## Periodic Table of 2x2 Games

### Payoff swaps link neighboring games
- Low swaps form tiles of 4 games
- Middle swaps join tiles into 4 layers
- High swaps cross layers, bonding bands of tiles
- Layers and table (tories) wrap side-to-side & top-to-bottom
- Layers differ by alignment of best payoffs
- Payoffs from symmetric games form asymmetric games
- High swaps turn Pd into Asym Dilemma (Sh/Pd) and Stag Hunt

### Payoff Families
- Harmonious
- Win-win, 4,4
- Stag Hunt
- Biased 4,3
- Battle
- Self-serving 1,1
- Benevolent 1,2
- UNfair 4,2
- Unfair 4,2
- Inferior 3,3
- Battle-Chicken
- Dilemma 2,2
- Alibi 3,2
- Cyclic 0,0
- Indeterminate

### Symmetric Games with Ties
Games with ties lie between strict ordinal games, linked by half-swaps that make or break ties. For example, Low Battle is between Battle and Hero, and Middle Battle (Volunteer's Dilemma) is between Chicken and Battle.

### High Ties
Making high ties (and double ties) creates duplicate games, identical or equivalent by switching rows or columns.

### Zero Ties
Basic
- Basic Harmony
- Basic Dilemma
- Triple Harmony
- Triple Lock
- Double Harmony
- Double Dilemma
- Double Coord.
- Double Hero
- Double Stag
-Double Conform

### Diagram Source
- Periodic Table of 2x2 Games
  - Based on Robinson & Rothstein's 2005 The Topology of the 2x2 Games: A New Periodic Table
  - www.cs.laurentian.ca/dfoster/home.html
The Robinson-Goforth topology of payoff swaps conveniently arranges two-person two-move (2x2) games in a natural order.

**Symmetric games on the diagonal.** Games where each faces the same payoff pattern form a diagonal axis. Payoff patterns from symmetric games combine to make asymmetric games, and so can give names for games.

**Payoff swaps link games.** Starting from any strict ordinal 2x2 game (with four ranked payoffs and no ties), swaps in the lowest payoffs (1—2) generate a tile of four games. Middle swaps (2—3) start new tiles. More low and middle swaps complete a layer of nine tiles and 36 games, forming a torus that wraps top to bottom, and left to right. Swapping the highest payoffs (3—4) starts a new layer.

**Dominant strategies define quadrants.** In each layer's lower left quadrant, both players have a dominant strategy, so the other's best choice leads to an equilibrium. In the upper right quadrant, neither has a dominant strategy; with no equilibrium in pure strategies, as in cyclic games; or two equilibria, as in stag Hunts and Battles in the coordination quadrants.

**An elegant array.** Social dilemmas, including Prisoner’s Dilemma, Chicken, Battles, and Stag Hunts, form a compact connected region in the space of 2x2 games. Most games can be transformed into win-win by a single swap. Games of pure conflict, where one person’s incentives always encourage moves that make things worse for the other, negative externalities, lie on a diagonal linking the cyclic tiles, including the zero-sum (fixed rank-sum) games. Zero-sum games are farthest from win-win. Most games have mixed interests.

**Mapping payoff space.** If payoffs occur randomly, then the chart shows the expected proportions of different games. Half swaps make games with ties, between strict games. Games with payoffs normalized to a 1—4 scale map onto the topology, so the chart shows the payoff space of all normalized 2x2 games, and the adjacent possible changes in payoffs.

**Sources.** See Robinson and Goforth 2005 *The Topology of 2x2 Games: A New Periodic Table* and Bruns 2014 *Changing Games: An Atlas of Conflict and Cooperation in 2x2 Games.*