Project II: Optimizing US-global Health Commodity Shipment Plan

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Background and Introduction

To support countries facing shortages of essential health commodities, the U.S. government implements a Global Health Commodity Support Plan. As part of this initiative, the government ships antiretroviral (ARV) medications and HIV lab supplies to supported countries annually.

A key challenge in this plan is designing a sustainable global health supply chain. Specifically, the U.S. government must determine a cost-effective method to deliver all health commodities as scheduled.

The Problem of Optimizing Shipment

The U.S. government plans to ship all health commodities in the support plan in three phases. During each phase, specific sets of countries and their corresponding health commodities are scheduled for shipment. One airplane will be used to deliver all required health commodities in each phase, with the plane having sufficient capacity for all shipments. Due to the air transport schedule, these flights will depart from JFK and return to LAX.

To minimize CO2 emissions from these shipments, the government aims to reduce the total distance of shipping routes for each phase. For simplicity, we assume that the route lengths are proportional to the haversine distances between destinations. Since the planes are also assigned other domestic tasks, CO2 emissions between JFK and LAX are excluded from the cost calculations for health commodity shipments.

Please assist the U.S. government in identifying the most efficient routes to deliver all health commodities to the supported countries.

The Problem of Optimizing Splitted Shipment

To enhance shipment efficiency, the U.S. government now plans to distribute health commodities from two separate warehouses: one near JFK and the other near LAX. Air transport schedules have been adjusted to ensure a plane with sufficient capacity is available to carry shipments from each airport, for each phase. In this revised plan, each plane must return to its original departure airport after completing its delivery route. As before, the health commodities will be shipped in three distinct phases.

The government remains committed to minimizing the total shipping route lengths for each phase. Please assist in identifying the most efficient routes to deliver all health commodities to the supported countries.