

**Input:** a  $k$ -NN graph  $\mathcal{G} = (\mathcal{D}, \mathcal{E})$ , a query point  $Q$ , the number of required nearest neighbors  $K$ , the number of random restarts  $R$ , the number of greedy steps  $T$ , and the number of expansions  $E$ .

$\rho$  is a distance function.  $N(Y, E, \mathcal{G})$  returns the first  $E$  neighbors of node  $Y$  in  $\mathcal{G}$ .

$\mathcal{S} = \{\}$ .

$\mathcal{U} = \{\}$ .

$Z = X_1$ .



**for**  $r = 1, \dots, R$  **do**

$Y_0$ : a point drawn randomly from a uniform distribution over  $\mathcal{D}$ .

**for**  $t = 1, \dots, T$  **do**

$Y_t = \operatorname{argmin}_{Y \in N(Y_{t-1}, E, \mathcal{G})} \rho(Y, Q)$ .



$\mathcal{S} = \mathcal{S} \cup N(Y_{t-1}, E, \mathcal{G})$ .

$\mathcal{U} = \mathcal{U} \cup \{\rho(Y, Q) : Y \in N(Y_{t-1}, E, \mathcal{G})\}$ .

**end for**

**end for**

Sort  $\mathcal{U}$ , pick the first  $K$  elements, and return the corresponding elements in  $\mathcal{S}$ .