

Current Topic in Applied Mathematics

Numerical Methods with Python

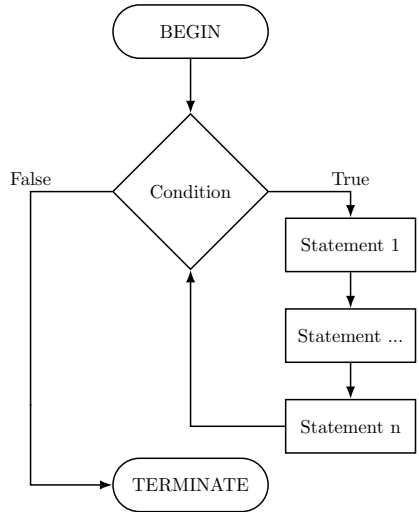
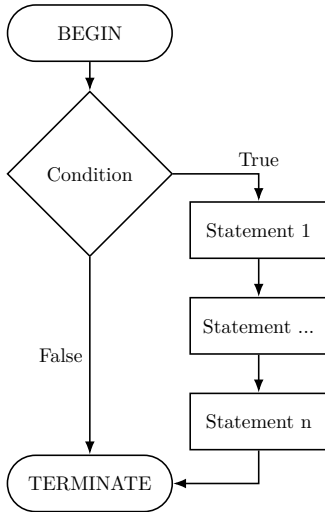
Repetition

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- 1 Understanding of Python Loops
- 2 Python List
- 3 Loop through a List

Conditions vs Loops

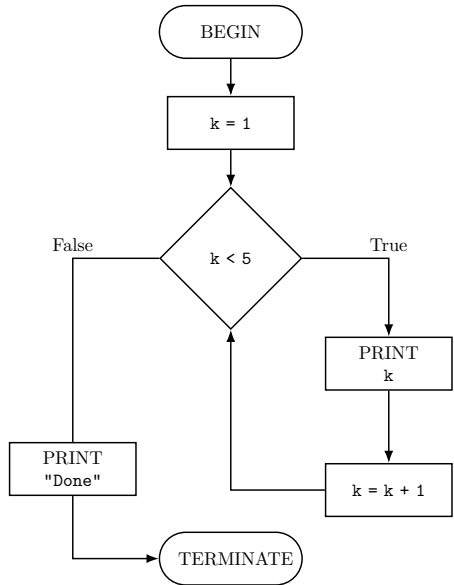


Python While Loops


 loop_ex1.py

```
1 k = 1
2 while k < 5:
3     print(k)
4     k = k + 1
5 print('Done')
```

```
>_ python loop_ex1.py
1
2
3
4
Done
```



Python While Loops

 loop_ex2.py

```
1 k = 1
2 while k > 0:
3     print(k)
4     k = k + 1
5 print('Done')
```

Always True!

This is an **infinite loop**

Only Exit with

ctrl + C


or

ctrl + D

```
>_ python loop_ex2.py
```

```
1
2
3
4
.
.
.
```


Examples

 times_table.py

```
1 print('Times-table Generator')
2 n = 1
3 k = int(input('Enter an integer: '))
4 while n <= 12:
5     x = n * k
6     print(k, '*', n, '=', x)
7     n = n + 1
8 print('-' * 25)
```

```
>_ python times_table.py
Times-table Generator
Enter an integer: 9
9 * 1 = 9
9 * 2 = 18
9 * 3 = 27
9 * 4 = 36
9 * 5 = 45
9 * 6 = 54
9 * 7 = 63
9 * 8 = 72
9 * 9 = 81
9 * 10 = 90
9 * 11 = 99
9 * 12 = 108
-----
```


Examples

 ftimes_table.py

```
1 print('Times-table Generator')
2 run = 1
3 while run > 0:
4     n = 1
5     k = int(input('Enter an integer: '))
6     while n <= 12:
7         x = n * k
8         print(k, '*', n, '=', x)
9         n = n + 1
10    print('-' * 25)
11 print('Program is terminated.')
```

```
>_ python ftimes_table.py
Times-table Generator
Enter an integer: 9
9 * 1 = 9
9 * 2 = 18
9 * 3 = 27
9 * 4 = 36
9 * 5 = 45
9 * 6 = 54
9 * 7 = 63
9 * 8 = 72
9 * 9 = 81
9 * 10 = 90
9 * 11 = 99
9 * 12 = 108
-----
Enter an integer:
```


Examples

 rtimes_table.py

```
1 print('Times-table Generator')
2 run = 1
3 while run > 0:
4     n = 1
5     k = int(input('Enter a number: '))
6     while n <= 12:
7         x = n * k
8         print(k, '*', n, '=', x)
9         n = n + 1
10    print('-' * 25)
11    key = input('Continue? ')
12    if key == 'exit':
13        run = -1
14 print('Program is terminated.')
```

```
>_ python rtimes_table.py
Times-table Generator
Enter an integer: 9
9 * 1 = 9
9 * 2 = 18
9 * 3 = 27
9 * 4 = 36
9 * 5 = 45
9 * 6 = 54
9 * 7 = 63
9 * 8 = 72
9 * 9 = 81
9 * 10 = 90
9 * 11 = 99
9 * 12 = 108
-----
Continue?
```


Examples

 circle_area.py


```
1 pi = 3.14159265359
2 run = 1
3 while run > 0:
4     r = float(input('Enter a radius: '))
5     area = pi * r ** 2
6     print('Area is', area)
7     print('-' * 25)
8     key = input('Continue? ')
9     if key == 'exit' or key == 'Exit':
10         run = -999
11 print('Program is terminated')
```

```
>_ python circle_area.py
Enter a radius: 2
Area is 12.56637061436
-----
Continue?
Enter a radius: 44
Area is 6082.12337735024
-----
Continue?
Enter a radius: 5.5
Area is 95.0331777710975
-----
Continue? exit
Program is terminated
```

Example

Write a Python program to find

$$1 + 2 + 3 + \dots + 1000.$$

 summation_1.py

```
1  summation = 0
2  k = 1
3  N = 1000
4  while k <= N:
5      summation = summation + k
6      k = k + 1
7  print('Summation is', summation)
```


```
>_ python summation_1.py
Summation is 500500
```

Example

Write a Python program to find

$$1 + 3 + 5 + \dots + 999.$$

$$\sum_{k=1}^{500} (2k - 1)$$


 summation_2.py

```
1  summation = 0
2  k = 1
3  N = 500
4  while k <= N:
5      x = 2*k - 1
6      summation = summation + x
7      k = k + 1
8  print('Summation is', summation)
```

```
>_ python summation_2.py
Summation is 250000
```


Write a Python program to find

$$\frac{1}{2 \cdot 3} + \frac{2}{3 \cdot 4} + \frac{3}{4 \cdot 5} + \dots + \frac{998}{999 \cdot 1000}.$$


$$\sum_{n=1}^{998} \frac{n}{(n+1)(n+2)}$$

Write a Python program to find

$$\left(\frac{1}{2 \cdot 3}\right) \times \left(\frac{2}{3 \cdot 4}\right) \times \left(\frac{3}{4 \cdot 5}\right) \times \dots \times \left(\frac{998}{999 \cdot 1000}\right).$$


$$\prod_{n=1}^{998} \frac{n}{(n+1)(n+2)}$$

Write a Python program to find

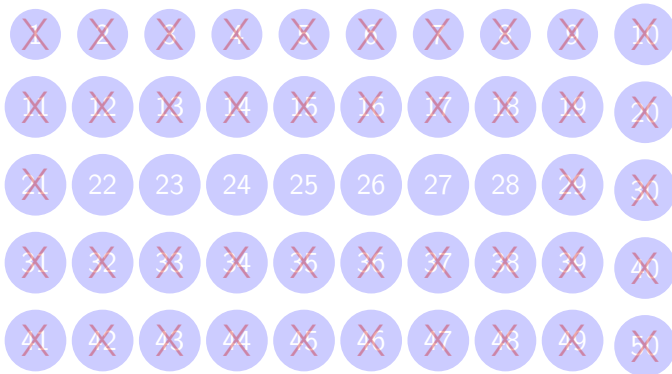
$$n! = (n)(n-1)(n-2) \cdots (3)(2)(1)$$

for any positive integer n .

Guessing Game

The computer has a secret integer from 1 to 50. A player keeps guessing numbers until he find the computer's number, and the computer will tell the player each time if the guess was too high or too low.

Write a Python program for this game.



Challenge!

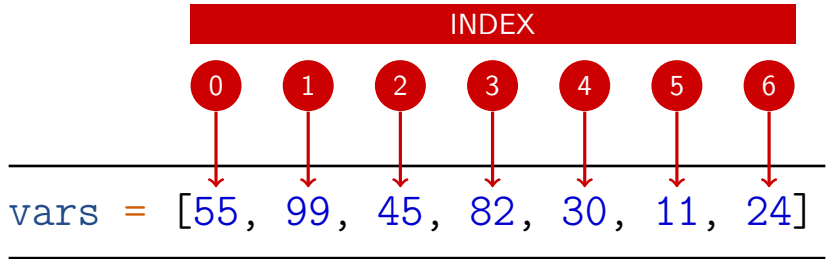
Guessing Game+

This is as same as the previous guessing game, but it comes with options allowing player to choose a difficulty. Each difficulty affects the secret integer lying in different ranges as follows;

Difficulty	Secret Integer Range
Easy	[1, 10]
Normal	[1, 50]
Hard	[-100, 100]
Custom	[?, ?]

Write a Python program for this game.

```
vars = [55, 99, 45, 82, 30, 11, 24]
```

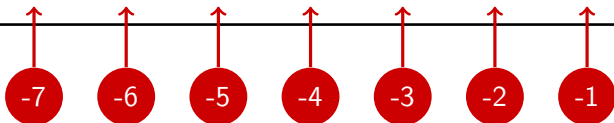


```
>>> vars[0]
55
>>> vars[1]
99
>>> vars[2]
45
```

```
>>> vars[3]
82
>>> vars[4]
30
>>> vars[5]
11
```

```
>>> vars[6]
24
>>> vars[7]
IndexError:
list index
out of range
```

`vars = [55, 99, 45, 82, 30, 11, 24]`



INDEX (BACKWARD)

```
>>> vars[-1]
```

```
24
```

```
>>> vars[-2]
```

```
11
```

```
>>> vars[-3]
```

```
30
```

```
>>> vars[-4]
```

```
82
```

```
>>> vars[-5]
```

```
45
```

```
>>> vars[-6]
```

```
99
```

```
>>> vars[-7]
```

```
55
```

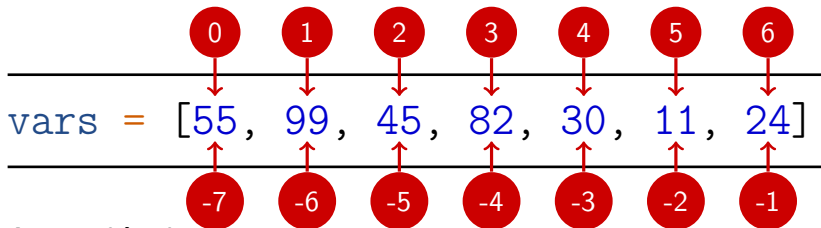
```
>>> vars[-8]
```

```
IndexError:
```

```
list index
```

```
out of range
```

Python List

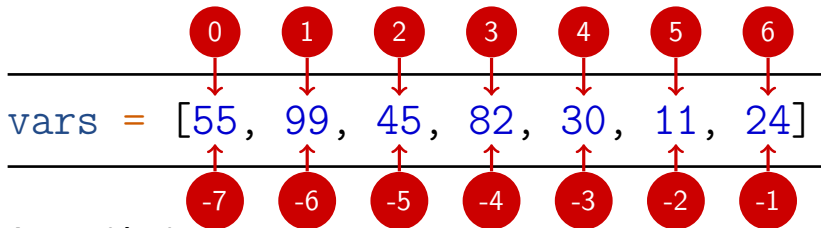


Access List Items

```
>>> vars[1]
99
>>> vars[0:3]
[55, 99, 45]
>>> vars[2:6]
[45, 82, 30, 11]
```

```
>>> vars[-2]
11
>>> vars[-5:-2]
[45, 82, 30]
>>> vars[-7:-1]
[55, 99, 45, 82, 30, 11]
```

Python List

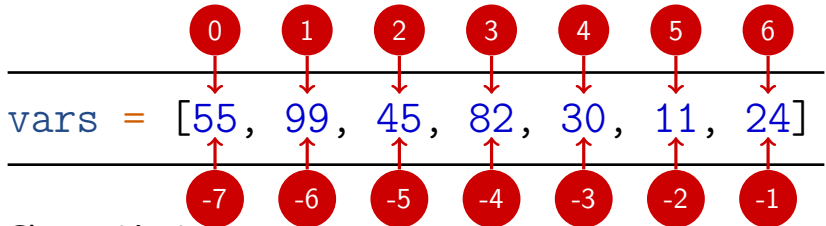


Access List Items

```
>>> vars[1:]  
[99, 45, 82, 30, 11, 24]  
>>> vars[-6:]  
[99, 45, 82, 30, 11, 24]
```

```
>>> vars[:5]  
[55, 99, 45, 82, 30]  
>>> vars[:-2]  
[55, 99, 45, 82, 30]
```

Python List

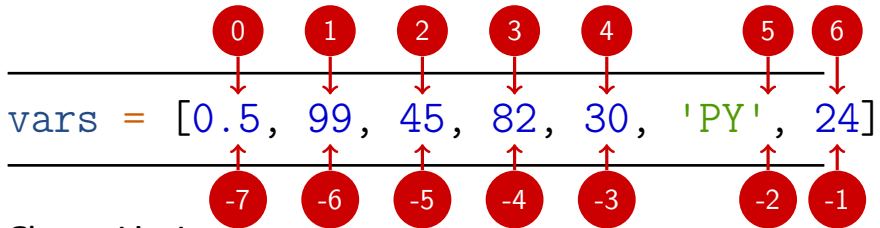


Change List Items

```
>>> vars[0] = 0.5  
>>> vars[-2] = 'PY'
```

```
>>> vars  
[0.5, 99, 45, 82, 30, 'PY', 24]
```

Python List

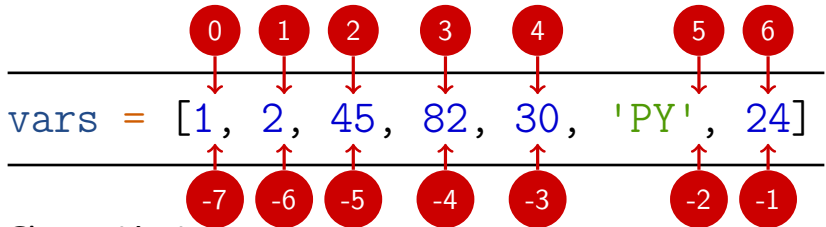


Change List Items

```
>>> vars[0:2] = [1, 2]
```

```
>>> vars  
[1, 2, 45, 82, 30, 'PY', 24]
```

Python List

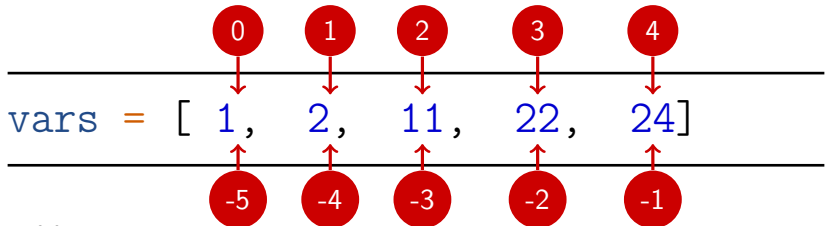


Change List Items

```
>>> vars[2:6] = [11, 22]
```

```
>>> vars  
[1, 2, 11, 22, 24]
```


Python List

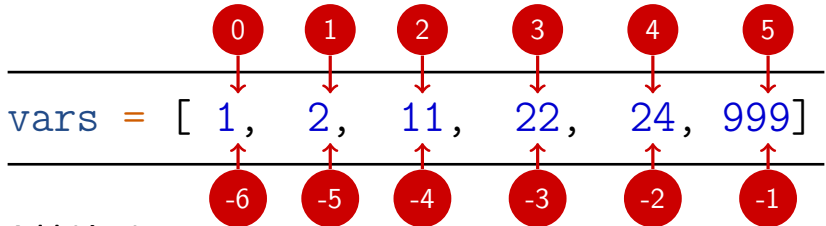


Add List Items

```
>>> vars.append(999)
```

```
>>> vars  
[1, 2, 11, 22, 24, 999]
```

Python List

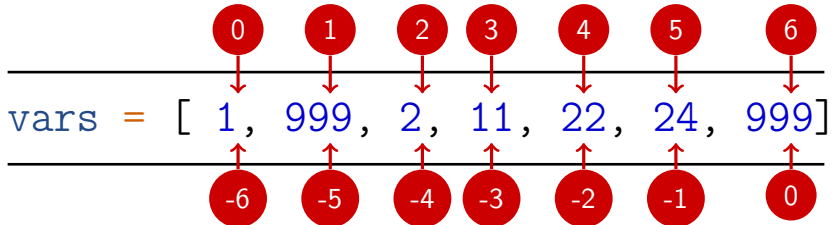


Add List Items

```
>>> vars.insert(1, 999)
```

```
>>> vars  
[1, 999, 2, 11, 22, 24, 999]
```

Python List



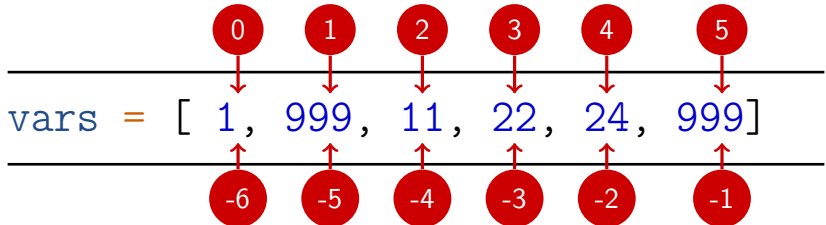
Remove List Items

```
>>> vars.remove(2)
```

```
>>> vars
```

```
[1, 999, 11, 22, 24, 999]
```

Python List

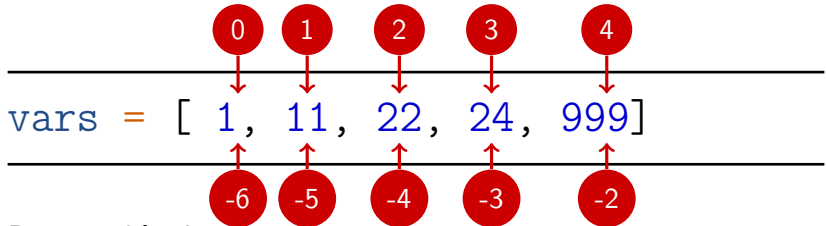


Remove List Items

```
>>> vars.remove(999)
```

```
>>> vars  
[1, 11, 22, 24, 999]
```

Python List

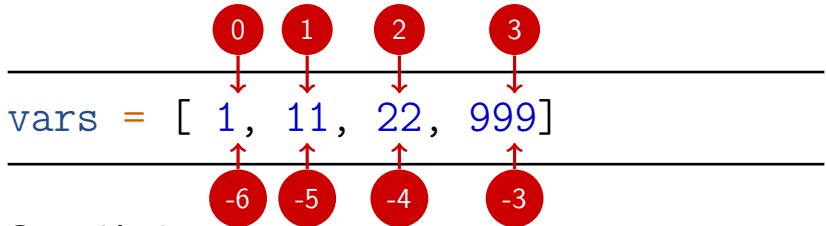


Remove List Items

```
>>> vars.pop(3)
```

```
>>> vars  
[1, 11, 22, 999]
```

Python List



Count List Items

```
>>> len(vars)
```

```
4
```

```
xlist = [ 1, 11, 22, 999]
```


```
ylist = [888, 168]
```

Join Lists

```
>>> xlist + ylist
[1, 11, 22, 999, 888, 168]
>>> ylist + xlist
[888, 168, 1, 11, 22, 999]
>>> 2 * xlist
[1, 11, 22, 999, 1, 11, 22, 999]
```

Example


Write a Python program to find a summation of items in xlist.

 summation.py

```
1 xlist = [3.22, 1.80, 46, 0.33, 4.5,
↪ 88, 76.23, 144.21, 36.77,
↪ 99.34, 60.32, 4.00, 45.33,
↪ 235.0, 453.22]
2 sumx = 0
3 num = len(xlist)
4 n = 0
5 while n < num:
6     sumx = sumx + xlist[n]
7     n = n + 1
8 print('Summation is', sumx)
```

```
>_ python summation.py
Summation is 1298.27
```



Example

 summation.py

```
1 xlist = [3.22, 1.80, 46, 0.33, 4.5,  
  ↪ 88, 76.23, 144.21, 36.77,  
  ↪ 99.34, 60.32, 4.00, 45.33,  
  ↪ 235.0, 453.22]  
2 sumx = 0  
3 num = len(xlist)  
4 n = 0  
5 while n < num:  
6     sumx = sumx + xlist[n]  
7     print('n =', n, '--> sumx =',  
  ↪ sumx)  
8     n = n + 1  
9 print('Summation is', sumx)
```

```
>_ python summation.py  
n = 0 --> sumx = 3.22  
n = 1 --> sumx = 5.02  
n = 2 --> sumx = 51.02  
n = 3 --> sumx = 51.35  
n = 4 --> sumx = 55.85  
n = 5 --> sumx = 143.85  
n = 6 --> sumx = 220.08  
n = 7 --> sumx = 364.29  
n = 8 --> sumx = 401.06  
n = 9 --> sumx = 500.40  
n = 10 --> sumx = 560.72  
n = 11 --> sumx = 564.72  
n = 12 --> sumx = 610.05  
n = 13 --> sumx = 845.05  
n = 14 --> sumx = 1298.27  
Summation is 1298.27
```

Python For Loop

 summation.py

```
1 xlist = [3.22, 1.80, 46, 0.33, 4.5,  
  ↪ 88, 76.23, 144.21, 36.77,  
  ↪ 99.34, 60.32, 4.00, 45.33,  
  ↪ 235.0, 453.22]  
2 sumx = 0  
3 num = len(xlist)  
4  
5 for n in range(num):  
6     sumx = sumx + xlist[n]  
7  
8 print('Summation is', sumx)
```

```
>_ python summation.py  
Summation is 1298.27
```

num = 14

n = 0, 1, 2, ..., 13

While-loop vs For-loop



while_loop.py

```
1  xlist = [3.22, 1.80, 46,  
    ↪ 0.33, 4.5, 88, 76.23,  
    ↪ 144.21, 36.77, 99.34,  
    ↪ 60.32, 4.00, 45.33,  
    ↪ 235.0, 453.22]  
  
2  sumx = 0  
3  num = len(xlist)  
4  
5  n = 0  
6  while n < num:  
7      sumx = sumx + xlist[n]  
8      n = n + 1  
9  
10 print('Summation is', sumx)
```



for_loop.py

```
1  xlist = [3.22, 1.80, 46,  
    ↪ 0.33, 4.5, 88, 76.23,  
    ↪ 144.21, 36.77, 99.34,  
    ↪ 60.32, 4.00, 45.33,  
    ↪ 235.0, 453.22]  
  
2  sumx = 0  
3  num = len(xlist)  
4  
5  
6  for n in range(num):  
7      sumx = sumx + xlist[n]  
8  
9  
10 print('Summation is', sumx)
```

Different Types of For-loop

```
xlist = [100, 200, 300, 400, 500, 600, 700, 800, 900]
```

```
num = len(xlist) ← num = 9
```

```
for n in range(num):  
    print(xlist[n]) ← n = 0, 1, 2, ..., 8
```

```
for m in range(3, 6):  
    print(xlist[m]) ← m = 3, 4, 5
```

```
for k in range(1, 8, 3):  
    print(xlist[k]) ← k = 1, 4, 7
```

```
for x in xlist:  
    print(x) ← x = 100, 200, ..., 900
```

Example



summation_f_1.py

```
1 xlist = [3.22, 1.80, 46,  
  ↪ 0.33, 4.5, 88, 76.23,  
  ↪ 144.21, 36.77, 99.34,  
  ↪ 60.32, 4.00, 45.33,  
  ↪ 235.0, 453.22]  
2 sumx = 0  
3 num = len(xlist)  
4  
5 for n in range(num):  
6     sumx = sumx + xlist[n]  
7  
8 print('Summation is', sumx)
```



summation_f_2.py

```
1 xlist = [3.22, 1.80, 46,  
  ↪ 0.33, 4.5, 88, 76.23,  
  ↪ 144.21, 36.77, 99.34,  
  ↪ 60.32, 4.00, 45.33,  
  ↪ 235.0, 453.22]  
2 sumx = 0  
3  
4  
5 for x in xlist:  
6     sumx = sumx + x  
7  
8 print('Summation is', sumx)
```

Example

Write a Python program to find a summation of numbers in data.



summation_for.py

```
1 data = ['tha', 'THB', 60,  
2         'eng', 'GHB', 55,  
3         'deu', 'EUR', 75,  
4         'jap', 'YEN', 46,  
5         'esp', 'EUR', 78]  
6 sumn = 0  
7 num = len(data)  
8  
9 for n in range(2, num, 3):  
10     sumn = sumn + data[n]  
11  
12 print('Summation is', sumn)
```




summation_while.py

```
1 data = ['tha', 'THB', 60,  
2         'eng', 'GHB', 55,  
3         'deu', 'EUR', 75,  
4         'jap', 'YEN', 46,  
5         'esp', 'EUR', 78]  
6 sumn = 0  
7 num = len(data)  
8 n = 2  
9 while n < num:  
10     sumn = sumn + data[n]  
11     n = n + 3  
12 print('Summation is', sumn)
```

Example

Write a Python program to collect numbers from 10 inputs.


 collect.py

```
1 data = [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
2 for n in range(10):
3     x = float(input('Enter a number: '))
4     data[n] = x
5 print(data)
```

```
>_ python collect.py
Enter a number: 34
Enter a number: 33
Enter a number: 23
Enter a number: 44
Enter a number: 66
Enter a number: 34
Enter a number: 23
Enter a number: 12
Enter a number: 55
Enter a number: 56
[34.0, 33.0, 23.0,
 44.0, 66.0, 34.0,
 23.0, 12.0, 55.0,
 56.0]
```

Example

Write a Python program to collect numbers from 10 inputs.


 collect.py

```
1 data = [ ]
2 for n in range(10):
3     x = float(input('Enter a number: '))
4     data.append(x)
5 print(data)
```

```
>_ python collect.py
Enter a number: 34
Enter a number: 33
Enter a number: 23
Enter a number: 44
Enter a number: 66
Enter a number: 34
Enter a number: 23
Enter a number: 12
Enter a number: 55
Enter a number: 56
[34.0, 33.0, 23.0,
 44.0, 66.0, 34.0,
 23.0, 12.0, 55.0,
 56.0]
```


Example

Write a Python program to collect exam scores from a number of students. Inputs must be positive numbers or zero. The program stops collecting with a negative input.

 collect.py

```
1 data = [ ]
2 run = True
3 while run:
4     x = float(input('Enter a number: '))
5     if x >= 0:
6         data.append(x)
7     else:
8         run = False
9 print(data)
```

```
>_ python collect.py
Enter a number: 34
Enter a number: 33
Enter a number: 23
Enter a number: 44
.
.
.
Enter a number: 82
Enter a number: -9
[34.0, 33.0, 23.0,
 44.0, ...,
 82.0]
```