

Information slides for the Practical Course: Algorithms for Programming Contests

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Content

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The Lectures

Time and Place

Thursday, 12:30 - 14:00, Room 00.09.013

- Solutions from last week's problems.
- Theoretical background about several concepts and algorithms.
- Learn and prepare for programming contests.
- No slides (in general): take notes!
- Most important facts will be on the whiteboard!

The Problem Sets

- Available on the course homepage, accessible with password only (ask us for it).
- Usually, five problems per week:
 - two easy (4 Points each),
 - two medium (6 Points each),
 - one hard (8 Points).
- Apply algorithms and concepts from the lecture.
- Each week's problems are (mostly) about the topics from that week's lecture.
- There will be a lot of hints in the lectures.

Have a Problem with a Problem?

Should difficulties arise: ask questions! Come to our offices or write a clarification!

The Problem Sets

- There are surveys to each week's problem set.
- Give us feedback about the problems.
- Found on the webpage.
- Please help us improve our problem sets!

Grading

Your final grade will be determined by how many points you earned, as well as an oral exam at the end of the semester. The oral exam will account for 40% of the grade.

The (tentative) key for grading the problems is the following:

Percentage	Grade
$\geq 90\%$	1.0
$\geq 85\%$	1.3
$\geq 80\%$	1.7
$\geq 75\%$	2.0
$\geq 70\%$	2.3
$\geq 65\%$	2.7
$\geq 60\%$	3.0
$\geq 55\%$	3.3
$\geq 50\%$	3.7
$\geq 40\%$	4.0

Topics

- ① Introduction
- ② Graphs, Minimum Spanning Trees, DFS, BFS
- ③ Shortest Paths
- ④ Flows
- ⑤ Data Structures
- ⑥ Brute Force / Backtracking
- ⑦ Dynamic Programming
- ⑧ Number Theory
- ⑨ Geometry
- ⑩ Projective Geometry
- ⑪ Contest
- ⑫ Conclusion

Official DOMjudge System


- In use for programming contests such as the GCPC or the ICPC.
- On the web:

TUMjudge

<http://judge.informatik.tu-muenchen.de/>

Registration

- Registration necessary.



Welcome to TUMjudge!

If you already have an account please choose a contest to participate.

ConPra

Algorithmen für Programmierwettbewerbe

[Scoreboard](#)
[Login](#)

GAD

Grundlagen: Algorithmen und Datenstrukturen

[Scoreboard](#)
[Login](#)

Registration

Please fill in the following form to create an account for you. If you are a student at TUM your login should be the login you use in the computer labs. For instance, use "test" if you have the mail address test@in.tum.de. The password to login is the same as in the computer labs.

Affiliation

TU München

Category

Students

Login

Create account

Login


- Authentication necessary.
- Works with LDAP and is identical with the login to the computer lab (“Rechnerhalle”).
 - Login is “name” in `name@in.tum.de`.
 - Password is the corresponding password.
- Forgot your password and want to change / reset it?
 - Get in contact with the RBG, not with us!



Overview

The overview page shows several pieces of information:

- the personal scoreboard of the current contest,
- an overview of already submitted programs,
- an overview of clarifications (more on that later on).

Overview


judge
overview
scoreboard
user: x
contest

RANK	TEAM	SCORE	WS14ND6A	WS14ND6B	WS14ND6C	WS14ND6D	WS14ND6E	WS14ND6F	WS14ND6G
3	  TUM München	2 / 20216	0	2	0	0	3/8908	0	0

Submissions

problem
language
submit
cancel

time	problem	lang	result
19.11.2014 17:58	WS14ND6E	CPP	CORRECT
19.11.2014 17:57	WS14ND6E	CPP	WRONG-ANSWER
19.11.2014 17:56	WS14ND6E	CPP	COMPILER-ERROR
13.11.2014 14:53	WS14ND6B	CPP	TIME-LIMIT
13.11.2014 14:49	WS14ND6B	CPP	TIME-LIMIT

Clarifications

time	from to	subject	text
17.11.2014 11:46	Jury AI	general	Could not see today's submission correctly. It says "problem not found".
13.11.2014 15:07	Jury AI	problem WS14ND6E	Some students unfortunately use description's output format for the IC...

Clarification Requests

No clarification requests.

Problem structure

A problem consists of several parts:

- name, abbreviation, difficulty,
- problem author,
- problem statement,
- input format specification,
- output format specification,
- constraints,
- sample input and output.

SS15N01A Hello World!

Author: Stefan Toman

This is probably the first problem you will solve and it should help you set up and test your system. Solve this problem first to make sure everything is in place.

We would like to introduce you to Lea. You will meet her in many of the problems you will solve. After reading all of them you will know her quite well.

Lea is a very friendly person who likes to say hello to everybody, but she doesn't want to say the same thing to every person she meets. Therefore, she never knows what to say. For greeting Bob it is appropriate to say "Hello Bob!", whereas for greeting Peter it is better to say "Hello Peter!". Help her and tell her which sentence to use.

Input

The first line of the input contains an integer t . t test cases follow.

Each test case consists of a single line containing a name *name*.

Output

For each test case, print a line containing "Case $\#i$: Hello *name*!" where i is its number, starting at 1. Each line of the output should end with a line break.

Constraints

- $1 \leq t \leq 20$.
- No name will contain whitespaces.
- The names' lengths will be at most 100.

Sample Data

Input

```
1 2
2 Bob
3 Peter
```

Output

```
1 Case #1: Hello Bob!
2 Case #2: Hello Peter!
```

Submitting programs

Submitting program is done on the TUMjudge web interface entirely.


- No files to be sent via e-mail etc.
- Only source code files are uploaded, no .class files or similiar.


Submit


- Choose files to be uploaded by Drag-and-Drop or in the menu “Choose Files”,
- choose problem,
- choose language (unless already chosen automatically),
- “submit”,
- F5, F5, F5, F5, ...

CAUTION: When submitting several files, the file including the main method must be chosen first.

Submitting programs


[judge](#)
[overview](#)
[scoreboard](#)


[logout](#)
[contest](#)

RANK	TEAM	SCORE	WS14ND6A	WS14ND6B	WS14ND6C	WS14ND6D	WS14ND6E	WS14ND6F	WS14ND6G
3	 TU München	2 20216	0	2	0	0	3/8008	0	0

Submissions

time	problem	lang	result
19.11.2014 17:58	WS14ND6E	CPP	CORRECT
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19.11.2014 17:56	WS14ND6E	CPP	COMPILER-ERROR
13.11.2014 14:53	WS14ND6B	CPP	TIME LIMIT
13.11.2014 14:49	WS14ND6B	CPP	TIME LIMIT

Clarifications

time	from to	subject	text
17.11.2014 11:46	Jury AI	general	Could not use fstream to open the input file for the second test case...
13.11.2014 15:07	Jury AI	problem WS14ND6E	When submitting, unfortunately, the description of the output format for the IC...

Clarification Requests

No clarification requests.

Judging

The TUMjudge

- compiles,
- executes,
- tests

the submission against several test cases. As long as the TUMjudge is working on a submission, the submission's status is "PENDING".

The submission is treated instantaneously and the TUMjudge (usually) announces its verdict within a few moments.

Judging

The following verdicts can occur:

CORRECT

The submission successfully solved all the test cases.

COMPILER-ERROR

The submission could not be compiled. The exact error message can be seen on the submission's detail page.

NO-OUTPUT

The submission does not produce any output. Be sure to output to "standard out".

Judging

TIMELIMIT

The submission runs longer than the maximal allowed time and was terminated.

Possible reasons:

- The submission runs in an endless loop.
- The submission is not efficient enough.

RUN-ERROR

An error occurred during the submission's execution.

Possible reasons:

- Division by 0.
- Incorrectly addressing memory locations, e.g. `ArrayIndexOutOfBoundsException`.
- Using more memory than the allowed memory limit.

Judging

WRONG-ANSWER

The submission's output is incorrect.

Possible reasons:

- The answer is just wrong.
- The answer does not conform to the output format specification given on the problem set.
- The answer is not exact enough (e.g. with floating point answers with a desired precision).

TOO-LATE

The program was submitted after the submission deadline. It is stored in the system, but no longer processed.

Scoreboard

TUMjudge

overview

scoreboard

contest

Scoreboard Algorithms for Programming Contests WS2014/15 - Week 3

final standings

RANK	TEAM	SCORE	WS14N03A	WS14N03B	WS14N03C	WS14N03D	WS14N03E
1	BAE <small>Technische Universität München (5 Wins)</small>	5 6389	1/188	2/186	2/603	3/1201	2/1325
2	BAB <small>Technische Universität München (2 Wins)</small>	5 8632	3/421	1/430	3/683	1/766	5/932
3	BAO <small>Technische Universität München (2 Wins)</small>	5 28151	2/2853	1/3363	1/4655	5/6006	3/7074
4	BAO <small>Technische Universität München (1 Win)</small>	5 35852	8/1756	2/1861	5/3677	2/4593	15/7765
5	BAA <small>Technische Universität München (1 Win)</small>	5 38868	3/3300	1/3302	4/8651	3/5776	8/9439
6	BAA <small>Technische Universität München (1 Win)</small>	5 40376	2/285	5/1479	1/1549	11/1685	30/8978
7	BAA <small>Technische Universität München (1 Win)</small>	5 41921	1/5814	1/5830	1/7332	2/7397	11/8948
8	BAO <small>Technische Universität München (1 Win)</small>	4 22614	4/3149	1/3174	2/6106	1/7785	6
9	BAO <small>Technische Universität München (1 Win)</small>	4 30425	4/4422	1/4445	4/8627	2/8731	1
10	BAO <small>Technische Universität München (2 Wins)</small>	4 32890	1/6477	1/6511	4/8816	1/9286	17
11	BAO <small>Technische Universität München (2 Wins)</small>	4 33650	4/5803	2/5786	1/9184	3/9277	0
12	BAA <small>Technische Universität München (1 Win)</small>	4 36422	5/7248	5/8582	2/7837	1/7355	8
13	BAO <small>Technische Universität München (2 Wins)</small>	4 41355	4/9307	1/9317	3/9542	2/9589	0
14	BAO <small>Technische Universität München (2 Wins)</small>	3 14871	3/4168	2	2/4532	1/4371	1
15	BAO <small>Technische Universität München (2 Wins)</small>	3 26225	3/6293	1/6299	7/8833	10	9

Different background colors indicate different outcomes:



Problem solved.



Problem solved first.



Incorrect submission(s).



Submission in pending status.



No submissions.

Scoreboard

Order (tie-breakers):

- ① number of solved problems,
- ② score:
 - per problem: (number of incorrect submissions) * (penalty time) + (time for the first correct submission),
 - penalty time = 600, i.e., 10 hours,
 - e.g. 3/421 indicates: the problem was solved with 3 submissions, with a total penalty time of 421.

You can submit any number of times to solve a problem!

Each week's score itself (apart from the number of problem solved) does not change the grading at the end of the semester, it only affects the position in the scoreboard of that week.

Scoreboard

Anybody who does not want to be seen in the public scoreboard, must choose the invisibility option during the registration (in “Category”).

Clarifications

- Messages to the system administrators, i.e., the teaching assistants and/or tutors.
- Sent via the “request clarification” form on the overview page.
- Used for questions about the problems or about the system in general.
- Please choose a subject accordingly: either “general” or the specific problem.
- Depending on the actual question, the answer is only visible to the persons who sent the question, or it is published to all users of the system.
- The answer (along with the question) can be seen on the right side on the overview page.

Clarifications

TUMjudge
overview
scoreboard

username
contest

RANK	TEAM	SCORE	WS14ND6A	WS14ND6B	WS14ND6C	WS14ND6D	WS14ND6E	WS14ND6F	WS14ND6G
3	TU München	2 20216	0	2	0	0	3/6008	0	0

Submissions

time	problem	lang	result
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13.11.2014 14:53	WS14ND6B	CPP	TIME-LIMIT
13.11.2014 14:49	WS14ND6B	CPP	TIME-LIMIT

Clarifications

time	from to	subject	text
17.11.2014 11:46	Jury AI	general	Could not use binary representation for input/output. Please use %d instead.
13.11.2014 15:07	Jury AI	problem WS14ND6E	Some students unfortunately use description of the output format for the IC...

Clarification Requests

No clarification requests.

Compiler Settings

Allowed languages are Java and C++.

java compile settings

```
java -client -Xdd8m -Xmx8038608k -DONLINE_JUDGE=1  
-DDOMJUDGE=1 '$MAINCLASS'
```

java version

```
java version "1.8.0_31"  
Java(TM) SE Runtime Environment (build 1.8.0_31-b13)  
Java HotSpot(TM) 64-Bit Server VM (build 25.31-b07,  
mixed mode)
```

Compiler Settings

cpp compile settings

```
g++ -Wall -O2 -std=c++11 -static -pipe -DONLINE_JUDGE  
-DDOMJUDGE -o $DEST "$@"
```

cpp version

```
g++ (Debian 4.7.2-5) 4.7.2  
Copyright (C) 2012 Free Software Foundation, Inc.  
This is free software; see the source for copying conditions.  
There is NO warranty; not even for MERCHANTABILITY or FITNESS  
FOR A PARTICULAR PURPOSE
```

Restrictions

- Compilation of a submission may take no longer than 30 seconds. After that time, compilation is aborted and the verdict will be a `COMPILER-ERROR`.
- The maximal allowed size of a source code file is 256 KB. Bigger submissions will not be accepted.
- During the execution of a submissions, up to 8 GB of memory is available. This includes source code, variables, stack, Java VM (up to 0,35 GB),... If a submission tries to address more memory, it will be terminated and the verdict will be a `RUN-ERROR`.
- It is not allowed to use multi threading. Each submission has only one processor fully at its disposal.

Restrictions

Tampering with the system in any way will be penalized!
Do not fool the system!

- Do not open files, input is always in “standard in”.
- Do not address files locally on the system! This is not possible anyways.
- Do not open network connections.
- ...

Furthermore, please keep the number of submissions at an acceptable level as to not unnecessarily slow judging for all participants.

Java Submission

```
import java.util.Scanner;

public class JavaSubmission {
    public static void main(String[] args) {
        // create scanner object
        Scanner s = new Scanner(System.in);

        // loop over all test cases
        int t = s.nextInt();
        for(int i = 1; i <= t; i++) {

            // read several types of input
            boolean b = s.nextBoolean();
            String st = s.next();

            // output: use the possibility you like more
            System.out.println("Case_" + i + ": " + st);
            System.out.format("Case_%d#: %s\n", i, s);
        }
        s.close();
    }
}
```

C++ Submission

```
#include <iostream>
#include <stdio.h>

int main() {
    // loop over all test cases
    int t;
    scanf("%d", t);
    for(int i = 1; i <= t; i++) {

        // read several types of input
        int j;
        std::string s1;
        char s2[101];
        // use the possibility you like more
        std::cin >> j >> s1;
        scanf("%d_100s", &j, s2);
        // output: use the possibility you like more
        std::cout << "Case_" << i << ":_" << s1 << std::endl;
        printf("Case_#%d:_s_%d", i, s2, j);
    }
    return 0;
}
```

Understanding Problems

- Read the problem statement very carefully.
- Also the constraints, think about special cases:
 - E.g. if there are negative values or 0 allowed, then there is probably a test case for that.
 - E.g. special characters or a space when dealing with strings.
 - ...

Solving Problems

- Code efficiently.
 - Think about which data types to use.
 - Sometimes arrays might not have to be two- or three-dimensional.
 - Implement algorithms given in the lecture with their amortized running times.
- Look carefully at the input and output specifications and let your program be conform to those!
- Remove all debug messages before submitting.
- Write comments!

Code from the Internet

- You are allowed to copy code you find on the internet, but you need to cite the correct source, otherwise we will not accept the submission and may apply other penalties.
- Do this by putting a comment in your code stating the url or similar.
- However, we advise you to code on your own as it improves the understanding about the algorithms involved. You probably need this in subsequent problems anyway.

Half Points

If the judge does not accept your solution but you are sure you solved it correctly, use the “request clarification” option. In your request include:

- the name of the problem (by selecting it in the subject field),
- a verbose description of your approach to solve the problem,
- the time you submitted the solution we should judge.

We will check your submission and award you half the points if there is only a minor flaw in your code.

Big Inputs / Outputs

- Some problems require you to read/write a substantial amount of input/output.
- Even without doing anything else, this can takes longer than the allowed time limit when not handled correctly!

Speed up your code easily!

Use the faster readers / writers when handling big data.

Comparison of Different Methods

- Input:

	Java		C++	
	Scanner	BufferedReader	cin	scanf
5 Mio Integers	3321 ms	431 ms	1887 ms	552 ms
50 Mio Integers	30988 ms	3937 ms	18789 ms	5467 ms

Comparison of Different Methods

- Input:

	Java		C++	
	Scanner	BufferedReader	cin	scanf
5 Mio Integers	3321 ms	431 ms	1887 ms	552 ms
50 Mio Integers	30988 ms	3937 ms	18789 ms	5467 ms

- Output:

	Java			
	println	format	BufferedWriter	StringBuilder(println)
5 Mio Integers	27220 ms	37250 ms	558 ms	440 ms
50 Mio Integers	-	-	5057 ms	4057 ms

	Java	C++	
	StringBuilder(BW)	cout	printf
5 Mio Integers	470 ms	11927 ms	492 ms
50 Mio Integers	4234 ms	-	4919 ms