ICPC Compete

Sunday, August 31, 2025

ICPC Compete

- **Welcome!** (Bill Poucher)
- **Internships at ICPC Foundation** (Christian Yongwhan Lim)
- **Contest Control Systems: Shadowing** (John Buck)
- **Really? They Missed That??** (Marc Furon)
- **Don’t copy ideas - get inspired by them!** (Mateusz Radecki)
- **ICPC vs IOI** (Tolga Can, Ryan Farrell, & Christian Lim)

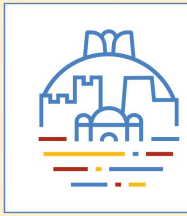
ICPC International Collegiate Programming Contest

The 2025 ICPC World Finals Baku

31 August – 5 September 2025 // hosted by **ADA University**

Welcome!

- [Video Link]



ICPC 2025
WORLD FINALS BAKU
HOSTED BY ADA UNIVERSITY

Internships at ICPC Foundation

Christian Yongwhan Lim

VP of Engineering, Arklex AI
Director of Internships, ICPC Foundation
Adjunct, Columbia University
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christian.lim@icpc.global

Overview

- Purpose
- Summary
- Feedback
- Testimonials
- After internship

Overview (con't)

- Project Showcases
- Growing List of Interns' Contributions
- Future Directions
- Q & A's

Purpose (for ICPC)

- Support multiple streams, including, but not limited to:
  - **Archive** (w/ Fredrik, Miguel)
  - **ICPC Journal - The Journal of Competitive Learning** (w/ Erich)
  - **North America Website Development** (w/ Toni, Lidia, Glenn)
  - **Contest Problem Development** (High School, Local, Regional)
  - **Online Training in Competitive Programming** (OTCP)
  - **Mobile App**

Purpose (for interns)

- Immigration assistance (F-1 OPT)
- Hands-on project experience
- Interview preparation and programming contest training

Summary

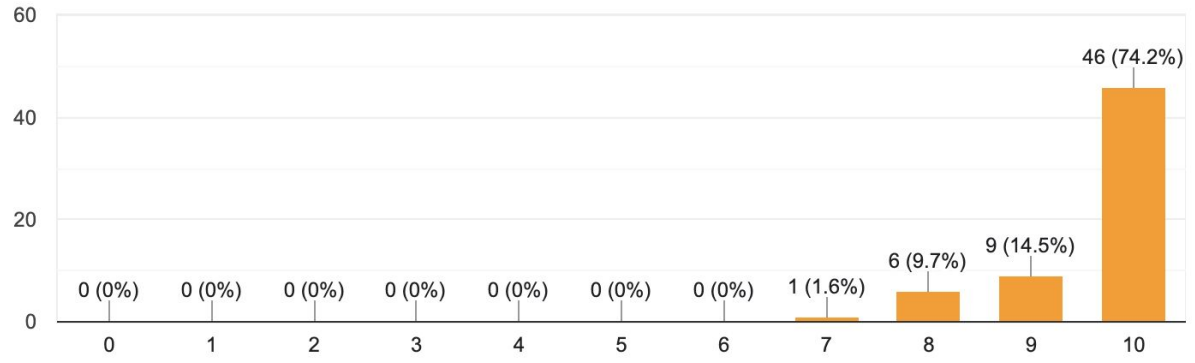
- Started early 2023 as an **initiative**! Soon to be an **official program**!
- Internship Program Status:
  - **343** interest forms submitted
  - **31** signed+send (current interns)
  - **79** completed

(Intern) Feedback (avg. 9.6/10)

How satisfied are you with your experience with the internship initiative?

Copy chart

62 responses



(Intern) Testimonials

Awesome experience, thank you so much Professor Lim! I really learnt a lot from this internship. And really appreciated your help and support for the last 6 months.

I've thoroughly enjoyed my internship experience at ICPC. It opened the vast new dimension of algorithms for me to discover and to improve on. Unfortunately, due to me two jobs I was not able to practice as much as I wanted during the last month or so of the internship nonetheless I am very grateful for the whole experience.

Shout out to Professor Lim for a great job of pushing his interns to make them better at problem-solving.

The leader of the project is responsive and helpful. Team members are passionate about the work and brings up innovatie ideas. All in all, my overall experience in this internship is positive.

(Intern) Testimonials

amazing expericen, learned a ton from the problem-solving session.

During my internship, I gained invaluable knowledge and experience. I'd like to extend my gratitude to Professor Lim for his exceptional master class on algorithms. It has notably improved my proficiency with LeetCode questions. I also want to express my appreciation for Professor Donaho and the ICPC developer team. With their guidance, I was able to gain hands-on experience relevant to the industry.

I am extremely satisfied with my experience with the internship initiative. It has been a valuable and enriching opportunity that has allowed me to learn and grow in various ways

I have no further questions; I genuinely appreciate this invaluable opportunity and the experience it has provided!

After internship

- After or during the internship, interns have gone to work full-time at software companies or quantitative firms as software engineer or quantitative analysis/developer/researcher including, but not limited to:
  - **Tech**: Google; Amazon;
  - **Quant**: Citadel; Two Sigma; Point72; Virtu; ING;

Project Showcase (Fredrik, Miguel, Christian)

- **ICPC Archive**
  - **ICPC Problem Archive** - A library of all ICPC contest problems, including statements, test data, and solutions.
  - **ICPC Contest Archive** - A library of all ICPC contest artifacts, including results, clarifications, and related materials.
- We collect, validate, and store problems from all ICPC contests in a reusable ICPC Problem Package format.

Project Showcase (Erich / Christian)

- **ICPC Journal – The Journal of Competitive Learning**
  - https://jcl.u.icpc.global

- **5** submissions are being prepared for the first issue.
- Growing fast!

Project Showcase (Erich / Christian) (con't)

- **Editorial Team**
  - **Erich Baker** (Editor-in-Chief)
  - **Bill Booth** (Senior Editor)
  - **Tomas Cerny** (Senior Editor)
  - **Christian Lim** (Senior Editor)
  - **Bill Poucher** (Senior Editor)

Project Showcase (Toni / Lidia / Glenn / Christian)

- North America Regional and Division Websites
- **11 Regionals**
  - Work with each RCD to standardize the look and feel.
- **4 Divisions**
- **North America**: na.icpc.global
- **North America Championship**: nac.icpc.global

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https://na.icpc.global/

CENTRAL BANK OF THE REPUBLIC OF AZERBAIJAN · PASHA Holding · Innovation and Digital Development Agency · HUAWEI · JETBRAINS · OpenAI · Google DeepMind

Examples

- Keep the sites current.
- Greatly improved UI/UX.
- Created a template with consistent look and feel with flexibility in mind.
- Archived NAC websites to preserve history (Toni wishes WF does this!)
- Archived regional problem sets for easy access.
- Incorporated maps for contest site locations at regionals.

Project Showcase (Christian Lim)

- **Online Training in Competitive Programming**
  - **Masterclass** @ Sundays from 7 PM ET to 8 PM ET
  - **Intern Sync-up** @ Sundays from 8:30 PM to 9 PM ET
  - **Weekend problem set** @ Fridays at 7 PM ET for 48 hours

- Masterclass is running strong w/ **136** sessions as of **August 31, 2025**!

Project Showcase (Christian Lim) (con't)

- **Mobile App Development**
  - Hope to premier on **2026 ICPC North America Championship**!
  - After improving, hope to showcase on **2026 ICPC World Finals**!
- **ICPC Internship Website Development**
- **Contest Problem Development**
  - High School
  - Local

Growing List of Interns' Contributions

- Full-stack
- Cloud Infrastructure
- End-to-end Testing
- Educational Outreach

Growing List of Interns' Contributions (con't)

- **Archive** (w/ Miguel, Fredrik)
- **Journal of Competitive Learning** (w/ Erich)
- **North America Website Development** (w/ Toni, Lidia, Glenn)

Growing List of Interns' Contributions (con't)

- Online Training in Competitive Programming Internship
- ICPC Internship Website Development
- Mobile App Development
- Contest Problem Development

Future Directions

- **Aiming to formally induct the initiative into an official program.**
- **Looking to expand the project list**
  - Some proposals are under review.
- **Strengthening the internship to be more impactful than ever.**
  - Looking into expanding to Canada first!
  - Then, organically, to other countries.

Thank you!

- **Now, Q&A's**

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CLI Symposium - Compete Track
August 31, 2025

Contest Control Systems: Shadowing

John Buck
VP Engineering
C-Scape Consulting Corporation
Email: buckj@icpc.global

Development Team

John Buck

ICPC Primary Contest Control System Group Leader

Current Occupation (whom I collect a salary from)

- Partner and Vice President of Engineering at C-Scape Consulting Corporation specializing in custom software and data feeds for large scale electronic displays.

Areas of expertise

- C, C++, Java.
- Embedded systems.
- Data feeds.

Academic background

- Polytechnic University (now, NYU).
- Involved with ICPC since 1985
- I currently have **NO** affiliation with *any* academic institution. (I'm in the real world,)

Current activities related to ICPC

- ICPC Systems Team and Primary CCS Group Leader for ICPC North America Championship and ICPC World Finals 49, Baku.
- Shadow CCS Group Leader at WF46/47 Luxor, WF48 Astana and the North America Championship 2024
- Chief Judge for ICPC North America Eastern Division (since 2023) and Greater New York Region (since 2002).
- PC^2 developer

Email: buckj@icpc.global
Office: +1-516-536-1759 x136

What is shadowing?

Why do we shadow?

When

“Hello World.” != “Hello World."

Accepted

Wrong Answer

Discussion Topics

1. ICPC Contest Control Systems (CCS)
2. Contestant submission flow through the systems
3. CLICS Application Programming Interface
4. Examples of why we shadow
5. Conclusion
6. Questions and Answers

The *Primary* Contest Control System

Interface seen by contestants (WTI)

Forwards submissions to shadow

Judges the submissions

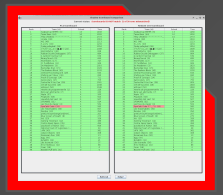
Returns judgments back to contestants

The *Shadow* Contest Control System

Completely “behind the scenes”

Receives submissions from primary

Independently judges the submissions



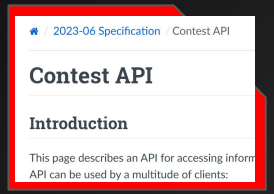
Compares with primary

Shadowing of Recent Contests

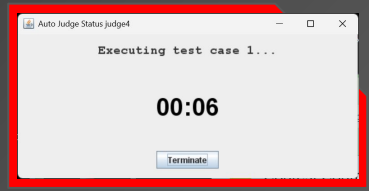
	Event	Primary	Shadow
	WF49 - Baku	PC^2	DOMjudge
	NAC2025 - Orlando	PC^2	DOMjudge
	EUC2025 - Porto	DOMjudge	PC^2
	Pacific NW 2024 & 2025	PC^2	DOMjudge
	Greater NY 2024 & 2025	PC^2	DOMjudge
	WF48 - Astana	DOMjudge	PC^2
	NAC2023 & 2024 - Orlando	DOMjudge	PC^2
	WF46/47 Luxor	DOMjudge	PC^2

Team Submissions (Primary)

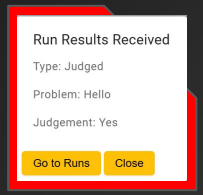
- A team submits source code over network (Typically using CLI submit utility)
- Primary CCS receives team submission



- Submission sent on CLICS Event Feed



- The primary CCS judges team submission

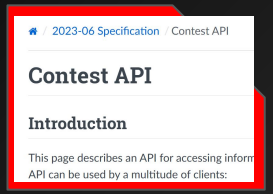


- Primary sends judgment back to team and over the CLICS Event Feed

Team Submissions (Shadow)

- Submission received via CLICS Event Feed

- The shadow CCS judges team submission



- Shadow receives Primary's judgment via CLICS Event Feed

- Shadow compares its judgment w/Primary's

- Any conflicts must be resolved with Primary team

CLICS API

- Secure REST API served up by a CCS
- Endpoint URLs: teams, problems, submissions, judgements, scoreboard, languages
- Streaming NDJSON Event Feed: CRUD-style
- Shadow CCS consumes Event Feed generated by the Primary CCS. Shadow can make EP requests as well.
- https://ccs-specs.icpc.io/2023-06/contest_api

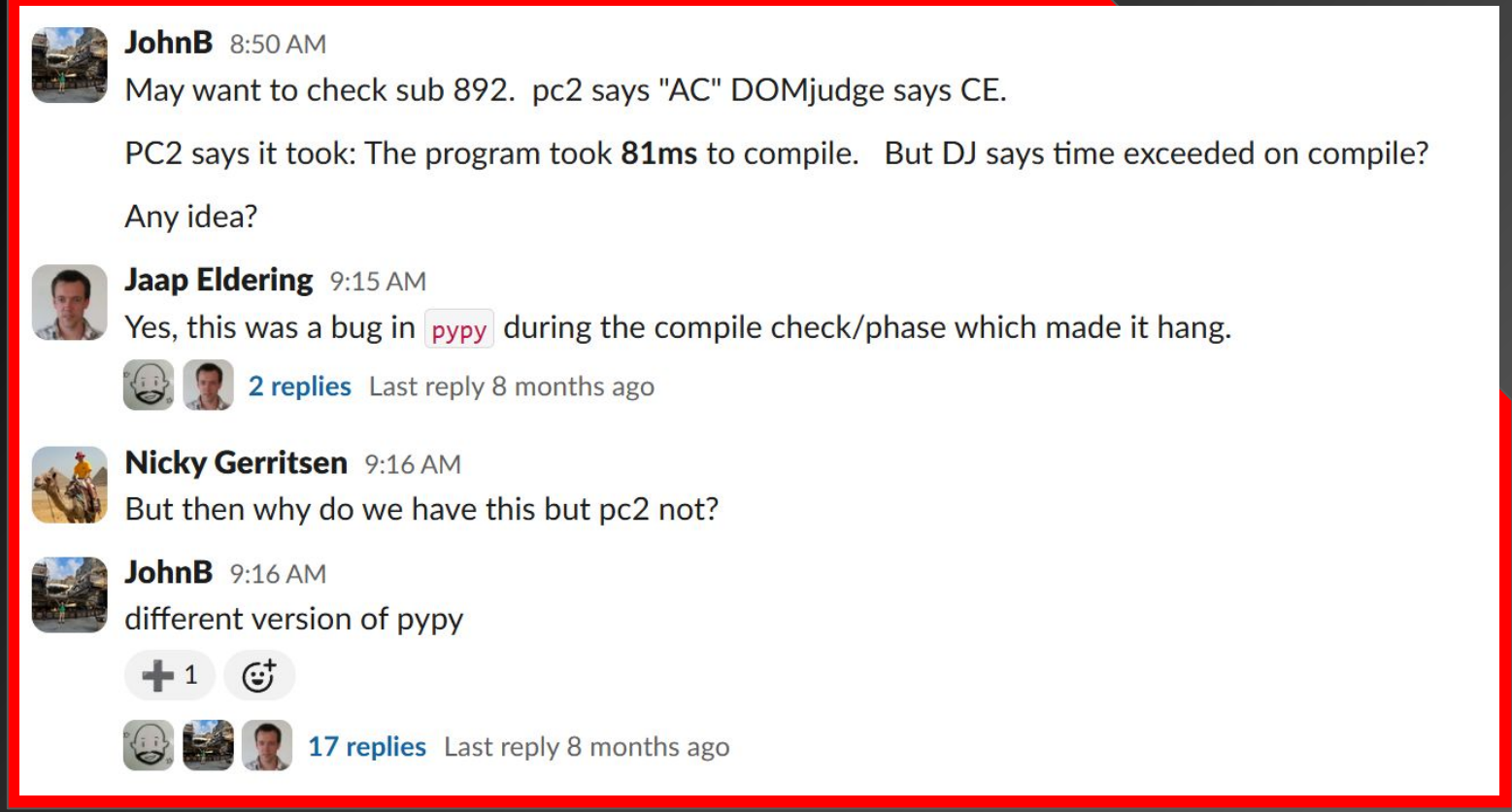
Event Feed Submission Example


```
{
   "id" : "521",
   "token" : "pc2-15075",
   "type" : "submissions"
   "data" : {
      "id" : "521",
      "language_id" : "cpp",
      "problem_id" : "circleofleaf",
      "team_id" : "46",
      "time" : "2025-05-26T13:24:06.654-04",
      "contest_time" : "03:36:00.693",
      "files" : [ {
            "filename" : "521.zip",
            "hash" : null,
            "href" : "contests/nac25/submissions/521/files",
            "mime" : "application/zip"
      } ]
   }
}
```

Event Feed Judgment Example


```
{
   "id" : "Run-60969086601404811143",
   "token" : "pc2-15076",
   "type" : "judgements",
   "data" : {
      "id" : "Run-60969086601404811143",
      "submission_id" : "521",
      "judgement_type_id" : "AC",
      "max_run_time" : 0.155,
      "start_contest_time" : "03:36:00.751",
      "end_contest_time" : "03:36:13.213",
      "start_time" : "2025-05-26T13:24:06.780-04",
      "end_time" : "2025-05-26T13:24:19.242-04"
   }
}
```

Example 1 - Software Versions



JohnB 8:50 AM

May want to check sub 892. pc2 says "AC" DOMjudge says CE.

PC2 says it took: The program took **81ms** to compile. But DJ says time exceeded on compile?

Any idea?

Jaap Eldering 9:15 AM

Yes, this was a bug in `pypy` during the compile check/phase which made it hang.

2 replies Last reply 8 months ago

Nicky Gerritsen 9:16 AM

But then why do we have this but pc2 not?

JohnB 9:16 AM

different version of pypy

➕ 1

17 replies Last reply 8 months ago

Example 2 - Hardware Differences

Thread

JohnB Oct 26th, 2024 at 9:38 AM

Run 1002. Close time limit. DJ says TLE, PC2 got WA. PC2 did not exceed time. it got wa at 9959ms (time limit is 10000ms). So, this could be hardware differences.

10 replies

Jaap Eldering Oct 26th, 2024 at 9:44 AM

Interesting. Here some of the testcases get killed at 15 seconds.

Let me resubmit and extend the timelimit overshoot for that to see how long it really takes. But it's definitely not close to the timelimit.

JohnB Oct 26th, 2024 at 9:46 AM

We got the WA at test case 4

(the first secret test case)
again, it could be hardware diffs.

I ran it a few more times and got some TLE's and some WA's on testcase 4. fyi

but it just trickled over the 10 second limit

Jaap Eldering Oct 26th, 2024 at 9:51 AM

I resubmitted and rejudged it at https://judge.bapc.eu/jury/submissions/1038?jid=1113 and test case 4 runs in 16.2 seconds here

I guess this can be attributed to hardware differences.

Example 3 - Parsing Libraries

Shadow Scoreboard Comparison

Current status: Scoreboards DO NOT match (1 of 50 rows mismatched)

PC2 Scoreboard

Rank	Team (Id)	Solved	Time
1	Segfault go BRRRR (6)	13	1468
2	Team Biem (44)	10	1202
3	They cheated ^^^^^^^^^^...	10	1773
4	cmake (38)	9	1018
5	W2 (40)	9	1113
6	S.L.O.N. (49)	9	1234
7	Friday volleyball (28)	9	1254
8	(ﾉ°□°)ﾉ (⊙_⊙') (■_■--) (22)	8	1309
9	ADA Refactor (48)	7	828
10	Rubber Duckie Debuggers (37)	7	884
11	A random triennial (2)	6	639
12	BinaryChurch (9)	6	695
13	Wormholes (17)	6	727
14	FC Puddlebee (11)	6	969
15	De Wasberen (3)	6	1010
16	Backedge boys (15)	6	1029
17	The Eastern Block (42)	6	1102
18	Central Processing Unit (29)	5	643
19	Stelling van Teleur (36)	5	690
20	Proof of Concept (14)	5	711
21	Kamicoders (27)	5	755
22	Cache Me If You Can (39)	5	1001
23	Ctrl-Alt-Succeed (26)	5	1048
24	aMUsed (50)	5	1048
25	Heerlie de programmeerlie (1)	4	229
26	Berg van abstractie (7)	4	243
27	Nope (57)	4	265
28	Plopkoek (58)	4	503
29	Hopefully Not Last (5)	4	507
30	CPUMONS (51)	4	524
31	Les fous du clavier (4)	4	562
32	SpaCatti Code (33)	4	585
33	Les Traversables (30)	4	657
34	Renske (13)	3	250
35	print(chr(sum(range(ord(min(...	3	257

Remote CCS Scoreboard

Rank	Team (Id)	Solved	Time
1	Segfault go BRRRR (6)	13	1468
2	Team Biem (44)	10	1202
3	They cheated ^^^^^^^^^^...	10	1773
4	cmake (38)	9	1018
5	W2 (40)	9	1113
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35	print(chr(sum(range(ord(min(...	3	257

Example 4 - Randomness

```c
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

int main()
{
        srand(time(NULL));

        if(rand()%5 == 2){
                printf("Yes!\n");
        } else {
                printf("No!\n");
        }

        return(0);
}
```

```c
#include <stdio.h>
#include <stdlib.h>
#include <sys/time.h>

int main()
{
   struct timeval tv;
   gettimeofday(&(tv), NULL);
   if((tv.tv_usec % 50) == 0){
       abort();
   }
   printf("This is the correct!\n”);
   return(0);
}
```

Example 5 - Testing CPU Speed

```
#include <stdio.h>
#define TEST_LIMIT      1000000000

int main()
{
        unsigned long long i = 0;

        while(i < TEST_LIMIT){
                // DoSomething();
                i++;
        }
        return(0);
}
```

Example 6 - I see nothing different

“Hello World.” != “Hello World."

Accepted

```
48 65 6c 6c 6f 20 57 6f  72 6c 64 2e 0a  |Hello World..|
```

Wrong Answer

```
48 65 6c 6c 6f 20 00 57  6f 72 6c 64 2e 0a |Hello .World..|
```

Summary

- What is shadowing?
- Why do we shadow?
- Folks involved:
  - WF Baku Primary CCS - PC^2 - Dr. John Clevenger, Troy Boudreau, Joe Terlizzi, Marc Furon, Samanway Sadhu, Kutay Karakaş, Doug Lane
  - WF Baku Shadow CCS - DOMjudge - Tobi Werth, Nicky Gerritsen, Jaap Eldering, Kevin Jilissen, Michael Vasseur, Mart Pluijmaekers, Daniel Brinkers

“This is why we shadow!”

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Q&A

Contact Information: John Buck
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Home Page: https://pc2ccs.github.io/

Really? They Missed *That??* (Unexpected Errors from Experienced Teams on Relatively "Easy" Problems)

Marc Furon
CLI ICPC Compete Track
2025-08-31

Surprises for the Southern California Judges

- Regional Contest teams have a wide range of experience, from first-time lower-division contestants to championship contenders
  - Problem sets reflect this:
    - Some problems are intended to be within the reach of first-time teams in the first year of study—expected to be solved by most teams
    - Others are somewhat harder, but are still expected to be solved by a majority of teams
  - Yet there have been several problems that the judges expected experienced teams to solve quickly on the first attempt—and teams missed something the judges thought they should have seen

Surprising Example #1

- 2018/2019 Southern California and Mid-Atlantic Regionals: ***"Backup Orphans"***
- Given a list of backup image names, and corresponding disk backup files, match the lists
  - Determine if there are "orphans"--image names with no backup files, or backup files with no corresponding image names
- Image names consist of 1 to 32 printable ASCII characters
- Backup file names are image names concatenated with time stamps and types
  - Time stamps are unsigned 31-bit integers
  - Types are 1 to 6 upper-case letters
  - Elements are separated by underscores
  - `backupimage-directoryA1_1234567890_FULL`

Problem Results

- In Southern California, out of 93 teams:
34 Accepted, 279 Rejected
4 Accepted on first attempt
- Most teams did not initially consider that image names of “printable ASCII characters” could include underscores, integer time stamps, and type strings!
- This problem was based on an incident in the presenter’s professional career: A customer had a very similar problem. The system vendor wrote a routine to do the matching, making the same error. The routine deleted production backup data!

Clarification Request

- At the four-hour mark, the following clarification request came in:
“Is underscore a printing character?”

Surprising Example #2

- 2009/2010 Southern California and Mid-Atlantic Regionals: ***"Parlay Wagering"***
- Calculate payments from a parlay wager at a "sports book", where a bettor places a wager on several outcomes all occurring—the wager only wins if no individual outcome loses
- The final payout is the compounded result of the amounts won—the amount won after one outcome becomes the wager for the next
- Each wager multiplier is truncated to three digits after the decimal point
- Amounts won are truncated to the cent after each outcome

Parlay Example

Money Line	Wager	Result	Multiplier	Multiplier Decimal	Amount Won
-170	$10.00	Win	100/170	0.588	$5.88
-160	$15.88	Win	100/160	0.625	$9.92
125	$25.80	Win	125/100	1.250	$32.25
-135	$58.05	Win	100/135	0.740	$42.95
-140	$101.00	Win	100/140	0.714	$72.11
				Total Returned	***$173.11***
Multiplier Decimal truncated to three digits after the decimal point					
Amount Won truncated to the cent for each wager					

Problem Results

- In Southern California, out of 62 teams:
17 Accepted, 218 Rejected
7 Accepted on first attempt
- Contestants tried various ways to handle the truncation rules…
- But only a few realized that this could best be done by scaling integers, avoiding floating-point!

Judges' Post-Problem Thoughts

- "Contestants apparently didn't know that money and floating-point don't mix."
--Steven Zeil, Retired Mid-Atlantic Chief Judge
- "One shouldn't be allowed to use floating-point without a license."
--Gary Roberts, Retired Southern California Judge

Concept Revisited

- 2023/2024 Southern California Regional: ***"Tontine Confusion"***
- Given investors with shares in an income-generating tontine, calculate per-share payouts each year, with the proviso that income that would go to investors who died gets distributed pro-rata among survivor shares
- Amounts are truncated to the cent
- 84 teams: 14 accepted, 69 rejected attempts, 5 accepted on first attempt
- First-place team solved it on the first attempt, as did tenth through twelfth
  - Interestingly, second through sixth-place teams all required multiple attempts

Surprising Example #3

- 2021/2022 Southern California Regional: ***"Ultimate Binary Watch"***
- Display a binary watch face in four vertical columns, with each column separated by single spaces and a blank middle column to separate hours from minutes

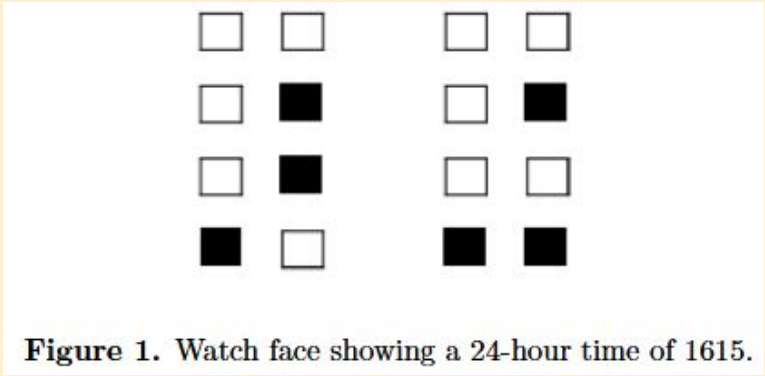


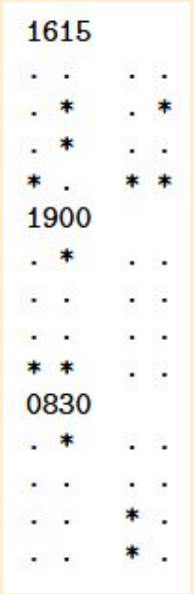
Figure 1. Watch face showing a 24-hour time of 1615.

Problem Results

- In Southern California, out of 48 teams (reduced due to the pandemic):
43 Accepted, 83 Rejected
12 Accepted on first attempt
- None of the top five teams solved the problem on the first attempt!
- Problem requires some basic formatting, lining up single-character columns with spaces in-between and an extra blank column in the middle
- While detailed formatting is often not expected for current problems, the judges did not expect lining up single-character columns to be an issue

Problem Sample Output

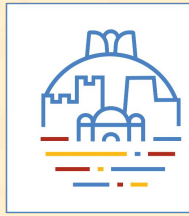
- Machine-readable sample output is provided
- A simple comparison (“diff”) would show clear differences



For Discussion

Given the discussions regarding “ICPC Curricula” and team preparation:

- What can coaches do to help (even experienced, generally high-performing) contestants avoid making preventable errors on relatively easy problems?
- Would addressing this mean contestants are better prepared not just at ICPC contests, but in their careers generally?



ICPC 2025
WORLD FINALS BAKU
HOSTED BY ADA UNIVERSITY

Don’t copy ideas - get inspired by them!

Mateusz Radecki

About me:

- You might know me as Radewoosh
- Since always connected with University of Warsaw (go Eagles!)
- “Nutella”, “Target”, “Golden Crown”
- Gold on IOI 2016 and ICPC 2019, won DCJ, 3rd on MHC
- Still in love with competitions and algorithms
- Terrible at making slideshows

What have I learned during my journey and want to share?

- Nobody is a genius
- People think differently
- How to practice (hopefully)

How to get better then?

Solve problems…

And possibly a few others, but that's a different topic…

Problem A

Given a tree, process queries about addition on a path or subtree and queries about finding maximum on a path or subtree.

Heavy-light decomposition!

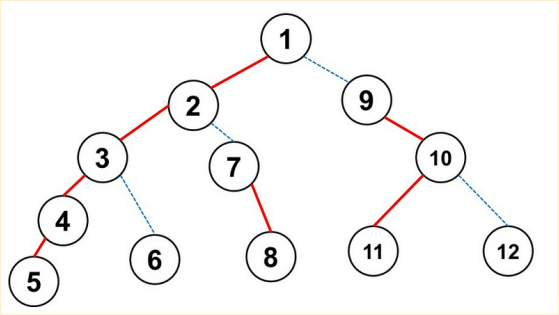


Image from AtCoder

What is a heavy-light decomposition?

- A tool to add and look for maximum on paths and subtrees?

Problem B

Given a tree, process queries about changing a value in a node and queries about finding gcd of values on a path or subtree.

Heavy-light decomposition!

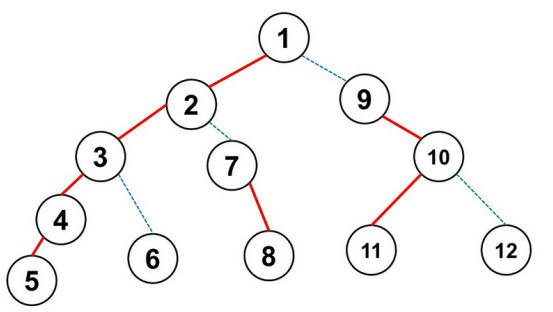


Image again from AtCoder

What is a heavy-light decomposition?

- A tool to add and look for maximum on paths and subtrees?
- A way to apply data structures to trees instead of arrays?

ICPC International Collegiate Programming Contest

The 2025 ICPC World Finals Baku

31 August – 5 September 2025 // hosted by **ADA University**

Problem C

Given a rooted tree with a permutation of numbers from 1 to n in the vertices, using at most O(n·log(n)) operations move each number to its corresponding vertex. In each operation you can take the value from the root and insert it into a vertex of your choice, thus making the rest of the path “shift” toward the root.

Heavy-light decomposition!

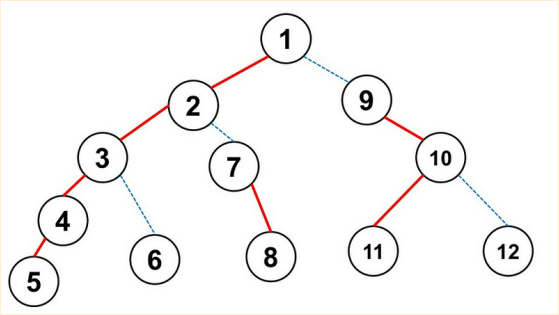


Image still from AtCoder

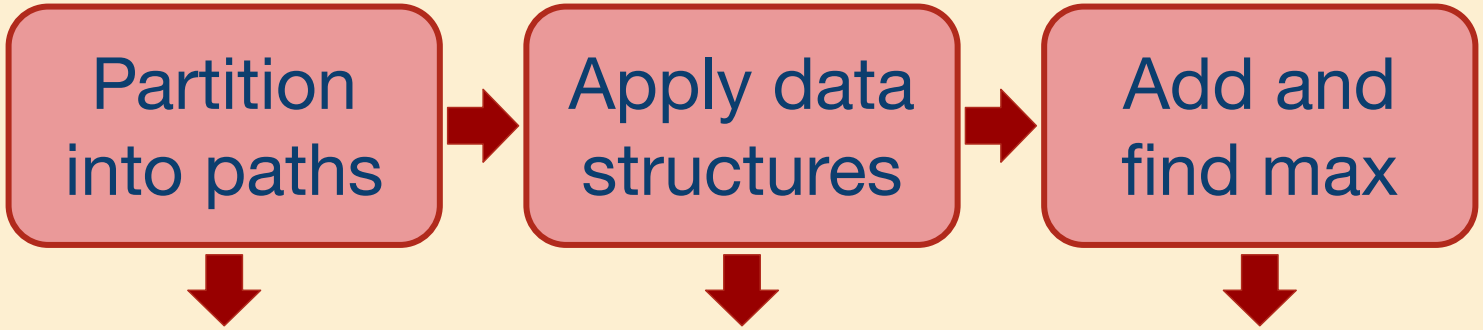
Hint: solve all paths with no children in Insertion Sort style in O(n) operations.

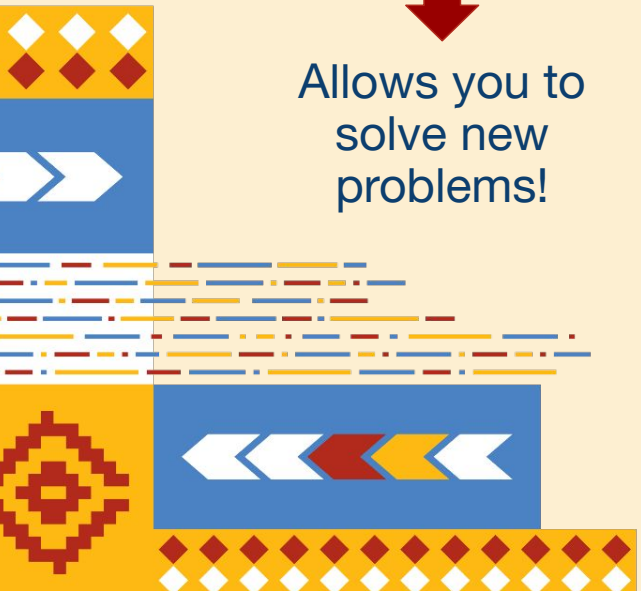
What is a heavy-light decomposition?

- A tool to add and look for maximum on paths and subtrees?
- A way to apply data structures to trees instead of arrays?
- A way to partition a tree into paths?

All of them!

Heavy-light decomposition

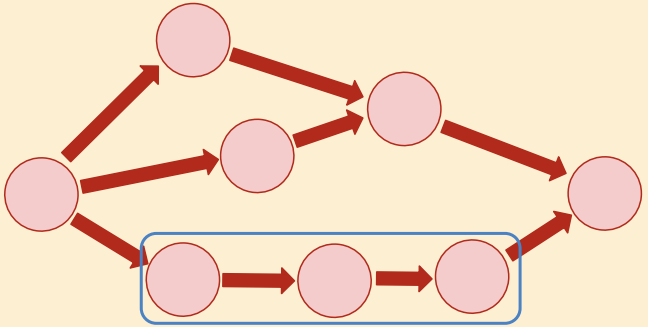




The meaning of the steps may be different each time!

~~Solution anatomy~~

“Coming up with a solution” anatomy



~~“Path Contraction”~~

“Subgraph Contraction”

Problem D

Given a and b compute a^b (possibly modulo some m).

“That’s easy, I know this one since high school!”

Problem E

Given k (which might be big) construct a graph (with the number of vertices way smaller than k) and exactly k independent sets.

???

Problem D

Given a and b compute a^b (possibly modulo some m).

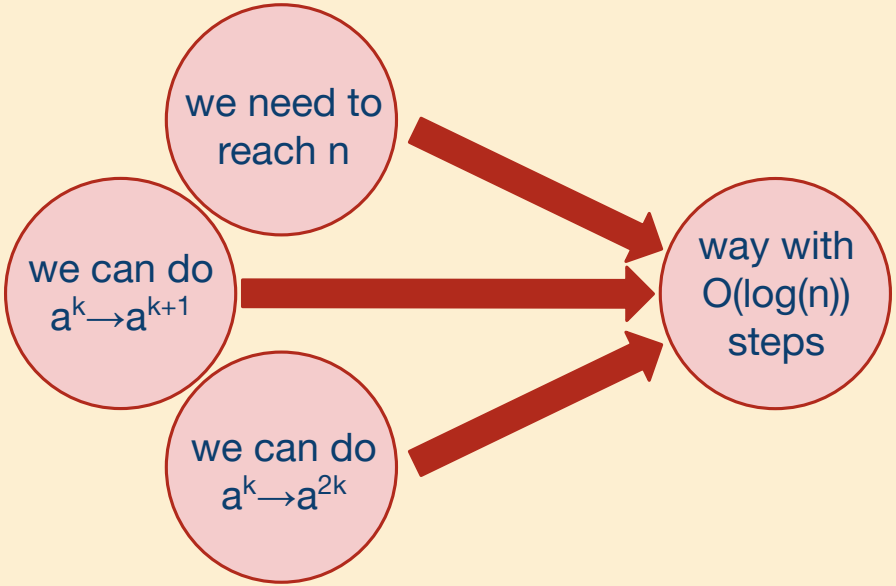
- We can compute something for k=0 (a^0).
- Having something computed for k we can compute it for k+1 ($a^k \to a^{k+1}$).
- Having something computed for k we can compute it for 2k ($a^k \to a^{2k}$).
- In a tricky manner we can compute it for any n in O(log(n)) steps.

Problem E

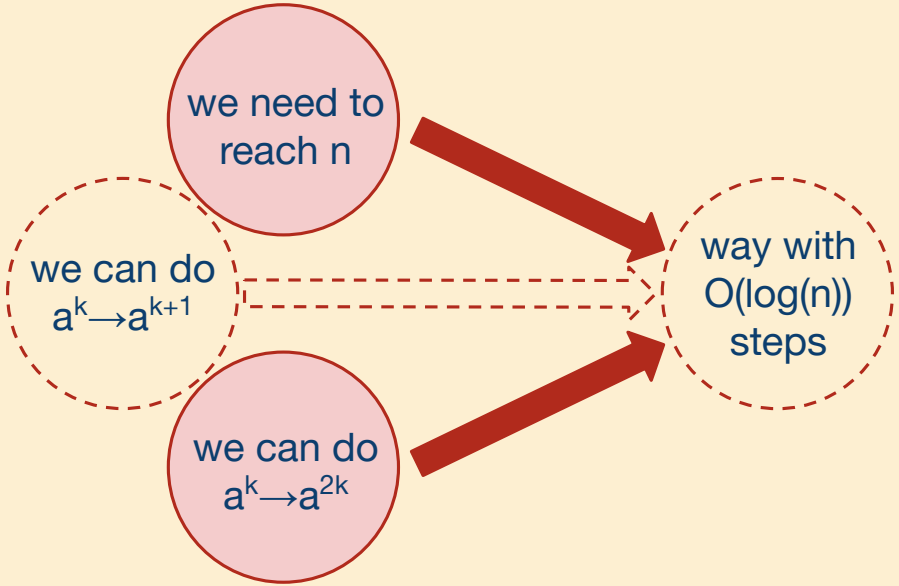
Given k (which might be big) construct a graph (with the number of vertices way smaller than k) and exactly k independent sets.

- Empty graph has one independent set.
- Adding an isolated vertex multiplies the number of independent sets by 2 (it can be in an independent set with anything else).
- Adding a vertex connected to everything adds one independent set (nothing else can be in an independent set with it).
- We need O(log(n)) vertices.

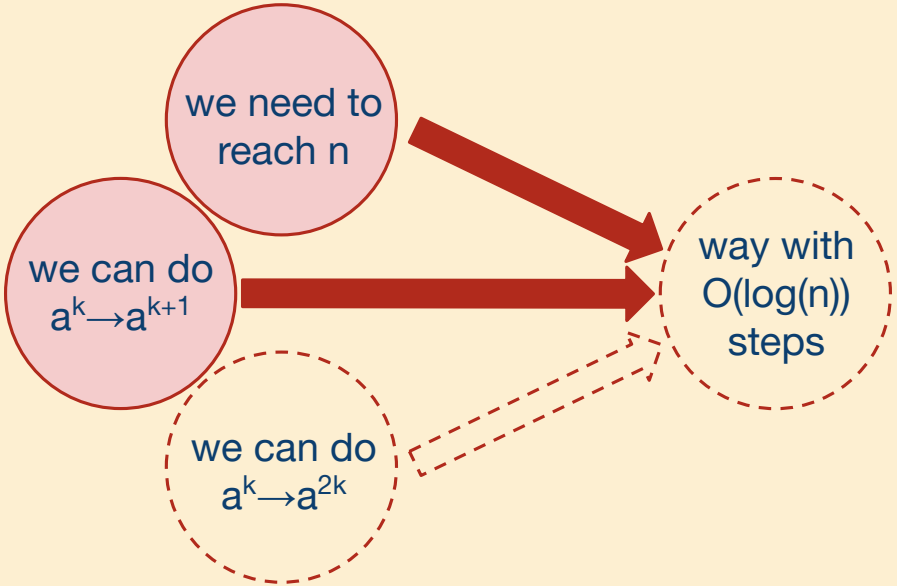
“Input Labeling”



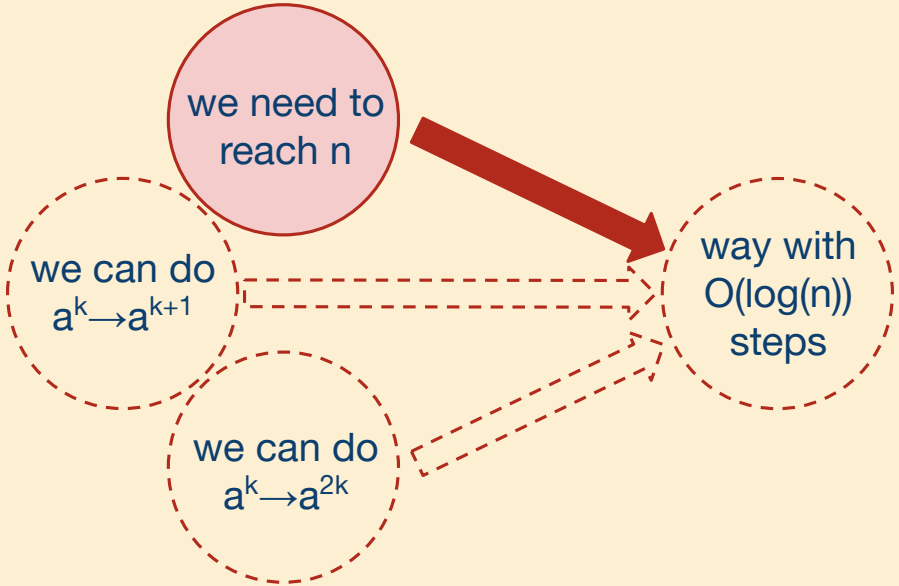
adding isolated vertex



adding vertex connected with everything



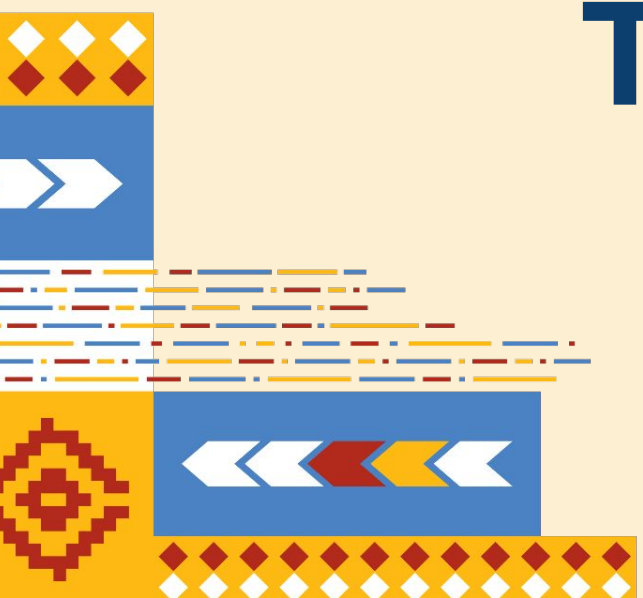
simply reading the problem



Don’t copy ideas - get inspired by them!

- No two problems will be the same, or at least they shouldn’t. 🙂
- Build a DAG of a way to come up with a solution to particular problem, which suits you.
- Actually spend time dedicated to the above. Ask yourself a question “what went wrong?”
- Easier to do it if you haven’t solved the problem, but don’t disregard it if you’ve solved it by yourself.
- Read the editorial, it might be different than your solution - authors post problems because they like them for some reason.
- “Subgraph contraction.”
- “Input labelling.”
- Practice practicing.
- Speak with others!

Thank you!



ICPC vs IOI

Tolga Can
Teaching Professor, Colorado School of Mines
Ryan Farrell
Associate Professor, Brigham Young University
Christian Yongwhan Lim
VP of Engineering, Arklex AI

Overview

- Introduction
- Overview of IOI
- Overview of ICPC
- Data

Overview (con't)

- Key Differences
- Guidelines for IOI Students Transitioning into ICPC
- Conclusions
- Acknowledgments

Introduction

- The ICPC and the IOI are two of the most esteemed competitions in the world of competitive programming.
- We provide a comprehensive comparison of the IOI and the ICPC focusing on:
  - structural differences,
  - target demographics, and problem-solving approaches

Introduction (con't)

- Present findings on various types of collected data
  - Contestant backgrounds
  - Score distributions
  - Topics

Overview of the IOI

- A pre-college level annual competition and is one of the major international science competitions such as the IMO and the IPhO.
- First IOI held in 1989 in Bulgaria
- Held once every year
  - No official feeder competitions like the ICPC; however, each delegation may have national/local competitions for team selection

Overview of the IOI (con't)

- 98 member countries and regions as of 2025
- Each country/regions has 4 contestants
  - Compete and awarded individually
  - No team ranking

IOI: Organization

- Several committees oversee the competition from hosting to problem selection to ensure success
  - International Committee (IC)
  - International Scientific Committee (ISC)
  - International Technical Committee (ITC)
- Decisions are made in the General Assembly comprised with one delegation member from each country
  - General Assembly meetings held during the contest week

IOI: Contest

- Held in two 5-hour each competition days with an excursion day in between
- Each contestant competes individually to solve 3 (or sometimes 4) problems per day → 300 pts/day
  - Closed books, only C++ STL reference manual
  - C++ solutions only
  - Problems have sub tasks → partial scoring possible

IOI: Contest (con't)

- Top **1/12th** are awarded **gold** medals (~25-30 students),
- The next **2/12th** are awarded **silver** medals (~50-60 students),
- The next **3/12th** are awarded **bronze** medals (~75-90 students),
- Honorable mentions are also given in the last couple of years.

IOI: Syllabus

- Overlaps mostly with the ICPC syllabus, but more defined boundaries compared to ICPC
- Notable exclusions:
  - Network Flow
  - 3D geometry
  - Voronoi diagrams, half space intersection
  - String algorithms and data structures (KMP, Rabin-Karp hashing, suffix arrays/trees, suffix automata, Aho-Corasick)

ICPC: Competition

- **World Finals Week**: Includes registration, practice, ceremonies, excursions, networking, and the ICPC CLI Symposium.
- **Contest Format**: 5-hour team-based algorithmic competition on one computer, no internet, using C/C++, Java, or Python.
- **Problem Set**: Curated and tested by judges pre-contest, covering topics like graphs, DP, data structures, geometry.

ICPC: Competition (con't)

- **Scoring System**: Real-time feedback, hidden test cases, and penalty-based ranking; no scoreboard in final hour.
- **Collaboration Focus**: Teams share one machine, use a 25-page TRD, and must coordinate efficiently under pressure.

ICPC: Syllabus

- **No Official Syllabus**: ICPC does not currently have an officially adopted syllabus.
- **Suggested Curriculum**: Developed by the ICPC Curriculum Committee to guide preparation and training.
- **Content Coverage**: Includes algorithms, data structures, problem-solving strategies, and mathematical foundations.

ICPC: Syllabus (con't)

- **Community-Driven**: Evolving based on feedback, field advancements, and committee discussions.
- **Future Outlook**: May become an official ICPC syllabus to support contestants, coaches, and educators globally.

ICPC: Statistics

- **Global Scale**: 50,000+ students from 3,000+ universities in 100+ countries compete annually.
- **Multi-Round Structure**: Starts with local/regional contests; ~140 top teams reach the World Finals (<1% of participants).
- **World Finals Stats**: 10–13 problems, fastest solves often under 10 minutes, record is 12 problems solved (ITMO, 2017).

ICPC: Statistics (con't)

- **Historical Highlights**: ICPC founded in 1970; hosted in 20+ cities; ITMO holds 7 titles—the most of any university.
- **Elite Competition**: Advancing teams are often regional winners or top global scorers, with some qualifying in under 2 hours.

ICPC: Data

- **Scoreboards and Results**
  - World Finals Scoreboards (from clist.by, 2011-2024, full scoreboards)
  - IOI Scoreboards (from clist.by, 2003-2024, full results for every problem)

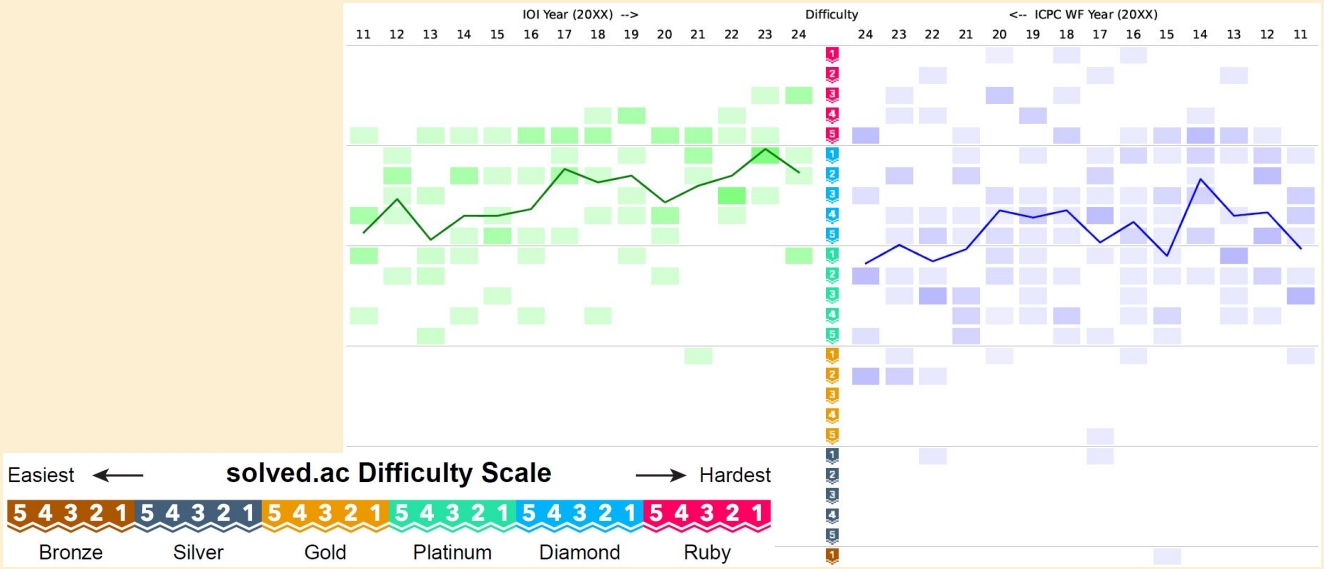
ICPC: Data (con't)

- **Teams and Profiles**
  - Teams and Profiles from cphof.org
  - For profiles that include codeforces (CF) or atcoder (AT) handles, we collected longitudinal data (every rating change), which allows rating calculation at the time of contest
- **Problems**
  - WF and IOI Problem difficulties and topics (from solved.ac)
- In the future we plan to integrate IMO and perhaps IPhO results, too

ICPC: Analysis - Key Differences

- Individual versus Team Based Competition
- Number of Problems and Partial Scoring
- Contest Environment

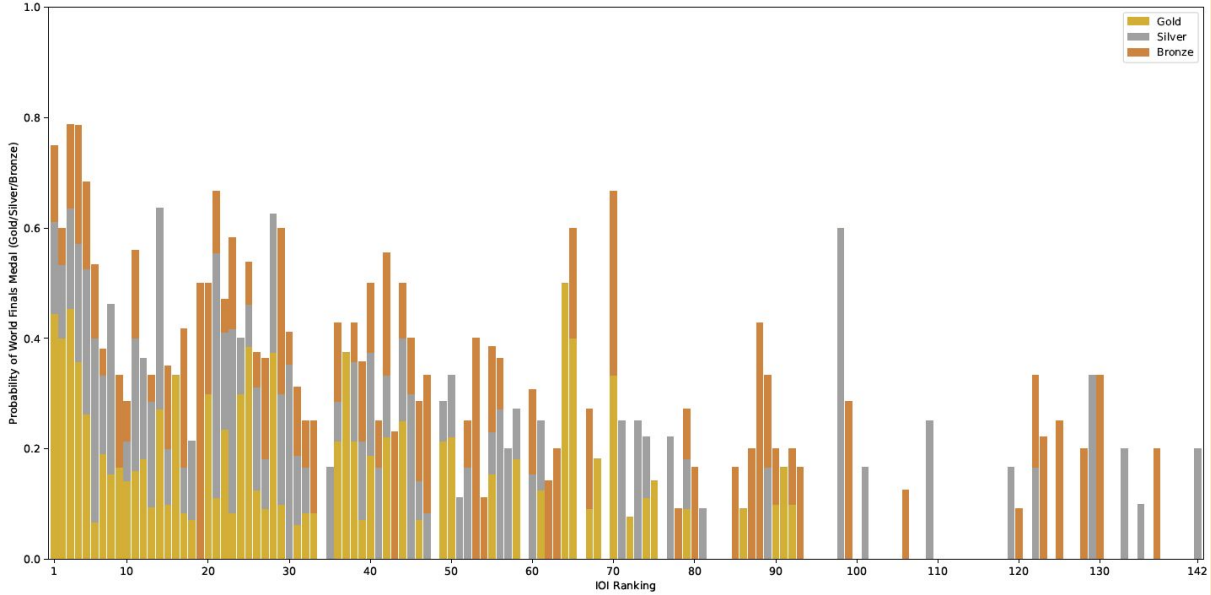
ICPC: Analysis - Problem Difficulty



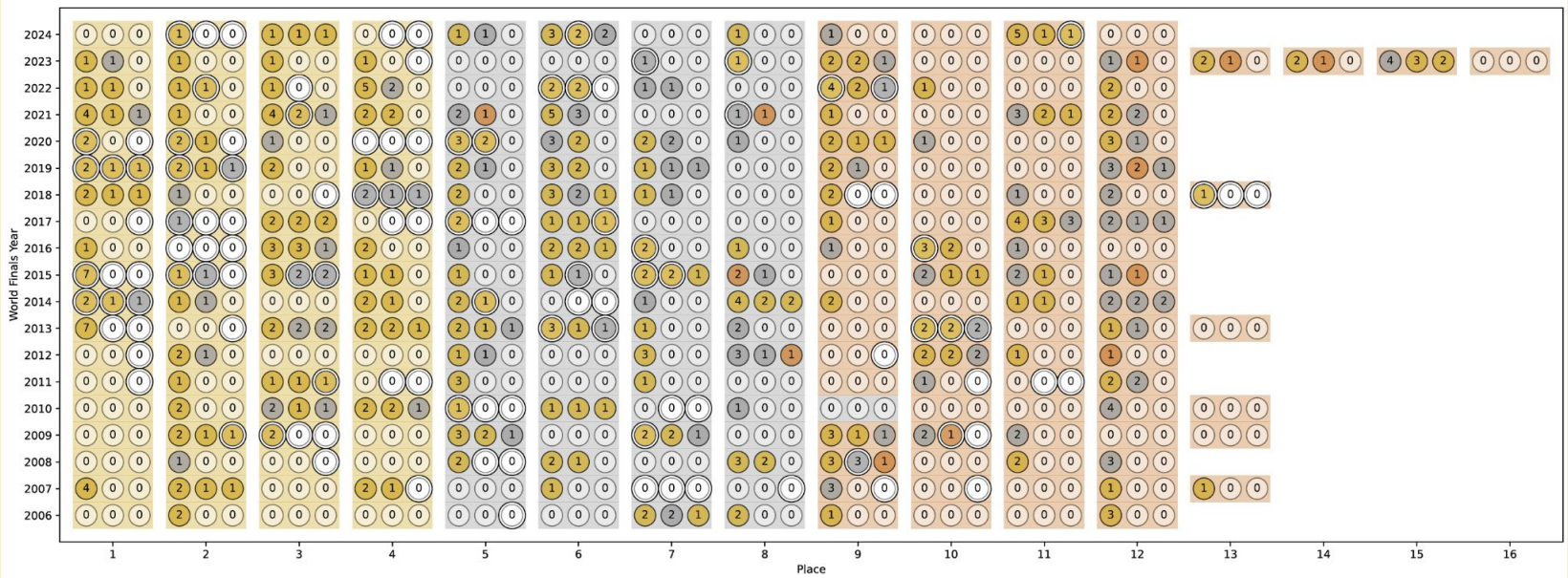
ICPC: Analysis - Topic Occurrence and Frequency

	IOI Year (20XX) -->														IOI/ICPC Frequency		<-- ICPC WF Year (20XX)											
	11	12	13	14	15	16	17	18	19	20	21	22	23	24			24	23	22	21	20	19	18	17	16	15	14	13	12	11
Graph Theory	2	2	1	1	1	1	3	1	2	3	2	1	2	2	14/14	12/14		1	2	4		4	4	1	3	2	3	3	5	2
Data Structures		3	3	3	2	1		3	4	3	4	2	2	4	12/14	12/14	1		1	2	2	3	2		3	2	4	1	2	1
Dynamic Programming		1	2	2	1	2	1			1	1	3	2	1	11/14	13/14		3	2	3	4	4	6	2	3	1	2	2	5	2
Mathematics	1			1						1	1	1			5/14	14/14	2	6	5	3	6	2	3	4	2	6	4	2	2	2
Greedy	1		2	2	2	1	1		2	1	1	1	2	2	12/14	14/14	1	2	1	2	2	2	2	2	4	2	3	1	1	2
Implementation	1	2	1					1	3	1			1	2	8/14	13/14	1	1	1	2	3	3	2	2	3	3		3	3	2
Ad-hoc		2		1	1		3	2	2	1	2	3	2	3	11/14	11/14	1	1	4		1	1	2	1	2	1	1	1		
Geometry						1		1							2/14	13/14		2	2	3	4	2	2	2	3	2	4	2	2	3
Binary Search	1		2		1	2	2	1			1	2	3	1	10/14	11/14	1			1	2	1		2	2	1	3	1	2	2
Graph Traversal	1	1	1				2	1	1	1	1	1	1		10/14	11/14		1	2	1		3	2	1	1	2	2	2		1
Segment Tree		1	2	2	2			3	1	1	1	2	1	2	11/14	9/14	1		1	1	2	1	1			1			1	1
Tree	1	2	1		1		1	3	1	1		1	2	1	11/14	6/14	1			2	2	1	2		2					
Sorting				1	1	1		1	1	1	1				7/14	9/14		1		2	2	1	2		2	1		2	1	
Bruteforcing																12/14	1	2	2	2	1	1	3	2	2			1	2	1
Sweeping								1	1				1		3/14	9/14					1	2	2	1	2	1		1	2	1
Prefix Sum	1					3	1		1		2	1	1	1	8/14	5/14					1	1	1		1					1
Constructive		1						2	2	1	1	2		2	7/14	5/14		1					1	1			1			1
Depth-first Search			1				1		1	1	1				5/14	8/14			1			2		1	1	1	1	1		1
Disjoint Set		1		1		1		1	1	1	2			3	8/14	1/14											2			
Case Work		1							1	2					3/14	8/14	2		1					1		1	1	1	1	1

ICPC: Analysis - IOI → ICPC Medalist



ICPC: Analysis - IOI → ICPC Medalist



Guidelines on IOI → ICPC

- Learn new topics that are not included in the IOI syllabus
  - String algorithms
  - Network flow
  - More geometry
  - Open ended questions

Guidelines on IOI → ICPC (con't)

- Learn how to work as a team
  - Utilize the strengths of team members in various areas:
    - Edge case finding
    - Typing fast
    - Debugging
    - Math, problem solving
- Learn how to best prioritize and multitask 12-13 problems compared to the 3 problems/day in the IOI

Conclusions

- **There is a lot to learn from both competitions**
  - How to train?
  - Problem types: interactive, output only, partial scoring
- **Contributions are welcome**
  - Challenge: World Final Ranking Prediction from CodeForces ratings

Acknowledgments

- We thank the granting organizations and the ICPC Executives, Judges, and Curriculum Committees for their invaluable feedback.

Thank you!

- **Reminder**: **ICPC Educate** on **Monday, September 1, 2025**!