

GEONAMES with GTAP: Tools for Generating Inter-regional Distances

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1 Introduction

Analysts working with GTAP data (www.gtap.org) often need to have measures of inter-regional distances. This note describes GAMS code for constructing such distances for an arbitrary aggregation of the GTAP7 dataset. The calculated distances are based on a database of city locations and populations provided by the GeoNames project (www.geonames.org). The distance between regions r and r' defined as a population-weighted average of the distances between the cities in r and the cities in r' :

$$D_{rr'} = \sum_{c \in \mathcal{C}(r)} \sum_{c' \in \mathcal{C}(r')} \theta_{cr} \theta_{c'r'} d_{cc'}$$

where:

$\mathcal{C}(r)$ is the set of cities in region r

θ_{cr} is the fraction of total city population in region r which resides in city c

$d_{cc'}$ is the great circle distance between cities c and c' , calculated on the basis of a great circle approximation. The calculation of these distances begins by conversion of latitude and longitude information to (x, y, z) coordinates on a unit sphere:

$$x_c = \cos(lon_c) \cos(lat_c)$$

$$y_c = \sin(lon_c) \cos(lat_c)$$

*The usual disclaimers apply.

$$z_c = \sin(\text{lat}_c)$$

These data are then used to compute the length of a line segment (through the sphere) which connects cities c and c' :

$$s_{cc'} = \sqrt{(x_c - x_{c'})^2 + (y_c - y_{c'})^2 + (z_c - z_{c'})^2}$$

Finally, the length of this line segment determines the great-circle distance:

$$d_{cc'} = 2 \tan^{-1} \left(\frac{s_{cc'}/2}{\sqrt{1 - (s_{cc'}/2)^2}} \right) \times 3959$$

in which 3959 is the radius of the earth in miles.

2 GAMS Code

Data files in this directory are from GeoNames. These include:

`cities15000.xls` a list of all cities with populations of 15,000 or more (roughly 20,000 cities)¹.

The GAMS programs in this directory include:

`gtapdist.gms` A GAMS program which computes the distances between regions in a sample aggregation of the GTAP 7 regions.

`rusgtapdist.gms` A GAMS programs which computes the distances between regions in dataset which includes a sample aggregation of the GTAP 7 regions together with the 7 federal okrugs of Russia (a partition of the GTAP region Russia).

`cisgtapdist.gms` A GAMS programs which computes the distances between regions in dataset which includes a sample aggregation of the GTAP regions together with all countries in the CIS (several of which are not included in GTAP 7).

`isoregions.gms` A GAMS program containing the definitions of ISO 3166 identifiers (2 digit, 3 digit, numeric) and corresponding FIPS codes for all countries and other geographic entities. These data are from <http://www.geonames.org/countries/>. This program is called by each of the application programs to generate a data file containing the list of region identifiers.

The GAMS data exchange (.gdx) files included in the directory are sample output from the corresponding GAMS programs.

¹Two larger city lists can be downloaded from <http://download.geonames.org/export/dump/>.