A Spatial Agent-Based Model for the Simulation of Adults' Daily Walking Within a City

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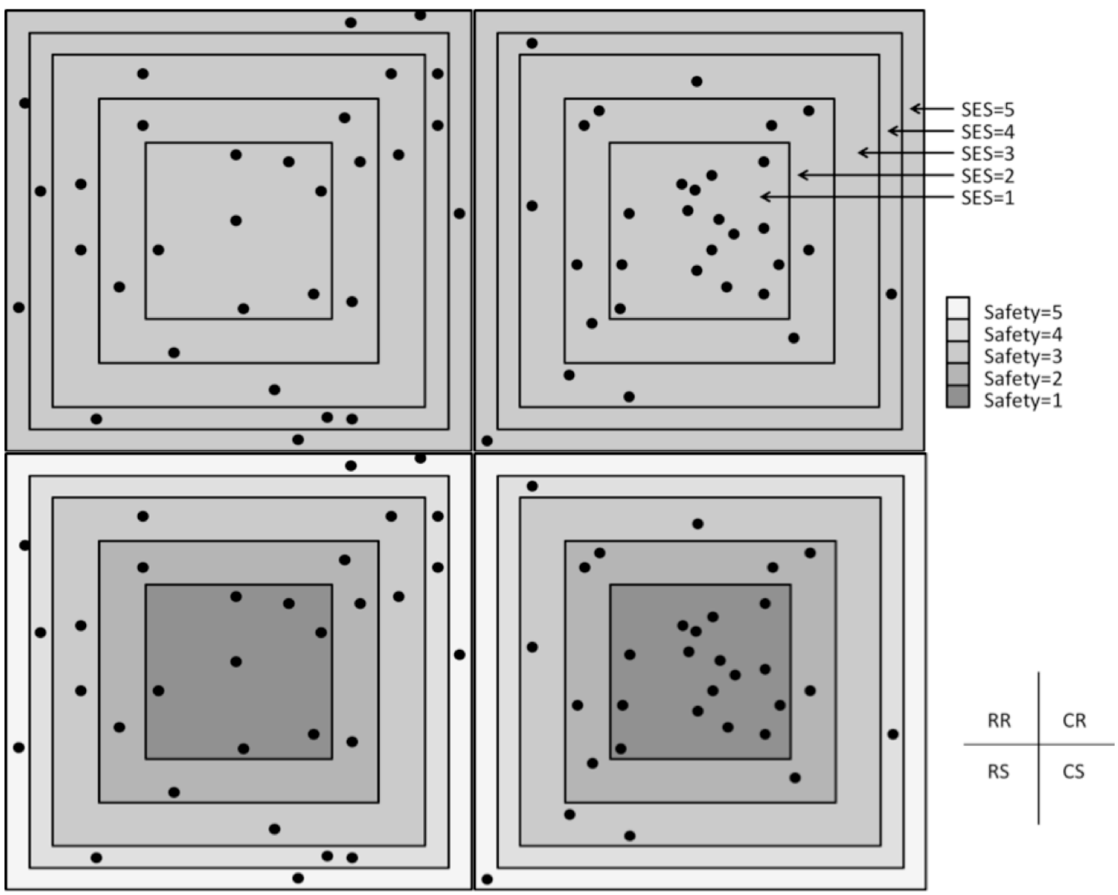
Appendix A

Four scenarios varying on the spatial distribution of land use and safety

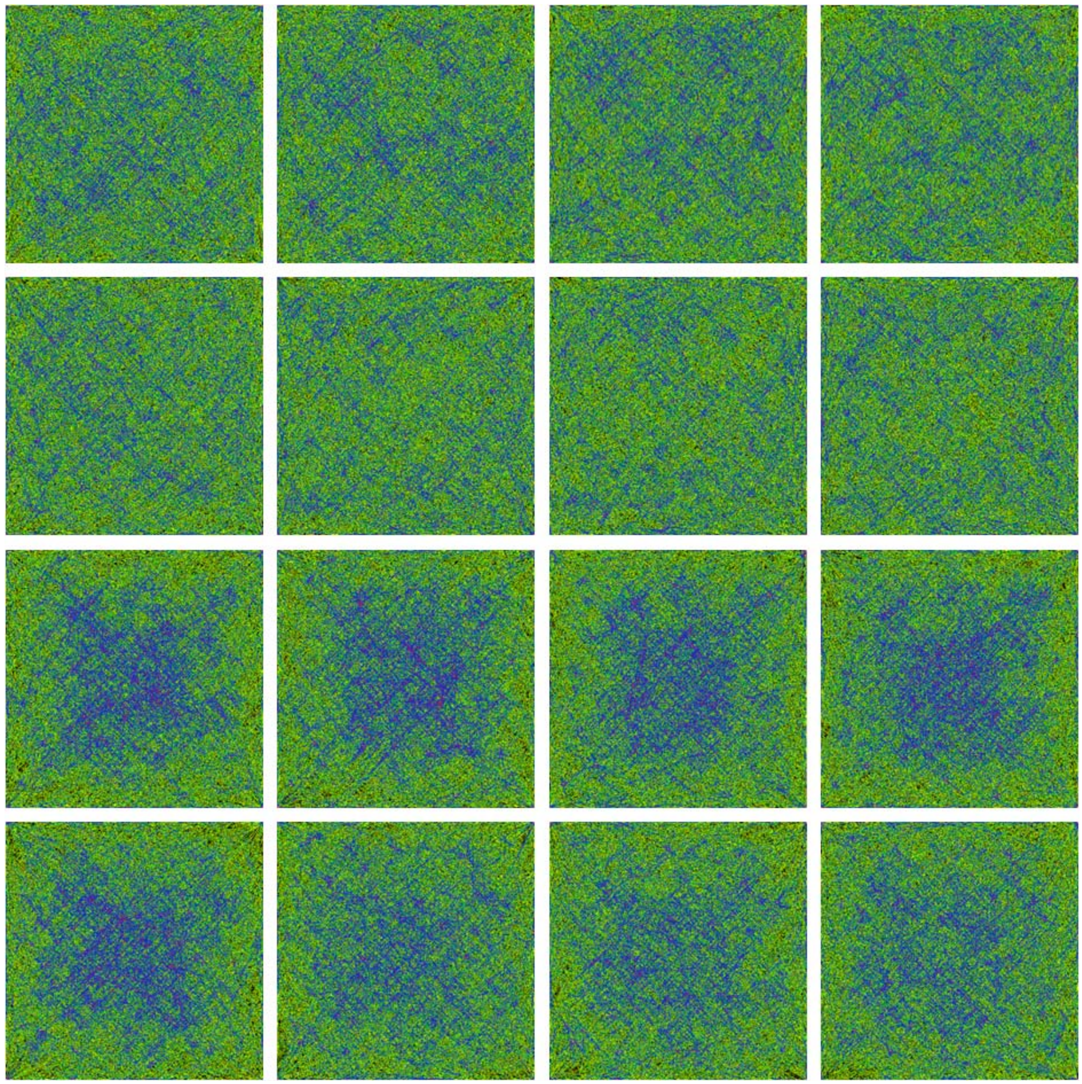


Note: Dots represent non-residential locations; gray shading represents level of safety, with a lighter shading indicating a higher level of safety; residential segregation by SES (identical in all scenarios) is shown by square zones in each figure with Levels 1–5 indicating increasing levels of SES. Random land use (indicated by "R") means that the density of non-household locations is constant; centralized land use (indicated by "C") means that non-residential locations tend to be concentrated in the center of the city. In C, the density of non-household locations within each of the five zones was assumed to decay outwards with the ratio of 0.5. Random safety (indicated by "R") means that safety was constant across the city; safer periphery (indicated by "S") means that safety increased as distance from the center of the city increased such that neighborhoods within the center have the lowest level of safety, and neighborhoods within the periphery have the highest level of safety . The combination of the two dimensions generated four scenarios: RR=randomly distributed non-household locations and random safety level; RS=randomly distributed non-household location and lower safety level in the core; CR=more non-household locations in the core and random safety level; and CS: more non-household locations and lower safety level in the core.

Appendix B

The figures below show the spatial distribution of walking in the city. Each row represents one scenario (RR, RS, CR and CS from top to bottom; RR=randomly distributed non-household locations and random safety level; RS=randomly distributed non-household location and lower safety level in the core; CR=more non-household locations in the core and random safety level; and CS: more non-household locations and lower safety level in the core.). Each column represents one point over time (Day 1, and Days 2,000, 6,000 and 10,000 from left to right). The colors represent the number of walking trips that cross the cell on the particular day (red for >5; blue for 3–5; green for 2; yellow for 1; and black for 0).

Generally, the figures show patterns that are consistent with those shown in a summarized fashion in Figure 2 (in printed journal article), although in contrast to Figure 2, they highlight the spatial dimension. In scenario RR (top row), different SES groups had similar levels of walking that did not change much over time. This is consistent with the approximately even spatial distribution of walking, which does not change substantially over time (from left to right). In Scenario RS (the second row), walking was evenly distributed at the beginning but became more concentrated at the boundary of the city (where the higher-SES groups live) and less concentrated in the city center (where the lower-SES groups live) over time. In scenario CR (third row), the lower-SES groups walked more than the higher-SES groups, with this pattern remaining stable over time. This is consistent with the higher concentration of walking within the city center, which does not change over time. For scenario CS (the fourth row), the higher concentration of walking in the city center (which is consistent with more walking in the lower-SES groups) at the beginning declines gradually over time. One interesting pattern that cannot be observed from Figure 2 but can be observed in the figures below pertains to the comparison of the walking distribution in Scenarios RR and CS at Day 10,000. Although in both RR and CS, different SES groups had approximately similar walking trips, the scenarios have very different spatial patterns. Whereas walking is more concentrated in the city center for Scenario CS, it is approximately evenly distributed in Scenario RR.



Calibration

Appendix C

The following two tables (C-1 and C-2) describe the calibration process. The process included seven steps labeled S1–S7. The “Input” section (Table C-1, top half) shows the starting values of the parameters used in each step. If the value of a given parameter is not shown, it was left identical to the one used in the previous step. The “Output” section shows the values of the distributional characteristics targeted in the calibration. The actual values targeted here (from National Household Travel Survey (NHTS) data, as detailed in the text) are shown in the column labeled “Target for calibration.” The values obtained from the simulation of the model with the corresponding input parameters at each step are shown in the columns for each step in the “Output” section (Table C-1, bottom half). When the value was not a target of that particular step, no value is shown in the output section. Note that values for food shopping, other shopping, and visiting a social place were not available in a disaggregated fashion from the NHTS but could be obtained from model simulations, so they are shown for reference only. Additional details on each step are shown in Table C-2.

Three clarifications:

1. Although the output for median distances is presented here, no attempt was made to calibrate to this value.
2. Some steps in the calibration process involved making assumptions based on reasonable guesses (such as the probabilities of performing different activities in Step 6). These assumptions were arbitrary, although an effort was made to make them plausible.
3. As is the case in agent-based models generally, the final set of parameters may be not be a unique way to obtain output variables that match the targets for calibration. This is a major challenge in validating these types of models.

Table C-1

	Category	Parameters/variables	Target for calibration[a]	Steps						
				S1	S2	S3	S4	S5	S6	S7
Input	Work	Maximum distance[b]		1	2	2.125				
	Food shopping	Probability		0.5					0.4	
		Maximum distance		1					1.5	2
	Other shopping	Probability		0.5					0.25	
		Maximum distance		1					1.5	
	Visiting a social place	Probability		0.5					0.2	
		Maximum distance		1					1.5	2.5
	Leisure within neighborhood	Probability		0.5			0.33			
		Maximum distance		1			5	5.5		
Output	Work	Trips per day	0.014	0.004	0.013	0.0139				
		Mean distance	0.78	0.415	0.803	0.817				
		Median distance	0.25	0.381	0.775	0.781				
	Food shopping	Trips per day		0.087					0.086	0.091
		Mean distance		0.301					0.397	0.492
		Median distance		0.250					0.3	0.372
	Other shopping	Trips per day		0.124					0.065	0.068
		Mean distance		0.240					0.33	0.327
		Median distance		0.181					0.21	0.225
	Visiting a social place	Trips per day		0.019					0.007	0.008
		Mean distance		0.930					0.916	0.917
		Median distance		0.881					0.9	0.846
	Basic needs (including above three items)	Trips per day	0.168	0.320					0.158	0.167
		Mean distance	0.44	0.321					0.394	0.445
		Median distance	0.22							
	Leisure within neighborhood	Trips per day	0.0805	0.121			0.083	0.0831		
		Mean distance	1.05	0.221			0.988	1.073		
		Median distance	0.485	0.088			0.388	0.416		

[a]The average number of trips per day for each purpose was computed as the product of the frequency[1] and 0.35 because according to NHTS (TRB 2005), Americans make slightly more than four travel trips per day of which 8.6% are walking trips[2]
[b]Units for all distances are miles.

Table C-2

Steps	Key targeted categories or variables	Comparison between the output of prior step and the targeted distribution parameters	Adjustment made as a result of comparison of output of prior steps to targeted distribution parameters
S1	All		Begin with 0.5 for all probabilities and 1 mile for all maximum distances.
S2	Maximum distance to work	Trips: 0.004<0.014 Distance: 0.415<0.78 It is necessary to increase the maximum distance to work	Set maximum distance to walk to work to 2 miles roughly based on the value of 1*(0.78/0.415).
S3	Maximum distance to work	Trips: 0.013<0.014 Distance: 0.803>0.78 Small difference, need finer adjustment of maximum distance to work	Eventually, set maximum distance of work to be 2.125 miles.
S4	Leisure within neighborhood	Trips: 0.0121>0.0805 Distance: 0.221<<1.05 Need to decrease probability and increase maximum distance	Set probability roughly equal to (0.0805/0.121)*0.5=0.33, and set maximum distance roughly equal to (1.05/0.221)*1= 5 miles.
S5	Leisure within neighborhood	Trips: 0.083>0.0805 Distance: 0.988<1.05 The difference is small, need finer adjustment.	Eventually, set maximum distance of work to be 5.5 miles.
S6	Basic needs	Trips: 0.32>0.168 Distance: 0.321<0.44 Need to decrease probability to roughly half the value and need to increase distance by roughly 50%.	People are assumed to have different probabilities for different needs. A value of 0.4 is assumed for the probability of food shopping (i.e., food shopping twice every 5 days); 0.25 for other shopping, (i.e., once in 4 days); and 0.2 for visiting a social place (i.e., once in 5 days). The maximum distances are set to be 1.5 miles for all three purposes.
S7	Basic needs	Trips: 0.158<0.168 Distance: 0.394<0.44 Need to increase the maximum distance.	It is assumed that visiting a social place may have a larger maximum distance compared to shopping (which involves carrying goods), and that other shopping may have a shorter maximum distance compared to food shopping ; therefore, the parameters were increased differently. Food shopping was set to be 2 miles, visiting a social place to be 2.5 miles, and other shopping was left at 5 miles.

References for Appendix C

1. Agrawal AW, Schimek P. Extent and correlates of walking in the U.S. Transportation Research Part D: Transport and Environment 2007;12(8):548–563.
2. Pucher J, Renne JL. Socioeconomics of Urban Travel: Evidence from the 2001 NHTS. Transportation Quarterly 2003;57(3):49–77.