

Figure 5: Expected First Success (EFS) of modularity and edge cut after applying Louvain on noisy communities of synthetic networks with $n = 1,000$. When $\mu = 0.5$, Louvain is able to improve modularity with low values of EFS, while when $\mu = 0.1$, Louvain is less likely to improve modularity. By increasing K , EFS for edge cut also increases.

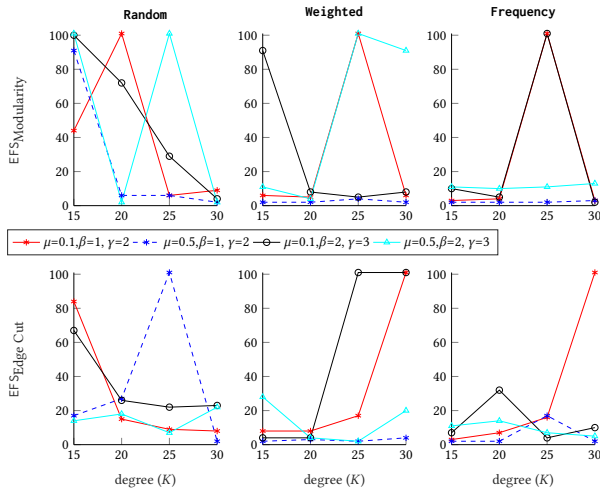


Figure 6: Expected First Success (EFS) of modularity and edge cut after applying Louvain on noisy communities of synthetic networks with $n = 10,000$. By increasing n and K , EFS for modularity decreases on average.

[10] Luca Gamaitoni, Peter Hänggi, Peter Jung, and Fabio Marchesoni. 1998. Stochastic resonance. *Reviews of modern physics* 70, 1 (1998), 223.
 [11] Michelle Girvan and Mark EJ Newman. 2002. Community structure in social and biological networks. *PNAS* 99, 12 (2002).
 [12] Roger Guimerà, Marta Sales-Pardo, and Luis A. Nunes Amaral. 2004. Modularity from fluctuations in random graphs and complex networks. *Phys. Rev. E* 70 (Aug 2004), 4. Issue 2.
 [13] Shengmin Jin and Reza Zafarani. 2020. The Spectral Zoo of Networks: Embedding and Visualizing Networks with Spectral Moments. In *Proceedings of the KDD*.

[14] Ravi Kannan, Santosh Vempala, and Adrian Vetta. 2004. On clusterings: Good, bad and spectral. *JACM* 51, 3 (2004).
 [15] Steven Kay. 2000. Can detectability be improved by adding noise? *IEEE signal processing letters* 7, 1 (2000), 8–10.
 [16] O. Krishna, R. K. Jha, A. K. Tiwari, and B. Soni. 2013. Noise induced segmentation of noisy color image. In *2013 NCC*. 1–5.
 [17] Andrea Lancichinetti, Santo Fortunato, and Filippo Radicchi. 2008. Benchmark graphs for testing community detection algorithms. *Phys. Rev. E* 78, 4 (2008), 046110.
 [18] Jure Leskovec and Andrej Krevl. 2014. SNAP Datasets: Stanford Large Network Dataset Collection.
 [19] Jure Leskovec, Kevin J Lang, and Michael Mahoney. 2010. Empirical comparison of algorithms for network community detection. In *Proc. of WWW*. 631–640.
 [20] Feifei Li, Dihan Cheng, Marios Hadjieleftheriou, George Kollios, and Shang-Hua Teng. 2005. On trip planning queries in spatial databases. In *SSTD*. 273–290.
 [21] Xueyu Mao, Purnamrita Sarkar, and Deepayan Chakrabarti. 2017. Estimating mixed memberships with sharp eigenvector deviations. *arXiv preprint arXiv:1709.00407* (2017).
 [22] Mark D McDonnell and Derek Abbott. 2009. What is stochastic resonance? Definitions, misconceptions, debates, and its relevance to biology. *PLoS comp. bio.* 5, 5 (2009).
 [23] Mark D McDonnell and Lawrence M Ward. 2011. The benefits of noise in neural systems: bridging theory and experiment. *Nature Reviews Neuroscience* 12, 7 (2011), 415.
 [24] Frank Moss, Lawrence M Ward, and Walter G Sannita. 2004. Stochastic resonance and sensory information processing: a tutorial and review of application. *Clinical neurophysiology* 115, 2 (2004), 267–281.
 [25] L. Nataraj, A. Sarkar, and B. S. Manjunath. 2009. Adding Gaussian noise to “denoise” JPEG for detecting image resizing. In *ICIP*. 1493–1496.
 [26] Lakshmanan Nataraj, Anindya Sarkar, and Bangalore S Manjunath. 2010. Improving re-sampling detection by adding noise. In *Media Forensics and Security II*, Vol. 7541.
 [27] Mark Newman. 2018. *Networks*. Oxford university press.
 [28] Mark EJ Newman. 2004. Fast algorithm for detecting community structure in networks. *Phys. Rev. E* 69, 6 (2004).
 [29] Mark EJ Newman. 2006. Finding community structure in networks using the eigenvectors of matrices. *Phys. Rev. E* 74, 3 (2006), 036104.
 [30] Mark EJ Newman. 2006. Modularity and community structure in networks. *PNAS* 103, 23 (2006), 8577–8582.
 [31] Mark EJ Newman and Michelle Girvan. 2004. Finding and evaluating community structure in networks. *Phys. Rev. E* 69, 2 (2004), 026113.
 [32] Osonde Osoba and Bart Kosko. 2013. Noise-enhanced clustering and competitive learning algorithms. *Neural Networks* 37 (2013), 132–140.
 [33] Osonde Osoba, Sanya Mitaim, and Bart Kosko. 2013. The noisy expectation-maximization algorithm. *Fluctuation and Noise Letters* 12, 03 (2013), 1350012.
 [34] Renbin Peng, Hao Chen, and Pramod K Varshney. 2009. Noise-enhanced detection of micro-calcifications in digital mammograms. *IEEE JSTSP* 3, 1 (2009), 62–73.
 [35] Pascal Pons and Matthieu Latapy. 2005. Computing communities in large networks using random walks. In *ISCI*.
 [36] Filippo Radicchi, Claudio Castellano, Federico Cecconi, Vittorio Loreto, and Domenico Parisi. 2004. Defining and identifying communities in networks. *PNAS* 101, 9 (2004).
 [37] Usha Nandini Raghavan, Réka Albert, and Soundar Kumara. 2007. Near linear time algorithm to detect community structures in large-scale networks. *Phys. Rev. E* 76, 3 (2007).
 [38] Erzsébet Ravasz, Anna Lisa Somera, Dale A Mongru, Zoltán N Oltvai, and A-L Barabási. 2002. Hierarchical organization of modularity in metabolic networks. *science* 297, 5586 (2002), 1551–1555.
 [39] Jörg Reichardt and Stefan Bornholdt. 2006. Statistical mechanics of community detection. *Phys. Rev. E* 74, 1 (2006), 016110.
 [40] Ryan A. Rossi and Nesreen K. Ahmed. 2015. The Network Data Repository with Interactive Graph Analytics and Visualization.
 [41] Jianbo Shi and Jitendra Malik. 2000. Normalized cuts and image segmentation. *Departmental Papers (CIS)* (2000), 107.
 [42] Enrico Simonotto, Massimo Riani, Charles Seife, Mark Roberts, Jennifer Twitty, and Frank Moss. 1997. Visual Perception of Stochastic Resonance. *Phys. Rev. Lett.* 78 (Feb 1997), 0. Issue 6.
 [43] Kit-Sang Tang, Kim-Fung Man, Sam Kwong, and Qun He. 1996. Genetic algorithms and their applications. *IEEE signal processing magazine* 13, 6 (1996), 22–37.
 [44] Ted C Wang and Nicolaos B Karayiannis. 1998. Detection of microcalcifications in digital mammograms using wavelets. *IEEE trans. on medical imaging* 17, 4 (1998).
 [45] R. Zafarani and H. Liu. 2009. Social Computing Data Repository. <http://socialcomputing.asu.edu>
 [46] Steeve Zozor and Pierre-Olivier Amblard. 2002. On the use of stochastic resonance in sine detection. *Signal Proc.* 82, 3 (2002).