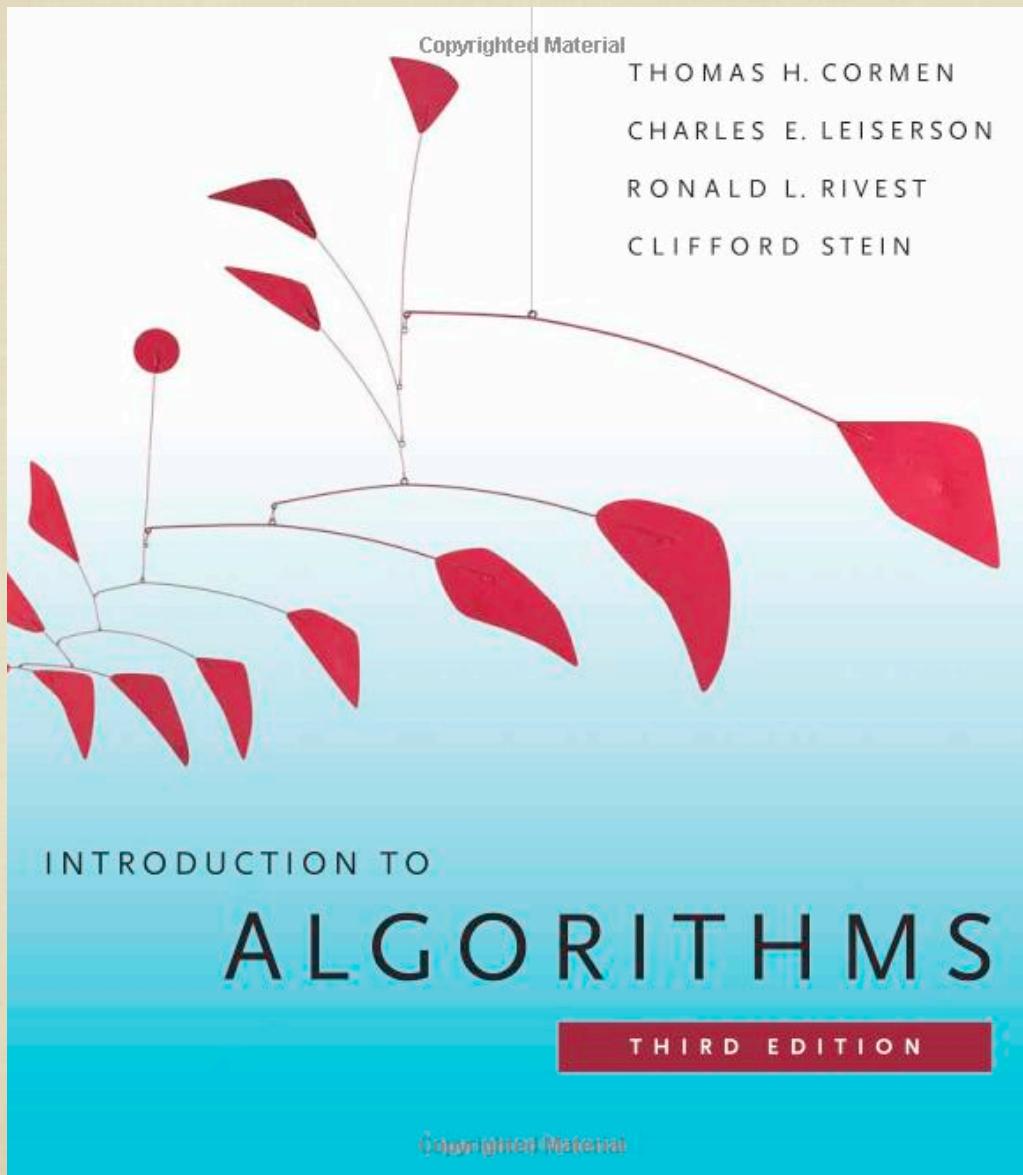


INFO1056
DESAFIOS DE
PROGRAMAÇÃO

PROF. JOÃO COMBA

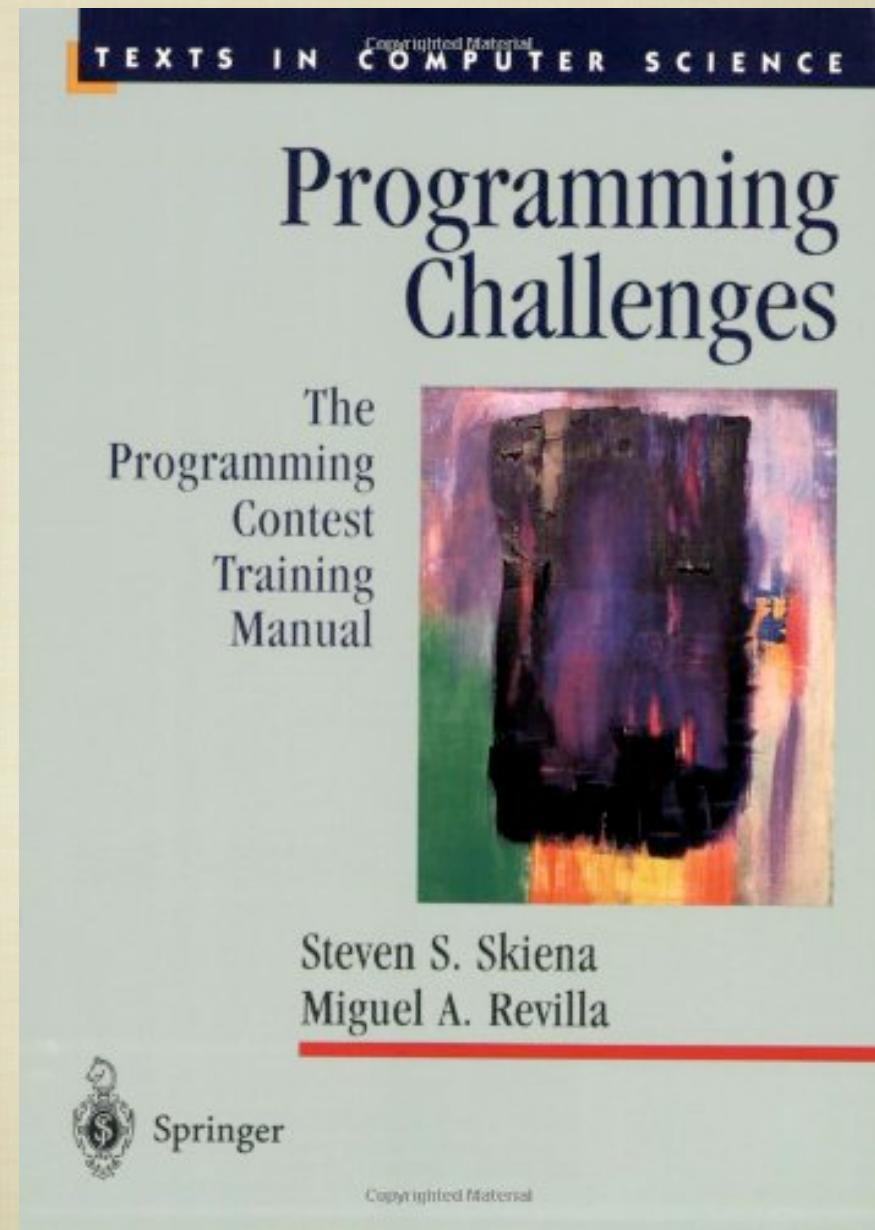
TÉCNICAS ALGORÍTMICAS



TÉCNICAS ALGORÍTMICAS

- **PROGRAMAÇÃO AVANÇADA:**

- PROBLEMAS GERAIS
- ESTRUTURAS DE DADOS
- STRINGS
- TEORIA DE NÚMEROS
- GRAFOS
- COMBINATÓRIA
- PROGRAMAÇÃO DINÂMICA
- BACKTRACKING
- GRIDS
- GEOMETRIA



TÉCNICAS ALGORÍTMICAS

- **COMPETITIVE PROGRAMMING:**
 - ESTRUTURAS DE DADOS E BIBLIOTECAS
 - PARADIGMAS DE RESOLUÇÃO DE PROBLEMAS (DC, GULOSO, DP)
 - GRAFOS
 - MATEMÁTICA
 - PROCESSAMENTO DE STRINGS
 - GEOMETRIA
 - TÓPICOS AVANÇADOS



SÚMULA DA DISCIPLINA

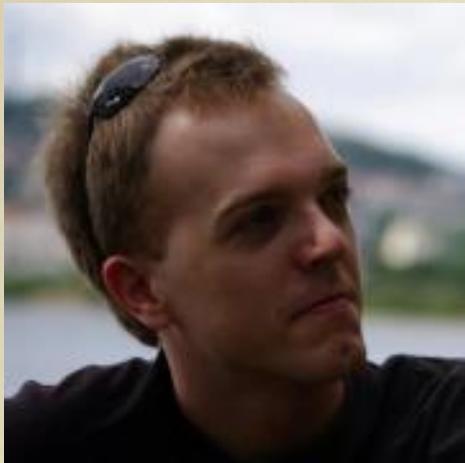
- moodle: inf01056
- código inscrição: inf01056-2012-1

PORQUÊ FAZER ESSA DISCIPLINA ?

- **RAZÕES DO ALUNO:**

- CONHECER PROFUNDAMENTE AS TÉCNICAS DE PROJETO DE ALGORITMOS E SEUS RESPECTIVOS ALGORITMOS
- EXPERIÊNCIA PRÁTICA DE IMPLEMENTAR ESTES ALGORITMOS
- MELHORAR SUA ESTRATÉGIA PARA RESOLUÇÃO DE PROBLEMAS E ESTIMULAR CRIATIVIDADE
- EVENTUAL PARTICIPAÇÃO EM MARATONAS CONTA NO CURRICULUM, E PODE ABRIR PORTAS PARA MELHORES EMPREGOS, E/OU POSIÇÕES ACADÊMICAS (MESTRADO OU DOUTORADO)

PORQUÊ FAZER ESSA DISCIPLINA ?



Luiz Scheidegger
Sw Engineering
Facebook



Daniel KO
PhD Student
New York University

muitos outros exemplos ...

PORQUÊ ENSINAR ESTA DISCIPLINA ?

- **RAZÕES DO PROFESSOR:**

- **ESTABELECER A UFRGS COMO CENTRO DE REFERÊNCIA NO ENSINO DE COMPUTAÇÃO**
- **FORMAR ALUNOS DE ALTA QUALIDADE COM FORTE FORMAÇÃO DE ALGORITMOS E PROGRAMAÇÃO**
- **MERCADO DE TRABALHO**
- **MESTRADO E OU DOUTORADO**
- **ESTE PROCESSO DE TREINAMENTO É EXTREMAMENTE GRATIFICANTE**

MOTIVAÇÃO ADICIONAL

- MARATONA:
 - 10-11 PROBLEMAS
 - 5 HORAS PARA RESOLVER (C, C++, JAVA)
 - TIMES DE 3 PESSOAS
 - 1 COMPUTADOR
 - SEM ACESSO A INTERNET E OUTRAS MÍDIAS
 - ACESSO A NOTAS PESSOAIS E LIVROS
 - IMPRESSORA DISPONÍVEL



MARATONA DE PROGRAMAÇÃO

- **COMO FORMAR TIMES ?**
- INTEGRANTES TEM QUE SABER TRABALHAR EM GRUPO
 - 3 PESSOAS TRABALHAM MELHOR QUE 1
- TODOS DEVEM CONHECER TODAS AS TÉCNICAS ALGORÍTMICAS E SABER RESOLVER PROBLEMAS NELAS
- PELO MENOS 1 ESPECIALISTA NO GRUPO EM CADA TÉCNICA ALGORÍTMICA
- LINKS: [HTTP://MARATONA.IME.USP.BR/PREPAREACAO08.HTML](http://MARATONA.IME.USP.BR/PREPAREACAO08.HTML)



MARATONA 2005



RESULTADOS 2005

#	Username	User Site	User	Solved	Problem Details	Total Time
1	TEAM11	1	ITA - IN THE CASE, IT IS	7	A:LARANJA(2/33) C:BRANCO(1/11) D:VERDEESCURO(2/215) E:AMARELO(1/143) F:AZUL(1/45) G:VERDECLARO(1/51) H:MARRON(1/93)	631
2	TEAM17	1	PUC-RIO LINK-EDISAMBA	7	A:LARANJA(3/104) C:BRANCO(1/10) D:VERDEESCURO(1/167) E:AMARELO(1/266) F:AZUL(3/42) G:VERDECLARO(2/94) H:MARRON(1/154)	937
3	TEAM6	1	IME-USP A	6	A:LARANJA(2/47) C:BRANCO(1/19) D:VERDEESCURO(2/121) E:AMARELO(1/-) F:AZUL(1/37) G:VERDECLARO(1/181) H:MARRON(2/260)	725
4	TEAM23	1	UFRN HDD1	6	A:LARANJA(2/60) C:BRANCO(1/9) D:VERDEESCURO(6/176) E:AMARELO(3/-) F:AZUL(2/88) G:VERDECLARO(2/162) H:MARRON(1/212)	867
5	TEAM25	1	DCC UFRJ FROST BYTE	5	A:LARANJA(1/57) C:BRANCO(1/10) F:AZUL(3/131) G:VERDECLARO(1/111) I:AZULMARINHO(1/216)	565
6	TEAM16	1	UNB =OD	5	A:LARANJA(4/97) C:BRANCO(1/16) D:VERDEESCURO(3/-) F:AZUL(2/38) G:VERDECLARO(2/156) H:MARRON(1/225)	632

MARATONA 2006



RESULTADOS 2006

#	Username	Site	User	Solved	Total Time	Problem Details
1	team34	1	PUC-Rio: Link-EdiSamba	9	1333	A(1/8) B(4/122) C(1/289) D(1/60) E(2/133) F(1/25) G(2/94) H(1/261) I(3/201)
2	team16	1	USP: A volta dos que não foram	7	1105	A(1/-) B(1/-) D(1/62) E(5/231) F(1/15) G(1/173) H(5/278) I(2/159)
3	team20	1	ITA - O que é Overflow?	6	847	A(1/14) D(1/65) E(8/275) F(1/23) G(1/212) I(1/118)
4	team18	1	DCC UFRJ De Marios World	5	895	A(2/14) B(4/-) D(1/101) E(9/294) F(1/26) I(1/280)
5	team6	1	UFRN HDD-1 O desafio final	4	269	A(1/10) B(4/-) C(1/-) D(1/57) E(2/-) F(1/32) I(2/150)
6	team21	1	UFRGS Veni Vidi Ducí	4	310	A(1/12) D(1/103) E(3/125) F(1/30) G(3/-)
7	team39	1	Instituto Militar de Engenharia: IME-RJ Atlântico	4	397	A(3/31) B(2/-) D(1/66) F(1/22) G(3/198) H(3/-)
8	team40	1	DCC UFRJ NOP	4	415	A(1/13) D(2/126) E(1/-) F(1/20) G(2/216)
9	team7	1	University of Campinas: IC-UNICAMP-paper	4	445	A(1/13) B(2/255) D(2/105) E(1/-) F(1/32) I(2/-)
10	team14	1	PUC-Rio: ProgramaSamba	4	466	A(1/10) B(1/-) D(1/93) F(1/29) G(5/254) I(2/-)



MARATONA 2007



MARATONA 2007



RESULTADOS 2007

#	User	Name	A	B	C	D	E	F	G	H	I	J	Total
1	team38	ITA - O que é Overflow?	 1/266		 2/47	 8/288	 1/166	 2/131	 1/85	 1/9	 1/136		8 (1308)
2	team49	IME-USP Who wants to code forever?			 1/93	 2/245	 1/216	 1/166	 1/53	 1/18	 5/177	3/-	7 (1088)
3	team1	IME-Atlântico			 2/74		2/-	 3/242	 2/224	 1/13	 2/178		5 (831)
4	team25	Unicamp GAP			 3/232	1/-	5/-	 3/235	 1/74	 3/43	 4/196		5 (960)
5	team33	DCC-UFRJ NOP			 6/185			 2/257	 2/208	 3/38	 2/283		5 (1171)
6	team42	PUC Rio Cnuth, Dijkstra & Edmonds			 2/117			7/-	 1/87	 1/19	 1/266		4 (509)
7	team47	UFPR Triforce			 4/152	4/-	8/-	 1/157	 2/112	 1/19	3/-		4 (530)
8	team20	UECE - Die aphthe schmerzen			 1/102			9/-	 3/163	 1/22	 2/227		4 (574)
9	team34	Unicamp NP-Rosa-Choque			 6/163		9/-		 3/119	 1/14	 2/264		4 (720)
10	team10	UFS Anuncie Aqui			 1/127			10/-	 3/157	 1/28	 8/230		4 (722)
11	team14	UECE - Camila, Tainara, Leonilia			 1/130			11/-	 3/155	 1/30	 9/298		4 (813)
12	team36	IME-USP O fim dos pesquisadores			 1/136	12/-		13/-	 1/77	 1/21	14/-		3 (234)
13	team48	UFRGS Veni Vidi Duci			 2/78		14/-		 2/142	 1/14	15/-		3 (274)
14	team35	UFES NULL			 2/80				 2/136	 1/24	16/-		3 (280)
15	team51	DCC-UFRJ YEP			 2/151	17/-			 1/141	 1/25	18/-		3 (337)

MARATONA 2008



MARATONA 2008



MARATONA 2008



MARATONA 2008



RESULTADOS 2008

#	User	Name	A	B	C	D	E	F	G	H	I	J	K	Total
1	team18	Prático, Cícero e Heitor	1/63		1/74	3/-	1/31	1/23	1/25		3/215	1/180		7 (651)
2	team33	Triforce	1/95		1/60	4/-	1/46	1/15	1/33	7/-		1/211		6 (460)
3	team07	YaThreeSobas	1/105		2/47		1/68	1/14	1/42	2/-		1/217		6 (513)
4	team15	NULL	1/136		1/76		1/35	1/12	2/49	1/-		2/269		6 (617)
5	team51	Posso ajudar?	3/154		1/115		1/75	1/16	1/29			2/255		6 (704)
6	team47	Time Limit Exceeded	1/104		5/227	1/-	1/54	1/13	1/17			1/243		6 (738)
7	team20	Guerreiros da Poli	1/233		1/120		1/64	1/24	2/16	2/-		2/260		6 (757)
8	team31	Tampureção	1/85		1/107	2/-	2/86	1/35	1/48			7/294	3/-	6 (795)
9	team36	EOL - End of List	3/109		1/156		2/141	1/29	1/49	3/-		2/280		6 (844)
10	team22	Merputação	1/107	4/-	1/77	3/-	1/28	1/11	1/43	2/-		4/-		5 (266)
11	team42	Deixa eu Sonhar	1/125		2/99	5/-	1/37	1/17	3/25		1/-	2/-		5 (363)
12	team10	Veni Vidi Duci	2/120		1/139		1/66	1/11	1/28	4/-		2/-		5 (384)

MARATONA 2009



RESULTADOS 2009

PLACAR

#	User	Name	A	B	C	D	E	F	G	H	I	J	K	Total
1	pvmova	UFPE - Pedro, Victorov e Mairova	7/63	1/33		1/44	1/163	1/187	1/157	2/115	1/54	1/19	1/76	10 (931)
2	anuncie	UFS - Anuncie Aqui	1/73	1/34	3	1/60	1/186	1/269	1/242	1/145	1/46	1/10	2/102	10 (1187)
3	grana	IME-USP - eh_muita_grana	1/98	1/14		1/113	1/74		3/226	1/293	1/71	2/26	1/72	9 (1047)
4	Carteado	ITA - Carteado	1/65	1/11		4/58	3/130		2/243	2/191	1/30	1/18	3/144	9 (1070)
5	samba	PUC-Rio - Dynasty of Samba	1/118	1/25		1/131	1/228		1/212	2/283	4/149	1/16	1/57	9 (1299)
6	IC_NO_Co mments	Unicamp - IC /*No Comments*/	1/59	1/22		4/113	3/205		1/201	4/-	1/30	1/12	1/122	8 (864)
7	luis	UFSC - Morte ao Luis Fernando	1/52	1/76		1/115	1/181		1/234		3/99	1/29	1/141	8 (967)
8	falha	PUC-Rio - Falha de SegmentoSamba	1/151	1/34		1/82	2/218		2/189		2/100	1/20	2/160	8 (1034)
9	IC_KMP	Unicamp - IC KMP	4/196	1/34		1/76	1/227		1/256	1/-	2/59	2/20	2/100	8 (1088)
10	kryptonITA	ITA - kryptonITA	2/163	2/83		4/110	7/201		4/233		1/110	1/9	2/154	8 (1363)

RESULTADOS 2009

1	sonhar	DCC-UFRJ - Deixa eu sonhar		2/128 1/36	1/161 2/133	4/-		1/65 1/17 3/84	7 (704)
1	sudo	UTFPR - sudo make a sandwich		1/99 1/54	1/210	3/239		1/122 1/13 1/149	7 (926)
1	Carcara	UFPE - Carcara		1/174 1/40	1/102 2/242			3/121 1/22 2/220	7 (1001)
1	sort	UERJ - Boa Noite, e Bom Sort		1/119 1/67	2/94 1/264			3/171 1/18 1/211	7 (1004)
1	zebra	IME-USP - So_se_der_zebra		3/149 2/58	1/138 5/291			1/76 1/25 1/176	7 (1053)
1	C_BEMOL	UFRGS - C-BEMOL		1/197 3/71	1/84 1/261			4/148 1/16 1/231	7 (1108)
1	Rumatoki o	UFCG - Rumatokio		1/135 2/80	1/256 1/214			2/227 1/20 2/202	7 (1194)
1	ballon	POLI - v.push_back(ballon)		1/189 1/17	1/69 1/210			1/122 1/34 2/-	6 (641)
1	ooo	DCC-UFRJ - o/o/o/		2/149 1/32	2/137	8/-		2/87 1/18 1/177	6 (660)
2	animouse os	UFMG aniMOUSES		3/129 1/55	2/224	2/-		1/89 1/19 1/206	6 (782)
2	sl	UFMS							6 (650)

RESULTADOS 2011



RESULTADOS 2011

#	User	Name	A	B	C	D	E	F	G	H	I	J	K	Total	
1	team27/1	UFPE - Challenge Accepted !	1/22	1/97			12/299		1/172	2/197	1/42	1/111	1/50	8 (1180)	
2	team23/1	ITA - Comp-Ele Error	1/47	2/128			5/-		1/228	1/69	1/35	1/96	1/11	7 (634)	
3	team22/1	UFCG - Modus Ponens Malditos	1/58	1/143					3/296	1/101	1/50	2/164	1/65	7 (937)	
4	team40/1	UFPR - * da Trypanossoma	1/25	2/175					1/-	1/95	1/36	1/157	1/23	6 (531)	
5	team17/1	UFRJ - double cheeseburger;	1/40	1/77						5/299	1/15	1/198	1/32	6 (621)	
6	team48/1	ITA - InkognITA	1/52	1/150						4/265	1/44	1/196	2/32	6 (819)	
7	team51/1	UFPE - Fulano, Beltrano e Sicrano	1/58	2/201						3/208	1/25	1/270	2/55	6 (905)	
8	team50/1	IME-USP - Up	1/19	5/-						1/135	1/31	1/95	1/55	5 (346)	
9	team12/1	UFRGS - GCV	1/58	2/-						1/124	1/41	2/192	1/18	5 (453)	
10	team29/1	Unicamp - Unicamp Alfa	1/46	1/217					9/-	1/24	1/126	2/28		5 (481)	
11	team37/1	UFG - Monkeys	1/56						3/209	1/24	1/-	1/45		4 (374)	
12	team3/1	IME-USP - ASA	2/175							1/106	1/62	1/-	1/32		4 (475)
13	team47/1	UECE - Colecionadores de Baloes	2/82						3/234	2/59	2/-	1/47		4 (512)	
14	team20/1	UFMG - FD*	3/145							1/115	1/273	1/36			4 (609)
15	team31/1	PUC-Rio - Pedrinhos e Luizinha + Samba	1/187							1/261	1/129	4/-	2/55		4 (646)
16	team5/1	UFSCar-Sorocaba - Platypus	1/35							3/-	1/70	2/-	1/19		3 (124)
17	team30/1	UERJ - O Grande Espaco em Branco	2/61	1/-							1/20	2/-	1/16		3 (127)
18	team38/1	UFU - Renegadores	2/27							7/-	2/59	3/-	1/66		3 (194)
19	team8/1	ICMC-USP - Dona Margarida	2/74	1/-						3/-	1/51		1/22		3 (197)
20	team4/1	UFAC - Androidos	1/32							5/-	1/103	2/-	1/71		3 (206)

RESULTADOS 2011



MUNDIAIS

Years

Year	Institution	Country
2011	Zhejiang University	China
2010	Shanghai Jiao Tong University	China
2009	Saint Petersburg State University of Information Technologies, Mechanics and Optics	Russia
2008	Saint Petersburg State University of Information Technologies, Mechanics and Optics	Russia
2007	University of Warsaw	Poland
2006	Saratov State University	Russia
2005	Shanghai Jiao Tong University	China
2004	Saint Petersburg State University of Information Technologies, Mechanics and Optics	Russia
2003	University of Warsaw	Poland
2002	Shanghai Jiao Tong University	China
2001	St. Petersburg State University	Russia
2000	St. Petersburg State University	Russia

MUNDIAL 2012 / POLÔNIA

ACM-ICPC World Finals

May 14-18

2012

Warsaw, Poland

hosted by the University of Warsaw



event
sponsor



[Video](#)

world finals ▾

- Schedule
- Activities
- Local Information
- World Finals Rules
- Video/Photo Coverage
- World Finals Results
- Past Problems
- ...

regionals ▾

- Regional Finder
- Upcoming Regionals
- Regional Results
- Regional Rules
- Getting Involved
- Starting a Regional
- Free ACM Membership
- ICPC Participation

compete ▾

- Preparation
- Policies & Procedures
- FAQs
- The Problems

community ▾

- ICPC Buzz
- IBM Sponsorship
- Upsilon Pi Epsilon
- ACM
- Fact Sheet
- History
- Contacts
- Credits

COMO FAZER UM BOM PAPEL NA MARATONA BRASILEIRA ?

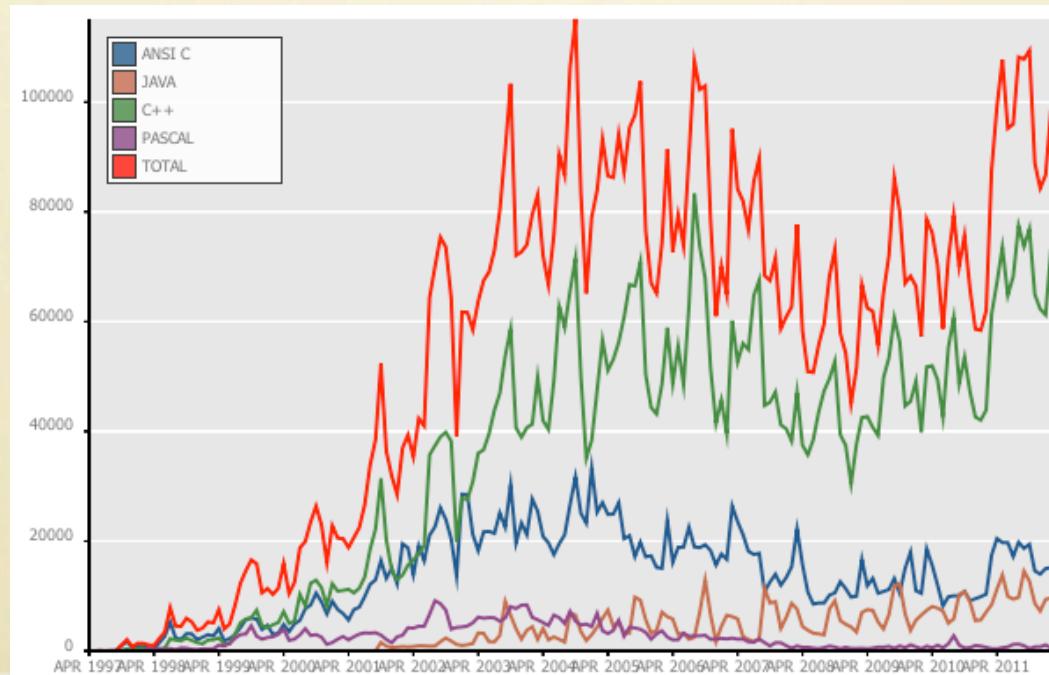
- **10 PRIMEIROS LUGARES ASSEGURAM MEDALHA**
 - 7-10: MEDALHA DE BRONZE
 - 4-6: MEDALHA DE PRATA
 - 1-3: MEDALHA DE OURO
- **1-2 LUGARES ASSEGURAM LUGAR NO MUNDIAL:
2008: FORAM 6 TIMES, 2009 FORAM 7 TIMES**
- **QUAL É O OBJETIVO ??**
 - 2 TIMES NA FINAL NACIONAL
 - 2 TIMES ENTRE OS 10
 - OURO ?

EXEMPLOS DE PROBLEMAS

- [HTTP://UVA.ONLINEJUDGE.ORG/](http://UVA.ONLINEJUDGE.ORG/)
- **2671 PROBLEMAS DISPONÍVEIS:**
- **CADASTRAR USUÁRIO:**
- **SUBMETER SOLUÇÕES EM C, C++, JAVA E PASCAL**

ESTATÍSTICAS

	Total	ANSI C		JAVA		C++		PASCAL	
1997	4031	3390	84.10%	0	0.00%	639	15.85%	2	0.05%
1998	42375	24697	58.28%	0	0.00%	13859	32.71%	3819	9.01%
1999	109202	44860	41.08%	0	0.00%	42226	38.67%	22116	20.25%
2000	199523	71895	36.03%	0	0.00%	95173	47.70%	32455	16.27%
2001	345305	124223	35.97%	3029	0.88%	187852	54.40%	30201	8.75%
2002	610151	227779	37.33%	13567	2.22%	305969	50.15%	62836	10.30%
2003	874762	282206	32.26%	37726	4.31%	481173	55.01%	73657	8.42%
2004	998194	279821	28.03%	41387	4.15%	607279	60.84%	69707	6.98%
2005	1050528	275220	26.20%	64898	6.18%	662432	63.06%	47978	4.57%
2006	999155	221526	22.17%	61752	6.18%	684062	68.46%	31815	3.18%
2007	914504	208229	22.77%	64815	7.09%	619607	67.75%	21853	2.39%
2008	730266	148037	20.27%	66985	9.17%	507514	69.50%	7730	1.06%
2009	782065	150784	19.28%	80082	10.24%	543717	69.52%	7482	0.96%
2010	828697	135284	16.32%	89154	10.76%	592933	71.55%	11326	1.37%
2011	1104715	201236	18.22%	118430	10.72%	776199	70.26%	8850	0.80%
2012	219737	37620	17.12%	22253	10.13%	158022	71.91%	1842	0.84%
Total 9813210 2436807 24.83% 664078 6.77% 6278656 63.98% 433669 4.42%									



RESULTADOS DO JUIZ

- # Accepted (AC) - Congratulations!
- # Presentation Error (PE) - Check for spaces, left/right justification, line feeds, etc.
- # Accepted (PE) - Your program has a minor presentation error, but the judge is letting you off with a warning. Stop here and declare victory!
- # Wrong Answer (WA) - Your program returned an incorrect answer to one or more secret test cases.
- # Compile Error (CE) - The compiler could not figure out how to compile your program. The resulting compiler messages will be returned to you. Warning messages are ignored by the judge.
- # Runtime Error (RE) - Your program failed during execution due to a segmentation fault, floating point exception, or similar problem. Its dying message will be sent back to you. Check for invalid pointer references or division by zero.
- # Submission Error (SE) - You did not correctly specify one or more of the information fields, perhaps giving an incorrect user ID or problem number.
- # Time Limit Exceeded (TL) - Your program took too much time on at least one of the test cases, so you likely have a problem with efficiency.
- # Memory Limit Exceeded (ML) - Your program tried to use more memory than the judge's default settings.
- # Output Limit Exceeded (OL) - Your program tried to print too much output, perhaps trapped in a infinite loop.
- # Restricted Function (RF) - Your source program tried to use an illegal system function such as fork() or fopen(). Behave yourself.

C STANDARD INPUT/OUTPUT

```
#include <stdio.h>
int main() {
    long a, b, c;
    while (scanf("%ld %ld", &a, &b) != EOF) {
        if (b > a) c = b-a; else c = a-b;
        printf("%ld\n", c);
    }
    return 1;
}
```

C++

STANDARD INPUT/OUTPUT

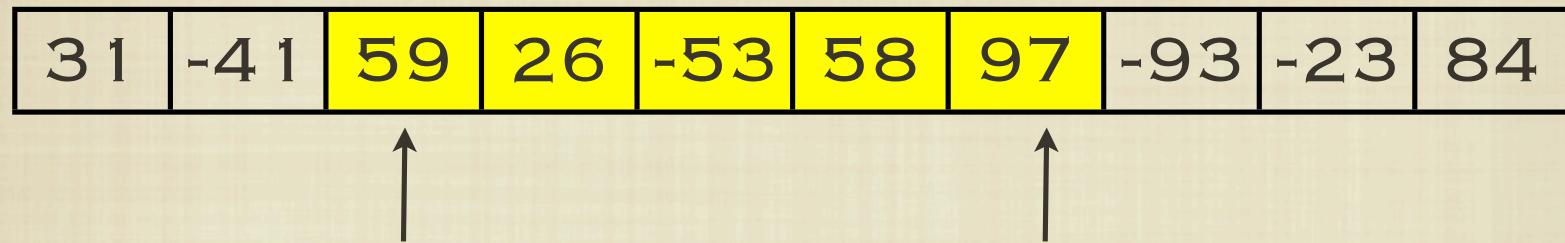
```
#include <iostream>
using namespace std;
int main() {
    long long a, b, c;
    while (cin >> a >> b) {
        if (b > a) c = b-a; else c = a-b;
        cout << c << endl;
    }
    return 1;
}
```

EXEMPLOS

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----

- QUAL É A MÁXIMA SOMA ENCONTRADA EM SUB-VETOR CONTÍGUO DESTE VETOR ?
- ASSUMIR SE TODOS NÚMEROS FOREM NEGATIVOS QUE A SOMA VALE O

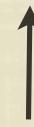
EXEMPLOS



- QUAL É A MÁXIMA SOMA ENCONTRADA EM SUB-VETOR CONTÍGUO DESTE VETOR ? **187**

EXEMPLOS

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----



- QUAL É A MÁXIMA SOMA ENCONTRADA EM SUB-VETOR CONTÍGUO DESTE VETOR ? **187**
- **COMO PROGRAMAR A SOLUÇÃO ?**

ENTRADA E SAÍDA

ENTRADA:

1

10

31 -41 59 26 -53 58 97 -93 -23 84

SAÍDA:

2 6 187

SOLUÇÃO 1

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----

```
maxsofar = 0;  
for (i=0; i<n; i++)  
    for (j=i; j<n; j++) {  
        sum = 0;  
        for (k=i; k<=j; k++) sum += x[k];  
            // sum contains sum of x[i..j]  
        maxsofar = max(maxsofar, sum);  
    }
```

SOLUÇÃO 1

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----

```
maxsofar = 0;  
for (i=0; i<n; i++)  
    for (j=i; j<n; j++) {  
        sum = 0;  
        for (k=i; k<=j; k++) sum += x[k];  
            // sum contains sum of x[i..j]  
        maxsofar = max(maxsofar, sum);  
    }
```

$O(N^3)$

SOLUÇÃO 2

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----

```
maxsofar = 0;  
for (i=0; i<n; i++)  
    sum = 0;  
    for (j=i; j<n; j++) {  
        sum += x[j];  
        // Sum is sum of x[i..j]  
        maxsofar = max(maxsofar, sum);  
    }
```

SOLUÇÃO 2

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----

```
maxsofar = 0;  
for (i=0; i<n; i++)  
    sum = 0;  
    for (j=i; j<n; j++) {  
        sum += x[j];  
        // Sum is sum of x[i..j]  
        maxsofar = max(maxsofar, sum);  
    }
```

$O(N^2)$

SOLUÇÃO 3

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----

```
cumarr[-1] = 0; // needs to be fixed !
for (i=0; i<n; i++)
    cumarr[i] = cumarr[i-1] + x[i];
maxsofar = 0;
for (i=0; i<n; i++)
    for (j=0; j<n; j++) {
        sum = cumarr[j]-cumarr[i-1];
        // sum is sum of x[i..j]
        maxsofar = max(maxsofar, sum);
    }
```

SOLUÇÃO 3

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----

```
cumarr[-1] = 0;  
for (i=0; i<n; i++)  
    cumarr[i] = cumarr[i-1] + x[i];  
maxsofar = 0;  
for (i=0; i<n; i++)  
    for (j=0; j<n; j++) {  
        sum = cumarr[j]-cumarr[i-1];  
        // sum is sum of x[i..j]  
        maxsofar = max(maxsofar, sum);  
    }
```

$O(N^2)$

SOLUÇÃO 4

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----

A

B

SOLUÇÃO 4

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----



SOLUÇÃO 4

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----



SOLUÇÃO 4

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----

```
float maxsum(int l, int u) {  
    if (l > u) return 0;  
    if (l == u) return (max(0, x[l]));  
    m = (l+u)/2;  
    lmax = sum = 0;  
    for (i = m; i>= l; i--) {  
        sum += x[i];  
        lmax = max(lmax, sum);  
    }  
    rmax = sum = 0;  
    for (i = m+1; i<=u; i++) {  
        sum += x[i];  
        rmax = max(rmax, sum);  
    }  
    return max(lmax+rmax, maxsum(l,m), maxsum(m+1,u));  
}
```

O(N LOG N)

SOLUÇÃO 5

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----



```
maxsofar = 0;                                I  
maxendinghere = 0;  
for (i=0; i<n; i++) {  
    maxendinghere = max(maxendinghere + x[i], 0);  
    maxsofar = max(maxsofar, maxendinghere);  
}
```

O(N)

SOLUÇÃO 5

31	-41	59	26	-53	58	97	-93	-23	84
----	-----	----	----	-----	----	----	-----	-----	----



```
maxsofar = 0;                                I  
maxendinghere = 0;  
for (i=0; i<n; i++) {  
    maxendinghere = max(maxendinghere + x[i], 0);  
    maxsofar = max(maxsofar, maxendinghere);  
}
```

O(N)

RESOLVER PROBLEMAS