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An empirical investigation of Backbone Filtering Techniques in weighted Complex Networks

Ali Yassin¹, Hocine Cherifi¹, Hamida Seba² and Olivier Togni¹

¹Laboratoire d'Informatique de Bourgogne - Univ. Bourgogne - Franche-Comté, Dijon, France

²Univ Lyon, UCBL, CNRS, INSA Lyon, LIRIS, UMR5205, F-69622 Villeurbanne, France

The size and the density of many real-world networks form a barrier for visualization and graph processing. Several approaches have been developed over the years to reduce the network size while representing the original network as well as possible [1, 2]. Among the so-called backbone extraction techniques, "edge-filtering" techniques focus on removing nodes and edges. They can be classified further into "structural" and "statistical" techniques; The structural techniques such as the High-Saliency-Skeleton, Doubly-Stochastic Transformation, and the Distance Backbone filter edges according to a criterion allowing the latent structure of the network to emerge. Statistical techniques such as the Disparity Filter, Noise Corrected, and Pólya Filter assess the significance of an edge according to a predefined null model and eliminate the least significant edges. In this study¹, we perform an extensive comparative investigation of the forenamed influential filtering techniques using two performance criteria. First, classical topological properties are compared to evaluate the algorithms' impact (density, weighted modularity, average weighted degree, average link weight, average betweenness, entropy). Second, the relevance of the backbone to the dynamical diffusion process is assessed using the popular Susceptible-Infected-Recovered (SIR) Model. Fig 1 shows the metric distance, disparity filter, and the high salience skeleton backbones and their topological properties compared to the original Les Miserables network. The disparity filter retains the lowest percentage of nodes 20% with the highest average weighted degree 24.68 and average link weight 7.596. In contrast, the other filtering techniques preserve most nodes with a smaller density than the original network.

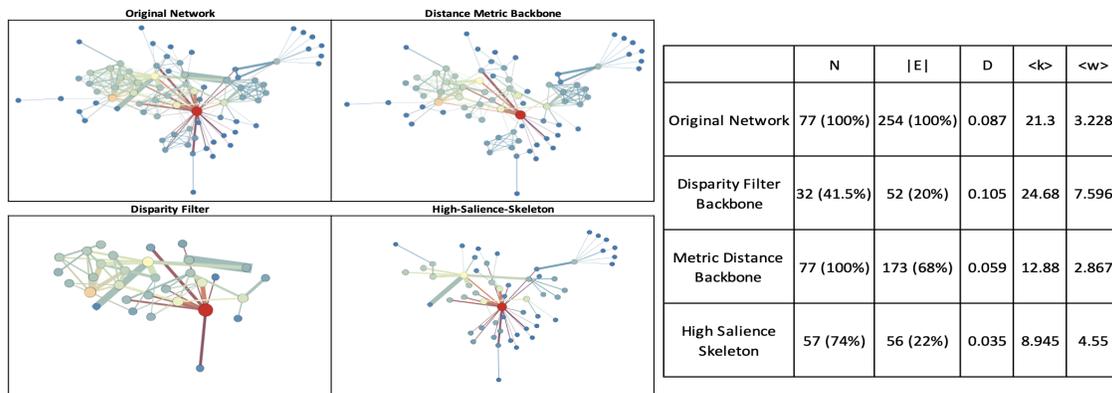


Figure 1: The Les Miserables original network, Metric Distance, Disparity Filter, and High Saliency Skeleton backbones. The table shows the topological properties; N is the number of nodes, $|E|$ is the number of edges, D is the density, $\langle k \rangle$ is the average weighted degree, and $\langle w \rangle$ is the average link weight.

References

- [1] Ghalmane, Zakariya, et al. "Extracting backbones in weighted modular complex networks." Scientific Reports 10.1 (2020): 1-18 Nature.
- [2] Ghalmane, Zakariya, et al. "Extracting modular-based backbones in weighted networks." Information Sciences Vol 576 (2021): 454-474. Elsevier.

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