SLUCE2 LMM ABM Lab Report:

David Pan - 20581567

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Dr. Dawn Parker

PLAN 416: Modelling the City

University of Waterloo

QUESTION 1: **(20 marks)** *First, report the number of transactions/sales (equal to the number of cells that urbanized). To find this information, click on the "**user panel**" tab at the bottom left. Second, query three cells (see the table below) and report their land rents as they move away from city centre. How do the results of this model compare to the simple Von Thunen model that we used in the first lab? How can you explain the differences in land rent at the different locations, given that the agents are identical?*
(Note: you need to double click on the landscape in Display A to get the coordinates and values. Follow the instructions in Step 4)

The number of transactions is **989**

Coordinate		Values in Display B
X	Y	Land rent
20	20	$ 536.91278
28	20	435.50308
36	20	288.95209

The results of this model agree with the simple Von Thunen model in that the transaction price (or land rent in the Von Thunen case) decreases as it moves away from the city center (see Figure 1b). The bid-rent theory states that households will choose locations at a certain distance from the CBD to maximize the utility they get from "the joint consumption of a land lot or house (spatial good) and all other goods (composite goods)" under limited budget which, in this case, is $800 (Filatova, Parker & Van der Veen, 2009). Given that the agents are identical, the differences in the land rent at the different locations is a result of bidding from the center. Again, bidders have a preference for being closer to the city center for household utility; hence they drive up prices from the center and down into the periphery, forming a price gradient. It may be observed that the preference to proximity (utilityBeta) in the model parameter is set to 0.85 or 85% of bidders, which explains this inveterate transaction behaviour.

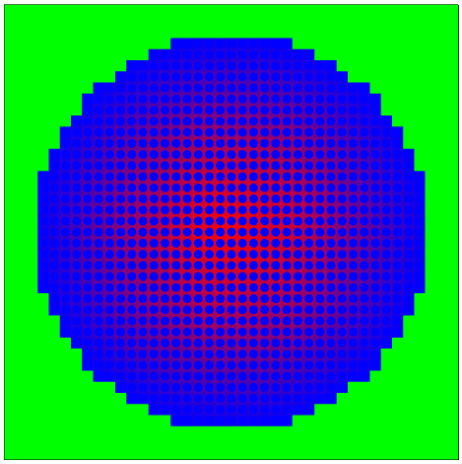


Figure 1a: Experiment 1: A display- Land converted to residential

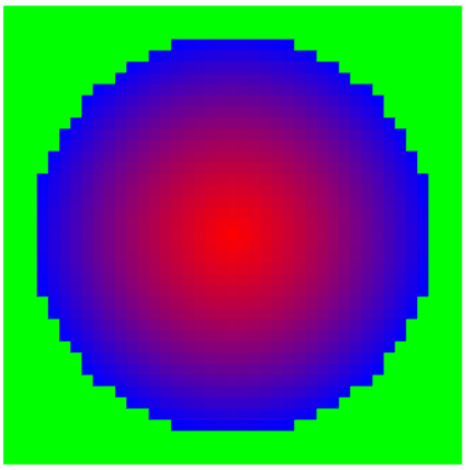


Figure 1b: Experiment 1: B display- Transaction price landscape

Question 2: (20 marks) *Report the total number of transactions. Query the same X and Y coordinates of the locations and report their land rents. How has the land rent changed? Why do you think the change has occurred?* (Hint: See the Filatova et. al 2009 paper for more context.)

Total number of transactions: **1,237**

Coordinate		Values in Display B
X	Y	Land rent
20	20	$ 536.91278
28	20	453.1637
36	20	330.28799

The results of this model show that the land rent changes so that the land away from the center has become more valuable than they were previously, which is evident when comparing the price of (36, 20) with the previous model (an increase from 289 to 330 for the peripheral land). This is because the preference for proximity has become a less significant factor of household utility after the adjustment of utlityBeta. This means that more bidders are willing to bid for places further away from the city center. Accordingly, we see that the total number of transactions has increased from 989 to 1237. In the Filatova et al. (2009) article, the adjustment was made to preferences for distance led to an increased tolerance for commuting among buyers, resulting in urban expansion spreading outwards (i.e., more transactions).

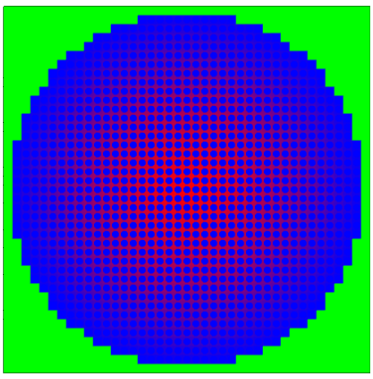


Figure 2a: Experiment 2: display A

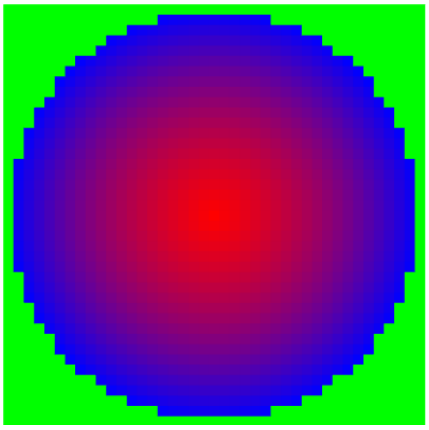


Figure 2b: Experiment 2: display B

Question 3: (10 marks) *Look at the pattern as it evolves. Is development contiguous or disconnected? Do you think it resembles the way that real-world landscapes evolve? Why or why not?* (You can argue both points.)

The development observed is contiguous in the central areas, and disconnected as it moves outwards (see Figure 3a). I think it resembles the way that real-world landscapes evolve in that urban centers are dense and are short of open spaces due to the high demand for development in central regions so that open spaces usually are "filled in" by infill developments, whereas the suburbs have more open areas for recreation because the demand for land is not high enough (utility of proximity to city center <= utility of open space). Conversely, when the utility of proximity to city center is higher than that of open space amenities, it reaches the threshold when development will be sought for even in a neighbourhood of limited open space.

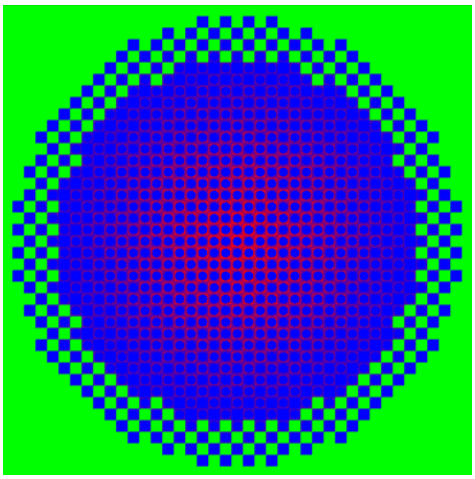


Figure 3a: Experiment 3 (Exercise Experiment with open space amenities): display A

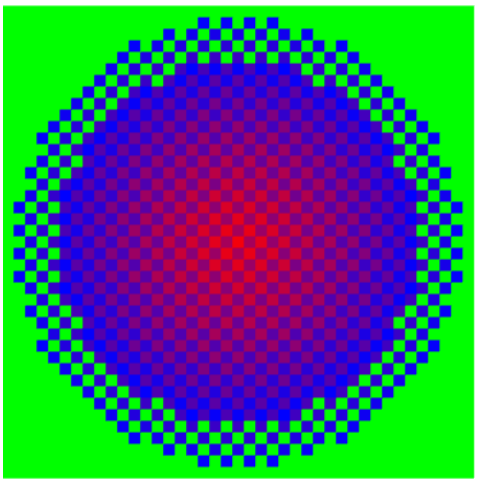


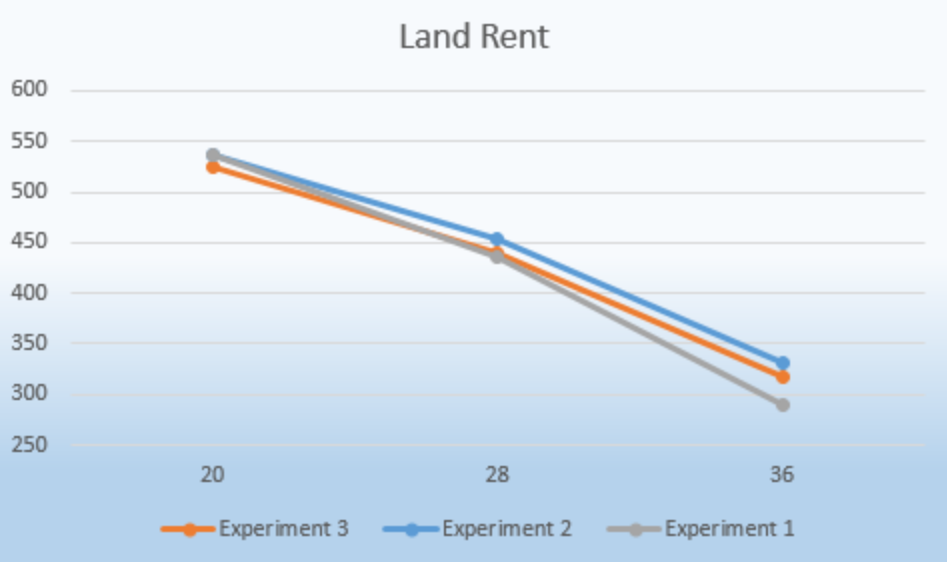
Figure 3b: Experiment 3: display B

Question 4: (30 marks) *Report the number of transactions. Query the three cells at the same locations, and fill the table below. Created a simple marked line plot in excel or similar, with the X coordinate on the X axis, and the land rents for each experiment on the Y axis. Set the Y axis range from 250 to 600 so you can see each curve clearly. Note that you are essentially plotting a few points from a land rent gradient, as illustrated in the paper. How do the results of Experiment 3 differ from Experiments 1 and 2, in terms of both the landscape patterns and the relative land rents? How might you explain the differences? (Hint: there are two sources of spatial complexity that determine land rent in the model. What are they, and how can you see their influence through the patterns of land rent and location?)*

Total number of transactions: **977**

Coordinate		Values in Display B
X	Y	Land rent
20	20	$ 524.28723
28	20	439.39816
36	20	316.86029

Unlike Experiments 1 and 2's contiguous landscape, the landscape pattern of Experiment 3 is more disconnected. The land price in the city center (20, 20) in Experiment 3 is the lowest of the three, and slightly lower than Experiment 2 as it moves away from the city center (see graph below). This difference results from the two adjustments made to Experiment 3: first, the household utility of proximity to the city center has been reduced, and secondly, there exists a competing demand for open space amenities. Both adjustments compete against the preference for proximity, which caused the land price to decrease in the city center due to its lack of open space amenities and the fact that more bidders are willing to pay for lands further away from the center. A lower demand for proximity to the city center caused the land rent outside the center to be higher than that of Experiment 1 as lands in the periphery has become more valuable, and yet the rent is lower than that of Experiment 2 because the same peripheral lands in Experiment 3 has some unmet demands for open spaces. The demand for open space amenities also accounts for the disconnected landscape, especially in the periphery where the utility of proximity to city center has not yet outcompeted the utility of open space amenities.



Question 5: (**5 marks**, A tough question) *As the city developed from the centre, some cells are left undeveloped in the first place even though their neighbours have been changed to city cells, and these cells will convert to city cells later. Do the patterns in infill area (especially the land values/rents) make sense or not?*

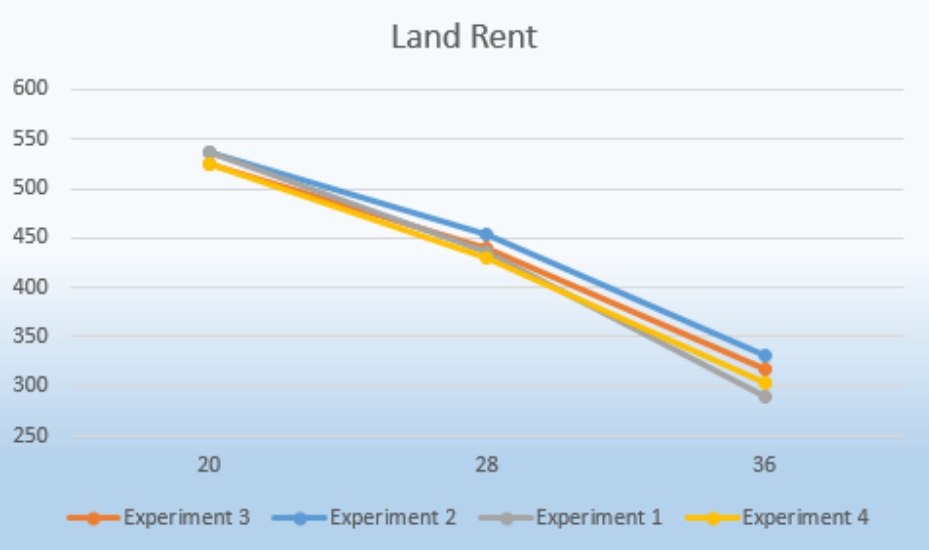
They do make sense because when neighborhoods are set to "1," then it will account for contiguity to identify if there is an undeveloped cell that is good for development (neighborhood effect). However, as the disconnected pattern grow out, the prices increase from the center because the proximity to the city center become more elusive and a desirable luxury. Instead of resorting to the periphery bidders will look to infill developments to take advantage of the available open spaces that were close to the center. The patterns in the rent landscape seen are reasonable because land values vary to a lesser extent with distance from the center when there is an additional adjustment of open space amenities which compete for household utility (people living in the suburbs has more household utility than before). It is only when the utility for proximity has crossed the equilibrium relative to the demand for open space that the open space areas are filled in. However, the demand for open space amenities always exist in these in-fill areas even when they are converted; hence the land rent is lower when comparing to the previous model.

Question 6 (15 marks): *What parameter or parameters have you changed? What sort of change in real-world conditions does your experiment represent? Report the number of transactions and show the final land-use locations and land rent patterns. Record the land rents as before, and add them to your plot. How does your model run differ from the previous experiments in terms of the number of transactions, the land rent patterns, and the spatial patterns of development? How might you explain your model outcomes, and why they differ from the other experiments?*

Number of transactions: **901**

Coordinate		Values in Display B
X	Y	Land rent
20	20	$ 524.28723
28	20	430.52145
36	20	303.92722

The new experiment designed is an extension of Experiment 3. I increased unitTransportCost from 1.0 to 3. This means that the transport cost for each unit of land has been tripled. Although the resulting general pattern of land use and the high-to-low gradient of rent does not change so much from Experiment 3, this adjustment caused the land in the periphery to become cheaper (see plot below) and there are fewer infill developments in the periphery (see Figure 4b versus Figure 3b) because the increase in transport cost decreases household utility and hence the demand for suburban land. As noted in the article, the bidders are operating under limited budget constraints (income – transport cost) (Filatova, Parker & Van der Veen, 2009). The transport cost is accessory to the utility of proximity to city center in that it decreases the importance of lands away from the city center. This is a real-world condition explained by the Von Thunen model where transport cost bears an inverse relationship to the distance from the town center so that when the cost is high, land use will not spread far from the center. Accordingly, the total number of transactions have decreased from 977 to 901 as evidenced from the fewer in-fill developments in the periphery.



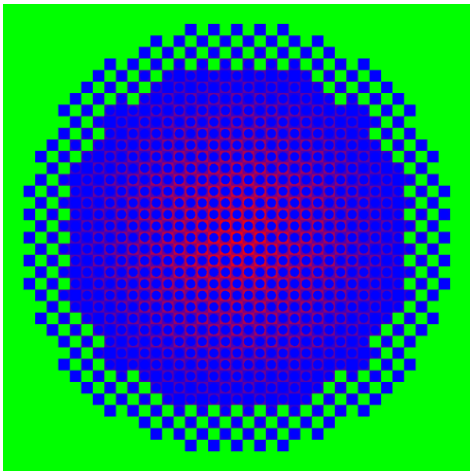


Figure 4a: Experiment 4 (with adjusted transport cost): display A: converted land-use locations

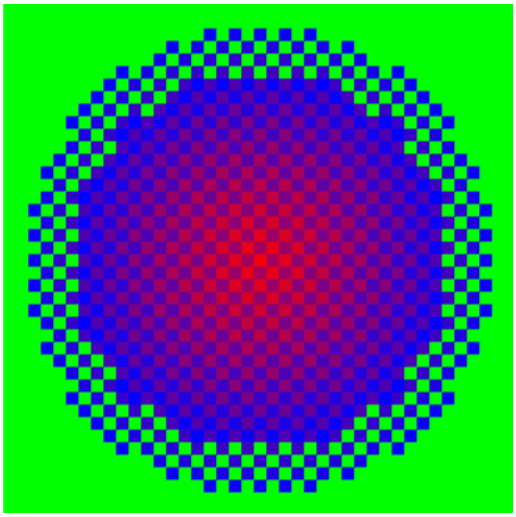


Figure 4b: Experiment 4: display B: land rent patterns

References:

Filatova, T., Parker, D., & Van der Veen, A. (2009). Agent-based urban land markets: agent's pricing behavior, land prices and urban land use change. *Journal of Artificial Societies and Social Simulation*, *12*(1), 3.

Appendix:

Parameters of Experiment 4: (XML file also attached)