Control structures in C

Lecture Topics

- Conditional constructs
- Iterative constructs
- Examples
- Style

Lecture materials

Textbook § 13.3-13.5

Homework

None

Machine problem

MP1.1 due February 2 at 5pm submitted electronically

MP1.2 due February 17 at 5pm submitted electronically

Conditional constructs

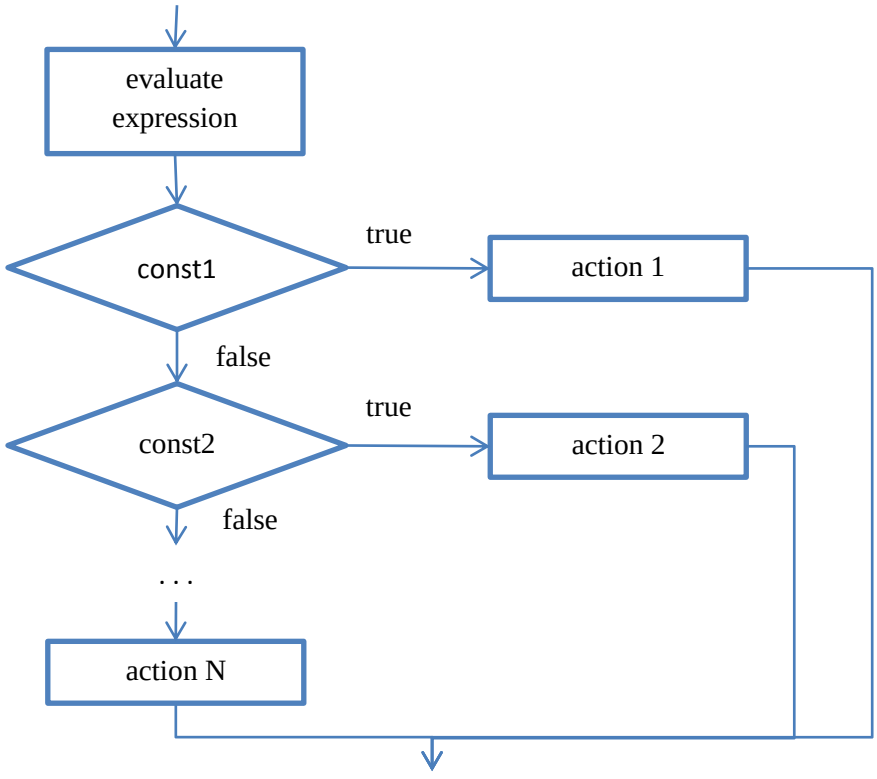
- In C, conditional constructs can be implemented using **if**, **if-else**, or **switch** statements
- In the last lecture we covered **if** and **if-else** constructs; we will now look at the **switch** statement

switch statement

- consider example shown in the left column; it also can be implemented as shown on the right:

Using cascaded **if-else** statements	Using **switch** statement

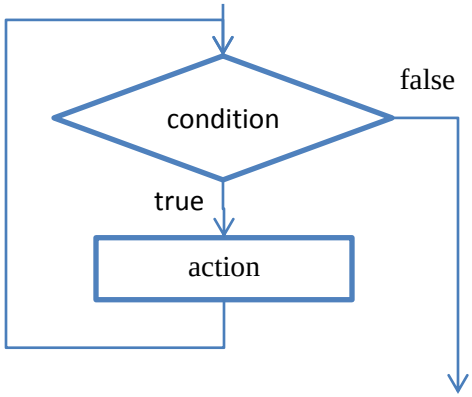
`if (expression == const1)`
`  action1;`
`else if (expression == const2)`
`  action2;`
`else if (expression == const3)`
`  action3;`
`...`
`else`
`  actionN;`
	`switch (expression) {`
	`  case const1:`
	`  action1;`
	`  break;`
	`  case const2:`
	`  action2;`
	`  break;`
	`  case const3:`
	`  action3;`
	`  break;`
	`...`
	`  default:`
	`  actionN;`
	`}`



- this only works when we consider some discrete values to which `expression` is evaluated, `const1, const2, …`

Iterative constructs

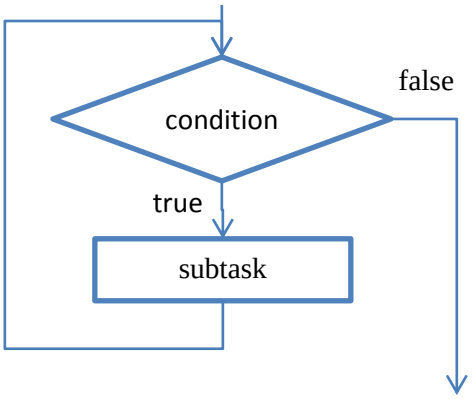
- Iterative construct means that some statements will be executed multiple times until some condition is met:

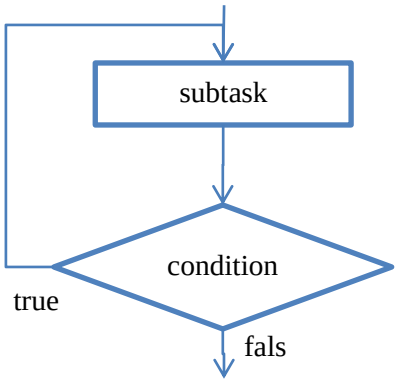


- Such construct implements a loop structure in which *action* is executed multiple times, as long as some *condition* is true
  - *action* is also called *loop body*
- In C, iterative constructs can be implemented using **while**, **do-while**, or **for** loop statements

while and do-while statements

- ```
  while (condition) {
      subtask;
  }
  ```
- ```
  do {
      subtask
  } while (condition);
  ```
- For while loop, loop body may or may not be executed even once
- For do-while loop, loop body will be executed at least once





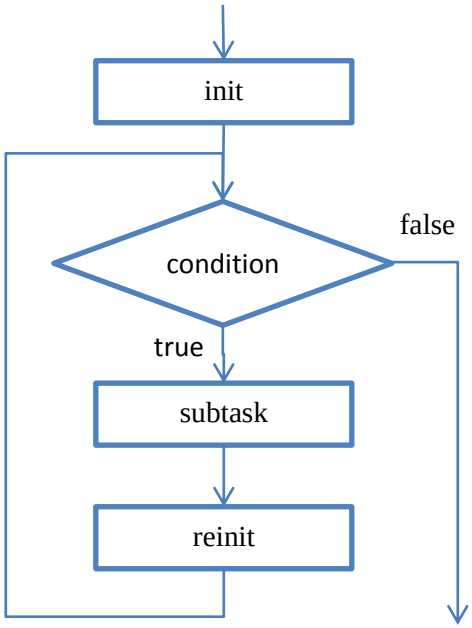
- Examples

while	do-while

`x = 0;`
`while (x < 10) {`
`  printf("x=%d\n", x);`
`  x = x + 1;`
`}`
	`x = 0;`
	`do {`
	`  printf("x=%d\n", x);`
	`  x = x + 1;`
	`while (x < 10);`

for statement

- **for** (init; test; reinit) {
  subtask;
  }



- Example

while	for

`x = 0;`
`while (x < 10) {`
`  printf("x=%d\n", x);`
`  x = x + 1;`
`}`
	`for (x = 0; x < 10; x++)`
	`  printf("x=%d\n", x);`

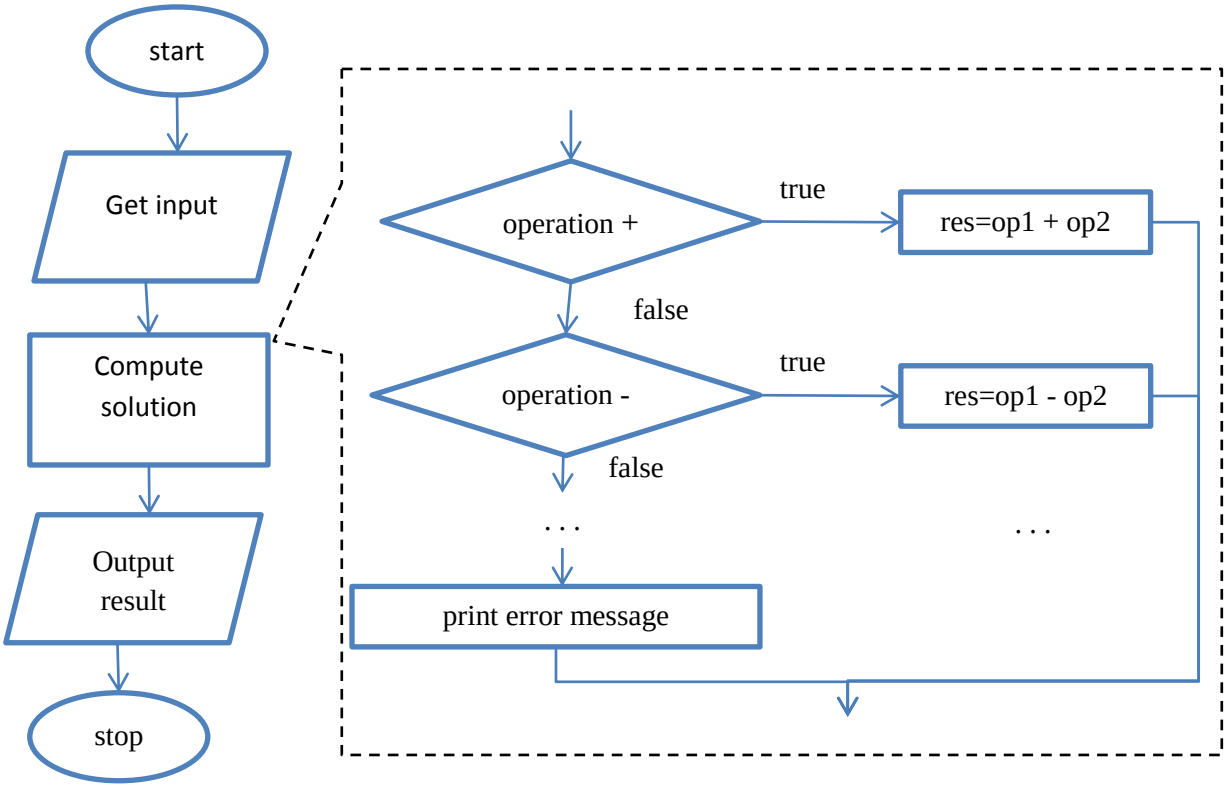
break and continue

- **break** will cause the loop to be terminated
- **continue** will cause to skip the rest of code in the loop and start executing next loop iteration

Examples

Simple calculator

- **Problem statement:** write a program that lets user enter a simple expression consisting of two operands and one operation, e.g., '2 + 3', performs the entered calculation, and prints the result.
- Using systematic decomposition, we first derive a flowchart that shows all the main steps in the program that need to be implemented
  - Get input (using scanf)
  - Recognize which operation is to be implemented (using switch construct)
  - Output results (using printf)




```
/* simple calculator
    Input: an expression to be evaluated, for example, 4 / 6
    Output: value to which the expression evaluates,
            or an error message if the operation is not supported
 */

#include <stdio.h>        /* needed for printf and scanf */

int main()
{
    int operand1, operand2;     /* two operands */
    char operation;             /* operation to be performed */
    int result;                 /* result of the operation */
```

```
    /* get input */
    printf("Enter expression operand1 operation operand 2: ");
    scanf("%d %c %d", &operand1, &operation, &operand2);

    /* calculate expression */
    switch (operation)
    {
        case '+':  result = operand1 + operand2; break;
        case '-':  result = operand1 - operand2; break;
        case '/':  result = operand1 / operand2; break;
        case '*':  result = operand1 * operand2; break;
        default: printf("Invalid operation %c\n", operation);
    }

    /* print result */
    printf("result=%i\n", result);

    return 0;
}
```

- Two problems with this implementation
  - What if user enters 10 / 0?
  - The program will still print out "result" even if the operator was not supported. How do we fix this?

Character counter

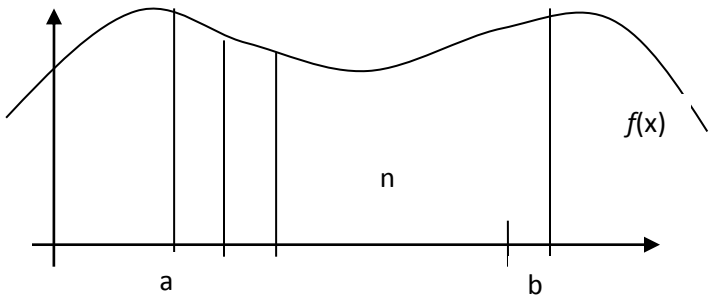
- **Problem statement:** read characters from the keyboard and convert them to lower case until '0' (sentinel) is entered

```
#include <stdio.h>        /* needed for printf and scanf */

int main()
{
    char inchar, outchar;

    scanf("%c", &inchar);

    while (inchar != '0')
    {
        if ((inchar >= 'A') && (inchar <+'Z'))
            outchar = ('a' - 'A') + inchar;
        else
            outchar = inchar;

        printf("%c\n", outchar);
        scanf("%c", &inchar);
    }

    return 0;
}
```

Riemann integral

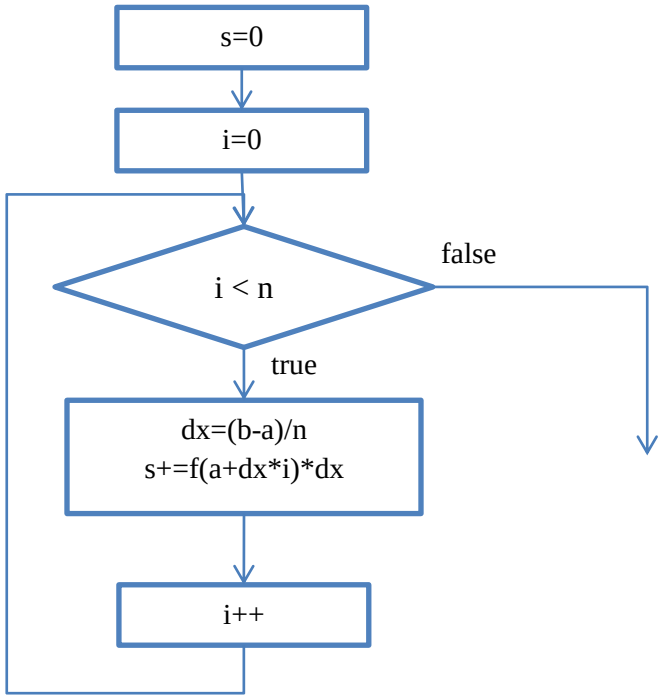
- **Problem statement:** write a program to compute integral of a function f(x) on an interval [a,b].

- **Algorithm:** use integral definition as an area under a function *f*(x) on an interval [a,b]



$$\int_a^b f(x)dx = \lim_{n\to\infty} \sum_{i=0}^{n-1} f\left(a + \frac{b-a}{n} i\right) \frac{b-a}{n}$$

- Using systematic decomposition, we first derive a flowchart




```
/* compute integral of f(x) = x*x+2x+3 on [a,b] */
#include <stdio.h>

int main()
{
    int n = 100;        /* hardcoded number of Reimann sum terms */
    float a = -1.0f;    /* hardcoded [a,b] */
    float b = 1.0f;
```

```
    float s = 0.0f;             /* computed integral value */
    int i;                      /* loop counter */
    float x, y;                 /* x and y=f(x) */
    float dx = (b - a) / n;     /* width of rectangles */

    for (i = 0; i < n; i++)
    {
        x = a + dx * i;
        y = x * x + 2 * x + 3;
        s += y * dx;
    }

    printf("%f\n", s);

    return 0;
}
```

Style

- Style is what separates a good program from not so good
- Once the program is written, a lot of time will be spent maintaining it, thus, it is important to make the maintenance task as simple as possible
    - Documentation
        - Program should be well-documented, it should start with an opening comment describing the purpose, input, output, authors, revision history, etc.
        - Each function must be documented as well
        - Variables should be documented
        - Code sections should be documented
    - Clarity
        - program should read like a technical paper
        - should be organized into sections based on functions implemented
        - code inside functions should be organized into paragraphs, each paragraph starting with a topic-specific comment and be separated from other paragraph by space
        - indentation should be used to identify code inside blocks or conditionals
        - variables should be named to have intuitive enough meaning
        - and so should be functions
    - Simplicity
        - The program should be made as simple and easy to understand as possible
        - Functions should be not extensively long
        - Avoid complex constructs, such as nested **if**s
        - Statements should be short
- Refer to ECE 190 C Coding Conventions at http://courses.engr.illinois.edu/ECE190/info/conventions.html