

Optimization Apps

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Abstract

This presentation is concerned with the teaching of optimization and optimization apps with App Inventor at a junior level at the University of Massachusetts. The course ME 379 is concerned with the theory of linear and combinatorial optimization along with certain aspects of integer and nonlinear programming. I have been teaching this course with App Inventor since 2010. The benefits, scope, and limitations of using App Inventor will be discussed through a sampling of the different projects developed in the course over the years along with a discussion of what the students have accomplished on their own after the course is completed.

1. Introduction

Teaching optimization to mechanical and industrial engineers at a junior level at the university is challenging, interesting, and can be extremely rewarding. Especially today, when most students have their own smart phone, the sophisticated tools of calculus and linear algebra they have learned by this time at the university are an extremely fine basis for further development. Of course the problem complexity of these engineering design problems must be coupled with the capabilities of the App Inventor platform and this is probably the key issue for the presentation. Formulating the problem and design idea is also of central importance. In fact, all these pedagogical issues will form the backbone of the presentation.

In the course over the years, a number of different projects have been developed. Some of them are mentioned below:

- I-beam design tool;
- Disk Brake design tool
- Apartment group menu planning
- Cost cutting mailing system
- Amherst Farm Planning
- Nurse Scheduling at Sunrise Senior Living
- Pipe Location Analysis and Design
- Optimal fuel delivery on Block Island
- Assignment of Relay Teams for UMass Swimming & Track Teams
- Optimal Order Picking in a UMass Warehouse

This latter project concerned with Optimal Order Picking in a Warehouse is a very interesting example to illustrate what the students are capable of doing. Many of the other projects and their characteristics will also be discussed during the presentation.

App to Develop a Pick Order for the UMass Amherst Warehouse

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Problem Statement

Every morning, before many students are awake, the employees at the UMass warehouse are busy sorting and palletizing orders of food for all the dining commons, snack bars and cafes. The current system has 10 to 15 clipboards hanging with orders on them and the orders are picked arbitrarily. This app takes into account variables such as delivery time, pick time and number of pallets to create an efficient and optimal pick order.

Methods

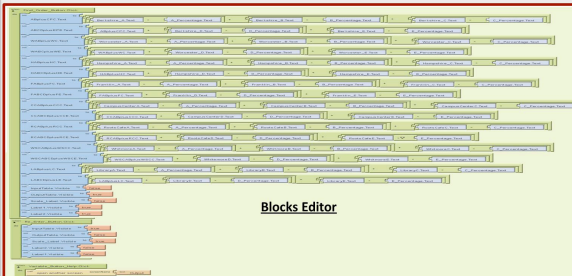
The variables that are considered in this app include:
A = Estimated Delivery Time (Time; 4 being the shortest)
B = Location Necessity (Rank; 4 being the highest)
C = Number of Locations (Exact Number)
D = Estimated Pick Time (Time; 4 being the shortest)
E = Estimated Number of Pallets (Exact Number)
The arbitrary assignment values had to be used because the inclusion of terms with different units (time and quantity).

Objective

Maximize the arbitrary output to determine the order. The pick order of the locations will be determined by the output values with the order ranging from highest to lowest.


Sensitivity

The nature of this problem does not lend itself to typical sensitivity analysis. This app includes a series of values that factor in the importance of each variable to the whole. These percentages sum to 1.
A = .22 B = .28
C = .20 D = .12
E = .18
By editing any of these values, it can place more importance on a variable while lessening another. Currently these values are hidden and not editable.



Blocks Editor

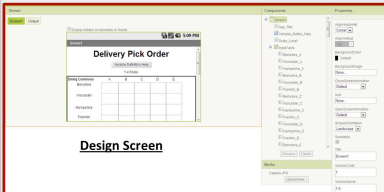
The App



Pick Order
Go Highest to Lowest

Variable Definitions

A.) Estimated Delivery Time (4 being the shortest)
B.) Location Necessity (4 being highest need)
C.) Number of locations (Exact Number)
D.) Estimated Pick Time (4 being the shortest)
E.) Estimated Number of Pallets

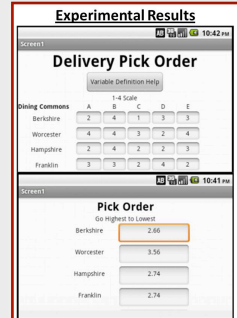



Design Screen

Summary

The goal of this app was to output an easy to read table with values of varying magnitudes. These outputs would be ordered from highest to lowest in order to determine the optimal order to pick pallets for shipment to the eateries around campus. With more variables this app could become more accurate. Even with five variables the calculated values closely reflect the day to day order that is currently used. This shows that a repetitious process can optimize itself with time.

Experimental Results





We will discuss these from a pedagogical viewpoint indicating the benefits, scope and limitations of using App Inventor for this optimization course. We will also discuss the follow-on by some students who then developed more apps for various other projects.