Learning stable cross-diffusion with reaction systems

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After the pioneering work of Keler and Segel in the 1970s cross-diffusion models became very popular in biology, chemistry and physics to emulate systems with multiple species. From a mathematical point of view, cross-diffusion models are described by time-dependent partial differential equations (PDE) of diffusion or reaction-diffusion type, where the diffusive part involves a general nonlinear non-diagonal diffusion matrix. This leads to a strongly coupled system where the evolution of each dependent variable depends on itself and on the others in a way governed by the diffusion matrix. The selection of the optimal coefficients and influence functions that rule the associated PDE system is always a critical question when modeling real phenomena.

In this talk we will focus on nonlinear cross-diffusion systems for image filtering. We will start with a concise introduction about complex diffusion and cross-diffusion models for image restoration. Some attention will be given to the numerical discretization of the models and to the qualitative properties of the corresponding computed solutions. Then, we will discuss a flexible learning framework in order to optimize the parameters of the models improving the quality of the denoising process. In particular, we use a back propagation technique in order to minimize a cost function related to the quality of the denoising process while we ensure stability during the learning procedure.

References

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