**Optimizing small satellite constellations using genetic algorithms - Proposal**

Alexander Evitt

**Objective**

*Purpose*

The purpose of this research is to use genetic algorithms to optimize satellites in constellations of 3 to 8 satellites for maximum communication time with a ground target.

*Expected Outcome*

It is expected that this research will result in the development of a method to optimize small satellite constellations using genetic algorithms, and that this method can then be applied to generic satellite constellations.

**Justification**

This research is important because satellites constellations are expensive, so maximizing the use of them is crucial to mission success. The lack of useful optimization can be the difference between 10 and 20 satellites needed for a mission.

**Description**

*Explanation and Techniques*

Genetic algorithms, a subset of evolutionary algorithms, will be used to optimize a set of solutions against a fitness function that will select for most communication time. Gradient descent will be used to modify the solutions at every successive level.

*Variables and Constraints*

The independent variables within the genetic algorithm will be the parameters of the orbits of the individual satellites in the constellation. The dependent variable, which is the variable optimized for within the fitness function, will be the communication time between points on the ground and the satellites in orbit. This research is constrained by the number of satellites in the constellation, which must be between 2 and 8, as previous research has investigated those paths, and by the fact that genetic algorithms may only find a locally optimized solution instead of a globally optimized one.

**Feasibility Study**

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| --- | --- | --- |
|  | Available Resources | Needed Resources |
| Personnel | Myself | n/a |
| Equipment | School computers | Cloud computing (likely Amazon) for computational power |
| Supplies | n/a | n/a |
| Knowledge/Skills | Basic linear algebra knowledge | Machine learning knowledge, with multivariable calculus |

*Proposed Budget*

Very little in the way of supplies is needed to complete this project. The only thing needed is a large amount of computing power, which is necessary for machine learning research. Cloud computing is necessary to conduct this project, and some expense may be involved, but exactly how much depends on where the cloud computing comes from, and the entire process is still under-development by myself, my research mentor, and several other research students.

**Risk Assessment**

Very little risk is inherent in the research. Pure mathematics, data analysis, and computing carry little to no risk.

**Alternatives**

Alternative research is possible, although the same result likely will not be achieved. Instead of genetic algorithms, other methods of optimization could be used, although those would not be as efficient. Other variables could also be optimized for, such as minimum energy of the constellation as a whole (reducing launch cost), maximum time-over-target, or countless more.