The Hawk Dove Game:

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02.06.2025 — *Game Theory (SS 2025)*

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Let's play a little game

Setup:

1. Two players compete over 2 pieces of chocolate.
2. Players are allowed to communicate for 30 seconds to 1 minute.
3. Each player simultaneously chooses between:
   - **Steal (Hawk)**
   - **Split (Dove)**

Outcomes:

- Both steal: no one gets anything.
- Both split: each gets 1 piece.
- One steals, one splits: the stealer gets both.

Game in Action

Video Example: Golden Balls ”Split or Steal”

The Hawk-Dove Game: Formal Representation

Payoff Matrix:

	Hawk	**Dove**
Hawk	$\left(\frac{V-C}{2}, \frac{V-C}{2}\right)$	$(V, 0)$
Dove	$(0, V)$	$\left(\frac{V}{2}, \frac{V}{2}\right)$

Definitions:

- V: Value of the resource
- C: Cost of conflict, with $C > V$

Equilibria:

- Nash Equilibria: (Hawk, Dove) and (Dove, Hawk)
- Pareto Efficient: All outcomes except (Hawk, Hawk)

Numerical Example: Chicken Game Form

- Interpretation as a game of chicken: mutual aggression is disastrous, but unilateral aggression pays

	Hawk	**Dove**
Hawk	$(-25, -25)$	$(50, 0)$
Dove	$(0, 50)$	$(25, 25)$

- Set $V = 50$, $C = 100$

Mixed Strategy Equilibrium

Assume:

- 50% of players choose Hawk, 50% choose Dove
- Hawk payoff: $\frac{1}{2} \cdot (-25) + \frac{1}{2} \cdot 50 = 12.5$
- Dove payoff: $\frac{1}{2} \cdot 0 + \frac{1}{2} \cdot 25 = 12.5$

Observation

If payoffs equalize, no player has an incentive to deviate. This is a mixed-strategy Nash equilibrium.
$\longrightarrow$ Why don't players always play Dove?

Evolutionary Stable Strategy (ESS)

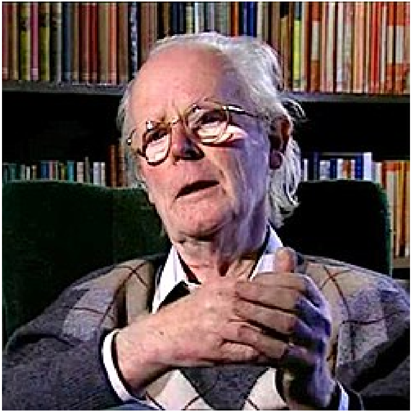
Coin Flip Strategy:

- Each individual follows a joint randomization signal (e.g., a coin toss).

Payoffs:

- Mutant using coin flip vs. population: 12.5
- Mutant vs. mutant: 25
- $\longrightarrow$ Mutant strategy spreads

History



John Maynard Smith

George R. Price

Empirical Motivation and Broader Application

Speckled Wood Butterflies:

- Males defend sunlit spots.
- 210 observed contests: incumbent won every time; fights lasted 3.7s.
- When both believed to be incumbent, fights lasted 40s.
- Selection Bias
- Suggests uncorrelated asymmetries reduce costly conflict.

Broader Interpretation:

- Ownership conventions emerge without centralized enforcement.
- Even babies exhibit respect for prior possession.
- Stable social asymmetries (e.g., rights, norms, or discriminatory systems).

Summary of Applications

- Conflict avoidance in animal behavior (ESS)
- Emergence of social conventions and norms
- Modeling systemic power imbalances and discrimination

Conclusion

The Hawk-Dove game explains both biological and societal mechanisms for avoiding destructive conflict.

Comparison: Hawk-Dove vs. Prisoner's Dilemma

Prisoner's Dilemma Payoff Matrix:

	Cooperate	**Defect**
Cooperate	(a, a)	$(c, 0)$
Defect	$(0, c)$	(b, b)

Key Differences:

- $a < b < c \quad \text{mit} \quad 2b = c$
- **Prisoner's Dilemma:** dominant strategy: Only one Nash-eq (defect, defect)
- **Hawk-Dove:** No dominant strategy; multiple Nash equilibria; inefficient outcomes depend on coordination failure.
- **Conflict Type:** PD models trust/cooperation problems; Hawk-Dove models escalation vs. deference.