Exercise sheet 2
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Ex. 1 — Convex hull - Benchmarking: In this exercise you should benchmark the runtime of various implementations of the convex hull computation algorithms. As we saw in class, a trivial worst case input is one where the point set is sampled from the boundary of the convex hull. Let $n$ be the number of sample points.

- Let $P$ be a convex shape in the plane.

- Generate five point sets, each of them of size $n$, as follows. For each $i \in \{0, 1, 2, 3, 4\}$, sample uniformly \( \frac{i}{4} n \) points from the boundary of $P$, denoted by $\partial P$, and \( \frac{4-i}{4} n \) points from the interior of $P$, denoted by $\mathring{P}$.

- Compute the convex hull of the sampled sets you generated using at least four different algorithms which are implemented in CGAL. Make sure to record the running time\(^2\) of each experiment and summarize all in a table. Run each experiment with different CGAL kernels and record these running times as well.

- **Bonus:** If you happen to have an implementation of your own which computes the convex hull of a point set, compare it to the algorithms implemented in CGAL.

Ex. 2 — Onion Peeling: Given a point set, $P_0$, in the plane, let $\text{conv}(P_0) \subset P_0$ be its convex hull. By letting $P_1 = P_0 \setminus \text{conv}(P_0)$ we obtain a new point set. We can again compute the convex hull of $P_1$ and obtain a new set $P_2$. This process is called onion peeling, and it terminates once $P_k$ has less than three points for some $k > 0$. Implement this using CGAL and visualize the result using either Qt\(^3\) or some other tool of your choice.

**Bonus:** Is your implementation efficient? Can you make it run faster? Did you try to run it over big inputs (more than 100K points)?

Ex. 3 — Adding a point: Suppose you have the convex hull of a given point set $P$. Let $q$ be a new point not in $P$. Assume that you have only some CGAL convex hull

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\(^1\)You can use the tools provided by CGAL; see [the manual](#).

\(^2\)Use the tool provided by CGAL; see [the manual](#).

\(^3\)Using the templates which can be found in the website.
function at your disposal, which you can call. How would you compute the convex hull of $P \cup \{q\}$? The answer is very simple. Give a simple implementation.