1. (4 points) Name at least four operating systems.
2. (4 points) What is a low-level programming language? Give an example of low-level programming languages.
3. (4 points) What may happen if we compress a compressed file again and again? Will the size become zero if this file is compressed for infinite times?
4. (4 points) List at least two differences between processes and threads.
5. (4 points) Do you think artificial intelligence (AI) can replace or beat human beings in the future? Explain why.

1、Windows、Mac OS、Linux、iOS、Android

2、

It is a type of language, which is machine- friendly.
These languages are considered high memory efficient.
It's difficult to comprehend.

Comparatively, it is complex to debug.
In comparison, it is difficult to maintain.
Low-level language is non-portable.
It is entirely dependent on the machine.

assembly language

machine Language

3、The different between this file and last file is smaller and smaller. No, it will reach a limit, but the limit is not zero. otherwise, it is against Information Entropy.

4、

进程和线程的关系：

（1）一个线程只能属于一个进程，而一个进程可以有多个线程，但至少有一个线程。

（2）资源分配给进程，同一进程的所有线程共享该进程的所有资源。

（3）处理机分给线程，即真正在处理机上运行的是线程。

（4）线程在执行过程中，需要协作同步。不同进程的线程间要利用消息通信的办法实现同步。线程是指进程内的一个执行单元,也是进程内的可调度实体.

进程与线程的区别：

（1）调度：线程作为调度和分配的基本单位，进程作为拥有资源的基本单位

（2）并发性：不仅进程之间可以并发执行，同一个进程的多个线程之间也可并发执行

（3）拥有资源：进程是拥有资源的一个独立单位，线程不拥有系统资源，但可以访问隶属于进程的资源.

（4）系统开销：在创建或撤消进程时，由于系统要为之分配和回收资源，导致系统的开销明显大于建或撤消线程时的开销。

5. I think it depends on the spheres.

In the field of complex computation, AI has

replace human being. However, in the fields of art and education, AI without real emotions cannot replace us.

6. (5 points) Write a function `getMinValue(int[] numbers)` that returns the smallest element of an array.

```
int min = numbers[0];
for (int i : numbers) {
    if (i < min) {
        min = i;
    }
}
return min;
```

type determines the actual method to use

7. (5 points) What is "dynamic binding" in Java?

Dynamic binding means that the type of an object is decided in runtime but not in compile time.

Polymorphism is on behalf of dynamic binding.

8. (5 points) How are reference-type arguments of methods passed in Java?

It passes the address of in the memory.

pass by value

9. (5 points) List at least two differences between methods and constructors.

1. ① A method executes a function of an object.
A constructor constructs an object.

② A method has a return value, a constructor not.

10. (5 points) In a 32-bit microprocessor, assume the machine code of each instruction is 32 bits long and each memory location holds one byte (8 bits), what is the size of required memory to store 1000 instructions?

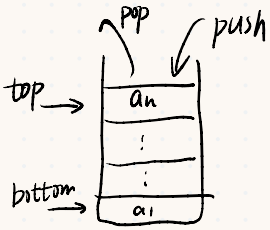
4000 ?

11. (5 points) What is a Stack and why do Stack Overflow errors occur?

A stack is an memony area. It follows the Last-in-first-out (LIFO) rule and stores local variables.

The stack has max capacity.

If the capacity is run out, such as infinite recusion, Stack Overflow errors occur.



12. (5 points) Given a set of integers, how to find the smallest number in the fastest way? How to find the third smallest number in the fastest way? Briefly describe the data structure and algorithm used.

①

13. (5 points) Can we override static methods in superclass in Java? Why can we or can't we?

No. If we

14. (5 points) In a group of five people, where every two are either friends or enemies, there must be either three mutual friends, or three mutual enemies. Prove this or disprove this by giving a counter example.

16. (10 points) Suppose you are participating in a game show and you are asked to choose one of three doors: one of them has a car behind it; the remaining two have goats behind them. You choose one door, assuming it is door number one, and then the host, who knows what is behind the door, opens the other door with the goat behind it, assuming it is door number three. He then asks you, "Do you want to choose door number two?" Would it be an advantage for you to vary your choices? What is the possibility of winning a car if you choose to change and why?

Yes.

① If I don't vary my choice, the behavious of host is not relative with me. The possibility is $\frac{1}{3}$

② If I vary my choice, there are three situations.

c	g	g
choose	open	vary

fail

g	c	g
choose	vary	open

success

g	g	c
choose	open	choose

success

We find the possibility is $\frac{2}{3}$.

17. (10 points) There are five people, four of them are fickle (善变的), one is honest. The definition of fickle is: the first time you ask him a question, he may tell the truth or lie. The second time you ask him again, the one who told truth tells lies now, and the liar tells the truth. Now you are allowed to ask two questions to determine which person is honest, how to ask? The two questions can ask the same person or different ones.

A, 你是诚实人吗?
- 是 → 诚实人在说真话
- 是 → fickle 在说假话 → 下次是真
- 否 → fickle 在说真话 → 下次是假

A，谁是诚实人？

- A
  - 真
    - A是老实人
    - A fickle（矛盾），刚刚说假话 ✗
  - 假 — A是fickle，刚刚说真话
- B-E
  - 真
    - 老实人（一个老实人，矛盾）
    - A fickle，刚说假话 ✓
  - 假 — A fickle，刚说真话

矛盾人

A，谁不是诚实人？

$$|A-\lambda I| = \begin{vmatrix} -\lambda & 0 & a \\ 0 & 1-\lambda & 0 \\ a & 0 & -\lambda \end{vmatrix} = \lambda^2(1-\lambda) - a^2(1-\lambda)$$

$$= (1-\lambda)(\lambda^2 - a^2) = 0$$

$$(1-\lambda)(\lambda-a)(\lambda+a)$$

$$1 \quad \underline{a} \quad \underline{-a}$$

18. (5 points) There is a positive integer:

奇

- When it divides 2, the remainder is 1.
- When it divides 3, the remainder is 2.
- When it divides 4, the remainder is 3.
- When it divides 5, the remainder is 4.
- When it divides 6, the remainder is 5.
- When it divides 7, the remainder is 6.
- When it divides 8, the remainder is 7.
- When it divides 9, the remainder is 8.
- When it divides 10, the remainder is 9.

This number is not small, but it is not big either. Give the smallest number that has these characteristics.

23 5

234 11

2519

2345 59

2×2

2×3×2×5 =

2

3

4 = 2×2

5

6 = 2×3

7

8 = 2×2×2

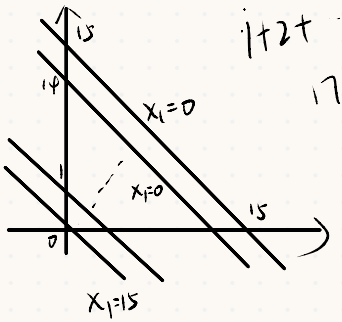
9 = 3×3

10 = 2×5

2×2×2×3×3×5×7 = 2520

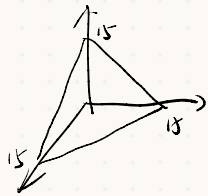
1. (10 points) How many triples of the form $(i, j, k)$with $1 \leq i < j < k \leq 20$ are there?

2. (15 points) How many solutions are there to the equation $x_1 + x_2 + x_3 = 15$, where x_1, x_2, and x_3 are all nonnegative (≥ 0) integers?



$1+2+\cdots+16$

$17\times 8 = 136$



3. (10 points) (a) What will be printed in the program below?

```
String str;
System.out.println(str.length());
```

NullPointerException

(b) What will be printed in the program below?

```
String str = "Hello World!";
System.out.println(str.length());
```

12

5. (20 points) We have 100 bottles of water; one of them is poisonous. Suppose the rat will die after seven days after it drank the poisonous water. Now, give you seven days, how many rats do you need (at least) to find the poisonous bottle? Why?

至少需要七只可怜的小白鼠

首先我们将100个瓶子做上标记为1-100，然后将所有的数字用二进制表示，1为0000001,2为0000010，以此类推，那么100就是1100100。

接着将所有第一位是1的瓶子取出一点混合在一个瓶子里，所有第二位是1的瓶子取出一点混合在一个新的瓶子里，接着第三个，第四个...第七个，然后将1-7个瓶子分别喂给1-7个小白鼠。

第二天哪个可怜小白鼠中毒了，那么哪个位置的数字就是1

假设标号为1,3,5,7的四只小白鼠被毒死了，那么1,3,5,7位上的数为1,即1010101,即85，那么就是第85瓶为毒药

① 0 0 0 0 0 0 0

② 0 0 0 0 0 0 1

0 0 0 0 0 1 0

1 0 1 0 0 1 0

1 2 3 5 7

1010101

6. (30 points) Recall that the Fibonacci sequence is the numbers $0, 1, 1, 2, 3, 5, 8, 13, \ldots$, which can be described by the recursive formula:

$$F_0 = 0; F_1 = 1; F_n = F_{n-1} + F_{n-2}$$

for all $n \geq 2$. Clearly, $F_n \leq 2F_{n-1} \leq 2^n$.

(a) Consider the following algorithm for computing F_n:

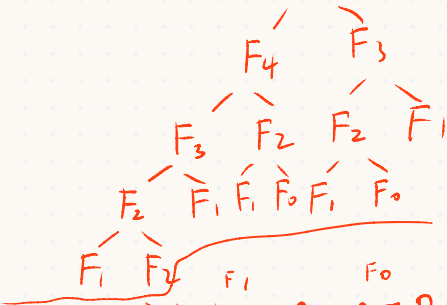
```
if n=0 then
  | return 0
else if n=1 then
  | return 1
else
  | return Fibo(n − 1) + Fibo(n − 2)
end
```

Algorithm 1: Fibo(n: a nonnegative integer)

Please analyze its running time in terms of big-O notation. Is it polynomial-time or exponential?

(b) Can you improve the above algorithm? Write down your algorithm, and analyze both the time complexity and space complexity.

(a) ~~O(n)~~ $O(2^n)$




```
int res = 0, a = 0, b = 1;
if (n=0) return 0;
if (n=1) return 1;

for (int i=2; i≤n; i++) {
    res = a+b;
    a = b;
    b = res;
}
return res;
```