CH-230-A

Programming in C and C++

C/C++

Lecture 4

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Local Variables

- Variables can be declared inside any function
  - These are called local variables
  - Local variables are created when the function is called (e.g., the control is transferred to the function) and are destroyed when the function terminates
- Local variables do not retain their values between different calls

The Concept of Scope

- The scope of a name (function, variable, constant) is the part of the program where that name can be used
- The scope of a local variable is the function where it is defined
  - From the point of its definition
- Names having different scopes do not clash

Global Scope

- The scope of the names of functions goes from the prototype/definition to the end of file
- After their name is known they can be used, i.e., called
- It is possible to define global variables, i.e., variables outside function
  - Their scope is from the point of definition to the end of the file
  - After their definition is given they can be used, i.e., written and read

Local and Global Scope

```c
#include <stdio.h>

//global variable
int x = 7;

void xlocal(int y)  {
  int x;
  x = y * y;
  printf("xlocal: %d\n", x);
  return;
}

void xglobal(int y)  {
  x = y * x;
  printf("xglobal: %d\n", x);
  return;
}
```

```c
int main() {
  //int x;
  // try to explain if not
  // commented out
  x = 8;
  printf("main: %d\n", x);
  xlocal(x);
  printf("main: %d\n", x);
  xglobal(x);
  printf("main: %d\n", x);
  return 0;
}
```

Do not Misuse Global Variables

- Global variables can be used to communicate parameters between functions
- They can introduce subtle bugs in your code
- In general try to avoid them unless enormous advantages can be gained at a price of low risk
  - Document why you insert them
- Bigger projects will avoid using global variables

Parameters

- Function parameters are treated as local variables
- Local variables within functions and parameters must have different names
- Therefore the scope of a parameter is its function

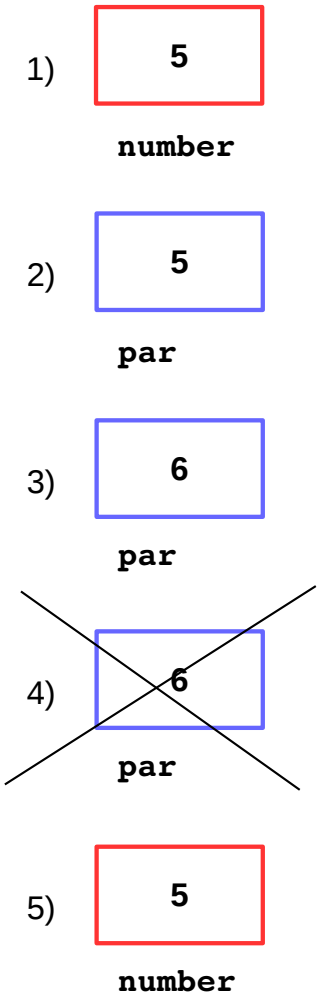
Parameters: by Value and by Reference

- **By value**: variables are copied to parameters
  - Changes made to parameters are not seen outside the function
- **By reference**: variables and parameters coincide
  - Changes made to parameters are seen outside the function
  - In C this is obtained by mean of pointers

Example: Passing by Value (1)

```
1  #include <stdio.h>
2  void increase(int par) {
3    par++;
4  }
5  /*  In this case no prototype:
6      can you tell why? */
7  int main() {
8    int number = 5;
9    increase(number);
10   printf("Increased number is %d\n", number);
11   /* not as expected? */
12   return 0;
13 }
```

Example: Passing by Value (2)



Parameters by Reference in C

- C passes only parameters by value
- For references it is necessary to provide a pointer to the variable
- In order to make a modification visible
- Outside it is necessary to use the dereference (∗) operator

Example: Passing by Reference (1)

```
1  #include <stdio.h>
2
3  void increase(int *par) {
4    *par = *par + 1;
5  }
6
7  int main() {
8    int number = 5;
9    increase(&number); /* pass pointer */
10   printf("Increased number is %d", number);
11   return 0;
12 }
```

Example: Passing by Reference (1)

1) **5**

`number`

2) **5**

`par` is pointing to number `par = &number`
`par` is the copy of the memory address of `number`

3) **6**

`number` manipulated via pointer `par`

4) **`par` is deleted as the copy of the address**

5) **6**

`number`

Indentation Styles (1)

- Use spaces between operators: `a = b + 5;`
- Exception: `b++;`
- Do not use spaces if parentheses act as delimiter (functions)
  `printf("Number %d", b);`
- But use spaces before after `if`, `for`, `while`:
  `while (i <= 10)`
- Always put a space after comma
- Do not put a space before semicolon:
  `printf("Number %d", b);`

Indentation Styles (2)

- Put the opening brace either behind last word (including space) or put it on the next line
- Indent the block inside by tab or 4 (8) spaces
- The closing brace should be on the same column as the opening statement

```
for (i = 0; i < 10; i++) {    // K&R style
  printf("%d\n", i);
}
```

or

```
for (i = 0; i < 10; i++)     // Allman style
{
  printf("%d\n", i);
}
```

Strings

- A string is a sequence of characters
- Strings are often the main way used to communicate information to the user
- Many languages provide a string data type, but C does not
- In C strings are treated as arrays of characters
- `char my_string[30];`

C Strings

- A string is represented as a sequence of chars enclosed by double quotes
  - `"This is it"`
- String are stored in arrays of chars
  - An extra character is always added at the end to mark the end of the string
  - The extra character is the `'\0'` character i.e., the character whose ASCII code is 0

T	**h**	**i**	**s**		**i**	**s**		**i**	**t**	**\0**

fgets versus gets (1)

- gets does not check if you type more characters than allowed:

```
char inputString[50];
gets(inputString);
```

- fgets allows additional parameters:

```
char line[50];
fgets(line, sizeof(line), stdin);
```

  - Reads up to 49 characters from the input stream
  - The 50th one is used to store the null character '\0'

fgets versus gets (2)

- gets replaces the trailing '\n' with a '\0'
- fgets does not replace '\n', but it leaves it in the string
- Read the man pages for learning more on these functions
  - man gets
  - man fgets
- To make your life easier use fgets and convert to integer via sscanf
- Avoid using gets, it is unsafe

fgets and scanf together

- scanf and fgets do not work well together
- Your code should look like this, if you use both

```
scanf("%d", &number);
getchar();
...
fgets(line, sizeof(line), stdin);
sscanf(line, "%d", &number);
```

String Functions

- Defined in `string.h`
- `strlen` Determines the length of a string
- `strcat` Concatenates two strings
- `strcpy` Copies one string into another
- `strcmp` Compares two strings
- `strchr` Searches a char in a string
- See man pages
  - Do not reinvent the wheel, there are many many functions that will help you

Passing Arrays to Functions

- An array does not store its size
- This has to be provided as a parameter, or by making assumptions on the contents of the array (like for strings)
- The name of an array is a pointer to the first element of the array, i.e., when an array is passed to a function, a copy of the address of the first element is given
- Modifications to the elements are seen outside
- Modifications to the array are not seen outside
- Can you explain why?

Passing Arrays to Functions: Example

```
1  #include <stdio.h>
2  #include <stdlib.h>
3  void strange_function(int v[], int dim) {
4    int i;
5    for (i = 0; i < dim; i++)
6      v[i] = 287;
7    // v = (int *) malloc(sizeof(int) * 1000);
8  }
9  int main() {
10   int array[] = {1, 2, 9, 16};
11   int *p = &array[0];
12   strange_function(array, 4);
13   printf("%d %p %p\n", array[0], p, array);
14   return 0;
15 }
```