PDE Based Cellular Neural Network Models

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Some autonomous Cellular Neural Networks (CNNs) represent an excellent approximation to the nonlinear partial diffrential equations (PDEs). Although the CNN equations describing reaction-diffusion systems are with the large number of cells, they can exhibit new phenomena that can not be obtained from their limiting PDEs. This demonstrates that an autonomous CNN is in some sense more general than its associated nonlinear PDE.

In this talk we shall present the derivation of the CNN implementations throught spatial discretization, which suggests a methodology for converting a PDE to CNN templates and vice versa. The CNN solution of a PDE has four basic properties- it is

i). continuous in time;

ii). continuous and bounded in value;

iii). continuous in interaction parameters;

iv). discrete in space.

We shall demonstrate how an autonomous CNN can serve as a unifying paradigm for active wave propagation, several well-known examples chosen from different disciplines will be modeled. Moreover, we shall show how the three basic types of PDEs: the diffusion equation, the Laplace equation, and the wave equation, can be solved via CNNs.