Eigenvector non-orthogonality in non-Hermitian random matrices

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Abstract

Complexity of eigenvalues of non-Hermitian random matrices challenges standard techniques from free probability. Besides that, non-Hermiticity often leads to non-orthogonality of eigenvectors, which calls for new tools to study such properties.

I present a formalism for the calculation of the correlation functions, which are the local averages of the matrix of overlaps between left and right eigenvectors. It relies on the quaternionic resolvent and a Kronecker product of two quaternionic resolvent for the two-point function, generalizing nicely concepts from standard free probability. Moment expansion in the large N limit leads to the Bethe-Salpeter equations, which can be solved in full generality from the knowledge of cumulants. A very simple and general formula can be obtained for the class of biunitarily invariant ensembles, which in the large N limit are R-diagonal operators. This result generalizes the Haagerup-Larsen theorem.

Based on :

[1] S. Belinschi, M. A. Nowak, R. Speicher, W. Tarnowski *Squared eigenvalue condition numbers and eigenvector correlations from the single ring theorem* J. Phys. A : Math. Th. **50**, 105204 (2017).

[2] M. A. Nowak, W. Tarnowski *Probing non-orthogonality of eigenvectors in non-Hermitian matrix models : diagrammatic approach* preprint arXiv :1801.02526 (2018).