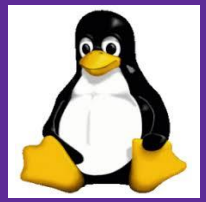
Introduction to Computation

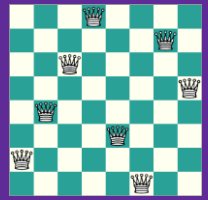
Autumn, 2023

Prof. Fan Cheng

Shanghai Jiao Tong University

chengfan85@gmail.com
https://github.com/ichengfan/itc





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Outline

- Review of Past Lectures
- Style Guide for Python Code
- Practice problems

Review of Past Lectures

Programming language

- All the popular PLs consisits of
  - Input and output
    - input(), print()
  - Types and variables
    - type(), id(), int(), float(), str(), chr(), ord()
  - Basic expressions: logic, mathematics
  - Conditional expression
    - Code block and indentation
  - Loop expression
    - while, for, break
  - Function
    - Parameters and return values
  - File
    - To be introduced
- Advanced
  - Class and OO
  - Exception
  - Functional Programming etc.
  - Standard library
- When you have fully mastered one, you could learn another very shortly
  - Don't learn programming languages but learn how to program
  - You should master 2-3 PLs and use them as your handy tools
  - Learn C in two days. ☺

Practice makes perfect

人类思考的特点

- 大脑不适合高强度，长时间的逻辑思维活动
  - 大脑更喜欢音乐、游戏、诗歌等活动
- 编程是一个对脑力、逻辑思维能力要求很高的活动
  - 手、脑、逻辑思维、语言
  - 短时间内，任务量要合理
- We are smart~~!
  - 智者千虑必有一失
- 需要从制度上面保证正确性
  - 特别是初学者，按照套路来，要讲究wood
  - 从每一个角度减少犯错的概率

先谋划好、想清楚

- 不谋全局者不足以谋一隅
- 不谋万世者不足以谋一时
- 不预则废
  - 要实现哪些功能，用到哪些语法，写哪些函数
  - 如果你想的都是错的，那写的肯定也是错的
- 推倒重来
  - 忌讳：面多加水，水多加面

编码与测试交叉进行

- 一边写，一边测试，3-5行就Run一次
- 一边测试，一边写：
  - 有些核心功能的选择可能要先测试一些方案
- 一个个功能实现，一个个调试
- print大法：输出中间变量的值
- 最常见的问题：我的程序没有反应怎么办？？？

函数(类, 模块)：分而治之

- 函数和函数之间没有耦合性，变量不会互相影响
  - 预防不小心重赋值、修改等等
  - 后面修改的时候不用考虑前面的实现
  - 人的视力的注意力范围也是有限的：10行
- 函数规模越小，人脑要检查、思考的地方就越少，越容易做好
- 保证前面每个小的模块是对的，后面整个程序运行测试越容易debug
  - 简单、明了、结构清晰是程序正确的制度保证
- 把功能拆分开，不要从头写到尾
  - 小的功能用函数单独表示，单独测试
  - 函数定义的语句和执行的语句分开，不要混写在一起
  - 固定的系统参数用变量事先写好，不要每次都再手写： limit = 1000000
  - 一个核心功能不要超过35行，超过要尽量写成几个函数
  - 循环不要超过2轮，超过要写成函数
  - 有2轮的循环，不要嵌套复杂逻辑语句，否则把里面的程序用单独的函数表示

不要玩火

- 准确才能保证最后正确 int(4.999999) int(4.99999999999999999)
- 用最简单、最可靠、最熟悉的语法
- 不要用来路不明的用法
- 有问题问Google和Stackoverflow
  - 要找到正确、准确的答案，不是所有的信息都是有益的
- 浮点数
  - / 和 //，能够整数就一定要整除，尽量不要用int()转换
  - **

效率问题

- 牢记各个语法的复杂度，实现做预判。CPU速度：10^9 个指令每秒
- 不要重复计算：譬如要计算f=y(n)*y(n)+y(n)，那我们计算一次y(n)就可以反复用了，不然就是重复计算
- 如果知道了一个list的规模，一次性把内存空间分配好。 lst = [0]*maxsize.
  - 不要反复append(). 反复append需要时间.
- List操作尽量不要insert或者delete，delete可以采用标记为-1的方法
- 不要重复、反复的建立新的数据结构，尽量重用
  - 特别是循环在内部，如果每轮都建立很大的list/ditc会很耗时间和空间
- 尽可能优化：二分等等

有技术难题

- Google + 英文关键字
  - 直接贴python报错的关键词
- Stackoverflow：全世界最优秀的程序员集散地
  - 他们可能就是写python语言的人
- Github
  - 世界上所有的源代码
- Wikipedia
  - 世界上最全的百科全书

形成自己的风格

- 建立自己的基本套路
- 在写代码的过程中，积累成功经验、套路
- 分析失败、错误的教训，避免再犯
- 遇到一些容易出错的地方马上能警觉，反复测试验证

写程序并不困难

- 看起来容易，做起来难
- 多练习是写好代码的唯一途径
- 多看优秀的代码github, stackoverflow
- 把自己的代码给优秀的人看看，互相看看
- 注意细节，不断积累改进
- 各做各的，各有高峰，不要攀比
- 有耐心，多问，多思考，多测试

多看看 import this

```
In [1]: import this
The Zen of Python, by Tim Peters

Beautiful is better than ugly.
Explicit is better than implicit.
Simple is better than complex.
Complex is better than complicated.
Flat is better than nested.
Sparse is better than dense.
Readability counts.
Special cases aren't special enough to break the rules.
Although practicality beats purity.
Errors should never pass silently.
Unless explicitly silenced.
In the face of ambiguity, refuse the temptation to guess.
There should be one-- and preferably only one --obvious way to do it.
Although that way may not be obvious at first unless you're Dutch.
Now is better than never.
Although never is often better than *right* now.
If the implementation is hard to explain, it's a bad idea.
If the implementation is easy to explain, it may be a good idea.
Namespaces are one honking great idea -- let's do more of those!
```

Bug-free code and Debug

- 反复思考程序大的框架，谋定而后动
  - 模块、类、函数
  - 算法、数据结构
- 能正确运行的代码才是好的代码
  - 先实现功能，再优化性能，不要提前优化
  - 提前优化会把系统实现复杂化
- 保证代码结构的清晰和简介
  - 循环深度不超过两轮
  - 单个函数的长度不要过长（25-35行）
  - 多用函数、类、包等机制来隔离代码
  - Zen of Python
- 多试运行
  - 一边编码，一边试运行
  - 3-5行运行一次，看看输出是否正确
  - 注意边界条件：: x=[], “”, (,), 0, None
  - 实现每个功能后都做调试，保证前面不错
  - 一个大的功能完成后先反复试运行
- 调试
  - print每个中间的重要数据，保证中间状态正确
  - IDE提供的debug功能，但不建议初学者用这个
  - 初学者的代码可能不超过300行，可以依靠观察能力和print来debug

Common Errors

- TypeError
- NameError
- None
- SyntaxError
- IndentationError
- AttributeError
- ZeroDivisionError
- 测试每个函数、每种可能情况
  - 注意特殊输入，譬如n=0，字符串为""，列表为[]，字典为{}
- Debug：强烈建议print大法，在每个关键步骤后输出变量信息
- 程序没有反应怎么办
  - 在一些关键的步骤前后加入 print()
  - 设置break point
  - 从小的开始，n=0,1,2……, 不要一开始就是0xFFFFFFFF
  - 一个个功能的编写，写一个测试一个
  - 循环不要超过2层，如果两层循环还嵌套if判断，建议写成单独的函数
  - 函数虽然logic上比直接写命令复杂，但是在理解上更直观，功能上独立，不会互相干扰。
  - 结构化、标准化是工业流水线生产的重要举措
  - 比混在一起编写好
  - 人的脑力是会疲劳的，长期的逻辑思维肯定会有疏漏，用系统提供的功能，更好的辅助编程
  - 一些系统参数用变量来表示
  - 把常量，变量，函数，都分类放置
  - concise

Leetcode练习

- 从简单题目开始
  - 自己写代码，能写出来就可以了
  - AC就是最好的
  - 本课程只是让大家大量的练习语法，多了解CS的问题
- 困难的题目
  - 看参考样例
  - 看懂、自己能仿照写
  - 回过头自己多写几遍
  - 不会写的原因是写的少了，见得少了，想的少了：maturity
- 可以先在vscode上写好，vscode可以提供一些辅助功能
- 反复练习：提升速度、减少bug
  - 刚开始总是困难的，怎么写怎么错
  - 当你超越50题的时候就会焕然一新
  - 日积月累，1-2个月可以看到效果
  - 我们不是为了期末考试而设置课程
- 目标：100+100+100

突破自己的认知和理解障碍
不贪多，每天保证3-5道就足够了
每道题务必做透
刚开始速度慢，一天3题，熟练了，可以远远超过3题
2个月的练习到期末前大概可以做完200道

看懂lec1-lec7所有基本语法(先把走学好)

熟练掌握。提到一个操作，马上能够记得语法是什么，有哪些细节要注意，有哪些坑要避开

遇到一个任务，要想到使用什么语法，数据结构

一直写Helloworld永远都不会有提高的，要勇攀高峰，否则还会有莫名的满足感.

写代码前，先想清楚问题是什么，解决方案是什么：谋定而后动。(和画画一样，先把全局轮廓勾勒好，再精加工细节)

一步步写，一步步调试。大概3-5行代码，回头看一遍，检查输出结果

print大法：有bug的时候，多用print输出中间变量看看，是不是有问题

每个问题，先自己写，能正确输出结果就是胜利

多看优秀的代码：有经验的助教、同学。

关键是自己能写，每个问题的代码有必要重复写N遍。手眼合一。

反复训练：优化自己的代码，简短、高效、不容易出bug

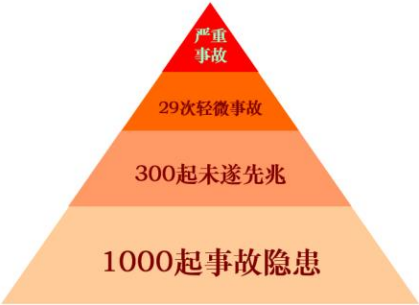
写代码是很简单、技术含量不高的事情。但是要花时间去练习。每道题目都会给你带来一定的提升。刻苦练习，通过大量练习，逐步建立你的技术优势。

标准题目+标准答案+足够的助教（细节的提升与积累）

Style Guide for Python Code

Python规范

- One of Guido's key insights is that code is read much more often than it is written
- import this: Readability counts
- PEP 8 -- Style Guide for Python Code
  - PEP: Python Enhancement Proposal
  - https://www.python.org/dev/peps/pep-0008/
  - This document gives coding conventions for the Python code comprising the standard library in the main Python distribution
- 除了语法上面合格，还要在风格上面保持一致
- 安全生产：不带电操作；电闸的开关为什么要挂在上面，而不是下面？
- 海恩法则，是航空界关于飞行安全的法则
- 海恩法则指出：每一起严重事故的背后，必然有29次轻微事故和300起未遂先兆以及1000起事故隐患
- 每一个规范，都是血泪教训



Indentation

- Use 4 spaces per indentation level
- Continuation lines should align wrapped elements either vertically using Python's implicit line joining inside parentheses, brackets and braces, or using a hanging indent. When using a hanging indent the following should be considered; there should be no arguments on the first line and further indentation should be used to clearly distinguish itself as a continuation line

```
# Correct:

# Aligned with opening delimiter.
foo = long_function_name(var_one, var_two,
                         var_three, var_four)

# Add 4 spaces (an extra level of indentation) to distinguish arguments from
the rest.
def long_function_name(
        var_one, var_two, var_three,
        var_four):
    print(var_one)

# Hanging indents should add a level.
foo = long_function_name(
    var_one, var_two,
    var_three, var_four)
```

```
# Wrong:

# Arguments on first line forbidden when not using vertical alignment.
foo = long_function_name(var_one, var_two,
    var_three, var_four)

# Further indentation required as indentation is not distinguishable.
def long_function_name(
    var_one, var_two, var_three,
    var_four):
    print(var_one)
```

怎么清晰怎么来

Binary Operator

- Donald Knuth explains the traditional rule in his Computers and Typesetting series: "Although formulas within a paragraph always break after binary operations and relations, displayed formulas always break before binary operations"

```
# Wrong:
# operators sit far away from their operands
income = (gross_wages +
          taxable_interest +
          (dividends - qualified_dividends) -
          ira_deduction -
          student_loan_interest)
```

```
# Correct:
# easy to match operators with operands
income = (gross_wages
          + taxable_interest
          + (dividends - qualified_dividends)
          - ira_deduction
          - student_loan_interest)
```

怎么漂亮怎么来

import

- Imports are always put at the top of the file, just after any module comments and docstrings, and before module globals and constants.
- Imports should be grouped in the following order:
  - Standard library imports.
  - Related third party imports.
  - Local application/library specific imports.
- You should put a blank line between each group of imports.
- Absolute imports are recommended, as they are usually more readable and tend to be better behaved
- Wildcard imports (from <module> import *) should be avoided

```
# Correct:
import os
import sys
```

```
# Wrong:
import sys, os
```

```
# Correct:
from subprocess import Popen, PIPE
```

怎么漂亮怎么来

White Space: Pet Peeves (1)

- Avoid extraneous whitespace in the following situations:
  - Immediately inside parentheses, brackets or braces:

```
# Correct:
spam(ham[1], {eggs: 2})
```

```
# Wrong:
spam( ham[ 1 ], { eggs: 2 } )
```

  - Between a trailing comma and a following close parenthesis:

```
# Correct:
foo = (0,)
```

```
# Wrong:
bar = (0, )
```

White Space: Pet Peeves (2)

- Avoid extraneous whitespace in the following situations:
  - Immediately before a comma, semicolon, or colon:

```
# Correct:
if x == 4: print x, y; x, y = y, x
```

```
# Wrong:
if x == 4 : print x , y ; x , y = y , x
```

  - Immediately before the open parenthesis that starts the argument list of a function call:

```
# Correct:
spam(1)
```

```
# Wrong:
spam (1)
```

White Space: Pet Peeves (3)

- Avoid extraneous whitespace in the following situations:
  - Immediately before the open parenthesis that starts an indexing or slicing:

```
# Correct:
dct['key'] = lst[index]
```

```
# Wrong:
dct ['key'] = lst [index]
```

  - More than one space around an assignment (or other) operator to align it with another:

```
# Correct:
x = 1
y = 2
long_variable = 3
```

```
# Wrong:
x             = 1
y             = 2
long_variable = 3
```

White Space: Recommendations

- Avoid trailing (结尾) whitespace anywhere.
- Always surround these binary operators with a single space on either side: assignment (=), augmented assignment (+=, -= etc.), comparisons (==, <, >, !=, <>, <=, >=, in, not in, is, is not), Booleans (and, or, not).
- If operators with different priorities are used, consider adding whitespace around the operators with the lowest priority(ies). Use your own judgment; however, never use more than one space, and always have the same amount of whitespace on both sides of a binary operator

  $x+y*z$ $\qquad$ $x + y*z$
- Function annotations should use the normal rules for colons and always have spaces around the -> arrow if present.
- Don't use spaces around the = sign when used to indicate a keyword argument, or when used to indicate a default value for an unannotated function parameter
  - When combining an argument annotation with a default value, however, do use spaces around the = sign:
- Compound statements (multiple statements on the same line) are generally discouraged
- While sometimes it's okay to put an if/for/while with a small body on the same line, never do this for multi-clause statements. Also avoid folding such long lines!

White Space: Summary

1. 代码符合英文写作规划
2. 用空格把程序切割成一个个合适的小的单元。每个单元有清晰的意思
3. 风格要统一
4. 不要挤成一坨
5. 清晰最重要

```
# Correct:
ham[1:9], ham[1:9:3], ham[:9:3], ham[1::3], ham[1:9:]
ham[lower:upper], ham[lower:upper:], ham[lower::step]
ham[lower+offset : upper+offset]
ham[: upper_fn(x) : step_fn(x)], ham[:: step_fn(x)]
ham[lower + offset : upper + offset]
```

```
# Wrong:
ham[lower + offset:upper + offset]
ham[1: 9], ham[1 :9], ham[1:9 :3]
ham[lower : : upper]
ham[ : upper]
```

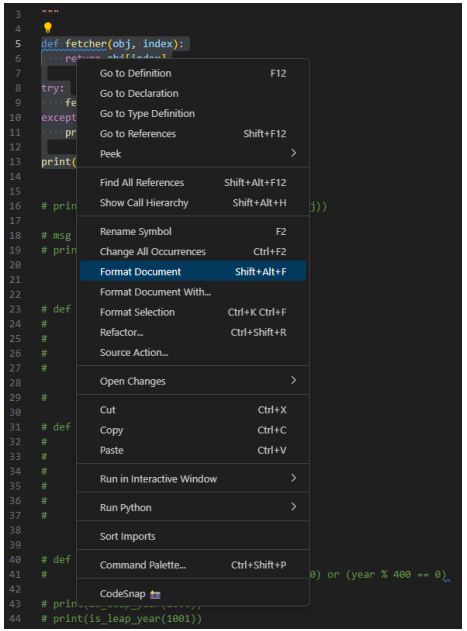
Name Convention

- Python命名: xxx_xxx_xxxxx
- 大小写区分规则： module_name, package_name, ClassName, method_name, ExceptionName, function_name, GLOBAL_CONSTANT_NAME, global_var_name, instance_var_name, function_parameter_name, local_var_name. CLASS_CONSTANT_NAME
- Names to Avoid
  - Never use the characters 'l' (lowercase letter el), 'O' (uppercase letter oh), or 'I' (uppercase letter eye) as single character variable names.
  - In some fonts, these characters are indistinguishable from the numerals one and zero. When tempted to use 'l', use 'L' instead.

https://www.python.org/dev/peps/pep-0008/

Useful VS Code Extensions

- autopep8, Black Format
- 解决很多格式问题
  - 空格
  - 布局
- Survey VS Code useful extensions



Practice problems

无他，唯手熟尔

编程的一般思路（个人看法）

- 将问题中隐含的信息，用合适的数据结构表示出来，加以利用和处理。 按题目意思做，维护好中间信息

```
while True:
    题目中信息 ---> 合适的数据结构表示
    对数据结构进行操作：修改更新

    更新题目的信息
```

必须对基本语法非常熟悉，对于问题能快速反应
有些问题是智力题，可以搜索leetcode的解答

Leap year

- A year is called leap:
  - It is divisible by 4 exactly
  - If it is divisible by 100, it should be divisible by 400
- Write a function to implement it, try to simplify your code

```python
def is_leap_year(year):
    if year % 4 == 0 and year % 100 != 0:
        return True
    if year % 400 == 0:
        return True

    return False
```

```python
def is_leap_year(year):
    if year % 4 == 0 and year % 100 != 0:
        return True
    elif year % 400 == 0:
        return True
    else:
        return False
```

```python
def is_leap_year(year):
    return (year % 4 == 0 and year % 100 !=0) or (year % 400 == 0)
```

细节来源于积累

代码技巧

```python
def f(n):
    if n == 1:
        return True
    else:
        return False


# 等价于
def f(n):
    return n == 1
```

```python
def f(n):
    if g(n):
        return a(n)
    else:
        return b(n)


# 等价于
def f(n):
    return a(n) if g(n) else b(n)
```

```python
# Bad
if v == True:
    f()

# Good
if v:
    f()

# Bad
if v == False:
    f()

# Good
if not v:
    f()
```

① 能够连写的地方一律连写
x = x +1
x += 1
② 函数定义内部不要用print，一律用return。除非题目让你print。调试可以用print
③ 调试的时候用小规模数据，不要一开始就1,000,000. 可以从1，2，3，4，5，6开始
④ 问问题记得截屏，不要手机拍照，发源代码，发图
⑤ 作业题不要用超出范围的语法，我们确保可以用讲过的语法解决
⑥ 不包含注释，单个函数的代码长度不要超过40行。超过这个长度，要么切割成更小的几个几个函数，要么你的思路有问题，要重新写
⑦ 务必先熟练掌握ppt上面的内容，做到能自己写出来
⑧ 编程是一个精密的数学工程，不要用蛮力，不要暴力复制粘贴

Prime Number

- A number n is prime is its only has divisors 1 and itself

```python
def is_prime_trivial(n):
    for x in range(2, n):
        if n%x == 0:
            return False

    return True
```

```python
def is_prime_fast(n):
    for x in range(2, n):
        if x * x > n:
            return True

        if n % x == 0:
            return False

    return True


for x in (2, 3, 4, 5, 6, 7, 7919, 10_000_001):
    print(is_prime_trivial(x), is_prime_fast(x))
```

```
True True
True True
False False
True True
False False
True True
True True
False False
```

Happy Number

- (202-Happy Number) Write an algorithm to determine if a number is "happy".
- A happy number is a number defined by the following process: Starting with any positive integer, replace the number by the sum of the squares of its digits, and repeat the process until the number equals 1 (where it will stay), or it loops endlessly in a cycle which does not include 1. Those numbers for which this process ends in 1 are happy numbers.
- Example: Input: 19 Output: true

Explanation:

$$1^2 + 9^2 = 82\,; 8^2 + 2^2 = 68;\ 6^2 + 8^2 = 100; 1^2 + 0^2 + 0^2 = 1$$

- Analysis: $n \to f(n) \to f\big(f(n)\big) \to f^3(n) \ldots \to 1$ or Loop
  1. Implement a function $f(n)$: the sum of the squares of its digits
  2. How to check whether $1 \in S$? Data structure: list, tuple, dict, set. Dict or set?

Happy Number: solution

```python
def sum_of_digit_squares(n):
    total = 0
    while n > 0:
        total += (n % 10) ** 2
        n //= 10
    return total


for x in (19, 91, 190, 109, 1, 11, 101):
    print(sum_of_digit_squares(x))
```

```python
def sum_of_digit_squares(n):
    return n * n if n < 10 else (n % 10) ** 2 + sum_of_digit_squares(n // 10)
```

```python
def sum_of_digit_squares(n):
    return sum([(ord(x)-ord('0'))**2 for x in str(n)])
```

```python
def happy_number(n):
    st = {n}

    while n != 1:
        x = sum_of_digit_squares(n)
        if x == 1:
            return True

        if x in st:
            return False

        st.add(x)
        n = x

    return True


ans = []
for x in range(1001):
    if happy_number(x):
        ans.append(x)

print(
    len(ans)
)  # 143 happy numbers including 921, 923, 931, 932, 937, 940, 946, 964, 970, 973, 989, 998, 1000
```

不断改进

Max Consecutive Ones

- Given a binary array, find the maximum number of consecutive 1s in this array.
- Example 1: Input: [1, 1, 0, 1, 1, 1] Output: 3
- Explanation: The first two digits or the last three digits are consecutive 1s. The maximum number of consecutive 1s is 3.
- Note:
  - The input array will only contain 0 and 1.
  - The length of input array is a positive integer and will not exceed 10,000
- Analysis: how to check consecutive 1s.
  - Start from position i, i++ if the current position is 1

```python
def max_conse_ones(number):
    ans = 0
    i = 0
    while i < len(number):
        if number[i] == 1:
            j = i

            while j < len(number) and number[j] == 1:
                j += 1

            if ans < j - i:
                ans = j - i
            i = j + 1
        else:
            i += 1
    return ans
```

```python
print(max_conse_ones([1, 1, 0, 1, 1, 1]))
print(max_conse_ones([]))
print(max_conse_ones([0]))
print(max_conse_ones([1]))
print(max_conse_ones([0, 0]))
print(max_conse_ones([0, 1]))
print(max_conse_ones([1, 0]))
print(max_conse_ones([1, 1]))
print(max_conse_ones([1, 0, 1, 0, 1]))
```

```
3
0
0
1
0
1
1
2
1
```

多测试

Longest Continuous Increasing Subsequence

- Given an unsorted array of integers, find the length of longest continuous increasing subsequence
- Example 1:

  Input: [1,3,5,4,7] Output: 3

  Explanation: The longest continuous increasing subsequence is [1,3,5], its length is 3. Even though [1,3,5,7] is also an increasing subsequence, it's not a continuous one where 5 and 7 are separated by 4
- Example 2:

  Input: [2,2,2,2,2] Output: 1

  Explanation: The longest continuous increasing subsequence is [2], its length is 1.

  Note: Length of the array will not exceed 10,000

Analysis: very similar to Max Consecutive Ones

```python
def longest_CIS(number):
    ans = 0
    i = 0
    while i < len(number):
        j = i+1
        while j < len(number) and number[j] > number[j-1]:
            j += 1

        if ans < j-i:
            ans = j-i

        i = j
    return ans
```

```python
print(longest_CIS([1,3,5,4,7]))
print(longest_CIS([2,2,2,2,2]))
print(longest_CIS([]))
print(longest_CIS([1]))
print(longest_CIS([1, 1]))
print(longest_CIS([1, 2]))
print(longest_CIS([2, 1]))
```

```
3
1
0
1
1
2
1
```

Valid Anagram

- (242-Valid Anagram) Given two strings s and t , write a function to determine if t is an anagram of s
  - An anagram is a word or phrase formed by rearranging the letters of a different word or phrase, typically using all the original letters exactly once – race: care, part: trap, heart: earth, knee: knee
- Example 1: Input: s = "anagram", t = "nagaram" Output: true
- Example 2: Input: s = "rat", t = "car" Output: false
- Note: You may assume the string contains only lowercase alphabets
- Solution: every character should have the same occurrence in s and t
- Data structure: list, tuple, str, dict or set? Dict Vs. set?

```python
def build_dt(s):
    dt = {}
    for x in s:
        if x in dt:
            dt[x] += 1
        else:
            dt[x] = 1

    return dt


def is_valid_anagram(s, t):
    if len(s) != len(t):
        return False

    dts = build_dt(s)
    dtt = build_dt(t)

    return dts == dtt
```

```python
def is_valid_anagram(s, t):
    if len(s) != len(t):
        return False

    return sorted(s) == sorted(t)


print(is_valid_anagram("anagram", "nagaram"))
print(is_valid_anagram("rat", "cat"))
```