

2022 ICPC Meeting

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NKU

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- 2 Programming in Python and Java
- 3 Data Structures
- 4 Today's topics - 'dynamic programming (DP)' and 'divide and conquer (DC)'

How to Prepare for it

- Make sure about the ICPC programming environment and rules.
- Be sure to register Kattis
- Be sure to register ICPC.
- In today's discussion, I use Python 3.X on Visual Studio Code with Code Runner Extension installed.

Advantages of Competition Programming (CP)

- It develops your programming skills.
- It is one of the best and practical ways to understand computer science and software engineering.
- Many US companies use similar/same programming questions for interviews.
- It is fun and rewarding!

How to get good results from CP

- There is no royal road or hidden secrets.
- Solve as many questions as possible.
- Find patterns in questions and answers.
- Understand why and memorize how.

Kattis example

- All the questions have inputs and sample output.
- Let's use [Simon Says](#) question as an example.
- In this example, if the input has 'Simon says, 'print out the rest of the input, otherwise ignore the input. The input starts with the number of inputs.

 Sample #Input

```
3
Simon says raise your right hand.
Lower your right hand.
Simon says raise your left hand.
```

 Sample #Input

```
raise your right hand.
raise your left hand.
```

- Write code and store it in a file. Be sure to make the file name correctly. Java files should have ".java" and python files ".py."
- Select language and submit your file.



Code

```
1 count = input()
2
3 strlen = len("Simon says")
4 for i in range(int(count)):
5     res = input()
6     if res.startswith("Simon says"):
7         result = res[strlen:]
8         print(result)
```


- It would be beneficial if you understand how the program is compiled and judged.
- If necessary, read how [DOMjudge](#) works.



Command > Compilation

```

1 javac -encoding UTF-8 -sourcepath . -d . ${files}
2 java -Dfile.encoding=UTF-8 -XX:+UseSerialGC -Xss64m -Xms1920m -
   ↪ Xmx1920m
3
4 # the main source file will be executed by the PyPy3 Python3
5 # interpreter to generate pyc file. Then the file is executed
6 # to generate the output of the submission.
7 pypy3 -m py_compile ${files}

```

- You will get the results.

Submission

ID	DATE	PROBLEM	STATUS	CPU	LANG
TEST CASES					
8373589	19:41:09	Simon Says	✓ Accepted	0.07 s	Python 3
✓✓✓✓✓✓✓					

- You can modularize the previous code as follows.



Code

```
1 def solution():
2     res = input()
3     if res.startswith("Simon says"):
4         result = res[strlen:]
5         print(result)
6
7 count = input()
8 strlen = len("Simon says")
9 for i in range(int(count)): # count is string, so convert it
10     solution()
```

Other CP sites

- You may use different CP sites for practice.
- The format might be different, so we should adjust the format of the source file.
- This example shows the format for [Leetcode](#) that does not use DOMjudge system but is a very popular CP site.

Sample #Two Sum

Given an array of integers `nums` and an integer `target`, return indices of the two numbers such that they add up to the target.

You may assume that each input would have exactly one solution, and you may not use the same element twice.

You can return the answer in any order.

—

Input: `nums = [2,7,11,15]`, `target = 9`

Output: `[0,1]`

Explanation: Because `nums[0] + nums[1] == 9`, we return `[0, 1]`.



Code

```
1 def twoSum(nums, target):
2     for i in range(len(nums)):
3         for j in range(i + 1, len(nums)):
4             if nums[j] == target - nums[i]:
5                 return [i, j]
6
7 class Solution:
8     def twoSum(self, nums: List[int], target: int) -> List[int]:
9         return twoSum(nums, target)
```

- You can reuse the method that solves the problem and call the method in a class method.

- If we need to run/debug the code in the local computer, you should make it a standalone Python application.
- we need to import all the necessary packages (line 1), and we need to make the starting point (line 13).



Code

```
1 from typing import List
2
3 def twoSum(nums, target):
4     for i in range(len(nums)):
5         for j in range(i + 1, len(nums)):
6             if nums[j] == target - nums[i]:
7                 return [i, j]
8
9 class Solution:
10     def twoSum(self, nums: List[int], target: int) -> List[int]:
11         return twoSum(nums, target)
12
13 if __name__ == "__main__":
14     print(Solution().twoSum([-3,4,3,90], 0))
```

- Even when you solve the problem, check if there can be a better solution.
- The previous answer's performance is $O(n^2)$. We can revise using cache to make it $O(n)$.



Code

```
1 def twoSum(self, nums, target):
2     hashmap = {}
3     for i in range(len(nums)): # only one loop
4         complement = target - nums[i]
5         if complement in hashmap:
6             return [i, hashmap[complement]]
7     hashmap[nums[i]] = i
```

Programming in Python and Java

- Turing completeness or equivalent means any programming language does the same thing.
- It means as long as a language has assignment and jump (selection or iteration), it can solve any programming questions.
- However, in practice, we use programming languages that support high-level features.

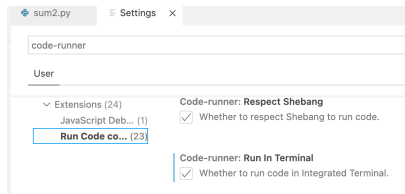
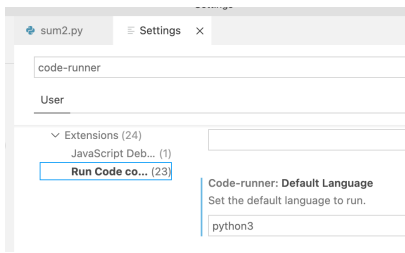
- The most important high-level features are data structures, including a list, set, and map.
- Both Java and Python support these data structures.
- Java has Collections to support them (we should import them), and Python has them in its core (we don't need to import anything).
- In general, Python is easier and simpler to use than Java, but Java is 10 - 100 times faster than Python.
- Students can choose between Python and Java, but I use Python 3 for discussing algorithms using data structures we discuss in this section.

PyPy3

- PyPy is a new implementation of Python to speed up.
- We can use PyPy for version 2.x Python and PyPy3 for version 3.x Python.
- PyPy3 is about 4.2 times faster than CPython3.
- That is why ICPC uses PyPy for evaluation, not Python.

Visual Studio Code

- We can use Visual Studio Code for debugging Python applications.
- Be sure to install the 'code runner' extension.
- We need to open the Settings dialog box to change two settings if necessary.



Data Structures

- In this section, we compare data structures that Java and Python provide.
- Java uses terminology 'Java Collections' to describe data structures in Java.
- Python has many data structures built-in (we call this feature 'battery included').
- In general, Python is shorter and more succinct in representing data structures (that is the reason why Python is called RApid Development, RAD, language).

Array/List

- Java supports arrays; Java's array size is fixed; after instantiation, we can't add or delete elements in it.
- Python does not support arrays. Instead, we use a list '[]'.



Code

```
1 int array[] = new array[5];  
2 int array2[] = new array[5][4];  
3  
4 array = []
```

Python List

- When we need to initialize the Python list, we can use `*` (line 1).
- When we need to make (and initialize) a 2D Python list, we can use python comprehension (line 2).



Code

```
1 array = [0] * 5
2 array2d = [[0] * 5 for _ in range(10)] # 5 x 10 list
```

Linked List

- Python's list ([]) is a linked list.
- To use the List data structure, we should use ArrayList.
- We need to import proper package, use a proper interface (List), and implementation (ArrayList).



Code

```
1 listx = []
2 listx.append(10)
3
4 import java.util.List;
5 import java.util.ArrayList;
6 ...
7 List listx = new ArrayList<Integer>();
8 listx.append(10);
```


Map

- Python uses a notation `{}` to represent a map (dictionary).
- Java uses proper interfaces and implementations. Of course, we should import packages also.



Code

```
1 mapx = {};  
2 map['a'] = 10; map['b'] = 20  
3  
4 import java.util.Map;  
5 import java.util.HashMap;  
6  
7 Map<String, Integer> mapx = new HashMap<>();  
8 mapx["a"] = 10; mapx["b"] = 20;
```

Set

- Python uses the same notation `{}` for set. So, to make a set in Python, we should use `set()`.
- Java uses Set interface and proper implementations for the interface.



Code

```
1 setx = set(); setx.add(10); setx.add(10); # {10}
2
3 import java.util.Set;
4
5 Set<Integer> setx = new HashSet<>();
6 setx.add(10); setx.add(10); // setx has only one 10
```

- There are other data structures both in Python and Java.
- However, in most cases, these data structures are good enough for the answers.
- Also, for implementing a graph, we should build the data structure using existing ones.

Graph

- To implement the Graph as follows:

 Code #

```
1 A -> B; A -> C; B -> C; B -> D; C -> D; D -> C; E -> F; F -> C
```

- We can use a map and a list as follows in Python:

 Code #

```
1 graph = {'A': ['B', 'C'],  
2         'B': ['C', 'D'],  
3         'C': ['D'],  
4         'D': ['C'],  
5         'E': ['F'],  
6         'F': ['C']}
```

Today's topics - 'dynamic programming (DP)' and 'divide and conquer (DC)'

- The first topic we will discuss today is 'Dynamic Programming (DP).'
- DP is one of the most important algorithms in a real world programming, and it is also one of the most frequently used one in CP.

- The second topic is 'Divid and Conquer (DC).'
- It is also important, but it is relatively easier to understand than DP.