

# Competitive Programming

An introduction to the art...

---

July 19, 2019

# Introduction

---

# What is Competitive Programming?

- It's a sport... a **mind sport**.
- Participants are given problems and they have to create computer programs to solve them.
- There are many types of problems that we will learn *later*...

# What is ACM-ICPC?

- **I**nternational **C**ollegiate **P**rogramming **C**ontest
- Thousands of students participate every year and attempt to be #1 in the world.
- Oporto 2019 → Moscow 2020!

*“Quite simply, it is the oldest, largest, and most prestigious programming contest in the world.”*

# Problem Structure

- Title and limitations
- Description
- Input and output (I/O)
- Examples

**Lets see the real thing:**

<https://codeforces.com/contest/1/problem/A>

# Virtual Judges

- It is impossible that a human checks all of the users submissions.
- Virtual Judges (VJ) are the ones in charged of validating the correctness of your solution.
- They will run a lot of test cases with your code to make sure it **ALWAYS** work.

- Codeforces - <https://codeforces.com>
- UVA - <https://uva.onlinejudge.org>
- Codechef - <https://www.codechef.com>
- Vjudge - <https://vjudge.net>

# Programming Languages

- They are the tool that allow us to give instructions to the machine.
- Every programming language has a purpose.
- In competitive programming some languages are *objectively* better than others.
- Not all PLs are allowed in the *ACM-ICPC*.



# ICPC Allowed Languages



# Why C++ is the Best

- Lower Level → More control
- Allows for better memory management.
- The **STL Library** is extremely powerful.
- Almost all learning resources are oriented to C++.

## Errors - Verdict Information

- **AC - Accepted**
- **WA - Wrong Answer**
- **TLE - Time Limit Exceeded**
- **RE - Runtime Error**

Others: [https://icpcarchive.ecs.baylor.edu/index.php?option=com\\_content&task=view&id=14&Itemid=30](https://icpcarchive.ecs.baylor.edu/index.php?option=com_content&task=view&id=14&Itemid=30)

# Setups & IDEs

- There are 3 main setups:
  - IDE
  - Text Editor
  - Console Text Editor
- What are some advantages and disadvantages of these?
- Do I **HAVE** to use a CTE?



- What is competitive programming?
- What is a Virtual Judge?
- Why are we learning C++?
- *Why do I want to get into competitive programming?*

**C++ in 2 weeks!**

---

# What is a Program?

- It a sequence of logical and ordered steps that the computer will execute.
- Programs are composed of *variables, functions and instructions*.
- In practice we write programs as files that we then *compile* to make an *executable*.
- For example: `main.cpp`, `calc.cpp`, `whatever.cpp`

# Variables

- A variable is a value that can change.
- Variables need to be *declared*.
- It has a *unique name* so that the program can identify it.
- Variables are stored in *memory*, with a *fixed* size.
- There are different types of variables or *data types*.
- In C++ we need to specify the data type of our variables.



# Data Types in C++

Type	Size	Range
short	16 bit	$[-2^{15}, 2^{15} - 1]$
int	32 bit	$[-2^{31}, 2^{31} - 1]$
long long	64 bit	$[-2^{63}, 2^{63} - 1]$
float	32 bit	$[-3.4 \times 10^{38}, 3.4 \times 10^{38} - 1]$
double	64 bit	$[-1.7 \times 10^{308}, 1.7 \times 10^{308}]$
char	8 bit	$[-2^7, 2^7 - 1]$

# Arithmetic Operators

- The name pretty much gives everything away.
- We need to be careful with data types.
- Operators obey the laws of order of operator.

## Operators

$$- 10 + 5 \rightarrow 15$$

$$- 10 - 5 \rightarrow 5$$

$$- 10 * 5 \rightarrow 50$$

$$- 10 / 5 \rightarrow 2$$

$$- 10 \% 5 \rightarrow 0$$

## Lets see the real thing - Hello World

```
#include <iostream>

using namespace std;

int main(){
    cout<<"Hello World!"<<endl;
    return 0;
}
```

## Flow Control - if, else

```
int main(){  
    int x;  
    cin>>x;  
    if(x < 0){  
        cout<<x<<" is smaller than 0!"<<endl;  
    }  
    else{  
        cout<<x<<" is greater than 0!"<<endl;  
    }  
    return 0;  
}
```

## Flow Control - else if

```
int main(){
    int x;
    cin>>x;
    if(x < 0){
        cout<<x<<" is smaller than 0!"<<endl;
    }
    else if(x == 0){
        cout<<x<<" is equal to 0!"<<endl;
    }
    else{
        cout<<x<<" is greater than 0!"<<endl;
    }
    return 0;
}
```

# Loops - while

```
int main(){  
    int i = 0;  
    while(i < 5){  
        cout<<i<< ' ' ;  
    }  
    cout<<endl;  
    return 0;  
}
```

# Loops - for

```
int main(){  
    for(int i = 0; i < 5; i++){  
        cout<<i<< ' ' ;  
    }  
    cout<<endl;  
    return 0;  
}
```

# Functions

```
int square(int n){  
    int answer = n*n;  
    return answer;  
}  
  
int main(){  
    cout<<square(5)<<endl;  
    cout<<square(7)<<endl;  
    return 0;  
}
```



# Functions

```
int main(){  
    int arr0[5];  
    int arr1[4] = {1,2,3,4};  
    int arr2[5] = {1,2,3,4};  
  
    cout<<arr0[0]<<endl;  
    cout<<arr1[1]<<endl;  
    cout<<arr2[4]<<endl;  
    cout<<arr2[5]<<endl;  
    cout<<arr1[5]<<endl;  
    return 0;  
}
```

# Problems

---

- *Ad-Hoc* → *For this* in Latin
- This tag is given to solutions that require no prior knowledge.
- They usually do not require a methodical approach.
- Basically the simplest problems.

## Problem - Description

**Time Limit:** 1s

**Memory Limit:** 256MB

Diego is about to enter his final maths exam. He has been very lazy throughout the semester, so he needs to get a perfect score or else he will fail the subject. The exam will consist of  $T$  questions. In each he will be given a number and he has to determine if it is prime. In an act of compassion the teacher decides that he will allow students to use their computers, but they can not use the internet.

Can you write a program to help Diego determine which numbers are prime?

## Problem - I/O

### Input:

The first line contains  $T$  ( $1 \leq T \leq 100$ ), the number of questions the exam has. The next  $T$  lines will have an integer  $n$  ( $1 \leq n \leq 10^6$ ) the number Diego has to determine if it is prime.

### Output

For each question print "T" (without the quotation marks) if the number is prime or "F" if it isn't.

## Problem - Examples

### Example 1:

Input
1
104729

Output
T

### Example 2:

Input
3
22
3
49

Output
F
T
F

**Homework:**

**Chats:**

- ACM Announcements: <https://bit.ly/2V0Sn1w>
- Competitiva UTEC: <http://bit.ly/2JGcf2X>