Australian
National
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COMP1730/COMP6730
Programming for Scientists

Control, part 2: Iteration

Outline

- Iteration: The `while` statement
- Example Problems

Program control flow

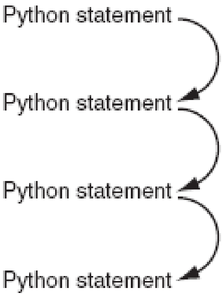


FIGURE 2.1 Sequential program flow.

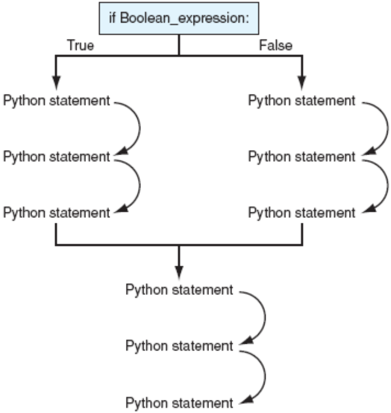
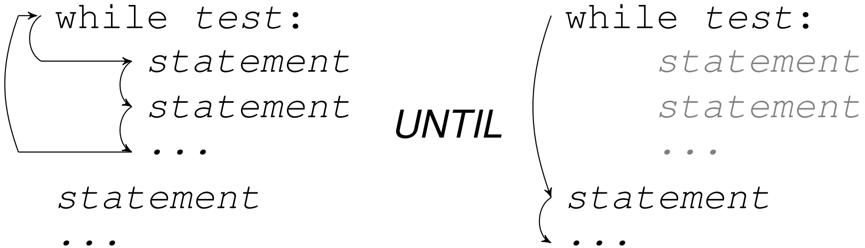


FIGURE 2.2 Decision making flow of control.

Images from Punch & Enbody

Iteration (Repetition)



```
while test:
    statement
    statement
    ...
statement
...
```

UNTIL

```
while test:
    statement
    statement
    ...
statement
...
```

- Iteration *repeats* a suite of statements.
- A test is evaluated before each iteration, and the suite executed (again) if it is true.

Iteration statements in python

- The `while` loop repeats a suite of statements as long as a condition is true.
- The `for` loop iterates through the elements of a collection or sequence (data structure) and executes a suite once for each element.
  - We’ll come back to the `for` loop later in the course.

The `while` loop statement

```
while test_expression:
    suite
statement(s)
```

1. Evaluate the test expression (converting the value to type `bool` if necessary).
2. If the value is `True`, execute the suite once, then go back to **1**.
3. If the value is `False`, skip the suite and go on to the following statements (if any).

Suites (reminder)

- A *suite* is a (sub-)sequence of statements.
- A suite must contain at least one statement!
- In python, a suite is delimited by indentation.
  - All statements in the suite **must be preceded by the same number of spaces/tabs** (standard is 4 spaces).
  - The indentation depth of the suite following `if` / `else` / `while :` must be greater than that of the statement.
- A suite can include nested suites (`if`’s, etc).

Variable assignment (reminder)

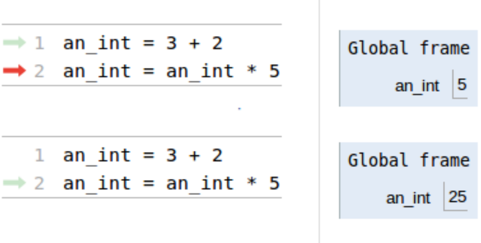
- A variable is a name that is associated with a value in the program.
- Variable assignment is a statement:

  ```
  var_name = expression
  ```

  - Note: Equality is written == (two =’s).
- A name–value association is created by the *first* assignment to the name;
- *subsequent* assignments to the same name *change* the associated value.

- For example,

```
an_int = 3 + 2
an_int = an_int * 5
```



```
an_int = 3 + 2
an_int = an_int * 5
```

Global frame

an_int	5

```
an_int = 3 + 2
an_int = an_int * 5
```

Global frame

an_int	25

(From `pythontutor.com`)

1. Evaluate expression `3 + 2` to `5`.
2. Store value `5` with name `an_int`
3. Evaluate expression `an_int * 5` to `25`.
4. Store value `25` with name `an_int`, replacing the previous associated value.

Example Problems

Example: Print numbers

- Print out the numbers 1 through 10.

```
n = 1
while n <= 10:
    print(n)
    n = n + 1
```

- This is a common `while` loop setup.

Example: Sums

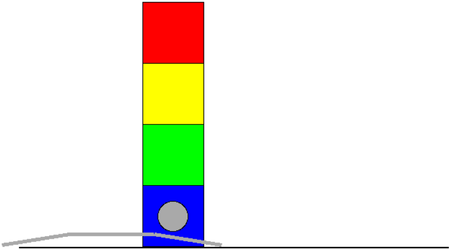
- For a given *n*, what is the sum of the integers 1 through *n*?

```
def sum_integers(n)
    k = 1
    sum = 0
    while k <= n:
        k = k + 1
        sum = sum + k
    return sum
```

- Is this correct? (Test, test, test!)

Problem: Counting boxes

- How many boxes are in the stack from the box in front of the sensor and up?

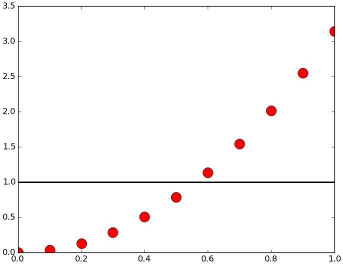


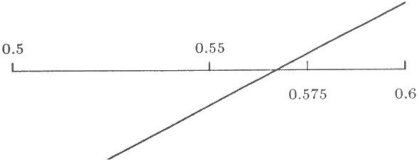
- While `robot.sense_color() != ''`, move the lift up, *and count how many times*; then move the lift down that many times.

```
def count_boxes():
    num_boxes = 0
    while robot.sense_color() != ’’:
        num_boxes = num_boxes + 1
        robot.lift_up()
    steps_to_go = num_boxes
    while steps_to_go > 0:
        robot.lift_down()
        steps_to_go = steps_to_go - 1
    return num_boxes
```

Problem: Solving an equation

- Solve $f(x) = 0$.
- The interval-halving algorithm:
  - if $f(m) \approx 0$, return m;
  - if $f(m) < 0$, set l to m;
  - if $f(m) > 0$, set u to m.





`return` from a loop

- A loop (`while` or `for`) can appear in a function suite, and a `return` statement can appear in the suite of the loop.

```
def find_box(color):
    while robot.sense_color() != ’’:
        if robot.sense_color() == color:
            return True
        robot.lift_up()
    return False
```

- Executing the `return` statement ends the function call, and therefore also exits the loop.

Common problems with `while` loops

- Loop never starts: the control variable is not initialised correctly.
- Loop never stops (infinite loop): the control variable is not modified in the loop.
- Loop runs one too many or one too few times (off by one error).