

Discrete processes and their continuous limits

Uri Ascher¹

Abstract: The possibility that a discrete process can be closely approximated by a continuous one, with the latter involving a differential system, is fascinating. Important theoretical insights, as well as significant computational efficiency gains may lie in store. A great success story in this regard are the Navier-Stokes equations, which model many phenomena in fluid flow rather well. Recent years saw many attempts to formulate more such continuous limits, and thus harvest theoretical and practical advantages, in diverse areas including mathematical biology, image processing, game theory, computational optimization, and machine learning.

Caution must be applied as well, however. In fact, it is often the case that the given discrete process is richer in possibilities than its continuous differential system limit, and that a further study of the discrete process is practically rewarding. I will show two simple examples of this. Furthermore, there are situations where the continuous limit process may provide important qualitative, but not quantitative, information about the actual discrete process. I will demonstrate this as well and discuss consequences.

¹ Department of Computer Science, University of BC, Vancouver, Canada
ascher@cs.ubc.ca