

# toqito – Theory of quantum information toolkit: A Python package for studying quantum information

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## Software

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## Summary

toqito is an open source library for studying various objects in quantum information, namely, states, channels, and measurements. toqito focuses on providing numerical tools to study problems pertaining to entanglement theory, nonlocal games, matrix analysis, and other aspects of quantum information that are often associated with computer science.

## Statement of Need

While there are many outstanding feature-rich Python packages to study quantum information, they are often focused on applications pertaining to physics (Johansson et al., 2013) (Killoran et al., 2019), (Steiger et al., 2018). Other excellent software offerings that are closer in scope to toqito, such as QETLAB (Johnston, 2016), are written in non-opensource languages and therefore require the users to have access to costly licenses.

toqito possesses functions for fundamental operations including the partial trace, partial transpose, and others. toqito also makes use of the cvxpy (Diamond & Boyd, 2016) convex optimization module to solve various semidefinite programs that pertain to problems arising in the study of nonlocal games, state discrimination, and other problems in quantum information. toqito provides the ability to either directly calculate or estimate the classical and quantum values of nonlocal games. toqito also provides numerous functions for performing operations on and for determining properties of quantum states, channels, and measurements. toqito provides utilities for exploring measures of entanglement and properties of entangled states. Support for generating random quantum states and measurement operators is also provided.

The toqito module is supported for Python 3.7 and makes use of many of the more modern features of the language including f-strings, type hinting, and others. toqito is available on GitHub (<https://github.com/vprusso/toqito>) and can be installed via pip (<https://pypi.org/project/toqito/>). Further information of features and uses can be found on the documentation page (<https://toqito.readthedocs.io/en/latest/>).

## Acknowledgements

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