# Structured Programming

## - Making Decisions

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With Thanks to Dr. Xin Feng and Dr. Haipeng Guo

# Outline

- C Statements
- Conditional Statements

# C Statements

- In the most general sense, a statement is a part of your program that can be executed.
- An expression is a statement (simple statement).

```
a = a+1;
a--;
```

- A function call is also a statement (more about function call will be introduced later).

```
printf("%d",a);
```

- A compound statement consists of several expressions and statements
  - Conditional statements
  - Loop statements

# C Statements

- C is a free form language, so you may type the statements in any style you feel comfortable:

```
a=
a+
1; a--;      // line breaks can be anywhere
```

- However, this style is not suggested

# Conditional Statements

- A conditional statement allows us to control whether a program segment is executed or not.
- Two constructs
  - *if* statement
    - *if*
    - *if-else*
    - *if-else if*
  - *switch* statement

# An Example

```
if (it is sunny){
        go to beach;
        swim;
  }
go to library;
```

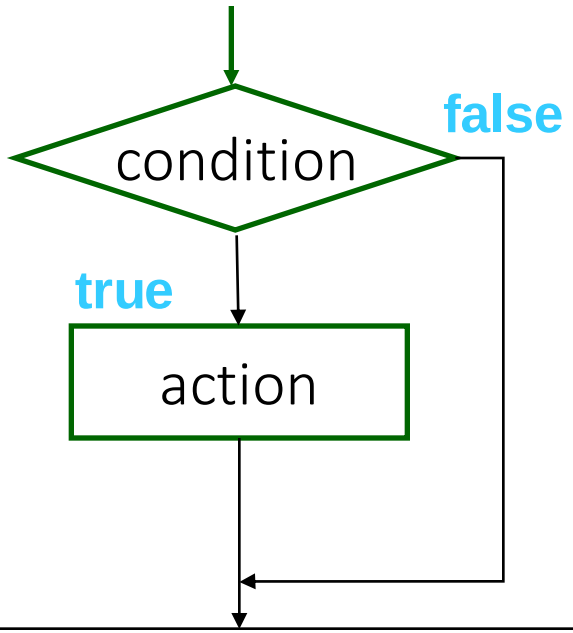
What does this mean?

# The Basic If Statement

Syntax:

```
if(<condition>){
    <action>
}
```

Flowchart:




- If the condition is true then execute the action.
- action is either a single statement or a group of statements within curly brackets.

# An Example

```
/* program to read number and print out its absolute
   value */
#include<stdio.h>
int main(){
    int value;
    printf(”Please enter an integer:”);
    scanf(”%d”, &value);
    if(value < 0)
      value = -value;
     printf(”The absolute value is %d.\n”, value);
     return 0;
}
```

What does this program want to do?

# An Example

```
/* program to read number and print out its absolute
   value */
#include<stdio.h>
int main(){
    int value;
    printf(”Please enter an integer:”);
    scanf(”%d”, &value);
    if(value < 0){
      value = -value;
     printf(”The absolute value is %d.\n”, value);
     }
     return 0;
}
```

What is the problem if a pair { } are added?

# Relational Expressions

| Operator | Description | Example |
|---|---|---|
| | | |
| > | greater than | 5 > 4 |
| >= | greater than or equal to | mark >= score |
| < | less than | height < 75 |
| <= | less than or equal to | height <= input |
| == | equal to | score == mark |
| != | not equal to | 5 != 4 |
| | | |

# '=' and '=='

- Compare these two programs

```
int a;
scanf("%d", &a);
if (a == 10)
   printf("a is 10");
```

```
int a;
scanf("%d", &a);
if (a = 10)
   printf("a is 10");
```

If the input is 5, what are the outputs of these two programs?
If the input is 10, what are the outputs of these two programs?

# ’= ’ and ’== ’

- Compare these two programs

```
int a;
scanf(”%d”, &a);
if (a == 10)
   printf(”a is 10”);
```

Input: 5
Output:

Input: 10
Output: a is 10

```
int a;
scanf(”%d”, &a);
if (a = 10)
   printf(”a is 10”);
```

Input: 5
Output: a is 10

Input: 10
Output: a is 10

# Condition

- a condition can have one of two values:
  - true (corresponds to a non-zero value)
    - E.g., if (x = 10)
  - false (corresponds to zero value)
    - E.g., if (0)

# Condition

- The Boolean data type bool
- A bool variable stores just a 0 or 1

```
bool x, y;
x = 0;
y = 1;
```

# Logical Operators

- Remember these logical operators?
  - && (and)
  - || (or)
  - ! (not)

What are the values of these Boolean variables

```
bool P = 1;
bool Q = 0;
bool R = 1;
bool S = P && Q;
bool T = !Q || R;
bool U = !(R && !Q);
bool W = -10;
```

# Precedence of Operators

- Precedence of operators (from highest to lowest)
  - Parentheses ( … )
  - Unary operators !
  - Multiplicative operators * / %
  - Additive operators + -
  - Relational ordering < <= >= >
  - Relational equality == !=
  - Logical and &&
  - Logical or ||
  - Assignment =

# An Example

```
int a;
scanf(”%d”, &a);
if (a <= 10 && a >= 5)
   printf(”a is between 5 and 10”);
```

# An Example

Sorting two numbers:

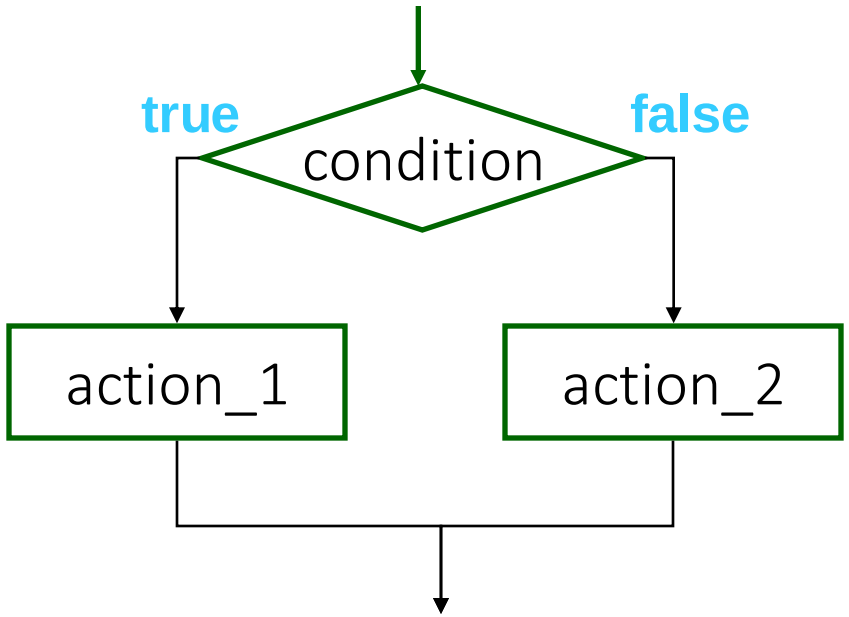
```
int value1;
int value2;
int temp;
printf(”Enter two integers:”);
scanf(”%d,%d”,&value1,&value2);
if(value1 > value2){
  temp = value1;
  value1 = value2;
  value2 = temp;
}
printf(”The input in sorted order: %d %d”,
value1,value2);
```

# The Basic If – else Statement

Syntax:

```
if(<condition>){
    <action_1>
}
else {
    <action_2>
}
```

Flowchart:




- if the condition is true then execute action_1; otherwise, execute action_2.
- action_1 and action_2 are either a single statement or a group of statements within curly brackets.

# An Example

```
if (it is sunny){
        go to beach;
        swim;
  }
go to library;
```

```
if (it is sunny){
        go to beach;
        swim;
  }
else
        go to library;
```

What is the difference between these code segments?

# An Example

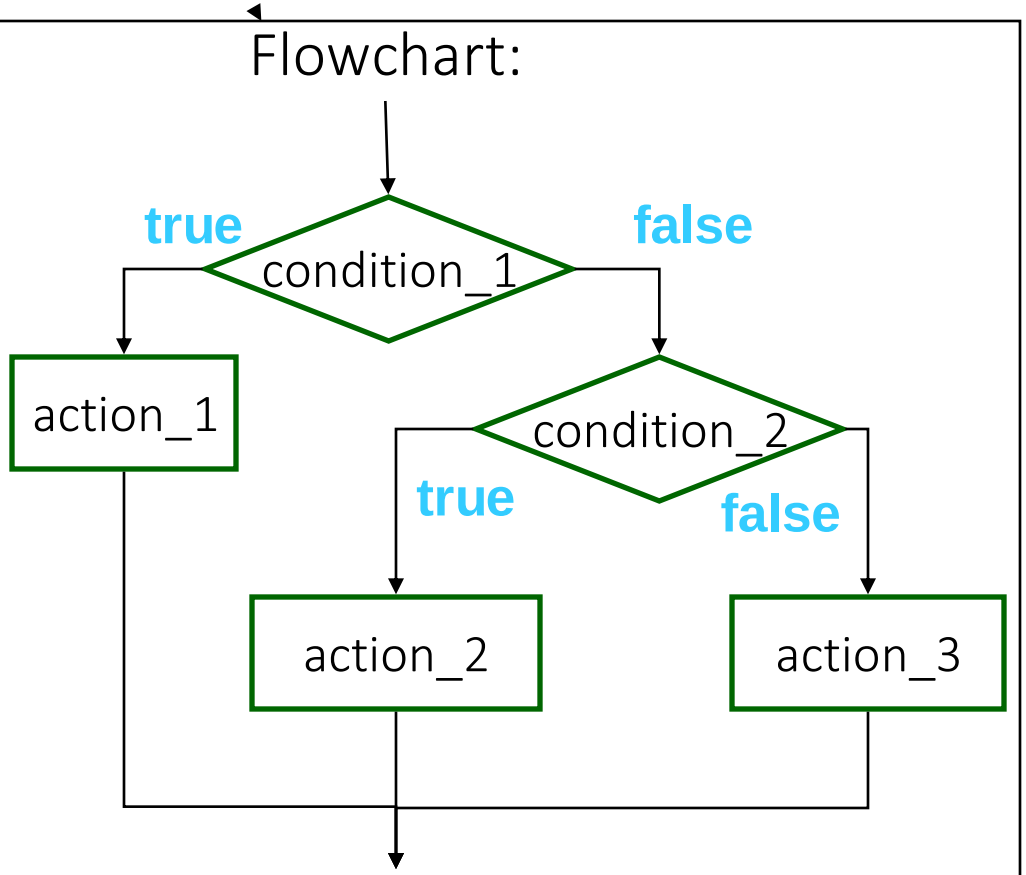
```
int value1;
int value2;
int larger;
printf(”Enter two integers: ”);
scanf(”%d%d”,&value1,&value2);
if(value1 > value2)
   larger = value1;
else
   larger = value2;
printf(”Larger of inputs is: %d.\n”,larger);
```

# The Basic if - else if Statement

Syntax:

```
if(<condition_1>){
    <action_1>
}
else if(<condition_2>){
    <action_2>
}
else {
    <action_3>
}
```

Flowchart:



# An Example

A calculator (for only +, - * and /):

```
char op;
int x, y;
scanf("%d,%c,%d",&x, &op, &y);
if(op == '+')
   printf("%d + %d = %d", x, y, x + y);
else if(op == '-')
   printf("%d - %d = %d", x, y, x - y);
else if(op == '*')
   printf("%d * %d = %d", x, y, x * y);
else if(op == '/')
    printf("%d / %d = %d", x, y, x / y);
else printf("Invalid operator!");
```

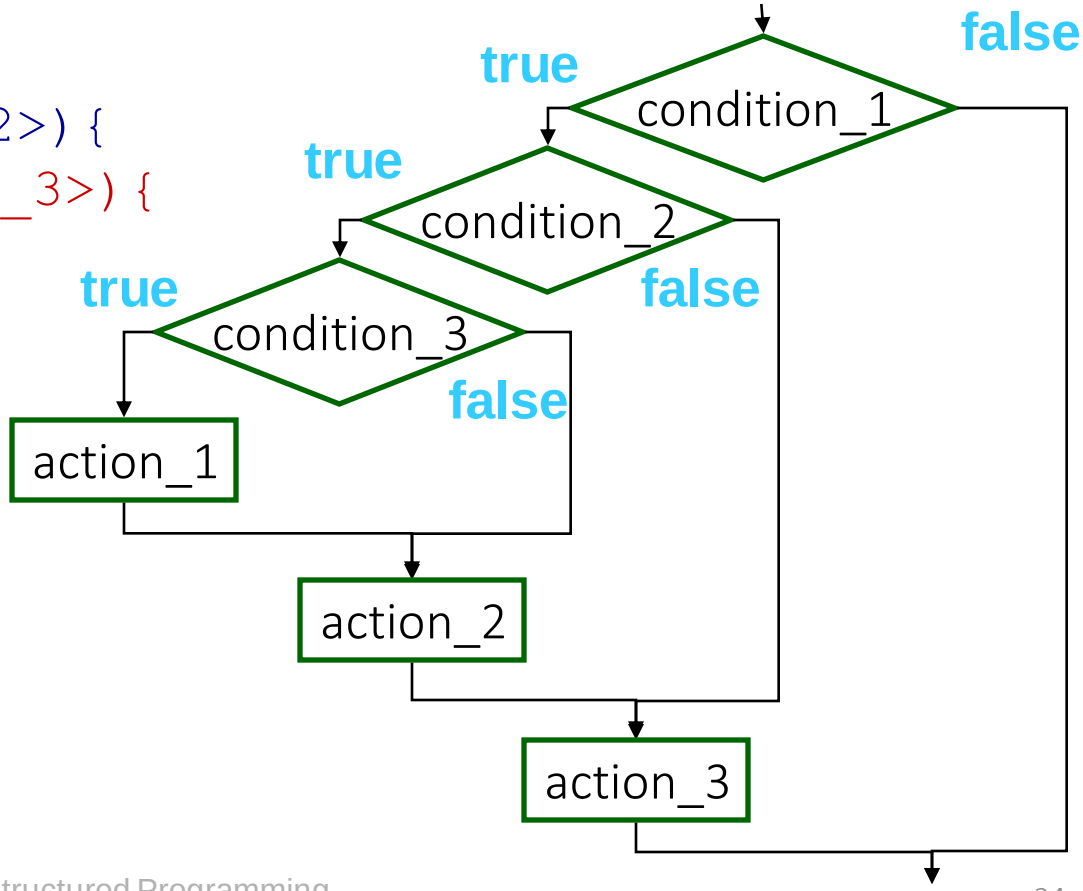
Can you draw a flowchart for this program?

# Nested if Statements

- Nested means that one complete statement is inside another

```
if (<condition_1>){
    if (<condition_2>){
      if (<condition_3>){
          <action_1>
      }
      <action_2>
    }
    <action_3>
}
```

Flowchart:



# Examples

```
if (member is true){
   if (age < 18)
      fee = fee * 0.5;
   if (age >= 18)
      fee = fee * 0.8;
}
```

```
if (member is true){
   if (age < 18)
      fee = fee * 0.5;
}
if (age >= 18)
   fee = fee * 0.8;
```

```
if (member is true){
   if (age < 18)
      fee = fee * 0.5;
   else
      fee = fee * 0.8;
}
```

```
if (member is true)
   if (age < 18)
      fee = fee * 0.5;
else
   fee = fee * 0.8;
```

# ” Dangling Else” Problem

```
if (member is true){
   if (age < 18)
      fee = fee * 0.5;
   else
       fee = fee * 0.8;
}
```

==

```
if (member is true)
   if (age < 18)
      fee = fee * 0.5;
else
   fee = fee * 0.8;
```

# ” Dangling Else” Problem

This one will produce a different result. →

```
if (member is true){
   if (age < 18)
      fee = fee * 0.5;
 }
else
   fee = fee * 0.8;
```

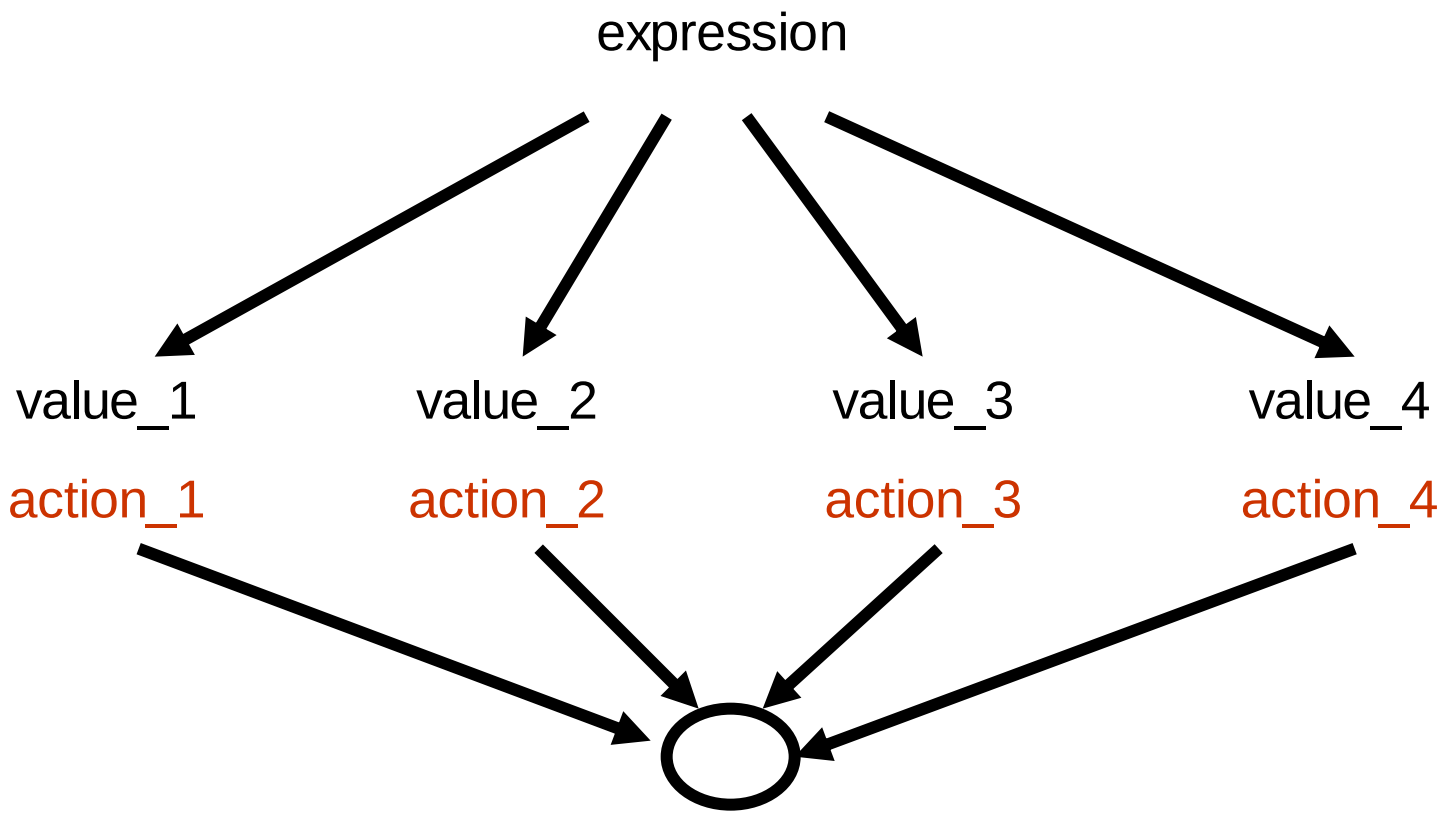
≠

```
if (member is true){
   if (age < 18)
      fee = fee * 0.5;
   else
       fee = fee * 0.8;
}
```

==

```
if (member is true)
   if (age < 18)
      fee = fee * 0.5;
else
   fee = fee * 0.8;
```

# Multi-way Selection: Switch Statement



# Switch Statement

Syntax:

```
switch (<expression>) {
  case <value_1>: <action_1>;
                  break;
  case <value_2>: <action_2>;
                  break;
  case <value_3>: <action_3>
                  break;
  default: <action_4>;
 }
```

Meaning:

- Evaluate selector expression.
- Match case label.
- Execute sequence of statements of matching label.
- If break encountered,

  go to end of the **switch** statement; otherwise continue execution.

# Switch Statement

- Attentions
  - The expression must be an integral expression.
  - The value following each **case** label must be a constant.
  - No two **case** labels have the same value.
  - Two **case** labels may be associated with the same statements.
  - Remember to include the break statement at the end of each case.
  - The **default** label is optional.
  - There can be only **one** default label, and it is usually last.

# An Example

```
char op;
int x, y;
scanf("%d,%c,%d",&x, &op, &y);
if(op == '+')
   printf("%d + %d = %d", x, y, x + y);
else if(op == '-')
   printf("%d - %d = %d", x, y, x - y);
else if(op == '*')
   printf("%d * %d = %d", x, y, x * y);
else if(op == '/')
    printf("%d / %d = %d", x, y, x / y);
else printf("Invalid operator!");
```

Can we rewrite this program using switch statement?

# An Example

```
char op;
int x, y;
scanf(”%d%c%d”,&x, &op, &y);
switch (op){
  case ’+’: printf(”%d + %d = %d”, x, y, x + y);
            break;
  case ’-’: printf(”%d - %d = %d”, x, y, x - y);
            break;
  case ’*’: printf(”%d * %d = %d”, x, y, x * y);
            break;
  case ’/’: printf(”%d / %d = %d”, x, y, x / y);
            break;
  default:  printf(”Invalid operator!”);
}
```

# An Example

```
switch(int(score)/10){
   case 10:
   case 9: printf(”Grade = A\n”);
           break;
   case 8: printf(”Grade = B\n”);
           break;
   case 7: printf(”Grade = C\n”);
           break;
   case 6: printf(”Grade = D\n”);
           break;
   default: printf(”Grade = F\n”);
}
```

- What is the output of this program if score is 95?
- What if all the ”break” are missed?
- How can we use if-else if statement to rewrite this program?

# Summary

- Make decisions in a program
  - if
  - if-else
  - if-else-if
  - switch
- Switch statements can be used at some fixed values
- Pay attention to the difference between = and ==
- Be careful in deciding the usage of < and <=, > and >=
- Decision statements are important in programming