Bilkent University
Department of Computer Engineering

CS 478/564 COMPUTATIONAL GEOMETRY
HOMEWORK 2

Instructor: Uğur Güdükbay
Due date: Friday, March 21st, 2025 (23.55)

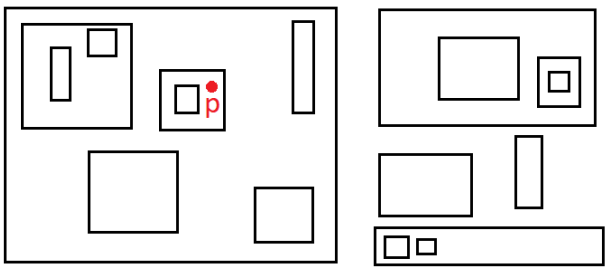
In doing the assignments, you are on the honour system, meaning that any submitted assignment is solely the work of the submitter. You are free to discuss the questions with your friends, but you should submit your own work.

You must use a Word Processor to prepare your answers. Handwritten homework will not be graded.

1) Given a **Doubly Connected Edge List (DCEL)**, give a linear time algorithm to check if it is a triangulation (each face in DCEL should be a triangle, except for the unbounded face).

2) We want to **maintain the convex hull** of a set of points S. Describe how to **add** new points to S and **remove** points from S so that the convex hull is updated accordingly. While updating you may utilize the existing convex hull. Suppose S has N points and the convex hull is made of H points, give a complexity analysis of your approach in terms of N and H. Consider the cases where the point is outside or inside the convex hull.

3) **R** is a given set of **N** rectangles with non-intersecting lines. Describe a data structure to store **R** such that given a query point **P**, we can find how many rectangles contain **P**, without needing to check all the rectangles. Also describe how to insert a new rectangle into this data structure, given that its lines do not intersect with any of the existing rectangles. You may assume no rectangle contains more than half of the total number of rectangles.



4) Modify the graph weight balancing algorithm (Preparata, page 51) given in the lecture slides so that it constructs a **monotone complete set of chains** from the given **Planar Straight Line Graph**. You should modify the second pass to construct the monotone complete set of chains.

5) Graham's scan is applied to a set of points in certain order. We used algorithm *Simple Polygon* to sort the points in the following way. We started with an extreme point ***p*** (which was guaranteed to be on the hull) and sorted all other

points according to the angles between a fixed line (e.g., the ***x*** axis) and the line segments connecting the points to ***p***. Prove (by showing a counterexample) that not every point ***p*** can be used for this purpose. In other words, show a set of points ***S*** and another point ***p, not in the set***, such that sorting the points relative to ***p*** (using the angles from ***p*** to the points in the set) and then applying Graham's Scan does not lead to the correct convex hull.