1 Old Town Code

Next to each line, write out in words what you think the code will do when it is run. Assume the Singer class exists and that the code below compiles. You can assume that the ```sing``` function in Singer returns a String and prints nothing.

```java
int x = 7;
String chorus = "Thank u, next";
Singer queen = new Singer("Ariana");

while (x > 0) {
    x -= 1;
    queen.sing(chorus);
}

String[] phrases = {"love", "patience", "pain", "what does the fox say?");

for (int i = 0; i < 3; i += 1) {
    System.out.println("One taught me " + phrases[i]);
}

System.out.println(phrases[phrases.length - 1]);
```

*Hint:* For reference, here is an equivalent Python program.

```python
x = 7
chorus = "Thank u, next"
queen = Singer("Ariana")

while x > 0:
    x -= 1
    queen.sing(chorus)

phrases = ["love", "patience", "pain", "what does the fox say?"

for i in range(3):" + phrases[i])

print(phrases[len(phrases) - 1])
```
2 A Mystery

Below is a function (or method) called mystery1. It takes in two arguments and returns an integer, answer. The first argument it takes in is an array of integers called inputArray, and the second argument it takes in is an integer, k.

```java
public static int mystery1(int[] inputArray, int k) {
    int x = inputArray[k];
    int answer = k;
    int index = k + 1;
    while (index < inputArray.length) {
        if (inputArray[index] < x) {
            x = inputArray[index];
            answer = index;
        }
        index = index + 1;
    }
    return answer;
}
```

Write the return value of mystery1 if inputArray is the array {3, 0, 4, 6, 3} and k is 2. Then, explain in English what the method mystery1 does.

Extra Below is another function called mystery2. It takes an array of integers called inputArray as an argument and returns nothing.

```java
public static void mystery2(int[] inputArray) {
    int index = 0;
    while (index < inputArray.length) {
        int targetIndex = mystery1(inputArray, index);
        int temp = inputArray[targetIndex];
        inputArray[targetIndex] = inputArray[index];
        inputArray[index] = temp;
        index = index + 1;
    }
}
```

Describe what mystery2 will do and return if inputArray is the array {3, 0, 4, 6, 3}. Then, explain in English what the method mystery2 does.
3 Fibonacci

Implement fib1 recursively. fib1 takes in an integer N and returns an integer representing the Nth Fibonacci number. The Fibonacci sequence is 0, 1, 1, 2, 3, 5, 8, 13, 21, . . . , where 0 is the 0th Fibonacci number. As a reminder, the Nth Fibonacci number is calculated as follows:

\[ \text{fib}(N) = \text{fib}(N - 1) + \text{fib}(N - 2) \]

```java
public static int fib1(int N) {
}
```
Extra Implement `fib2` in 5 lines or fewer that avoids redundant computation. `fib2` takes in an integer `N` and helper arguments `k`, `f0`, and `f1` and returns an integer representing the `N`th Fibonacci number. To compute the `N`th fibonacci number, you should call `fib2(N, 0, 0, 1)`. If you're stuck, try implementing `fib1` iteratively and then see how you can transform your iterative approach to implement `fib2`.

```java
public static int fib2(int N, int k, int f0, int f1) {
    // Implementation goes here
}
```