THE POPULATION DENSITY PARTICLE METHOD TO SIMULATE OSCILLATOR POPULATIONS

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Abstract. Populations of noisy, coupled oscillators abound in all scientific fields and provide a fertile area for mathematicians to study. To obtain a tractable mathematical model of an oscillator population, it is common to use dimension reduction and replace an initial model having physically relevant variables with a phase oscillator model. This can impede the modeller's ability to address many scientific questions. In this talk, I will present an analytical-numerical method that results in a tractable model that retains the physical meaning of all variables. In a population density approach, the density over states is tracked rather than the individual states of all the oscillators. After accounting for noise and coupling within the population, the population density is governed by a non-linear and non-local integro-advection-diffusion differential equation. I discretize this equation with a particle method in a grid-free approach to mitigate the curse-of-dimensionality associated with many spatial dimensions. After presenting the method, I will demonstrate its use for studying coupled oscillator populations in the suprachiasmatic nucleus, the site of the mammalian circadian clock, and the sinoatrial node, the cardiac pacemaker.

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Date: November 12, 2017.