Robust Product Line Design by D. Bertsima and V. Misic

**Product line:** a series of products were created base on a simple basic product different with respect to some attributes.

**Product line design:** how to create a product line so company can maximize the expected revenues.

**Contributions:**

Most of current research solved the product line design problem assuming that the underlying choice model that describe consumer’s choice were known for sure, i.e. we know the correct structure of models and values of parameters. However, in reality, companies are not certain about the correct structure of models or the values of parameters. Therefore, this paper addresses these uncertainties by proposing a new approach to optimize the product line design.

**Robust approach:**

1st create an uncertainty set comprises several possible models, with either a model with several different values of parameters or several structural distinct models

2nd optimizes the worst-case expected revenue through this uncertainty set, choose the product line that maximizes the worst-case expected revenue.

**Difference between old approach (nominal) and new approach (robust):**

1. **Assumption**: Nominal approach assume that the structure of models and values of parameters are known for sure, while robust approach only assume that the correct model was included in the uncertain set without any strict assumptions on the full-awareness of how consumers respond.
2. **PLD:** Nominal approach optimizes PLD by maximizing the expected revenue, while the robust approach optimizes PLD by maximizing the worst-case expected revenue.

**Several based nominal models:**

1. First-Choice Model
2. Latent Class Multinomial Logit Model
3. Mixture Multinomial Logit Model
   1. Expectation maximization
   2. **Hierarchical Bayes**

where R(S;m) is the expected revenue given S, the product line, and m, a particular model.

Estimation approach “divide-and-conquer” heuristic:

Firstly, product line was broken in to groups and sequentially optimize each group of attributes to improve the equation (1) until no further enhancement can be obtained.

**Robust models**:

where R(S;M) is the worst-case expected revenue given S, the product line, and M, a particular uncertainty set.

**Results:**

The paper legitimates their approach by comparing robust approach with nominal approach using a real conjoint data set of Toubia et al. (2003). They created two measurement scales to compare these two approaches.

They found robust approach significantly outperforms nominal approach in the worst case, with relative improvement of up to more than 20% given parameter uncertainty. Robust approach also edges nominal approach with structure uncertainty.

**Possible extension:**

1.They did not include cost function in their model, without further justification, the cost of extra attributes may somehow distort the results. Scrutiny in the sense of how including cost function may affect the results is needed to further solidify this approach.

2.They assume worst-case expected revenues based on an underlying assumption that company is risk averse, which limits their application. Therefore, optimizing the product line with respect to other rules such as best-case, mode or even expectation across the whole set can be studied to extent this research further to be applicable to other companies that may willing to take some risk in exchange of possible high revenues.

3.This paper generally assume company decide what to offer given the outside options. However, as some IO paper had reviewed, most companies simultaneously decide what products to offer at first period and then compete in the next period. Thus this paper may further extent to the strategic response given possible outside options as a probabilistic product that not been defined specifically.