

[illegible]

Social Choice: Voting Schemes

Game Theory Course:
Jackson, Leyton-Brown & Shoham

Introduction



Our setting now:

- a set of **outcomes** or **alternatives**
- agents have **preferences** over them
- the 'goal': a **social choice function**: a mapping from profiles of preferences to a particular outcome
 - Which such functions have desirable properties?

Preferences



- Given is a finite set of **outcomes** or **alternatives** O .
- agents have (strict) **preferences**, \succ , over the outcomes: linear orders (or total orders).
- Linear orders L : binary relations \succ that are total and transitive
 - total: for every pair of outcomes $a \neq b$ either $a \succ b$ or $b \succ a$ (but not both: so it is complete and antisymmetric)
 - transitive: $a \succ b$ and $b \succ c$ implies $a \succ c$.
- Non-strict preferences L_{NS} : binary relations \succeq that are complete and transitive:
 - total: for every a, b either $a \succeq b$ or $b \succeq a$ (both indicates indifference)
 - transitive: $a \succeq b$ and $b \succeq c$ implies $a \succeq c$.

Formal model



Given is a set of agents $N = \{1, 2, \dots, n\}$, a finite set of outcomes (or alternatives, or candidates) O , and the linear orders on the outcomes, L .

Definition (Social choice function)

A **social choice function** is a function $C : L_{NS}^n \mapsto O$.

Definition (Social welfare function)

A **social welfare function** (or social welfare ordering) is a function $C : L_{NS}^n \mapsto L_{NS}$.

A word cloud visualization centered around the theme of game theory. The words are arranged in various sizes and orientations, with "Game Theory" being the largest and most prominent. Other significant words include "Bayesian Normal-form auctions", "equilibrium class players", "Nash equilibria", "predator", "strategies", "zero-sum probability", "Online", "cooperative payoff utility", "paradoxes", "repeated", "tragedy of the commons", "antisocial", "rational", "action", "game theory", "dynamic games", "stochastic", "formal", "behavioral", "social choice", "mechanism design", "decision making", "information", "signaling", "coordination", "competition", "cooperation", "conflict", "communication", "learning", "evolution", "biology", "economics", "psychology", "philosophy", "law", "politics", "business", "management", "education", "medicine", "engineering", "computer science", "artificial intelligence", "robotics", "autonomous systems", "networks", "distributed computing", "multi-agent systems", "crowd sourcing", "online markets", "digital advertising", "video games", "sports", "finance", "energy", "transportation", "urban planning", "environmental policy", "climate change", "terrorism", "cybersecurity", "space exploration", "defense", "intelligence", "counterterrorism", "humanitarian aid", "disaster relief", "public health", "global development", "international relations", "diplomacy", "peacekeeping", "human rights", "gender equality", "social justice", "labor rights", "workers' movement", "civil disobedience", "protest movements", "activism", "volunteering", "community organizing", "grassroots politics", "participatory budgeting", "open source", "freemium models", "subscription services", "paywalls", "advertising revenue", "merchandise sales", "licensing", "patent law", "copyright infringement", "piracy", "plagiarism", "fraud", "scams", "phishing", "identity theft", "credit card fraud", "bankruptcy", "insolvency", "debt collection", "asset protection", "estate planning", "tax avoidance", "charitable deductions", "retirement savings", "investing", "real estate", "venture capital", "private equity", "hedge funds", "commodities trading", "cryptocurrency", "blockchain technology", "smart contracts", "digital currencies", "central banks", "monetary policy", "inflation", "deflation", "interest rates", "exchange rates", "foreign exchange", "trade agreements", "tariffs", "sanctions", "embargos", "boycotts", "strikes", "lockouts", "collective bargaining", "union representation", "labor laws", "employment contracts", "non-compete clauses", "intellectual property", "trademarks", "patents", "copyrights", "trade secrets", "know-how", "technical assistance", "consulting fees", "royalties", "franchise fees", "joint ventures", "partnerships", "corporate governance", "board of directors", "shareholders", "executive compensation", "performance metrics", "key performance indicators", "balanced scorecard", "total quality management", "lean manufacturing", "six sigma", "continuous improvement", "innovation management", "research and development", "product lifecycle management", "supply chain management", "logistics", "distribution channels", "retail strategy", "marketing mix", "brand positioning", "competitive advantage", "market research", "customer segmentation", "target marketing", "personalized marketing", "direct response", "conversion optimization", "analytics", "data mining", "machine learning", "artificial neural networks", "deep learning", "reinforcement learning", "genetic algorithms", "simulated annealing", "tabu search", "hill climbing", "greedy algorithms", "dynamic programming", "branch and bound", "integer programming", "linear programming", "quadratic programming", "convex optimization", "non-linear optimization", "metaheuristics", "swarm intelligence", "ant colony optimization", "particle swarm optimization", "genetic programming", "neural network pruning", "feature selection", "dimensionality reduction", "principal component analysis", "singular value decomposition", "matrix factorization", "recommendation systems", "collaborative filtering", "content-based filtering", "hybrid recommendation systems", "implicit feedback", "explicit feedback", "cold start problem", "sparsity problem", "scalability problem", "interpretability problem", "bias-variance tradeoff", "overfitting", "underfitting", "cross-validation", "hyperparameter tuning", "model deployment", "monitoring", "maintenance", "updates", "version control", "documentation", "testing", "debugging", "profiling", "benchmarking", "stress testing", "load testing", "performance optimization", "caching", "database indexing", "query optimization", "distributed databases", "NoSQL databases", "graph databases", "time-series databases", "data lakes", "data warehouses", "ETL processes", "data integration", "data cleansing", "data deduplication", "data archiving", "data backup", "disaster recovery", "business continuity planning", "risk management", "insurance", "hedging", "derivatives", "options trading", "futures trading", "swap trading", "structured products", "synthetic CDOs", "CDOs", "RMBS", "CMBS", "MBS", "ABS", "securitization", "special purpose vehicles", "trusts", "corporations", "limited liability companies", "partnerships", "sole proprietorships", "general partnerships", "limited partnerships", "master limited partnerships", "REITs", "mutual funds", "ETFs", "hedge funds", "private equity firms", "venture capital firms", "angel investors", "seed funding", "series A financing", "series B financing", "series C financing", "exit strategies", "IPOs", "acquisitions", "mergers", "takeovers", "hostile takeovers", "friendly takeovers", "leveraged buyouts", "management buyouts", "employee stock ownership plans", "401(k) plans", "IRA rollovers", "Roth IRAs", "traditional IRAs", "SEP IRAs", "SIMPLE IRAs", "Keogh plans", "qualified pension plans", "defined contribution plans", "defined benefit plans", "profit sharing plans", "non-qualified deferred compensation plans", "executive incentive compensation plans", "restricted stock units", "stock options", "phantom stock", "cash bonuses", "commission splits", "sales incentives", "performance bonuses", "gainsharing plans", "profit-sharing plans", "employee ownership plans", "ESOPs", "employee stock purchase plans", "401(c) plans, 408(a) plans, 409(b) plans, 529 plans, 527 plans, 501(c)(3) organizations, 501(c)(6) organizations, 501(c)(29) organizations, 501(c)(28) organizations, 501(c)(27) organizations, 501(c)(26) organizations, 501(c)(25) organizations, 501(c)(24) organizations, 501(c)(23) organizations, 501(c)(22) organizations, 501(c)(21) organizations, 501(c)(20) organizations, 501(c)(19) organizations, 501(c)(18) organizations, 501(c)(17) organizations, 501(c)(16) organizations, 501(c)(15) organizations, 501(c)(14) organizations, 501(c)(13) organizations, 501(c)(12) organizations, 501(c)(11) organizations, 501(c)(10) organizations, 501(c)(9) organizations, 501(c)(8) organizations, 501(c)(7) organizations, 501(c)(6) organizations, 501(c)(5) organizations, 501(c)(4) organizations.

- [illegible]

Voting Schemes base on Ranking

- **Plurality with elimination** (“instant runoff”, “transferable voting”)
 - everyone indicates their favorite outcome
 - if some outcome has a majority, it is the winner
 - otherwise, the outcome with the fewest votes is eliminated (may need some tie-breaking procedure)
 - repeat until there is a winner.
- **Borda Rule, Borda Count**
 - assign each outcome a number.
 - The most preferred outcome gets a score of $n - 1$, the next most preferred gets $n - 2$, down to the n^{th} outcome which gets 0.
 - Then sum the numbers for each outcome, and choose the one that has the highest score
- **Successive elimination**
 - in advance, decide an ordering of alternatives
 - everyone votes for the first or second, and the loser is eliminated



Condorcet Consistency:



If there is a candidate or outcome that is **preferred to every other candidate in pairwise majority-rule comparisons**, that candidate should be chosen.

- There is not always a Condorcet winner:
- sometimes, there is a cycle where A defeats B , B defeats C , and C defeats A , known as a Condorcet Cycle.