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Major Research Interest: **Continuous Optimization**
Other Interests: **Interior-point Algorithms**
Convex Analysis

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Optimization is a major tool in various scientific, engineering and financial disciplines. Dr. Chua studies the theory of continuous optimization, and develops efficient solution methods for several types of optimization models. He has designed and analyzed interior-point algorithms for semidefinite optimization, symmetric cone optimization and homogeneous cone optimization.

Semidefinite optimization is a widely used mathematical model for numerous real-world problems such as control system design, VLSI circuit design, truss topology design, portfolio optimization, option pricing, etc. These structured convex optimization models are also used in approximating very hard combinatorial problems. This is best exemplified by the Goemans and Williamson's algorithm for approximating the maximum cut of a graph. A semidefinite optimization model was used in this algorithm to approximate the value of the maximum cut.

One of Dr. Chua's project studies the possibility of applying homogeneous cone optimization on various problems where semidefinite optimization models are used. This study is partly driven by the possible reduction in the size when semidefinite optimization models are solved as homogeneous cone optimization problems, hence allowing large-scale problems to be solved via homogeneous cone optimization. Since homogeneous cone optimization is a mathematical generalization of semidefinite optimization, they may also give better approximations to very hard combinatorial problems.

Dr. Chua also studies the application of interior-point method in solving convex conic optimization models. Interior-point method is a class of algorithms that searches the interior of the set of feasible solutions for the optimal solution. It has been used extensively to provide efficient algorithms for many classes of optimization models, including linear optimization, convex quadratic optimization and semidefinite optimization.

A fundamental object in the theory of interior-point method is the primal-dual central path. Path-following algorithms—an important sub-class of interior-point algorithms—search for optimal solutions by following central paths. Dr. Chua investigated and proved several properties of the primal-dual central paths for semidefinite optimization and homogeneous cone optimization. These properties are useful in the study of local convergence behaviour of path-following algorithms.

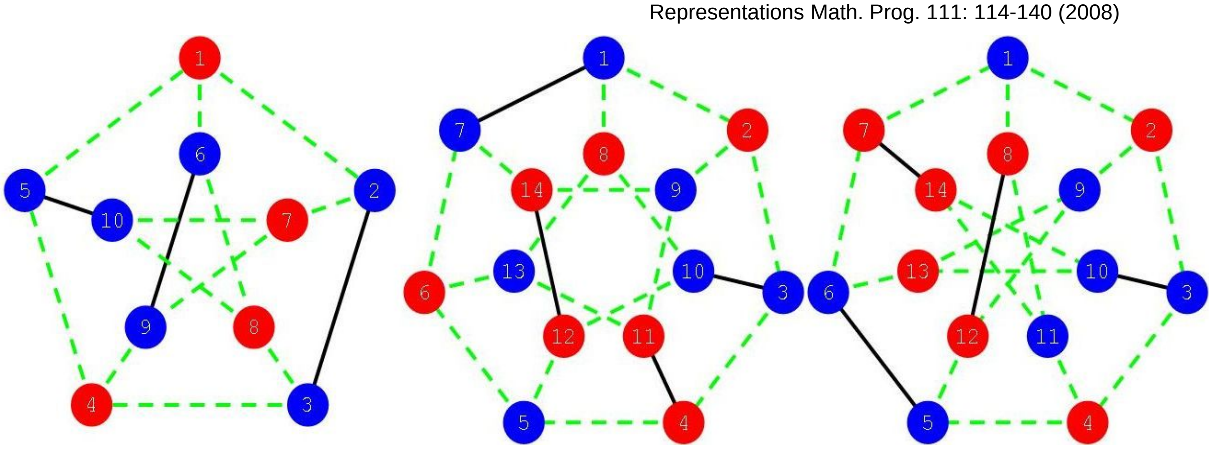
Selected Publications

Chua, C.B., Relating homogeneous cones and positive definite cones via T-algebras, SIAM J. Opt. 14:500-506 (2003)

Chua, C.B., A new notion of weighted centers for semidefinite programming, SIAM J. Opt. 16:1092-1109 (2006)

Chua, C.B., The Primal-Dual Second-Order Cone Approximations Algorithm for Symmetric Cone Programming, FoCM 7: 271-302 (2007)

Chua, C.B. and L. Tunçel, Invariance and Efficiency of Convex Representations Math. Prog. 111: 114-140 (2008)



These are examples of max-cut problems. The first graph is known as Peterson's graph. It is often used as a counter-example to conjectures in graph theory. The next two are examples of one type of generalization of Peterson's graph. For these examples, the semidefinite optimization models are tight --- solving the models gives the maximum cuts for these graphs. In each of these graphs, the nodes are grouped according to their colour. The green dashed arcs are those that contribute to the cut.