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Diffuse Interface Models on Graphs for Classification of High Dimensional Data

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Phase field methods are well-known in the physical sciences and in image processing and segmentation problems, but have only recently been studied for discrete high dimensional data classification problems. We present new variational algorithms that combine recent ideas from spectral methods on graphs with nonlinear edge/region detection methods traditionally used in the PDE-based imaging community. The algorithms are based on the Ginzburg–Landau functional which has classical PDE connections to total variation minimization. Convex-splitting algorithms allow us to quickly find minimizers of the proposed model and take advantage of fast spectral solvers of linear graph-theoretic problems. This method can be made even faster by adapting the MBO Scheme (Merriman-Bence-Osher) for motion by mean curvature, thereby removing the diffuse interface scale and reducing the computations to alternating between solving a graph heat equation and thresholding. We present diverse computational examples involving both basic clustering and semisupervised learning for different applications. We show how these ideas can be extended to computationally complex problems such as modularity optimization for community detection. We also discuss connections between these algorithms and L1-compressed sensing methods. This presentation includes joint work with Arjuna Flenner, Cristina Garcia, Tijana Kostic, Thomas Laurent, Ekaterina Merkurjev, Allon Percus, and Mason Porter.

REFERENCES

[1] Andrea L. Bertozzi and Arjuna Flenner, Diffuse interface models on graphs for classification of high dimensional data, *Multiscale Modeling and Simulation,* 10(3), pp. 1090-1118, 2012.

[2] E. Merkurjev, T. Kostic, and A. L. Bertozzi, An MBO Scheme on Graphs for Segmentation and Image Processing , accepted *SIAM J. Imag. Proc*. 2013.

[3] Huiyi Hu, Thomas Laurent, Mason A. Porter, Andrea L. Bertozzi, A Method Based on Total Variation for Network Modularity Optimization using the MBO Scheme accepted in *SIAM J. Appl. Math.*, 2013.

[4] Cristina Garcia-Cardona, Ekaterina Merkurjev, Andrea L. Bertozzi, Arjuna Flenner and Allon G. Percus, Fast Multiclass Segmentation Using Diffuse Interface Methods on Graphs, submitted 2013.

[5] B. Merriman, J. K. Bence, and S. J. Osher, Motion of multiple junctions: a level set approach, *Journal of Computational Physics*, 112 (2) (1994), pp. 334–363.