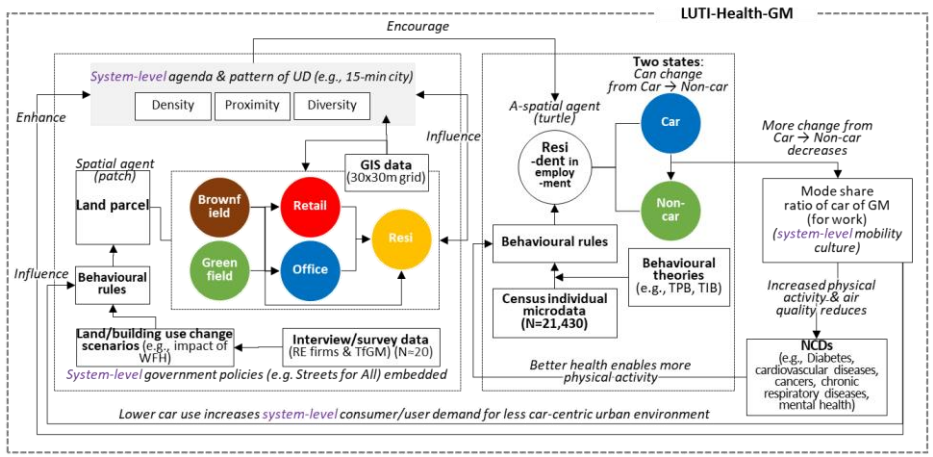
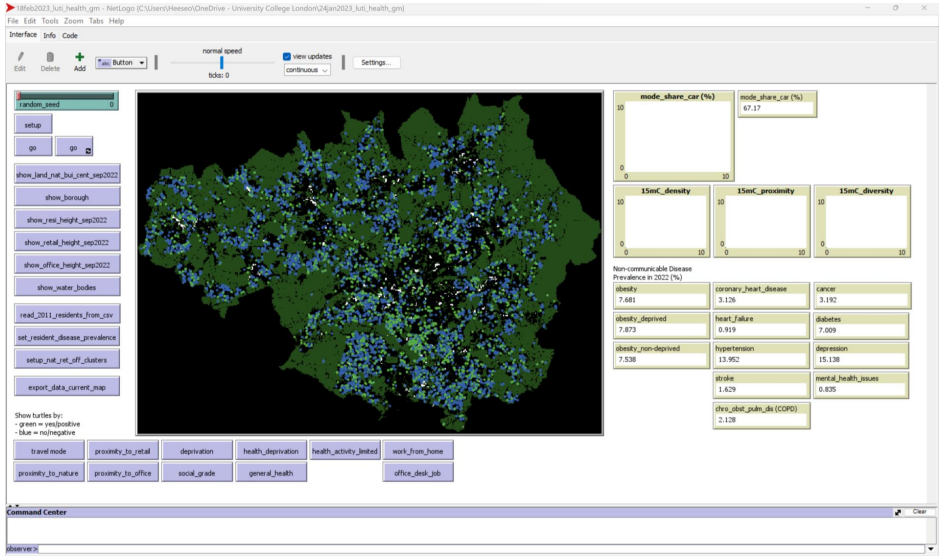


Source: Adapting from Kwon, 2020



Lecture 4:

Using ABM and behavioural theories for land use-transport interaction (LUTI) simulation: Healthier urban development and healthier travel behaviour

Dr Heeseo Rain Kwon

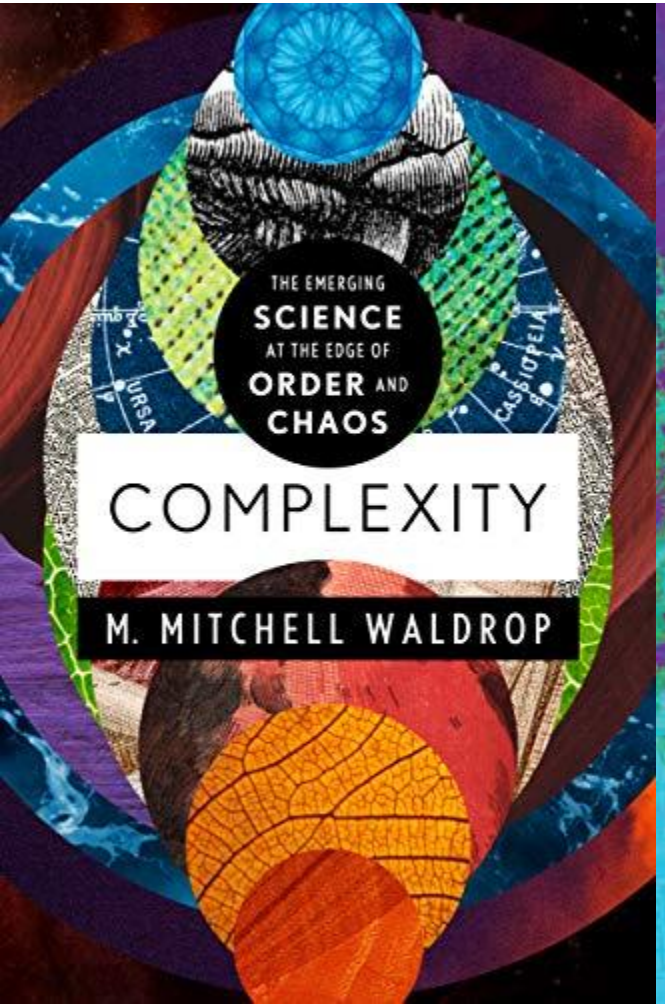
BSP Post-doctoral Research Fellow

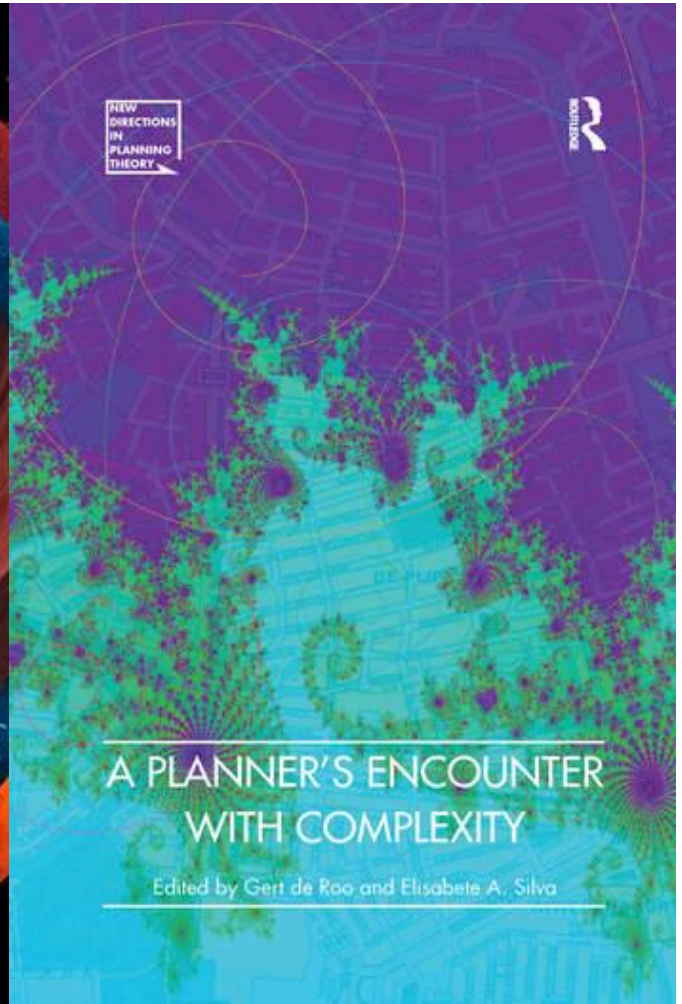
Bartlett School of Planning, University College London

heeseo.kwon.10@ucl.ac.uk

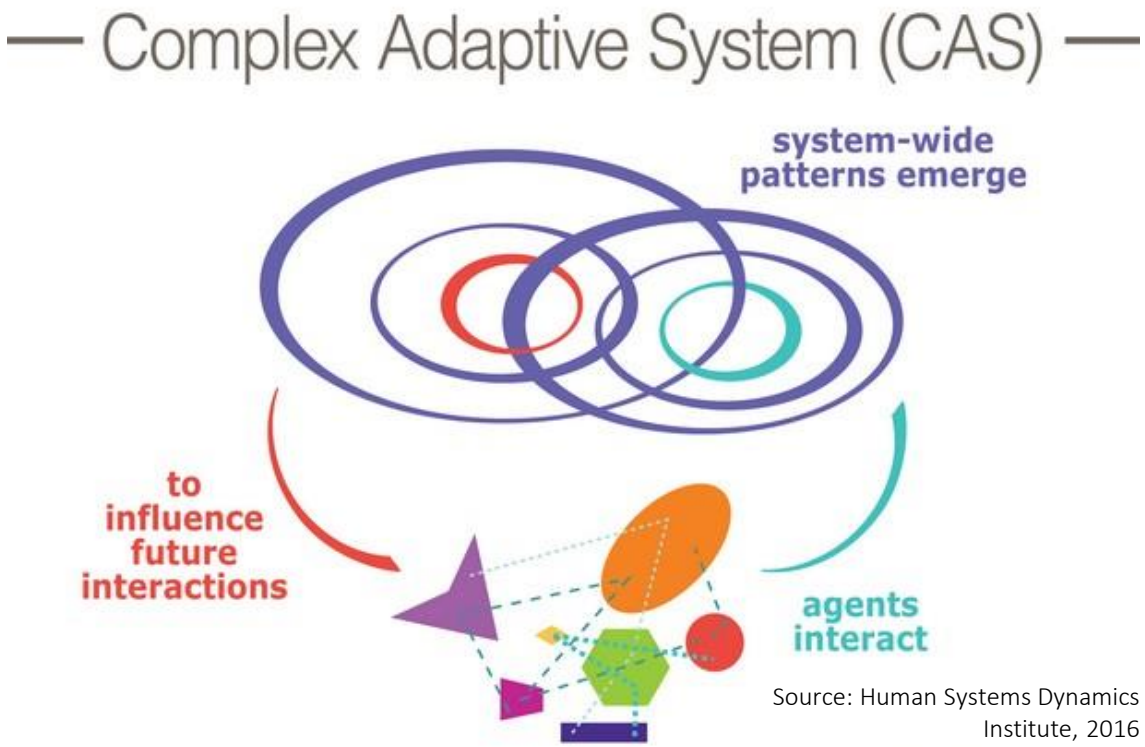
Note: Slides are based on Kwon's PhD research at Cambridge at postdoc research conducted as part of a UKPRP network-funded project.

Applying complexity theory in urban planning to inform policies for positive behavioural change



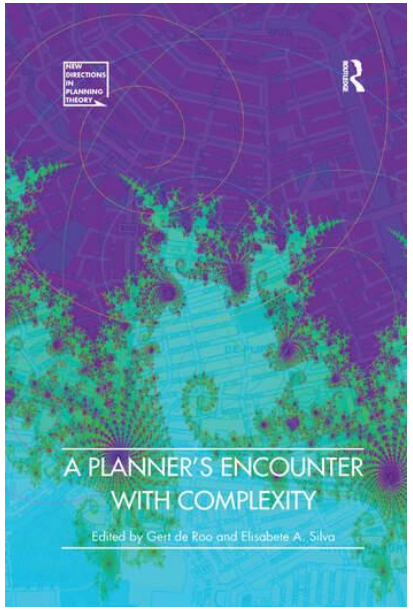


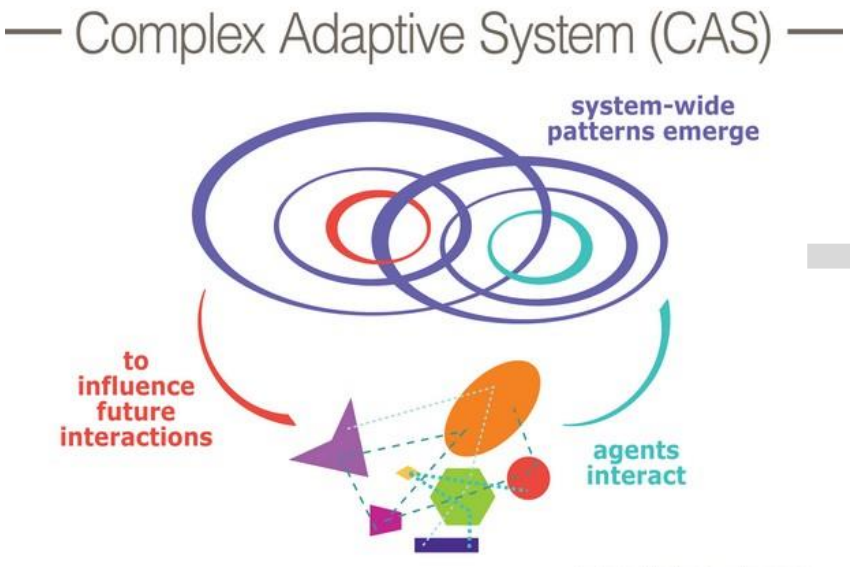
Modelling of individual agent behaviours and their interactions in feedback loops with system-level behaviour



Source: Human Systems Dynamics Institute, 2016

Establishing a robust theoretical framework is very important for modellers



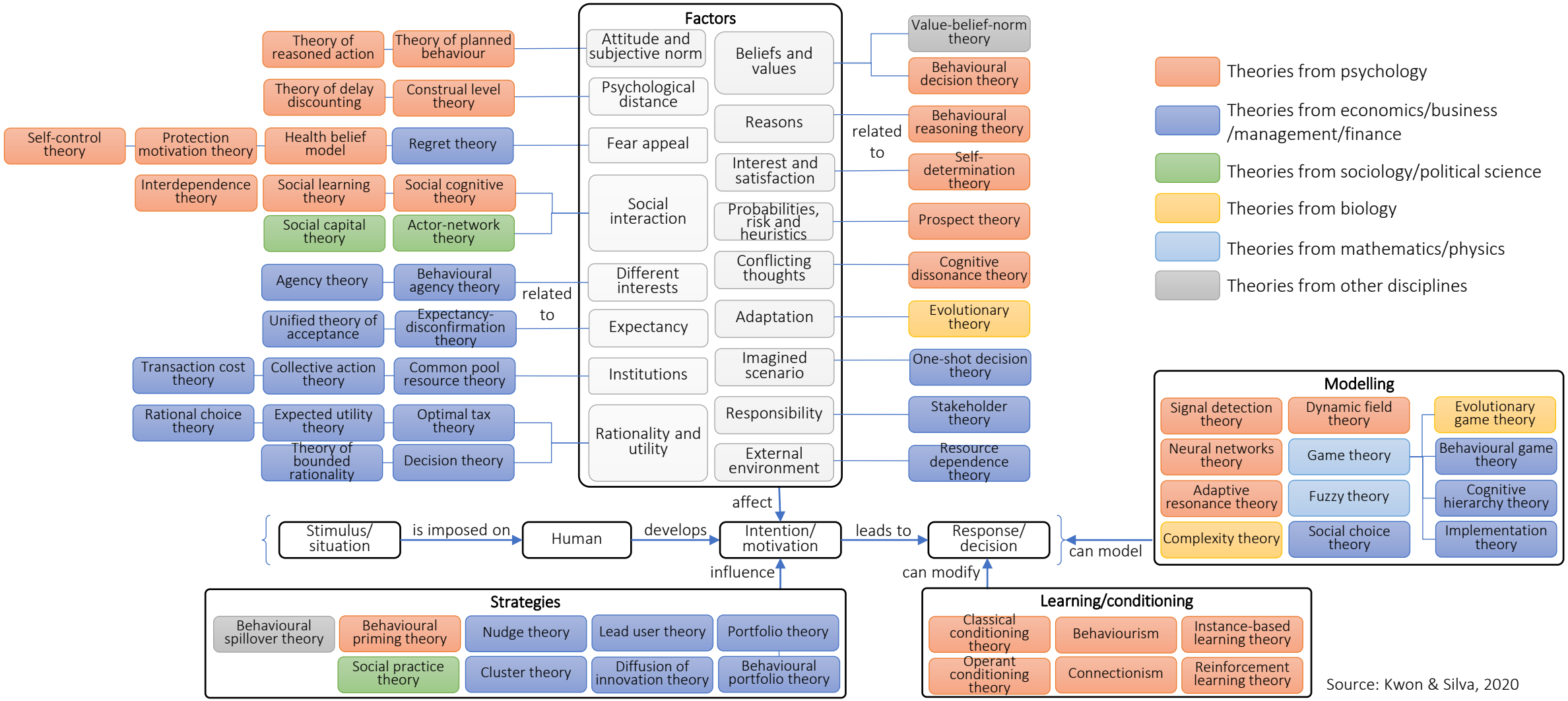


+

Relevant theories in the discipline

Relevant social and behavioural theories
(from psychology, sociology, economics…)

Kwon & Silva (2020) Mapping the Landscape of Behavioural Theories: Systematic Literature Review, *Journal of Planning Lit.*



Source: Kwon & Silva, 2020

These theories can help explain individual actor behaviour, group behaviour, dynamics within a group/system. Different theories can be especially appropriate for different types of behaviour of different types of agents. Examples given in yellow boxes.

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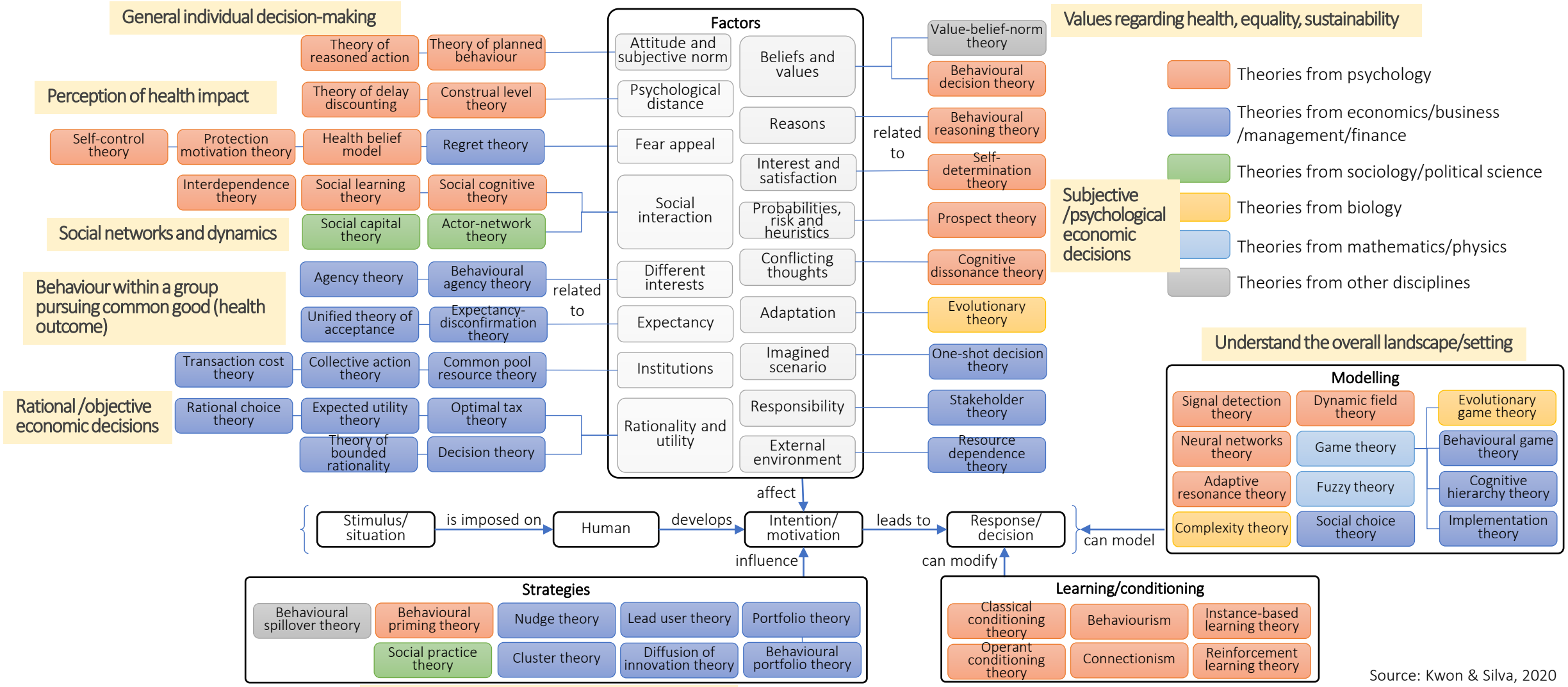
"Mapping the Landscape of Behavioural Theories: Systematic Literature Review" (Kwon & Silva, 2020)



Source: Kwon & Silva, 2020

Journal of Planning Literature
Volume 35, Issue 2, May 2020, Pages 161-179

https://doi.org/10.1177/0885412219881135

Article

Mapping the Landscape of Behavioral Theories: Systematic Literature Review

Heeseo Rain Kwon and Elisabete A. Silva

Abstract

The term "behavioral" has become a hot topic in recent years in various disciplines; however, there is yet limited understanding of what theories can be considered behavioral theories and what fields of research they can be applied to. Through a cross-disciplinary literature review, this article identifies sixty-two behavioral theories from 963 search results, mapping them in a diagram of four groups (factors, strategies, learning and conditioning, and modeling), and points to five discussion points: understanding of terms, classification, guidance on the use of appropriate theories, inclusion in data-driven research and agent-based modeling, and dialogue between theory-driven and data-driven approaches.

Keywords

behavioral theories, behavioral science, data-driven research, theory-driven research, agent-based modeling, urban and environmental planning, data science, complexity theory

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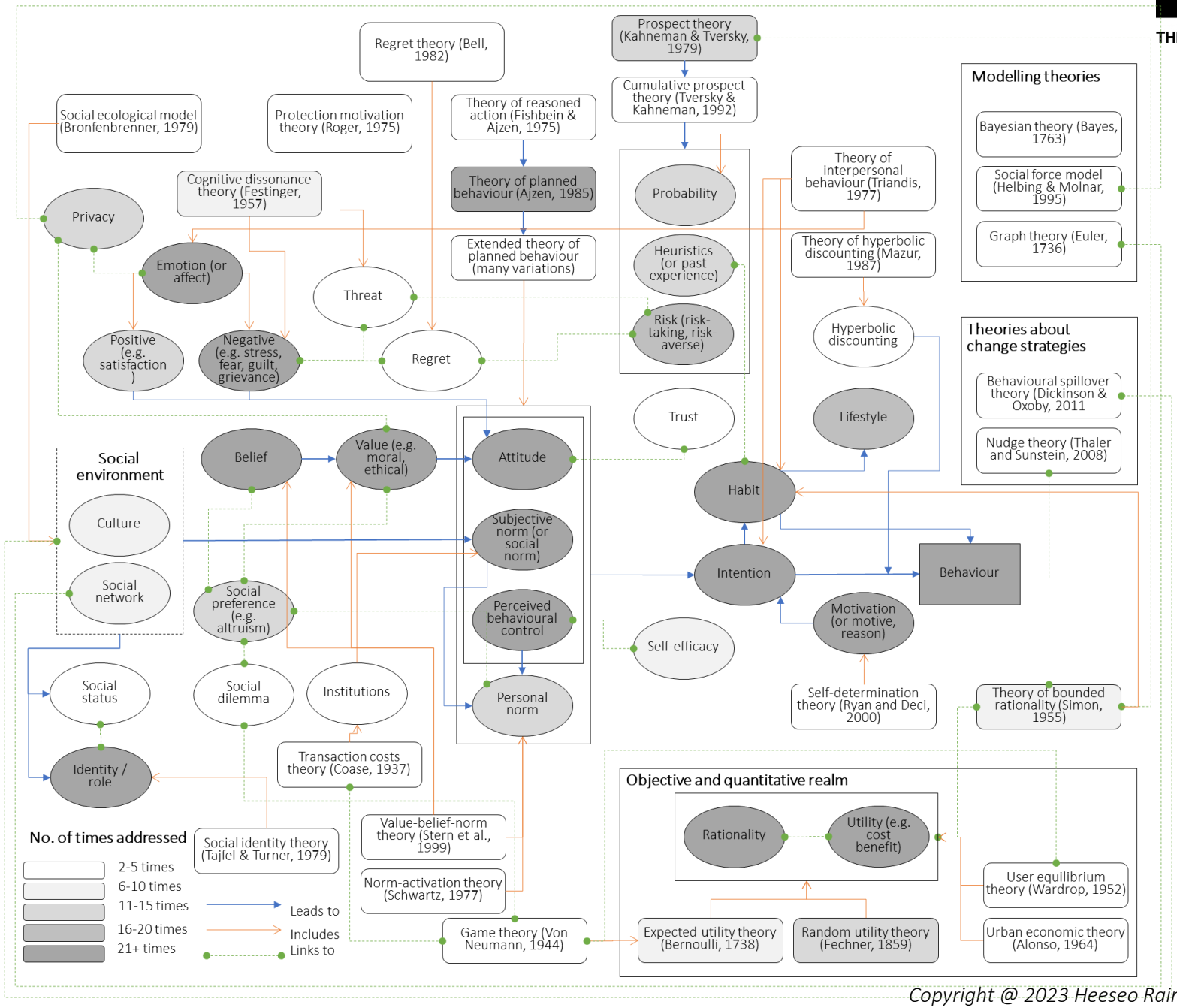
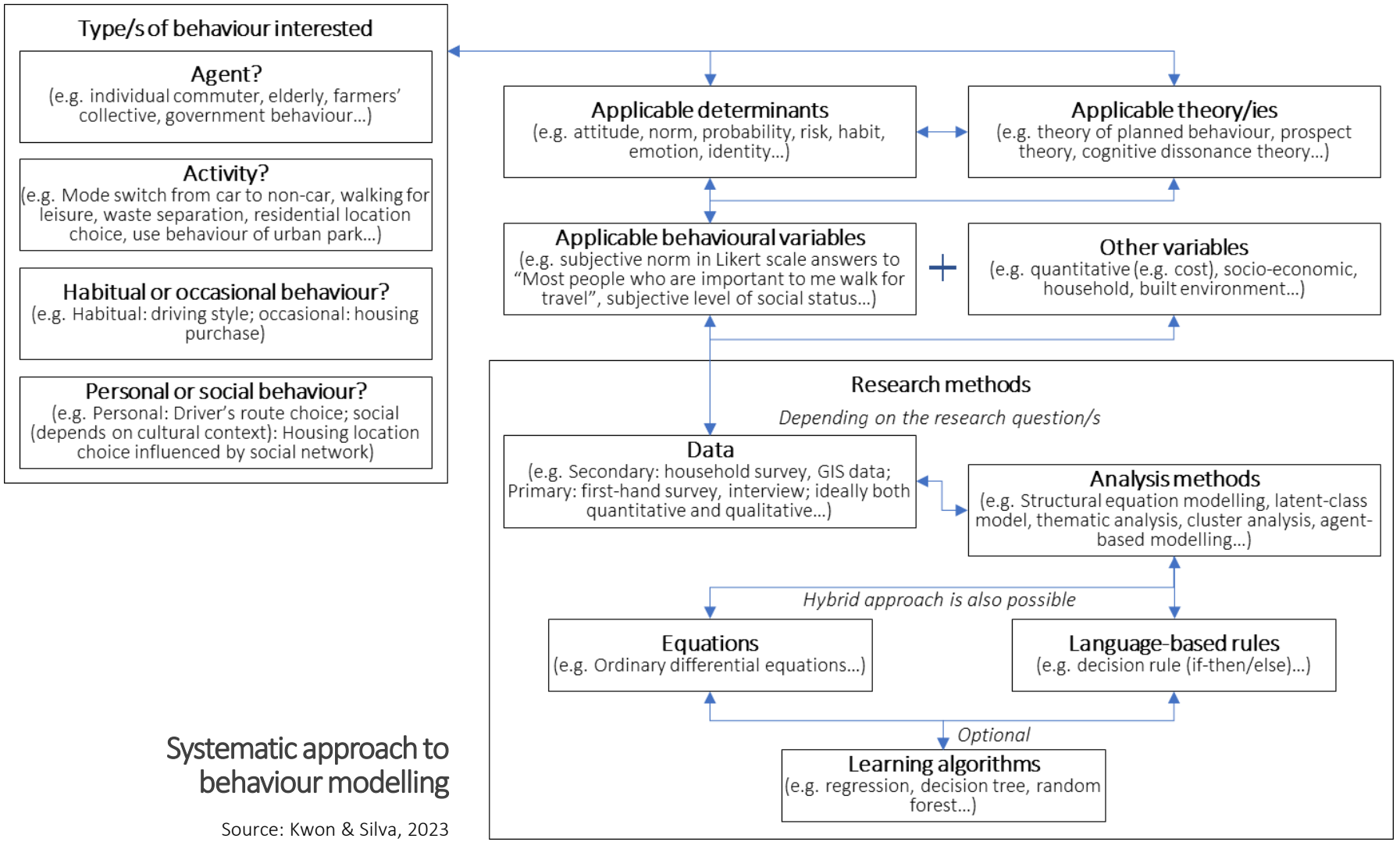
Kwon & Silva (2023) Matching Behavioural Theories and Rules with Research Methods in Spatial Planning-related Fields, *Journal of Planning Lit.*



Flow chart of behavioural theories and determinants used in planning-related fields

Source: Kwon & Silva, 2023

Kwon & Silva (2023) Matching Behavioural Theories and Rules with Research Methods in Spatial Planning-related Fields, *Journal of Planning Lit.*



Systematic approach to behaviour modelling

Source: Kwon & Silva, 2023

Journal of Planning Literature
OnlineFirst

https://doi.org/10.1177/08854122231157708

SAGE journals

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Original Article (literature review or lit review with annotated bibliography)

Matching Behavioral Theories and Rules with Research Methods in Spatial Planning-Related Fields

Heeseo Rain Kwon [1] **and Elisabete A. Silva** [2]

https://journals.sagepub.com/doi/10.1177/08854122231157708

Abstract

Despite the popularity of the "behavioral approach," there is as yet a lack of guidance on the selection and use of appropriate behavioral theories for specific planning purposes. Based on a literature review of 318 articles in spatial planning-related journals, this paper presents a portfolio of behavioral theories by types of behavior, key variables, rules, and research methods. In addition, based on the survey of twenty-two international experts, it cross-validates the findings and highlights particularly appropriate theories for certain types of behavior dealt in related disciplines. Finally, the paper derives discussion points including the applicability of various behavioral theories in urban models such as space and time-sensitive dynamic simulations.

Keywords

behavioral theories and rules, behavioral sciences, research methods, quantitative-qualitative analysis, dynamic simulation, agent-based modeling, equation-based and language-based computation and models, space and time interaction models, coding, urban and environmental planning

[1]Department of Real Estate and Planning, Henley Business School, University of Reading, Reading, UK
[2]Department of Land Economy, University of Cambridge, Cambridge, UK

Corresponding author(s):
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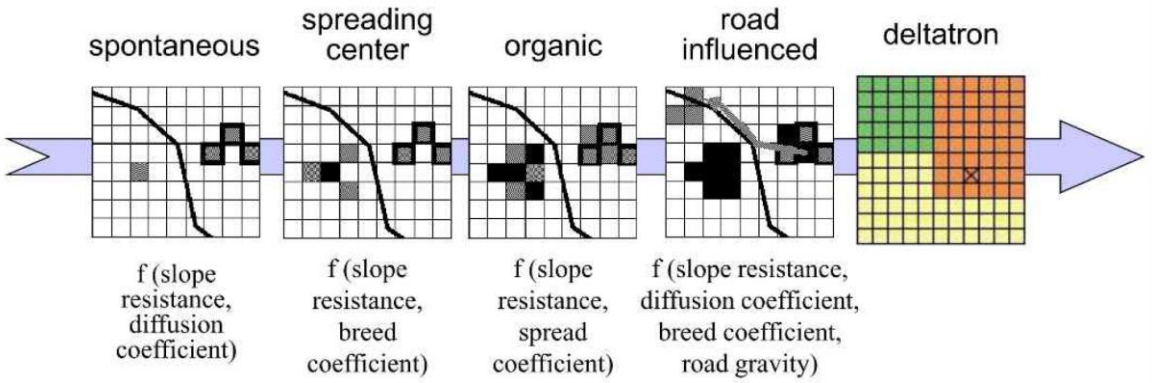
Cellular Automata (CA) and Agent-Based Modelling (ABM): Different Strengths

Cellular Automata
(e.g. SLEUTH urban growth model)

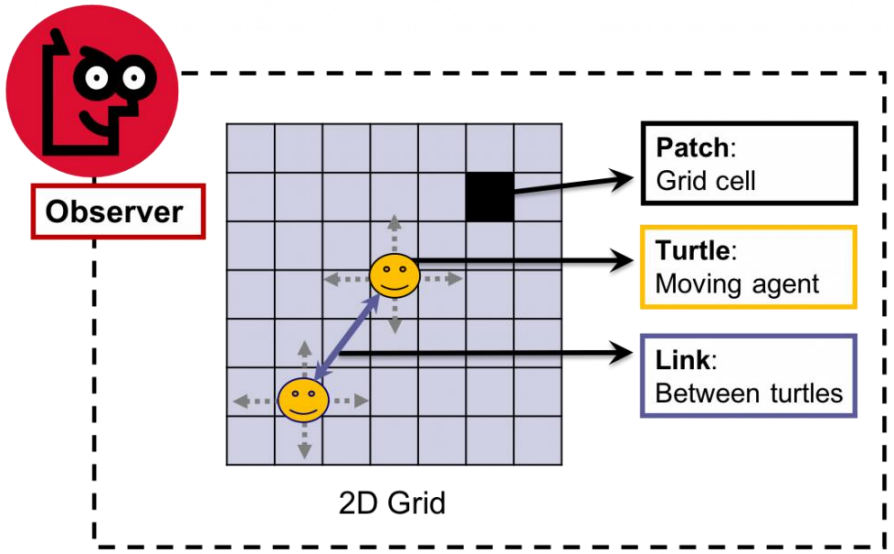
Particularly effective in modelling the spatial dynamics (e.g., land change)



Source: Clarke., 2019

Agent-Based Model
(e.g. on NetLogo platform)

Particular strength in simulating human decision-making dynamics and interaction with the environment



Source: Izquierdo et al., 2019

Hybrid CA-ABM models

Three dimensions of human-environment dynamic modelling

SLEUTH urban growth model (Cellular Automata) →

Through CA-ABM? → *

Key

A-Time series statistical models, STELLA models with no human dimension

B- Time-series models with human decision-making explicitly modeled

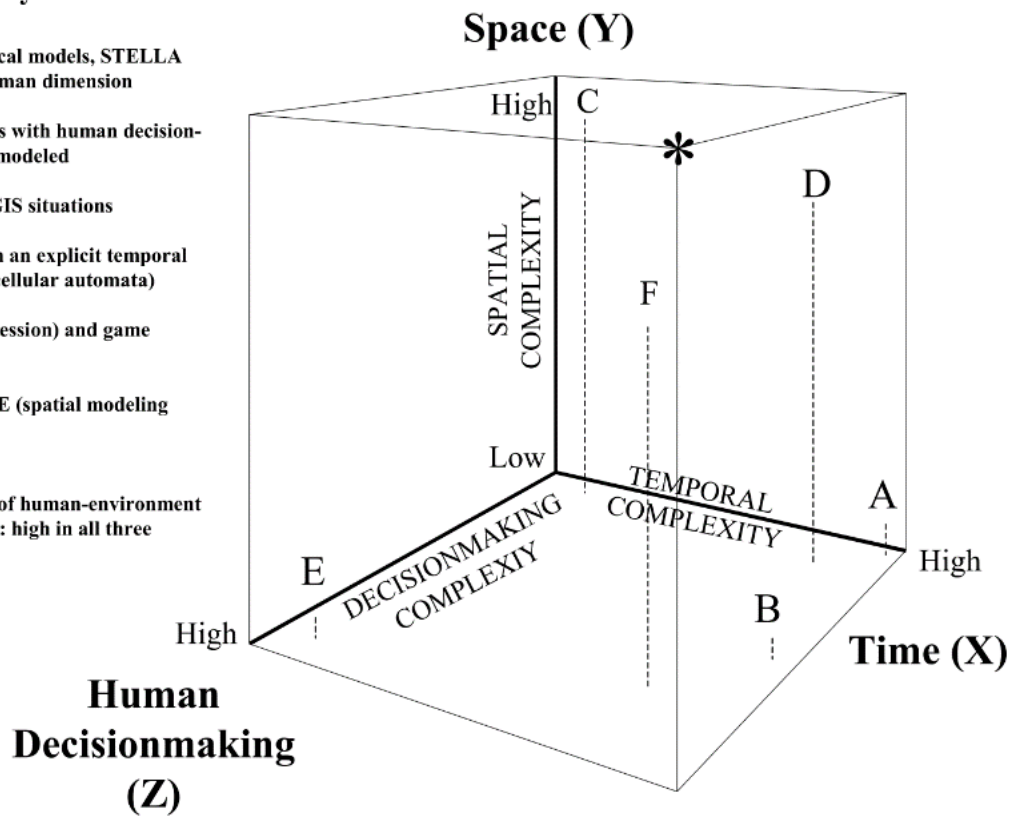
C- Most traditional GIS situations

D- GIS modeling with an explicit temporal component (e.g., cellular automata)

E- Econometric (regression) and game theoretic models

F- SWARM and SME (spatial modeling environment)

* **The ultimate goal of human-environment dynamic modeling: high in all three dimensions**



Source: Agarwal et al. 2002, p.7;
Kwon et al., forthcoming a

Cellular Automata (CA) and Agent-Based Modelling (ABM): Different Strengths

Cellular Automata
(e.g. SLEUTH urban growth model)

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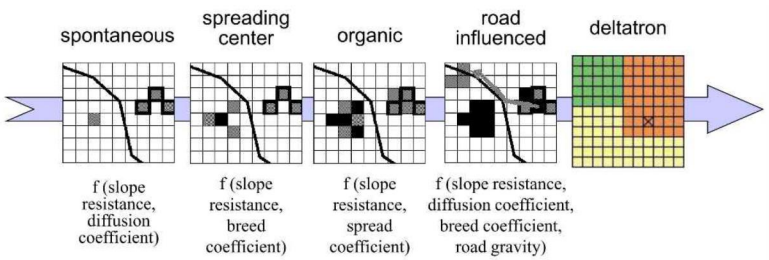

Source: Clarke., 2019

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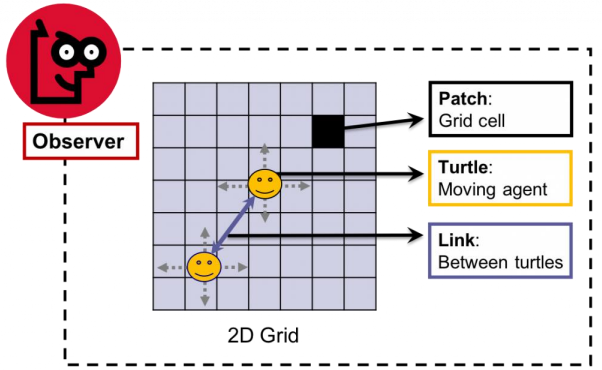
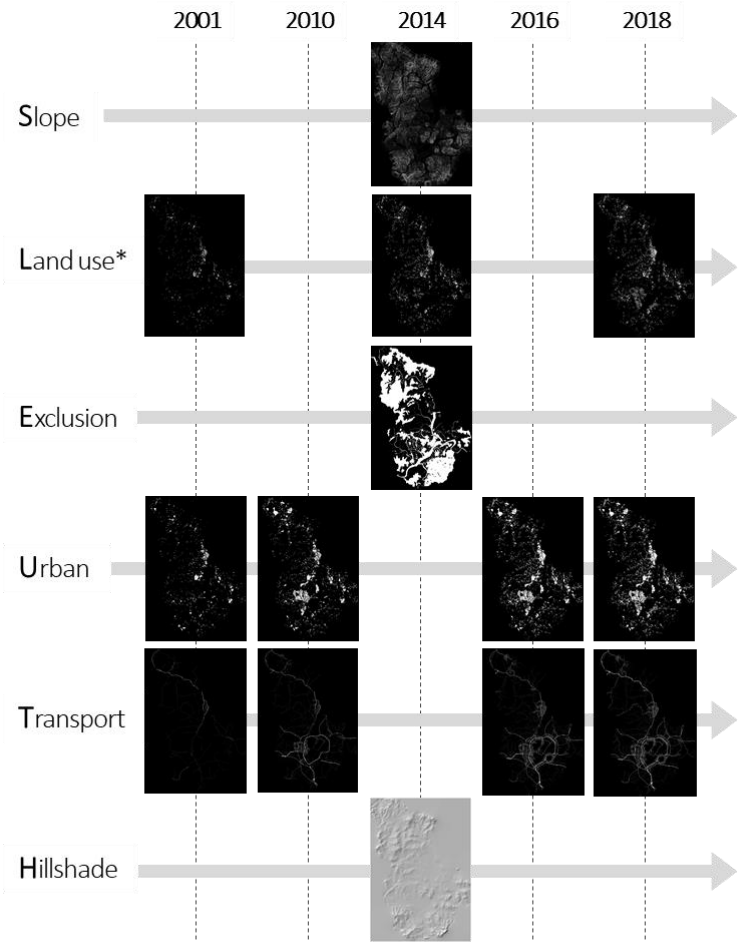


Source: Izquierdo et al., 2019

Hybrid CA-ABM models

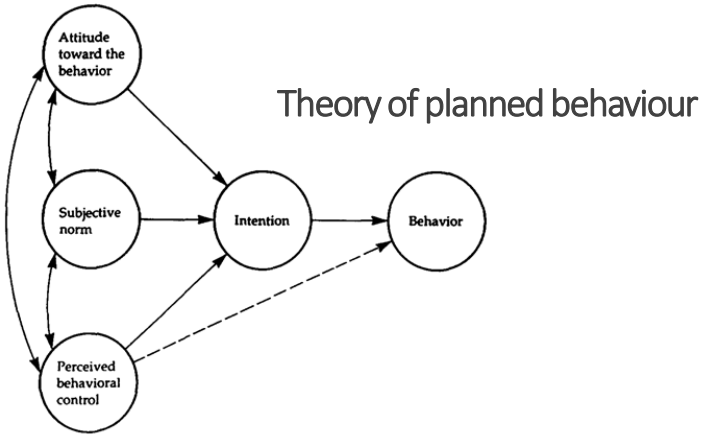
Source: Kwon et al., forthcor

Input layers of NL-SLEUTH-LUTI (30*30m raster)

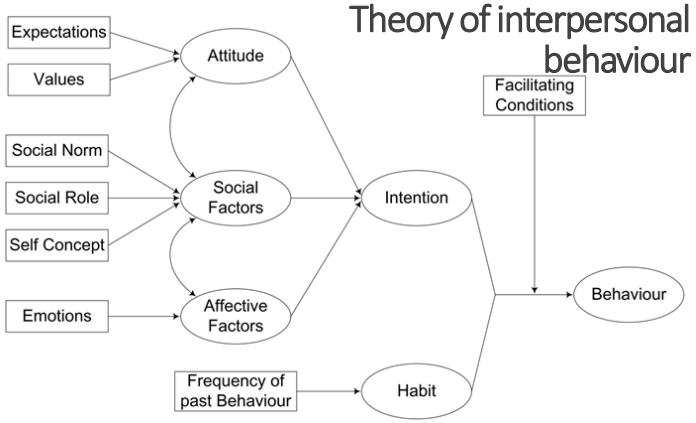


Note: Land use maps are not included in SLEUTH because the model concerns non-urban → urban only. Instead, building use is used to calculate "mixed-use" as a variable for resident behaviour.

Kwon *et al*. (Forthcoming b) Implementing SLEUTH on NetLogo and Adding an A-spatial Layer based on Survey Data



Theory of planned behaviour

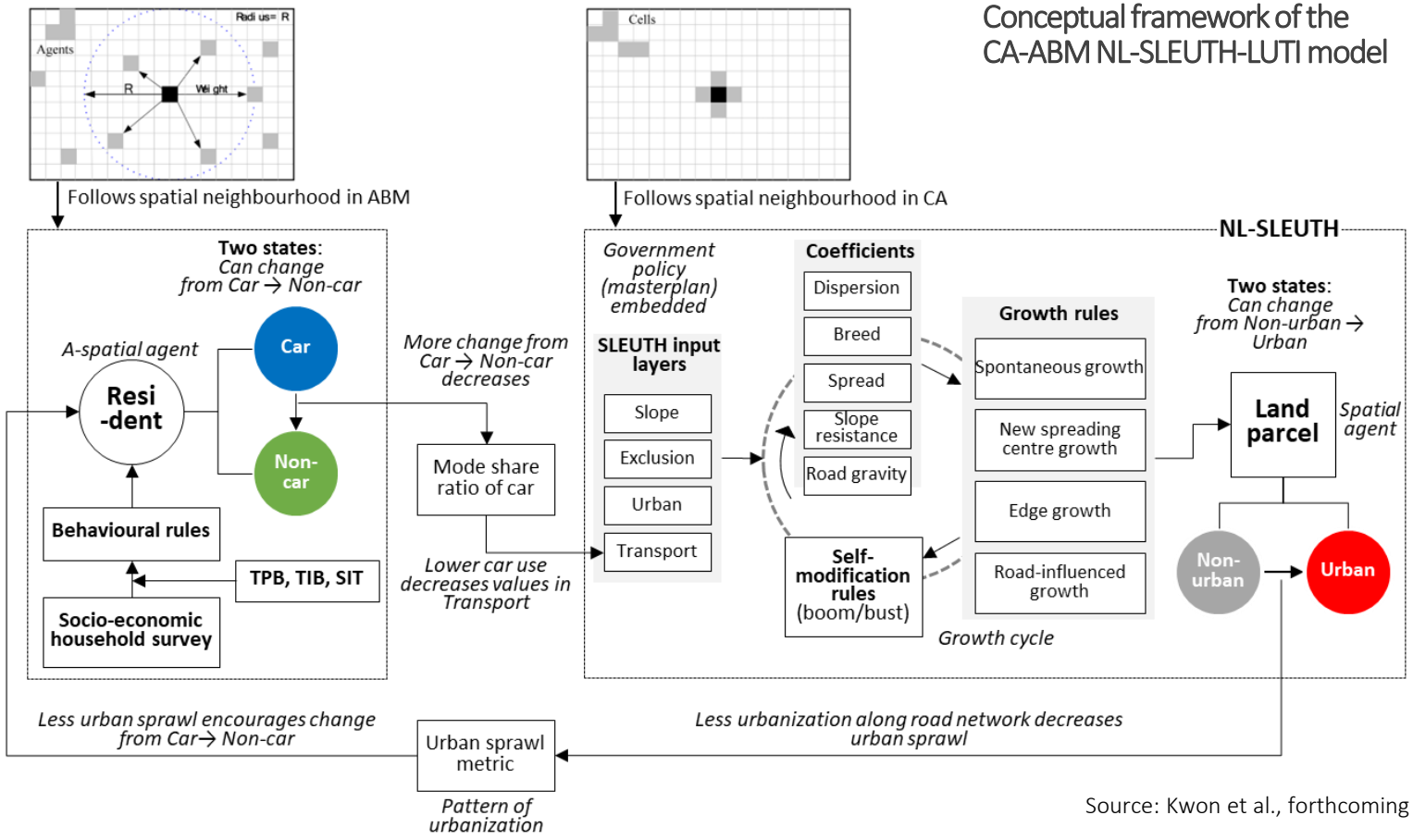


Theory of interpersonal behaviour

Social identity theory

Source: Ajzen (1991, p. 182); adopted from Tajfel and Turner (1979); and Triandis (1977) and Tudela et al. (2013, p. 3)

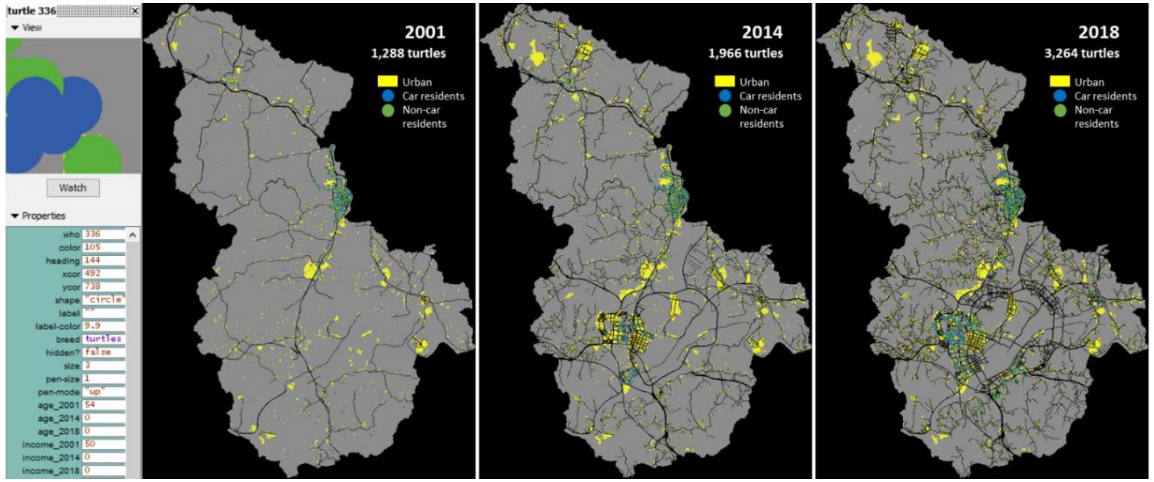
Conceptual framework of the CA-ABM NL-SLEUTH-LUTI model



Source: Kwon et al., forthcoming

Kwon *et al*. (Forthcoming b) Implementing SLEUTH on NetLogo and Adding an A-spatial Layer based on Survey Data.

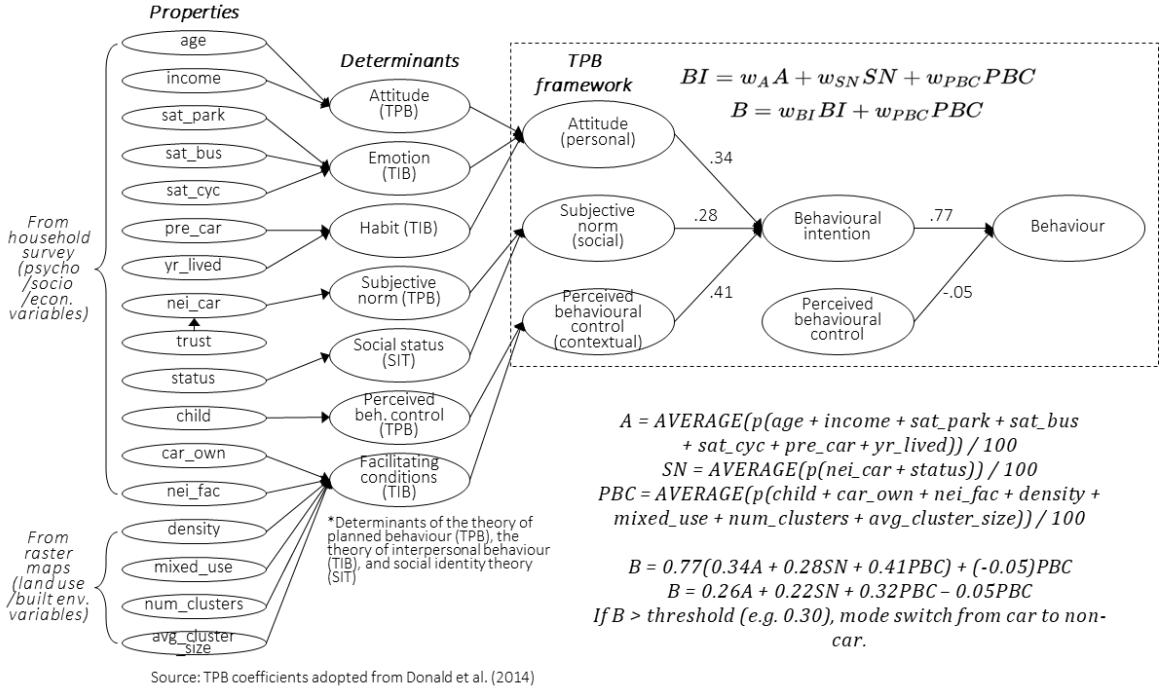
Turtles (residents) placed on the residential patches in corresponding districts



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	id	distr	car_main	color	age	income	sat_park	sat_bus	sat_cyc	pre_car_n	pre_car	yr_lived	trust	status	child	car_own	nei_fac
2	1	11	0	55	22	0	0	100	50	37.51	51.3	3	100	40	0	0	70
3	2	11	0	55	23	14.29	0	75	0	4.1	46.1	5	75	40	0	0	100
4	3	11	0	55	23	0	0	50	0	0	22.4	0	75	40	0	0	5
5	4	11	0	55	19	0	0	75	50	54.83	55.2	1	50	40	0	0	35
6	5	11	0	55	24	28.57	0	0	0	54.83	55.2	1	75	40	0	0	75
7	6	11	0	55	23	0	0	75	75	4.1	46.1	1	75	40	0	0	50
8	7	11	0	55	24	0	0	50	0	0	22.4	5	100	40	0	0	60
9	8	11	0	55	28	28.57	0	75	25	94.33	65.8	2	75	20	0	0	35
10	9	11	0	55	24	28.57	0	100	0	37.51	51.3	5	75	60	0	0	30
11	10	11	0	55	24	0	0	50	0	4.1	46.1	5	50	0	0	0	30

CSV file of 2018 resident characteristics from household survey (N=3,264)

Calculating individual resident turtle's probability to switch to non-car



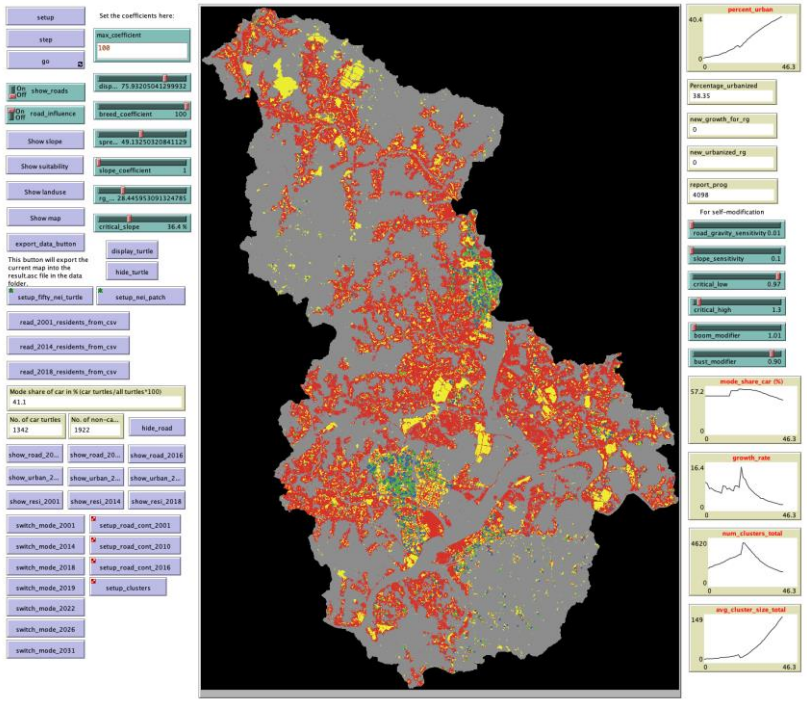
Source: TPB coefficients adopted from Donald et al. (2014)

Example: nei_car (car dependency of neighbours)

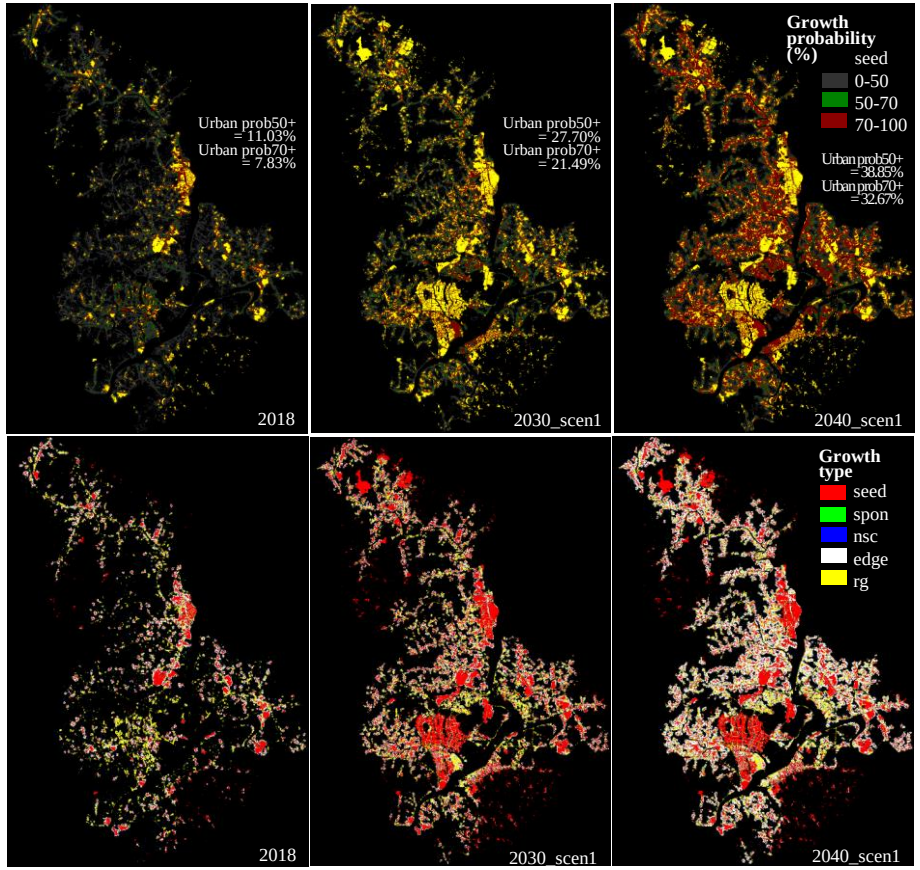
```
set fifty_nei min-n-of 50 turtles [distance myself]
set nei_car count fifty_nei with [color = blue ]*2
set p_trust random_float trust
set p_nei_car random-float (100-nei_car) * (p_trust*2)/100
ask turtles with [p_nei_car > 100] [set p_nei_car 100]
```

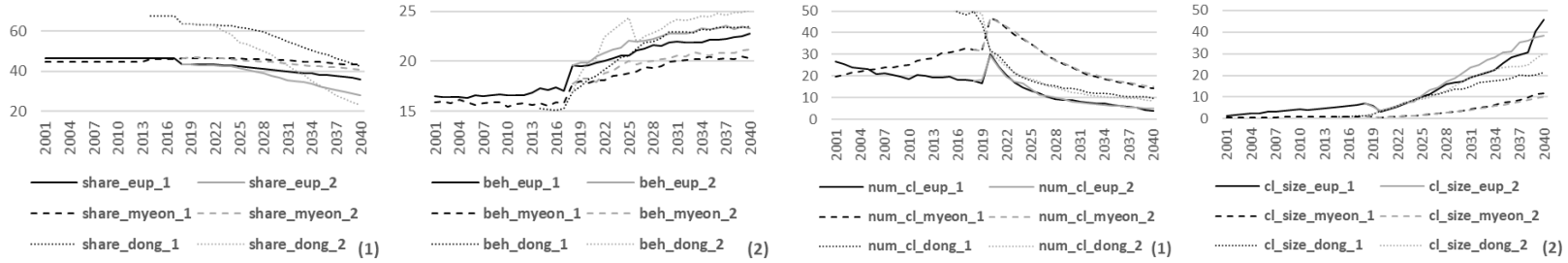
Kwon *et al*. (Forthcoming c) Extending SLEUTH into a CA/ABM-based Land Use-Transport Interaction Model with Behavioral Theories and Rules

NL-SLEUTH-LUTI at tick 40 (NetLogo interface)



Map of urban parcels by growth probability and growth rule (2018, 2030, 2040)

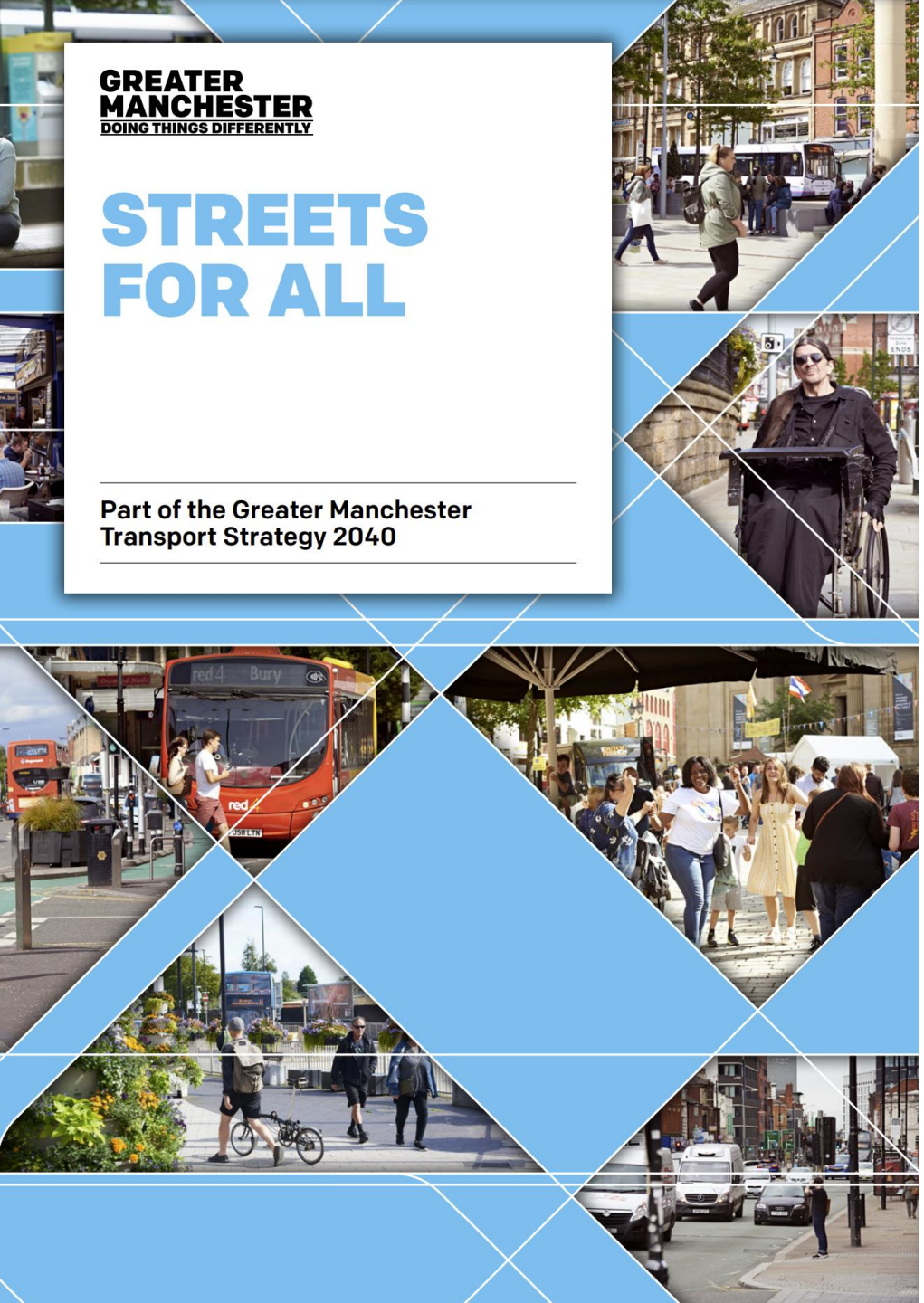




Mode_share_car, behavior score, num_clusters, and avg_cluster_size in Scenario 1 & 2

Urban development, health and health equity

Source: ISGlobal, 2021



PHASE Population Health Agent-based Simulation nEtwork

UKPRP Prevention Research Partnership Joint action for a healthier, fairer future

Henley Business School UNIVERSITY OF READING *in collaboration with* MANCHESTER 1824 The University of Manchester

Healthier Urban Development and Healthier Travel Behaviour: Case study of Greater Manchester

Source: Greater Manchester, 2021

Source: Nilfanion, 2010

Greater Manchester

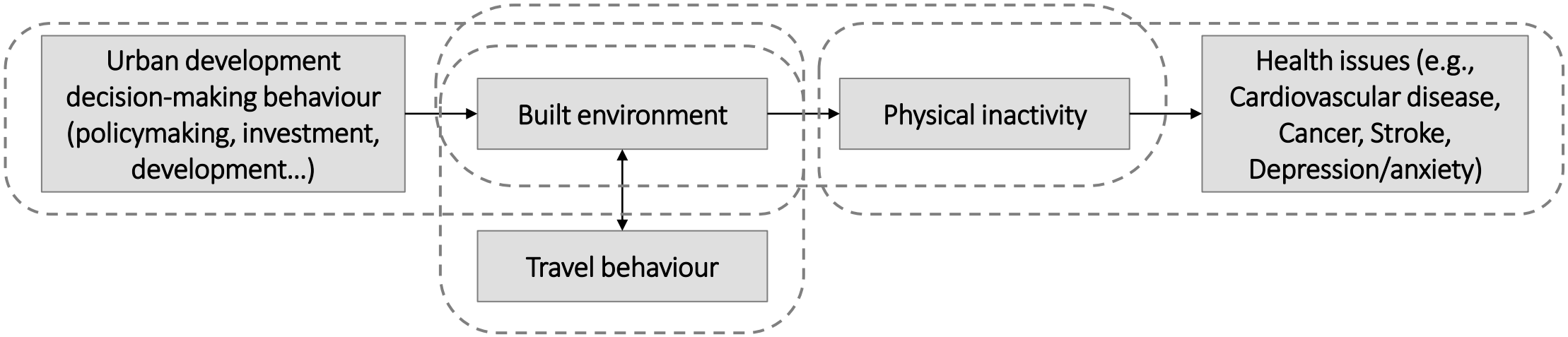
- **Area**: 1,276km2
- **Population** (2021): 2,812,569
- Composted of ten districts

Two most relevant government bodies for this study:

GMCA GREATER MANCHESTER COMBINED AUTHORITY

Transport for Greater Manchester

ABM for healthier urban development and healthier travel behaviour



ABM for healthier urban development and healthier travel behaviour

Research scope

Healthy building design

Building-level
- Healthy, sustainable air
- Healthy, sustainable thermal control
- Healthy, sustainable light
- Workplace ergonomics & env. quality
- Access to natural environment

Urban env.-level
- Land use and transportation

Source: Loftness et al., 2007

Healthy placemaking

Urban env.-level
- Neighbourhood design (e.g., walking & cycling)
- Improved quality of housing
- Access to healthier food
- Conservation of and access to natural and sustainable environments
- Improved transport and connectivity

Source: Public Health England, 2017

Likely to encourage active mode of transport

Healthier urban development

- Metrics based on the **15-Minute City** framework
- Focusing on the **urban land use change** (e.g., resi, office, retail) and residents' access to essential functions
- Based on the **development decision-makers'** urban land use change **scenarios** (focusing on the implications of **working from home**)

Healthier travel behaviour

- Metrics based on the residents' **method of travel to work** based on the Census individual microdata
- Focusing on residents' **car to non-car mode switch (active mobility)**
- Likelihood of behavioural change based on various **psychological and socioeconomic factors**

Likely to demand less car-centric urban env.

ABM for healthier urban development and healthier travel behaviour

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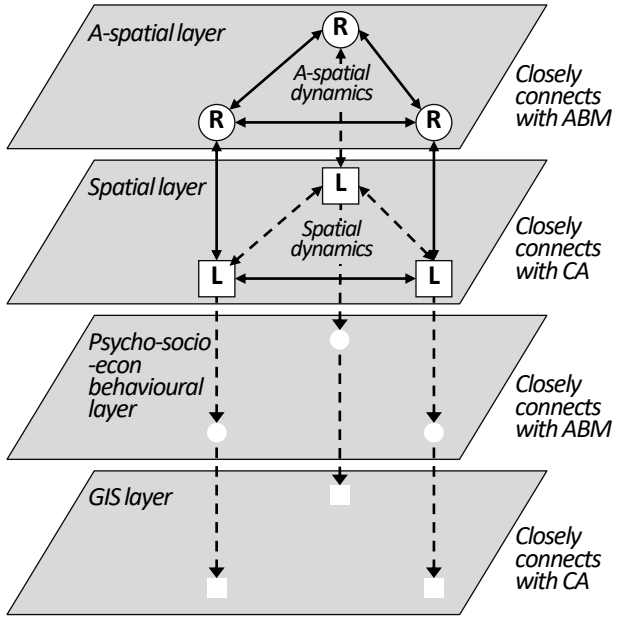
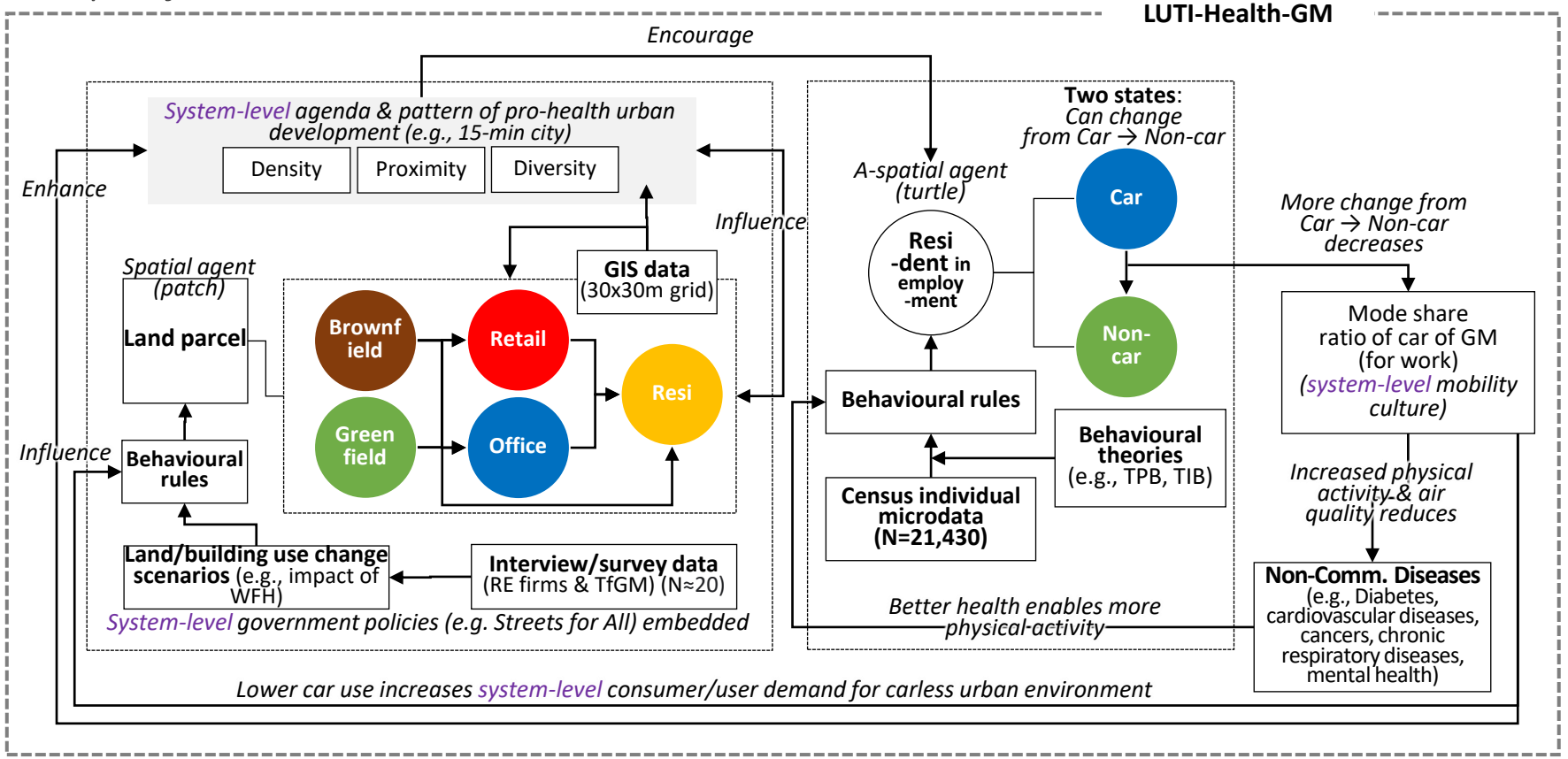
Interaction among layers



Note: ABM can include CA

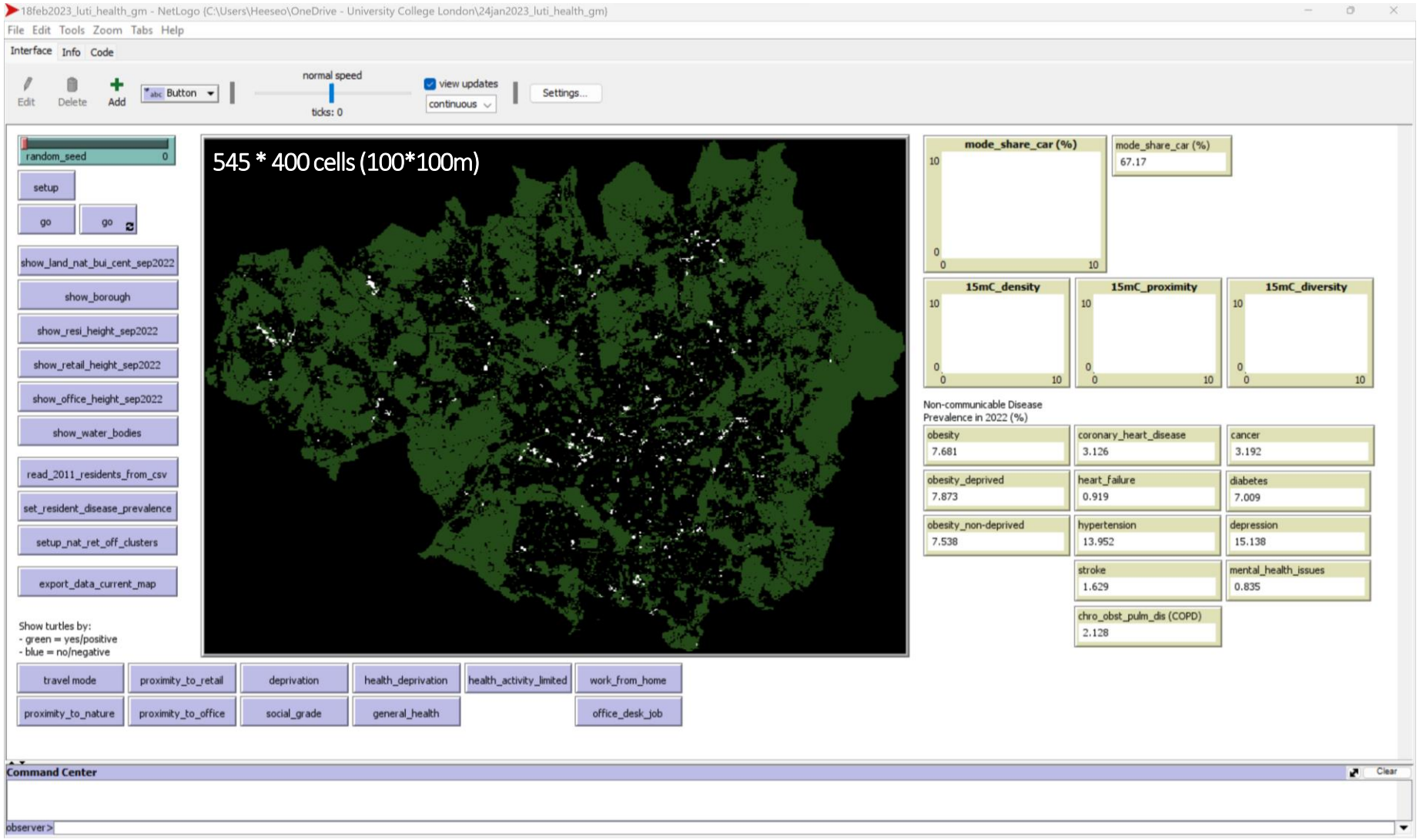
Adapted from Wu and Silva (2014)

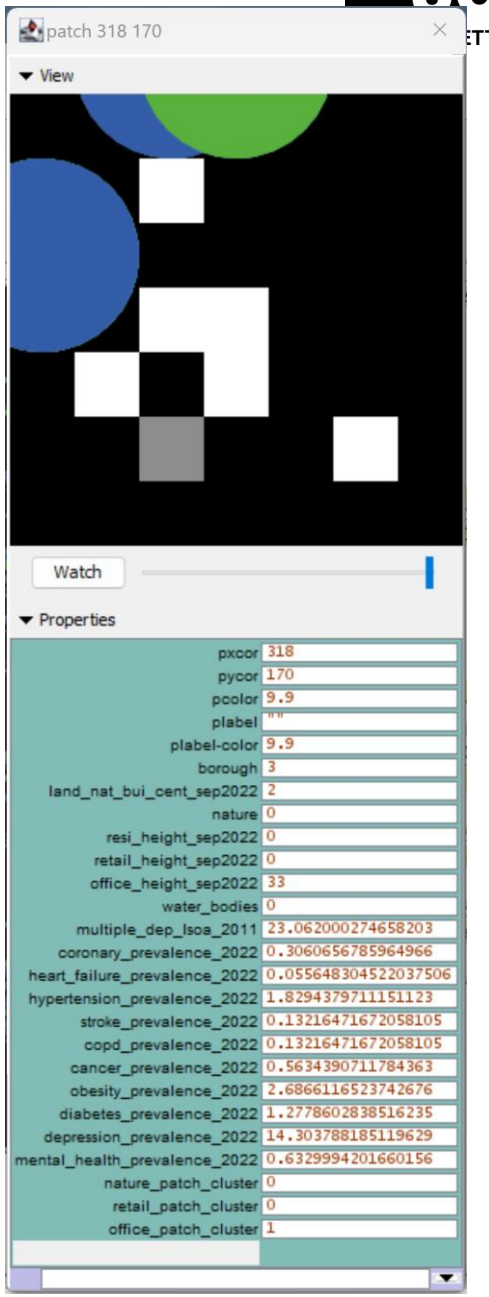
Conceptual framework



Source: Adapting from Kwon, 2020

ABM for healthier urban development and healthier travel behaviour





Nature Built Urban centre

Data: UKLand_Sep2022 (57,269 features). Gets updated once a year since Oct 2020.

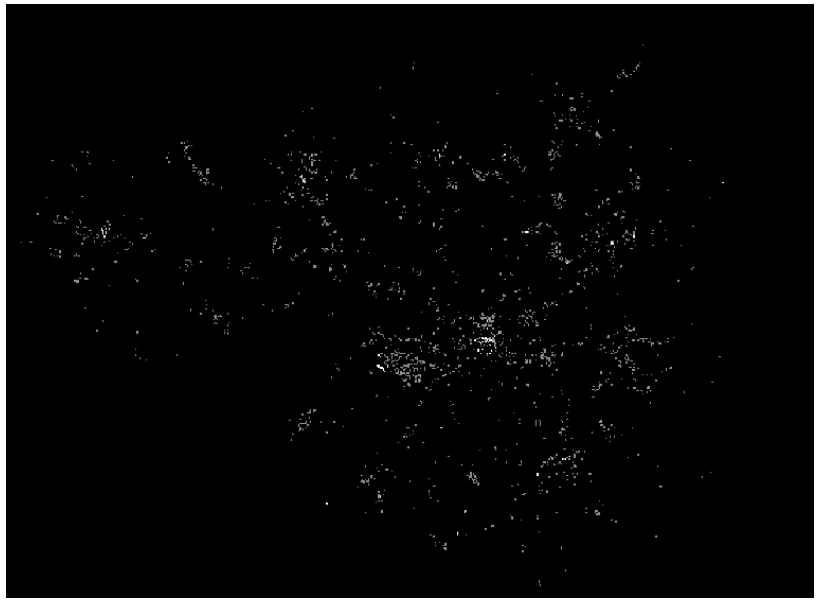
Spatial input data

Building use maps by building height

Data: UKBuildings_Sep2022 (1,467,143 features). Gets updated 3 times a year since Feb 2020.

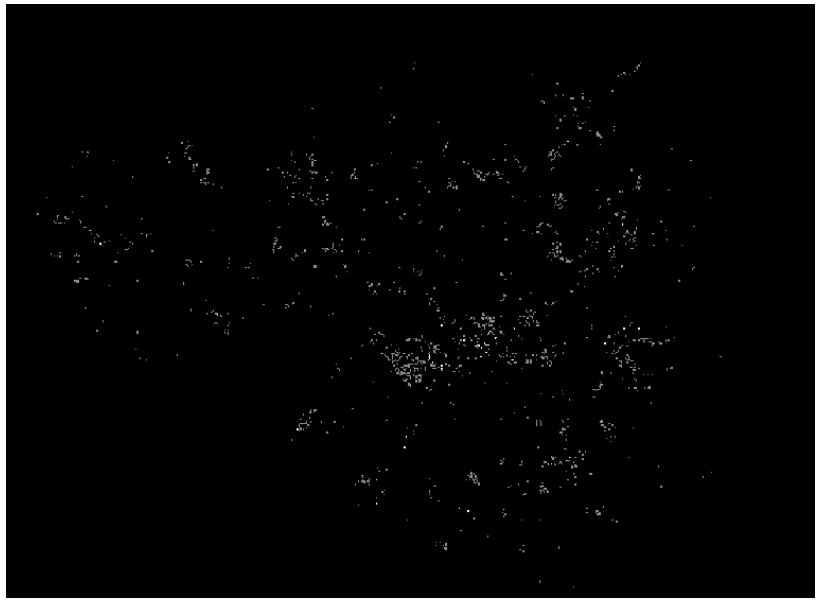
Low
High

General commercial mixed use (25% resi)
Residential with retail on ground floor (80% resi)
Residential only (100% resi)



Low
High

General commercial mixed use (25% retail)
Retail with office/residential above (80% retail)
Retail only (100% retail)



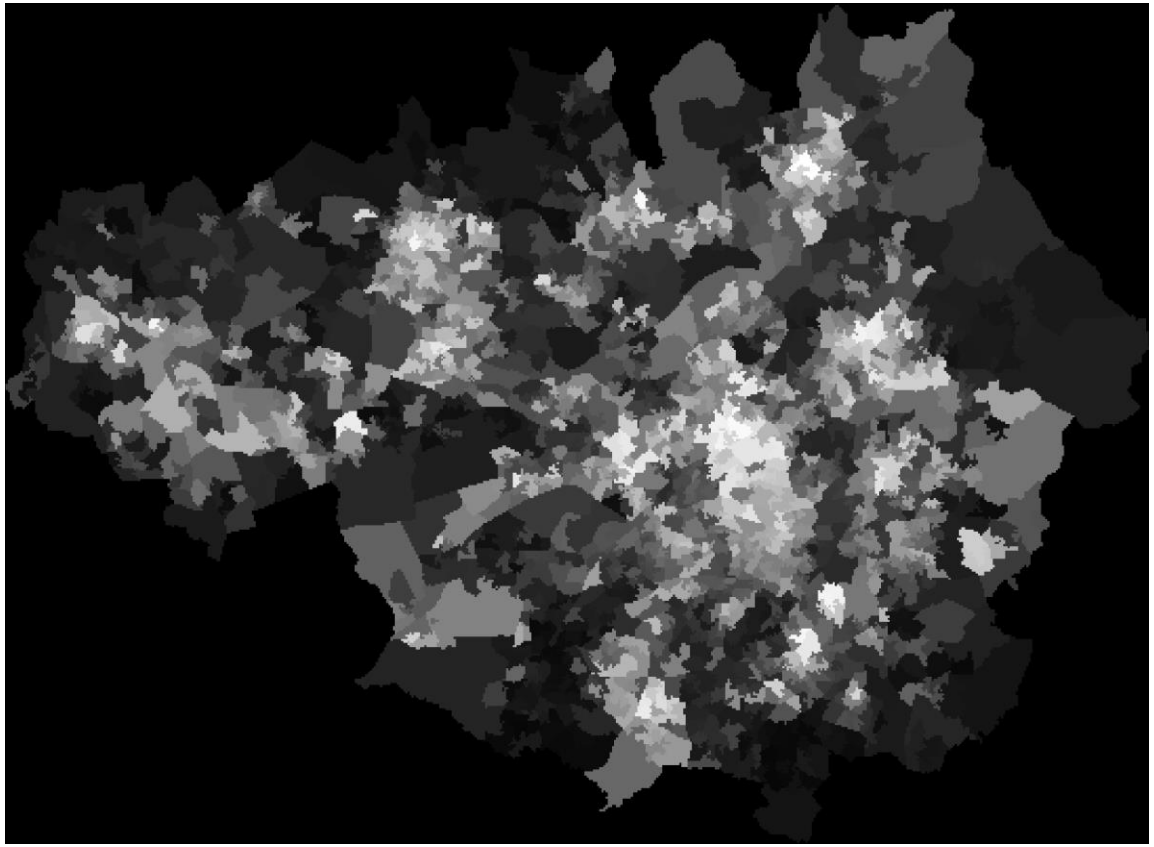
Low
High

General commercial mixed use (25% office)
Office with retail on ground floor (80% office)
Office only (100% retail)

Spatial input data

Multiple deprivation by lower super output area (LSOA)

Data: English Indices of Deprivation 2019



Spatial input data

Disease prevalence by GP practice

Data: NHS Quality and Outcomes Framework 2021-22.

NHS Digital

Table 1: Prevalence and achievement, lifestyle group, obesity, 2021-22, GP practice level

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							Prevalence								
							2020-21			2021-22				2020-21	
	Sub ICB Loc ODS code	Sub ICB Loc ONS code	Sub ICB Loc name	PCN ODS code	PCN name	Practice code	Practice name	List size ages 18+	Register	Prevalence (%)	List size ages 18+	Register	Prevalence (%)	Year on year change (percentage point)	Total Achievement Score (max 8)	Achievem
147	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	Y00186	3D Medical Centre	1,078	47	4.36	1,136	74	6.51	2.15	8.00	100
148	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	P82640	Al Fal Medical Group	2,888	248	8.59	3,157	501	15.87	7.28	8.00	100
149	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	P82616	Beehive Surgery	2,474	131	5.30	2,633	312	11.85	6.55	8.00	100
150	00T	E38000016	NHS Greater Manchester ICB - 00T	U11602	Horwich Network PCN	Y03079	Bolton Community Practice	10,283	418	4.06	10,696	1,102	10.30	6.24	8.00	100
151	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	Y02319	Bolton General Practice	4,041	221	5.47	4,249	330	7.77	2.30	8.00	100
152	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	Y02790	Bolton Medical Centre	4,238	363	8.57	4,279	413	9.65	1.09	8.00	100
153	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	P82033	Bradford Street Surgery	1,677	85	5.07	1,699	191	11.24	6.17	8.00	100
154	00T	E38000016	NHS Greater Manchester ICB - 00T	U05517	Hwl Network PCN	P82025	Burnside Surgery	3,697	277	7.49	3,665	417	11.38	3.89	8.00	100
155	00T	E38000016	NHS Greater Manchester ICB - 00T	U05517	Hwl Network PCN	P82625	Charlotte Street Surgery	1,514	53	3.50	1,567	141	9.00	5.50	8.00	100
156	00T	E38000016	NHS Greater Manchester ICB - 00T	U97801	Chorley Roads Network PCN	P82627	Cornerstone Surgery	3,000	270	9.00	3,023	468	15.48	6.48	8.00	100
157	00T	E38000016	NHS Greater Manchester ICB - 00T	U79678	Turton PCN	P82607	Crompton View Surgery	4,255	592	13.91	4,292	723	16.85	2.93	8.00	100
158	00T	E38000016	NHS Greater Manchester ICB - 00T	U97801	Chorley Roads Network PCN	P82010	Dalefield Surgery	5,548	214	3.86	5,765	505	8.76	4.90	8.00	100
159	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	P82660	Deane Clinic 1	2,494	330	13.23	2,514	394	15.67	2.44	8.00	100
160	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	P82030	Deane Medical Centre	2,799	163	5.82	2,858	334	11.69	5.86	8.00	100
161	00T	E38000016	NHS Greater Manchester ICB - 00T	U05517	Hwl Network PCN	P82012	Dr Earnshaw And Partners	5,176	451	8.71	5,165	782	15.14	6.43	8.00	100
162	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	P82629	Dr M Dakshina-Murthi	1,570	221	14.08	1,565	281	17.96	3.88	8.00	100
163	00T	E38000016	NHS Greater Manchester ICB - 00T	U11602	Horwich Network PCN	P82006	Dr Malhotra & Partners	6,457	461	7.14	6,601	707	10.71	3.57	8.00	100
164	00T	E38000016	NHS Greater Manchester ICB - 00T	U79678	Turton PCN	P82034	Edgworth Medical Centre	2,680	125	4.66	2,785	256	9.19	4.53	8.00	100
165	00T	E38000016	NHS Greater Manchester ICB - 00T	U79678	Turton PCN	P82643	Egerton/Dunscar Health Centre	5,387	257	4.77	5,416	436	8.05	3.28	8.00	100
166	00T	E38000016	NHS Greater Manchester ICB - 00T	U09883	Farnworth & Kearsley PCN	P82652	Farnworth Family Practice	2,758	205	7.43	2,833	299	10.55	3.12	8.00	100
167	00T	E38000016	NHS Greater Manchester ICB - 00T	U09883	Farnworth & Kearsley PCN	P82037	Fig Tree Medical Practice	3,731	268	7.18	3,718	707	19.02	11.83	8.00	100
168	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	P82633	Great Lever One	1,673	138	8.25	1,787	222	12.42	4.17	8.00	100
169	00T	E38000016	NHS Greater Manchester ICB - 00T	U05517	Hwl Network PCN	P82022	Halliwell Surgery 1	3,337	108	3.24	3,440	434	12.62	9.38	8.00	100
170	00T	E38000016	NHS Greater Manchester ICB - 00T	U05517	Hwl Network PCN	P82029	Halliwell Surgery 2	2,712	345	12.72	2,710	415	15.31	2.59	8.00	100
171	00T	E38000016	NHS Greater Manchester ICB - 00T	U05517	Hwl Network PCN	P82626	Halliwell Surgery 3	3,435	217	6.32	3,501	329	9.40	3.08	8.00	100
172	00T	E38000016	NHS Greater Manchester ICB - 00T	U79678	Turton PCN	P82016	Harwood Medical Centre	9,622	482	5.01	9,506	1,010	10.62	5.62	8.00	100
173	00T	E38000016	NHS Greater Manchester ICB - 00T	U97801	Chorley Roads Network PCN	P82031	Heaton Medical Centre	8,368	562	6.72	8,450	998	11.81	5.09	8.00	100
174	00T	E38000016	NHS Greater Manchester ICB - 00T	U09883	Farnworth & Kearsley PCN	P82007	Kearsley Medical Centre	10,680	944	8.84	10,633	1,255	11.80	2.96	8.00	100
175	00T	E38000016	NHS Greater Manchester ICB - 00T	U11602	Horwich Network PCN	P82003	Kildonan House	12,578	320	2.54	12,525	454	3.62	1.08	8.00	100
176	00T	E38000016	NHS Greater Manchester ICB - 00T	U65316	Bolton Central PCN	P82013	Lever Chambers 2	2,843	293	10.31	2,815	225	7.99	-2.31	8.00	100
177	00T	E38000016	NHS Greater Manchester ICB - 00T	U79938	Breightmet & Little Lever PCN	P82020	Little Lever Health Centre 1	3,246	294	9.06	3,314	502	15.15	6.09	8.00	100

Title sheet | OB | SMOK

Ready | Filter Mode | Accessibility: Investigate | 80%

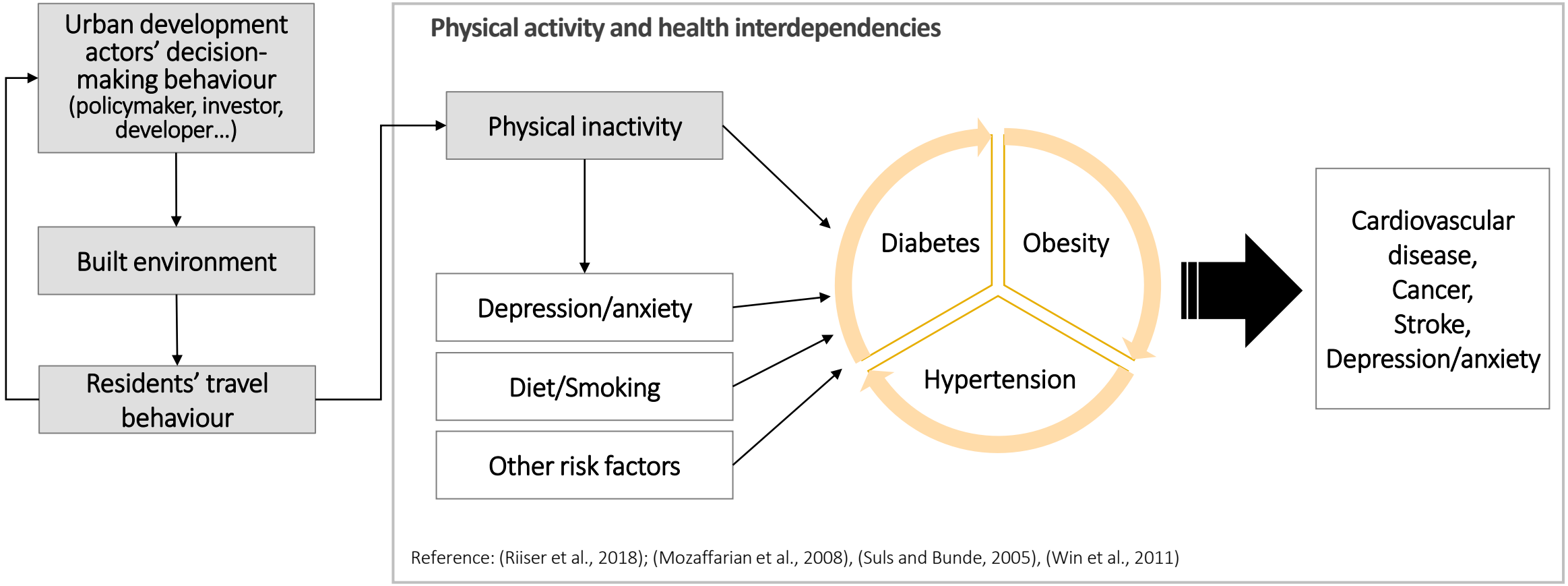
One map each for 8 disease types related to physical (in)activity:

- Obesity
- Coronary heart disease
- Heart failure
- Hypertension
- Chronic obstructive pulmonary disease (COPD)
- Cancer
- Diabetes
- Depression
- Mental health issues

Low
High

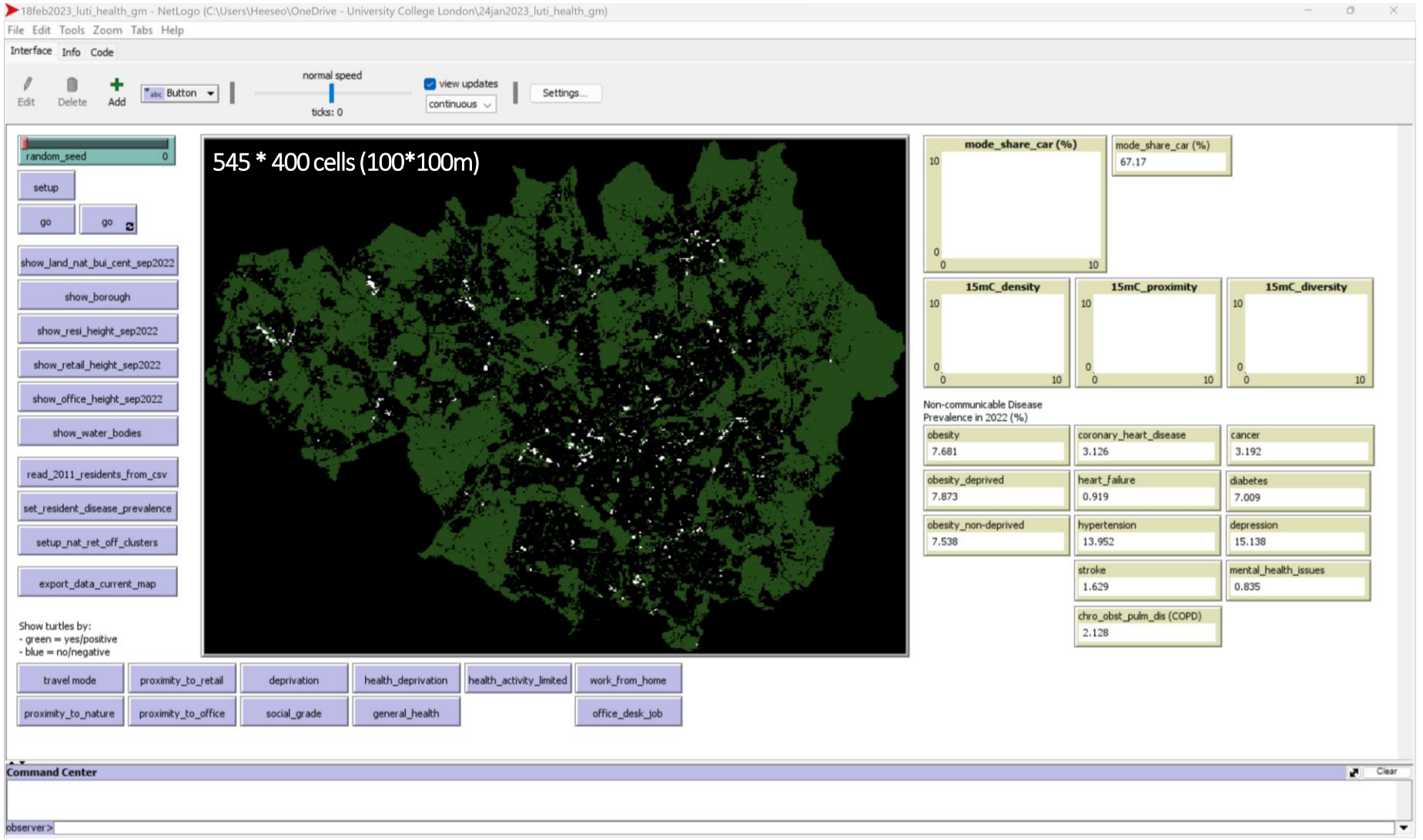
Obesity. Point data converted to Voronoi polygons

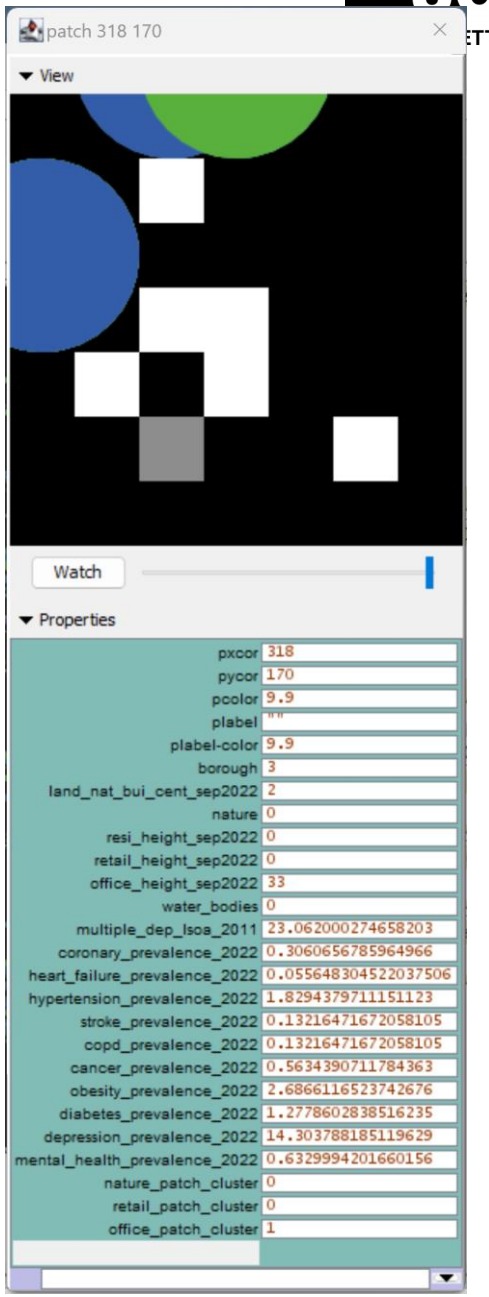
ABM for healthier urban development and healthier travel behaviour



Reference: (Riiser et al., 2018); (Mozaffarian et al., 2008), (Suls and Bunde, 2005), (Win et al., 2011)

ABM for healthier urban development and healthier travel behaviour

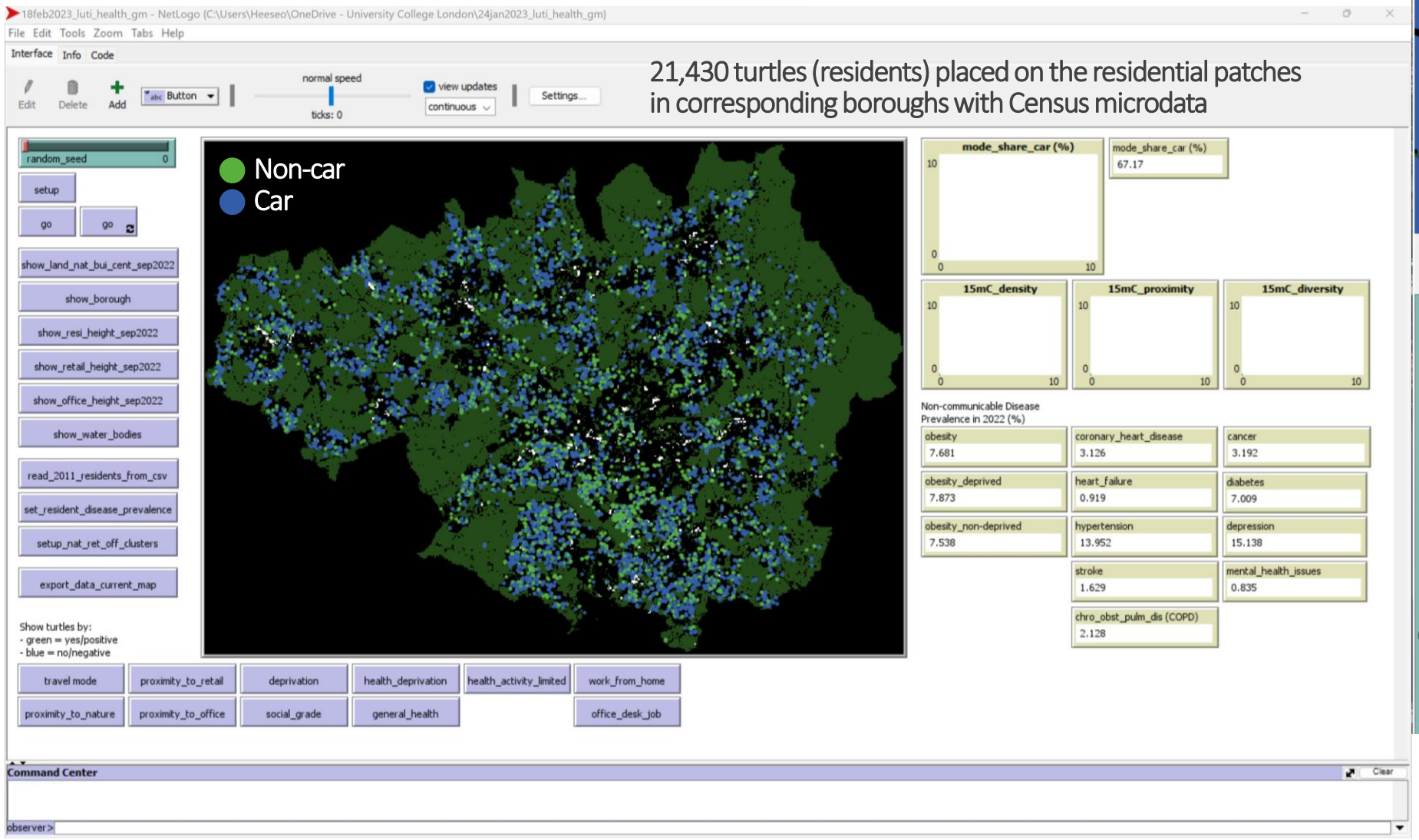




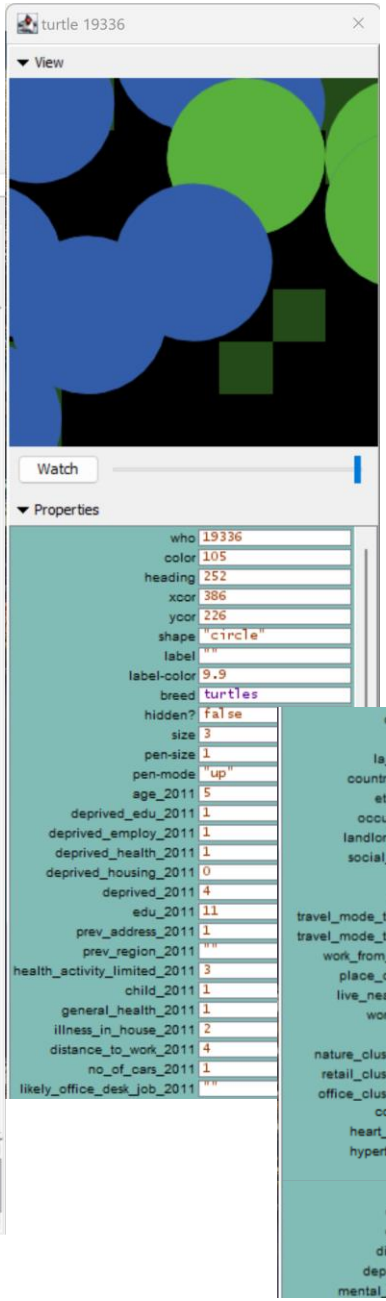
Nature Built Urban centre

Data: UKLand_Sep2022 (57,269 features). Gets updated once a year since Oct 2020.

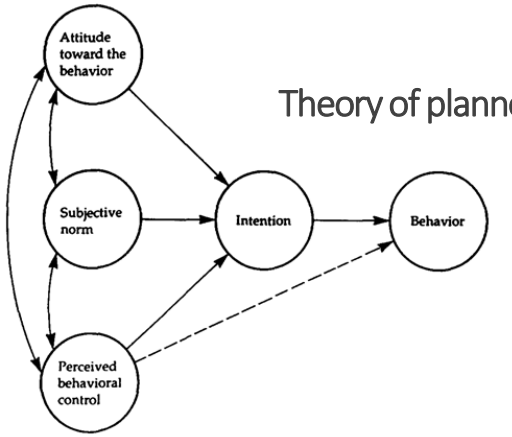
ABM for healthier urban development and healthier travel behaviour



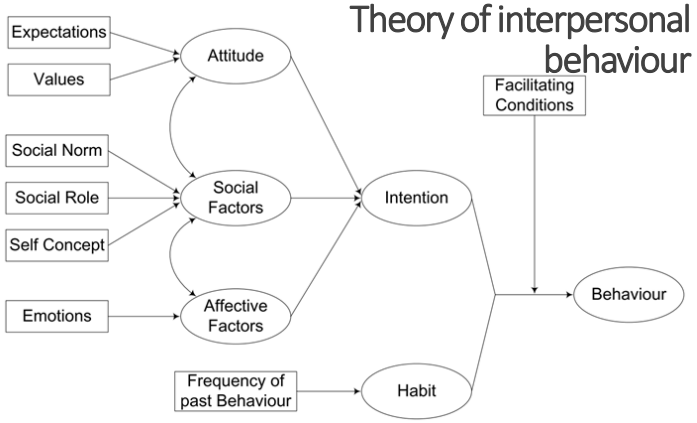
21,430 turtles (residents) placed on the residential patches in corresponding boroughs with Census microdata



Kwon *et al*. (Forthcoming b) Implementing SLEUTH on NetLogo and Adding an A-spatial Layer based on Survey Data.



Theory of planned behaviour

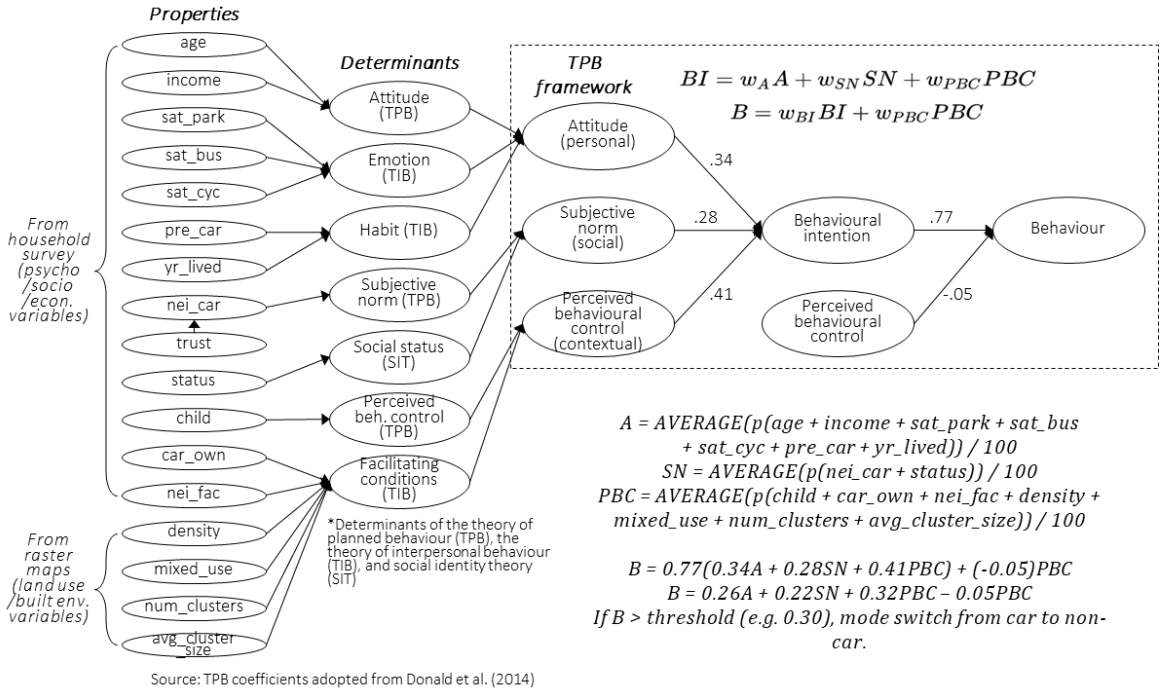


Theory of interpersonal behaviour

Social identity theory

Source: Ajzen (1991, p. 182); adopted from Tajfel and Turner (1979); and Triandis (1977) and Tudela et al. (2013, p. 3)

Calculating individual resident turtle's probability to switch to non-car



Source: TPB coefficients adopted from Donald et al. (2014)

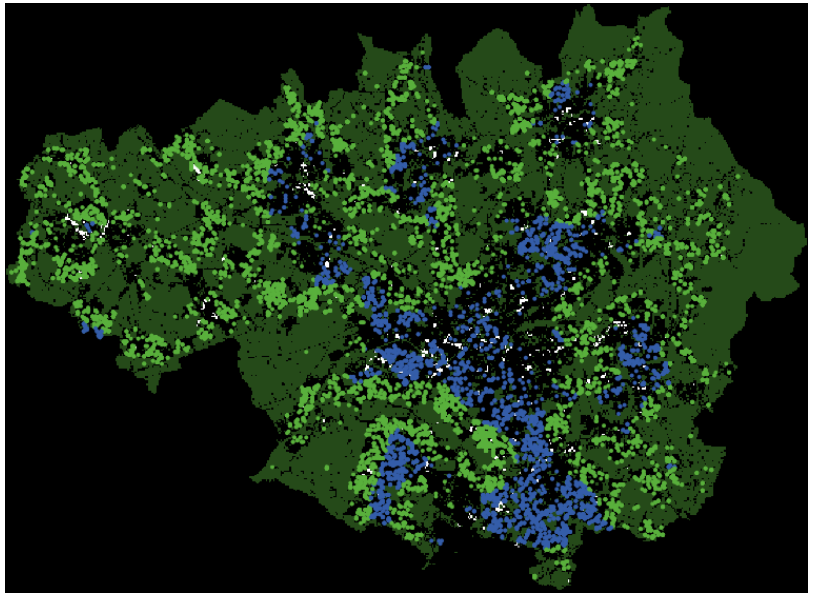
Example: nei_car (car dependency of neighbours)

```
set fifty_nei min-n-of 50 turtles [distance myself]
set nei_car count fifty_nei with [color = blue ]*2
set p_trust random_float trust
set p_nei_car random-float (100-nei_car) * (p_trust*2)/100
ask turtles with [p_nei_car > 100] [set p_nei_car 100]
```

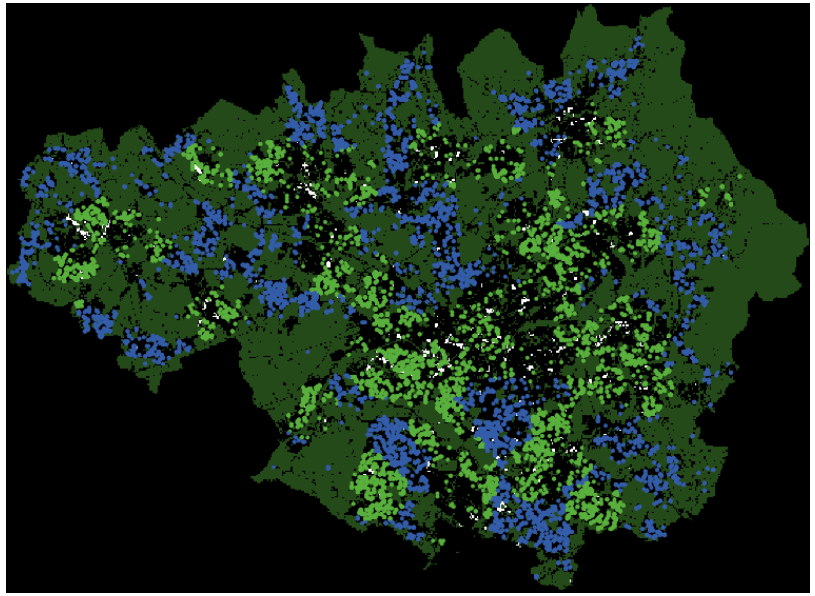
Spatial analysis within NetLogo

UCL THE BARTLETT

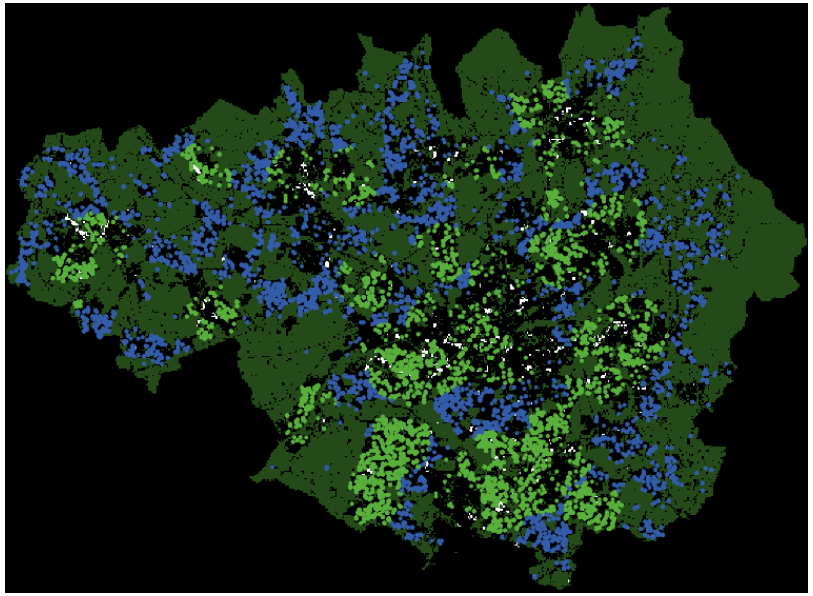
Proximity to nature cluster



Proximity to retail cluster



Proximity to office cluster

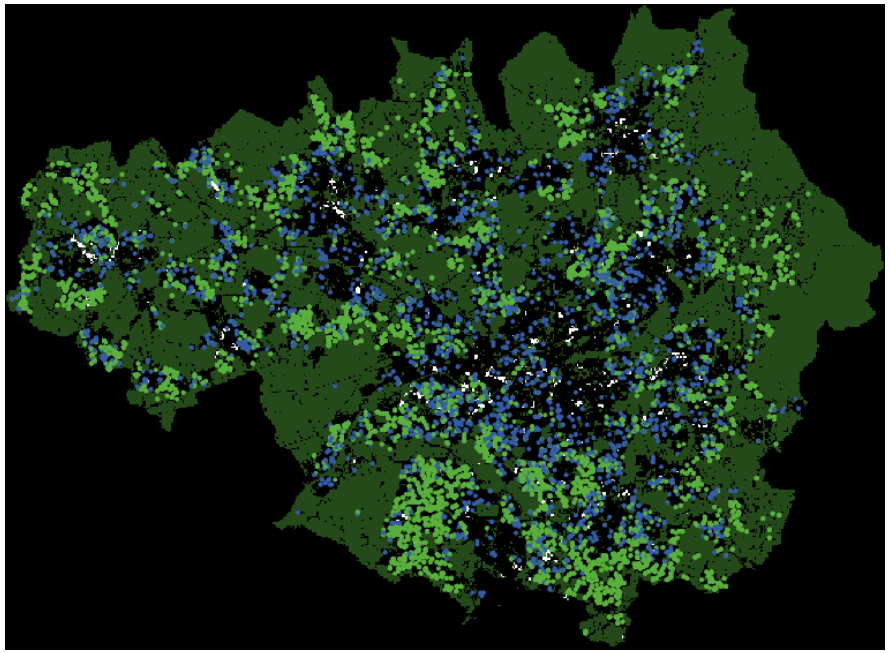


Within 2km
Not within 2km

Spatial analysis within NetLogo

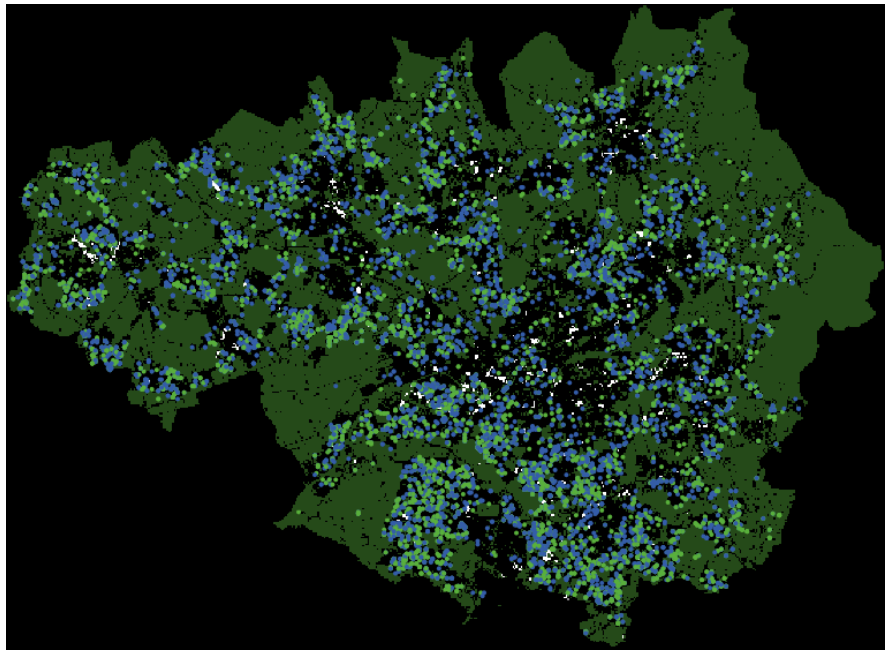
UCL
THE BARTLETT

Health deprivation



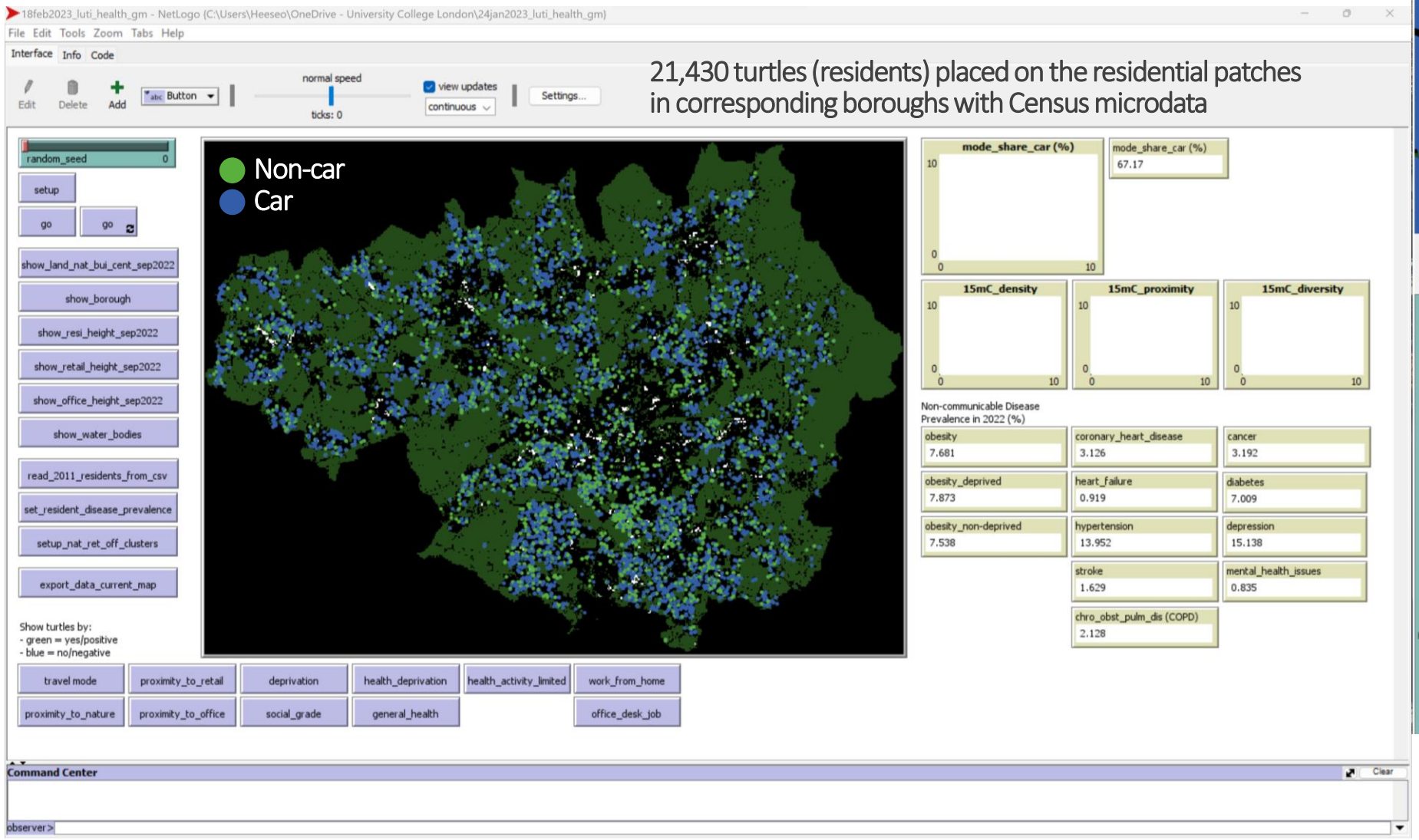
- Not deprived
- Deprived

General health

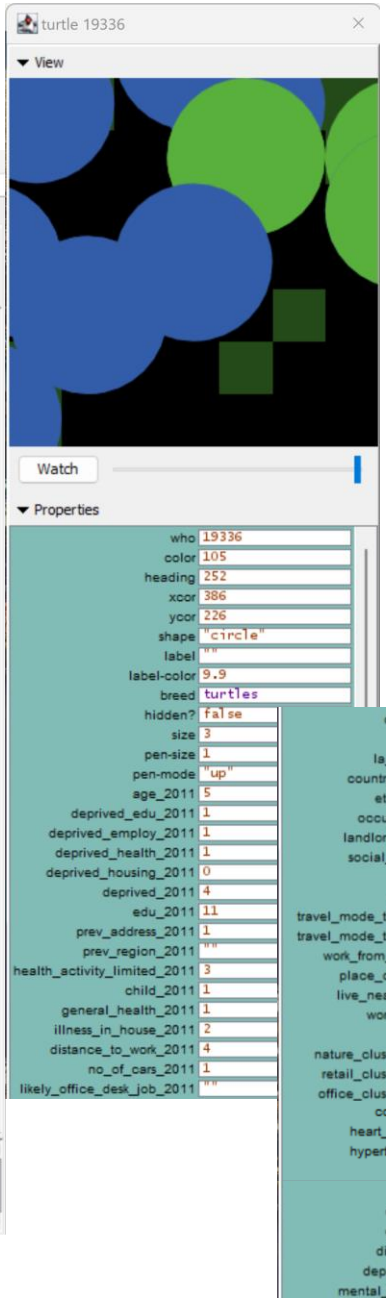


- Very good
- Good/fair/bad/very bad

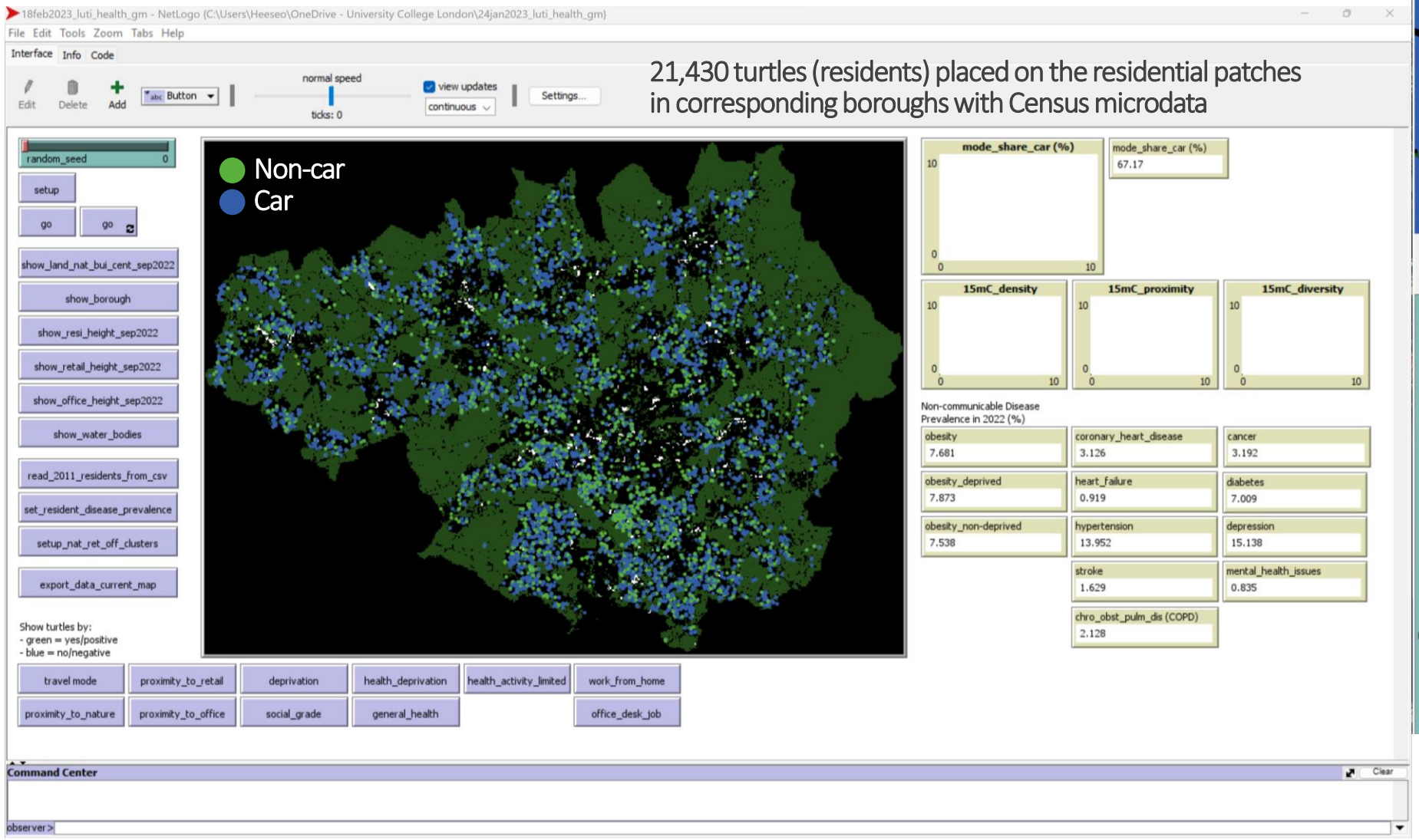
ABM for healthier urban development and healthier travel behaviour



21,430 turtles (residents) placed on the residential patches in corresponding boroughs with Census microdata



ABM for healthier urban development and healthier travel behaviour



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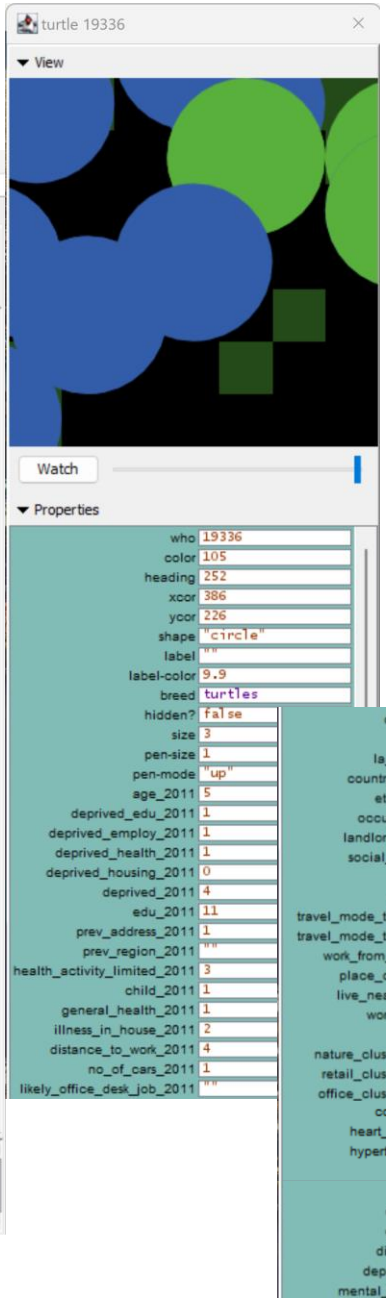
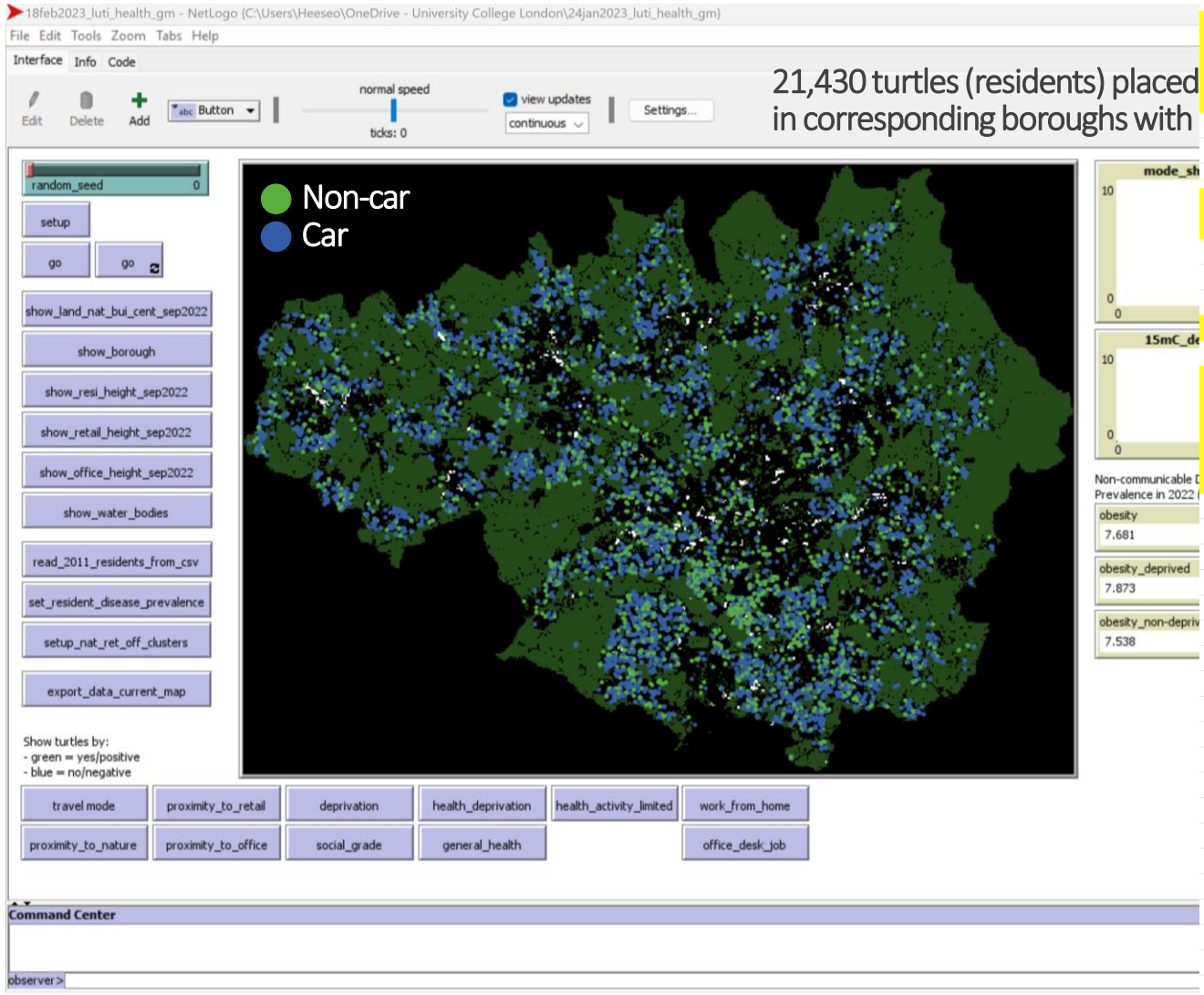


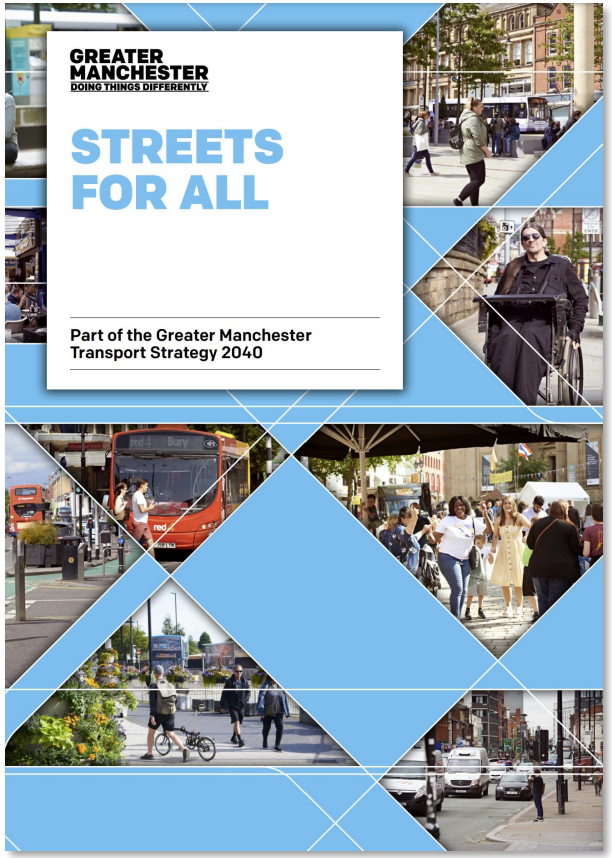
ABM for healthier urban development and healthier tra



APPENDIX 1 - ISCO-08 2 digit codes		Category (%)
ISCO 08 Code	Title	
1	Commissioned armed forces officers	0.1
2	Non-commissioned armed forces officers	0.1
3	Armed forces occupations, other ranks	0.2
11	Chief executives, senior officials and legislators	0.2
12	Administrative and commercial managers	1.5
13	Production and specialised services managers	3.8
14	Hospitality, retail and other services managers	4.3
21	Science and engineering professionals	3.0
22	Health professionals	3.2
23	Teaching professionals	3.9
24	Business and administration professionals	4.6
25	Information and communications technology professionals	1.6
26	Legal, social and cultural professionals	2.3
31	Science and engineering associate professionals	1.5
32	Health associate professionals	0.8
33	Business and administration associate professionals	6.5
34	Legal, social, cultural and related associate professionals	2.0
35	Information and communications technicians	0.6
41	General and keyboard clerks	1.0
42	Customer services clerks	4.2
43	Numerical and material recording clerks	2.0
44	Other clerical support workers	3.5
51	Personal service workers	4.4
52	Sales workers	8.5
53	Personal care workers	6.2
54	Protective services workers	1.6
61	Market-oriented skilled agricultural workers	1.0
62	Market-oriented skilled forestry, fishery and hunting workers	0.1
63	Subsistence farmers, fishers, hunters and gatherers	0.0
71	Building and related trades workers, excluding electricians	3.8
72	Metal, machinery and related trades workers	3.0
73	Handicraft and printing workers	0.7
74	Electrical and electronic trades workers	0.9
75	Food processing, wood working, garment and other craft and related trades workers	1.2
81	Stationary plant and machine operators	2.1
82	Assemblers	0.5
83	Drivers and mobile plant operators	3.5
91	Cleaners and helpers	3.4
92	Agricultural, forestry and fishery labourers	0.3
93	Labourers in mining, construction, manufacturing and transport	4.4
94	Food preparation assistants	1.5
95	Street and related sales and service workers	0.1
96	Refuse workers and other elementary workers	1.7

ABM for healthier urban development and healthier travel behaviour

Setting land/building use change scenario based on document analysis, interview and survey



Street for All

Street for all (The Greater Manchester) is a people centred approach to street planning focusing on decreasing traffic and road danger and making the urban environment better place for pedestrians, cyclists and public transport users.

Vision

- Streets should be:
- welcoming, green, and safe spaces for all people
- More walkable, appropriate for cycling and using public transport while creating thriving places that support local communities and businesses
- **Enable people to drive less and increase the level of physical activity**

Ambition

- **Delivering one school street per ward which enable children safe commuting to school**
- Transport investment on improving health wellbeing and quality of life (minimum 10£ per capita per year)
- **Doubling the number of people who live within a 10 minute walk or cycle to local green spaces**
- Removing all access barriers to walking and cycling path

ABM for healthier urban development and healthier travel behaviour

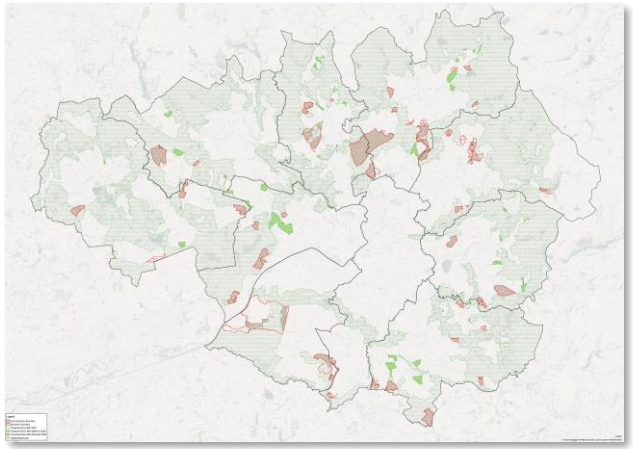
Setting land/building use change scenario based on document analysis, interview and survey

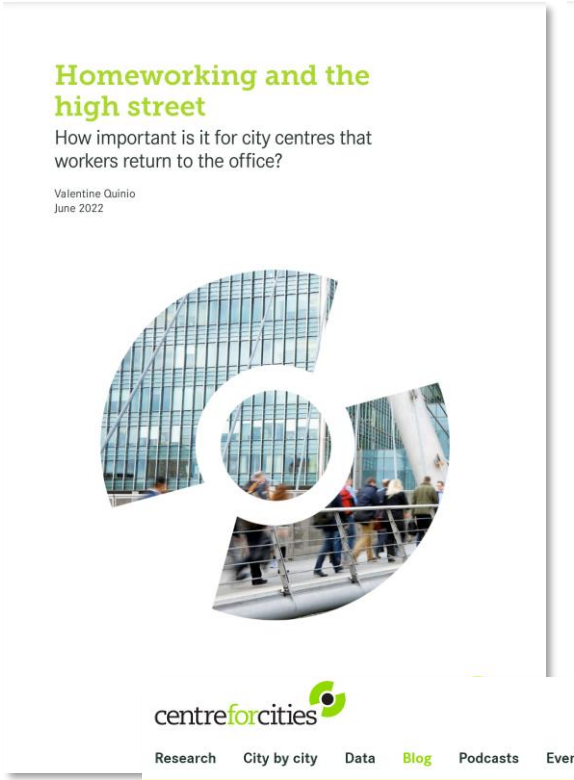
Greater Manchester's Plan for Homes, Jobs and the Environment:

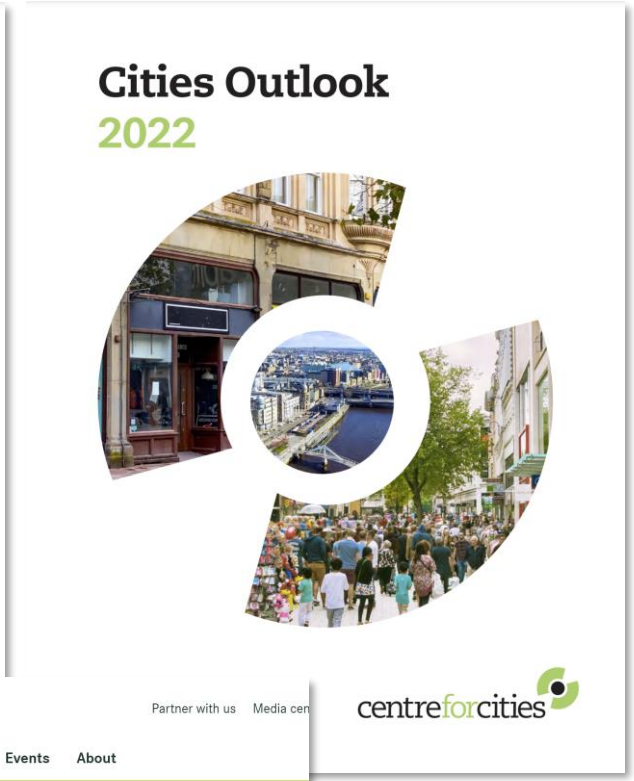
Greater Manchester Spatial Framework Publication Plan 2020

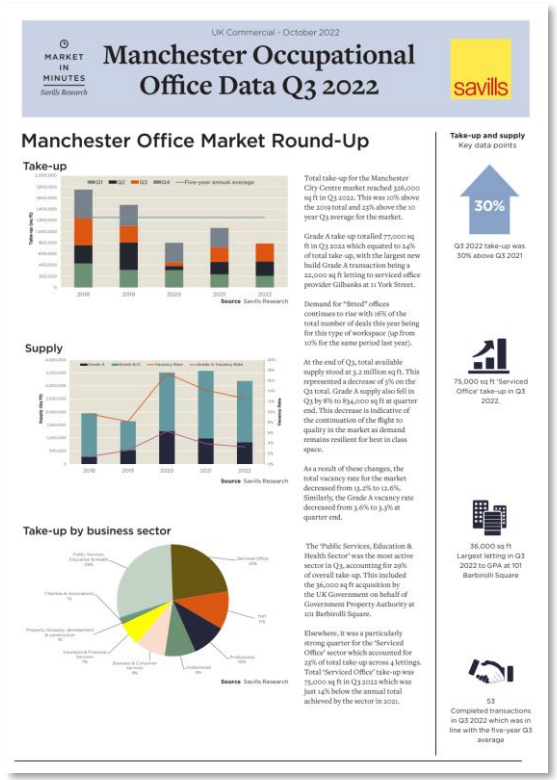
Draft for Approval

October 2020





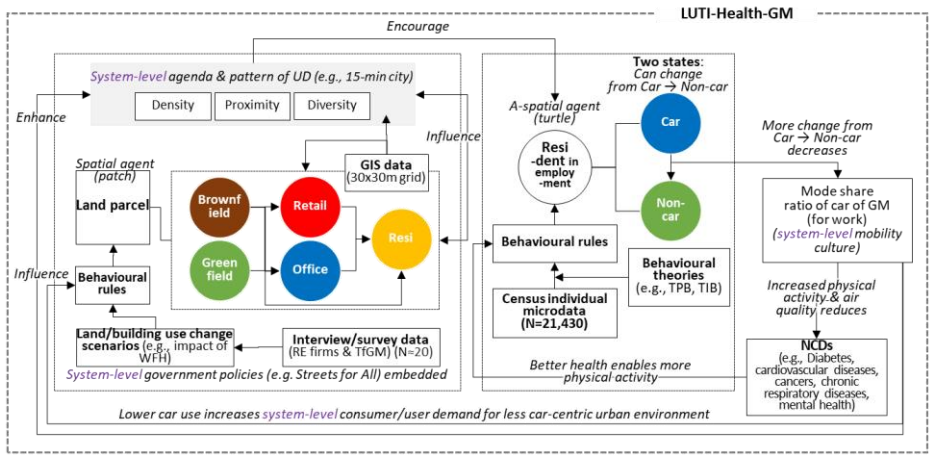




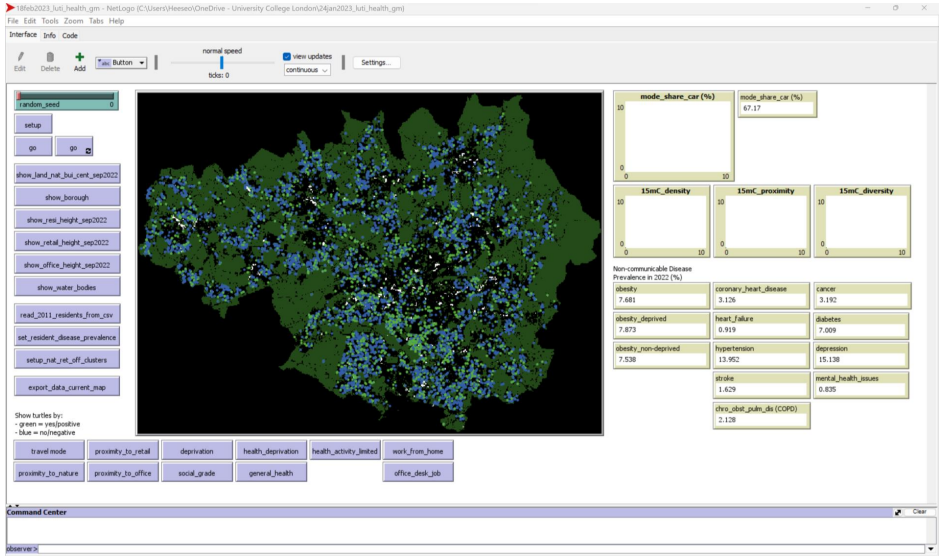
Further thoughts on behavioural theories, agent-based modelling and policymaking

- **Big data can be harnessed to better understand urban dynamics and human behaviour**
- Can inform microsimulation behavioural models like ABM
- Behavioural theories can help make sense of big data and suggest the psychological/sociological reasons behind behavioural patterns
- **Behavioural models and the analysis of patterns within data remain a technical activity until we take it to public policy with value judgments**
- Behavioral intervention: ethical debate concerning individual freedom (Campbell, 2006) e.g., level of surveillance with CCTVs, face recognition, etc.
- **Important for modelers to apply various behavioural theories to answer**
- *Why* certain behavioral patterns are observed in the data (explanations)
- *What* is the meaning and intent of certain behavior of certain actors (interpretations)
- *Why* should certain behavioural intervention measures be instituted (justifications) (Donaghy, 2021).
- **Applying psychological/sociological behavioural theories can enable more bottom-up behavioural interventions**
- Encourage individuals to make proactive and lasting behavioural change

Source: Kwon & Silva, 2023



Source: Adapting from Kwon, 2020



Lecture 4:

Thank you!

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Note: Slides are based on Kwon's PhD research at Cambridge at postdoc research conducted as part of a UKPRP network-funded project.

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Kwon, H.R., Silva, E.A., Scherer, P.M., and Clarke, K.C. (Forthcoming) Implementing SLEUTH on NetLogo and Adding an A-spatial Layer based on Survey Data.

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Software exercise 4: Questions

Q1. Going back to our NetLogo file, these turtles that we loaded can be coloured linked with their properties.

- For example, If one wants to look at 15-minute city/20-minute neighbourhood theme and mode swith away from car use,
  - We can link with a census variable, by main mode of transport: non-car (green) and car (blue)).
  - Or can calculate within NetLogo, whether or not a turtle is within 1km of green cluster and centrality: yes (green), no (blue).
  - Naturally, we could put these as `monitor` or `plot` in the `Interface`.
- What kind of metric/s would be your personal interest?

Software exercise 4: Questions

Q2. I have only included the census variables that I thought would have relevance for car to non-car mode switch behaviour. You can see the whole list of variables in the census data in the Codebook.

- Is there specific type/s of behaviour of citizens that you are interested in for research?
  - If so, which of these variables especially interest you?

Software exercise 4: Questions

Q3. What kind of opportunities do you think looking at the census data an an individual level create, compared to looking at them at an aggregate level?

Software exercise 4: Questions

Q4. What kind of opportunities do you think using GIS and CSV extensions in NetLogo can present for researchers and practitioners in urban planning and development?

Wrap-up

Applying Agent-Based Modelling in Urban Planning and Development

A workshop providing an introduction to agent-based modelling (ABM) and behavioural theories through lectures and software exercises.

This mini-module/workshop provides an introduction to agent-based modelling (ABM) and behavioural theories. The lectures will focus on the theoretical aspect and encourage students to develop critical thinking regarding the topics related to urban modelling. The workshops will enable students to get a taste of how spatiotemporal models can be built using software such as QGIS and NetLogo, and how the concepts of complex systems theory can be applied to various behaviour modelling in the fields of urban planning and real estate development.

The aims of the module are to develop the students' ability to:

1. understand and explore how systems approach and ABM can be used to conceptualise and study various behaviours and interactions in feedback loops in urban systems; and

2. understand current limitations and potentials of modelling approaches like ABM.

By the end of the module, students would have acquired skills in:

1. understanding basic concepts of cellular automata (CA), agent-based modelling (ABM) and human-environment dynamic modelling; and

2. using QGIS and NetLogo at an introductory level.

What were the most interesting aspects for you? Any final questions? Thank you!

UCL THE BARTLETT

Course outline

Time	Lecture	Topic
1-1:20pm	Lecture 1	Complex systems theory and behavioural modelling used in urban planning and development: Focusing on CA and ABM [Slides]
1:20-1:50pm	Software exercise 1	Introduction to NetLogo: Game of life and wolf sheep predation model) [Exercises]
2-2:15pm	Lecture 2	Using actor-network theory (ANT) and ABM to conceptualise pro-health urban development decision-making system [Slides]
2:15-2:30pm	Software exercise 2	Introduction to NetLogo: Language change model and contact tracing [Exercises]
2:40-3pm	Lecture 3	Isobenefit urbanism morphogenesis: Using ABM to simulate future urban growth of 15-minute neighbourhoods [Slides]
3-3:40pm	Software exercise 3	Using QGIS with NetLogo: Preparing spatial input data on QGIS for an urban growth model loading on NetLogo [Exercises]
3:50-4:30pm	Lecture 4	Using ABM and behavioural theories for land use-transport interaction (LUTI) simulation: Healthier urban development and healthier travel behaviour [Slides]
4:30-4:50pm	Software exercise 4	Using QGIS and Excel with NetLogo: Linking census data with turtles on NetLogo and using NHS disease prevalence data [Exercises]