

Close Encounters with a Black Hole or Explorations and Gatherings in Dangerous Graphs

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Abstract. Consider a netscape inhabited by mobile computational entities (e.g., robots, agents, sensors). In the algorithmic literature, these environments are usually assumed to be safe for the entities. Outside of the literature, this is hardly the case: highly harmful objects can operate in the netscape rendering the environment dangerous for the entities. A particular example is the presence of a *black hole*: a network site (node, host) that disposes of any incoming robot/agent, leaving no observable trace of such a destruction. The reasons why a node becomes a black hole are varied; for example, the presence at a node of a harmful static process (e.g., a virus) that destroys incoming code and messages transforms that node into a black hole; the undetectable crash failure of a host renders that host a black hole; "receive-omission" failures in the communication software of a site makes that site act as a black hole. Indeed, this type of danger is not rare.

Clearly the presence of a black hole renders computations in the net dangerous to be performed, and some tasks become impossible to be carried out. We will examine two classic problems for mobile entities, *Exploration* and *Gathering* (or *Rendezvous*), and discuss how they are affected by the presence of a black hole. In particular, we will view them with respect to a new task that, in this context, is even more basic and essential: *Black Hole Search*, the problem of a team of mobile entities locating the black hole. Obviously, any entity entering the black hole is destroyed; the black hole location problem is solved if at least one agent survives, and all surviving agents know the location of the black hole.

Not satisfied with correctness, our focus is on efficiency. The basic cost measures are the number of entities (and of casualties), and the number of moves.

Keywords: Harmful Host, Exploration, Rendezvous, Gathering, Mobile Agents, Robots, Asynchronous, Anonymous Networks, Anonymous Agents, Whiteboards, Tokens.

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