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Acknowledgements

The problem of computing a quantal correlated equilibrium is PPAD-hard.

Applications of Quantal Correlated Equilibrium

1. Content accuracy signaling (anti-missinformation)
2. Cyber-security (network defenses)
3. Trading coordination (supply chains)
4. Robust system design
& others

Comparison to BARON - Algorithm for General Optimization

Homotopy Formulation of Quantal Correlated Equilibrium

Tracing the path from uniform strategies to QCE using the system:

\[ H(k,t) = H_{QCE}(k,t) \]

For each player and uniform strategies, the homotopy towards the maximum of criterion \( f^{QCE}(\lambda) \) is upper hemicontinuous. If QCE(\( \lambda \)) is unique then \( \lambda \) is connected.

Properties of Quantal Correlated Equilibrium

1. QCE is an agent quantal response equilibrium in the extended game.
2. Any quantal response equilibrium may be extended into a QCE.
3. Let Q be a sequence of quantal response functions that approach the best response in the infinity. Then the limit quantal correlated equilibrium is a correlated equilibrium.

Advantage: Let \( q \) be exponential for each player and \( u(\cdot) \). Assume the signaller's utility is negatively correlated with other players' utilities. Then \( u(QCE) > u(QRD) \).

Topology: Let \( C = (Q, QCE) \). Then \( C \) is compact and the correspondence \( \lambda \rightarrow QCE(\lambda) \) is upper hemicontinuous. If QCE(\( \lambda \)) are unique then \( \lambda \) is connected.

Complexity: The problem of computing a quantal correlated equilibrium is PPAD-hard.

Formally defined using a generalized Luce model:

Given a continuous, increasing function \( q \), every player plays the following quantal distribution over actions:

\[ Q(u(s),X) = \sum_{x \in X} \frac{q(u(s,x))}{\sum_{y \in X} q(u(s,y))} \]

Solution concept

Quantal Correlated Equilibrium (QCE)

All players quantal-respond after receiving their private signals

\[ a_i(s_a) = \sum_{a \in A} \frac{\lambda(s_a,a_i) \delta(a_i|s_a)}{\sum_{a \in A} \lambda(s_a,a) \delta(a|s_a)} \]

\[ a_i(s_a) = \frac{q_i(s_a,a_i)}{\sum_{a \in A} q_i(s_a,a)} \]

Examples:

Quantal response equilibrium

Polytope of correlated equilibria

Optimization with criterion function \( f \)

\[ \max_{\lambda} \sum_{x \in X} f(\lambda,x) \]

Subject to : \( \sigma \in QCE(\lambda) \)

Correlation Device

Each player has a set of possible signals \( S \)

Signals are sent privately

Distribution \( \lambda \) over signal tuples is a public knowledge

Model of subrationality

Quantal Response

Suggests that players take suboptimal actions with non-zero probability

Actions with higher expected utility are chosen with higher probability

Formally defined using a generalized Luce model:

Given a continuous, increasing function \( q \), every player plays the following quantal distribution over actions:

\[ Q(u(s),X) = \sum_{x \in X} \frac{q(u(s,x))}{\sum_{y \in X} q(u(s,y))} \]

Quantal Correlated Equilibrium

in Normal Form Games

“Coordinating subrational players using a signaling device”

Jakub Černý, Bo An, Allan N. Zhang

Homotopy algorithm is faster

Homotopy algorithm is faster

Linear generator

Quadratic generator

Logarithmic generator

Exponential generator

... and provides better solutions.

Jakub is looking for a postdoc position! 15 publications — EC, AAAI, IJCAI, etc. See his other work at cernyj.github.io

Contact email: cerny@disroot.org

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