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# 2017 ICM

Problem D: Optimizing the Passenger Throughput at an Airport Security **Checkpoint**

# 问题 d︰ 优化在机场安检旅客吞吐量

## Throughput

## bottleneck anjianhuanjiezhong jianmansudude huanjie

## precheck

Following the terrorist attacks in the US on September 11, 2001, airport security has been significantly enhanced throughout the world. Airports have security checkpoints, where passengers and their baggage are screened for explosives and other dangerous items. The goals of these security measures are to prevent passengers from hijacking or destroying aircraft and to keep all passengers safe during their travel. However, airlines have a vested interest in maintaining a positive flying experience for passengers by minimizing the time they spend waiting in line at a security checkpoint and waiting for their flight. Therefore, there is a tension between desires to maximize security while minimizing inconvenience to passengers.

在 2001 年 9 月 11 日美国恐怖袭击后，机场安全已在世界范围内大大加强。机场有安全检查站，用来扫描排查乘客和他们的行李中的爆炸物和其他危险物品。这些安全措施的目标是防止乘客被劫持或破坏飞机并保证所有的乘客的安全，在旅行时。然而，航空公司在维持乘客积极的飞行经验有既得利益，通过最小化在安全检查站排队等待以及候机的时间。因此，存在一个张力——要最大限度地安全，同时尽量减少对乘客造成的不便。

During 2016, the U.S. Transportation Security Agency (TSA) came under sharp criticism for extremely long lines, in particular at Chicago’s O’Hare international airport. Following this public attention, the TSA invested in several modifications to their checkpoint equipment and procedures and increased staffing in the more highly congested airports. While these modifications were somewhat successful in reducing waiting times, it is unclear how much cost the TSA incurred to implement the new measures and increase staffing. In addition to the issues at O’Hare, there have also been incidents of unexplained and unpredicted long lines at other airports, including airports that normally have short wait times. This high variance in checkpoint lines can be extremely costly to passengers as they decide between arriving unnecessarily early or potentially missing their scheduled flight. Numerous news articles, including [1,2,3,4,5], describe some of the issues associated with airport security checkpoints.

在 2016 年，美国运输安全局 (TSA) 因为非常长的队伍受到了尖锐的批评，特别是在芝加哥的奥黑尔国际机场。之后这个公众的注意力，TSA 投资了几个修改它们的检查点设备和程序，增加在高度拥挤的机场工作人员。虽然这些修改是某种程度上成功地减少了等待时间，尚不清楚多少钱 TSA 招致用于实施新的措施，并增加人手。除了在奥黑尔的问题，也有其他机场，包括机场，通常有短等待时间，而存在不明原因和难以预测较长队伍的事件。在检查站排队的极大差别，对于乘客可能是代价昂贵的，当他们决定是不必要地早到还是可能错过他们的航班。众多的新闻文章，包括 [1,2,3,4,5]，描述一些与机场安全检查站相关联的问题。

原因：机场安检人员锐减，经济发展带动旅客增多，石油价格下降

Your Internal Control Management (ICM) team has been contracted by the TSA to review airport security checkpoints and staffing to identify potential bottlenecks that disrupt passenger throughput. They are especially interested in creative solutions that both increase checkpoint throughput and reduce variance in wait time, all while maintaining the same standards of safety and security.

你的内部控制管理 (ICM) 团队已经被TSA承包，来审查机场安全检查站和人员，以识别潜在扰乱客运吞吐量的瓶颈。他们特别感兴趣创造性的解决方案，既增加检查点吞吐量和减少等待时间的变化，同时保持同样的安全和保障标准。

The current process for a US airport security checkpoint is displayed in **Figure 1**.

美国机场安全检查站的当前过程如图 1 所示。



**Zone A:**

o Passengers randomly arrive at the checkpoint and wait in a queue until a security officer can inspect their identification and boarding documents.

区A︰

o 乘客随机到达检查站和队列中等待，直到一名安全官员可以检查自己的身份及登机凭证。

**Zone B:**

o The passengers then move to a subsequent queue for an open screening line; depending on the anticipated activity level at the airport, more or less lines may be open.

o Once the passengers reach the front of this queue, they prepare all of their belongings for X-ray screening. Passengers must remove shoes, belts, jackets, metal objects, electronics, and containers with liquids, placing them in a bin to be X-rayed separately; laptops and some medical equipment also need to be removed from their bags and placed in a separate bin.

o All of their belongings, including the bins containing the aforementioned items, are moved by conveyor belt through an X-ray machine, where some items are flagged for additional search or screening by a security officer (Zone D).

o Meanwhile the passengers process through either a millimeter wave scanner or metal detector.

o Passengers that fail this step receive a pat-down inspection by a security officer (Zone D).

区域 b:

o 乘客然后移动到一个连着的队伍以等待开放扫描队列;根据在机场的预期活动水平，更多或更少队伍可能被打开。

o 一旦乘客到达该队列的前面，他们准备所有随身物品 x 线筛查。乘客必须删除鞋、 皮带、 外套、 金属物体，电子和液体的容器放在 bin 分开进行 x 光检查;笔记本电脑和一些医疗设备也需要从他们的书包中删除并放置在一个单独的托盘。

o 所有他们的随身物品，包括包含上述物品的分类回收箱，被输送带移动通过 x 光机，其中一些物件是标记为附加的搜查或由保安主任筛选 (D 区)。

o 同时乘客通过毫米波扫描仪或金属探测器。

O 此步骤失败的乘客接受由保安主任 (D 区) 搜身检查。

**Zone C:**

o The passengers then proceed to the conveyor belt on the other side of the X-ray scanner to collect their belongings and depart the checkpoint area.

区域 c:

o 乘客继续前往x 射线扫描仪另一侧的输送带，收集他们的随身物品，离开安检区。

**Figure 1:** Illustration of the TSA Security Screening Process.

Approximately 45% of passengers enroll in a program called Pre-Check for trusted travelers. These passengers pay $85 to receive a background check and enjoy a separate screening process for five years. There is often one Pre-Check lane open for every three regular lanes, despite the fact that more passengers use the Pre-Check process. Pre-Check passengers and their bags go through the same screening process with a few modifications designed to expedite screening. Pre-Check passengers must still remove metal and electronic items for scanning as well as any liquids, but are not required to remove shoes, belts, or light jackets; they also do not need to remove their computers from their bags.

Data has been collected about how passengers proceed through each step of the security screening process. Click here to view the Excel data.

图 1︰ 图示的 TSA 安全检查过程。

大约 45%的乘客报名参加对受信任旅客的预办登机项目。这些乘客支付 $85 接受背景调查和享受五年的一个独立的筛选过程。往往是一个预办登机通道开放来匹配每三个正常的通道，尽管事实上有更多乘客使用预办登机过程。预办登机乘客和他们的行李进行了一些修改，旨在加快筛选经过相同的筛选过程。预办登机乘客仍然必须去掉金属，电子物品和液体以便扫描，但不是需要去掉鞋子、 皮带、 或轻便夹克;他们也不需要从他们的书包中去掉他们的计算机。

关于乘客如何通过安检过程的每一步，收集了数据。单击此处以查看 Excel 数据。

2识别瓶颈，通过对四个环节检查，查出问题存在的方面，如何解决瓶颈（针对瓶颈）：设备

3存在问题的原因，某些时间段人流过于密集，不匀速到来，插队即管理有问题，

文化

1引言

* 1. 问题背景
  2. 前期调查
  3. 我们的工作

2总体假设

3 符号描述

4 主要问题

4.1基本模型

4.2改进模型

5变量干涉

5.1变量1的影响

5.2…….2…..

……

6其他重要因素

7措施

8敏感性分析

9优缺点

Your specific tasks are:

1. Develop one or more model(s) that allow(s) you to q1 matlab excel前两列数据 纵轴人次 explore the flow of passengers through a security check point and q2 identify bottlenecks. Q3 Clearly identify where problem areas exist in the current process.

具体任务是︰

a.建立一个或更多的模型以探索通过安全检查的旅客流量和识别瓶颈。清楚地标识当前进程中问题领域存在何处。

1. Develop two or more potential modifications to the current process to improve passenger throughput and reduce variance in wait time. Model these changes to demonstrate how your modifications impact the process.

建立两个或更多对于当前进程的潜在修改，以提高旅客吞吐量并减少等待时间的差异。对这些改变建模来演示您的修改如何影响过程。

假设优化前后机场客流量一定，在参数改变后，总时长变短，即刻流量增大，效率提高

c. It is well known that different parts of the world have their own cultural norms that shape the local rules of social interaction. Consider how these cultural norms might impact your model. For example, Americans are known for deeply respecting and prioritizing the personal space of others, and there is a social stigma against “cutting” in front of others. Meanwhile, the Swiss are known for their emphasis on collective efficiency, and the Chinese are known for prioritizing individual efficiency. Consider how cultural differences may impact the way in which passenger’s process through checkpoints as a sensitivity analysis. The cultural differences you apply to your sensitivity analysis can be based on real cultural differences, or you can simulate different traveler styles that are not associated with any particular culture (e.g., a slower traveler). How can the security system accommodate these differences in a manner that expedites passenger throughput and reduces variance?

c.众所周知，世界上不同地区有自己文化的规范，塑造了社会互动的当地规则。考虑这些文化的规范会如何影响您的模型。例如，众所周知，美国人，对他人的个人空间表示高度尊重和优先，还有反对在别人面前"插队"的社会偏见。同时，瑞士著称集体效率，他们强调，中国以优先考虑个别效率著称。考虑到文化差异可能会影响乘客通过检查站的方法，作为敏感性分析。您应用于您的灵敏度分析的文化差异可以基于真正的文化的差异，或您可以模拟不与任何特定文化 （例如，一个较慢的旅行者） 相关联的不同旅行样式。安全系统如何应对这些差异，来加快旅客吞吐量并降低差异？

d. Propose policy and procedural recommendations for the security managers based on your model. These policies may be globally applicable, or may be tailored for specific cultures and/or traveler types.

d.基于你的模型，为安全管理人员提出政策和程序的建议。这些政策可能是全球适用，或者可能会针对特定的文化和/或旅行者类型。

In addition to developing and implementing your model(s) to address this problem, your team should validate your model(s), assess strengths and weaknesses, and propose ideas for improvement (future work).

*Your ICM submission should consist of a 1 page Summary Sheet and your solution cannot exceed 20 pages for a maximum of 21 pages. Note: The appendix and references do not count toward the 20 page limit.*

除了制定和执行您的模型来解决这一问题，您的团队应该验证您的模型、 评估优势和劣势，并提出想法的改进 （未来工作）。

你 ICM 提交应包括 1 页摘要和您的解决方案不能超过 20页，总共最多 21 页。注︰ 附录和参考文献不计入 20 页的限制。

**References:**

[1] <http://www.wsj.com/articles/why-tsa-security-lines-arent-as-bad-as-youd-feared-1469032116>

[2] <http://www.chicagotribune.com/news/ct-tsa-airport-security-lines-met-20160823-story.htm>

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[3] <http://www.cnn.com/2016/06/09/travel/tsa-security-line-wait-times-how-long/>

[4] http://wgntv.com/2016/07/13/extremely-long-lines-reported-at-chicago-midway-airports-tsa-checkpoint/

<http://wgntv.com/2016/07/13/extremely-long-lines-reported-at-chicago-midway-airports-tsa-checkpoint/>

[5] http://www.cnbc.com/2016/04/14/long-lines-and-missed-flights-fuel-criticism-of-tsa-screening.html

建模解决：增加吞吐量，降低等待时间变化

等待时间差异大原因：动作快慢（年龄，性格），文化因素（抱团，私人空间，高效），优化人力资源（提高员工能力和工作匹配度），设备（高科技）

改进措施：Performance measurement and feedback ( diagnose operators’ weakness and tailor training &assess new technology & operator selection and job assignment )，（privacy algorithm见文献）

论文结构

Summary

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* 1. problem restatement

2 planned approach

3 assumptions

4 notations

5 model for…

6 model for

7 sensitivity analysis

7.1 sensitivity analysis for model1

7.1.1 factor1

7.1.2 factor2

7.1.3 conclusion

7.2 sensitivity analysis for model2

7.2.1 factor1

7.2.2 factor2

7.2.3 conclusion

8 strength and weakness

8.1 strengths

8.2 weaknesses

Reference

appendix

问题的重述（背景知识和要解决的问题）

问题的分析

模型的基本假设（与符号说明）

模型n(或第n问)的分析和求解

模型n的评价（strength & weakness）

！灵敏度和误差分析sensitivity analysis(文化差异)

！模型检验（将模型分析的结果“翻译“回实际对象中，用实际现象、数据等检验模型的合理性和适用性；如检验结果与实际不符或部分不符，或者不如预期那样精确，试着弄清原因，求解失误或修改/补充假设，重新建模）

！模型的推广和改进（）

参考文献

**Worldbank**

<http://www.worldbank.org/en/search?q=self-driving+car>

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<http://g3.zzyjxs.com/search?hl=zh-CN&as_q=car&as_epq=self+driving&as_oq=&as_eq=&as_nlo=&as_nhi=&lr=lang_en&cr=&as_qdr=all&as_sitesearch=&as_occt=any&safe=images&as_filetype=pdf&as_rights>=

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