

Assignment: Recursion, Recurrence Relations and Divide & Conquer

1. **Implement algorithm:** There are two 2D-boxes that can be placed on the coordinate system. A box can be represented by the position of the coordinates where it is placed. This can be listed as $[x_1, y_1, x_2, y_2]$, where the first pair of coordinates correspond to the location of the bottom-left corner, and second pair of coordinates correspond to the top right corner.

Given coordinates of two boxes, identify if they overlap. If they overlap return true else return false.

Note: If the boxes that touch each other at the corner or edges should return false.

A rectangle is represented as a list $[x_1, y_1, x_2, y_2]$, where (x_1, y_1) are the coordinates of its bottom-left corner, and (x_2, y_2) are the coordinates of its top-right corner.

Two rectangles overlap if the area of their intersection is positive. To be clear, two rectangles that only touch at the corner or edges do not overlap.

Think if you can come up with recursive function to solve this problem, if yes write it, if not explain why.

Write a function `doBoxesOverlap(box1, box2)` that take the coordinate positions of each box as input and return whether they overlap or not. Name your file **BoxAlgorithm.py**

Example 1:

Input: `box1 = [0,0,2,2]`, `box2 = [1,1,3,3]`

Output: true

Example 2:

Input: `box1 = [0,0,1,1]`, `box2 = [1,0,2,1]`

Output: false

2. **Solve recurrence relation using three methods:**
 - a. Write recurrence relation of below pseudocode that calculates x^n , and solve the recurrence relation using three methods that we have seen in the explorations.

```
power2(x,n):
    if n==0:
        return 1
    if n==1:
        return x
    if (n%2)==0:
        return power2(x, n/2) * power2(x,n/2)
    else:
        return power2(x, n/2) * power2(x,n/2) * x
```

- b. Give the asymptotic bounds for $T(n)$ in each of the following recurrences. Make your bounds as tight as possible and justify your answers. Assume the base cases $T(0)=1$ and/or $T(1) = 1$.
 - a) $T(n) = 4T(n/2) + n$

$$b) T(n) = 2T(n/4) + n^2$$

3. **Implement an algorithm using divide and conquer technique** [includes proving correctness]:

A group of friends want to find out which day of the week majority of them share their birthday's on. They count week from Monday through Sunday. Monday:1, Tuesday:2... Sunday:7. If a person is born on Wednesday his birthday is said to fall on number 3. Write a function that would take these days as input and return the day of week on which most of them share their birthday's on.

Example 1:

Input: [3,2,3]

Output: 3

Example 2:

Input: [2,2,1,1,1,2,2]

Output: 2

- Write a pseudocode for a function MajorityBirthdays(days) that uses divide and conquer technique. The function would take these days as input (in the form of an array) and return the day of week on which most of them share their birthday's on
- Prove the correctness of your pseudocode that you wrote in part a of this question.
- Implement the function MajorityBirthdays(days) that was written in part a. Name your file **DACAAlgorithm.py**

Debriefing (required!): -----

Report:

- Approximately how many hours did you spend on this assignment?
- Would you rate it as easy, moderate, or difficult?
- How deeply do you feel you understand the material it covers (0%–100%)?
- Any other comments?