2. For Loop

Fig. 2.5 Photo by Tine Ivanič on Unsplash

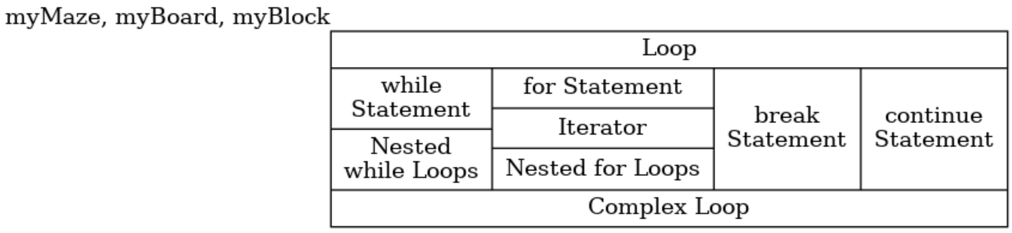
Note

Outline

Note

Roadmap

1. This topic: Loop



myMaze, myBoard, myBlock

<table>
<tr><td colspan="4">Loop</td></tr>
<tr><td rowspan="3">while Statement</td><td rowspan="2">for Statement</td><td rowspan="6">break Statement</td><td rowspan="6">continue Statement</td></tr>
<tr></tr>
<tr><td rowspan="2">Iterator</td></tr>
<tr><td rowspan="3">Nested while Loops</td></tr>
<tr><td rowspan="2">Nested for Loops</td></tr>
<tr></tr>
<tr><td colspan="4">Complex Loop</td></tr>
</table>

2. Course: Python 1
3. Subject: Programming
4. Field
   a. Software Engineering (SE)
   b. Computer Science and Information Engineering (CSIE)
   c. Electrical/Electronics Engineering (EE)

2.1. For Loop

1. for...in迴圈，一般也會簡稱為for迴圈，通常拿來處理有次序性且已知應該執行次數的問題。
2. 在執行for迴圈時需要下列三個條件，

   a. 設定控制變數的初始值。

   b. 設定控制變數的終止值，也就是迴圈的結束條件。

   c. 設定控制變數值的變動方向與量，也就是迴圈的疊代(Iteration)。

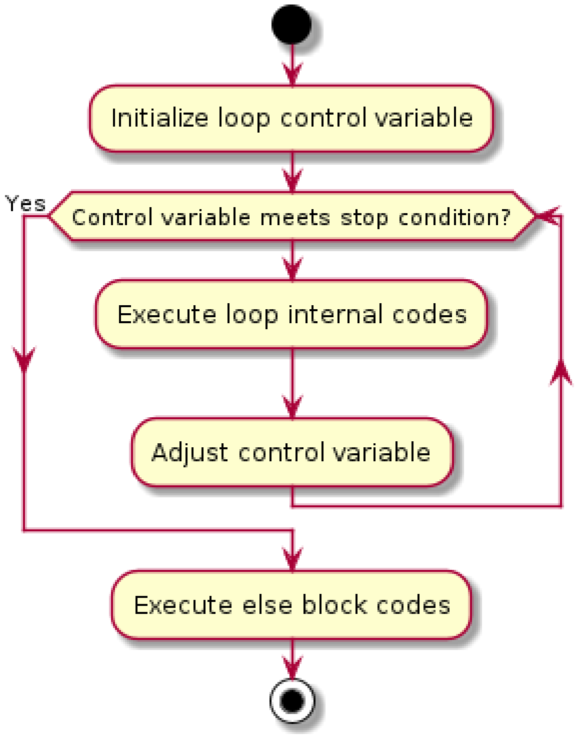
3. 一般來說，在for迴圈裡面的expression如果不是一個變數（如常用的i）， 就是一個變數序列（如list與tuple等）。
4. iterable是疊代的意思，在這裡要放置可以循序疊代的物件， 例如list、tuple或range()函數。
5. 而else是選擇性設定，後面的程式碼會在for迴圈中止之後被執行。

> **Note**
>
> a. iterator (n.) 疊代子
>
> b. iteration (n.)疊代
>
> c. iterable (a.) 可疊代的
>
> d. container (n.) 容器

6. Syntax

```
for expression in iterable:
    欲執行的程式碼1…
[else:]
    [欲執行的程式碼2…]
```

7. Activity Diagram


Initialize loop control variable
Yes
Control variable meets stop condition?
Execute loop internal codes
Adjust control variable
Execute else block codes

8. 從上圖可以看出for 迴圈的執行流程。
9. 一開始會先給定for 迴圈控制變數的初始值，然後判斷控制變數是否已符合迴圈終止條件；如果還沒符合終止條件，便會執行for 迴圈內部的程式碼，並且將控制變數進行疊代。
10. 執行完一次for 迴圈之後會回到條件判斷，看控制變數是否已符合迴圈終止條件，如果還不符合，則會再執行一次for 迴圈，直到控制變數符合終止條件為止。
11. 在前面的內容中，菲絲恩曾提到一個在for迴圈中常被使用的函數—range()。
12. 顧名思義，range就是範圍的意思。

函數	描述
range([start,]stop[, step])	建立整數序列

13. 如上表所示，range() 所必須要給予的傳入值是stop，也就是停止條件。至於start跟step都是選擇性選項屬性。
14. start是起始值，預設為0；step是疊代數字，預設為1。
15. 三者所需要的資料型態都是int。
16. 而range() 所傳回的資料是一個名稱為range 的物件，因此直接使用的可用性不高，通常會將其轉型成其他容器資料型態，如list、tuple 等。
17. 事實上，在for 迴圈中使用range() 時， 是將range() 放在上圖中的iterable，也就是疊代的位置。
18. 值得注意的是，range() 裡面的step 不僅能設定為正整數，也能設定為負整數（如-1、-2等）。
19. 以下舉例說明之：

2.1.1. Ex1: range()

1. Source

Listing 2.1.1.4 /src/Loop/p0601Range.py

```
'''
Created on 2015年8月28日

@author: cph
'''
print(range(10))                   # 直接印出range() 會印出range 物件，使用意義不大
print(list(range(10)))             # 將range 物件轉型為list
print(list(range(3, 15, 4)))       # 設定起始值為3，終止值為15，迭代數字為4
print(list(range(10, -14, -3)))  # 設定起始值為10，終止值為-14，迭代數字為-3
print(tuple(range(-7, 24, 5)))   # 也可以將range 物件轉型為tuple
```

2. Output

```
range(0, 10)
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[3, 7, 11]
[10, 7, 4, 1, -2, -5, -8, -11]
(-7, -2, 3, 8, 13, 18, 23)
```

3. 以起始值為10，終止值為-14，疊代數值為-3 的range() 為例，普羅可以發現range() 終止值的結果並沒有被輸出。
4. 也就是初始值疊代到小於或等於終止值時，疊代便會結束，然後將資料傳回給print() 進行列印的動作。
5. 請注意，上述例子中，若疊代數值為正數，則為大於或等於終止值時，疊代才會結束。
6. 如同上面所說，for 迴圈通常拿來執行已知執行次數的程式碼，例如：
7. Source 2

Listing 2.1.1.5 /src/Loop/p0601Range2.py

```
'''
Created on 2021年7月16日

@author: cph
'''
#
# range([start, ]stop[, step])
#
print(list(range(10)))
print(list(range(1, 10)))
print(list(range(1, 10, 1)))
print(list(range(0, 10, 1)))

print(list(range(10, 1, -1)))

print(list(range(0, 10, 2)))
print(list(range(10, 0, -2)))

print(list(range(1, 10, 3)))
print(list(range(10, 1, -3)))
```

8. Output 2

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[1, 2, 3, 4, 5, 6, 7, 8, 9]
[1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[10, 9, 8, 7, 6, 5, 4, 3, 2]
[0, 2, 4, 6, 8]
[10, 8, 6, 4, 2]
[1, 4, 7]
[10, 7, 4]
```

2.1.2. Ex2: Sum

1. Source

```
iSum = 0               # 將iSum給定初始值為0
for i in range(101):   # 設定for迴圈的執行條件，讓i從0疊代到100
    iSum += i          # 將i的值加到iSum
else:
    print("將0到100加總，所得總和為", iSum)   # 在迴圈執行結束時將iSum值印出
```

2. Output

```
將0到100加總，所得總和為 5050
```

2.1.3. Ex3: From While Loop To For Loop

1. Source 1: 1+2+...+8+9+10=55

Listing 2.1.3.7 /src/Loop/p14LoopWhileFor1/__init__.py

```
# 1+2+...+8+9+10=55
#== While Loop =========================
iSum = 0                # 設定iSum為0
iCount = 1              # 設定iCount也就是起始條件為0
```

```
while (iCount <= 10):   # 當iCount < 100 時執行以下的程式碼
    iSum += iCount      # 將iCount的值加總到iSum
    iCount += 1         # 每次執行時iCount+1

print('While:', iSum)   # 利用格式化輸出

#== For Loop ===========================
iSum = 0
for iCount in range(1, 11):
    iSum += iCount

print('For:', iSum)     # 利用格式化輸出

```

2. Output 1

```
While: 55
For: 55
```

3. Source 2: 10+9+...+2+1=55

Listing 2.1.3.8 /src/Loop/p14LoopWhileFor2/__init__.py

```
# 10+9+...+2+1=55
#== While Loop =========================
iSum = 0
iCount = 10
while (iCount >= 1):
    iSum += iCount
    iCount -= 1

print('While:', iSum)  # 利用格式化輸出

#== For Loop =========================
iSum = 0
for iCount in range(10, 0, -1):
    iSum += iCount

print('For:', iSum)    # 利用格式化輸出
```

4. Output 2

```
While: 55
For: 55
```

5. Source 3: 1+3+5+7+9 = 25

Listing 2.1.3.9 /src/Loop/p14LoopWhileFor3/__init__.py

```
# 1+3+5+7+9 = 25
#== While Loop =========================
iSum = 0
```

```
iCount = 1
while (iCount <= 10):
    iSum += iCount
    iCount += 2

print('While:', iSum)

#== For Loop ========================
iSum = 0
for iCount in range(1, 10, 2):
    iSum += iCount

print('For:', iSum)
```

6. Output 3

```
While: 25
For: 25
```

7. Source 3a: 9+7+5+3+1 = 25

Listing 2.1.3.10 /src/Loop/p14LoopWhileFor3a/__init__.py

```
# 9+7+5+3+1 = 25
#== While Loop ========================
iSum = 0
iCount = 9
while (iCount >= 1):
    iSum += iCount
    iCount -= 2

print('While:', iSum)

#== For Loop ========================
iSum = 0
for iCount in range(9, 0, -2):
    iSum += iCount

print('For:', iSum)
```

8. Output 3a

```
While: 25
For: 25
```

9. Source 3b: 9+7+5+3+1 = 25

Listing 2.1.3.11 /src/Loop/p14LoopWhileFor3b/__init__.py

```
# 9+7+5+3+1 = 25
#== While Loop ========================
iSum = 0
```

```
iCount = 10
while (iCount >= 1):
    if (iCount % 2 == 1):
        iSum += iCount
    iCount -= 1

print('While:', iSum)

#== For Loop ========================
iSum = 0
for iCount in range(9, 0, -1):
    if (iCount % 2 == 1):
        iSum += iCount

print('For:', iSum)
```

10. Output 3b

```
While: 25
For: 25
```

11. Code+Output 3c: 10+8+6+4+2 = 30

Code Output

```
While: 30
For: 30
```

12. Code+Output 3d: 10+7+4+1 = 22

Code Output

```
While: 22
For: 22
```

13. Code+Output 3e: 3+6+9+12=30

Code Output

```
While: 30
For: 30
```

14. Code+Output 4: 1+4+7+10 = 22

Code Output

```
While: 22
For: 22
```

2.1.4. Ex4: 6!

1. 複賽開始了， 第一關主考官要求普羅計算出6的階層 $6!$， 這點難度的題目對於他們來說簡直易如反掌， 普羅在彈指之間就算出來了。
2. Code+Output

Code Output

```
720
720
```

2.1.5. Ex5: Split Me!

1. 輕鬆地通過了第一關， 普羅正得意著。 但緊接著，下一關就是要普羅利用魔法把句子裡的字母給一一分開， 普羅頓時陷入難題之中。
2. 這時，菲絲恩信心喊話道：「這題目不難呀！腦筋轉個彎，答案就出來了。」
3. Code+Output

Code Output

```
sLine = "Split me!"
for i in sLine:
    print(i + "_", end = "")
```

2.1.6. Ex6: International Day of Mathematics

1. 每年的03/14是國際數學日． 有人說物理的極致是宗教，數學的極致是哲學，是有一定道理的。 輸出以下有趣的算式。

```
1 x 8 + 1 = 9
12 x 8 + 2 = 98
123 x 8 + 3 = 987
1234 x 8 + 4 = 9876
```

```
12345 x 8 + 5 = 98765
123456 x 8 + 6 = 987654
1234567 x 8 + 7 = 9876543
12345678 x 8 + 8 = 98765432
123456789 x 8 + 9 = 987654321
```

Code Output

Listing 2.1.6.1 /src/Loop/p0604LoopForMathDay.py

```python
'''
Created on 20210722
@author: cph
'''
sCat = ''
for i in range(1, 10):
    sCat += str(i)
    print(sCat, 'x 8 +', i, '=', (int(sCat) * 8 + i))
```

Code Output

```
1 x 9 + 2 = 11
12 x 9 + 3 = 111
123 x 9 + 4 = 1111
1234 x 9 + 5 = 11111
12345 x 9 + 6 = 111111
123456 x 9 + 7 = 1111111
1234567 x 9 + 8 = 11111111
12345678 x 9 + 9 = 111111111
123456789 x 9 +10= 1111111111
```

Code Output

```
9 x 9 + 7 = 88
98 x 9 + 6 = 888
987 x 9 + 5 = 8888
9876 x 9 + 4 = 88888
98765 x 9 + 3 = 888888
987654 x 9 + 2 = 8888888
9876543 x 9 + 1 = 88888888
98765432 x 9 + 0 = 888888888
```

Code Output

```
1 x 1 = 1
11 x 11 = 121
111 x 111 = 12321
```

```
1111 x 1111 = 1234321
11111 x 11111 = 123454321
111111 x 111111 = 12345654321
1111111 x 1111111 = 1234567654321
11111111 x 11111111 = 123456787654321
111111111 x 111111111 = 12345678987654321
```

2.1.7. Ex7: Star-typed Triangles

1. Code+Output

   Code **Output**

   Listing 2.1.7.1 /src/Loop/p14LoopStarFor4/__init__.py

```python
iLevel = eval(input())
'''
*           *   *****   *****
**         **   ****     ****
***       ***   ***       ***
****     ****   **         **
*****   *****   *           *
'''

for i in range(1, iLevel + 1):
    print('*' * i + ' ' * (iLevel - i), end='')
    print(' ' * 3, end='')

    print(' ' * (iLevel - i) + '*' * i, end='')
    print(' ' * 3, end='')

    print('*' * (iLevel - i + 1) + ' ' * (i - 1), end='')
    print(' ' * 3, end='')

    print(' ' * (i - 1) + '*' * (iLevel - i + 1))
```

2. Note that the shortest space between each triangle is with 3 spaces.

2.1.8. Ex8: Forever

1. Code+Output

   Case 1: itertools.repeat() **Case 2: itertools.count()** **Case 3a: itertools.cycle()**
   Case 3b: itertools.cycle() **Case 3c: itertools.cycle()** **Case 3d: itertools.cycle()**
   Case 4: asyncio **Output**

Listing 2.1.8.7 /src/Loop/p0604LoopForeverAsyncio.py

```python
'''
Created on 20230724
@author: cph
'''
import asyncio

if __name__ == '__main__':
    loop = asyncio.get_event_loop()
    try:
        loop.run_forever()
    finally:
        loop.close()
        print(f'End of infinite loop...')
```

2.1.9. Ex9: Echo

1. Code+Output

Case 1: itertools.repeat() Input Output

Listing 2.1.9.2 /src/Loop/LoopEcho.py

```python
'''
author: cph
since:  20230801
input:
        5
        I love my dear mom.
'''
N = int(input())
S = input().split()
print(f'S: {S}')
print(f'[1a] Remove the first word: While...')
n = 0
while n < N:
    print(' '.join(S[n:]))
    n += 1

print(f'[1a] Remove the first word: For...')
for n in range(N):
    print(' '.join(S[n:]))

print(f'[1b] Remove the first character: While...')
n = 0
while n < N:
    print(' '.join(S)[n:])
    n += 1
```

```python

print(f'[1b] Remove the first character: For...')
for n in range(N):
    print(' '.join(S)[n:])

print(f'[2a] Remove the last word: While...')
n = 0
while n < N:
    print(' '.join(S[:N - n]))
    n += 1

print(f'[2a] Remove the last word: For...')
for n in range(N):
    print(' '.join(S[:N - n]))

print(f'[2b] Remove the last character from index 5:
While...')
n = 0
while n < N:
    print(' '.join(S)[:N - n])
    n += 1

print(f'[2b] Remove the last character from index 5: For...')
for n in range(N):
  print(' '.join(S)[:N - n])

print(f'[3a] Remove the last 2 words: While...')
n = 0
while n < N:
    print(' '.join(S[:N - n]))
    n += 2

print(f'[3a] Remove the last 2 words: For...')
for n in range(0, N, 2):
    print(' '.join(S[:N - n]))

print(f'[3b] Remove the last 2 characters from index 5:
While...')
n = 0
while n < N:
    print(' '.join(S)[:N - n])
    n += 2

print(f'[3b] Remove the last 2 characters from index 5:
For...')
for n in range(0, N, 2):
    print(' '.join(S)[:N - n])
    n += 2

print(f'[4a] Remove the first 2 words: While...')
n = 0
while n < N:
    print(' '.join(S[n:]))
    n += 2

```

```
print(f'[4a] Remove the first 2 words: For...')
for n in range(0, N, 2):
    print(' '.join(S[n:]))

print(f'[4b] Remove the first 2 characters: While...')
n = 0
while n < N:
    print(' '.join(S)[n:])
    n += 2

print(f'[4b] Remove the first 2 characters: For...')
for n in range(0, N, 2):
    print(' '.join(S)[n:])
```

Note

1. Start: 20170719
2. System Environment:

Listing 2.1.9.3 requirements.txt

```
sphinx==7.1.2                           # Sphinx
graphviz>=0.20.1                        # Graphviz
sphinxbootstrap4theme>=0.6.0            # Theme: Bootstrap
sphinx-material>=0.0.35                 # Theme: Material
sphinxcontrib-plantuml>=0.25            # PlantUML
sphinxcontrib.bibtex>=2.5.0             # Bibliography
sphinx-autorun>=1.1.1                   # ExecCode: pycon
sphinx-execute-code-python3>=0.3        # ExecCode
btd.sphinx.inheritance-diagram>=2.3.1   # Diagram
sphinx-copybutton>=0.5.1                # Copy button
sphinx_code_tabs>=0.5.3                 # Tabs
sphinx-immaterial>=0.11.3               # Tabs

#-----------------------------------------------------
#-- Library Upgrade Error by Library Itself
#   >> It needs to fix by library owner
#   >> After fixed, we need to try it later
#-----------------------------------------------------
pydantic==1.10.10                       # 2.0: sphinx compiler
error, 20230701

#-----------------------------------------------------
#-- Minor Extension
#-----------------------------------------------------
sphinxcontrib.httpdomain>=1.8.1         # HTTP API

#sphinxcontrib-blockdiag>=3.0.0         # Diagram: block
#sphinxcontrib-actdiag>=3.0.0           # Diagram: activity
#sphinxcontrib-nwdiag>=2.0.0            # Diagram: network
#sphinxcontrib-seqdiag>=3.0.0           # Diagram: sequence

#-----------------------------------------------------
#-- Still Wait For Upgrading Version
#-----------------------------------------------------

#-----------------------------------------------------
#-- Still Under Testing
#-----------------------------------------------------
#numpy>=1.24.2                          # Figure: numpy

#-----------------------------------------------------
#-- NOT Workable
#-----------------------------------------------------
#sphinxcontrib.jsdemo==0.1.4    # ExecCode: Need replace
add_js_file()
#jupyter-sphinx==0.4.0          # ExecCode: Need gcc compiler
```

```
#sphinxcontrib.slide==1.0.0     # Slide: Slideshare
#hieroglyph==2.1.0              # Slide: make slides
#matplotlib>=3.7.1              # Plot: Need Python >= v3.8
#manim==0.17.2                  # Diagram: scipy, numpy need gcc
#sphinx_diagrams==0.4.0         # Diagram: Need GKE access
#sphinx-tabs>=3.4.1                     # Tabs: Conflict w/ sphinx-material
```