Informal Introduction to Mesh Free Interpolation of Scattered Large Spatio-Temporal Data

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Abstract:

Nowadays "standard" engineering problems are usually solved by specialized computational packages. As technology advances, it is necessary to solve problems that are ill-conditioned or processed large data sets organized in meshes structured or unstructured and tessellation techniques, like Delaunay triangulation (DT), are used to create meshes usually in 2D or 3D and computational methods, like Finite Elements Method etc., are used for computation of physical phenomena. All those techniques actually rely on interpolations or approximation.

An implementation tessellation algorithms is getting significantly harder with a dimensionality of the geometrical domain. Computational complexity of the DT is $O\left(n^{\lfloor d/2+1 \rfloor}\right)$ for n points and d dimension and numerical problems grows significantly as well.

In the case of scattered or spatio-temporal scatted data solution of computational problems, e.g. solution partial differential equations (PDE), is becoming very hard.

However, a new meshlees approach using radial basis functions (RBF) was introduced recently and over the past decades those techniques reach applicability level. Their significant advantage is that RBF are highly scalable, simply handling higher dimensionality and high adaptability to local features replacing adaptive meshing etc.

As RBF application actually leads to a solution of a system of linear equations with a positively definite sparse matrix, solution is usually fast, especially if GMRES methods are used.

In this short tutorial an informal introduction to radial basis function interpolation and approximation will be given together with multilevel approach. Applicability of radial basis functions in computation will be demonstrated on simplified examples, like partial differential equations, surface representation and corrupted image reconstruction.

Recently given tutorials:

- Skala,V.: Projective geometry and duality for graphics, games and visualization, International Conference on Applied Mathematics and Computational Methods in Engineering AMCME 2013, Europment, Rhodos, 2013
- Skala,V.: Projective Geometry, Duality and Precision of Computation in Computer Graphics, Visualization and Games, Tutorial Eurographics 2013, Girona, 2013
- Skala,V.: Projective Geometry and Duality for Graphics, Games and Visualization - Course SIGGRAPH Asia 2012, Singapore, ISBN 978-1-4503-1757-3, 2012
- Skala,V.: Robust Computation in Engineering, Geometry and Duality – TUTORIAL, 7th Int.Conf. on Systems, ICONS 2012, St. Gilles, Reunion Island, IARIA, 2012
- Skala,V.: Mathematical Foundations for Computer Graphics and Virtual Reality, Tutorial Intuition 2008 conference, Torino, Italy, 2008
- Skala,V.: Mathematical Foundations for Computer Graphics and Computer Vision, Tutorial CGI 2008 conference, Istanbul, Turkey, 2008

Brief Biography of the Speakers:

Prof.Vaclav Skala is a Full professor of Computer Science at the University of West Bohemia, Plzen, Czech Republic. He received his Ing. (equivalent of MSc.) degree in 1975 from the Institute of Technology in Plzen and CSc. (equivalent of Ph.D.) degree from the Czech Technical University in Prague in 1981. In 1996 he became a full professor in Computer Science. He is the Head of the Center of Computer Graphics and Visualization at the University of West Bohemia in Plzen (http://Graphics.zcu.cz) since 1996.

Prof.Vaclav Skala is a member of editorial board of The Visual Computer (Springer), Computers and Graphics (Elsevier), Machine Graphics and Vision (Polish Academy of Sciences), The International Journal of Virtual Reality (IPI Press, USA) and the Editor in Chief of the Journal of WSCG. He has been a member of several international program committees of prestigious conferences and workshops. He is a member of ACM SIGGRAPH, IEEE and Eurographics Association. He became a Fellow of the Eurographics Association in 2010.

Prof.Vaclav Skala has published over 200 research papers in scientific journal and at international research conferences. His current research interests are computer graphics, visualization and mathematics, especially geometrical algebra, algorithms and data structures.

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