Product Level Weight Inference

The utility form
$u(p) = w_0 * v_0(p) + w_1 * v_1(p) + \cdots + w_n * v_n(p)$
where $w_i, v_i(p)$ is the *weight* and *value function* on i-th attribute for product p.

How to calculate the possible (uncertain) weights?

When weights are uncertain, a set of possible product orderings is induced. When some preferences are given as input, the feasible weights can be computed as shown in the Figure 1.

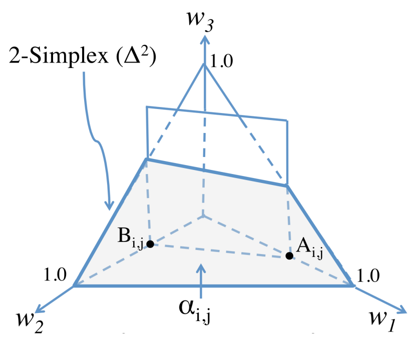

Figure 1: Geometrical representation of feasible weights

For example, if given the product p^* contains the highest utility among the product $p_i \in \mathcal{P}$, we have the following constraints, defined as follows:

$$
\begin{gathered}
w_0 * v_0(p^*) + w_1 * v_1(p^*) + \cdots + w_n * v_n(p^*) > w_0 * v_0(p^1) + w_1 * v_1(p^1) + \cdots + w_n * v_n(p^1) \\
w_0 * v_0(p^*) + w_1 * v_1(p^*) + \cdots + w_n * v_n(p^*) > w_0 * v_0(p^2) + w_1 * v_1(p^2) + \cdots + w_n * v_n(p^2) \\
\cdots > \cdots \\
w_0 * v_0(p^*) + w_1 * v_1(p^*) + \cdots + w_n * v_n(p^*) > w_0 * v_0(p^k) + w_1 * v_1(p^k) + \cdots + w_n * v_n(p^k) \\
w_0 + w_1 + \cdots + w_n = 1
\end{gathered}
$$

With the constraints as defined as above, we can get some feasible weights which can be geometrically represented as polyhedron.

How to infer the weights ordering given the feasible weights?

we can randomly draw sample weights from the feasible region, each sample weights will induce a weight ordering. These weight orderings from different weight samples can be aggregated into one final weight orderings. This final ordering represent the most possible weight ordering given the feasible weight region.

After we get the weight ordering, the attributes which have the top 2 weights can be identified as the most-important attributes, the attributes which have low 2 weights can be identified as the least-important attributes, and the other 3 attributes can be identified as important attributes.