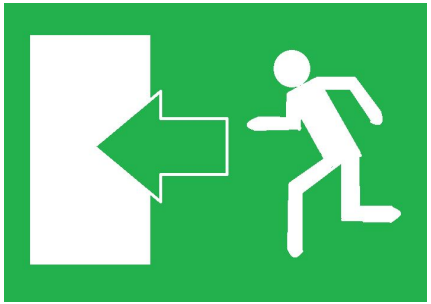
CITY SIMULATIONS IN EXTRAORDINARY CIRCUMSTANCES

MID-TERM PRESENTATION
GROUP 5 PRIII 3CD1

INDEX

INTRODUCTION



GOALS AND VALUE

Main goal

Prepare population in case of:

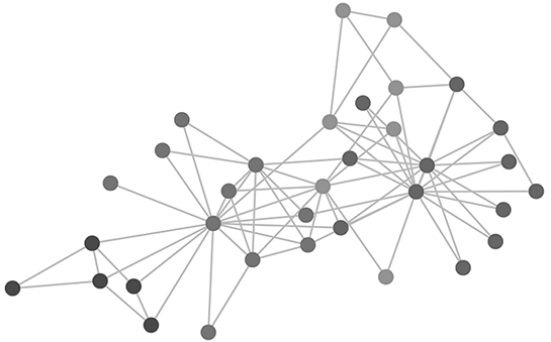
1. Natural disasters.
2. Terrorist attacks.
3. War-related catastrophes.

GOALS AND VALUE

¿How we will develop such goal?

Programming languages able to support agent-based modeling.

GOALS AND VALUE



Model

1. Human Behaviour
2. Graph-like city modelling
3. Urban mobility

GOALS AND VALUE

Data related topics

1. Geographical data
2. Mobility
3. Agent features

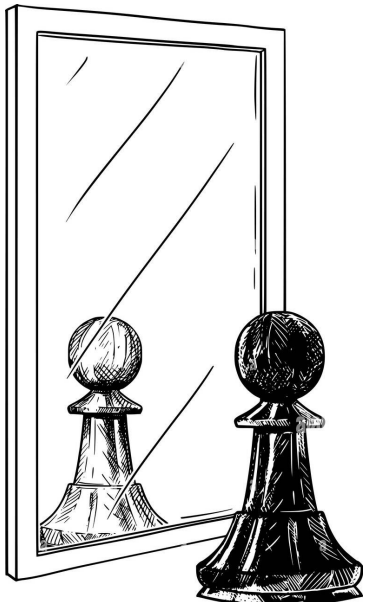
GOALS AND VALUE

Innovative ideas

1. Emulate situations that cannot be studied in real life.
2. Studying how public transport could be helpful in a critical scenario.
3. Study everything on a local scale.
4. Adapting our work to certain Valencia-related events → Fallas

STATE OF ART

- Digital twins.



STATE OF ART

- Digital twins.

- Agent-based modeling.

STATE OF ART

- Digital twins.

- Agent-based modeling.

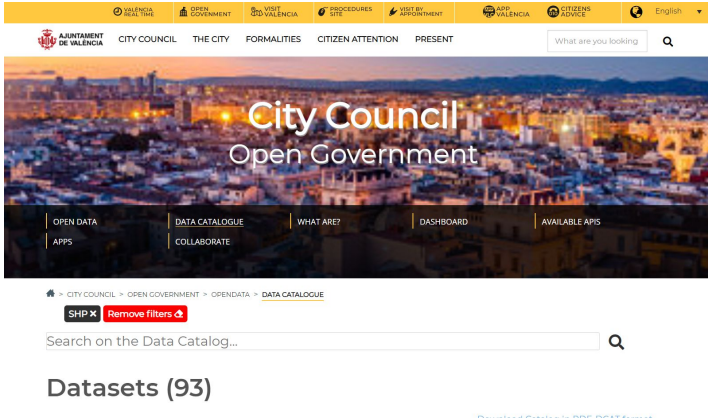
- Base models

DATA

- All data has been obtained from Valencia City Council Open Data and Geoportal webpages.
- All files had to be available in .shp extension as so as to work with GAMA.

AJUNTAMENT DE VALÈNCIA

SHP

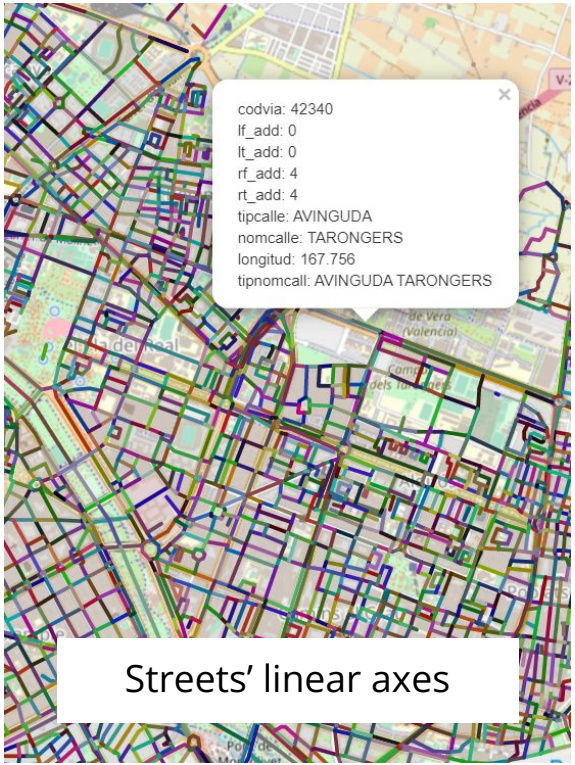


DATA

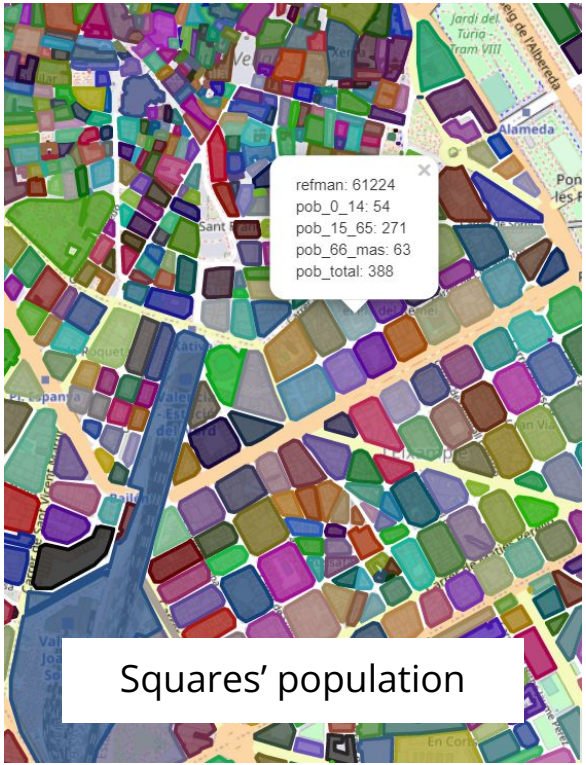
The data we've acquired is the following:

- Linear axes of the city’s streets.
- Urban squares with its registered population by group ages.
- Direction of the circulation in the lanes of the municipality.
- Traffic in Valencia main ways (vehicles per hour).
- Cadastre with types of use of the different locations.
- Paths closed to traffic because of Fallas.

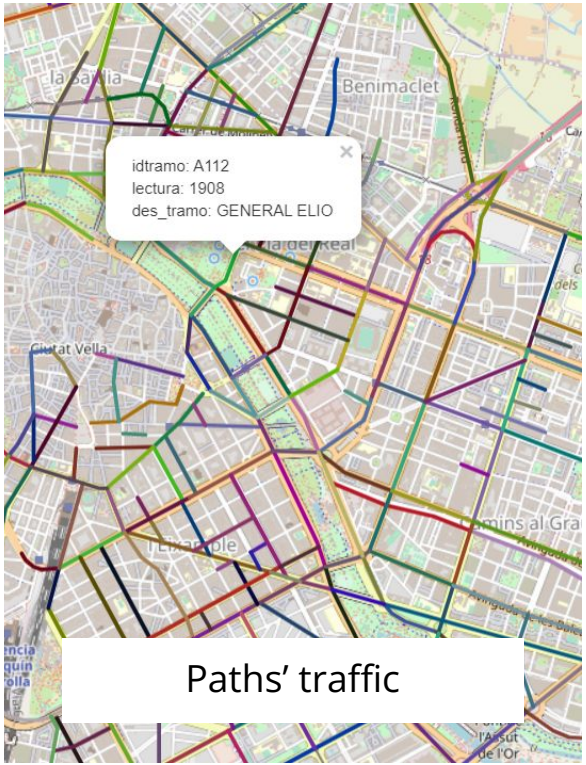
DATA



Streets' linear axes



Squares' population

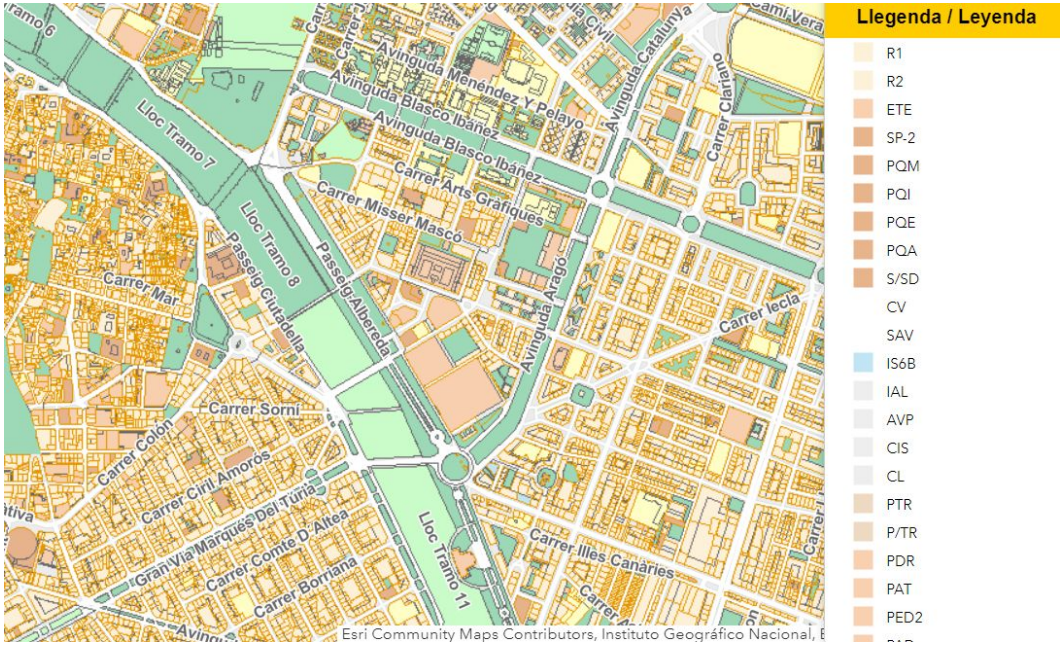


Paths' traffic

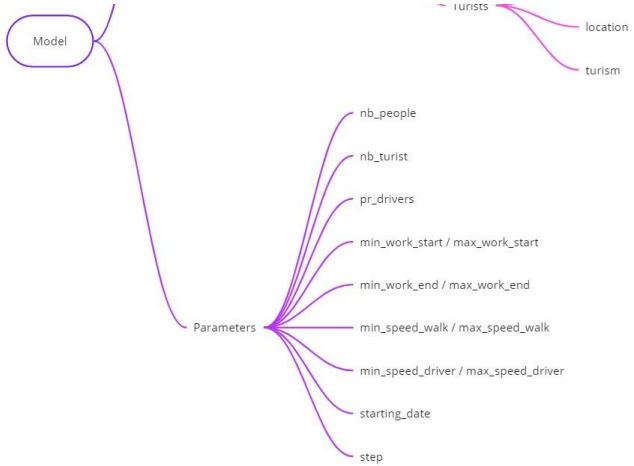
DATA

- More data may be used in order to have a closer twin of the conurbation.
- The data we have to analyse will be obtained by the model of the city, in order to optimise the actions we end up simulating.

DATA PREPARATION



MATERIALISING MINABLE VIEW



MATERIALISING MINABLE VIEW

Name	Type	Unit	Explanation
nb_people	int	number	Number of people in the city
nb_turism	int	number	Number of tourists in the city
min_work_start	float	hour	Minimum start time
max_work_start	float	hour	Maximum start time

MATERIALISING MINABLE VIEW

Name	Type	Explanation
industrial_buildings	list	A list of all industrial buildings
recreative_buildings	list	A list of all recreative buildings
turism_buildings	list	A list of all turism buildings
residential_buildings	list	A list of all residential buildings
host_buildings	list	A list of all host buildings

MATERIALISING MINABLE VIEW

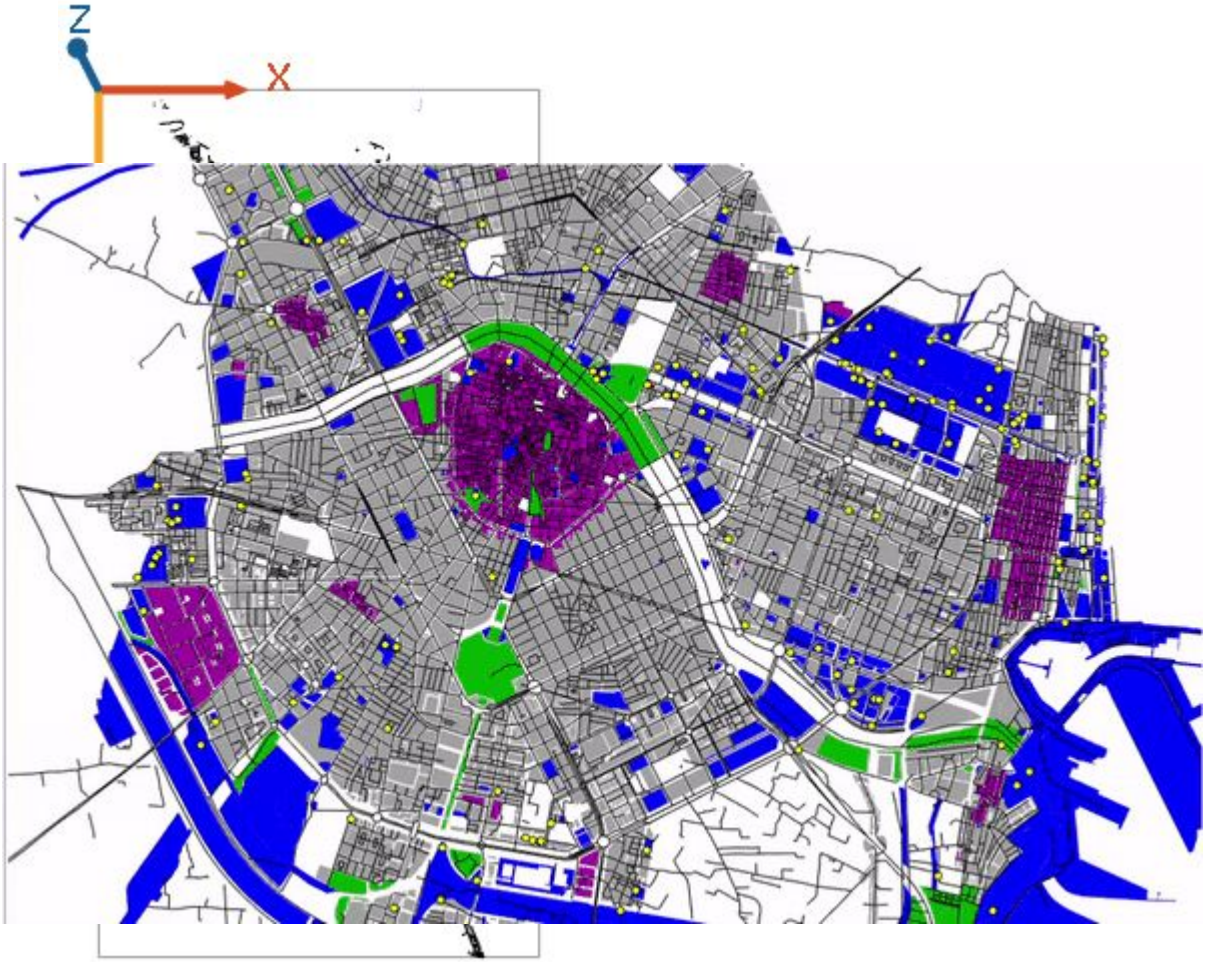
Name	Explanation
speed	A random number between the parameters of min_speed_walk and max_speed_walk
start_work	A random number between the parameters of min_work_start and max_work_start
end_work	A random number between the parameters of min_work_end and max_work_end
living_place	A building on the list of residential_buildings
working_place	A building on the list of industrial_buildings
location	Any location in living_place
leisure	The list of recreative_buildings

MATERIALISING MINABLE VIEW

Name	Explanation
speed	A random number between the parameters of min_speed_walk and max_speed_walk
hotel	A building on the list of host_buildings
turism	The list of turism_buildings
location	Any location in hotel

Model

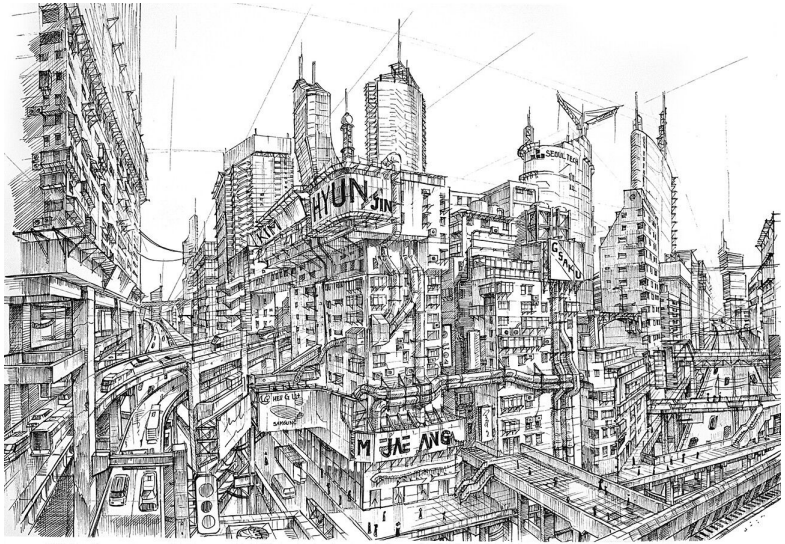
- Grey: residential buildings
- Blue: working centres
- Green: recreative areas
- Purple: tourist centres



DEPLOYMENT MOCKUP

Main components:

- Basic environment
- Agents



DEPLOYMENT MOCKUP

Graph:

- External data in shape files.
- Colored squares → buildings.
- Lines → streets.

```
global {
    file shape_file_roads <- file("C:/Users/Home/Desktop/EJES-CALLE.shp");
    file shape_file_buildings <- file("C:/Users/Home/Desktop/buildings2.shp");
    geometry shape <- envelope(envelope(shape_file_buildings) + envelope(shape_file_roads));
```

DEPLOYMENT MOCKUP

Agents:

- Emulated.
- Behaviour determined by both parameters in background & user interaction.
- Color determines type.

```
create locals number: nb_people {
    speed <- rnd(min_speed_walk, max_speed_walk);
    start_work <- rnd (min_work_start, max_work_start);
    end_work <- rnd(min_work_end, max_work_end);
    living_place <- one_of(residential_buildings);
    working_place <- one_of(industrial_buildings);
    objective <- "resting";
    location <- any_location_in (living_place);
    color <-  #yellow;
    ocio <- recreative_buildings;
}
```

DEPLOYMENT MOCKUP

Execution (1):

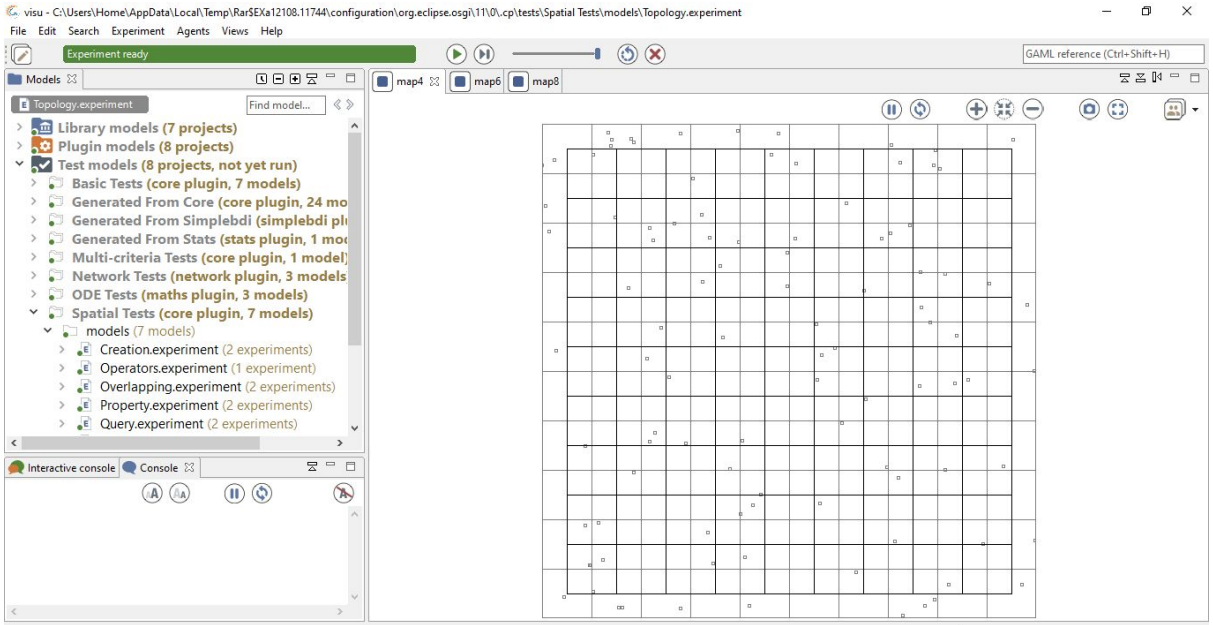
- Each model written in a script.
- GAMA automatically pops up a green square with a play button.
- Experiment runs in a new window.

DEPLOYMENT MOCKUP

Topology.experiment

visu | Topology

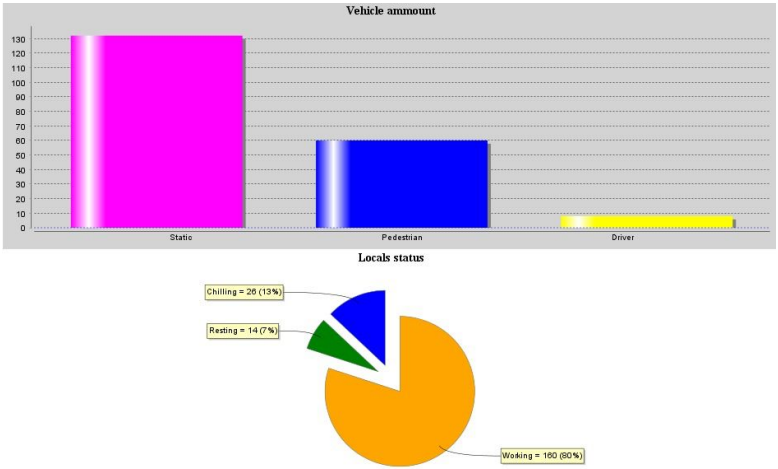
```
 5  * Tags: spatial, topology, grid, graph
 6  ***/
 7  model testTopology
 8
 9  global {
10
11      graph c_graph4;
12      graph c_graph6;
13      graph c_graph8;
14
15      int x_cells <- 10;
16      int y_cells <- 10;
17
18      init {
19          c_graph4 <- grid_cells_to_graph(cell4);
20          c_graph6 <- grid_cells_to_graph(cell6);
21          c_graph8 <- grid_cells_to_graph(cell8);
22          create dummy number:100;
23      }
24
25  }
26
27  grid cell4 width: x_cells height: y_cells neighbors: 4 {}
28  grid cell6 width: x_cells height: y_cells neighbors: 6 {}
29  grid cell8 width: x_cells height: y_cells neighbors: 8 {}
30
31  species dummy { aspect default {draw shape color:#grey;} }
32
```



DEPLOYMENT MOCKUP

Execution (2):

- Besides the graphical representation, a statistics page will appear.
- Bar graph.
- Pie graph.



FINAL IMPACT

- Computational cost
- People’s privacy
- Evacuation
- Mobility
- Risks

REFERENCES

Bankes, S. C. (2002). Agent-based modeling: A revolution? *PNAS*, *99*(3), 7199-7200. https://doi.org/10.1073/pnas.072081299

Batty, M. (2018, September 10). Digital twins. *SAGE Journals*, *5*(5), 817-820. https://doi.org/10.1177/2399808318796416

Castiglione, F. (2006). Agent based modeling. *Scholarpedia*, *1*(10), 1562. https://doi.org/10.4249/scholarpedia.1562

Data assimilation for Agent-Based Modelling (DUST). (n.d.). https://urban-analytics.github.io/dust/index.html

Deren, L., Wenbo, Y., & Zhenfeng, S. (2021, March 29). Smart city based on digital twins. *Computational Urban Science*, *1*(4), 1-11. https://doi.org/10.1007/s43762-021-00005-y

Gama main page. (n.d.). GAMA-Platform · GAMA. https://gama-platform.org/

Helbing, D. (2012). *Social Self-Organization: Agent-Based Simulations and Experiments to Study Emergent Social Behavior*. Springer.

Marroco, L., & Castelló Ferrer, E. (2019). Towards a Blockchained Agent-Based SImulator for Cities (T. Ishida, F. Zambonelli, I. Noda, & D. Lin, Eds.). *Massively Multi-Agent Systems II: International Workshop, MMAS 2018, Stockholm, Sweden, July 14, 2018, Revised Selected Papers*, 144-162. https://doi.org/10.1007/978-3-030-20937-7_10

Mitropoulos, V. (2019). *Modeling and simulation of the movement of people in space in a city environment* (National Technical University of Athens, Ed.) [Bachelor thesis]. https://dspace.lib.ntua.gr/xmlui/handle/123456789/50344

Traffic model: network, demand and agent-based simulation for San Francisco or other cities. (2018, September 11). GitHub. https://github.com/cb-cities/sf_abm

Wiesner, P., & Thamsen, L. (2021). *2021 IEEE 5th International Conference on Fog and Edge Computing (ICFEC)*. IEEE. https://doi.org/10.1109/ICFEC51620.2021.00012