



美赛B题特点与切入

《美国数学建模竞赛》

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2016 MCM B: Space Junk 太空垃圾



2016 MCM B: Space Junk太空垃圾

- 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.
- 小碎片在轨道上绕地球的数量已日益受到关注。据估计，超过50万件的空间碎片，也被称为轨道碎片，目前都正在跟踪的潜在危害飞船。这个问题就在新闻媒体上变得更广泛的讨论时，俄罗斯卫星的Kosmos-2251和美国铱卫星-33于2009年2月10日相撞。



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- 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.
- 已经提出许多清除碎屑的方法。这些方法包括小型的太空水射流和高能激光，这些激光被用来瞄准特定的碎片，大型卫星被设计用来清扫碎片。从碎片到废弃的卫星，碎片的大小和质量各不相同。碎片在高速轨道使得捕获变得困难。



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- 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.
- 创建一个随时间变化的模型，以确定私营公司可采用的最佳备选办法或备选办法的组合，作为解决空间碎片问题的一个商业机会。您的模型应该包括成本、风险、收益以及其他重要因素的定量、定性评估。您的模型应该能够评估独立的备选方案以及备选方案的组合，并且能够探索各种重要的“切合目前情况的”场景。



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- 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.
- 使用你的模型，确定经济上有吸引力的机会是否存在或者不存在。如果可行的商业机会的存在作为替代的解决方案，提供了用于去除碎屑的不同选项的比较，并包括特定建议作为对碎片应如何除去。如果没有这样的机会，就提供用于避免碰撞的创新方案。



2016 MCM B: Space Junk太空垃圾

- 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.
- 除了MCM提交所需的单页摘要外，您的报告还必须包含一个两页的执行摘要，描述考虑的选项和主要的建模结果，并为特定的操作、操作组合或不操作提供适当的建议。执行摘要应该为没有技术背景的高层决策者和新闻媒体分析师编写。



2017MCM Problem B: Merge After Toll通道合并



2017MCM Problem B: Merge After Toll合并后的人数

- Multi-lane divided limited-access toll highways use “ramp tolls” and “barrier tolls” to collect tolls from motorists. A ramp toll is a collection mechanism at an entrance or exit ramp to the highway and these do not concern us here. A barrier toll is a row of tollbooths placed across the highway, perpendicular to the direction of traffic flow. There are usually (always) more tollbooths than there are incoming lanes of traffic (see former 2005 MCM Problem B). So when exiting the tollbooths in a barrier toll, vehicles must “fan in” from the larger number of tollbooth egress lanes to the smaller number of regular travel lanes.
- 有限接入收费公路的多车道，采用“坡道收费”和“障碍收费”的方法，来收取驾驶员的费用。斜坡收费，是一种设在高速公路的入口或出口匝道处的收费方法，在这里我们不考虑这个问题。障碍收费站是横过公路的一排收费站，与车流方向垂直。通常收费站数比交通车道数更多（见前2005年MCM问题B）。因此，当驶出障碍收费的一个收费站时，车辆必须从较大数量的收费站出口车道“扇入”到较少数量的常规行驶车道。



2017MCM Problem B: Merge After Toll 通道合并

- A toll plaza is the area of the highway needed to facilitate the barrier toll, consisting of the fan-out area before the barrier toll, the toll barrier itself, and the fan-in area after the toll barrier. For example, a three-lane highway (one direction) may use 8 tollbooths in a barrier toll. After paying toll, the vehicles continue on their journey on a highway having the same number of lanes as had entered the toll plaza (three, in this example). Consider a toll highway having L lanes of travel in each direction and a barrier toll containing B tollbooths ($B > L$) in each direction. Determine the shape, size, and merging pattern of the area following the toll barrier in which vehicles fan in from B tollbooth egress lanes down to L lanes of traffic.
- 收费广场是公路上为方便过路而需要的区域，包括过路前的扇形区、过路中的区域和过路后的扇形区。例如，一个三车道的高速公路(一个方向)可能使用8个收费亭的障碍收费。支付过路费后，车辆继续行驶在与进入收费广场的车道数相同的高速公路上(本例中为三条)。考虑在每个方向上具有 L 个行驶车道的收费高速公路，障碍通行在每个方向上包含 B 个收费站 ($B > L$)。障碍收费中，车辆从 B 过街出口车道下行到 L 个车道。据此，确定区域的形状，尺寸和合并模式。



2017MCM Problem B: Merge After Toll通道合并

- Important considerations to incorporate in your model include accident prevention, throughput (number of vehicles per hour passing the point where the end of the plaza joins the L outgoing traffic lanes), and cost (land and road construction are expensive). In particular, this problem does not ask for merely a performance analysis of any particular toll plaza design that may already be implemented. The point is to determine if there are better solutions (shape, size, and merging pattern) than any in common use.
- 在您的模型中需要考虑的重要因素包括事故预防、吞吐量(每小时通过广场尽头与 L 出站交通车道连接处的车辆数量)和成本(土地和道路建设成本很高)。特别地，该问题不仅仅要求，针对可能已经实现的任何特定收费广场设计的性能分析，重点是确定是否有比任何常用的更好的解决方案（形状，大小和合并模式）。



2017MCM Problem B: Merge After Toll 通道合并

- Determine the performance of your solution in light and heavy traffic. How does your solution change as more autonomous (self-driving) vehicles are added to the traffic mix? How is your solution affected by the proportions of conventional (human-staffed) tollbooths, exact-change (automated) tollbooths, and electronic toll collection booths (such as electronic toll collection via a transponder in the vehicle)?
- 确定您的解决方案在畅通和堵塞的交通中的性能。随着更多自主（自驾）车辆添加到交通组合中，您的解决方案如何改变？改变常规（人员配备）收费站，精确更换（自动）收费站和电子收费站（例如通过车辆中的应答器收取电子费用），三者的比例，您的解决方案会受到怎样的影响？



2017MCM Problem B: Merge After Toll 通道合并

- Your MCM submission should consist of a 1 page Summary Sheet, a 1-2 page letter to the New Jersey Turnpike Authority, and your solution (not to exceed 20 pages) for a maximum of 23 pages.
Note: The appendix and references do not count toward the 23 page limit.
- 您的MCM提交应包括1页摘要表，一份1-2页给新泽西州收费公路管理局的信件，以及您的解决方案（不超过20页），最多23页。注意：附录和参考文献不计入23页的限制。



2018 MCM Problem B: How Many Languages? 多少种语言?



2018 MCM Problem B: How Many Languages? 多少种语言?

- **Background:** There are currently about 6,900 languages spoken on Earth. About half the world's population claim one of the following ten languages (in order of most speakers) as a native language: Mandarin (incl. Standard Chinese), Spanish, English, Hindi, Arabic, Bengali, Portuguese, Russian, Punjabi, and Japanese. However, much of the world's population also speaks a second language. When considering total numbers of speakers of a particular language (native speakers plus second or third, etc. language speakers), the languages and their order change from the native language list provided.
- 背景：目前地球上约有6,900种语言。普通话（包括标准中文），西班牙文，英文，印度文，阿拉伯文，孟加拉文，葡萄牙文，俄文，旁遮普文和日文，大约有一半的世界人口是以下十种语言中的一种。但是，全世界的许多人口也会说第二种语言。在考虑特定语言（母语人士，第二或第三等语言发言者）的总发言人数时，语言及其顺序会从所提供的母语列表中变化。



2018 MCM Problem B: How Many Languages? 多少种语言?

- The total number of speakers of a language may increase or decrease over time because of a variety of influences to include, but not limited to, the language(s) used and/or promoted by the government in a country, the language(s) used in schools, social pressures, migration and assimilation of cultural groups, and immigration and emigration with countries that speak other languages. Moreover, in our globalized, interconnected world there are additional factors that allow languages that are geographically distant to interact. These factors include international business relations, increased global tourism, the use of electronic communication and social media, and the use of technology to assist in quick and easy language translation.
- 一种语言的说话人总数可能随着时间的推移而增加或减少，原因是各种影响包括但不限于一国政府使用和/或推广的语言，语言，用于学校，社会压力，文化团体的移民和同化，以及与讲其他语言的国家的移民。而且，在我们这个全球化的，相互联系的世界里，还有另外的因素让地理上遥远的语言能够互动。这些因素包括国际商业关系，增加的全球旅游业，电子通讯和社交媒体的使用，以及利用技术来协助快速和简单的语言翻译。



2018 MCM Problem B: How Many Languages? 多少种语言?

Native Language Rank	Native Language	Family	Native Speakers	Second (or 3rd, etc) Language Speakers	Second Language Rank	Total
1	Mandarin Chinese (incl. Standard Chinese)	Sino-Tibetan, Sinitic	897 million	193 million	4	1.09 billion
2	Spanish	Indo-European, Romance	436 million	91 million	8	527 million
3	English	Indo-European, Germanic	371 million	611 million	1	983 million
4	Hindustani (Hindi/Urdu)	Indo-European, Indo-Aryan	329 million	215 million	2	544 million
5	Arabic	Afro-Asiatic, Semitic	290 million (2017)	132 million	6	422 million
6	Bengali	Indo-European, Indo-Aryan	242 million	19 million in Bangladesh (2011)	13	261 million
7	Portuguese	Indo-European, Romance	218 million	11 million	15	229 million
8	Russian	Indo-European, Slavic	153 million	113 million (2010)	7	267 million
9	Punjabi	Indo-European, Indo-Aryan	148 million	?	?	148 million
10	Japanese	Japonic	128 million	1 million (2010)	19	129 million

从... 获得https://en.wikipedia.org/wiki/List_of_languages_by_total_number_of_speakers 2018年1月17日

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2018 MCM Problem B: How Many Languages? 多少种语言?

- **Problem:** A large multinational service company, with offices in New York City in the United States and Shanghai in China, is continuing to expand to become truly international. This company is investigating opening additional international offices and desires to have the employees of each office speak both in English and one or more additional languages. The Chief Operating Officer of the company has hired your team to investigate trends of global languages and location options for new offices.
- 问题：一家在美国纽约市和中国上海设有办事处的大型跨国服务公司正在不断拓展，成为真正的国际化公司。该公司正在调查开设更多的国际办事处，并希望每个办事处的员工都能用英语和一种或多种其他语言进行讲话。该公司的首席运营官已经聘请了你的团队来调查全球语言的发展趋势以及新办公室的位置选择。



2018 MCM Problem B: How Many Languages? 多少种语言?

- **Part I:**
- **A.** Consider the influences and factors described in the background paragraph above, as well as other factors your group may identify. Based on projected trends, and some or all of these influences and factors, model the distribution of various language speakers over time.
- **第一部分:**
- **A.** 考虑上述背景段落中描述的影响和因素，以及您的团队可能识别的其他因素。根据预测的趋势，以及一些或所有这些影响和因素，建立各种语言使用者随时间分布的模型。



2018 MCM Problem B: How Many Languages? 多少种语言?

- **B.** Use your model to predict what will happen to the numbers of native speakers and total language speakers in the next 50 years. Do you predict that any of the languages in the current top-ten lists (either native speakers or total speakers) will be replaced by another language? Explain.
- **B.** 使用你的模型来预测在未来50年以英语为母语者和以英语为母语者的人数会发生什么变化。你认为目前排名前十的语言(母语或总母语)会被另一种语言取代吗?并做解释说明。



2018 MCM Problem B: How Many Languages? 多少种语言?

- C. Given the global population and human migration patterns predicted for the next 50 years, do the geographic distributions of these languages change over this same period of time? If so, describe the change.
- C. 鉴于未来50年预测的全球人口和人口迁移模式，这些语言的地理分布在同一时期是否会发生变化？如果是这样，请描述这个变化。



2018 MCM Problem B: How Many Languages? 多少种语言?

- **Part II:**
- **A.** Based on your modeling from **Part I**, and assuming your client company wants to open six new international offices, where might you locate these offices and what languages would be spoken in the offices? Would your recommendations be different in the short term versus the long term? Explain your choices.
- 第二部分:
- A. 根据您在第一部分中的模型，并假设您的客户公司想要开设六个新的国际办事处，那么您可以将这些办事处设在哪里？这些办事处使用什么语言？你的建议是短期的还是长期的？解释你的选择。



2018 MCM Problem B: How Many Languages?多少种语言?

- **B.** Considering the changing nature of global communications, and in an effort to save your client company resources, might you suggest that the company open less than six international offices? Indicate what additional information you would need and describe how you would analyze this option in order to advise your client.
- **B.** 考虑到全球通信的变化, 为了节省客户公司的资源, 您是否可以建议公司开设少于六个国际办事处?说明你需要哪些额外的信息, 并描述你将如何分析这个选项, 以便为你的客户提供建议。



2018 MCM Problem B: How Many Languages? 多少种语言?

- **Part III:**

- Write a 1-2 page memo to the Chief Operating Officer of the service company summarizing your results and recommendations.
- **Note:** In your analysis, ignore unpredictable or high-impact, low probability events such as asteroid collisions that would cause a catastrophic jump in evolutionary trends over time, and possibly render all languages extinct.
- 第三部分：
- 向服务公司的首席运营官写一个1-2页的备忘录，总结你的结果和建议。
- 注意：在您的分析中，忽略不可预测的或高影响的低概率事件，例如小行星碰撞，随着时间的推移会导致演化趋势发生灾难性的跳跃，并可能使所有语言都灭绝。



2018 MCM Problem B: How Many Languages? 多少种语言?

- Your submission should consist of:
 - One-page Summary Sheet,
 - Two-page memo,
 - Your solution of no more than 20 pages, for a maximum of 23 pages with your summary and memo.
 - Note: Reference list and any appendices do not count toward the 23-page limit and should appear after your completed solution.
- 您的提交应该包括：
 - 一页总结表，
 - 两页的备忘录，
 - 您的解决方案不超过20页，最多23页的摘要和备忘录。
 - 注意：参考列表和任何附录不计入23页限制，应在完成解决方案后出现。



2018 MCM Problem B: How Many Languages?多少种语言?

- Attachments: List of Languages by Total Numbers of Speakers
- *nologue* (2017 20th edition)
- The following 26 languages are listed as having 50 million or more total speakers in the 2017 edition of *Ethnologue*, a language reference published by SIL International based in the United States[2] (although *Ethnologue* also lists more than only these 26 languages as having 50 million or more total speakers, e.g., the Wikipedia page for the Tagalog language reports 70+ million speakers by as early as 2000 and 73+ million speakers by 2013: 28 million L1 speakers as of 2007 and 45 million L2 speakers as of 2013; these are largely based on *Ethnologue* reports and would, e.g., unless further updated, rank it as the language with the 26th most L1 speakers, the 13th most L2 speakers, and the 23rd most speakers in total). Speaker totals are generally not reliable, as they add together estimates from different dates and (usually uncited) sources; language information is not collected on most national censuses.
- 附件： 发言人总数的语言清单
- 民族志（2017年第20版）
- 以下26种语言在2017年版“民族志”（*Ethnologue*）中被称为总计5000万或以上的语言，这是SIL International在美国出版的一种语言参考\（尽管民族语言也列出了不止26种语言，总计有百万或更多的讲者，例如，塔加拉语言的维基百科页面最早在2000年报告了7千多万讲话者，并在2013年之前报告了7千3百万讲话者：
- 截至2007年，有2800万L1语言员工，截至2013年，有4500万名L2语言员工；这些主要基于民族志报告，例如，除非进一步更新，否则将其作为第二十一话者，第二十三话者和第二十三讲话者的语言。 演讲者总数通常是不可靠的，因为他们将来自不同日期的估计值（通常是未被引用的）来源加在一起；大多数国家人口普查都不收集语言信息。



2019 MCM Problem B:发送无人 机：开发空中灾难救援响应系统



2019 MCM Problem B: Send in the Drones: Developing an Aerial Disaster Relief Response System 发送无人机：开发空中灾难救援响应系统

- **Background:** In 2017, the worst hurricane to ever hit the United States territory of Puerto Rico (see Attachment 1) left the island with severe damage and caused over 2900 fatalities. The combined destructive power of the hurricane's storm surge and wave action produced extensive damage to buildings, homes, and roads, particularly along the east and southeast coast of Puerto Rico. The storm, with its fierce winds and heavy rain, knocked down 80 percent of Puerto Rico's utility poles and all transmission lines, resulting in loss of power to essentially all of the island's 3.4 million residents. In addition, the storm damaged or destroyed the majority of the island's cellular communication networks.
- **背景：**2017年，遭受美国波多黎各领土袭击的最严重飓风（见附件1）使该岛遭受严重破坏，造成2900多人死亡。飓风风暴潮和波浪作用的综合破坏力对建筑物，房屋和道路造成了广泛的破坏，尤其是波多黎各东部和东南沿海地区。风暴和暴雨带来的风暴击倒了 波多黎各80%的电线杆和所有输电线路，导致基本上所有岛屿三四百万居民都失去了电力。此外，风暴还破坏或摧毁了岛上大部分的蜂窝通信网络。



2019 MCM Problem B: Send in the Drones: Developing an Aerial Disaster Relief Response System 发送无人机：开发空中灾难救援响应系统

- The electrical power and cell service outages lasted for months across much of the island, and longer in some locations. Widespread flooding blocked and damaged many highways and roads across the island, making it nearly impossible for emergency services ground vehicles to plan and navigate their routes. The full extent of the damage in Puerto Rico remained unclear for some time; dozens of areas were isolated and without communication. Demands for medical supplies, lifesaving equipment, and treatment strained health-care clinics, hospital emergency rooms, and *non-governmental organizations*' (NGOs) relief operations. Demand for medical care continued to surge for some time as the chronically ill turned to hospitals and temporary shelters for care.
- 岛上大部分地区的电力和电池服务中断持续数月，而在某些地区则更长。广泛的洪水阻塞并破坏了岛上的许多高速公路和道路，使得紧急服务地面车辆几乎不可能规划和导航他们的路线。波多黎各的全面破坏程度在一段时间内仍不明朗；数十个地区被孤立，没有沟通。对医疗用品，救生设备和治疗紧张的保健诊所，医院急诊室和非政府组织（NG）救济行动的需求。由于长期病患转向医院和临时住所接受护理，医疗保健需求持续激增一段时间。



2019年MCM的问题B：发送无人机：开发空中灾难救援响应系统

- **Problem:** Non-governmental organizations (NGOs) are often challenged to provide adequate and timely response during or after natural disasters, such as the hurricane that struck the United States territory of Puerto Rico in 2017. One NGO in particular – HELP, Inc. - is attempting to improve its response capabilities by designing a transportable disaster response system called “DroneGo” DroneGo will use rotor wing *drones* to deliver pre-packaged medical supplies and provide high-resolution aerial video reconnaissance.
- **问题：**在自然灾害期间或之后，如2017年袭击美国领土波多黎各的飓风，非政府组织经常面临提供充分和及时反应的挑战。一个特别的非政府组织——帮助公司——正试图通过设计一种叫做“DroneGo”的可运输的灾难响应系统来提高它的响应能力。“DroneGo”将使用旋翼无人机运送预先包装好的医疗用品，并提供高分辨率的空中视频侦察。



2019年MCM的问题B：发送无人机：开发空中灾难救援响应系统

- Selected drones should be able to perform these two missions — medical supply delivery and video reconnaissance — simultaneously or separately, depending on relief conditions and scheduling. HELP, Inc. has identified various candidate rotor wing drones that it would like your team to consider for possible use in designing its *DroneGo fleet* (see Attachments 2, 3).
- 被选中的无人机应该能够同时或分别执行这两项任务——医疗物资运送和视频侦察——这取决于救援条件和日程安排。HELP, Inc. 已经确定了各种候选旋翼无人机，希望您的团队在设计其DroneGo机队时考虑使用这些无人机(见附件2, 3)。



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- DroneGo's pre-packaged medical supplies, called *medical packages*, are meant to augment, not replace, the supplies provided by local medical assistance organizations on-site within the country affected by the disaster. HELP, Inc. is planning on three different medical packages referred to as MED1, MED2, and MED3. Drones will carry these medical packages within *drone cargo bays* for delivery to selected locations (see Attachments 4, 5).
- DroneGo的预先包装的医疗用品被称为医疗包，其目的是增加而不是取代受灾国家当地医疗援助组织提供的物资。HELP公司计划推出三种不同的医疗包，分别称为MED1、MED2和MED3。无人机将在无人机货舱内携带这些医疗包裹，将其运送到选定的地点（见附件4、5）。



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- Depending on the specific drone being used to transport medical supplies, it may be possible that multiple medical packages can be transported in a single drone cargo bay. Note that drones must land on the ground to offload medical supplies from the drone cargo bays. The video capability of the drones will provide high-resolution video of damaged and serviceable transportation road networks to HELP, Inc.'s command and control center for ground-based route planning.
- 根据用于运输医疗用品的特定无人机，可能在一个无人机货舱中可以运输多个医疗包。请注意，无人机必须降落在地面，从无人机货舱卸载医疗用品。无人机的视频能力将提供损坏和可用的运输道路网络的高分辨率视频，以帮助公司的指挥和控制中心进行地面路线规划。



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- HELP, Inc. will use International Standards Organization (ISO) standard dry *cargo containers* to quickly transport a complete DroneGo disaster response system to a particular disaster area. The individual shipping containers for all drones in the DroneGo fleet, along with all required medical packages, must fit within a maximum of three of the ISO cargo containers to be delivered to a single location, or up to three different locations if three cargo containers are used in the disaster area. Each shipping container's contents should be packed in order to minimize any need for buffer materials for unused space. Table 1 shows the dimensions of an ISO standard dry cargo container.
- HELP公司将使用国际标准组织(ISO)的标准干货集装箱快速将完整的DroneGo灾难响应系统运送到特定的灾区。单个集装箱所有无人机DroneGo舰队,连同所有必需的医疗包,必须符合ISO的最大的三个集装箱交付给一个位置,或者如果三个货物集装箱用于灾区的话可交付三个不同的位置。每个集装箱内的货物都应进行包装,以尽量减少对缓冲材料的需求



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Table 1. Standard ISO Container Dimensions

	Exterior			Interior			Door Opening	
	Length	Width	Height	Length	Width	Height	Width	Height
20' Standard Dry Container	20'	8'	8'6"	19'3"	7'8"	7' 10"	7'8"	7'5"

表1. 标准ISO容器尺寸

	外观			内部			开门	
	长度	宽度	高度	长度	宽度	高度	宽度	高度
20' 标准干 燥容器	20'	8'	8'6"	19'3"	7'8"	7' 10"	7'8"	7'5"



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- HELP, Inc. is asking your team to use the 2017 situation in Puerto Rico to design a DroneGo disaster response system that will fit within the containers noted while meeting the anticipated medical supply demands during a potential similar future disaster scenario. It is possible that the demand requirements of this scenario may exceed the capabilities of the drone fleet your team identifies. If this occurs, HELP, Inc. wants to clearly understand any tradeoffs that it must make for implementing solutions to address these shortcomings.
- HELP公司要求您的团队利用2017年波多黎各的情况来设计一个DroneGo灾难响应系统，该系统将适用于已记录的容器，同时在未来可能发生类似灾难的情况下满足预期的医疗供应需求。该场景的需求需求可能超出您的团队识别的无人机舰队的能力。如果出现这种情况，HELP公司希望清楚地了解它在实现解决方案来解决这些缺陷时必须进行的任何权衡。



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- **Part 1. Develop a DroneGo disaster response system to support the Puerto Rico hurricane disaster scenario.**
- Consider the background information, the requirements identified in the problem statement, and the information provided in the problem attachments to address the following.
- **A. Recommend a drone fleet and set of medical packages for the HELP, Inc. DroneGo disaster response system that will meet the requirements of the Puerto Rico hurricane scenario. Design the associated packing configuration for each of up to three ISO cargo containers to transport the system to Puerto Rico.**
- **第1部分。开发DroneGo灾难响应系统，以支持波多黎各飓风灾难情景。**
- 请考虑背景信息，问题陈述中确定的要求以及问题附件中提供的信息，以解决以下问题。
- **A. 为HELP公司推荐一个无人机舰队和一套医疗包。DroneGo灾难响应系统将满足波多黎各飓风场景的要求。为每个最多三个ISO货物集装箱设计相关的包装配置，以便将系统运输到波多黎各。**



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- B. Identify the best location or locations on Puerto Rico to position one, two, or three cargo containers of the DroneGo disaster response system to be able to conduct both medical supply delivery and video reconnaissance of road networks.
- B. 确定波多黎各的最佳位置，放置一个、两个或三个DroneGo灾难响应系统的货物集装箱，以便能够进行医疗供应的交付和道路网络的视频侦察。



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- C. For each type of drone included in the DroneGo fleet:
- a. Provide the *drone payload packing configurations* (i.e. the medical packages packed into the drone cargo bay), delivery routes and schedule to meet the identified emergency medical package requirements of the Puerto Rico hurricane scenario.
- C. 对于DroneGo车队中包含的每种类型的无人机：
- a. 提供无人机有效载荷包装配置（即包装在无人机货舱中的医疗包），交付路线和时间表，以满足波多黎各飓风情况下确定的紧急医疗包要求。



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- b. Provide a drone flight plan that will enable the DroneGo fleet to use onboard video cameras to assess the major highways and roads in support of the Help, Inc. mission.
- b. 提供无人机飞行计划，使DroneGo车队能够使用车载摄像机评估支持 Help, Inc. 任务的主要高速公路和道路。



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- **Part 2. Memo** Write a 1–2 page memo to the Chief Operating Officer (CEO) of HELP, Inc. summarizing your modeling results, conclusions, and recommendations so that she can share with her Board of Directors.
- **第2部分。备忘录**
- 为HELP, Inc. 的首席运营官（CEO）写一份1-2页的备忘录，总结您的建模结果，结论和建议，以便她与董事会分享。



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- Your MCM team submission should consist of:
 - One-page Summary Sheet,
 - One- to Two-page memo to the HELP, Inc. CEO
- Your solution of no more than 20 pages, for a maximum of 23 pages with your summary and memo.
- Note: Reference list and any appendices do not count toward the 23-page limit and should appear after your completed solution.
- 您的MCM团队提交应包括：
 - 一页摘要表，
 - 向HELP, Inc。首席执行官发送一到两页的备忘录
 - 您的解决方案不超过20页，最多23页，包括您的摘要和备忘录。
 - 注意：参考列表和任何附录不计入23页的限制，应在完成的解决方案后显示。



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- **Attachments:**

- 1. Map of Puerto Rico
 - 2. Potential Candidate Drones for DroneGo Fleet Consideration (with Drone payload capability)
 - 3. Drone Cargo Bay Packing Configuration/Dimensions by Type
 - 4. Anticipated Medical Package Demand
 - 5. Emergency Medical Package Configuration/Dimensions
-
- 1. 波多黎各地图
 - 2. 针对DroneGo舰队考虑的潜在候选无人机（具有无人机有效载荷能力）
 - 3. 无人机货物海湾包装配置/尺寸
 - 4. 预期的医疗包装需求
 - 5. 紧急医疗包配置/尺寸



Attachment 1: Map of Puerto Rico 附件1：波多黎各地图





Attachment 2: Potential Candidate Drones for DroneGo Fleet Consideration (with Drone *Payload Capability*)

Drone	Shipping Container Dimensions			Performance Characteristics/Capabilities			Configurations Capabilities		
	Length (in.)	Width (in.)	Height (in.)	Max Payload Capability (lbs.)	Speed (km/h)	Flight Time No Cargo (min)	Video Capable	Medical Package Capable	Drone Cargo Bay Type*
A	45	45	25	3.5	40	35	Y	Y	1
B	30	30	22	8	79	40	Y	Y	1
C	60	50	30	14	64	35	Y	Y	2
D	25	20	25	11	60	18	Y	Y	1
E	25	20	27	15	60	15	Y	Y	2
F	40	40	25	22	79	24	N	Y	2
G	32	32	17	20	64	16	Y	Y	2
H Tethered	65	75	41	N/A	N/A	Indefinite	N	N	N/A

*Note that cargo bays are affixed to the drone and that drone must be on the ground to offload cargo. See Attachment 3 for Drone Cargo Bay Type Configuration/Dimensions.



附件2：DroneGo舰队考虑的潜在候选无人机（具有无人机负载能力）

附件2：DroneGo舰队考虑的潜在候选无人机（具有无人机负载能力）

无人机	运输集装箱尺寸			性能特征/功能			配置功能		
	长度 (英寸)	宽度 (英寸)	高度 (英寸)	最大有效负载能力 (磅)	速度 (km / h)	飞行时间没有货物 (分钟)	视频功能	医疗包装能力	无人机货舱类型*
A	45	45	25	3.5	40	35	Y	Y	1
B	30	30	22	8	79	40	Y	Y	1
C	60	50	30	14	64	35	Y	Y	2
D	25	20	25	11	60	18	Y	Y	1
E	25	20	27	15	60	15	Y	Y	2
F	40	40	25	22	79	24	N	Y	2
G	32	32	17	20	64	16	Y	Y	2
H 挂	65	75	41	N/A	N/A	不定	N	N	N/A

*请注意，货舱设在无人机上，无人机必须在地面上以卸载货物。有关无人机货舱类型配置/尺寸，请参阅附件2。



Attachment 3: Drone Cargo Bay Packing Configuration/Dimensions by Type

Drone Cargo Bay Type	Length (in)	Width (in)	Height (in)	
1	8	10	14	Top Loaded
2	24	20	20	Top Loaded

Attachment 3: Drone Cargo Bay Packing Configuration/Di mensions by Type

Delivery Location			Emergency Medical Packages **		
Location Name	Latitude	Longitude	Requirement	Quantity	Frequency
Caribbean Medical Center Jajardo	18.33	-65.65	MED 1	1	Daily
			MED 3	1	Daily
Hospital HIMA San Pablo	18.22	-66.03	MED 1	2	Daily
			MED 3	1	Daily
Hospital Pavia Santurce San Juan	18.44	-66.07	MED 1	1	Daily
			MED 2	1	Daily
Puerto Rico Children's Hospital Bayamon	18.40	-66.16	MED 1	2	Daily
			MED 2	1	Daily
			MED 3	2	Daily
Hospital Pavia Arecibo Arecibo	18.47	-66.73	MED 1	1	Daily

**See Attachment 5 for Emergency Medical Packages 1, 2, and 3 Configurations/Dimensions.



附件3：无人机货物海湾包装配置/尺寸类型

无人机货物湾类型	长度 (in)	宽度 (in)	高度 (in)	
1	8	10	14	顶部装载
2	24	20	20	顶部装载

附件4：预期的医疗包装需求

交货地点			紧急医疗包**		
地点名称	纬度	经度	需求	数量	频率
加勒比医疗中心 贾哈多	18.33	-65.65	医学1	1	日常
			3	1	日常
HIMA医院 圣巴勃罗	18.22	-66.03	医学1	2	日常
			3	1	日常
医院帕维亚桑图尔塞 圣胡安	18.44	-66.07	医学1	1	日常
			2	1	日常
波多黎各儿童医院 巴亚蒙	18.40	-66.16	医学1	2	日常
			2	1	日常
			3	2	日常
帕维亚阿雷西博医院 阿雷西博	18.47	-66.73	医学1	1	日常

**请参阅附件5，了解紧急医疗包装1、2和3的配置/尺寸。



Attachment 5: Emergency Medical Package Configuration/Dimensions

Emergency Medical Package Configuration		
Package ID	Weight (lbs.)	Package Dimensions (in.) (L × W × H)
MED 1	2	14 × 7 × 5
MED 2	2	5 × 8 × 5
MED 3	3	12 × 7 × 4

附件5：紧急医疗包配置/尺寸

紧急医疗包配置		
包ID	重量 磅。)	包装尺寸 (英寸) (L × W × H)
医学1	2	14 × 7 × 5
2	2	5 × 8 × 5
3	3	12 × 7 × 4



- **Glossary: Cargo Container (Shipping Container):** a large rectangular container with doors on the ends for loading and packing, and made of material suitable for shipping, storing, and handling in many weather and climate conditions.
- **名词解释:**
- **货物集装箱（集装箱）：**一种大型矩形集装箱，两端装有门，用于装载和包装，并由 适合在许多天气和气候条件下运输，储存和处理的材料制成。



- **Drone (Unmanned Aerial Vehicle, UAV):** a flying robot that can be remotely controlled or fly autonomously through software-controlled flight plans in their embedded systems that work in conjunction with onboard sensors and GPS.
- 无人机（无人机）：一种飞行机器人，可通过其嵌入式系统中的软件控制飞行计划进行远程控制或自主飞行，与机载传感器和GPS配合使用。



- **Drone Cargo Bay:** For rotor wing drones, this is an externally carried “box” used to transport materials. For this problem, the drones under consideration have one of two types (sizes) of cargo bays. Note that each drone must land for the medical packages to be unloaded from the bay at its destination.
- **Drone Cargo Bay:** 对于旋翼无人机来说，这是一个用于运输材料的外部运输“盒子”。对于这个问题，所考虑的无人机具有两种类型（尺寸）的货舱。请注意，每个无人机必须着陆才能将医疗包从目的地的海湾卸下。



- **Drone Fleet:** a set of drones for a particular mission or purpose. For this problem, the total set of drones by type (A to H) and Payload Capability (Visual and Medical) needed to meet the requirements of HELP, Inc.
- **无人机舰队：**用于特定任务或目的的一组无人机。对于这个问题，按类型（A到H）和有效负载能力（视觉和医疗）的无人机总数需要满足HELP公司的要求。



- **Drone Payload Packing Configuration:** how the drone payload bays are packed. For this problem, how the medical packages being transported by a drone are packed inside the drone cargo bay.
- 无人机有效载荷包装配置：如何打包无人机有效载荷托架。
无人机运输的医疗包装如何在无人机货舱内包装。



- **Medical Package:** a predetermined set of medical supplies packed in a single container. For this problem, there are three Medical Package Configurations (MED1, MED2, MED3) available for transport by a drone from a deployed cargo container location to the demand location.
- **医疗包：**一套预装的医疗用品，装在一个容器中。对于此问题，有三种医疗包配置（MED1，MED2，MED3）可供无人机从已部署的货物集装箱位置运输到需求位置。



- **Non-governmental Organization (NGO):** Usually non-profit and sometimes international organization independent of government and governmental organizations that is active in humanitarian, educational, healthcare, social, public policy, human rights, environmental and other areas in attempts to affect change.
- **Payload Capability:** the carrying capacity of an aircraft or launch vehicle, usually measured in terms of weight. For this problem, the capability/capacity of the drone to carry medical packages.
- **非政府组织 (NGO)：** 通常是非营利组织，有时是独立于政府和政府组织的国际组织，它们活跃于人道主义，教育，医疗，社会，公共政策，人权，环境和其他领域，试图影响变革。
- **有效载荷能力：** 飞机或运载火箭的承载能力，通常以重量来衡量。对于这个问题，无人机携带医疗包的能力/容量。