Vending Machine Optimization Problem

Problem Description

The Vending machine optimisation is closely related to the assignment problem, which is concerned with the optimal placement of products (from a set of products) in a machine having a specific capacity to maximize the minimum days of supply (dos) for each machine.

About Vending machine [Input file - machines.csv]

There are a few(12) vending machines at different locations, each machine has a unique machine id, machine_type, list of the product types that the machine can occupy, and supply per day(spd) of each product associated with the machine id.

About Products[Input file - items.csv]

There is a total of 5 types of products with unique product ids eg. [1:soda,2:cola,3:tropics,4:cherry,5:cola can] and each product has a volume (pack) of container eg. 16.9oz bottle,12oz can.

Product Machine[Input file - capacity_matrix.csv]

The volume of the product container(pack) and machine_type decides how much space that product has in the vending machine.

Assumptions

- Each column can occupy only one type of product, a column can't be shared between two or more products
- Once a product is assigned to a column, it uses its total capacity.
- One product can be placed in multiple columns but one column can't occupy more than one products.

Solution Approach

A mathematical optimization model has five components, namely:

- Sets and indices.
- Parameters.
- Decision variables.
- Objective function(s).
- Constraints. We now present a BIP formulation for the Vending Mcachine optimisation problem.

Model Formulation

Sets

machine $m \in M$: Set of Machines.{1, 2, 3,.....12}

machines_types $i \in I$: Set Machine Types, {closed_front_1, closed_front_2, closed_front_3, closed_front_4, closed_front_5, closed_front_6}.

columns $c \in C$: Set of Columns in a machine.{col1, col2, col3, col4, col5, col6,col7, col8, col9, col10, col11, col12}

products $p \in P$: Set of products {111, 222, 333, 444, 555}

volumns $v \in V$: Set of volumns {12oz,16.9oz}

Parameters

$cap_{i,v,c} \in \mathbb{R}^+$: Fixed capacity associated with machine type, volumn of product, and machine column for machine type $i \in I$ for volumn $v \in V$ for column $c \in C$.

$spdm_{m,i,p} \in \mathbb{R}^+$: Supply per day for a machine $m \in M$ and type $i \in I$ of product $p \in P$.

$vol_p \in \mathbb{R}^+$: Volume of product $p \in P$.

Decision Variables

$selectsingle_{m,i,c,p} \in \{0,1\}$: 1 If product p is placed in column c of machine type i in machine m; 0 therwise that

Objective Function

Minimum days of supply: Maximize(z) the minimum days(min y[p]) of supply for machine m :

$$y[p] = \frac{\sum_{(m,i,c,p)\in \text{Pairings}} selectsingle_{m,i,c,p} * cap_{i,v,c}}{spdm_{m,i,p}} \qquad \forall p \in \text{Products} \tag{0}$$

$$\text{Maximize} \quad z = \text{Min} y[p] \qquad \forall p \in \text{Products} \tag{1}$$

Constraints

- **One column one product constraint**. For each column $c \in C$ ensure that it contains only one type of product.

$$\sum_{m\in M} \sum_{i\in I} \sum_{p\in P} selectsingle_{m,i,c,p} \leq 1 \qquad \forall c \in \text{Columns} \tag{2}$$

Output file format

- #### A solution file for each machine_id

  Hivery_submission.xlsx - each sheet in the excel file is named by machine id,contains the solution file for each machine_id

- #### A results table that includes each machine_id

  Model_performance.csv

- #### Brief writeup of any assumptions, things you would consider if you had more time, and any thoughts you would like to share

  `Readme.html`

In [172…

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Sample output
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Out[172…

			Capacity	dos
Machine_id	**Machine_type**	**Product**	**spd**		
9	**closed_front_3**	**111**	**12.1**	44.0	3.636364
		222	**9.8**	32.0	3.265306
		333	**8.6**	33.0	3.837209
		444	**4.7**	18.0	3.829787
		555	**12.1**	36.0	2.975207