Discrete Choice Model

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0.1 Introduction.

Discrete Choice Model (DCM) is implemented in GAMA platform to simulate the agent movement between targets, more specifically **multinomial logit** function is used in this model. Since this is the very beginning of the project, we are starting with very basic model which has single pair of origin/destination with 2 different paths.

0.2 The concept of discrete choice modelling.

In Discrete Choice Modelling underlying preferences of persons are derived by observing choices that people make from different available choice options (Chorus, 2012). When the chosen option and characteristics of the available choice options are known, discrete choice models (DCMs) enable estimating which weights individuals attach to the different characteristics when they have to make a choice and in which scenarios people switch to another alternative.

Important components of the choice behaviour theory are the decision-maker, choice set, attributes of alternatives, the decision rule (i.e. behavioural rule). The decision-makers can for example be individuals, companies or households (Train, 2002). The choice set contains all alternatives from which a decision-maker can choose. A choice set should have three characteristics. First of all the alternatives have to be 'mutually exclusive' (Train, 2002), which means that from the perspective of the decision-maker there should not be any overlap between the alternatives. So choosing one alternative excludes choosing other alternatives. Secondly, the choice set must be 'exhaustive' (Train, 2002), i.e. all possible alternatives should be taken into account. Lastly, there must be a finite number of alternatives (Train, 2002). From each choice set, individuals can only choose one alternative. This defines the discrete character. The attributes of the alternatives concern the characteristics of the alternatives.

0.3 Multinomial logit model.

The Multinomial Logit model (MNL) is most widely used in discrete choice modelling. The MNL model is based on the assumption that the error term is independently and identically distributed (i.i.d.) as Gumbel variable (double exponential) for all alternatives. This means that the unobserved utility components are uncorrelated over the alternatives and that they have the same variance for all alternatives. In other words, the different alternatives do not have unobserved characteristics which they share and in all alternatives the error terms determine to the same extent the utility. The probability that an individual i chooses alternative j is:

$$P_{ij} = \frac{e^{V_{ij}}}{\sum_j e^{V_{ij}}} \tag{1}$$

where V_{ij} is called structural utility which is deterministic in nature and is defined as follows:

$$V_{ij} = \sum_k \beta_k X_{ijk} \tag{2}$$

where X represents attribute, β is coefficient (weight) of the attribute. and $k = 1, 2, ..k$ atributes.

0.4 Simulation.

Simple simulation experiment is implemented in GAMA. The model consists of origin/destination pair and two other pseudo targets on a 50 by 50 weighted grid space (see figure 1). Weighted grid is been used because on a plane grid path taken by the agent across the targets where different. Since to obtain a consistent path between target points weighted grid is used. In this model the choice rule is based on multinomial logit mode, i.e.,an agent chooses one out of two choices (pseudo targets) while shuttling between origin and destination. The probability of choosing a pseudo target is drawn from the multinomial logit function (eqn. 1).

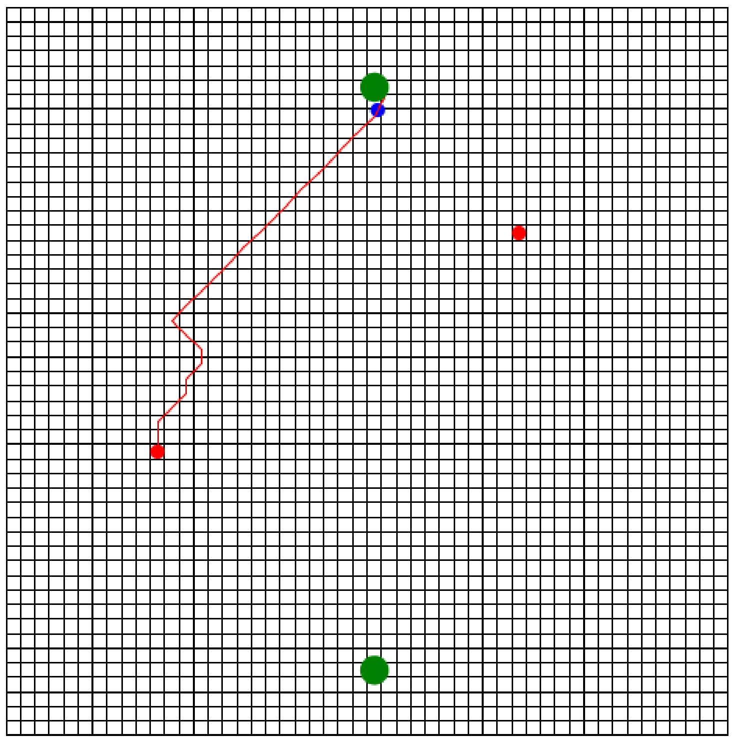

Figure 1: Snapshot from the GAMA experiment, green target points represents origin/destination and red points are pseudo target points. Red curve represents shortest path between target points

0.4.1 Parameter used

Only two choices are taken in the GAMA implementation. For simplicity only one attribute with a coefficient value 1 is used in this model. So the probability of choosing a path is as follows:

$$P(path1) = \frac{e^{V_{path1}}}{e^{V_{path1}} + e^{V_{path2}}} \tag{3}$$

$$P(path2) = \frac{e^{V_{path2}}}{e^{V_{path1}} + e^{V_{path2}}} \tag{4}$$

putting $\beta = 1$ and using eqn (2) one can write eqn (3) & (4) as

$$P(path1) = \frac{e^{X_{path1}}}{e^{X_{path1}} + e^{X_{path2}}} \tag{5}$$

$$P(path2) = \frac{e^{X_{path2}}}{e^{X_{path1}} + e^{V_{path2}}} \tag{6}$$

In the current experiment, $X_{path1} = 5$ and $X_{path1} = 4.5$ so,the probability of choosing path1(via pseudo target 1) is $P(path1) = 0.62$, and probability of choosing path2 (via pseudo target 2) is $P(path2) = 0.38$.

0.4.2 Algorithm/pseudo-code

1. Define grid.
2. Populate agent.
3. for N steps:
3.1 if agent at origin/destination:
3.2 set current destination,
3.3 get route via pseudo target from MNL function,
3.4 goto destination