

CSEN 102– Introduction to Computer Science

Lecture 5: Algorithmic Problem Solving Iterative Operations Over Lists

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What you should have learned so far...

Algorithms can be constructed by the following operations:

- Sequential Operation
- Conditional Operation
- Iterative Operation

Syntax

Conditional control flow: general format

```
1 if condition:  
2     # <operations for the then-part>  
3 else  
4     # <operations for the else-part>
```

Iterative control flow: general format

```
1 while <condition>:  
2     step 1: <operation>  
3     ...  
4     step i: <operation>
```

Syntax

By the way...

what is the control-flow syntax for **sequential** operations?

Sequence, conditional, and iteration in one algorithm

- Remember the **Euclidean Algorithm** from [lecture 1](#), [slide 28](#) to determine the greatest common divisor (GCD) of two integers.
- Method:** To find the GCD of two numbers, repeatedly replace the larger by subtracting the smaller from it until the two numbers are equal.

Consider this little warm-up...

```
1 A, B = eval(input()), eval(input())
2 while not A == B:
3     if A > B:
4         A = A - B
5     else:
6         B = B - A
7 print("The_GCD_is_")
8 print(A)
```

Lists

- A **list** is a **collection of data**.
- In Python, we denote a list with `[]`
- `A[i]` corresponds to the value of the item in position `i`
- To get a list of `n` elements:
`A = eval(input())`
- To get its length `n`:
`n = len(A)`

Example I

Example

Given a list of n numbers, where n is odd, find the middle number in the list.

```
1 list_A = eval(input())
2 n = len(list_A)
3 i = int(n/2)
4 mid = list_A[i]
5 print(mid)
```

Example II

Example

Given a list of numbers, find the sum of the numbers in the list.

```
1 list_A = eval(input())
2 n = len(list_A)
3 i = 0
4 result = 0
5 while i < n:
6     result = result + list_A[i]
7     i = i + 1
8
9 print(result)
```


Example III

Example

Given a list of numbers, find the number of times a given number occurs in the list.

```
1 number = eval(input())
2 list_A = eval(input())
3 n = len(list_A)
4 count = 0
5 i = 0
6 while (i < n):
7     if (list_A[i] == number):
8         count += 1
9     i +=1
10 print(count)
```

Example IV

Sequential search

Problem: Find the phone number of a given Name in an (unsorted) list of names and their phone numbers

Names	Phone numbers
N0	T0
N1	T1
...	...
N999	T999

Example IV

Sequential search

Problem: Find the phone number of a given Name in an (unsorted) list of names and their phone numbers

Sequential search, 1st attempt

```
1 Name = input()
2 list_N = eval(input())
3 list_T = eval(input())
4 if Name == list_N[0]: print(list_T[0])
5 if Name == list_N[1]: print(list_T[1])
6 # ...
7 if Name == list_N[999]: print(list_T[999])
```

Example IV

Sequential search, using a loop (2nd attempt)

```
1 Name = input()
2 list_N = eval(input())
3 list_T = eval(input())
4 i = 0
5 Found = False
6
7 while Found == False and i < 1000:
8     if Name == list_N[i]:
9         print(list_T[i])
10        Found = True
11    else:
12        i = i + 1
13 if Found == False:
14    print("Sorry, name is not in directory")
```

Example V

Lists: Find The Largest Number

Problem: Given a list of values $A_0, \dots, A_{(n-1)}$, find the largest value and its (first) location

- Example:

			↓				
	A0	A1	A2	A3	A4	A5	A6
Value	5	2	8	4	8	6	4

The largest number is 8 at location 2.

- **Idea:** Go through the entire list, at each iteration find the largest-so-far and record its location

Example V

Lists: Find The Largest Number

Problem: Given a list of values $A_0, \dots, A_{(n-1)}$, find the largest value and its (first) location

- Example:

		i						
		↓						
	A_0	A_1	A_2	A_3	A_4	A_5	A_6	
Value	5	2	8	4	8	6	4	

Largest value: $A_0, 5$

Position: 0

- 1 Set the **largest-so-far** to the value of A_0
- 2 Set location to 0
- 3 Set i to 1

Example V

Lists: Find The Largest Number

Problem: Given a list of values $A_0, \dots, A_{(n-1)}$, find the largest value and its (first) location

- Example:

		i	i				
		↓	↓				
	A_0	A_1	A_2	A_3	A_4	A_5	A_6
Value	5	2	8	4	8	6	4

Largest value: $A_0, 5$

Position: 0

- 1 Compare the entry at position i (A_1) with the current maximum
- 2 Since A_0 is bigger, do not update the current maximum
- 3 Set i to $i + 1$ (now 2)

Example V

Lists: Find The Largest Number

Problem: Given a list of values $A_0, \dots, A_{(n-1)}$, find the largest value and its (first) location

- Example:

			i	i				
			↓	↓				
	A_0	A_1	A_2	A_3	A_4	A_5	A_6	
Value	5	2	8	4	8	6	4	

Largest value: $A_0, 5, A_2, 8$

Position: 0, 2

- 1 Compare the entry at position i (A_2) with the current maximum
- 2 Since A_2 is bigger, **update** the current maximum
- 3 Set i to $i + 1$ (now 3)

Example V

Lists: Find The Largest Number

Problem: Given a list of values $A_0, \dots, A_{(n-1)}$, find the largest value and its (first) location

- Example:

				i	i	i	i
				↓	↓	↓	↓
	A0	A1	A2	A3	A4	A5	A6
Value	5	2	8	4	8	6	4

Largest value: $A_2, 8$

Position: 2

- 1 Compare the entry at position i (A_3) with the current maximum
- 2 Since A_2 is bigger, do not update the current maximum
- 3 Set i to $i + 1$ (now 4)... and so on (now 5)... and so on (now 6)...

Example V

Lists: Find The Largest Number

Problem: Given a list of values $A_0, \dots, A_{(n-1)}$, find the largest value and its (first) location

- Example:

							i	i
							↓	↓
	A0	A1	A2	A3	A4	A5	A6	
Value	5	2	8	4	8	6	4	

Largest value: $A_2, 8$

Position: 2

- 1 As soon as i is larger than the number of elements in the list
- 2 Stop the algorithm
- 3 Output the current maximum and position

Example V

Largest number, python

```
1 list_A = eval(input())
2 n = len(list_A)
3 largest_so_far = list_A[0]
4 location = 0
5 i = 1
6 while i < n:
7     if list_A[i] > largest_so_far:
8         largest_so_far = list_A[i]
9         location = i
10    i = i + 1
11 print(largest_so_far)
12 print(location)
```

Example VI

List reversal I

Reverse a list in another list

```
1 list_A = eval(input())
2 n = len(list_A)
3 list_B = []
4 i = 0
5 while i < n:
6     list_B = list_B + list_A[n-(i+1)]
7     i = i + 1
8
9 print(list_B)
```

Example VI

List reversal II

Reverse a list in place

- **Idea:** Swap the first element with the last element and the second element with the last but one element and so on

```
1 list_A = eval(input())
2 n = len(list_A)
3 i = 0
4 while i < n//2:
5     tmp = list_A[i]
6     list_A[i] = list_A[n-(i+1)]
7     list_A[n-(i+1)] = tmp
8     i += 1
9
10 print(list_A)
```

Iteration over Strings: Example VII

Characters in Strings:

Write an algorithm to print the characters in a String one by one

```
1 word = input()
2 n = len(word)    # len() gets the length of the String
3 i = 0           # the first char is at position 0
4 while(i<n):
5     print(word[i])
6     i +=1
```

Iteration over Strings: Example VIII

Reverse a String:

Write an algorithm to reverse a given String

```
1 word = input()
2 n = len(word)    # len() gets the length of the String
3 i = n - 1       # the first char is at position 0
4 result = ""
5 while(i >= 0):
6     result += word[i]
7     i -=1
8 print(result)
```