Introduction to Computer Engineering
0702111

3. Selection Statements

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1

Introduction

- Selection Statements: Sometimes in programming, we need to be able to choose between **two** or **more** alternatives.
- Selection statements include ***if*** and **switch** statements.
- Logical expressions need to be discussed as it is used in statements such as ***if***
- **Logical Expressions:** A logical expression such as **a < b** appears in statements such as '***if*** ' that:
  - Tests value of expression, and
  - Chooses a course of action based on whether the value is "**true" 1** or **"false" 0;**

2

- **Operators** used to build Logical Expressions:
  - Relational Operators (**<, >, <=, >=**);
  - Equality Operators (**==, !=**);
  - Logical Operators (**!, &&, ||**).
- **Relational Operators:**
  - **<, >, <= and >=**
  - Produce **0** or **1** when used in expressions.
  - Are Binary **infix** operators (Operators between operands).
  - **Lower precedence** than Arithmetic Operators.
  - **Left Associative (evaluated LtR)**.
- **Example:**
  - ➔ **20 < 30** ➔ produces **1**
  - ➔ **30 < 20** ➔ produces **0**
  - ➔ **a + b > c - 2** ➔ means **(a+b) > (c-2)**

3

- ➔ **a < b < c does not** test if **b** lies between **a** and **c**! Instead, the value of **a < b (which can be 0 or 1)** is compared against **c.**
- **Equality Operators:**
  - **==, !=**
  - Produce either **0 "False"** or **1 "True";**
  - Are ***binary Infix*** operators;
  - **Lower precedence** than Relational Operators;
  - **Left Associative.**
- **Example:**
  - ➔ **a == b < c** ➔ equivalent to **a == (b < c)**
  - ➔ **a < b == b < c** ➔ equivalent to **(a < b) == (b < c)**
  - ➔ **TRUE: IF a < b and b < c** are **both True** or **False**
  - **(Both relational operators are equal in priority)**
  - ➔**a == b < c** ➔ equivalent to **a == (b < c)**

4

Hint: **Equality Operators** have **lower precedence** than Relational Operators;

- **Notes**:
  - Compiler deals with 0's & 1's as logical operations' results
  - '**bool**' keyword: Used to declare Boolean variables.
- **Logical Operators : ! (NOT), && (AND), || (OR)**
  - Used to **combine** simple logical expressions into more complex ones;
  - **!** (**Negation**): **Toggles** operand's value: **0** to **1**, or **1** to **0**
    - Is **unary** prefix, **right associative (RtL)**;

5

- **&& (AND), || (OR): Binary** infix, **left associative**;
  - **&&:** Produces **1** if **both** its operands are **Non-Zero**, otherwise, produces **Zero**
  - **||:** Produces **1** if **either** operands are **Non-Zero**
- Both **||** and **&&** have **left-to-right** order of evaluation:
  - Left operand is evaluated **first**, and Right operand is evaluated ***IF Necessary!***

(3==4) && exp'n Yields (**0**) without evaluating exp'n.

(3==3) || exp'n Yields (**1**) without evaluating exp'n!

Examples:

```
age > 12 && age < 20
gpa > 3.5 || Twajihi_Score > 850
gpa > 3.5 || Twajihi_Score > 850 && age > 17
```

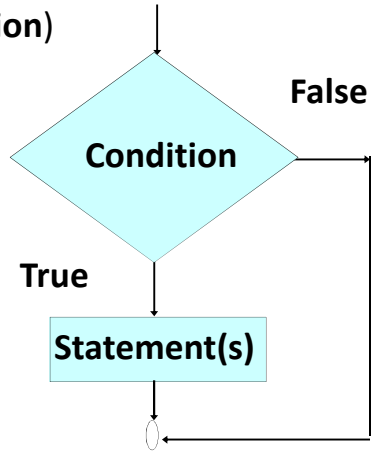
6

Making Decisions: *The if Statement*

- *if* statements allows branching (decision making) depending upon the value or state of variables.
- Allows statements to be **executed** or **skipped**, depending upon decisions.
- *if first form* (**One-Way Selection**)
  - Syntax:

```
if (expression / condition)
    statement;
```

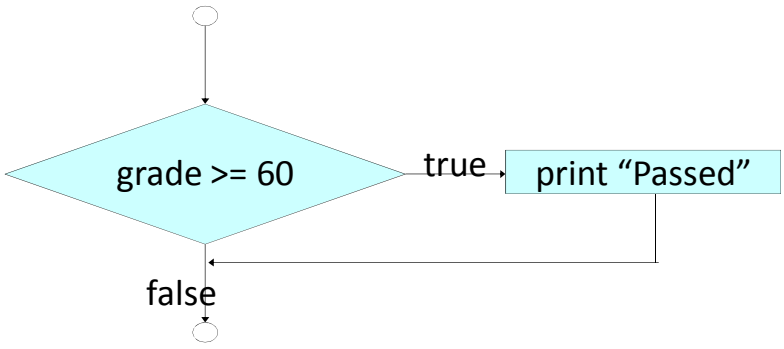
```
if (expression / condition)
                    {
  statement1;
  statement2;
  statementn;
                    }
```



7

Pseudocode:

If student's grade is greater than or equal to 60
Print "Passed"



Statement in C:

```
if ( grade >= 60 )
printf( "Passed\n" );
```

8

- ***Examples:***

```
if (hours > 40)
   printf("Overtime!\n");
if (students < 65)
     ++student_count;
if (temperature < 0)
     printf("Frozen\n");
if (Cost > 30000)
{
   Tax = (Cost - 30000) * 0.1;
   printf("For a car costing %8.2f, a
   tax of %8.2f is due.", Cost, Tax);
}
printf("Thanks for helping the economy");
```

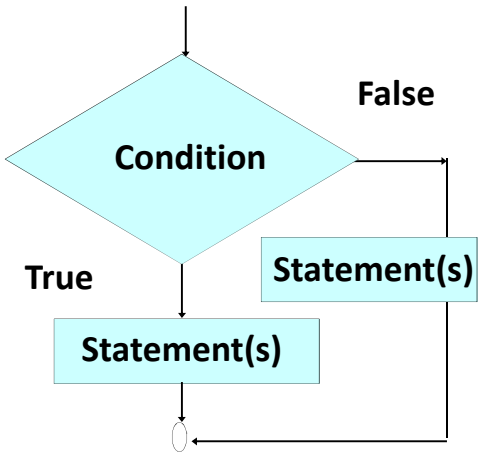
9

- ***if Second form (Two-Way Selection):***

Syntax:

```
if (expression / condition)
    statement;
else
    statement;
```

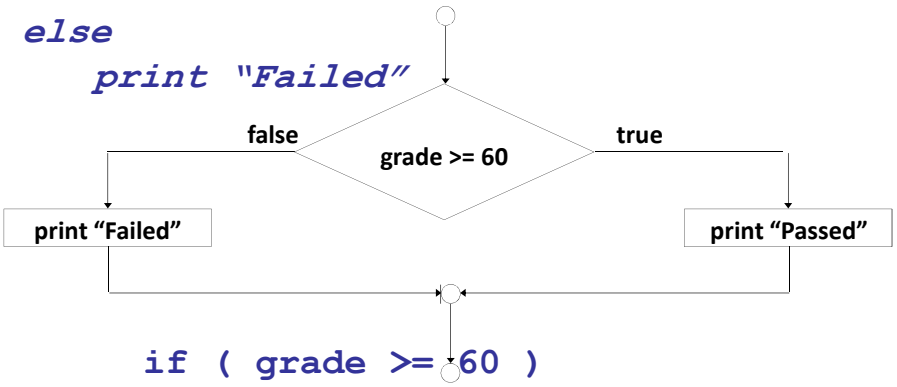
```
if (expression / condition)
{ statement1;
  statement2;
  statementn;}
else
{   statement1;
    statement2;
    statementn; }
```



10

- Psuedocode:

```
If grade is greater than or equal to 60
    print "Passed"
else
    print "Failed"
```




```
if ( grade >= 60 )
 printf( "Passed\n");
       else
 printf( "Failed\n");
```

11

Examples:

```
if (result >= 45)
   printf ("Pass\n");
else
   printf ("Fail\n");
```

//Tests whether a student has passed (a pass mark of 45)

```
if (hours <= Reg_Hours)
   Gross_Pay = Wage * Hours;
else
{
 Overtime_Hours = Hours – Reg_Hours;
 Overtime_Pay = Wage * Overtime_Hours *
                          Overtime_Rate;
 Gorss_Pay=Wage*Reg_Hours+Overtime_Pay;
}
```

12

- **Compound statements** has the form of:
  - {statements}

  ➔ Putting **braces** around group of statements will force compiler to treat it as single statement.

```
if (result >= 45)
{
   printf("Passed\n");
   printf("Congratulations\n")
}
else
{
   printf("Failed\n");
   printf("Good luck in the rests\n");
}
```

13

Cascaded if example (ladder)

```
if (n<0)
     printf("n is less than 0\n");
else
     if (n==0)
       printf("n is equal to 0\n");
     else
       printf("n is greater than 0\n");
```

- **The second `if` is nested inside the first.**
- **This leads to *ladder* shape**
- ***if third form* (*Multi*-Way Selection / Ladder Structure):**

14

- ***(Multi*-Way Selection / Ladder Structure)** Syntax:

```
if (expression1 / condition-1)
   {statement-1;}
else if (expression2 / condition-2)
   {statement-2;}
else if (e xpression3 / condition-3)
   {statement-3};
        …….
else if (expression-n / condition-n);
   {statement-n;}
else
   {statement-n+1;}
```

15

- Pseudocode for a nested if…else statement

if grade is greater than or equal to 90 Print "A"
else if grade is greater than or equal to 80 Print "B"
else if grade is greater than or equal to 70 Print "C"
else If grade is greater than or equal to 60 Print "D"
else Print "F"

- ***if (result >= 75) printf("Passed: Grade A\n");***

else if (result >= 60) printf("Passed: Grade B\n");

else if (result >= 45) printf("Passed: Grade C\n");

else printf("Failed\n");

- All comparisons test a single variable called ***result***. In other cases, each test may involve a different variable or some combination of tests

16

Develop a C code to provide a user with a division of two input numbers?

- **Analysis:**
  - **Output: Division_Result;**
  - **Inputs: Number1, Number2;**
  - **Process:**
    if Number2 == 0 Print "Can't Divide";
    else Division_Result = Number1/Number2;
- **Algorithm:**
  1. **Start;**
  2. **Read Number1, Number2;**
  3. **if (Number2 == 0) Display "Can't Divide";**
     else { Division_Result = Number1/Number2;
     Print (Division_Result); }
  4. **End.**

17

```
/* Code Demonstrates the Use of if else block:
 To provide a division of two input numbers. */
#include <stdio.h>
main()
 {
  int Number1, Number2, Div_Result;
  printf("\nEnter first number ");
  scanf("%d",&Number1);
  printf("\nEnter second number ");
  scanf("%d",&Number2);
  if (Number2 ==0)
     printf("\n\n Can't divide by zero\n\n");
  else
  { Div_Result = Number1/Number2;
    printf("\nAnswer:%d\n\n",Div_Result);
  } return 0;} //end of main function
```

18

Example: Calculating a broker's commission:

- The broker's commission is calculated as follow:

Transaction size	Commission rate
Under $2500	**$30 + 1.7%**
$2500 – $6250	**$56 + 0.66%**
$6250 - $20000	**$76 + 0.34%**
$20000 - $50000	**$100 + 0.22%**
$50000 - $500000	**$155 + 0.11%**
Over $500000	**$255 + 0.09%**

The minimum charge is $39.

- The Algorithm to Calculate a broker's commission:

1. Start;

2. Read value;

3. What's the value of the transaction?

19

```
if (value < 2500.00)      commission = 30.00 + .017 * value;
else if (value < 6250.00)
        commission = 56.00 + .0066 * value;
        else if (value < 20000.00)
                commission = 76.00 + .0034 * value;
            else if (value < 50000.00)
                    commission = 100.00 + .0022 * value;
                    else if (value < 500000.00)
                            commission = 155.00 + .0011 * value;
                        else commission = 255.00 + .0009 * value;
4.  Check for the minimum charge ($39)
   if (commission < 39.00)
      commission = 39.00;
5.  Print Commission
6.  End.
```

20

```
#include <stdio.h>
main()
{float commission, value;
 printf("Enter value of trade: ");
 scanf("%f", &value);
 if (value < 2500.00)
    commission = 30.00 + .017 * value;
 else if (value < 6250.00)
    commission = 56.00 + .0066 * value;
 else if (value < 20000.00)
    commission = 76.00 + .0034 * value;
 else if (value < 50000.00)
    commission = 100.00 + .0022 * value;
 else if (value < 500000.00)
    commission = 155.00 + .0011 * value;
 else commission = 255.00 +.0009* value;
 if (commission< 39.00)commission=39.00;
 printf("Commission:$%.2f\n",commission);
 return 0; }
```

21

RULE: ***else*** clause **belongs to the nearest** ***if*** statement that hasn't been paired with an ***else;***

One way to make the ***else*** clause part of the outer ***if*** Statement: Enclose the inner ***if*** statement with braces

```
int a = 2;
int b = 2;
if (a == 1)
  if (b == 2)
  {
    printf("a was 1 and b was 2\n");
  }
  else
    printf("a wasn't 1\n");
```

22

A Ternary Operator

"Conditional Expressions"

- C has many **unary** operators, and plenty of binary ones!
- In addition, C has a ***ternary* operator** (one that takes *three* operands.)

  cond ? expT : expF Read as ➔

  "if cond then expT else expF"

- ***Conditional Expression***:
  - *Consists of Symbols:* **?** *and* **:**
  - *Must be together* ➔ ***cond ? expT : expF***
  - Similar to ➔ ***if*** **(cond) expT**
    else **expF**

23

How it works? **(*cond ? expT : expF*)**

➔ The ***?*** operator evaluates ***cond***:

➔ If it is **true**, it evaluates ***expT*** and **returns it as the value of the *?* expression**

➔ If it is **false**, it evaluates ***expF*** and **returns it as the value of the expression.**

Example 1:

```
int i, j, k;
i = 1;
j = 2;
k = i > j ? i : j;  // or max of both (k is 2 now)
k = (i >= 0 ? i : 0) + j;// k is now 3 i.e (1+2)
```

Similar to:

```
if (i>j)k=i;
  else k=j;
```

24

Example 2:

```
int y = 7;
int x;
x = ((y > 5) ? 1 : 0); /* since y is greater than
                          5, x is assigned a value of 1 */
```

- Conditional statements tend to make programs **shorter** BUT **harder** to understand! Occasionally they are tempting to use. Instead of writing:

```
if (y > 5)
   x=1;
else
   x=0;
return x;
```

We may write:

```
return (y > 5 ? 1 : 0);
```

Also ➔ `printf("%d/n", y > 5 ? 1 : 0);` **is valid**

25

Switch Statement

- **Switch statement**: A construct that is used to replace deeply **nested or chained (Multiple)** ***if*** ***else*** statements.
- ***Example:*** Suppose that an ice cream store has asked us to write a program that will automate taking of the orders?
  - **We will need to present a menu** and
  - **Based on the customer's choice take an appropriate action.**

26

```
#include <stdio.h>
main()
{
 int choice;
 printf("What flavor ice cream do you want?\n");
 printf("Enter 1 for chocolate\n");
 printf("Enter 2 for vanilla\n");
 printf("Enter 3 for strawberry\n");
 printf("Enter 4 for green tea flavor, yuck\n");
 printf("Enter you choice: ");
 scanf("%d",&choice);
 if (choice==1){
          printf("Chocolate, good choice\n");}
 else if (choice==2) {printf("Vanillarific\n");}
 else if (choice==3) {printf("Berry Good\n");}
 else if (choice==4) {printf("Big Mistake\n");}
 else {printf("We don't have any.\n");
       printf("Make another selection.\n");}
 return 0;}
```

27

- This program will works fine, but the ***if else*** block is **cumbersome**.
- It would be easy, particularly if there were more *choices* and maybe *sub choices* involving more ***if else's*** to end up with program that doesn't perform the actions intended.
- The general form of a **switch** statement is:

```
switch (variable)
{
   case expression1:     Action1; break;
   case expression2:     Action2; break;
        ....
   default:              default_Action;
}
```

- Here's the same program re-written with a **switch structure**.

28

```
#include <stdio.h>
main()
{
 int choice;
 printf("What flavor ice cream do want?\n");
 printf("Enter 1 for chocolate\n");
 printf("Enter 2 for vanilla\n");
 printf("Enter 3 for strawberry\n");
 printf("Enter 4 for green tea flavor\n");
 printf("Enter you choice: \n");
 scanf("%d",&choice);
 switch (choice)
 {
  case 1: printf("Chocolate, good choice\n");
     break;
  case 2: printf("Vanillarific\n");
     break;
  case 3: printf("Berry Good\n");
     break;
  case 4: printf("Big Mistake\n");
     break;
  default: printf("We don't have any.\n");
           printf("Make another selection.\n");
 }
 return 0;
}
```

29

Notes:

- **Each expression must be a *constant.***
- **The variable is compared for equality against each expression.**
- **When an expression is found equal to the tested variable, execution continues *until* a break statement is encountered**
- **No need to use *{ }* around statements.**
- **It is possible to have a case without a break**
- **This causes execution to *fall through* into the next case!!**

30

```
#include <stdio.h>   //Another example
main()
{
char Grade;
printf("What's your grade?\n");
scanf("%c", &Grade);
switch(Grade)
{
case 'A': printf("Excellent" ); break;
case 'B': printf("Good" );      break;
case 'C': printf("OK" );        break;
case 'D': printf("Mmmmm...." ); break;
case 'F': printf("Do better than this");break;
default:printf("What's your grade anyway?");
}
return 0;
}
```

31

```
#include <stdio.h>      //Another example
 main()
 {
   float mark1, mark2, sum, avg;
   int tens;
   scanf("%f", &mark1);
   scanf("%f", &mark2);
   sum=mark1+mark2;
   avg=sum/2;
   tens=avg/10; //ignoring the fractions ! Tens is int
   switch(tens)
    {
      case 10:
      case 9: printf( "Excellent" ); break;
      case 8: printf( "Very Good" ); break;
      case 7: printf( "Good" ); break;
      case 6: printf( "Mmmmm...." ); break;
      case 5: printf( "FAIL!" ); break;
      default: printf( "What is your grade anyway?" );
    }
  return 0;     }
```

32

Analyze, develop an Algorithm, draw a Flowchart, write a C Code, and run the following questions?

(No Need to submit the answers!)

1. **Develop** an **interactive** and **efficient (FAST) C** program to **display** the **date entered (mm/dd/yyyy): 02/28/1955** into the following format: **This is the 28th Day of February 1955?** **Try it for the 21st century date!**

33

2. **Develop** an **interactive and efficient C** program to **select** one item from the following menu by **Either entering the number, OR the number * 10, OR the first character:**
   1. **Word Processing**
   2. **Spreadsheet**
   3. **Database**
   4. **Access**
   5. **Internet Explorer**
   6. **Outlook**
   7. **PowerPoint**
   8. **Visio**
   9. **Quit**

Word processing could be accessed by:

w, W, 1, or 10!

34