Advanced Dynamic Programming for Optimizing PT JNE's Delivery Operations Through Enhanced Truck Scheduling Systems

Computer Science

This document is prepared to fulfill the assignment for the Data Structures and Algorithms course

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Main Reference

Project Overview (Background)

The logistics sector, particularly large-scale courier services like PT JNE, encounters significant challenges in optimizing delivery routes amid growing operational complexity. Efficient route optimization is crucial for minimizing transportation costs, fuel consumption, and delivery times, all of which enhance service performance and profitability. Dynamic programming, known for its capability to tackle complex optimization problems by dividing them into simpler subproblems, presents a promising solution. This project aims to utilize dynamic programming with backward recursive equations to systematically identify the optimal delivery routes for PT JNE, thereby addressing the challenges linked to multi-point delivery systems and varying distances.

a) Research Questions

How can dynamic programming, applied through backward recursive equations, be employed to optimize the identification of the shortest possible delivery routes for PT JNE, while adhering to logistical constraints such as multiple delivery points and variable distances?

b) Research Hypothesis

The incorporation of dynamic programming, particularly through backward recursive equations, is expected to yield significant enhancements in PT JNE's route optimization processes. This approach is hypothesized to markedly decrease delivery times and operational costs compared to traditional route planning methodologies.

c) Research Aim

The primary objective of this research is to develop a dynamic programming model utilizing backward recursive equations to determine the most efficient and shortest delivery routes for PT JNE. This model aims to improve the overall efficiency of the company's logistics operations by streamlining delivery processes, thereby contributing to better service outcomes.

Abstract

Efficient logistics and delivery operations are crucial for maintaining customer satisfaction and meeting evolving market demands. PT JNE, a leading delivery service provider in Indonesia, faces several operational challenges, including delivery delays, flight disruptions, and suboptimal resource utilization. To address these challenges, this study presents the development and implementation of an *Adaptive Dynamic Programming (ADP)* model aimed at optimizing PT JNE's delivery scheduling. The proposed model integrates real-time data on traffic conditions, weather forecasts, and resource availability to generate dynamic and responsive delivery schedules. Through comprehensive simulations and experiments, the study evaluates the effectiveness of the *ADP* model in terms of reduced delivery delays, improved resource efficiency, and enhanced customer satisfaction. The findings of this study offer significant implications for PT JNE to enhance its operational performance and sustain its competitive advantage in the delivery service industry.

Keywords : *Adaptive Dynamic Programming, Delivery Optimization, Traffic Conditions, Weather Forecasting, Resource Management, Customer Satisfaction*.

Introduction

Logistics companies like PT JNE face significant challenges in ensuring timely and efficient deliveries, especially within extensive and densely populated shipping networks. A crucial element in the operational framework of goods transportation is scheduling flights for international and inter-island shipments. Flight delays can lead to shipment delays, negatively impacting customer satisfaction and increasing operational costs.

Currently, the challenges related to flight scheduling for PT JNE's logistics are becoming more complex due to rising demand and unpredictable factors such as bad weather, limited flight slots, and the complexities of cargo capacity management. To effectively tackle these multifaceted challenges, there is an urgent need for a more advanced approach to flight scheduling—one that not only optimizes costs but also reduces overall delivery delays.

Dynamic Programming (DP) is a powerful method for solving optimization problems involving multiple conditions and constraints. However, traditional DP often requires complex computations, especially in situations with unpredictable variables. To overcome these challenges, advanced methods like Adaptive Dynamic Programming (ADP) have been developed. By incorporating reinforcement learning, ADP can continuously learn and adapt to changing situations, making it an ideal solution for the flight scheduling challenges faced by PT JNE.

This research aims to implement Adaptive Dynamic Programming to optimize flight scheduling in PT JNE's logistics operations, focusing on minimizing delays and improving operational efficiency. The proposed model is expected to enhance delivery timeliness, reduce operational costs, and increase customer satisfaction.

Methodology

To optimize PT JNE's delivery scheduling, we developed an ADP model that employs a learning algorithm to calculate optimal departure schedules. This model considers various factors, including traffic conditions, weather conditions, and resource availability.

a. Modeling Traffic Conditions

We utilize real-time traffic data sourced from various channels, such as traffic sensors and digital mapping applications. This data estimates travel times between delivery points, factoring in road congestion, alternative routes, and traffic speeds. The model continuously updates delivery time estimates based on the latest traffic conditions.

b. Integration of Weather Conditions

Weather forecasts are integrated into the model to account for the impact of weather on delivery times. Variables such as rainfall, wind speed, and temperature are considered to dynamically adjust the delivery schedule as necessary. Weather information is sourced from reliable forecasting services and updated in real-time.

c. Resource Availability Management

The ADP model also considers the availability of vehicles and personnel to ensure that the necessary resources are available at the right time. Scheduling is adjusted to optimize resource utilization and prevent delays due to resource shortages.

d. Simulation and Experimentation

We will conduct simulations using historical delivery data from PT JNE to test the effectiveness of the developed ADP model. The following parameters will be analyzed:

- **Delivery Delay**: We will compare the reduction in delivery delays before and after the implementation of the ADP model.
- **Resource Efficiency**: We will measure the utilization of vehicles and personnel to assess improvements in efficiency.
- **Customer Satisfaction**: We will conduct surveys to evaluate the impact of schedule changes on customer satisfaction.

By integrating various factors into the ADP model and performing comprehensive simulations, we aim to generate an optimal delivery schedule, reduce delivery delays, and improve the operational efficiency of PT JNE.

For applying the ADP Algorithm, we will be starting to design or making the program by implementing a code that currently is still in development for finding a shortest path for JNE carrier by using Truck as Delivery Package. Therefore, to know more our progression by developing an ADP Algorithm method in our code, here is our GitHub link as an attachment in details: https://github.com/Skylovaa/Project-UAS-DAA.