Computer Efficient Stochastic Models of Cell Cultures

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With the emergence of personalised medical therapies, digital pharmacokinetics and pharmacodynamics, mathematical modelling of cell cultures has become a prominent area of *in silico* biology. In this talk, we will address the modelling issues of cell movement and division, with a special focus on the phenomenon of volume exclusion.

Consider circular cells with uniform size of diameter d and place the cells on a 2 dimensional square lattice with grid constant d. Under these conditions, the principle of volume exclusion states that there can be at most one cell per lattice site.

Our goal is to provide a sound interpretation of volume exclusion and exact stochastic algorithms for the numerical simulation of cell cultures in continuous time and discrete space. We present the *prompt decision method*, which applies the exclusion principle directly, and the *reduced rate method*, which applies it indirectly. Then we prove that the two methods are statistically equivalent in the sense that in a given state of the system the time until the next event and also the next event to be realized are drawn from the same time and event distribution in case of both methods.

Finally, we give a condition that we can use to decide which one of the above algorithms is the fastest in a given state of the simulation, thus we can minimize the simulation runtime.