Problem C: “Cooperate and navigate”

Traffic capacity is limited in many regions of the United States due to the number of lanes of roads. For example, in the Greater Seattle area drivers experience long delays during peak traffic hours because the volume of traffic exceeds the designed capacity of the road networks. This is particularly pronounced on Interstates 5, 90, and 405, as well as State Route 520, the roads of particular interest for this problem.

Self-driving, cooperating cars have been proposed as a solution to increase capacity of highways without increasing number of lanes or roads. The behavior of these cars interacting with the existing traffic flow and each other is not well understood at this point.

The Governor of the state of Washington has asked for analysis of the effects of allowing self-driving, cooperating cars on the roads listed above in Thurston, Pierce, King, and Snohomish counties. (See the provided map and Excel spreadsheet). In particular, how do the effects change as the percentage of self-driving cars increases from 10% to 50% to 90%? Do equilibria exist? Is there a tipping point where performance changes markedly? Under what conditions, if any, should lanes be dedicated to these cars? Does your analysis of your model suggest any other policy changes?

Your answer should include a model of the effects on traffic flow of the number of lanes, peak and/or average traffic volume, and percentage of vehicles using self-driving, cooperating systems. Your model should address cooperation between self-driving cars as well as the interaction between self- driving and non-self-driving vehicles. Your model should then be applied to the data for the roads of interest, provided in the attached Excel spreadsheet.

*Your MCM submission should consist of a 1 page Summary Sheet, a 1-2 page letter to the Governor’s office, 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.*

Some useful background information:

On average, 8% of the daily traffic volume occurs during peak travel hours.

• The nominal speed limit for all these roads is 60 miles per hour.

• Mileposts are numbered from south to north, and west to east.

• Lane widths are the standard 12 feet.

• Highway 90 is classified as a state route until it intersects Interstate 5.

• In case of any conflict between the data provided in this problem and any other source, use the data provided in this problem.

Definitions:

milepost: A marker on the road that measures distance in miles from either the start of the route or astate boundary.

average daily traffic: The average number of cars per day driving on the road.interstate: A limited access highway, part of a national system.

state route: A state highway that may or may not be limited access.

route ID: The number of the highway.

increasing direction: Northbound for N-S roads, Eastbound for E-W roads.

decreasing direction: Southbound for N-S roads, Westbound for E-W roads.

问题C：“合作和导航”

由于道路的数量，美国许多地区的交通容量有限。例如，在大西雅图地区，由于交通量超过道路网络的设计容量，司机在交通高峰时段经历长时间的延误。这在5号，90号和405号州际公路以及520号国道，特别关注这个问题的道路上尤其明显。

自动驾驶，合作车已被提出作为增加公路的能力而不增加车道或道路的数量的解决方案。在这一点上，这些汽车与现有交通流和彼此交互的行为尚未被很好地理解。

华盛顿州州长要求分析允许在Thurston，Pierce，King和Snohomish县的上述道路上自行驾驶合作汽车的影响。 （见提供的地图和Excel电子表格）。特别是，自动驾驶汽车的百分比从10％增加到50％到90％，效果如何变化？平衡是否存在？是否有性能变化明显的临界点？在什么条件下，如果有的话，应该有车道专用于这些车？您对模型的分析是否表明有任何其他政策变化？

您的答案应包括对车道数量，峰值和/或平均交通量的交通流量的影响的模型，以及使用自动驾驶，合作系统的车辆的百分比。你的模型应该解决自驾车之间的合作以及自驾车和非自驾车之间的相互作用。然后，您的模型应用于附带的Excel电子表格中提供的感兴趣道路的数据。

您的MCM提交应包括1页摘要表，1至2页总督办公室信，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。

一些有用的背景信息：

  平均而言，每天交通量的8％发生在高峰旅行时间。

•所有这些道路的名义速度限制为每小时60英里。

•里程数从南到北，从西到东。

•车道宽度为标准12英尺。

•高速公路90被分类为状态路线，直到它与州际5相交。

•如果此问题中提供的数据与任何其他源出现冲突，请使用此问题中提供的数据。

定义：

milepost：道路上的标记，用于测量距离路线或天体边界的距离（以英里为单位）。

平均每日交通量：在road.interstate上行驶的平均每天的汽车数量：有限访问高速公路，国家系统的一部分。

国家路线：可能受限或不受限制的国家公路。

路由ID：高速公路的编号。

增加方向：N-S道路北行，E-W道路东行。

下降方向：N-S道南行，E-W道西行。