A 题

A person fills a bathtub with hot water from a single faucet and settles into the bathtub to cleanse and relax. Unfortunately, the bathtub is not a spa-style tub with a secondary heating system and circulating jets, but rather a simple water containment vessel. After a while, the bath gets noticeably cooler, so the person adds a constant trickle of hot water from the faucet to reheat the bathing water. The bathtub is designed in such a way that when the tub reaches its capacity, excess water escapes through an overflow drain.

Develop a model of the temperature of the bathtub water in space and time to determine the best strategy the person in the bathtub can adopt to keep the temperature even throughout the bathtub and as close as possible to the initial temperature without wasting too much water.

建立时间和空间上的关于浴缸水温度的模型，确定浴缸中的人可以采纳的最佳策略使得即便是人在浴缸中也能保持水温，且在不浪费水的同时还尽可能的接近原来的水温。

Use your model to determine the extent to which your strategy depends upon the shape and volume of the tub, the shape/volume/temperature of the person in the bathtub, and the motions made by the person in the bathtub. If the person used a bubble bath additive（气泡浴剂）while initially filling the bathtub to assist in cleansing, how would this affect your model's results?

用你的模型确定浴缸形状和体积、浴缸中人的形状/体积/温度以及浴缸中人的动作对你的策略的影响程度。如果人在最初水填入浴缸时使用了气泡浴剂，则对模型的结果又有何影响？

In addition to the required one-page summary for your MCM submission, your report must include a one-page non-technical explanation for users of the bathtub that describes your strategy while explaining why it is so difficult to get an evenly maintained temperature throughout the bath water.

B 题

The amount of small debris in orbit around earth has been a growing concern. It is estimated that more than 500,000 pieces of space debris, also called orbital debris, are currently being tracked as potential hazards to space craft. The issue itself became more widely discussed in the news media when the Russian satellite Kosmos-2251 and the USA satellite Iridium-33 collided on 10 February, 2009.

A number of methods to remove the debris have been proposed. These methods include small, space-based water jets and high energy lasers used to target specific pieces of debris and large satellites designed to sweep up the debris, among others. The debris ranges in size and mass from paint flakes to abandoned satellites. The debris' high velocity orbits make capture difficult.

Develop a time-dependent model to determine the best alternative or combination of alternatives that a private firm could adopt as a commercial opportunity to address the space debris problem. Your model should include quantitative and/or qualitative estimates of costs, risks, benefits, as well as other important factors. Your model should be able to assess independent alternatives as well as combinations of alternatives and be able to explore a variety of important "What if?" scenarios.

建立一个由时间来决定的模型，以确定最好的备选或组合组合备选方案使得一家私人公司可以在处理太空废墟物问题上将其采纳为一种商业机会。你们的模型应当包括对成本、风险、效益以及其他重要因素的定量和（或）定性的估计。也要能够评估独立的备选方案以及组合备选方案，并考虑多种"如果。。。又会。。。"的情形。

Using your model, determine whether an economically attractive opportunity exists or no such opportunity is possible. If a viable commercial opportunity exists as an alternative solution, provide a comparison of the different options for removing debris, and include a specific recommendation as to how the debris should be removed. If no such opportunity is possible, then provide innovative alternatives for avoiding collisions.

使用你们的模型确定是否存在一个经济上吸引人的机会亦或者这样的机会是不可能的。若一切实可行的商业机会作为一种替代解决方法是存在的，那么就出去废墟物的不同方法提供一个比较。模型还要包括关于废墟物当如何出去的特别建议。

In addition to the required one-page summary for your MCM submission, your report must include a two-page Executive Summary that describes the options considered and major modeling results, and provides a recommendation for a particular action, combination of actions, or no action, as appropriate from your work. The Executive Summary should be written for high level policy makers and news media analysts who do not have a technical background.

C 题

The Goodgrant Foundation is a charitable organization that wants to help improve educational performance of undergraduates attending colleges and universities in the United States. To do this, the foundation intends to donate a total of $100,000,000 (US100 million) to an appropriate group of schools per year, for five years, starting July 2016. In doing so, they do not want to duplicate the investments and focus of other large grant organizations such as the Gates Foundation and Lumina Foundation.

Your team has been asked by the Goodgrant Foundation to develop a model to determine an optimal investment strategy that identifies the schools, the investment amount per school, the return on that investment, and the time duration that the organization's money should be provided to have the highest likelihood of producing

a strong positive effect on student performance. This strategy should contain a 1 to N optimized and prioritized candidate list of schools you are recommending for investment based on each candidate school's demonstrated potential for effective use of private funding, and an estimated return on investment (ROI) defined in a manner appropriate for a charitable organization such as the Goodgrant Foundation.

你们的团队受 GF 的委托，去建立一个模型来确定最优的投资策略包括确定学校、每个学校的投入、投资的回报以及该机构所提供的钱对学生学业起到一个强大的正效用所需要的时间跨度。你的策略要包括一个一对多的最优及你推荐学校的优先次序的投资，该投资需基于每个备选学校有效率的使用自有资金所表现得潜力，以及以一种适合诸如 GF 一类的慈善机构所定义的关于投资的预期回报。

To assist your effort, the attached data file (ProblemCDATA.zip) contains information extracted from the U.S. National Center on Education Statistics (www.nces.ed.gov/ipeds), which maintains an extensive database of survey information on nearly all post-secondary colleges and universities in the United States, and the College Scorecard data set (https://collegescorecard.ed.gov) which contains various institutional performance data. Your model and subsequent strategy must be based on some meaningful and defendable subset of these two data sets.

In addition to the required one-page summary for your MCM submission, your report must include a letter to the Chief Financial Officer (CFO) of the Goodgrant Foundation, Mr. Alpha Chiang, that describes the optimal investment strategy, your modeling approach and major results, and a brief discussion of your proposed concept of a return-on-investment (ROI) that the Goodgrant Foundation
should adopt for assessing the 2016 donation(s) and future philanthropic educational investments within the United States. This letter should be no more than two pages in length.

Note: When submitting your final electronic solution DO NOT include any database files. The only thing that should be submitted is your electronic (Word or PDF) solution.

The Problem C DATA.zip data file contains:
    Problem C - IPEDS UID for Potential Candidate Schools.xlsx
    Problem C - Most Recent Cohorts Data (Scorecard Elements).xlsx
    Problem C - College Scorecard Data Dictionary-09-08-2015.xlsx
    IPEDS Variables for Data Selection.pdf