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Modelling of disease spread through heterogeneous population

We present a simple model of disease spread that incorporates spatial variability in population density. Starting from first principles, we derive a novel PDE with state-dependent diffusion. Consistent with observations, this model exhibits higher infection rates in the areas of higher population density. The model also exhibits an infection wave whose speed varies with population density. In addition, we demonstrate the possibility of super-diffusive propagation of infection, whereby an infection can "jump" across areas of low population density towards the areas of high population density. Finally, a case study of coronavirus spread in the Canadian province of Nova Scotia is presented with qualitatively similar features as our model, including density-dependent infection rates and infection that jumps across main population centers.