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It is better to be semi-regular when you have a low degree

We study the algebraic connectivity for several classes of random semi-regular graphs. For large random semi-regular bipartite graphs, we explicitly compute both their algebraic connectivity and as well as the full spectrum distribution. For an integer $d \in [3, 8]$, we find families of random semi-regular graphs that have higher algebraic connectivity than a random d-regular graphs with the same number of vertices and edges. On the other hand, we show that regular graphs beat semiregular graphs when d >8. More generally, we study random semi-regular graphs whose average degree is d, not necessary an integer. This provides a natural generalization of a d-regular graph in the case of a non-integer d. We characterise their algebraic connectivity in terms of a root of a certain 6th-degree polynomial. Finally, we construct a small-world-type network of average degree 2.5 with a relatively high algebraic connectivity. We also propose some related open problems and conjectures