13th Annual

WiCS Programming Competition

2017 Problem Set

Team Bonus Question:

Who was the first computer programmer?

Tell a WiCS volunteer the correct answer and receive an *extra raffle ticket* for each team member!

Look out for a page of trivia questions in each of your swag bags—the first person to get all questions correct wins a copy of *Cracking the Coding Interview*!

1 - Chandelier Shopping

Ada Lovelace wants to buy a chandelier, but doesn't know how many layers she can afford. The first layer has 1 crystal, and each layer above has 1 crystal more than the layer below it. A chandelier costs $100 per crystal.

Given a number of layers, tell Ada Lovelace the price of the chandelier and display what the chandelier would look like, representing each crystal as '$' (shown in the examples below).

Constraints

$3 \leq \text{Input} < 2^{32}-1$
Input is an integer.

Example 1.1

Input

```
6
```

Output

```
Price: $2100
$!$!$!$!$!$
 $-$-$-$-$
  $!$!$!$
   $-$-$
    $!$
     $
```

Example 1.2

Input

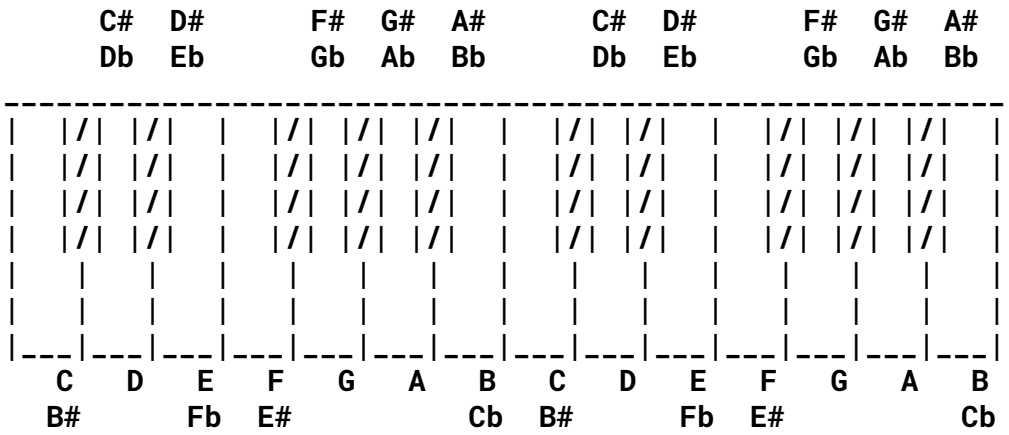
```
3
```

Output

```
Price: $600
$!$!$
 $-$
  $
```

2 - Chord Quality

Shafi Goldwasser is transcribing one of her favorite songs on her 2-octave keyboard, shown below, each note labelled with all of its acceptable note names.



She knows that a *half step* is the interval between two adjacent notes, whether they are black or white. F#-G is a half step, as is B-C.
She also knows that a *chord* is a series of 3 notes with one of four qualities:

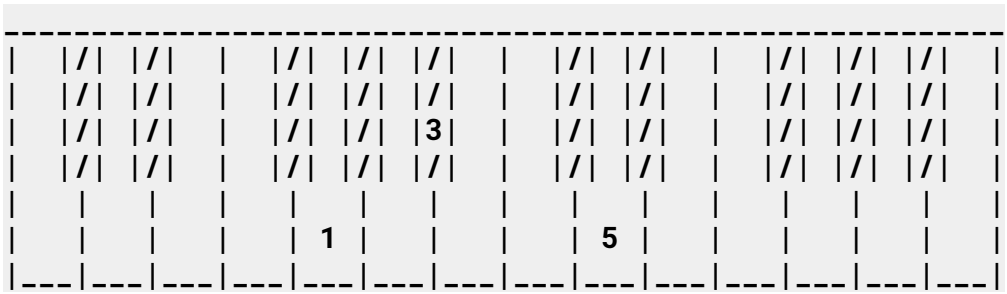
Quality	1st interval	2nd interval	Examples (Spellings)	
Major	4 half steps	3 half steps	D-F#-A	B-D#-F#
Minor	3 half steps	4 half steps	E-G-B	C-Eb-G
Augmented	4 half steps	4 half steps	C-E-G#	E-G#-B#
Diminished	3 half steps	3 half steps	G-Bb-Db	A-C-Eb

For the *spellings* of each chord, the alphabetic names of each note in the chord must be two letters away from the next note (A is one letter from G). In a few instances two distinct spellings are correct for a chord.
The chord *name* is the name of the 1st note in a correct spelling and the abbreviated quality. C Min and Bb Maj are chord names, as are G Aug and C# Dim.

Shafi Goldwasser hears a chord and plays it on her keyboard. Given the 2-octave keyboard with her finger placements (1 on the 1st note, 3 on the 2nd note, and 5 on the 3rd note), tell her the spelling and the corresponding name of the chord. If two spellings are correct, either is accepted.

Example 2.1

Input

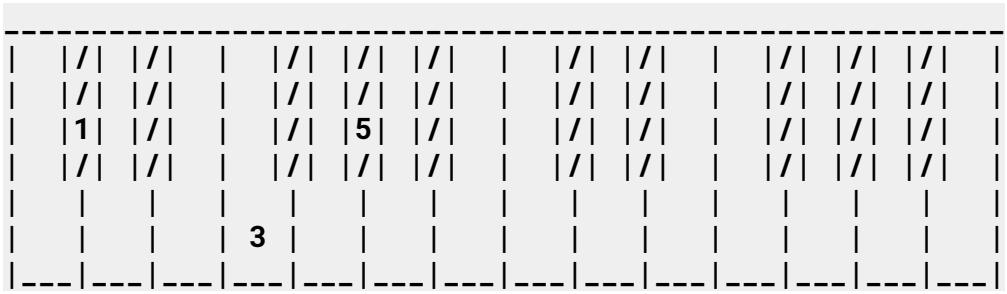


Output

```
G-Bb-D
G Min
```

Example 2.2

Input



Output A

```
C#-E#-G#
C# Maj
```

OR

Output B

```
Db-F-Ab
Db Maj
```

3 - Binary Bias

Hedy Lamarr is starring as the Number 1 in an upcoming Wild West movie where all the characters are Numbers. According to the script, the order the Numbers can enter the Saloon is determined by their *loaded-binary order*. Loaded-binary order is determined by sorting the Numbers by the least number of "1"s in each Number's binary representation, then sorted numerically for Numbers that share the same number of "1"s.
The Saloon also will hold exclusive events where only a certain range of Numbers of a certain increment can attend.

Hedy Lamarr is curious which Numbers should line up and in what order for scenes involving these exclusive events. Given a range (inclusive) and in increment starting at the first Number, tell her the order of all Numbers that can attend.

Constraints

For Input: `A`, `B`, `C`
$0 \leq A < B < 2^{32}$
$0 < C$
`A`, `B`, and `C` are integers.

Example 3.1

Input

```
0,20,1
```

Output

```
0 1 2 4 8 16 3 5 6 9 10 12 17 18 20 7 11 13 14 19 15
```

Reference (not included in Output)

Binary Representations of Numbers:

```
00000 - 0     00111 - 7     01110 - 14
00001 - 1     01000 - 8     01111 - 15
00010 - 2     01001 - 9     10000 - 16
00011 - 3     01010 - 10    10001 - 17
00100 - 4     01011 - 11    10010 - 18
00101 - 5     01100 - 12    10011 - 19
00110 - 6     01101 - 13    10100 - 20
```

Example 3.2

Input

```
0,22,3
```

Output

```
0 3 6 9 12 18 21 15
```

Reference (not included in Output)

Binary representations of numbers:

```
00000 - 0       01001 - 9       10010 - 18
00011 - 3       01100 - 12      10101 - 21
00110 - 6       01111 - 15
```

4 - Quicker Keyboard

Grace Hopper is playing her favorite video game, and it asks her to name her character, using the following keyboard of symbols to enter input:

_	'	-	p	y	f	g	c	r	l
a	o	e	u	i	d	h	t	n	s
↑	q	j	k	x	b	m	w	v	z

where "↑" is the Shift key which switches all alphabetic symbols to capital letters until the next key is pressed.

The following buttons on her controller allow her to navigate and choose symbols:

1. D Pad right - move right one symbol
2. D Pad left - move left one symbol
3. D Pad up - move up one symbol
4. D Pad down - move down one symbol
5. Button A - append current symbol to name

The keyboard wraps horizontally and vertically (so pressing D Pad right on "`s`" moves to "`a`" and pressing D Pad up of "`f`" moves to "`b`"), and the current position always starts on "_" in the upper left hand corner.

Grace Hopper wonders whether her intended character name can be typed by pressing at most a certain number of buttons. Given a name and a number of button presses, tell her "`Possible`" if the name can be typed within the number of button presses or "`Not Possible`" if the name must use more than the given number of button presses.

Constraints

The name contains only characters found on the keyboard (including capital letters).
$0 <$ length of name ≤ 180
$0 <$ number of button presses ≤ 10000
The number of button presses is an integer.

Example 4.1

Input

```
Shenandoah
50
```

Output

```
Possible
```

Example 4.2

Input

```
Lord_Reginald_Protector_of_the_Brickyard_Realm
100
```

Output

```
Not Possible
```

5 - Pins and Prudence

Megan Smith's latest hardware project involves connecting a number of pins to each other using wire. Wire can only go straight from one pin to another. Only some of the pins need to be wired together, while the other pins are not affected by being wired or not. When properly wired, all needed pins should be connected.

Megan Smith has a strict budget for wire. Given a list of needed pins, a list of other pins, and a list of lengths of each possible wiring in centimeters between two pins, tell Megan Smith the minimum amount of wire she needs to buy in centimeters to the nearest tenth.

Constraints

The pin names are denoted by distinct capital letters.
`0` < number of pins ≤ `26`
`0` < each length ≤ `500`
`0` < number of lengths ≤ `325`

Example 5.1

Input

```
Needed: A,B,C,D,E,F
Other: G,H,I,J,K
Lengths: (A-B 2),(C-D 2),(E-F 2),(A-G 2.2),(B-G 2.2),(C-H 2.2),(D-H
2.2),(E-I 2.2),(F-I 2.2),(B-C 9),(D-E 9),(F-A 9),(A-J 4),(B-J 4),(C-J
4),(D-J 4),(E-J 4),(F-J 4),(A-K 3),(B-K 3.5),(G-H 5),(H-I 5),(I-G
5),(G-J 3),(H-J 3),(I-J 3)
```

Output

```
22.2
```

Example 5.2

Input

```
Needed: B,I,R,D
Other: W,A,T,C,H
Lengths: (W-T 502.33),(W-R 305.77),(W-I 256.22),(W-H 654.88),(W-D
401),(W-C 543.11),(W-B 343.22),(W-A 622.55),(T-R 256.22),(T-I
305.77),(R-I 502.33),(R-D 622.55),(R-A 401),(I-C 343.22),(I-B
543.11),(H-D 343.22),(H-B 401),(D-B 654.88),(D-A 305.77),(C-B 256.22)
```

Output

```
1306.21
```

6 - Frustrating Fractions

Margaret Hamilton came across an interesting type of fraction expansion:
Let b_0, b_1, b_2,..., b_n be integers with $b_k > 0$ for $k > 0$. The *continued fraction expansion* of order n with coefficients b_1, b_2,..., b_n and the initial term b_0 is defined by the following expression:

$$b_0 + \cfrac{1}{b_1 + \cfrac{1}{b_2 + \ldots + \cfrac{1}{bn}}}$$

which is abbreviated as $[b_0; b_1, \ldots, b_n]$.

Margaret Hamilton wants to know the expansion of different rational numbers. Given a numerator and a denominator of a rational number, tell her the abbreviated continued fraction expansion of that number such that $b_n > 1$.

Constraints

For Input: `A B`
$0 < A, B \leq 100$
`A` and `B` are integers.

Example 6.1

Input

```
1 2
```

Output

```
[0;2]
```

Example 6.2

Input

```
43 19
```

Output

```
[2;3,1,4]
```

7 - Hitori Help

Sheryl Sandberg really enjoys playing *Hitori*, a Japanese grid puzzle of the same genre as Sudoku, but instead of filling in numbers, the player solves the puzzle by blackening out numbers to meet the following criteria:

1. A given row or column will have at most one of a given number.
2. No black squares are next to each other horizontally or vertically.
3. All white squares are connected via a horizontal/vertical path.

Help Sheryl Sandberg solve the next puzzle! Given a length and a grid of numbers, return the grid with "`X`"s in place of the blackened out numbers.

Constraints

The puzzle has a unique solution.
The puzzle is square.
`0` < each number in the puzzle ≤ length of puzzle < `10`
All numbers given are integers.

Example 7.1

Input

```
6
2 1 2 6 3 4
3 2 4 1 4 5
5 2 2 3 1 2
3 4 3 5 5 1
1 2 3 4 6 2
4 6 5 2 5 3
```

Output

```
2 1 X 6 3 4
X 2 4 1 X 5
5 X 2 3 1 X
3 4 X 5 X 1
1 X 3 4 6 2
4 6 5 2 X 3
```

Example 7.2

Input

```
9
8 7 1 6 3 1 4 2 5
2 1 3 4 1 9 5 8 7
2 5 2 7 8 1 6 9 1
7 6 1 9 5 8 7 7 3
5 3 6 2 7 3 6 1 8
7 9 4 4 5 3 8 3 2
9 7 7 3 8 5 2 4 3
1 2 8 5 4 5 3 7 5
7 7 5 8 9 2 5 6 2
```

Output

```
8 7 X 6 3 X 4 2 X
X 1 3 4 X 9 5 8 7
2 5 X 7 8 1 X 9 X
X 6 1 9 X 8 7 X 3
5 3 X 2 7 X 6 1 8
X 9 4 X 5 3 8 X 2
9 X 7 3 X 5 2 4 X
1 2 8 X 4 X 3 7 5
7 X 5 8 9 2 X 6 X
```

8 - Knotted or Not

Katherine Johnson's favorite necklace is laying on the floor. The necklace can be represented using the characters "`-`" and "`|`" to represent horizontal and vertical segments, and "`+`" to represent corners. Places where the necklace passes over itself are represented as follows:

```
   |                    |
-------              ---|---
   |                    |
Horizontal segment on top   Vertical segment on top
```

The ends of the necklace are connected together, so there are no loose ends. The necklace is *knotted* if it cannot be untangled into a simple loop.

Katherine Johnson wonders whether her necklace is knotted or not. Given a representation of the necklace on the floor, tell her "`Knotted`" if it is knotted or "`Not Knotted`" if it is not.

Constraints

Each line of input contains exactly `38` characters.
`0` < lines of input ≤ `20`
"(padded spaces)" shown in Examples not included in Input.

Example 8.1

Input

```
   +------------------------+          (padded spaces)
   |                        |          (padded spaces)
+----------------------+    |          (padded spaces)
|  |                   |    |          (padded spaces)
|  |      +------+     |    |          (padded spaces)
|  |      |      |     |    |          (padded spaces)
|  |      +------|-----+    |          (padded spaces)
|  |             |          |          (padded spaces)
+--|-------------------------+          (padded spaces)
   |             |                      (padded spaces)
   +-------------+                      (padded spaces)
```

Output

```
Knotted
```

Example 8.2

Input

```
     +----------------+                (padded spaces)
     |                |                (padded spaces)
+----------------+    |                (padded spaces)
|    |           |    |                (padded spaces)
|    |           |    |                (padded spaces)
|    +-----------|----------+          (padded spaces)
|                |    |     |          (padded spaces)
+----------------|----+     |          (padded spaces)
                 |          |          (padded spaces)
                 +----------+          (padded spaces)
```

Output

```
Not Knotted
```

9 - Rocky Roads

In mountainous Genovia, two-way roads connect distinct towns, and a maximum of one road will connect any two distinct towns. For business to run as normal, people from all towns must be able to drive to all other towns. Every once in awhile a rockslide will shut down a road. For simplicity's sake, we can assume only one road will be shut down at a time. The roads which would disrupt business if they were shut down are called *crucial roads* and the country's rock-moving machines are stored on these roads.

Emmy Noether is wanting to travel around Genovia, but only if she can drive to all of the towns. She is watching the news to see which roads are shut down, so she can determine whether or not to travel that day. Given a number of roads, then a list of road names and the towns the road connects, tell her which roads are crucial roads, in the order the roads are listed, or `"None"` if no roads are crucial.

Constraints

With no roads shut down, all towns are drivable from all other towns.
Town names and road names will be unique.
$2 \leq$ number of towns $<$ `200`
$1 \leq$ number of roads $<$ `19900`
The number of roads given is an integer.

Example 9.1

Input

```
7
Lust Road: Neilo -> Tritone
Gluttony Highway: Tritone -> Asopo
Greed Interstate: Rhodia -> Tipoplo
Sloth Drive: Tipoplo -> Heptapora
Wrath Highway: Asopo -> Heptapora
Envy Road: Tipoplo -> Tritone
Pride Highway: Asopo -> Tipoplo
```

Output

```
Lust Road, Greed Interstate
```

Example 9.2

Input

```
5
Denial Drive: Death -> Conquest
Anger Road: Famine -> Death
Bargaining Highway: Death -> War
Depression Interstate: War -> Conquest
Acceptance Drive: War -> Famine
```

Output

```
None
```

10 - Bountiful Blossoms

Latanya Sweeney's garden is really blooming. She has noticed the following trend:

```
Number of blossoms on Day t is denoted by B(t)
B(0) = 1
B(1) = 2
B(2) = 3
When t > 2,
B(t) = B(t-3) + B(t-1)%B(t-2)
Sequence: 1 2 3 2 4 3 5 6 4 9…
```

She wonders how many blossoms she'll have in the future. Given a Day `t`, tell Latanya Sweeney how many blossoms she'll have.

Constraints

`0` ≤ Input < `100`
Input is an integer.

Example 10.1

Input

```
10
```

Output

```
7
```

Example 10.2

Input

```
34
```

Output

```
472
```