Lab6 Learn from the past

Task

After the baptism of the five labs before, the last lab must be a piece of cake for you.

Intro

In this lab, you only need to use a high-level programming language(e.g. C/C++) to implement all the code that has been written before. **Note that the algorithm needs to be consistent with what was used before.** (e.g. Modulo operations cannot be replaced with `%` for the second lab.)

Here are program lists:

1. lab1: counting how many 1
2. lab2: a variant of the fibonacci sequence
3. lab3: longest duplicate substring
4. lab4: sort and count

rules

Here are some details:

1. You are expressly **forbidden** to use operations like ***, /, %, >>, <<** which LC3 does not support directly and the equivalent library functions;
2. You are allowed to use **+, -, =, ++, --, ==, !=, <, >, <=, >=, &, |, ~**;
3. You are allowed to use `for`, `while`, `do while`, `if`, `continue`, `break`, `switch case`;
4. You are allowed to define help functions that do not violate the above rules.

skeleton

For your convenience, your code may be written as:

```
#include <cstdint>
#include <iostream>
#include <fstream>

#define MAXLEN 100
#ifndef LENGTH
#define LENGTH 3
#endif

int16_t lab1(int16_t a, int16_t b) {
    // initialize

    // calculation

    // return value
```

```cpp
}

int16_t lab2(int16_t p, int16_t q, int16_t n) {
    // initialize

    // calculation

    // return value
}

int16_t lab3(int16_t n, char s[]) {
    // initialize

    // calculation

    // return value
}

void lab4(int16_t score[], int16_t *a, int16_t *b) {
    // initialize

    // calculation

    // return value
}

int main() {
    std::fstream file;
    file.open("test.txt", std::ios::in);

    // lab1
    int16_t a = 0, b = 0;
    for (int i = 0; i < LENGTH; ++i) {
        file >> a >> b;
        std::cout << lab1(a, b) << std::endl;
    }

    // lab2
    int16_t p = 0, q = 0, n = 0;
    for (int i = 0; i < LENGTH; ++i) {
        file >> p >> q >> n;
        std::cout << lab2(p, q, n) << std::endl;
    }

    // lab3
    char s[MAXLEN];
    for (int i = 0; i < LENGTH; ++i) {
        file >> n >> s;
        std::cout << lab3(n, s) << std::endl;
    }

    // lab4
    int16_t score[16];
    for (int i = 0; i < LENGTH; ++i) {
        for (int j = 0; j < 16; ++j) {
            file >> score[j];
```

```
        }
        lab4(score, &a, &b);
        for (int j = 0; j < 16; ++j) {
            std::cout << score[j] << " ";
        }
        std::cout << std::endl << a << " " << b << std::endl;
    }

    file.close();
    return 0;
}
```

with the test.txt we provide, here is the output

```
2
4
15
146
818
1219
3
4
3
0 10 20 25 30 35 40 45 50 55 60 80 85 90 95 100
4 1
0 10 15 20 25 35 40 45 50 65 70 75 80 90 95 100
3 2
9 10 11 21 22 33 44 53 55 57 66 77 88 97 98 99
4 1
```

Note: If you write from scratch yourself, please describe your program structure in the report, and make sure your output is consistent with our skeleton.

Score

Correctness for 50% and the report for other 50%.

Submission

Your submission be structured as shown below.

```
PB21******_Name.zip
├── PB21******_Name_report.pdf
└── lab6.c
```

Reports

Your reports should contain at least the five parts below:

- purpose

- principles (e.g. how to solve these problems using high-level programming language)

- procedure (e.g. bugs you encountered and how to solve them)

- result of your test

- answers to the questions
  - What is the difference between programming in a high-level language and programming in LC3 assembly language?
  - What instructions do you think need to be added to LC3? (Hint: You can think about the previous labs and what instructions could be added to greatly simplify the previous programming)
  - Is there anything you need to learn from LC3 for the high-level language you use?

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