

Appendix 3

Construction of the A-BEST Model

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CONSTRUCTION OF THE A-BEST MODEL

Nighttime population

The Nighttime population is “estimated” based on the US census data.

- **The input** is the US census data that includes 227 block groups within a 2-mile distance from the BU Medical Center.
- **Purpose:** The input data are used to assign 245,842 individuals to 104,000 households.
- The assignment is based on information of gender, age, household type, household size, relationship to the householder, presence of children, etc. provided in a number of tables in the census data.
- These categories of information are in turn used as attributes (**attribute set 1**) of each simulated household and each simulated individual.
- **The output** includes i) 104,000 families containing 245,842 individuals, ii) the attributes for each household and each individual.

The Nighttime population data were “purchased” from ReferenceUSA and includes the following:

- **The input** contains information at the household level including location, income, religion, purchase power, etc.
- **The Purpose** of this step is to merge the previously “estimated” nighttime population to the “purchased” nighttime population.
- The above categories of information, described as **input**, are used as additional attributes (**attribute set 2**) for previously estimated households.

The “estimated” data is then merged with the “purchased” data.

- The merge is based on household size, marital status of householder, gender of householder, age of householder, and presence of children.
- **The output** includes i) 104,000 families containing 245,842 individuals, ii) two sets of attributes for each household and each individual.

Daytime population

- **The input** data were purchased from ReferenceUSA. The data contained information for 310,400 “businesses”. Each business contains name, address, employee size, estimated sale, and type of business according to North America Industry Classification System (NAICS).
- **Purpose:** to assign the individuals in the households to a workplace (including schools).
- The assignment is based on a number of tables in the census data
 - i) **Workers:** according to gender of workers, age of workers, total number of workers, workers by household type, number of workers in household, workers in household with children.
 - ii) **Transportation mode:** according to the number of vehicles in household, age of householder with or without vehicles, median household income.
 - iii) **Time for travel to work:** according to workers who work outside home, time takes to travel to work, and transportation mode
- All above information was extracted from the census data and used as additional attributes (**attribute set 3**) for simulated individuals and households.
- Individuals were assigned to workplaces according to:
 - i) distance to travel to work = transportation mode x time travel to work, while the distance is computed according to actual street network and speed limit.
 - ii) the match between the employer type of a worker (NAICS) and the type of business (NAICS).
- **The output** includes, i) location and other attributes of each business, ii) individuals working at each business, iii) working hours of each individual (daytime or past time)

Pastime population

- **The input** data include:
 - i) 89,259 service-oriented businesses from the 310,400 “business” data
 - ii) 1991 travel survey of the Boston area (the latest survey of the area) which involves 3,906 households containing 9,256 individuals who took 39,934 trips. Every individual in a household reports their trips in 24 hours.
- **Purpose:** Assign individuals to service places.

- Assign individuals to service-places according to individual and household attributes, specifically the age of individuals, gender of individuals, number of vehicles in a household, number of workers in a household, and size of a household. All of this information is assigned during the simulation of nighttime population and daytime population.
- Assign individuals according to service type and trip frequency.
 - i) six types of services identified in the 1991 travel survey pick up or drop off, shopping, eat out, recreation, personal, and social. Plus medical care.
 - ii) for each type, the frequency of trips is based on the frequency distribution of the 1991 travel survey.
 - iii) for location, the nearest location is chosen, plus randomization.
- Assign trips based on time
 - i) service trips occur during daytime and past time.
 - ii) inserted differences between weekdays and weekends
- **The output** includes, i) location and other attributes of each service-place, ii) individuals at each business, iii) service-seeking hours of each individual

Infection

- **The input** includes
 - i) Disease data: Diseases (Ebola, Monkeypox, Sabia, Rift Valley fever, and influenza) Infection and fatality rate for each generation of infection. Infection periods are described as incubation, infectious, or immune.
 - ii) First case of infection
 - iii) Individuals at homes, workplaces, and service places at nighttime, daytime, and pastime, respectively.
- **Purpose:** simulate the spread of disease
- The simulation involves three major steps, i) trace family members, co-workers, and co-shoppers/sales-persons of the infected, ii) check the attributes and health status of these family members, co-workers, and co-shoppers/sales-persons, iii) assign infection to these people according to the disease, infection rate, generation of infection, and infection period.
- **The output** includes simulated infection by date, individual identification, location, and fatality.

