Expression & Statement (Command)

- A pure expression gives a value e.g. 2, -2, $-a$, $-2 * a + b$.
- A command or a statement changes the content of a location, but does not have a value.
- In C language many expressions are impure and cause side effects by changing value of locations e.g. `++count`, n = 2*m + 4.

- Any expression in C (with or without any side effect) can be converted to a statement by putting a semicolon at the end[a]. These are called expression statements.
- This blurs the distinction between an expression and a command in this language.

[a] There is no value of a statement.

Null Statement

- A semicolon in C language, unlike Algol or Pascal languages, does not compose two statements to form a new statement. In C it forms or terminate a statement (command).
- A semicolon ';' itself may be viewed as null statement (no operation).

Compound Statement

- A sequence of statements within a pair of curly braces { } forms a single compound statement or block.
- Variables can be declared within a block and are local to the block (visible only within the block).
- A name clash is resolved in favor of the local object.

```
#include <stdio.h>
int main() // temp17.c
{
  int a = 10, b = 20, c = 30;
  {
    int b = 200, c = 300 ;
    {
      int c = 3000 ;
      printf("L3 - a: %d, b: %d, c: %d\n",
                a, b, c) ;
    }
```

```
    printf("L2 - a: %d, b: %d, c: %d\n",
                a, b, c) ;
  }
  printf("L1 - a: %d, b: %d, c: %d\n",
                a, b, c) ;
  return 0 ;
}
```

```
$ cc -Wall temp17.c
$ ./a.out
L3 - a:  10, b:  200, c:  3000
L2 - a:  10, b:  200, c:  300
L1 - a:  10, b:  20, c:  30
```

Change in Control Flow

- Depending on data it may be necessary to perform different sets of operations in a program.
- This calls for data dependent choice of the execution sequence of statements (control-flow).

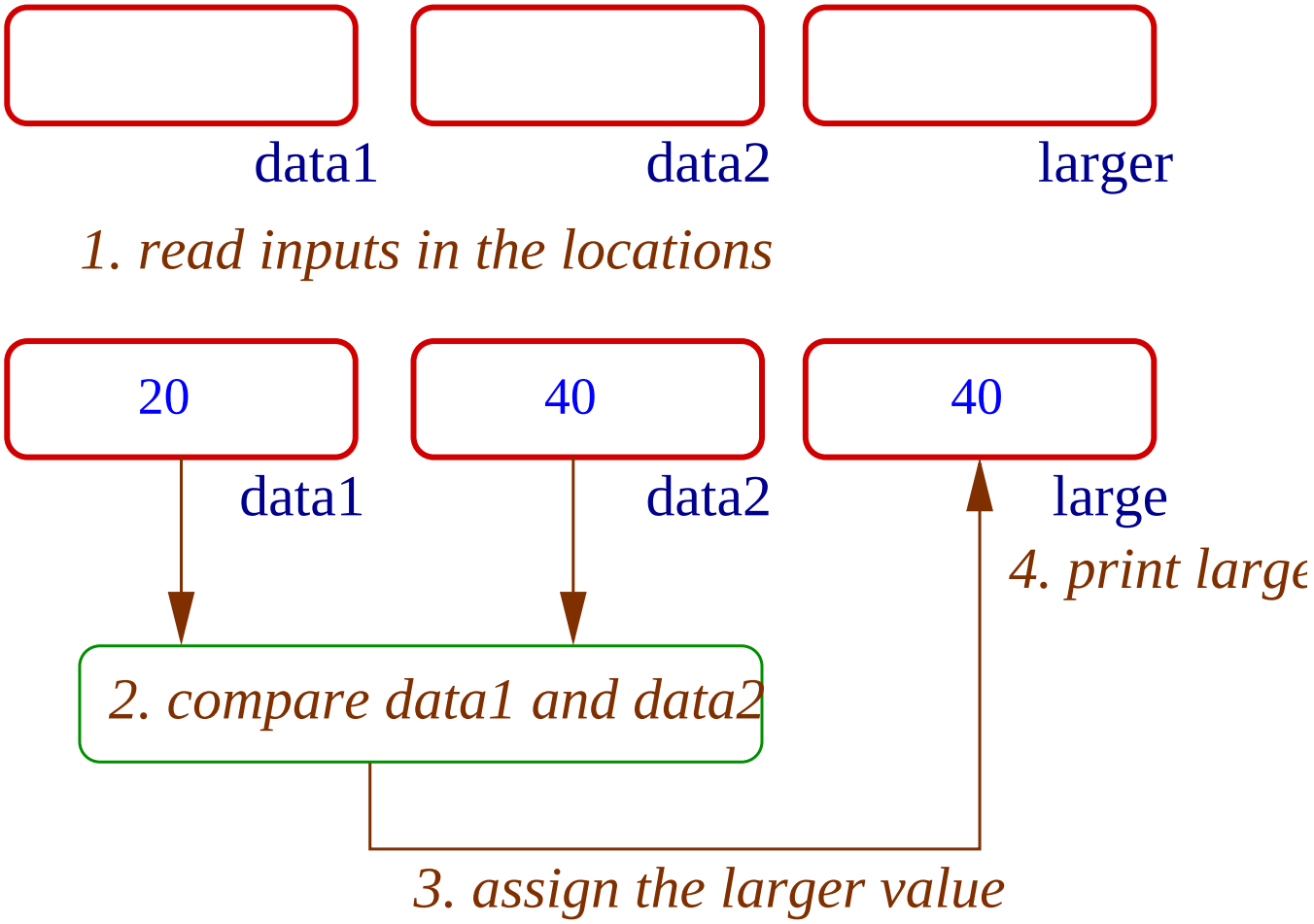
Example I

Write a C Program that reads two `int` data from the keyboard, finds the larger among them, and prints it on the VDU.

Sequence of Operations

1. Read the two input data in two variables (locations) of type `int`.
2. Compare the variables (r-values) and put the larger value in a third variable (location).
3. Print the content of the third variable.

int data1, data2, larger ;



```
#include <stdio.h>
int main() // temp18.c
{
    int data1, data2, larger;
    printf("Enter two integer data: ");
    scanf("%d%d", &data1, &data2);
    if(data1 > data2) larger = data1 ;
    else larger = data2;
    printf("\n%d is the larger among %d & %d\n",
                larger, data1, data2);
    return 0 ;
}
```

`if` Statement

We use a command called `if`-statement for controlling the execution sequence in this program. The structure or syntax of `if`-statements are as follows.

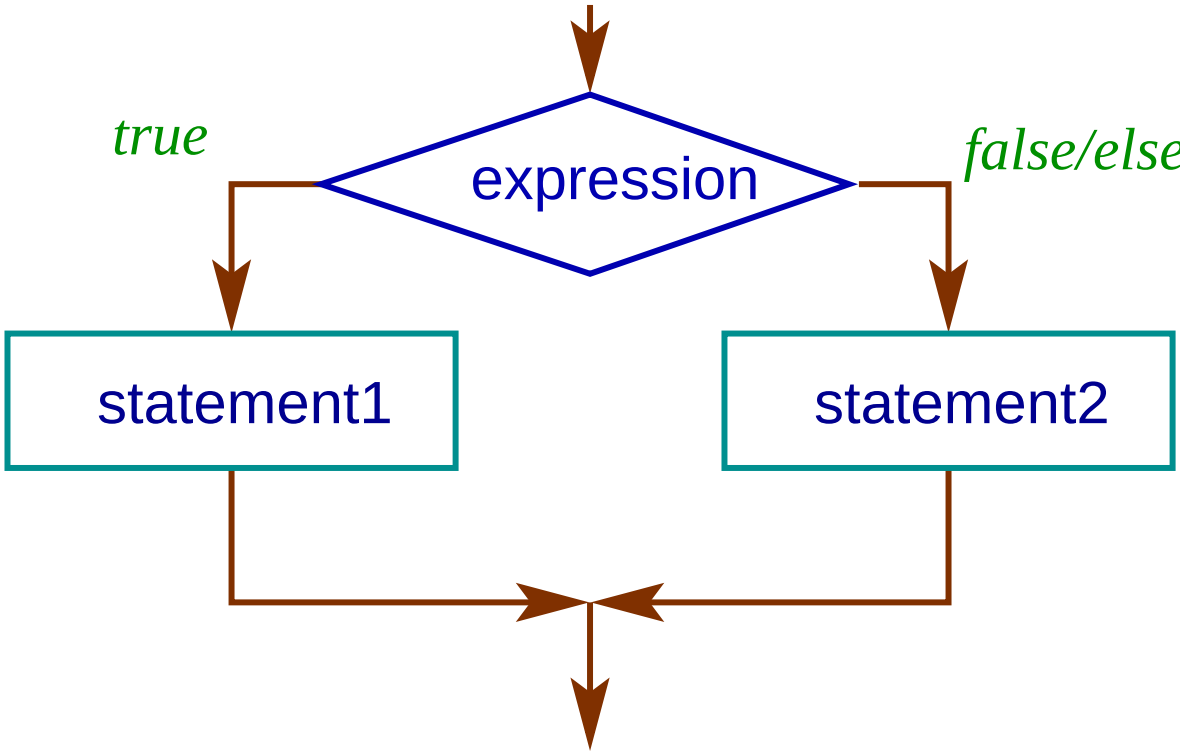
`if` (*expression*) $statement_1$ `else` $statement_2$

`if` (*expression*) $statement_1$

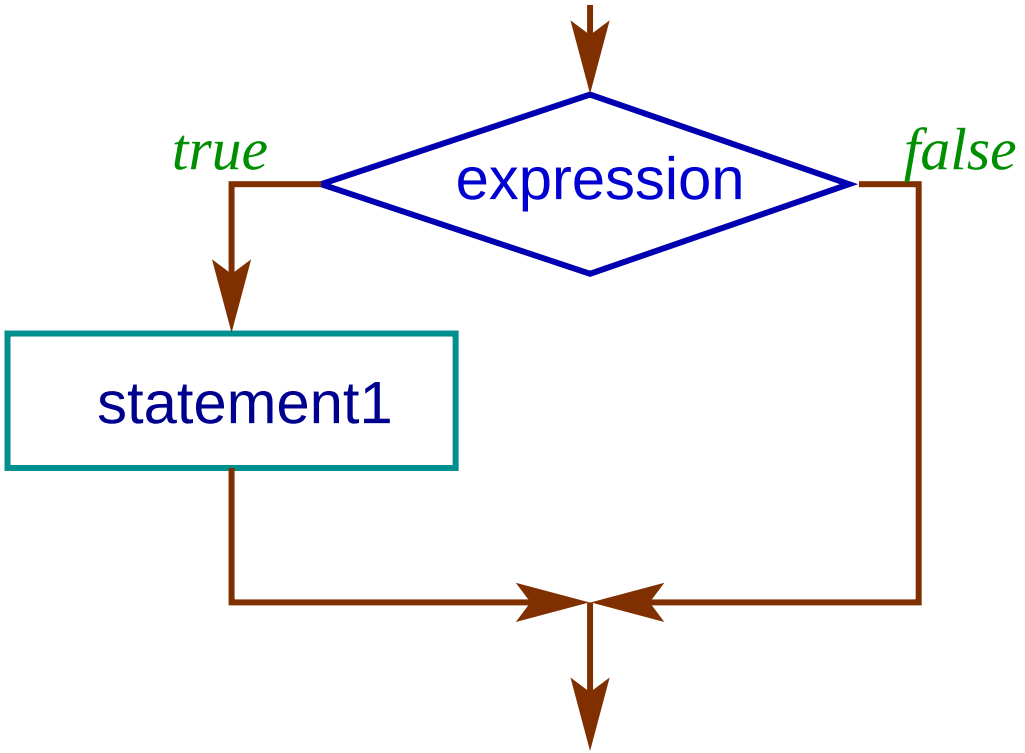
In this example we use the first type and we have

- *expression*: `data1 > data2`
- $statement_1$: `larger = data1;`
- $statement_2$: `larger = data2;`

Control Flow



Control Flow



Relational and Boolean Expressions

Two new types of expressions are used in `if`-statement and other control-flow constructs of the language. They are called relational and boolean expressions.

Relational and Boolean Expressions

C language does not have distinct truth values (*true* and *false*). The value zero (0) is treated as false and any non-zero value is treated as true.

```
#include <stdio.h>
int main() // temp19.c
{
    int a;

    scanf("%d", &a) ;
    if(a) printf("non-zero\n") ;
    else printf("zero\n") ;
    return 0 ;
}
```

```
$ cc -Wall temp19.c
$ ./a.out
0
zero
$ ./a.out
-1
non-zero
$ ./a.out
1
non-zero
```

Relational Operators

Following are the relational operators with their usual meaning.

== (equal to), != (not-equal to), < (less than)

> (greater than), <= (less than or equal to),

>= (greater than or equal to).

The usual operands of relational operators are `int`, `float`, `char` etc. Their values are boolean.

Boolean Operators

Following are the boolean operators with their usual meaning.

&& (logical and), ∼ (logical not), || (logical or).

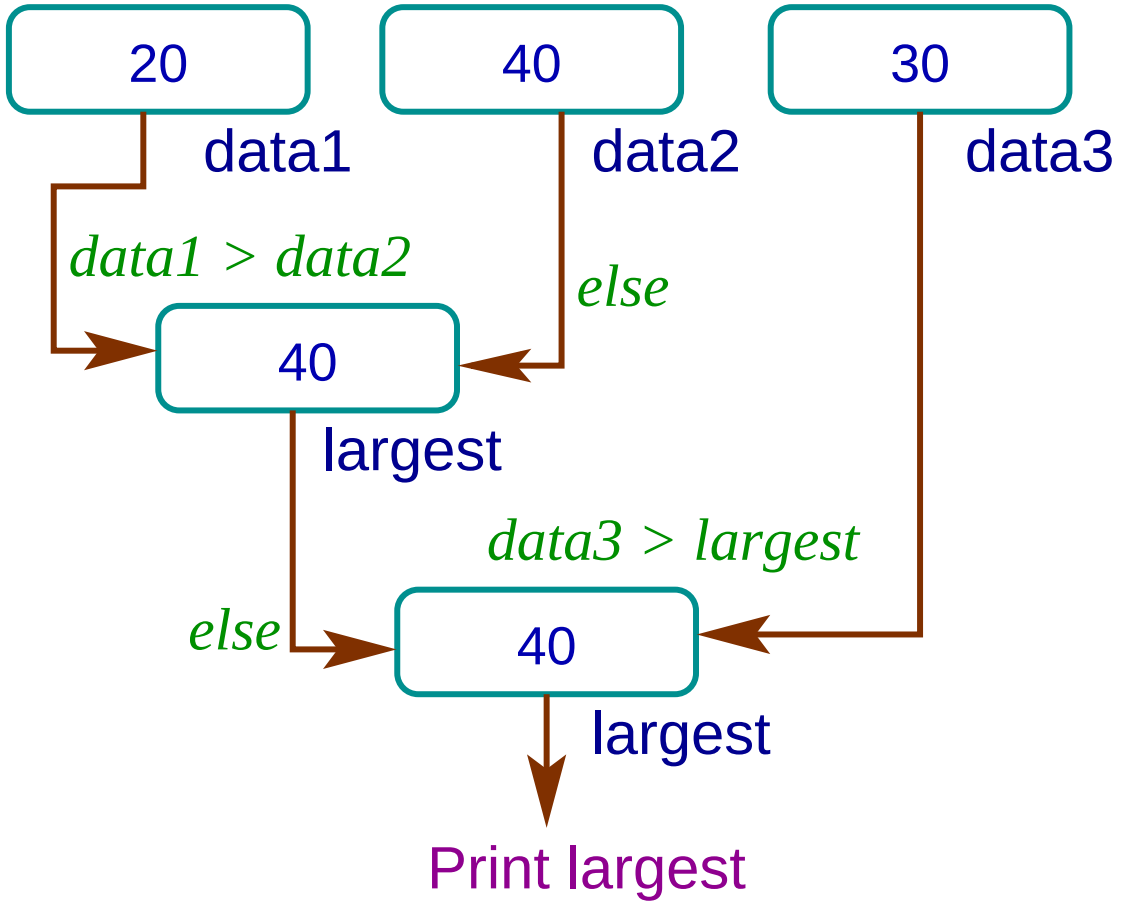
The operands and values of boolean operators are boolean values. Find out the precedence and associativity of these operators from the book.

Example II

Write a C program to find the largest among three `int` data.

Sequence of Operations

1. Read three input integers in three variables `data1, data2` and `data3` of type `int`.
2. Compare `data1` and `data2`, put the larger value in a fourth variable, `largest`.
3. Compare `data3` and `largest`. If `data3` is larger, copy it in `largest`.
4. Print the content of `largest`.


20
40
30
data1
data2
data3
data1 > data2
else
40
largest
data3 > largest
else
40
largest
Print largest

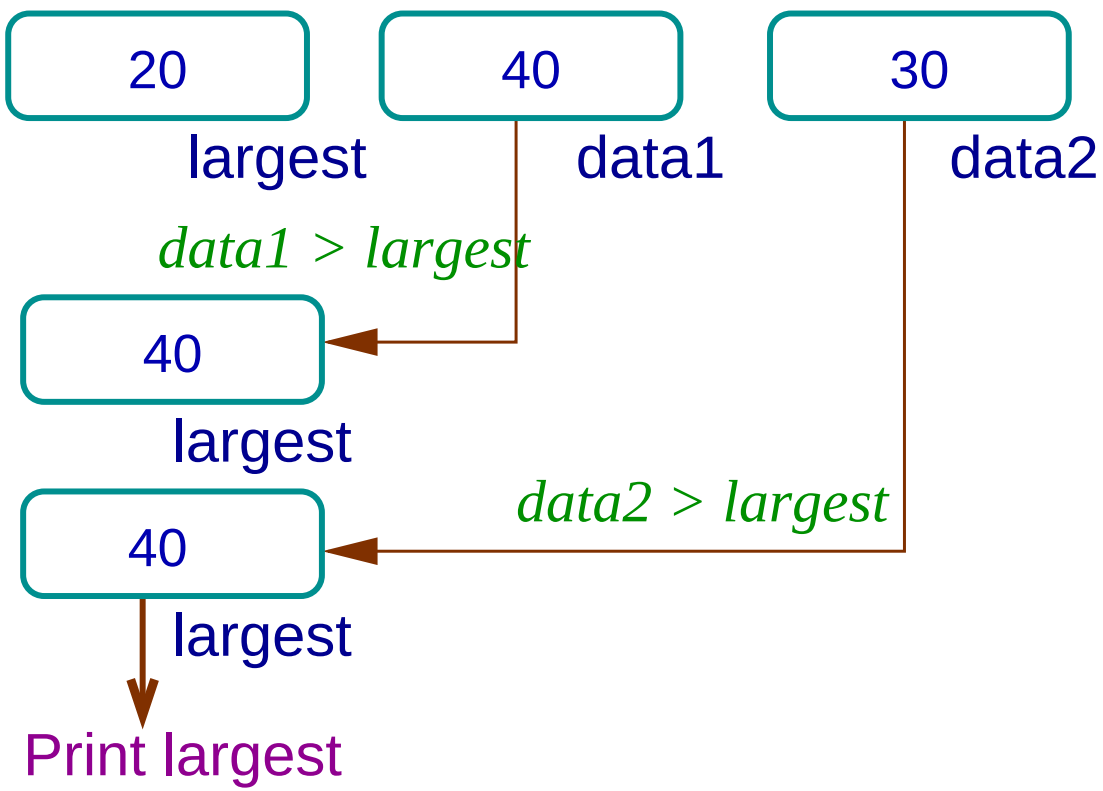
```
#include <stdio.h>
int main() // temp20.c
{
  int data1, data2, data3, largest ;
  printf("Enter three integer data: ") ;
  scanf("%d%d%d", &data1, &data2, &data3) ;
  if(data1 > data2) largest = data1 ;
  else largest = data2 ;
  if(data3 > largest) largest = data3 ;
  printf("\n%d is the largest among %d, %d & %d\n",
            largest, data1, data2, data3);
  return 0;
}
```

An Alternate Sequence

1. Read the first input in the variable `largest`.
2. Read the second and third data in `data1` and `data2`.
3. If `data1` is greater than `largest`, copy `data1` to `largest`.
4. If `data2` is greater than `largest`, copy `data2` to `largest`.
5. Print the content of `largest`.

Note

In this method we use three variables but one input data may be lost at the end.


20
40
30
largest
data1
data2
data1 > largest
40
largest
data2 > largest
40
largest
Print largest

```
#include <stdio.h>
int main() // temp21.c
{
  int data1, data2, largest ;
  printf("Enter three integer data: ") ;
  scanf("%d%d%d", &largest, &data1, &data2) ;
  if(data1 > largest) largest = data1 ;
  if(data2 > largest) largest = data2 ;
  printf("\n%d is the largest data\n",
            largest);
  return 0;
}
```

Alternate Sequence

1. Read the first input in the variable `largest`.
2. Read the second data in `data`.
3. If `data` > `largest`, copy `data` to `largest`.
4. Read the third data in `data`.
5. If `data` > `largest`, copy `data` to `largest`.
6. Print the content of `largest`.

```
#include <stdio.h>
int main() // temp21a.c
{
    int data, largest ;
    printf("Enter 3 integers : ") ;
    scanf("%d%d", &largest, &data) ;
    if(data > largest) largest = data ;
    scanf("%d", &data) ;
    if(data > largest) largest = data ;
    printf("\n%d is the largest data\n",
            largest);
    return 0;
}
```

Note

We use two variables but two input data may be lost at the end.

Alternate Sequence

1. Read three input in `data1`, `data2` and `data3`.
2. If `data1` $>$ `data2`, if `data1` $>$ `data3`, then `data1` contains the largest value.
3. Similarly consider the other cases.

```
#include <stdio.h>
int main() // temp21b.c
{
    int data1, data2, data3, largest ;
    printf("Enter three integer data: ") ;
    scanf("%d%d%d", &data1, &data2, &data3) ;
    if(data1 > data2)
       if(data1 > data3) largest = data1 ;
       else largest = data3 ;
    else if(data2 > data3) largest =data2 ;
         else largest = data3 ;
    printf("\n%d is the largest data\n", largest);
    return 0;
}
```

Note

This is an example of nested if-statement. No input data is lost in this case.

Note

Statements within the `if` and the `else` parts may be compound statements.

```
if (expression) {
        statement_1
        ...
        statement_k
    }
else    {
        statement_1
        ...
        statement_m
    }
```

```
if (expression) {
        statement_1
        ...
        statement_k
    }
```

```
#include <stdio.h>
int main() // temp22.c
{
    int data;
    printf("Enter an integer: ") ;
    scanf("%d", &data) ;
    if (data<0) printf("-ve\n");
    else if (data == 0) printf("zero\n");
         else printf("+ve\n") ;
    return 0;
}
```

Note

As it was mentioned earlier, `if-else` and `if` statements can be nested. The `else` part will be associated to the nearest `if`. It is better to use curly braces {} to disambiguate the association.

```
#include <stdio.h>
int main() // temp23.c
{
    int data;
    printf("Enter an integer: ") ;
    scanf("%d", &data) ;
    if (data>0)
        if (data%5) printf("not-divisible\n");
    else printf("-ve data\n"); // incorrect association
    return 0;
}
```

```
$ cc -Wall temp23.c
temp23.c:  In function ‘main’:
temp23.c:7:  warning:  suggest explicit braces
to avoid ambiguous ‘else’
$ ./a.out
Enter an integer:  -3
$ ./a.out
Enter an integer:  3
not-divisible
$ ./a.out
Enter an integer:  10
-ve data
```

```
#include <stdio.h>
int main() // temp23a.c
{
    int data;
    printf("Enter an integer: ") ;
    scanf("%d", &data) ;
    if (data>0) {
        if (data%5) printf("not-divisible\n");
    }
    else printf("-ve data\n");
    return 0;
}
```

```
$ cc -Wall temp23a.c
$ ./a.out
Enter an integer:  -3
-ve data
$ ./a.out
Enter an integer:  3
not-divisible
$ ./a.out
Enter an integer:  10
$
```

`switch` Statement

In a program it may be necessary to take multi way decision and control of execution.

C language uses `switch` statement where the control is transfered by matching the value of an expression to a value from a finite set of constants.

`switch` Statement

```
switch (expression) {
        case const-exp1: statement1
        case const-exp2: statement2
        ...
        case const-expk: statementk
        default: statementk+1
        }
```

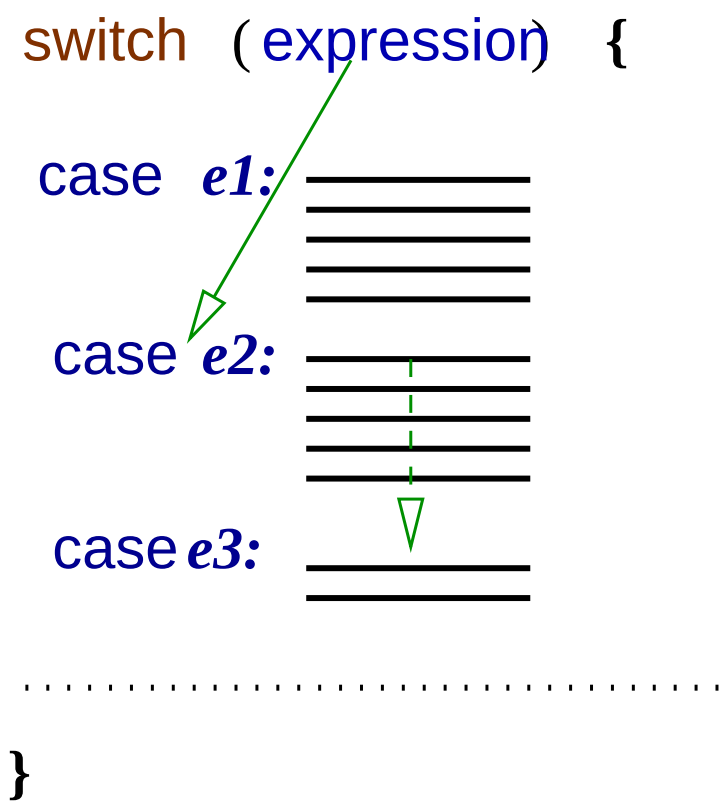
Example III

Read a non-negative integer and take different actions depending on the remainders obtained by dividing the data by 5.

```
#include <stdio.h>
int main() { // Incorrect, temp24.c
    int data;
    printf("Enter a +ve integer: ") ;
    scanf("%d", &data) ;
    switch(data%5){
           case 0: printf("remainder is 0\n") ;
           case 1: printf("remainder is 1\n") ;
           case 2: printf("remainder is 2\n") ;
           case 3: printf("remainder is 3\n") ;
           default: printf("remainder is 4\n") ;
    }
    return 0;
}
```

```
$ cc -Wall temp24.c
$ ./a.out
Enter a +ve integer:  27
remainder 2
remainder 3
remainder 4
```

The control is falling through. It is to be transfered out of the `switch` statement.


switch (expression) {
case e1:
case e2:
case e3:
. . . . . .
}

`break` Statement

A `break` statement forces the control out of the `switch` statement.

```
#include <stdio.h>
int main() { // temp25.c
    int data;
    printf("Enter a +ve integer: ") ;
    scanf("%d", &data) ;
    switch(data%5){
       case 0: printf("remainder 0\n"); break;
       case 1: printf("remainder 1\n"); break;
       case 2: printf("remainder 2\n"); break;
       case 3: printf("remainder 3\n"); break;
       default: printf("remainder 4\n");
    }
    return 0;
}
```

```
$ cc -Wall temp25.c
$ ./a.out
Enter a +ve integer:  27
remainder 2
```