Optimization Model for Campus Parking Space Allocation

MISGSA 2011, Wits

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Friday 14 January 2011

Suggestions:

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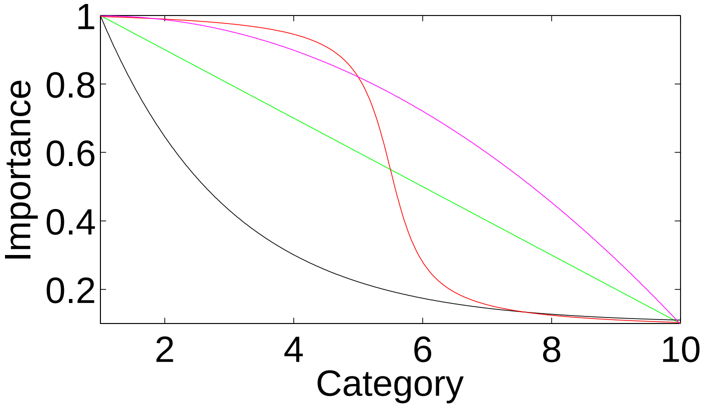
- Assign a *cost* to each category
- Assign proportion of population for each type of parking
- Assign priorities to population
- Define parking policies

Suggestions:

- Reserved (x_1 spaces for $N_1 = x_1$ VIPs)
- Open for Staff (x_2 spaces for N_2 Staff members)
  - If $\alpha_2 = \frac{x_2}{N_2}$, what is the *best* value to choose for α_2?
- Open to All (x_3 spaces for the N_3 remaining to fight for)
  - First Come First Served
  - Staff without parking can come here


1
0.8
0.6
0.4
0.2
Importance
2
4
6
8
10
Category

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- Maximize Parking Use (University and Users)
- Minimize Unhappiness (Users)
- Possible combination of the above

Minimizing Unhappiness

Unhappiness is not easy to define

Suggestion:

- Individual: $u_i = w_i X_i$ where w_i is the *weight*

$$X_i = \begin{cases} 0 & \text{if satisfied} \\ \alpha \quad (0 < \alpha < 1) & \text{if parking found but far} \\ 1 & \text{if no parking found} \end{cases}$$

- General: $G = \sum_i u_i$

Minimizing Unhappiness

Input

- Divide the N people into categories
- Assign ranking r_i to people according to their category
- Consider the time t_i each applicant spent in the system
- Consider the office building b_j
- Consider the parking P_k with m_k bays $(\sum_k m_k = M)$
- Consider the distance d_{jk} from b_j to P_k

Minimizing Unhappiness

Procedure:

- Assign a *weight* w_i to each applicant

$$w_i = r_i \times t_i \quad (1)$$

- Each applicant is coded as a vector $[w_i, b_j]$
- Choose the M applicants with the highest weight
- Choose the closest available parking according to the weight
- The remaining are distributed in the open space
- Anyone out of the system brings the first on the waiting list in the system

Minimizing Unhappiness

For category i, choose the number of allocated parking bays proportional to the ranking

$$x_i = \frac{M \times r_i \times N_i}{\sum_i r_i \times N_i}$$

Minimizing Unhappiness

We have 10 applicants divided into 3 categories working in two buildings with two available parkings (3 bays per parking).

$$\begin{matrix} r_i = \\ t_i = \\ Bi = \\ w_i = \end{matrix} \begin{bmatrix} 1 & 1 & 1 & 0.8 & 0.8 & 0.8 & 0.6 & 0.6 & 0.6 & 0.6 \\ 2 & 6 & 1 & 10 & 2 & 8 & 12 & 4 & 13 & 7 \\ B1 & B2 & B1 & B1 & B1 & B2 & B2 & B1 & B1 & B2 \\ 2 & \color{red}{6} & 1 & \color{red}{8} & 1.6 & \color{red}{6.4} & \color{red}{7.2} & 2.4 & \color{red}{7.8} & \color{red}{4.2} \end{bmatrix}$$

$$\text{Best weights} \begin{bmatrix} \color{red}{8} & \color{red}{7.8} & \color{red}{7.2} & \color{red}{6.4} & \color{red}{6} & \color{red}{4.2} \\ B1 & B1 & B2 & B2 & B2 & \color{red}{B1} \end{bmatrix}$$

What was done

- Define different policies
- Translate them in mathematical terms
- Define possible goals
  - Maximize profit
  - Maximize space usage
  - Minimize unhapppiness
- Arbitrary choices
- Solution highly dependent on objectives

Future work

- Data analysis
- Case study
- Generalize the presented solutions
  - Study more complex cases
  - Problem not specific to universities

Thank You!!!
Questions?