INTRO TO COMPETITIVE PROGRAMMING

WORKSHOP #1

MONDAY, MARCH 25TH • 5:00 - 6:30 PM

Lower Napier – LG21

WHO'S HERE?

Everyone is going to have slightly different experience

- No programming experience?
- Currently doing IP?
- Currently doing Matlab?
- Current doing OOP?
- Finished OOP?

WORKSHOP STRUCTURE

Intro to Competitive Programming Talk

~45 Minutes

- *What is Competitive Programming?*

- *What is the ACPC?*

- *How do I write/submit a program?*

- *What competitions are there?*

- *How do I learn more?*

Workshop and Solving Problems

~45 Minutes

- *Chance to submit first competitive programming solutions*

- *Get to know HackerRank*

- *Learn basic c++ and competitive programming skills*

WHAT IS COMPETITIVE PROGRAMMING?

Competitive Programming is about working together in a team to solve challenging programming problems within a time limit

(but it's fun I promise)

Problem C
Candy Sales
Time limit: 8 seconds

Cathy's favourite candy brand is releasing n new flavours of candy: one new flavour on each of the next n days. A pack of candy flavour i (the new flavour released on the ith day) will cost w_i dollars on the day that it is released, but in order to encourage customers to try the new flavours, each candy flavour increases in price by one dollar on each day after it has been released. Precisely, on day $j \geq i$, a pack of the candy flavour released on day i costs

$$w_i + (j - i)$$

dollars.

Source: By Tiia Monto, CC BY-SA 3.0

Cathy wants to buy exactly one pack of candy on each one of the next n days and wants to get the most candy for her money. Calculate the price of the cheapest pack of candy available on each of the next n days. There is an unlimited number of packs of each flavour of candy and each flavour is available on the day of its release and all subsequent days.

Input

The input consists of two lines. The first line contains an integer n ($1 \leq n \leq 200\,000$), which is the number of flavours. The second line contains n integers $w_1, w_2, ..., w_n$ ($1 \leq w_i \leq 100\,000$), where w_i is the initial price of the ith candy flavour in dollars.

Output

Display n integers, the ith of which is the price of the cheapest pack of candy that Cathy can buy on day i.

Sample Input 1	Sample Output 1
4 3 6 7 4	3 4 5 4

Sample Input 2	Sample Output 2
4 22 22 28 24	22 22 23 24

COMPETITION RULES

- Compete in teams of three people

- One computer per team

- Can bring in as many hand-written or printed notes as you like

- Can use a variety of different programming languages (eg. C++, Java and Python)

- Not allowed to use the internet (apart from accessing the programming language documentation)

Scoreboard South Pacific ICPC Divisional Finals 2018

final standings

▽ (filtered on affiliation)

RANK		TEAM	SCORE		A	B	C	D	E	F	G	H	I	J	K	L
1	🇦🇺 ♡	**stinkypete** The University of Adelaide	11	1591	1/94	0	1/163	2/113	2/15	1/70	1/23	1/84	1/137	3/292	1/208	3/272
2	🇦🇺 ♡	**TensorMellow** The University of Adelaide	10	1336	1/79	0	2/259	1/55	1/22	1/37	1/64	3/161	1/210	2/193	2/156	0
3	🇦🇺 ♡	**3SpacesPerTab** The University of Adelaide	8	1201	5/293	0	1/202	1/56	1/15	1/21	1/39	0	1	3/288	1/167	0
4	🇦🇺 ♡	**stdbits** The University of Adelaide	3	128	1	0	0	1	2/59	1/26	1/23	0	0	1	3	0
5	🇦🇺 ♡	**The Re-attempters** Flinders University	3	137	0	0	0	2	1/27	1/46	1/64	2	0	0	0	0
6	🇦🇺 ♡	**Counting From Zero** Flinders University	3	620	0	0	0	0	3/127	1/141	2/292	0	0	0	0	0
7	🇦🇺 ♡	**TwoForOne** Flinders University	2	336	0	0	0	0	4/115	3/121	1	6	0	0	0	0
7	2 / 1	SUMMARY	40		8/3	0/0	4/3	7/3	14/7	9/7	8/6	12/2	3/2	9/3	7/3	3/1

CLUB ACTIVITIES

So what do we do at the ACPC?

- Contests and Programming Competitions
    - We run practice contests such as the ANZAC rounds
    - We work with companies to run company-oriented competitions
    - We prepare for the ICPC

- We organise industry events

- We run workshops (for both new and advanced programmers)

- We organise mock interviews

QUESTIONS?

LETS WORK THROUGH A PROBLEM

Given an array of integers, find the sum of its elements.

For example, if the array $ar = [1, 2, 3]$, $1 + 2 + 3 = 6$, so return 6.

Input Format

The first line contains an integer, n, denoting the size of the array.

The second line contains n space-separated integers representing the array's elements.

Constraints

$0 < n, ar[i] \leq 1000$

Output Format

Print the sum of the array's elements as a single integer.

Sample Input

```
6
1 2 3 4 10 11
```

Sample Output

```
31
```

Explanation

We print the sum of the array's elements: $1 + 2 + 3 + 4 + 10 + 11 = 31$.

COMPETITIVE PROGRAMMING C++ TEMPLATE

```cpp
#include <bits/stdc++.h>

using namespace std;

int main() {
    // solution comes here
}
```

INCLUDING LIBRARIES

Regular C++ Way

```cpp
#include <iostream>
#include <string>
#include <vector>
#include <algorithm>
...
```

Competitive Programming Way

```cpp
#include<bits/stdc++.h>
```

READING INPUT

```
int a, b;
string x;
cin >> a >> b >> x;
```

```
123 456 monkey
```

```
123     456
monkey
```

READING INPUT

```
6
1 2 3 4 10 11
```

```cpp
int n;
cin >> n;

int vals[n];
for (int i = 0; i < n; i++) {
    cin >> vals[i];
}
```

WRITING OUTPUT

```
int a = 123, b = 456;
string x = "monkey";
cout << a << " " << b << " " << x << "\n";
```

MULTIPLICATION WOES

```cpp
int a = 123456789;
int b = a * a;
cout << b << endl; //-1757895751
```

MULTIPLICATION WOES

```
int a = 123456789;
long long b = a * a;
cout << b << endl; //-1757895751
```

MULTIPLICATION WOES

```cpp
long long a = 123456789;
long long b = a * a;
cout << b << endl; //15241578750190521
```

MULTIPLICATION WOES

```cpp
long long a = 123456789 * 123456789;
cout << a << endl; //-1757895751
```

MULTIPLICATION WOES

```cpp
long long a = 123456789LL * 123456789LL;
cout << a << endl; //15241578750190521
```

C++ BASIC DATA TYPES

Data Type	What it stores
int	An integer between $-2*10^9$ and $2*10^9$
long long	An integer between $-9*10^{18}$ and $9*10^{18}$
float	A decimal number usually with about 7 decimal digits
double	A decimal number usually with about 15 decimal digits
string	Any text, e.g. the work "monkey"
Arrays (e.g. int[100])	Fixed size list used to store a bunch of the same data type together
Vectors(e.g. vector<int>)	Dynamically sized list used to store a bunch of the same data type together

IF, WHILE AND *FOR*

```cpp
int x = 5;
if (x < 10) {
    cout << "x is less than 10" << endl;
}
else if (x < 20) {
    cout << "x is between 10 and 20" << endl;
}
else {
    cout << "x is greater than 10" << endl;
}
```

```cpp
int x = 5;
while (x < 10) {
    cout << "x is currently " << x << endl;
    x++;
}
```

```cpp
for (int x = 0; x < 10; x++) {
    cout << "x is currently " << x << endl;
}
```

```cpp
#include <bits/stdc++.h>

using namespace std;

int main() {

    int n;
    cin >> n;

    int vals[n];
    for (int i = 0; i < n; i++) {
        cin >> vals[i];
    }

    int total = 0;
    for (int i = 0; i < n; i++) {
        total += vals[i];
    }
    cout << total << endl;

    return 0;

}
```
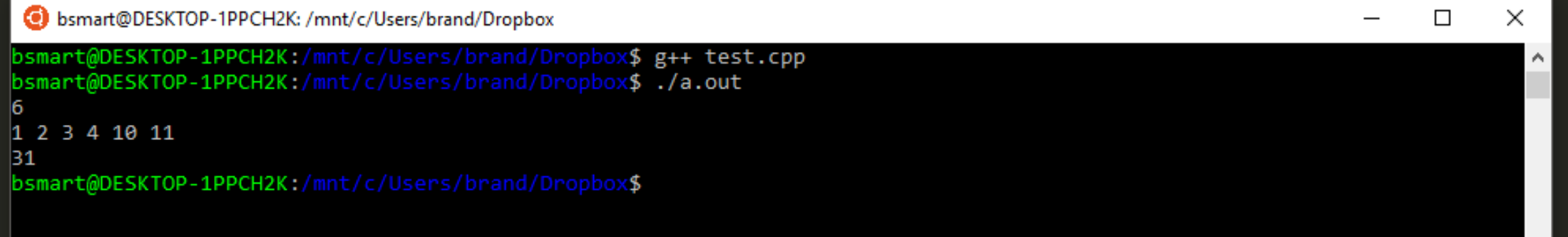
COMPILING/RUNNING

```
g++ -std=c++11 -O2 -Wall test.cpp -o test
```

QUESTIONS?

COMPLEXITY

input size	required time complexity
$n \leq 10$	$O(n!)$
$n \leq 20$	$O(2^n)$
$n \leq 500$	$O(n^3)$
$n \leq 5000$	$O(n^2)$
$n \leq 10^6$	$O(n \log n)$ or $O(n)$
n is large	$O(1)$ or $O(\log n)$

RESOURCES

Competitive Programmer's Handbook

by Antti Laaksonen

https://cses.fi/book/book.pdf

Cracking the Coding Interview

by Gary Laakmann McDowell

WEBSITES

HackerRank

https://www.hackerrank.com

As well as...

TopCoder	Coderbyte
LeetCode	Codewars
Codeforces	UWA: pcs.org.au
CodeChef	GeeksForGeeks
AtCoder	Project Euler

COMPETITIONS

- The major competitive programming event for university students is the International Collegiate Programming Contest (ICPC)
  - Practice rounds for this competition are called ANZAC rounds, and will run throughout the year (tune into Facebook for notifications)
  - The ICPC has Divisional Finals, Regional Finals and World Finals

- We (the ACPC) also regularly host independent events (again tune into Facebook)

- Online programming contests are also held regularly by Codeforces, AtCoder, CS Academy, HackerRank, Topcoder and others

NEXT COMPETITION

ANZAC Round #1 was last Saturday...

But Join Us For:

ANZAC Round #2

Saturday, 13st April (probably)

(Tune into Facebook)

Maptek are also on campus on Wednesday so join us for that

QUESTIONS?

WORKSHOP QUESTIONS

HackerRank

https://www.hackerrank.com

(we recommend writing each problem from scratch)

Questions for C++ newbies:

- Solve Me First, Simple Array Sum, A Very Big Sum, Plus Minus, Birthday Cake Candles

Questions for First Years:

- Sock Merchant, Electronics Shop, Birthday Chocolate, Picking Numbers, Strange Advertising

Questions for Non-First Years (Difficult):

- Forming a Magic Square, Sherlock and Valid String, Non-Divisible Subset, Bigger is Greater

```cpp
#include <bits/stdc++.h>

using namespace std;

int main() {

    int n;
    cin >> n;

    int vals[n];
    for (int i = 0; i < n; i++) {
        cin >> vals[i];
    }

    int total = 0;
    for (int i = 0; i < n; i++) {
        total += vals[i];
    }
    cout << total << endl;

    return 0;

}
```

NEXT WORKSHOP

Next Workshop Will Be On:

Sorting, Searching and Data Structures

Notifications about the when and where of that event will be on Facebook