CS2_3b 演習

Archer Shu

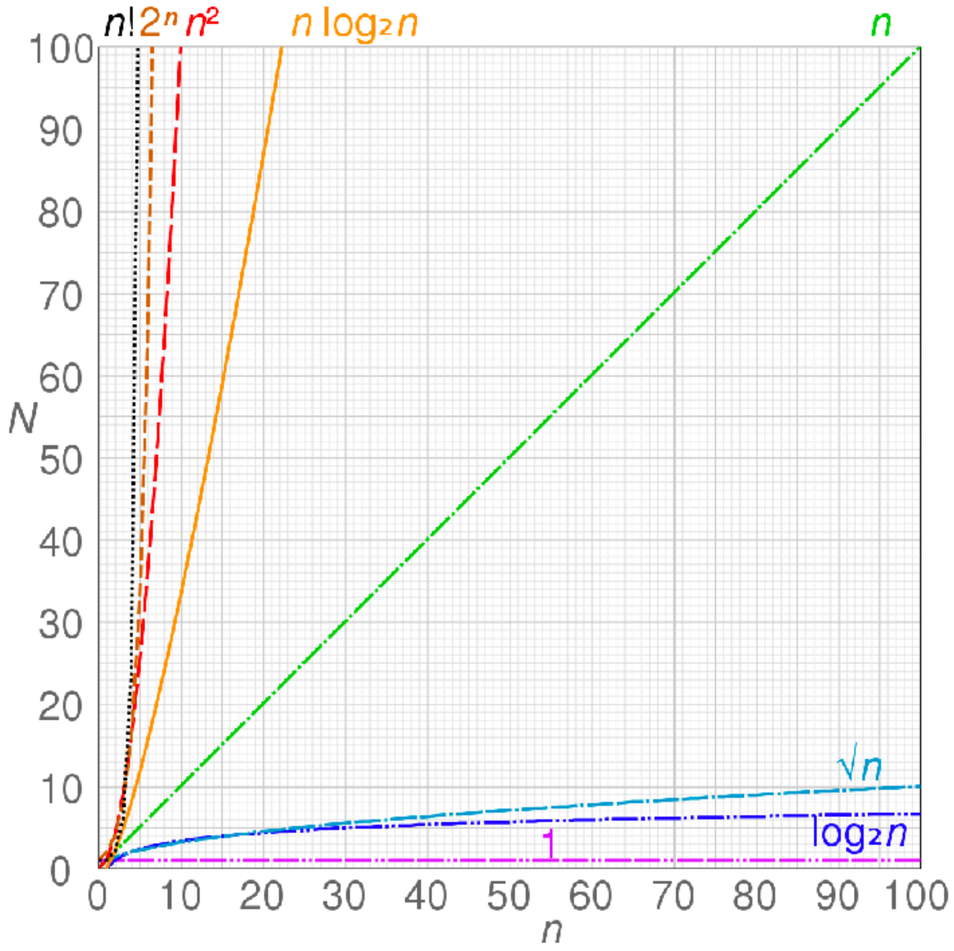
- P, NP, NP-hard問題
- アルゴリズム演習： Valid Anagram
- 自習

Time Complexity
時間複雜性

- P: Polynomial time
  多項式時間

- NP: Non-deterministic Polynomial time
  非決定性多項式時間

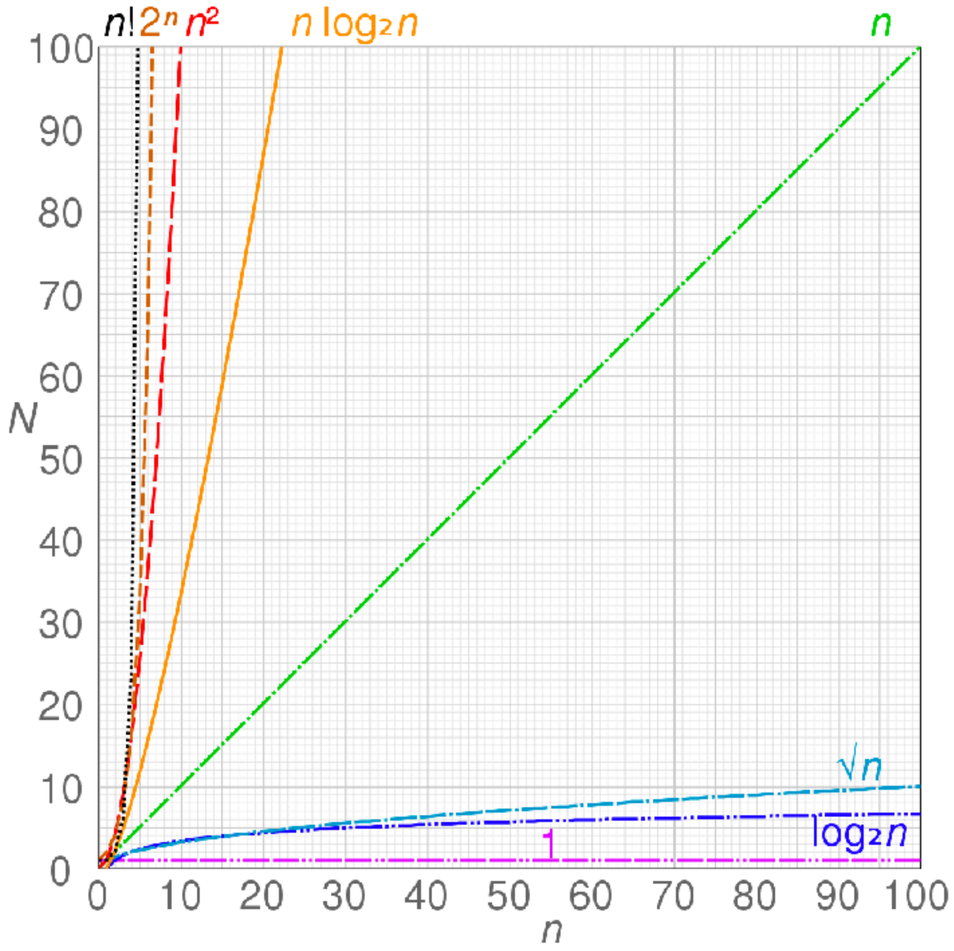
NP ！= Not P



Time Complexity
時間複雑性

- P: Polynomial time
  多項式時間 解く
- NP: Non-deterministic Polynomial time
  非決定性多項式時間 検証

NP ！= Not P



100^2 milliseconds to years

2^100 milliseconds to years

100! milliseconds to years

NP問題の例: 数独

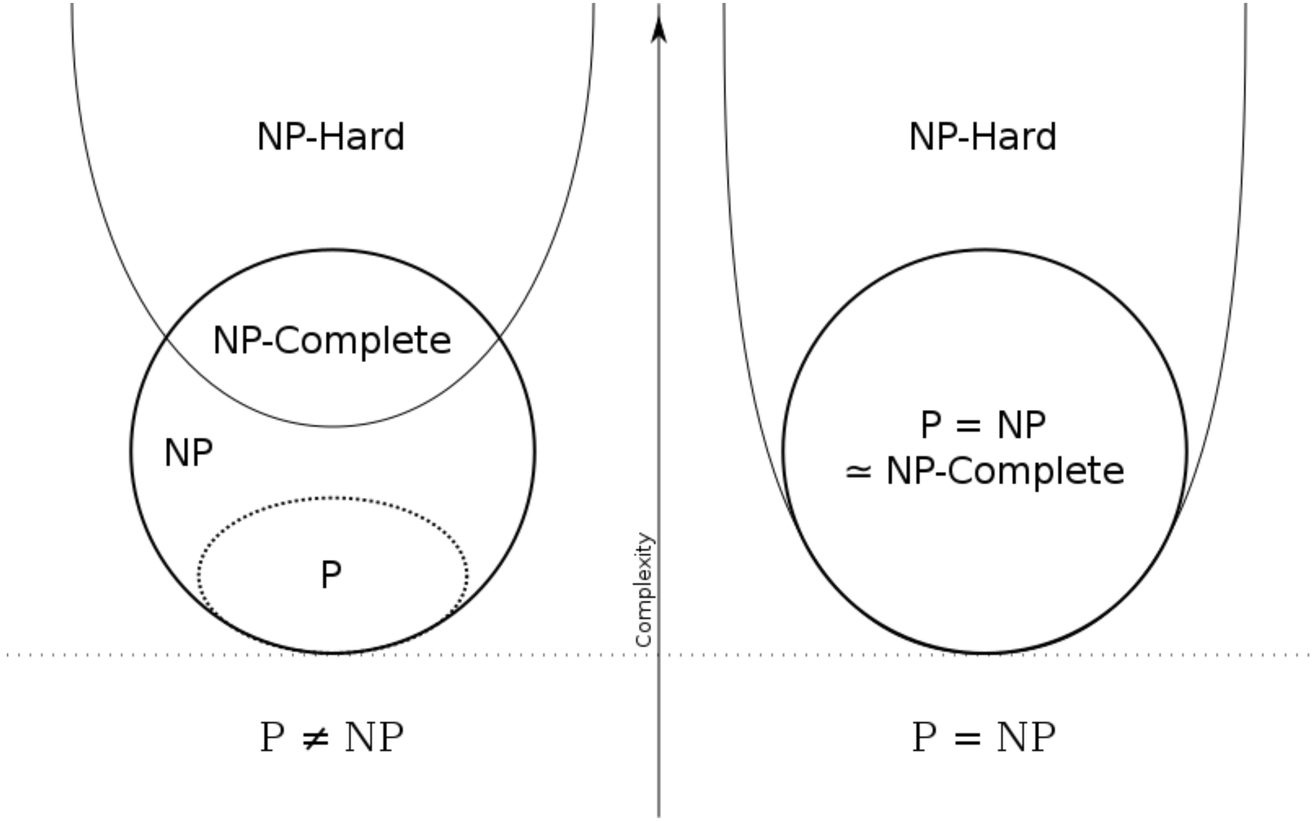
		6		5	4	9		
1				6			4	2
7				8	9			
	7				5		8	1
	5		3	4		6		
4		2						
	3	4				1		
9			8				5	
			4			3		7

2	8	6	1	5	4	9	7	3
1	9	5	7	6	3	8	4	2
7	4	3	2	8	9	5	1	6
3	7	9	6	2	5	4	8	1
8	5	1	3	4	7	6	2	9
4	6	2	9	1	8	7	3	5
6	3	4	5	7	2	1	9	8
9	1	7	8	3	6	2	5	4
5	2	8	4	9	1	3	6	7

P ≠ NP

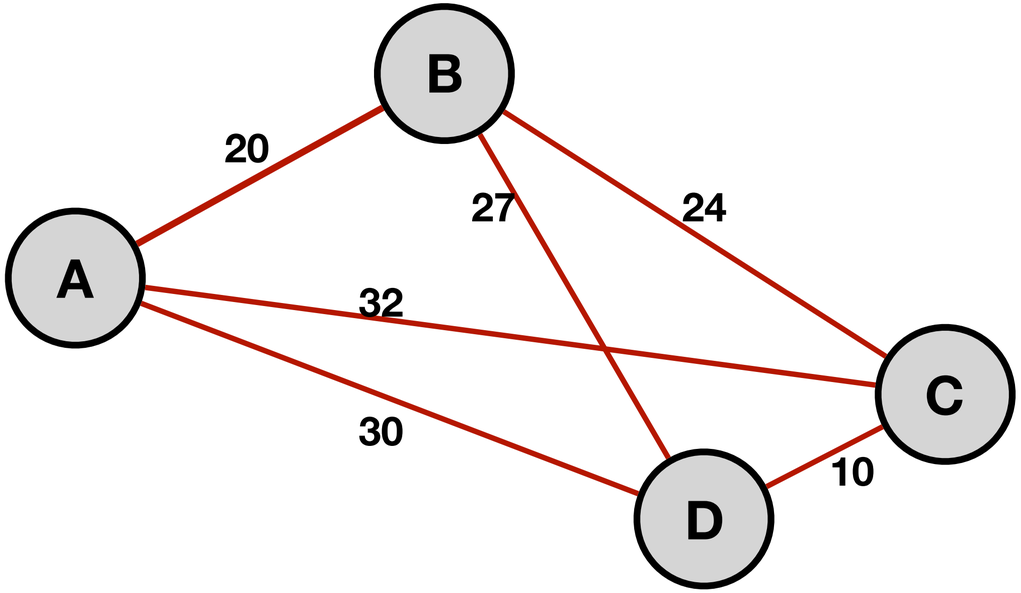
- Millennium prize problems
  ミレニアム懸賞問題

- 応用例：RSA暗号



TSP (Traveling Salesman Problem)
巡回セールスマン問題

- Condition
  - Starting from a city, the salesman must travel to all cities once before returning home
  - The distance between each city is given, and is assumed to be the same in both directions.
  - Only the links shown are to be used
- Question
  - Minimum distance to be travelled.



NP-hard

Valid Anagram

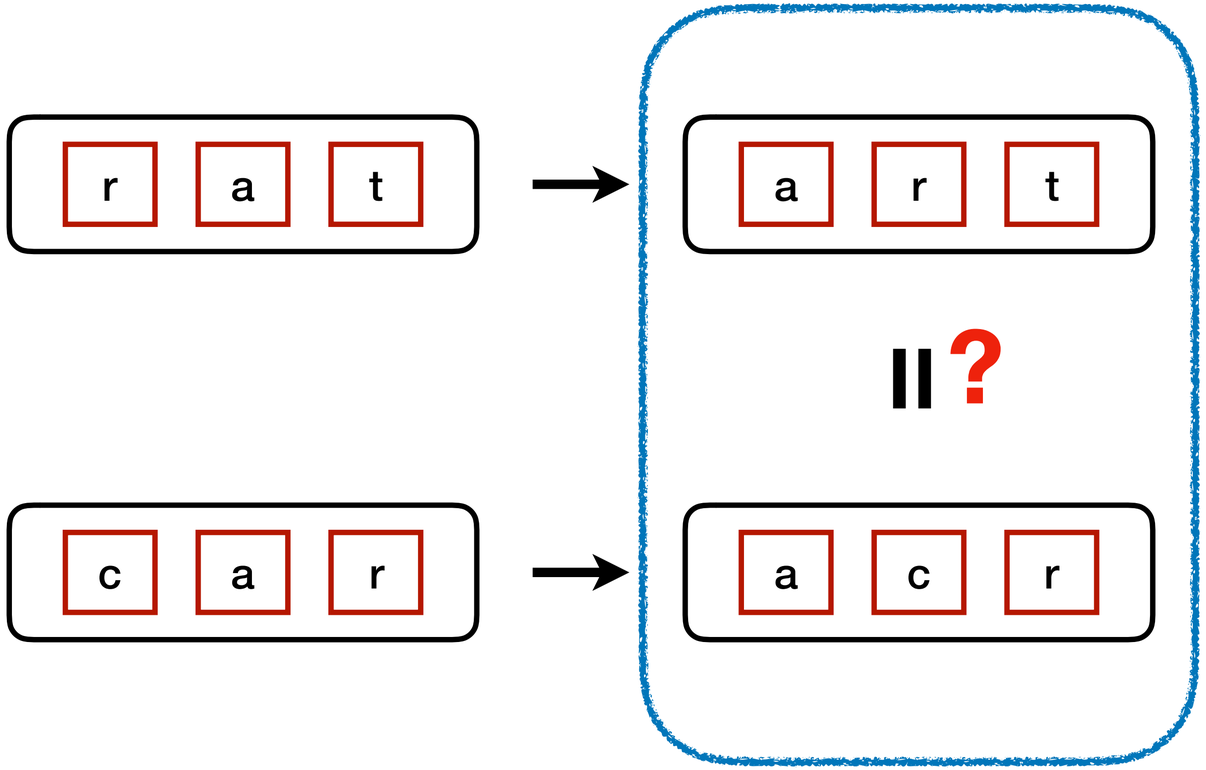
- LeetCode 242
- Anagram: アナグラム、(語句の)つづり換え
- E.g. “titech” & “tchite”

Solution One: Sort & Compare

sort s

sort t

sorted s equals t?



```
class Solution:
  def isAnagram(self, s: str, t: str) -> bool:
      return sorted(s) == sorted(t)
```

Selection Sort

Insertion Sort

Heap Sort

Merge Sort

Quick Sort

...

Selection Sort

- $O(n^2)$

```
def sort(nums):
    for i in range(len(nums)):
        for j in range(i+1, len(nums)):
            if(nums[i] > nums[j]):
                nums[i], nums[j] = nums[j], nums[i]
    return nums
```

```
sort([5,2,4,6,1,3])
```

Selection Sort

- $O(n^2)$

```
def sort(nums):
    for i in range(len(nums)):
        for j in range(i+1, len(nums)):
            if(nums[i] > nums[j]):
                nums[i], nums[j] = nums[j], nums[i]
    return nums
```

```
sort([5,2,4,6,1,3])
```

→

```
def sort(str):
    lst = list(str)
    for i in range(len(lst)):
        for j in range(i+1, len(lst)):
            if(lst[i] > lst[j]):
                lst[i], lst[j] = lst[j], lst[i]
    return "".join(lst)
```

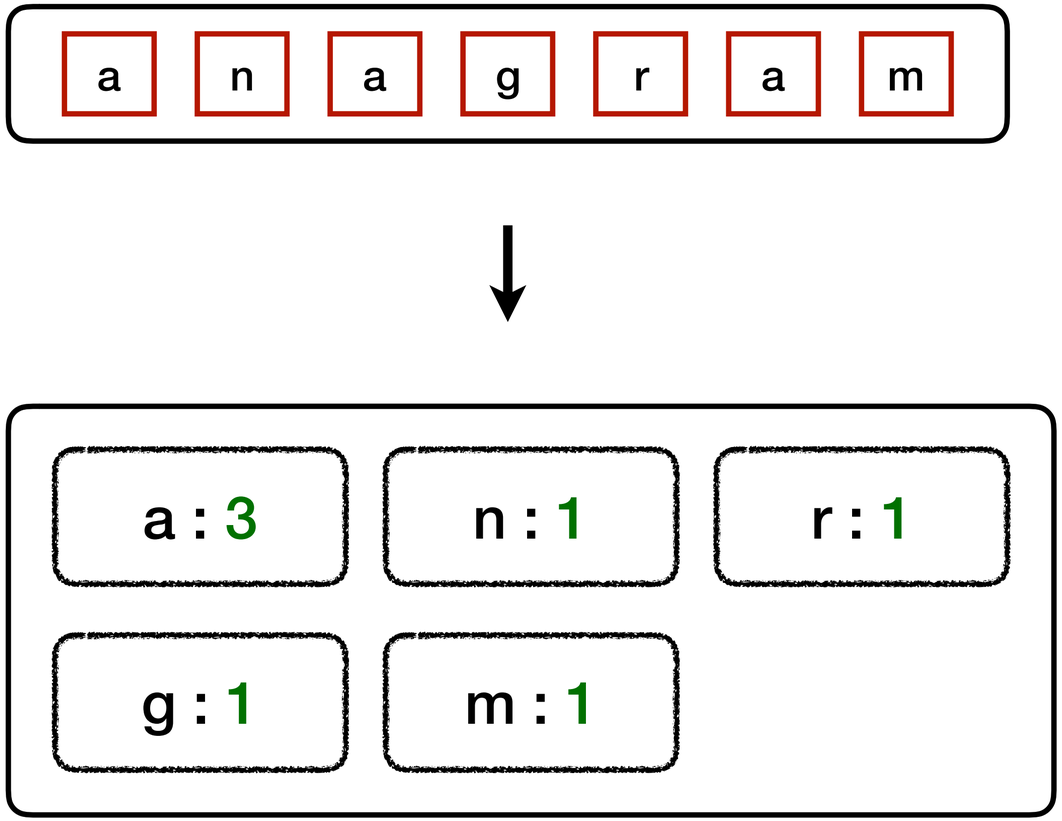
```
sort(“anagram”)
```

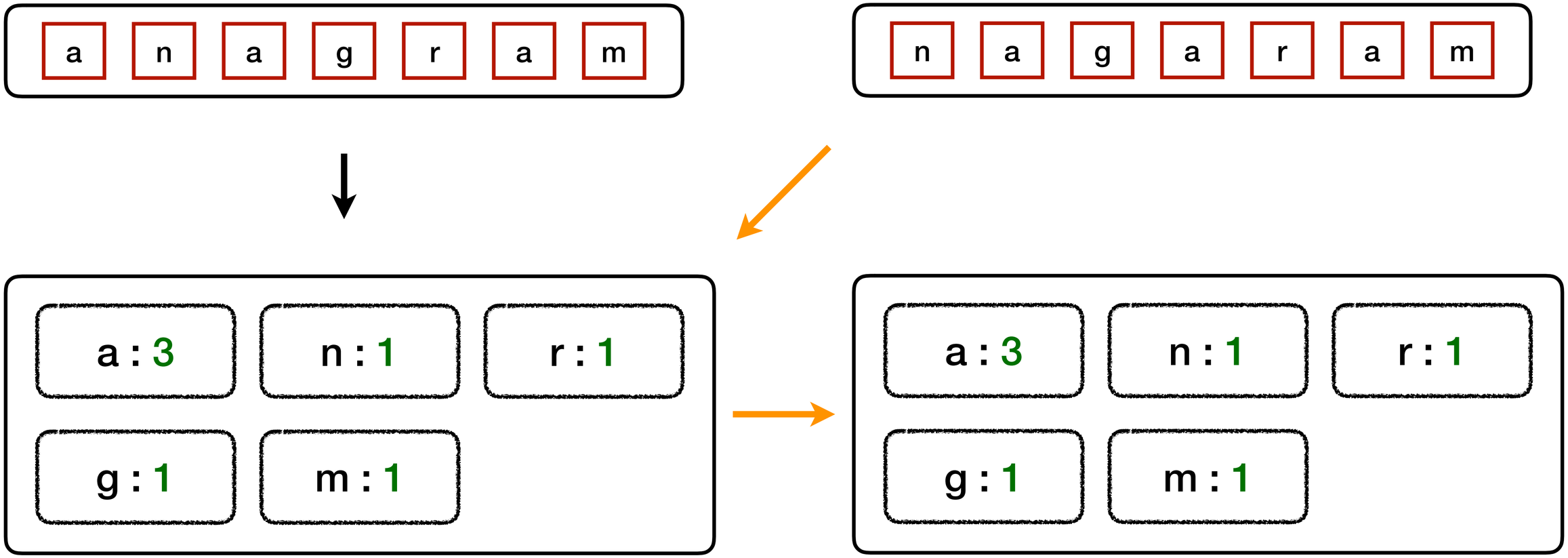
- sorted( )
  - timsort
  - O($nlogn$) (faster than selection sort)

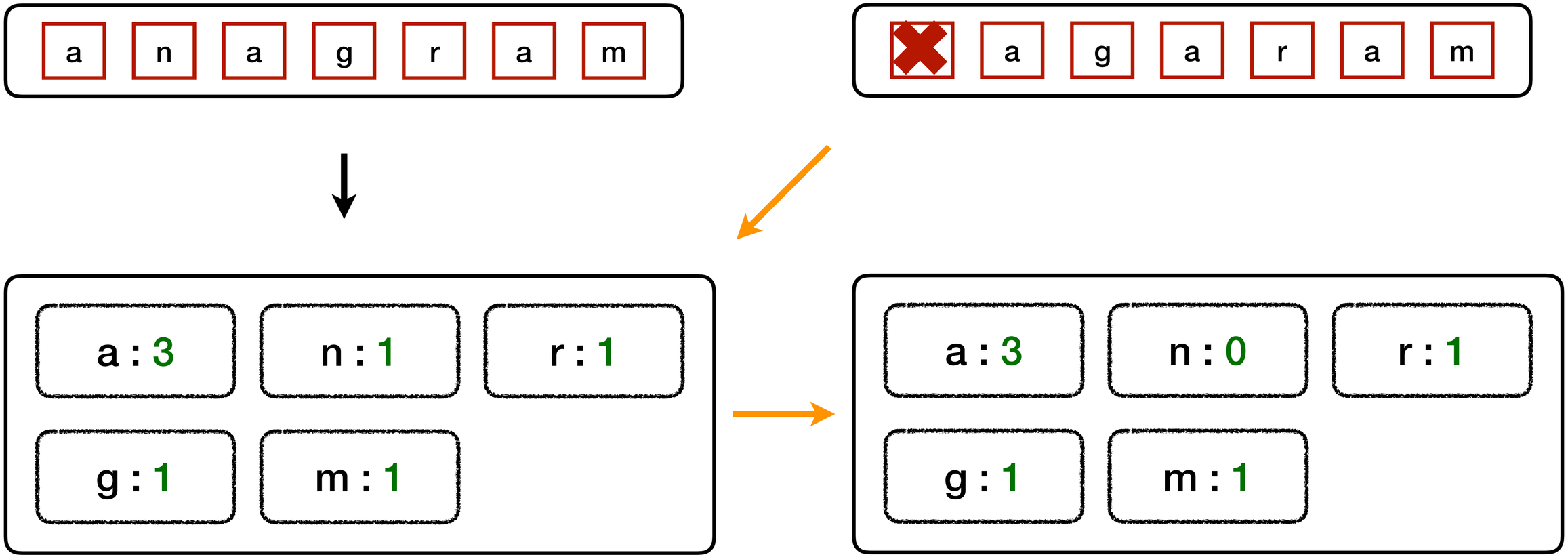
```
class Solution:
    def isAnagram(self, s: str, t: str) -> bool:
        return sorted(s) == sorted(t)
```

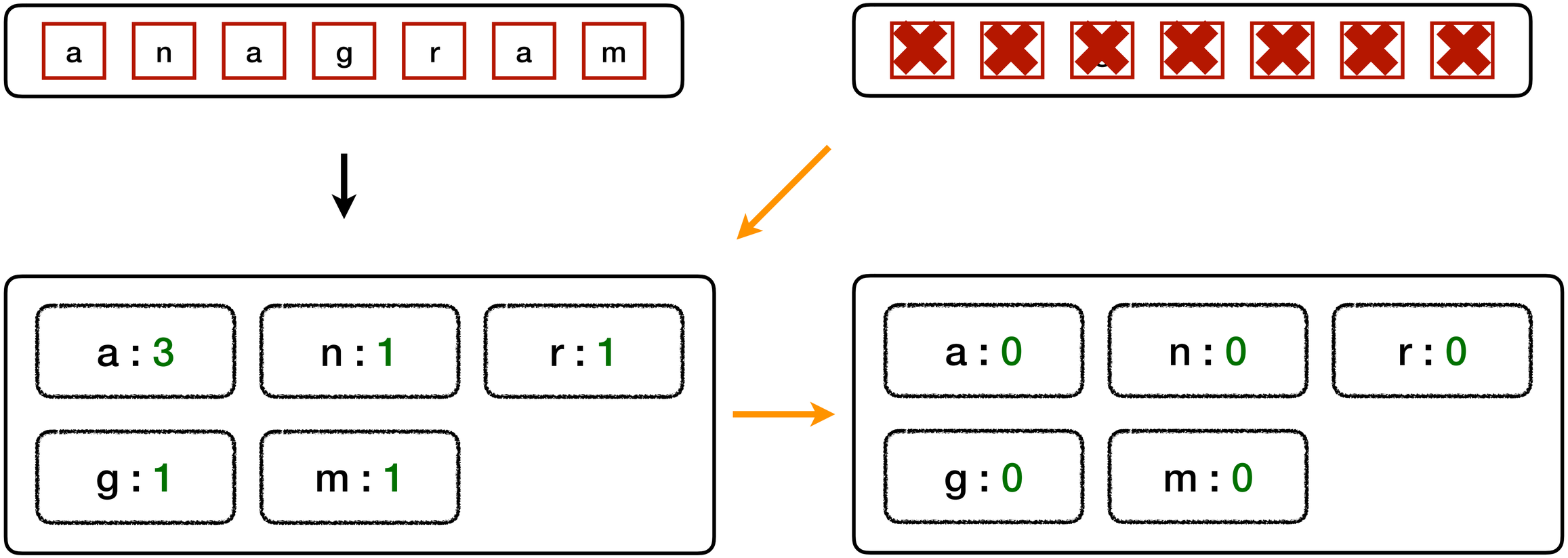
HashMap

- A data structure that the time complexity of searching is O(1)




a n a g r a m
n a g a r a m
a : 3
n : 1
r : 1
g : 1
m : 1
a : 3
n : 1
r : 1
g : 1
m : 1


a n a g r a m
a g a r a m
a : 3
n : 1
r : 1
g : 1
m : 1
a : 3
n : 0
r : 1
g : 1
m : 1


a n a g r a m
a : 3
n : 1
r : 1
g : 1
m : 1
a : 0
n : 0
r : 0
g : 0
m : 0

HashMap

- O(n) (faster than sort)

```
class Solution:
    def isAnagram(self, s: str, t: str) -> bool:
        h={}
        for ch in s:
            if ch not in h:
                h[ch] = 0
            h[ch] += 1

        for ch in t:
            if ch not in h:
                h[ch] = 0
            h[ch] -= 1

        for key in h.keys():
            if h[key] != 0:
                return False

        return True
```

Try Other Method~

Practise Website

- 日本語
  - Atcoder: https://atcoder.jp/
  - paiza: https://paiza.jp/
- English
  - LeetCode: https://leetcode.com/