**Text. S1. Computational Complexity Analysis.** The BHD strategy falls into the general category of immunization algorithms based on the self-avoiding walks [1]. Starting with a self-avoiding walk at a randomly chosen node, we examine the overlap and the existence of links from \( f_t \) (i.e., all the neighbors of the last node after step \( t \)) back to \( F_{t-1} \) (i.e., the union of the friendship circles of all the visited nodes up to step \( t-1 \)) in the trail of the walk, and this examination procedure is taken after every step once the walk has visited three or more sites.

For a randomly chosen node, it takes time \( O(1) \). A self-avoiding walk takes the worst-case time \( O(N \ln N) \) [2], where \( N \) is network size. Following the above examination procedure, the connection relations between each node in \( f_t \) and all the nodes in \( F_{t-1} \) are examined after each step of the walk, which takes the worst-case time \( O(\langle k \rangle N) \), where \( \langle k \rangle \) is the average degree of the network. As \( N \) nodes may be visited at most by the walker, the whole process of this examination takes the worst-case time \( O(\langle k \rangle N^2) \).

When a walk stops, one bridge node and one bridge hub are identified. Thus, an identification process based on the self-avoiding walks takes the worst-case time \( O(1 + N \ln N + \langle k \rangle N^2) = O(\langle k \rangle N^2) \). To achieve the desired immunization ratio \( f \), the entire algorithm runs in time \( O(f \langle k \rangle N^3) \). Analogously, the ACQ and CBF take the worst-case run times that go like \( O(f N) \) [3] and \( O(f N^3) \), respectively.