Programming project

Geometric Algorithms, Spring 2021

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Due date: 1st June 2020 @ 14:30

You may do a project, either doing a presentation or the programming project. Doing the project can improve your final grade by up to a point. There are two possibilities of doing a project, either doing the programming project described below or doing a presentation in class on a topic that Evanthia will specify.

Programming project description:
Implement the algorithms for exercise 1 of the second homework assignment:

Let R be an axis-parallel rectangle and $D = \{d_1, ..., d_n\}$ a collection of closed circular disks. Each disk d_i is represented by its center p_i, which lies within R, and its positive radius r_i. Disks may extend outside of R, and one disk may be contained within another.

- If every point of R lies within at most one disk of D (see left Figure 1) then we say that the elements of D form a packing of R . Implement a plane-sweep $O(n \log n)$ time algorithm that determines whether D is a packing of R.
- If every point of R lies within at least one disk of D then We say that the elements of D form a cover of R. See right Figure 1: The disks do not form a cover because there is a small gap as shown in the figure. Implement a plane-sweep $O((n+m) \log n)$ time algorithm that determines whether D is a cover of R, where m is the number of intersection points lying within R between the boundaries of disks. The running time should not depend on the number of intersection points that lie outside of R.

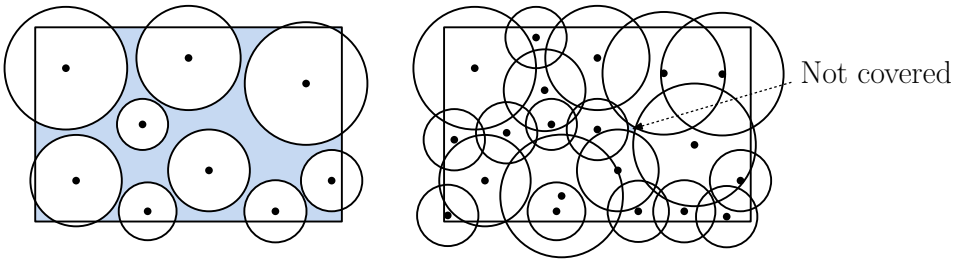

Figure 1: Disk Packing and Covering

You should implement a plane-sweep algorithm from left to right. Your program should take as input a file (a sample file is attached), which has the minimum and maximum x-coordinate

in its first line:
$x_{min}\ x_{max}$
And the respective coordinates for the y-coordinate in the second line.
$y_{min}\ y_{max}$
Each following line describes a circle with center $c = (c_x, c_y)$ and radius r by:
$c_x\ c_y\ r$

At the termination of the program, the program should clearly state if D is a packing/cover. Ideally you should use the efficient data structures as discussed in lecture. If that is not possible, then you should state which data structures you used instead and how that affects the running time.

- Ideally you should use the efficient data structures as discussed in lecture. If that is not possible then you should state which data structures you used instead and how that affects the running time.
- There is no intention to tackle you with numerical errors and robustness issues. Therefore, no events will be too close, and 2 digits after the decimal point should be enough to hide any numerical inaccuracies.
- You may use Matlab, Python or C++.
- Write a small document, in which you describe your implementation. Please mention clearly in the documentation (and justify) the space complexity of your implementation.