Odds and Evens (Last seen 2019-10-17)

Given an array `A` of non-negative integers, return an array consisting of all the *even* elements of `A`, followed by all the *odd* elements of `A`.

You may return any answer array that satisfies this condition.

```
Input:  [3,1,2,4]
Output: [4,2,1,3]
```

Extension:

Your output array must now be composed of the even array in ascending order, and the odd array in descending order.

```
Input:  [3,1,2,4,8,3,4,1]
Output: [2,4,4,8,3,3,1,1]
```

Submatrix (Last seen 2019-10-17)

Given a 2-dimension array filled with `0`s and `1`s (a binary matrix), find the largest rectangle containing only `1`s and return its area.

```
Input: [[1,0,1,0,0],
        [1,0,1,1,1],
        [1,1,1,1,1],
        [1,0,0,1,0]]
Output: 6
Explanation: A 3*2 rectangle is formed starting at row 1, column 2 and ending
in row 2 column 4.
```

Zero-Sum Game (Last seen 2019-10-24)

Given an array of `n` integers, find all pairs that sum to zero.

```
Input:  [-1, 0, 1, 2, -2, -4]
Output: [[-1, 1], [2, -2]]
```

Part B:

Extend this such that you find triples that sum to zero :-)

```
Input:  [-1, 0, 1, 2, -2, 2, -4]
Output: [[-1, 0, 1],[-2, 0, 2], [-4, 2, 2]]
```

Lispy Business (Last seen 2021-11-08)

Given an input containing parentheses, write a function to decide if the parentheses are matched. That is, for every opening parenthesis there must be a respective closing parenthesis and vice-versa.

```
Input:  "((Hello) world))"
Output: false

Input:  "((((((HELLO))))))World"
Output: true

Input:  "()()()()()()()123()()()()))(("
Output: true
```

The Legendary Door Problem (Last Seen 2021-11-01)

There are 100 closed lockers in a hallway. Behind the lockers are monsters. On round 1, you go through the lockers and open every single one. On round 2, you go through the lockers and shut every second. On round 3, you go through the lockers and toggle every third. On round N, you go through the lockers and toggle every Nth. After 100 rounds, the monsters will exit the open lockers and attack. How many monsters will there be attacking you?

Extension 1: Instead of 100 lockers, you now have N lockers and N rounds. Solve the same problem :-)

Extension 2: Now, you have N lockers and M rounds, where N and M are not necessarily the same number. Solve the same problem once more.

Sorted Stacking (Last Seen 2019-10-31)

Mix up in groups of first, second, and third years (where possible) and write a program to sort a stack with the smallest items on top.

Recall that the allowed operations on a stack are: `push`, `pop`, `peek` and `is_empty`.

Part A:

You are allowed to use exactly one additional stack. How fast can you go?

Part B:

You are allowed to use as many additional stacks as you like. How fast can you go?

Binary Neighbours (Last seen 2019-11-07)

Given a positive integer, print the next smallest and next largest numbers that have the same number of 1 bits in their binary representation. Assume it is even.

Part B:

If you want to have a really, really tough problem, try it for any positive integer.

(Shut up and) Calculate (Last seen 2019-11-14)

You have a computer that only 'knows' addition and negation of integers (E.g. can turn -4 to 4 and 4 to -4). Do each of these in turn:

1. Define subtraction using only the above two operations
2. Define multiplication using the above three operations
3. Define division using the above four operations.

Hint: You may not need all available operations for each part.

Magic Indices (Last seen 2020-11-24)

A magic index in an array of `n` integers (index from `0` to `n-1`) is defined to be an index such that `array[i] == i`.

Part A:

The array is unsorted, what is the most efficient algorithm that can be written (i.e. write an algorithm that takes `O(_)` time, and provide an argument why you can't go faster than `O(_)` time)

The array is unsorted, what is the most efficient algorithm that can be written (i.e. write an algorithm that takes `O(_)` time, and provide an argument why you can't go faster than `O(_)`)

Part B:

The list of integers is now sorted in the array. How fast can you go?

Zero the Matrix (Last seen 2021-11-08)

Write an algorithm such that if an element in an `N x M` matrix is zero, the entire row and column of that element are set to zero.

Given an `N x M` matrix of random integers, some of which will be zero, zero-out any row and column where a cell contains a zero.

```
Input:  1 2 3 4
        1 0 8 7
        4 4 0 2
        6 7 8 9
        1 2 3 4

Output: 1 0 0 4
        0 0 0 0
        0 0 0 0
        6 0 0 9
        1 0 0 4

Input:  14 0  7
         8 0 31
         1 4  9

Output: 0 0 0
        0 0 0
        1 0 9
```

Part B:

What is the time and space complexity of your algorithm?

Part C:

Can you do this in `O(1)` space and `O(N x M)` time?

Matrix Search (Last seen 2019-11-28)

Write an efficient algorithm that searches for a value `x` in an `N x M` matrix. This matrix has the following properties:

1. Integers in each row are sorted from left to right.
2. The first integer of each row is greater than the last integer of the previous row.

If we are searching for `x=3`, our output is its position:

```
Input: [[01, 03, 05, 07],
```

```
        [10, 11, 16, 20],
        [23, 30, 34, 50]]
Output: (0,1)
```

Note: If the value is not in the matrix, you can return `(-1,-1)` or something signifying it was not found (`None`, `Nothing`, `null`, etc.)

How fast can you go, and why?

Too Many Twos (Last seen 2019-11-28)

Write a method to count the number of twos (`2`) that appear between the number `0` and `n` (for a given `n`).

```
Input: 25
Output: 9
Why?: 2, 12, 20, 21, 22, 23, 24, 25
```

Part A:

Assume `n` < 10000. How fast can you go?

Part B:

Now there are no restrictions on the value of `n`. How fast can you go?

Top Temperatures (Last seen 2020-12-01)

Given a list of daily temperatures, return a list such that, for each day in the input, tells you how many days you would have to wait until a warmer temperature. If there is no future day for which this is possible, put 0 instead.

```
Input:  [73, 74, 75, 71, 69, 72, 76, 73]
Output: [ 1,  1,  4,  2,  1,  1,  0,  0]
```

Part B:

Can you do this in linear time?

Matrix Flipper (Last seen 2019-12-05)

Given a matrix consisting of `0`s and `1`s, we may choose any number of columns in the matrix and flip every cell in that column. Flipping a cell changes the value of that cell from `0` to `1` or from `1` to `0`. Return the maximum number of rows that have all values equal after some number of flips.

```
Input: [[0,1],
        [1,1]]
Output: 1
Explanation: After flipping no values, 1 row has all values equal.

Input: [[0,1],
        [1,0]]
Output: 2
Explanation: After flipping values in the first column, both rows have equal values.

Input: [[0,0,0],
        [0,0,1],
        [1,1,0]]
Output: 2
Explanation: After flipping values in the first two columns, the last two rows have equal va
```

Partition Petition (Last seen 2020-02-27)

Write code to partition a linked list around a value `X` such that all nodes less than `X` come before all nodes greater than or equal to `X`. The two partitions should preserve their order.

```
Input:  3->5->8->5->10->2->1
Parititon on: 5
Output: 3->2->1->5->8->5->10
```

Around and Around and (Last seen 2020-02-27)

Given a circular linked list, implement an algorithm that returns the node at the beginning of the loop. A circular linked list is a corrupted linked list in which a node's next pointer points to an earlier node in the linked list as to make a loop.

```
Input:  a->b->c->d->e-+
               ^      |
               |      |
               +------+
Output: c
```

This problem has many possible methods. Try to come up with a few :-)

Path Sums (Last seen 2020-03-12)

Given a binary tree and a sum, find all root-to-leaf paths where have a sum of values/labels equal to the given sum.

```
Sum: 22
Tree: 5
     / \
    4   8
   /   / \
  11  13  4
 /  \    / \
7    2  5   1
Output: [[5,4,11,2],
         [5,8,4,5]]
```

Extension:

If this was a binary search tree would this make a difference?

Balancing Lists (Last seen 2020-03-12)

Given an array where elements are sorted in ascending order, convert it to a balanced binary search tree (as balanced as possible, at least).

Hint: CS115 has already given you two very useful algorithms for this ;)

```
Input: [-10,-3,-1,0,2,5,9]
Output:  0
        / \
       /   \
     -3     5
    / \    / \
  -10 -1  2   9
```

Searching the Search Tree (Last seen 2020-03-12)

Given a binary search tree, write a function to find the `N`th smallest element in it.

```
N: 1
Tree: 3
     / \
    1   4
     \
      2
Output: 1
```

Deadly Soda (Last seen 2021-11-01)

You have 1000 bottles of soda, and exactly one is poisoned. You have 10 test strips which can be used to detect poison. A single drop of poison will turn the test strip positive permanently. You can put any number of drops on a test strip at once, and you can reuse a test strip as many times as you'd like (as long as the results are negative). However, you can only run tests once per day, and it takes seven days to return a result. How would you figure out the poisoned bottle in as few days as possible?

Island of Paradise (Last seen 2020-10-27)

A bunch of people are living on an island, when a visitor comes with a strange request: all blue-eyed people must leave the island as soon as possible. There will be a flight of unlimited capacity out at 8:00pm every evening. Each person can see everyone else's eye colour, but they do not know their own (nor can they find out through someone or something else). Additionally, they do not know how many people have blue eyes, although they do know that at least one person does. How many days will it take the blue-eyed people to leave?

Hint: You can assume the people are all equally intelligent, and if one can think in a specific way, then all of them can.

Note: Solutions via proxy, i.e. "Invent a reflective surface to look at yourself" or "Invent a machine that tells you your eye colour" are not acceptable. This is a logic puzzle!

Baby Boom (Last seen 2020-10-27)

In the new post-apocalyptic world, the world queen is desperately concerned about the birth rate. Therefore, she decrees that all families should ensure that they have one girl or else they face massive fines. If all families abide by this policy -that is, they continue to have children until they have one girl, at which point they immediately stop- what will the sex ratio of the new generation be? (Assume that the odds of someone having a boy or a girl on any given pregnancy is equal.)

Note: This problem can be solved logically, and by computer simulation. It is up to you to decide how you choose to solve it, but we recommend you try writing the simulation first, and then try to logically reason about the result.

Side-note: If you are unsure how to program the simulation, or if you are just starting with programming in Java and you need some help let us know! If you are confident with programming, look out for others you can help :-)

The Legally Distinct Minty Hill Problem (Last seen 2020-11-03)

You're on a game show and there are 3 doors, which are all shut.

The game show host asks you to pick a door. You pick a door and then the game show host opens a door other than the one you picked, to reveal a pair of goats. She says: "Behind one of the remaining doors is a goat and behind the other door is a luxurious car". What is the best strategy to win the car?

1. Hold on to the door you selected originally
2. Switch and select the other door

Or, are the two strategies leading to the same result? Try writing a simulation for this problem and report on the results :-)

L A M P (Last seen 2020-11-03)

You're outside a room with the door shut. There are three light switches on the wall next to you and three antique lamps inside.

You're allowed to open the door and walk into the room exactly once. That is the only time when you can observe the lamps. Before you open the door you are allowed to play with the light switches as much as you like.

Your task is to determine which light switch corresponds to which lamp.

Array Sort You! (Last seen 2020-11-03)

You want to sort an array of numbers. However, you have a problem. You are a dictator and your philosophy is: if something doesn't follow your rules, kill it! Let's introduce Stalin Sort:

1. You have an array of random positive integers.
2. In this array, if a number is "out of order" it shall be deleted (killed).
3. At the end of the algorithm, all numbers should appear consecutively with any open spaces appearing at the end of the array.

What's the fast implementation of Stalin Sort? **Automatic weapons are not allowed and since cloning technology is not available, you must perform it in-place. Stalin is merciful, and allows you to place a tombstone value of `-1` for each dead number.**

```
Input:  [4, 17, 5, 6, 12, 1, 9]
Output: [4, 5, 6, 9, -1, -1, -1]
```

Substring (Last seen 2020-11-10)

Given two strings `s1` and `s2`, where `length(s1) < length(s2)`, find the index of the first instance where s1 is a substring of s2.

```
Input: s1 = "abCd", s2 = "ffffabCdCefg"
Output: 4
```

Extension:

Return the index of all substrings of s1 in s2.

Interleaved Intermission (Last seen 2020-11-10)

Given strings `s1`, `s2`, and `s3`, where `length(s1) + length(s2) = length(s3)`, determine if you can interleave the characters in `s1` and `s2` to get `s3`.

```
Input: s1 = "aadcc", s2 = "beebt", s3 = "aabeedcbtc"
Output: true

Input: s1 = "aadcc", s2 = "xeebt", s3 = "aabeedcbtc"
Output: false
```

Part A:

The strings `s1` and `s2` do not share any characters.

Part B:

The strings `s1` and `s2` can contain any characters (i.e. `s1 = "aabc"`, `s2 = "aabf"`).

Say a Word, Any Word (Last seen 2020-11-17)

Given any integer `n` in range (-2000000000,2000000000) (That is -2 billion to +2 billion), produce a string that represents it in natural English language.

Note: The "and" is optional but preferred.

```
Input : 1234
Output: One Thousand Two Hundred (and) Thirty Four

Input : -92435
Output: Minus Ninety-two Thousand Four Hundred (and) Thirty Five
```

Matrix Revolutions (Last seen 2020-11-17)

Given an `N x N` matrix, write a method to rotate the matrix by 90 degrees.

```
Input: [[1,2,3],
        [4,5,6],
        [7,8,9]]

Output: [[7,4,1],
         [8,5,2],
         [9,6,3]]
```

Extension:

How fast can you go? Can you do this with `O(1)` space?

Odd Bitswap Even (Last seen 2020-11-24)

Write a program to swap sequential pairs of odd and even bits in an integer with as few operations as possible.

```
Input:  01010101
Output: 10101010

Input:  1011110100
Output: 0111111000
```

Minesweeper (Last seen 2020-12-08)

Design and implement a text-based Minesweeper game. Minesweeper is the classic single-player computer game with an `N x N` grid and `B` mines (or bombs) hidden across the grid. The remaining cells are either blank or have a number behind them. The numbers reflect the number of bombs in the surrounding eight cells.

The user then uncovers a cell. If it is a bomb, the player loses. If it is a number, the number is exposed. If it is a blank cell, this cell and all adjacent blank cells (up to and including the surrounding numeric cells) are exposed.

The player wins when all non-bomb cells are exposed.

The player can also flag certain places as potential bombs. This doesn't affect gameplay, other than to block the user from accidentally clicking a cell that is thought to have a bomb. (Tip: if you're not familiar with this game, please play a few rounds online first.)

Word Sort (Last seen 2021-03-09)

You are given a string containing multiple words. Your output is the same string, except that each word has had its characters sorted.

```
Input: "hello world"
Output: "ehllo dlorw"

Input: "welcome back to green book club"
Output: "ceelmow abck ot eegnr bkoo bclu"
```

Extension:

How fast can you do this? What about if you are constrained to at-most 4 different letters per word? Any number of repetitions are allowed, such as:

```
Input: "green book club is so much fun"
Output: "eegnr bkoo bclu is os chmu fnu"
```

Sum 123s (Last seen 2021-03-16)

Given a sorted array of integers that contains only the values 1, 2, or 3, write a function to compute the sum of the array.

```
Input:  [1,1,1,1,1,1,2,2,3,3,3,3,3,3]
Output: 28

Input:  [1,2,3]
Output: 6

Input:  [1,3]
Output: 4

Input:  [1,1,1,1,3,3]
Output: 10
```

Extension:

Can you solve this problem in less than O(n) time?

A Little Missing Something (Last seen 2021-03-16)

Given an array of integers, find the smallest missing integer greater than 0.

```
Input: [1,2,0]
```

```
Output: 3

Input: [3,4,-1,1]
Output: 2

Input: [7,8,9,11,12]
Output: 1
```

Water Trap (Last seen before 2020-04-02)

Imagine a histogram (bar graph). Design an algorithm to compute the volume of water it could hold if someone poured water across the top. You can assume that each histogram bar has width 1. (Says "volume" but really it's area since 2D.)

```
Input: {0, 0, 4, 0, 0, 6, 0, 0, 3, 0, 5, 0, 1, 0, 0, 0}
Output: 26
```

Can visualise the problem if you wish, the above example looks like:

```
     #
     #~~~~#
  #~~#    #
  #  #  # #
  #  #  # #
  #  #  # #~#
---------------- (height=0) # = solid, "~" = waterline
0040060030501000
```

(Green book page 189)