Sublinear Time and Space Algorithms 2026A – Problem Set 5

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General instructions: Please keep your answers short and easy to read. You can use results, calculations or notation seen in class without repeating them, unless asked explicitly to redo them.

1. Design a deterministic algorithm that given a set of vertices $S \subseteq V$ finds a neighbor of it using $O(n^{1/r})$ queries in $O(r)$ rounds. Then, use this to create a deterministic algorithm that determines if a graph is connected using $O(n^{1+1/r})$ queries in $O(r \log n)$ rounds.

2. Design a sublinear-time algorithm that, given $0 < \varepsilon < 1$ and access to an n-vertex graph G, approximates the number of connected components, within additive error εn. The access to G allows to query, for each vertex, its degree and its neighbors list (e.g., ask for the i-th neighbor). What is the running time of your algorithm?

   Hint: Start with the special case that all connected components have size at most $1/\varepsilon$. Consider sampling a uniformly random vertex v and computing its connected component C_v.