when a block is entered.
• Released when the block is exited.
• After release, the former value is ignored.
• Stored in the “stack”

Register

• The associated variables should be stored in memory registers.
• Changed into auto if failed to reserve proper registers
Extern

- Stored in the "data area"
- If defined outside of a function, automatically set to extern.
- External variables never disappear until the end of program.

```c
#include <stdio.h>

int a = 1;
int b = 2;
int c = 3;
int add(void);

int main(){
    printf("%d\n", f()); // 12 is printed
    printf("%d %d %d", a, b, c); // 4 2 3 printed
    return 0;
}

int f(){
    int b, c; // local b, c
    a = b = c = 4; // external b, c are masked
    return (a + b + c);
}
```
• Limited only into current file if you omit “extern”
• “Look for it elsewhere, either in this file or in some other file!”

```c
#include <stdio.h>
int a = 1, b = 2, c = 3;
int add(void);

int main()
{
    printf("%d\n", add());
    printf("%d %d %d\n", a, b, c);
    return 0;
}
```

```c
int f()
{
    extern int a;
    int b, c;
    a = b = c = 4;
    return (a + b + c);
}
```

• How to compile and link them?
Static

• Stored in the “data area”
• Value is stored even if the block is closed!
• Can not be accessed & modified by other files.

```c
void f()
{
    static int cnt = 0;
    ++cnt;
    if(cnt % 2 == 0) printf("cnt %d is even!\n", cnt);
    else printf("cnt %d is odd!\n", cnt);
}
```
Static external: what is different?

• Scope: the remainder of the source file

```c
void f (){
    ...
    // v is not available
}
static int v;
void g(){
    ...
    // v can be used
}
```

Unlike external, cannot be accessed from other files
Static external: Continued

- The value of seed is preserved between function calls.
- Every time random is called, the seed value is changed.

```c
static unsigned seed = 17;

unsigned random(void){
    seed = seed * 25173 + 13849;
    return seed;
}

double probability(void){
    seed = seed * 25173 + 13849;
    return (seed / 65536.0);
}
```
Exercise 1

Calculate mean value for 5 double numbers. Use appropriate definitions and declarations.

```c
#include <stdio.h>
#define SIZE 5

double target[] = {1.5, 2.1, 1.7, 0.8, 3.1};
int main()
{
    double target_mean, mean, input;
    int j;

    for(j = 0; j < 5; j++)
    {
        scanf("%lf", &input);
        add_mean(input, &mean);
        printf("Mean = %lf\n", mean);
    }

    for(j = 0; j < 5; j++)
    {
        add_target_mean(&target_mean);
    }
    printf("Target mean = %lf\n", target_mean);

    return 0;
}
```

```c
#include <stdio.h>

double add_mean(double input, double *m){
}

double add_target_mean(double *m){
}
```

```
gcc -c add_mean.c
gcc -c week11_exercise.c
gcc -o week11 add_mean.o week11_exercise.c
./week11
```