1. THE PURPOSE OF THIS MODEL AND EXTERNAL RESOURCES

The purpose of this hybrid ABM is to answer the question: where is the best place for a new swimming pool in a region of Krakow (in Poland)?

The model is well described in ODD protocol, that can be found in the end of my article published in JASSS journal (available online). Comparison of this kind of models with spatial interaction ones, is presented in the article. Before developing the model for different purposes, area of interest or services, I recommend reading ODD protocol and the article.

This ABM model was designed for the purpose of my Ph.D. thesis: Modelling the best location for sport facilities in the region of Krakow (written in Polish; available online at [ResearchGate](https://www.researchgate.net/publication/317779856_Modelowanie_optymalnej_lokalizacji_dla_dzialalnosci_sportowo-rekreacyjnej_w_regionie_miejskim_Krakowa_en_Modelling_the_best_location_for_sport_facilities_in_the_region_of_Krakow)). It was written in Polish and it was mainly about comparison agent-based modelling and spatial interaction model approaches. The models were based on fitness and swimming pool's clients behaviour, as an example for other services. The default parameters are set for swimming pool version, but in this document I also provide final version of parameters for fitness clubs (more information about parameterization of this services is described in my Ph.D. thesis). Similarly – in the Java code, input and outputs for this model fitness clubs option is present.

1. ECLIPSE AND REPAST CONFIGURATION

Last time, when I worked with my model it was in:

* Eclipse Version: Oxygen.1a Release (4.7.1a), Build id: 20171005-1200
* RepastSimphony-2.5
* Run Configuration: Project's JRE: JRE System Library: Java jdk 1.7.0\_80, Execution environment: CDC-1.1/Foundation-1.1 (jdk1.8.0\_192)
* External java libraries installed: commons-math3-3.0.jar

1. INPUT DATA

This part of README is for readers and researchers, who have already read my article in JASSS and ODD protocol in the Appendix and would like to develop the model for another purpose or area.

If you want to change city you want to work on, you need to change input files, that are in the data catalog ()

In the directory *repastcity\_bankers\data* there are 2 kinds of files needed for the model: csv and shapefiles.

1. Shapefiles:

**buildings.shp** – the most important shapefile – it consist all buildings that exist in the model – homes of agents and sport facilities (swimming pools and fitness clubs).

|  |  |  |
| --- | --- | --- |
| **fieldname** | **alias** | **comment** |
| swimming | is it swimming pool? | 0 – no, 1 – yes |
| fitness | is it fitness club? | 0 – no, 1 – yes |
| ZONE\_ID | ID of zone that the building represents (it was centroid of housing buildings in the zone, moved on road network). | 0-395 – ID of zones, -1 – not applicable (club building) |
| clubID | ID of sport club (swimming pool or fitness club) | 0 – for zone buildings, other numbers for clubs, checked new locations got numbers > 3000 |
| identifier | string identified of buildings | c in the front of the id– sport club, z – zone |
| type | type of building | 1 – club, 3 – home |
| facility\_t | facility type | clients's home, fitness club, swiming pool or fitness club, swimming pool. Just for visualization purpose. |
| strefa\_moj | research areas | centre - Krakow's centre, KRKrest - Krakow, outside centre, KRKoutside - outside Krakow (see: Figure 8 in Appendix) |
| f\_rooms | number of fitness | just for visualization purpose, not used in code |
| s\_area | area of swimming pool in sq. meters | just for visualization purpose, not used in code |
| dist2road | distance from building to road in meters |  |
| dist4walk | distance from public transport stop to building in meters | not used in code |
| accessCar | is the building in Paid Parking Area? | 0 – no, 1- yes |
| accessBus | distance from public transport stop to building in minutes | time distance from public transport stop to building in mintues |
| agentsCarS | number of car drivers for swimming pools simulation |  |
| agentsBusS | number of public transport passengers for swimming pools simulation |  |
| agentsCarF | number of car drivers, for fitness clubs simulation |  |
| agentsBusF | number of public transport passengers for fitness clubs simulation |  |

roads.shp – used just for visualization purpose and primary code testing.

|  |  |  |
| --- | --- | --- |
| **field name** | **alias** | **comment** |
| Toid,C,16 | ID | int |
| identifier,C,20 | ID | string |
| access,C,20 | mode of transport that can move along this road | car walk bus (separated by whitespace) |
| Fields: *type, DescTerm, Nature,* type can be used by algoritm that handles agents movement along road network. Currently the algoritm was used for visualization purposes and code testing. Implementing hierarchy required further work. | | |

people.shp – used just for visualization purpose and primary code testing.

|  |  |  |
| --- | --- | --- |
| **field name** | **alias** | **comment** |
| ZONE\_ID | ID that agent belongs |  |
| X | X coordinate of home location | according to network projection |
| Y | Y coordinate of home location | according to network projection |
| transport | mode of transport used by agent | Only 'car walk' or 'bus walk' are possible |
| myTime1, myTime2 | preferred hour of sport activity | it is drawn by probability (see ODD chapter: Process overview and scheduling) |
| Fields: Toid and identifier are ID, type was not used | | |

b) Csv files are generated from excel file **myMatrixes.xlsx.** They are the heart of the model, because they consist precalculated origin-destination matrices – that are needed for clients decisions and evaluation of each club from client's perspective. Distances along road network were precalculated with ArcGIS network analysis on network layer built based on roads.shp.

|  |  |
| --- | --- |
| **file name** | **description** |
| **HCkmSWIM\_AUTO** | home-club distances in km for car drivers to all swimming pools |
| **HCkmSWIM\_MPK** | home-club distances in km for public transport passengers to all swimming pools |
| **HCkmFIT\_AUTO** | home-club distances in km for car drivers to all fitness clubs |
| **HCkmFIT\_MPK** | home-club distances in km for public transport passengers to all fitness clubs |
| **rankSWIM\_AUTO** | ranking of all home-club distances, according to exponential function with specified beta parameter (=EXP(-beta\_parameter \* distance\_in\_km) for car drivers to all swimming pools (see ODD for more information) |
| **rankSWIM\_MPK** | ranking of all home-club distances, according to exponential function with specified beta parameter (=EXP(-beta\_parameter \* distance\_in\_km) for public transport passengers to all swimming pools (see ODD for more information) |
| **rankFIT\_AUTO** | ranking of all home-club distances, according to exponential function with specified beta parameter (=EXP(-beta\_parameter \* distance\_in\_km) for car drivers to all fitness clubs (see ODD for more information) |
| **rankFIT\_MPK** | ranking of all home-club distances, according to exponential function with specified beta parameter (=EXP(-beta\_parameter \* distance\_in\_km) for public transport passengers to all fitness clubs (see ODD for more information) |
| **timeArraySWIM** | number of available swim lanes at specified time of day in swimming pool |
| **timeArrayFIT** | number of available finess classes at specified time of day in fitness club |

1. CONTROLLING THE MODEL

In the Repast console a user can play with following parameters:

- *choose service type* - there are 2 options available - swimming pools and fitness clubs. I explained it broadly in my PhD thesis. Although in my article in JASSS I describe only swimming pool option, I thought it might be useful to keep both option in the model console, for comparison of different services.

- *display clients movement or turn on teleportation (faster)* - it is one of the most important parameter. If you want to undersdand and test model use display clients. If you want to run real analysis the parameter should defenitely be set to 'turn on teleportation' for – in this way is 17 times faster!

- *following parameters* - 1 experienceCar & 2 experiencePT, 3 minRankCar (called minimum rate in the JASSS article), 4 minRankBus (called minimum rate in the JASSS article), 5 trafficImpact, 6 busStopDistanceImpact - they differ for swimming and fitness, and were explicitly described in Appendix to JASSS article (chapter 7. Submodels).

- *List of new locations* - if the value is set to 42, the model works without consideration of new locations. If ID of new locations are given - the model opens them for agents,

- *Default Random Seed* - this is repast parameter, not used by my model,

- *End Time* - after this number of ticks the simulation will end,

- *Agent Definition* - it should be set to 'random:42' - in this case the model draw number of agents, based on information in buidlings.shp layer. The parameter should not be changed. Nevertheless it was left, because it was part of Nick Malleson RepastCity model - that opens some new ways of model control for new applications.

- *number of runs* - this parameter should not be changed - it should work in batch mode.

All of above parameters are in *repastcity3.rs\parameters.xml file.*

Other variables, can be found in GlobalVars.java file.

There are: *getSpeed, howLongAtClub, numberOfPools, numberOfFitness, maxFcarKM, maxFbusKM, maxScarKM, maxSbusKM, placesPerRoomAtFitness, placesPerLaneAtPool, hours* - their meaning is explained by comments in the code.

5. OUTPUT DATA AND RESULTS

The ABM produce an output in csv tables. They have to be properly handled, e.g. copied & processed in excel file. Due to stochastic nature of this model, proper results should represent summarized values, e.g. it can be average of 30 model runs.

The model generates following csv files (first part of filename indicates if the model is designed for swimming pools or fitness centers):

|  |  |
| --- | --- |
| **file name** | **description** |
| results1.csv | Statistics needed to assess model performance |
| SWIM\_distanceDecay1.csv | Distance decay statistics – distance in km, number of clients travelling by car, and by public transportation. Needed for Spearman’s rho (see Appendix)Needed for Spearman’s rho (see Appendix, Table 5) |
| SWIM\_chi2\_1.csv | Total number of clients that were Needed for Chi2 test (see Appendix, Table 6) |
| SWIM\_MPK1.csv | Total number of public transport passengers who tried to get into a club |
| SWIM\_AUTO1.csv | Total number of car drivers who tried to get into a club |
| SWIM\_crowdInClubs1.csv | Number of clients who tried to get into a club at certain time in % of club’s capacity (number of available places per hour) |
| SWIM\_myTimesReport1.csv | Summary statistics of popularity of certain hours – needed to check if the model behaves in a sensible way |

Every set of 30 model runs should be further processed. It can be done with excel/libre office calc. Example of how I did it is here: ..\location\_analysis\_ABM\repastcity\_bankers\data\gis\_data\myTM\results\resultsSWIM30.ods – name of the tabs correspond with filenames. Eventually Market share (% of clients that went to each swimming pool) can be calculated for each set of 30 runs. Next step is to check all new locations of a club, and choose the one that attracted the highest number of clients.

Description of the model calibration and how to process results can be found in my article, that is freely available on-line: http://jasss.soc.surrey.ac.uk/22/1/1.html

5. GENERAL COMMENTS

I wrote the code few years ago. There might be some hard-coded parts. The simplest way to implement it, is to use the same parameters in input data.

Feel free to develop the model.

If you have any questions, you should find the answers in my article:

<http://jasss.soc.surrey.ac.uk/22/1/1.html>

If you cannot find the answers there, feel free to contact me at: [lukaszkowalski2013@gmail.com](mailto:lukaszkowalski2013@gmail.com)

If you manage to develop my model and you will publish it on github, please let me know, I’d love to hear that my research project was further used.