A Simple Method for Solving PDEs on Point Clouds: 25 Years of Simple Methods for Complicated Problems

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Modeling physical and biological problems in realistic settings often leads to posing the governing Partial Differential Equations on a domain of complicated shape, such as the body of an aircraft or a network of blood vessels in the body. This greatly complicated the process of creating computational grids, discretizing the equations, and solving these numerically. Here we introduce an amazingly simple new approach, in which the geometric representation is merely an unstructured point cloud approximating the domain, and the equations are discretized and solved using only the completely standard, well-known, Cartesian Grid finite difference methods. This new method is result of 25 years of developing simple embedding methods for solving complicated PDEs, initially motivated by the level set method. I will also discuss the history of this development, as well as applications to complicated problems in biology, genetics, materials science and engineering.