Project Proposal: CSE 6730 Project 2

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1 Proposal

In the United States, the National Aeronautics and Space Administration (NASA) has announced its plan to send humans to Mars during the 2030s. This ambitious goal requires a variety of studies be conducted to effectively plan the endeavor. General habitation, food production, resource extraction, communication, spacecraft, and many other areas must be studied to determine their optimal configuration.

For our second project, we propose a simulation of population growth dynamics on Mars, with the goal of determining an optimal strategy for sustainable population growth. Population growth models have been extensively studied in the literature [4], [3], [7], [2], [5] but generally only in the context of our own planet. Often, natural populations without resource limitations exhibit exponential growth [1]. However, this type of rapid growth will likely be unsustainable under the extreme resource constraints of Mars. By considering several proposed habitation models for Mars, we hope to better understand the resource requirements of these approaches, and by that develop recommendations for sustainable growth.

More specifically, we intend to model humans as consumer entities, and several types of resources such as food, water, and sanitation availability as resource entities. We intend to take a stochastic, discrete-time approach. As David Quammen notes [9], there are four sources of uncertainty to which a population may be subject: demographic, environmental, natural catastrophes, and genetic. We will attempt to model several of these to provide the greatest realism possible.

A stochastic model of population growth during the Neolithic transition focused on foragers and farmers is presented by [6] where a two-population model is used. Foragers and farmers are modeled separately but maintain a relationship through total population density. Crop production is also modeled by a formula based on soil nutrients, production rate, and yield. The study discusses the change in food supply as population density increases and farm land degrades. Despite the model being developed for the Neolithic transition, the same concepts will apply to colonization in Mars as it is anticipated that farming will be an important part of our model.

Another study by [8] introduces five models of human colonization. The study focuses around expansion of colonies by modeling migration patterns of the population as well as mortality and fertility rates. The five models of colonization mentioned are the matrix model, beachhead model, string of pearls, outpost model and the pulse model. The paper concludes that regardless of population size, low fertility rates and/or high mortality rates will cause colonization to fail.

From a programming perspective, we plan to use the Python programming language, which is object-oriented, dynamically typed, and interpreted, making it an excellent choice for developing our simulation in an iterative manner.

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