

# Algebraic invariants for distinguishing graphs

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## Summary

The work in [1] presents new enumeration results on the number of connected graphs up to 10 vertices for which there is at least one other graph with the same spectrum (a cospectral mate), or at least one other graph with the same Smith normal form (coinvariant mate) with respect to several matrices associated to a graph. Such data give some indication that possibly the Smith normal form of the distance Laplacian and the signless distance Laplacian matrices could be a finer invariant to distinguish graphs in cases where other algebraic invariants, such as those derived from the spectrum, fail.

On the other hand, the case study from [2] aims to improve the search engine for a database printed circuit boards in order to improve search query times. Computations that must run during query time urge being fast and not overtraining server capacities. To avoid this, the authors in [2] break down the complexity of the Graph Isomorphism problem (for the case in hand, printed circuit boards equivalence) by applying first a preprocessing method which uses graph invariants (like the degree sequence, spectrum, ...). Such preprocessing is necessary in order to run the Isomorphism test only on promising pairs of two graphs, thus reducing running times.

The main idea is that a graph invariant with high discriminating power will produce relatively few cases of pairs of non-isomorphic graphs having the same value. In this project we propose to experimentally study the discriminant power of the Smith normal form (of the distance Laplacian and signless distance Laplacian matrices) [2] in order to distinguish graphs which represents real networks.

## Details and general food for thought

- Perform a literature study on graph invariants and their discriminant power.
- Understand and include in the literature review the work in [1, 2] and Drehmer et al on the degeneracy of graph invariants.
- Implement, study and compare the discriminant power that the Smith normal form can have in practice to distinguish large graphs representing real networks.

## References

- [1] A. Abiad and C.A. Alfaro. Enumeration of cospectral and coinvariant graphs. [arXiv:2008.05786](#).
- [2] A. Abiad, A. Grigoriev and S. Niemzok. Printed Circuit Boards Isomorphism: an Experimental Study. *Computers&Industrial Engineering* 148 (2020).