Loosely Modelling Heat Transfer Using A Taxation System

What it models

This automaton models the spread of heat in a substance using some of the principles from finance. By simplifying the complex physics involved in heat transfer to the rules of a taxation system, interesting effects can be observed. In this model, the transfer of heat is treated like as the transfer of money.

The basic structure of a taxation system is that wealthier individuals are taxed money to help the less wealthy. The taxation system is similar to heat transfer because hot objects emit heat, that is then transferred to surrounding objects or throughout the object itself. Objects only transfer heat if there is a difference in heat energy between the objects. Hotter objects transfer heat to cooler objects. Hotter objects if given a choice, also transfer more heat to a colder object than an object that is only slightly cooler than itself.

Taxation System	Heat Transfer
❖ Net worth	❖ Kinetic energy of molecules
❖ Receive government aid (donations from surrounding cells)	❖ Heat that is transferred to one part of the material
❖ Taxed amount	❖ Heat that is transferred to other parts of the material

Fig. 1 Comparison of Heat Transfer and the Taxation System

The taxation brackets used in this taxation system take into account a person's net worth in comparison to the **highest level of wealth (HLW)**, which is a predetermined level of wealth that cannot be exceeded. In real life, there is no limit on how wealthy a person can be. For the purposes of this simulation, the highest net worth a person can accumulate is the HLW.

If the wealth of the cell is…	The amount they are taxed is…
80% of HLW or higher	The difference between their net worth and HLW and an additional 10% of their net worth
Lower than 20% of HLW	None
Between 20% of HLW and 80% of HLW	A range up to and including 10% of their net worth

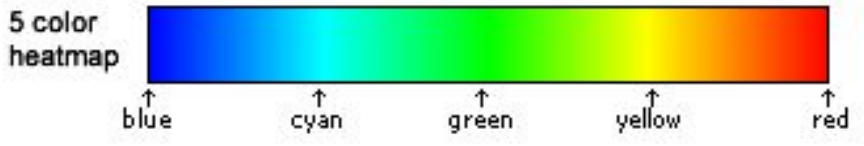
Fig. 2 Taxation Brackets

States of a cell

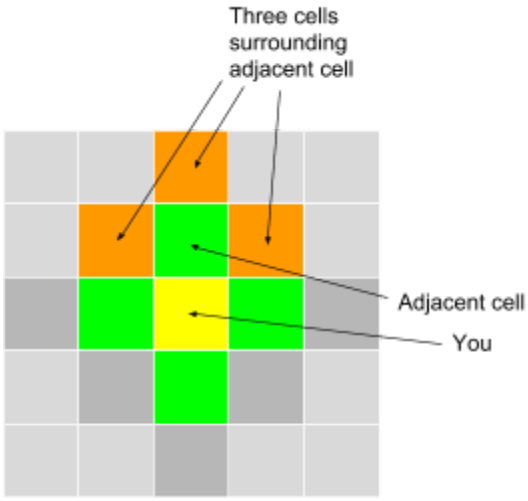
A cell can be any colour on the specified colour spectrum (see picture). Red represents the highest level of wealth and blue represents the lowest level of wealth in the simulation. Levels of wealth in between are mapped accordingly on the specified colour spectrum.

A. The wealth of a cell cannot exceed the HLW.
B. If a cell is in debt (has a negative net worth), then it will be colored black.

Evolution rules



A. Cells are assigned a net worth value.
B. The amount of money received from an adjacent neighbour is calculated by looking at how "needy" your cell is compared to the three cells surrounding the adjacent cell. The neediness of a cell is determined by a rank value.
    a. The rank value is increased when one of the three surrounding cells to your adjacent cell is richer than your cell.
    b. If one of the three surrounding cells to your adjacent cell has the exact amount of money your cell has, rank does not increase.



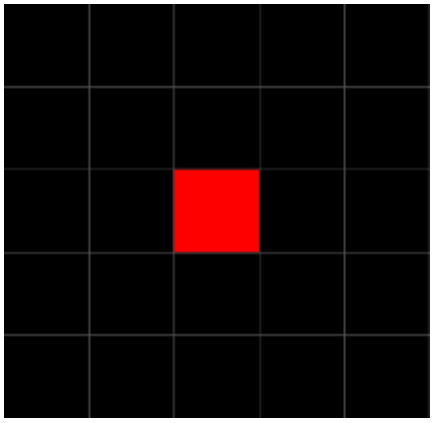
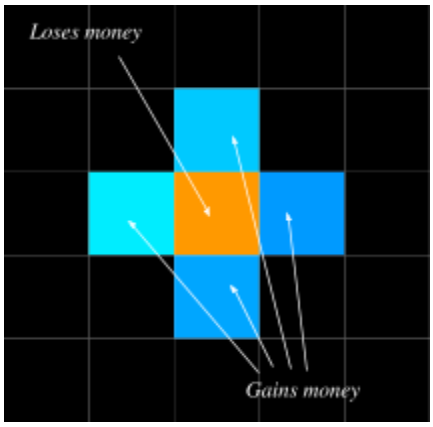
C. The amount by which your cell's net worth increases or decreases in the next generation is the amount of money you receive in donations less the amount that you were taxed.
D. The amount of money donated by an adjacent cell is recalculated once the cell's net worth is updated.
E. If a cell exceeds the HLW, their net worth is reset to HLW less their donation for that generation.

A cell's wealth in comparison to the three surrounding cells of an adjacent cell	**The amount that a cell receives is…**
Richer than the other three cells	10% of Adjacent cell's donation
Richer than two of the cells	20% of Adjacent cell's donation
Richer than one other cell	30% of Adjacent cell's donation

Poorest cell of them all	40% of Adjacent cell's donation

Fig. 3 Incoming Donations

Sample evolution

Generation 1	Generation 2
	
- *Red represents the HLW.* - *The adjacent cells to the red cell cannot donate any money to the red cell since their net worths are 0.* - *The cell to the left of the red cell compares itself in rank to the three cells surrounding the red cell. The cell's rank would be 0 since it is not poorer than the other three cells (they are all equal in their poverty).*	- *The red cell has turned orange because it has donated some of its wealth.* - *The four adjacent cells to the previously red cell have turned shades of blue as they have received a donation from the red cell.* - *The different shades are a result of the donations from the adjacent cells being updated after the net wealth is re-calculated in order to create different shades and asymmetrical patterns.*
Generation 5	**Generation 23**