|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | | For office use only | | | T1 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | T2 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | T3 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | T4 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | |  | | --- | | Team Control Number **1901387** | |  | | Problem Chosen **B** | | |  |  | | --- | --- | | For office use only | | | F1 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | F2 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | F3 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | F4 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | |
| **2019 MCM/ICM Summary Sheet** | | |

A Dynamic Model of Language Evolution

Summary

In order to predict the number of L1 and L2, we looked at several types of data: the number of L1 and L2 in the first category. The second category: the number of countries over the years and the use of languages. The third Category: Gross domestic product, GDP per capita, natural index of each country, assessment of national education level, evaluation of national Policy index, etc.

In order to find the relationship between the data, we first carried out the cluster analysis, and then we had the linear regression analysis respectively. We believe that the population and language use are the main factors affecting the number of L1, while the number of L2 is related to GDP, natural index and language area. So we decided to use the logistic population forecast model to predict the number of L1 in terms of the data characteristics, and finally our results show that there are several languages L1 in the next 50 years (this is the predicted result). For L2 we think that diffusion equations in fluid mechanics can simulate the growth of L2 population, so we build our equations according to the Fick law. The number of L2 in the next 50 years is calculated.

In order to solve the problem of the office clearly, we have further processed the data. First we took advantage of the scoring queue to evaluate the situation of the language for the next 50 years, and finally confirmed that the offices we were going to set up should be located in the (results), and the language in the office would be the results. Of course, through the analysis we found that the results of the assessment in the last 20 years and the next 50 years there are differences. So we think that the future office may need to change. As for the need to set up six offices, we have interpolated the population data and calculated the slope of the points, because the lack of company data does not yield accurate benefit expectations, so we generally think that we need to handle six offices.

Keywords: cluster analysis, linear regression, population prediction, diffusion equation, scoring line method参考模板简要说明(Page6), 阅后务必删除…

Contents

[1 Introduction 3](#_Toc506270747)

[1.1 Problem Background 3](#_Toc506270748)

[1.2 Previous Research 3](#_Toc506270749)

[1.3 Breaking Down the Problem 3](#_Toc506270750)

[2 Assumptions 4](#_Toc506270751)

[3 Nomenclature 4](#_Toc506270752)

[4 Part I: Two Models 5](#_Toc506270753)

[4.1 Model I: Drone loading 5](#_Toc506270754)

[4.1.1 Throwing area 5](#_Toc506270755)

[4.1.2 Region Partition 7](#_Toc506270756)

[4.1.3 Prediction of Parameters 7](#_Toc506270757)

[4.1.4 Increasing Rate of Total Speakers’ Number 12](#_Toc506270758)

[4.1.5 Conclusion 13](#_Toc506270759)

[4.2 Model II: Non-native Speakers 13](#_Toc506270760)

[4.2.1 Influential Parameters 13](#_Toc506270761)

[4.2.2 Molecular Diffusion Model 14](#_Toc506270762)

[4.2.3 Conclusion 16](#_Toc506270763)

[5 Part II: Company’s future 16](#_Toc506270764)

[5.1 Our six international offices 16](#_Toc506270765)

[5.2 Our suggest 18](#_Toc506270766)

[6 Strengths and Weaknesses 18](#_Toc506270767)

[6.1 Strengths 18](#_Toc506270768)

[6.2 Weaknesses 18](#_Toc506270769)

[7 Memo to the Chief Operating Officer 20](#_Toc506270770)

[Appendices 23](#_Toc506270771)

[Appendix A First appendix 23](#_Toc506270772)

# 1 Introduction

## 1.1 Problem Background

In recent years, the deployment of medical drugs through airdrops has become more common and more widely used; it is because it is a precise method of calculating the speed, wind direction, wind speed, height and other factors of the drone. Very accurate air delivery.

Now HELP, Inc invites us to design a mobile disaster response system called "DroneGo" that not only provides high-resolution aerial video but also accurately delivers pre-packaged medical supplies. This is extremely important for areas hit by natural disasters.

## 1.2 Previous Research

Some magazines and websites that focus on language have collected the increase of users. We download database from Wor88ld Bank and other organizations. And take a look on many professional maginzes.

## 1.3 Breaking Down the Problem

After carefully analyzed the requirement from the Chief Operating Officer, we sort out five main sub-problems below to resolve in this paper:

1. Identification the parameters which have significant influence to the number of native speakers or non-native speakers.
2. Build reasonable models to predict how those parameters which influenced the number of native speaker growth over time.
3. Build reasonable models to predict how those parameters which influenced the number of non-native speaker growth over time.
4. Find out a logical model to estimates the increase(decrease) trend of the native speakers’ and non-native speakers’ number.
5. Design a strategy study for the company’s development.

To tackle the first problem, we choose some of the influential parameters referring the evaluation method to the language’s vitality from the Word's 10 Most Influential Languages written by George Weber. After that, we choose the more relative one by using the Hierarchical Clustering Method.

As for the second problem, considering all the influential parameters are consecutive and irrelevant, we use Logistic Regression to predict their growth trends

In a view of non-native speakers’ number increase(decrease) in dynamic process. We draw an analogy between the trend of non-native speakers’ number and the Fick’s Law to solve the third problem.

The fourth problem will be easily resolved through Regression Analysis with the data from the previous questions.

To deal with the touchy issue of operate the company. We use George Weber’s evaluation method to remark each language’s score.

# 2 Assumptions

* Since Puerto Rico’s geographical location is very small in the latitude and longitude of the Earth, it is assumed that Puerto Rico’s surface map on the globe is approximately flat.
* According to the background, there are four different types of packages from large to small: ISO container, shipping container, cargo bay, medical package. Their relationship is that the medical packages are installed in the cargo bay, and the cargo bay is installed in the shipping container. The entire emergency system is installed in the ISO container.
* Different types of medical packages need to be placed every day from five locations, so we can reasonably assume that all the medical packages required for each location are packed in a cargo bay. When the drone delivers these supplies, it only needs to be in the shipping container. A cargo bay is placed in one of the five locations specified. The parameter of population growth rate only rely on the birth rate, the death rate and the population base.
* In order to simplify the calculations that follow, we will present the above five locations, Caribbean Medical Center, Hospital HIMA, Hospital Pavia Santurce, Puerto Rico Children's Hospital and Hospital Pavia Arecibo, a, b, c, d, e, respectively.
* 无人机在传递医疗包的路线是直线，而且途中不允许降落到ISO cargo containers里面添加能量和医疗包，也就是说，无人机只有卸医疗包和完成传递任务返航回来才可以降落。
* 假设无人机负重时航程的减少和负重成正比。
* 本论文使用的数据都是可靠的。

# 3 Nomenclature

表头，三列，第一列参数，第二列描述，第三列，单位（没有可写无，个这种单位也是无），最好是下面这种表格的形式

2005 年地方院校招生人数

|  |  |  |  |
| --- | --- | --- | --- |
| 学院 | 新生 | 毕业生 | 更改 |
|  | 本科生 |  |  |
| Cedar 大学 | 110 | 103 | +7 |
| Elm 学院 | 223 | 214 | +9 |
| Maple 高等专科院校 | 197 | 120 | +77 |
| Pine 学院 | 134 | 121 | +13 |
| Oak 研究所 | 202 | 210 | -8 |
|  | 研究生 |  |  |
| Cedar 大学 | 24 | 20 | +4 |
| Elm 学院 | 43 | 53 | -10 |
| Maple 高等专科院校 | 3 | 11 | -8 |
| Pine 学院 | 9 | 4 | +5 |
| Oak 研究所 | 53 | 52 | +1 |
| 总计 | 998 | 908 | 90 |

In this paper, we use the nomenclature in Figures and Formulas to describe our model.

|  |  |
| --- | --- |
| x | The Maximum of shipping container’s Length, Width, and Height |
| y | The Second largest value of shipping container’s Length, Width, and Height |
| z | The Minimum of shipping container’s Length, Width, and Height |
| q | The Maximum of cargo bay’s Length, Width, and Height |
| p | The Second largest value of cargo bay’s Length, Width, and Height |
| n | The Minimum of cargo bay’s Length, Width, and Height |
| N | The total number of shipping container can load cargo bay |

# 4 Part I: Two Models

## 4.1 Model I: Drone loading

### 4.1.1 Drone loading

要说一下在这个部分是不考虑距离的。

Through the background, we can know that each of the four aircrafts A, B, C, and D can only carry one of two cargo bays. (After calculating A, B, C, D, E, F, the six aircrafts are calculated according to the volume space. The largest number of cargo bays that can be loaded is 27, 8, 4, 6, 1, 4 (Table 1, 2);

For aircraft, the shipping container's Length, Width, and Height are x, y, z respectively, from large to small; the cargo bay's demainsion from large to small are q, p, n.

If x>y>z, q>p>n, The main formula is

,,

With the data upper we can get the shipping container can load up to the total number of cargo bay is

|  |  |  |  |
| --- | --- | --- | --- |
|  | Length (in) | Width (in) | Height (in) |
| Cargo bay1 | 8 | 10 | 14 |
| Cargo bay2 | 24 | 20 | 20 |

**Table 1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Length(in) | Width (in) | Height (in) | Weight(lbs.) | Bay type | Load |
| A | 45 | 45 | 25 | 35 | 1 | 27 |
| B | 30 | 30 | 22 | 8 | 1 | 8 |
| C | 60 | 50 | 30 | 14 | 2 | 4 |
| D | 25 | 20 | 25 | 11 | 1 | 6 |
| E | 25 | 20 | 27 | 15 | 2 | 1 |
| F | 40 | 40 | 25 | 22 | 2 | 4 |

**Table 2**: Load is the number of Cargo bays that can accommodate the corresponding kind

We will have the above five locations: Caribbean Medical Center, Hospital HIMA, Hospital Pavia Santurce, Puerto Rico Children's Hospital and Hospital Pavia Arecibo is represented by a, b, c, d, e, respectively. To determine whether it can be loaded into two types of cargo bays by calculating the sum of the storage space required for the different medical packages required by the five locations. We use this method to handle the following situations.

(1) Assuming that each aircraft can only be departed from one location and can only be in one ISO contioner; the ratio of the total load of the aircraft and the maximum number of cargo bays that can be loaded into the cargo bay is different from that required for the five types of locations. The type of aircraft loaded into the cargo bay is compared, and it can be concluded that the aircraft types that meet the five locations sent to a, b, c, d, e are shown in the following table (see Table 3).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Place | Requirement | Quantity | Weight(lbs.) | Ability Drone |
| a | MED 1  MED 3 | 1  1 | 5 | BCDEF |
| b | MED 1  MED 3 | 2  1 | 7 | CEF |
| c | MED 1  MED 2 | 1  1 | 4 | BCDEF |
| d | MED 1  MED 2  MED 3 | 2  1  2 | 12 | CEF |
| e | MED | 1 | 2 | ABCEF |

**Table 3:** The weight is the total weight of the medical packages and determines the type of drone that can be used.

(2) Assuming that the aircraft can deliver the required drugs to two different locations at a time; there are ten combinations of flight conditions, which are required to compare the total load of the aircraft and the maximum number of cans loaded into the cargo bay and ten combinations. Different medical packages are loaded into the type of cargo bay for comparison. It can be concluded that the aircraft types for ten conditions are as shown in the following table (see Table 4).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Place | Requirement | Quantity | Weight(lbs.) | Ability Drone |
| ab | Bay a+b | 5 | 12 | CF |
| ac | Bay a+c | 4 | 9 | CDF |
| ad | Bay a+d | 8 | 17 | F |
| ae | Bay a+e | 3 | 7 | BCDF |
| bc | Bay b+c | 5 | 11 | CF |
| bd | Bay b+d | 8 | 19 | F |
| be | Bay b+e | 4 | 9 | CF |
| cd | Bay c+d | 7 | 16 | F |
| ce | Bay c+e | 3 | 6 | BCDF |
| de | Bay d+e | 6 | 14 | CF |

**Table 4:** The type of drug contained in cargo bay is the same as in table3.

(3) Assuming that the aircraft can deliver the required drugs to three different locations at a time, there are a total of ten combinations of flight conditions, which are required to compare the total load of the aircraft and the maximum number and ten types that can be loaded into the cargo bay. Different medical packages are loaded into the type of cargo bay for comparison. It can be concluded that the aircraft types for ten conditions are as shown in the following table (see Table 5).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Place | Requirement | Quantity | Weight(lbs.) | Ability Drone |
| abc | Bay abc | 7 | 16 | F |
| abd | Bay abd | 10 | 24 | None |
| abe | Bay abe | 6 | 14 | CF |
| acd | Bay acd | 9 | 21 | F |
| ace | Bay ace | 5 | 11 | CDF |
| ade | Bay ade | 8 | 19 | F |
| bcd | Bay bcd | 10 | 23 | None |
| bce | Bay bce | 6 | 13 | F |
| bde | Bay bde | 9 | 19 | F |
| cde | Bay cde | 8 | 18 | F |

**Table 5:** The type of drug contained in cargo bay is the same as in table3.

(4) Assuming that the aircraft can deliver the required drugs to four different locations at a time, there are five combinations of flight conditions, which are required to compare the total load of the aircraft with the maximum number of five types that can be loaded into the cargo bay. Different medical packages are loaded into the type of cargo bay for comparison. It can be concluded that the five types of aircraft are as shown in the following table (see Table 7).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Place | Requirement | Quantity | Weight(lbs.) | Ability Drone |
| abcd | Bay abcd | 12 | 28 | None |
| abce | Bay abce | 8 | 18 | None |
| abde | Bay abde | 11 | 26 | None |
| acde | Bay acde | 10 | 23 | F |
| bcde | Bay bcde | 11 | 25 | None |

**Table 7:** The type of drug contained in cargo bay is the same as in table3.

### 4.1.2 距离

基于上面只考虑空间和负重的分析，我们提出了set of medical packages的方案。下面再结合距离信息来计算出drone fleet和至多三个ISO cargo containers的位置，这会容易一些，因为上面的分析给出了一些可能的组合，已经排除了一些组合。首先给出每种无人机的无负载最大航程（保留两位小数），如下表所示

|  |  |
| --- | --- |
| 无人机型号 | 最大航程(km) |
| A | 23.33 |
| B | 52.67 |
| C | 37.33 |
| D | 18.00 |
| E | 15.00 |
| F | 31.60 |
| G | 17.07 |

假设无人机负重最大航程和负重，无人机最大负重无负载最大航程的关系：



其中是一个系数，本文中取。

### 4.1.2 .1 无人机只携带一个投放点的医疗包的情况

这种情况我们在上面的表3里又看到，为了方便表示，用一个5行7列矩阵表示。



其中第行第列的元素代表类飞机和投放点之间的关系(A类无人机对应的,B类对应…，以此类推，a地点对应,b地点对应，以此类推)。元素为1代表类飞机可以承担投放点医疗包投放(delivery)的任务，0代表不能承担。因为是一架无人机只装载一个投放点的医疗保并且有五个投放地点，所以每天需要出动五架无人机来投放物资。设是第架无人机每天传递物资需要的航程。那么提出一个目标函数：



为了尽可能地节省能源，这个函数地值应该尽可能的小，也就是要使用优化算法实现：



我们使用粒子群优化算法来解决这个问题，步骤如下：

第一步：初始化粒子群和速度，采用100个粒子群，粒子群和速度都是遵循下面的公式产生：



其中，是第个粒子群中3个粒子的纬度，是第个粒子群中3个粒子的经度， 产生三个-1到1之间的随机数，它们都是1×3的向量。是第个粒子群中3个粒子的速度，产生六个-1到1之间的随机数，它们都是1×6的向量。之所以按照上面的公式来产生初始粒子群，是因为波多黎各所跨的纬度大概是17.9度到18.5度，所跨的经度大概是-67.2到-65.6度，上面公式里面经度没有带负号，这并不会影响结果。然后要计算适应度函数的值，计算方法如下：