2.e. Using CELLULAR AUTOMATA to develop a model of microbial colonization of the rhizosphere.

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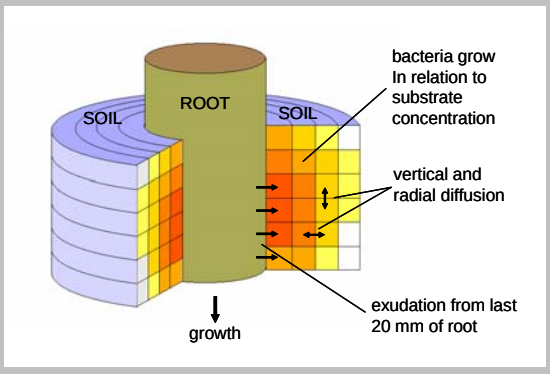
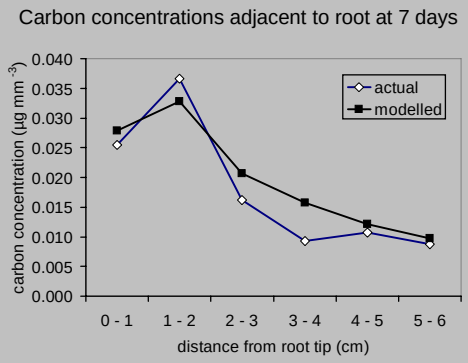
The problem
Understanding how soil microbes colonize the region around a root (the "rhizosphere").

Data available
(i) Carbon exudation rates from roots and carbon uptake dynamics of microbes, derived from a series of experiments, (ii) Carbon concentrations around a root obtained by destructive sampling 7 days after planting (used to validate the model).

Why use cellular automata and not another method?
The data available to validate the model are the result of a very complex sequence of interacting events. Using cellular automata allowed us to fully incorporate this complexity using a set of very simple models.

Simple description of how it was done
In the computer model the soil around the root is divided into small cells (0.25 mm), each with its own carbon concentration and concentration of microbes. The model works using a series of 3 minute time steps. In each time step the root grows downwards through the soil, the last 20 mm of the root exudes carbon into the surrounding cells, carbon diffuses between neighbouring cells, and carbon is taken up by the microbial population in each cell which in turn grows or dies, controlling the rate of carbon uptake in the next time step. Conditions are considered constant throughout any individual cell and rates to stay constant over a time step. This allows very simple models to be used to update each cell. By applying these models repeatedly to a large number of cells, which interact with one another, the overall complexity of the system is built up.





Software used and alternative generic packages that could be used
The model was programmed in Fortran because this is good at handling large arrays. Most other high level programming languages could also be used.

Further reading
Another example of the use of cellular automata: Aitkenhead MJ, Foster AR, FitzPatrick EA and Townend J (1999). Modelling water release and absorption in soils using cellular automata. *Journal of Hydrology* 220: 104-112.