Pure and Mixed Multi-Step Strategies for Rendezvous Search on the Platonic Solids

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The *astronaut problem* is an open problem in the field of rendezvous search. The premise is that two astronauts randomly land on a planet and want to find one another. Research explores what strategies accomplish this in the least expected time. To investigate this problem, we create a discrete model which takes place on the edges of the Platonic solids. Some baseline assumptions of the model are: (1) The agents can see all of the faces around them. (2) The agents travel along the edges from node to node and cannot jump. (3) The agents move at a rate of one edge length per unit time. The 3-dimensional nature of our model makes it different from previous work. We first explore an unbiased random walk strategy where the agents move one step in a random direction on each turn. We then explore multi-step strategies, which are strategies where both agents move randomly for one step, and then follow a pre-determined sequence. For the cube and octahedron, we are able to prove optimality of the "Left Strategy", in which the agents move in a random direction for the first step and then turn left. In an effort to find lower expected times, we explore mixed strategies. Mixed strategies incorporate an asymmetric case which under certain conditions can result in lower expected times. By comparing these results, we hope to gain insight into a possibly optimal strategy for the sphere. Most of the calculations were done using first-step decompositions for Markov chains.