Modelling Coupled Metronomes: An Application of the Kuramoto Model

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The curious behavior of coupled oscillators has intrigued physicists for centuries. The first to discuss this phenomenon was physicist Christian Huygens, who discovered an odd synchronization of two pendulum clocks hanging the same wall. No matter the starting phase difference of the hanging weights, they would always evolve to a stable 180 degrees out of phase. This mysterious behavior known as entrainment is present in many non-mechanical systems as well, such as the flashing of fireflies, applause at concerts and neuron signaling. The purpose of this project is to investigate entrainment in systems of weakly coupled metronomes. If the frequency of the metronomes is nearly identical, they inevitably synchronize. Perhaps the most common mathematical framework for such systems is the Kuramoto model, which models synchronization behavior in systems of coupled oscillators. I adjust and solve the governing equation for two metronomes, obtaining a model for the evolution and eventual synchronization of the coupled system. To test the model, I collected data from two metronomes synchronizing by recording the time lag between their ‘ticks’. After data processing, I examined the details of the synchronization. Although there were some issues regarding non-perfect oscillators, the Kuramoto model provided an excellent theoretical framework for modelling the coupled metronome system.

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