

# Technical Notes

romuald.lefrioux18@gmail.com

October 2022

This document explains the process for creating connectors and the rescale OD matrix. It is set up as follows. The connector script is described in the first part. The second explains the script's logic used to rescale OD matrix.

## Create connectors script

Connectors are used in METROPOLIS in order to connect zones to the road network. Connectors are a crucial element of the overall network and their creation should responds to certain important characteristics. This script is using a simple logic. For each zone, at most 4 entering and 4 exiting connectors are created. Each entering/exiting connectors are connected to the intersection with the higher exiting/entering capacity. Therefore, connectors entering and exiting connectors could be asymmetric. However, this rules is subject to different issues:

- To prevent travelers from taking a detour, connectors must be connected in each direction (north, east, west, and south). We build a connector for each of those directions to get around this problem. Whether an intersection is present in the list of possible intersections.
- Connectors has to be connected to an intersection that is close to the centroid of the zone. We limit the range of potential intersections to those with in order to do that. The X nearest intersections (default = 15) are used for this.
- Connectors can create "artificial congestion" if they are connected to a road with a too small capacity. We limit the list of potential intersections to those that are connected to roads with a capacity larger than a certain threshold (default = 1001) in order to prevent this problem.
- Roads must be connected to connectors in a realistic way. For example, if restrictions are not put in place, it is feasible that a connection will be

linked to the center of a highway, creating an unrealistic simulation pattern. We limit the set of possible intersections to intersections that are connected to roads with a speed lower than a certain threshold (default = 129) in order to prevent this problem.

## Rescall OD matrix script

It is common in data transport to find OD matrix with a too low resolution. Meaning that the size of the zones used as origin/destination is too big. Therefore, this will result in a lot of intra-commuters (diagonal values of the OD matrix) which cannot be taken into account with METROPOLIS. We created a script that enables users to scale down the OD matrix and cut down on intra-commuters number using zones with a higher resolution. Those zones have to be downloaded from an external source or produced using a clustering algorithm.

First, the script is computing from input tiff files for each new zone ( $i$ ), the density of roads ( $Road_i$ ), population ( $Population_i$ ), residential buildings ( $Residential$ ) and working buildings ( $Working_i$ ). Then those values are aggregated in two indexes for each zone  $i$  ( $X_i$  and  $Y_i$ ):

$$X_i = Population_i * Road_i * Residential_i$$

$$Y_i = Population_i * Road_i * Working_i$$

Home-to-work data are typically used to construct OD matrices. Consequently, in order to account for the disparity in the probabilities of beginning and ending its trip in a particular zone. The two asymmetrical indexes are used to generate those probabilities. The probability of leaving zone  $i$  is constructed using  $X_i$ , while the probability of arriving in zone  $i$  is constructed using  $Y_i$ . The following formulation is used:

The probability that agent start his trip in zone  $I$  is given by:

$$P_{Ij} = \frac{X_I}{\sum_{k \in \mathcal{M}(I)} X_k}$$

The probability that agent end his trip in zone  $J$  is given by:

$$P_{iJ} = \frac{Y_J}{\sum_{k \in \mathcal{M}(J)} Y_k}$$

where  $\mathcal{M}(I)$  ( $\mathcal{M}(J)$ ) is the set of new zone(s) which are in the same old zone as the new zone  $I$  (resp.  $J$ )

Finally, the number of travellers between the new zone  $I$  to the the new zone  $J$  ( $OD_{IJ}$ ) is then computed using the following formula:

$$OD_{IJ} = P_{iJ} * P_{Ij} * OD_{\mathcal{M}(I);\mathcal{M}(J)}$$

Remember to take into consideration the fact that as spatial resolution declines, so does the likelihood that individuals would use a car for intra-commuting. To accommodate for this impact, it is feasible to use the *diag\_scaling\_factor* option in order to limit the size of the initial number of intra-commuting.