Glossary

Here we define the key terms that appear in the text. We aim for verbal definitions that are logically precise but not mathematical or detailed like those found in more advanced textbooks.

acceptability condition An upper bound on the probability of fulfillment in a brinkmanship threat, expressed as a function of the probability of error, showing the upper limit of risk that the player making the threat is willing to tolerate.

action node A node at which one player chooses an action from two or more that are available.

addition rule If the occurrence of *X* requires the occurrence of *any one* of several disjoint *Y*, *Z*, . . . , then the probability of *X* is the sum of the separate probabilities of *Y*, *Z*, . . .

adverse selection A form of information asymmetry where a player's type (available strategies, payoffs . . .) is his private information, not directly known to others.

agenda paradox A voting situation where the order in which alternatives are paired when voting in multiple rounds determines the final outcome.

agent The agent is the more-informed player in a principal–agent game of asymmetric information. The principal (less-informed) player in such games attempts to design a mechanism that aligns the agent's incentives with his own.

all-pay auction An auction in which each person who submits a bid must pay her highest bid amount at the end of the auction, even if she does not win the auction.

alternating offers A sequential move procedure of bargaining in which, if the offer made by one player is refused by the other, then the refuser gets the next turn to make an offer, and so on.

amendment procedure A procedure in which any amended version of a proposal must win a vote against the original version before the winning version is put to a vote against the status quo.

antiplurality method A positional voting method in which the electorate is asked to vote against one item on the slate (or to vote for all but one).

approval voting A voting method in which voters cast votes for all alternatives of which they approve.

ascending auction An open-outcry auction in which the auctioneer accepts ascending bids during the course of the auction; the highest bid wins. Also called **English auction**.

assurance game A game where each player has two strategies, say, Cooperate and Not, such that the best response of each is to Cooperate if the other cooperates, Not if not, and the outcome from (Cooperate, Cooperate) is better for both than the outcome of (Not, Not).

asymmetric information Information is said to be asymmetric in a game if some aspects of it—rules about what actions are permitted and the order of moves if any, payoffs as functions of the players strategies, outcomes of random choices by "nature," and of previous actions by the actual players in the game—are known to some of the players but are not common knowledge among all players.

babbling equilibrium In a game where communication among players (which does not affect their payoffs directly) is followed by their choices of actual strategies, a babbling equilibrium is one where the strategies are chosen ignoring the communication, and the communication at the first stage can be arbitrary.

backward induction Same as **rollback**.

battle of the sexes A game where each player has two strategies, say, Hard and Soft, such that [1] (Hard, Soft) and (Soft, Hard) are both Nash equilibria, [2] of the two Nash equilibria, each player prefers the outcome where he is Hard and the other is Soft, and [3] both prefer the Nash equilibria to the other two possibilities, (Hard, Hard) and (Soft, Soft).

Bayesian Nash equilibrium A Nash equilibrium in an asymmetric information game where players use Bayes' theorem and draw correct inferences from their observations of other players' actions.

Bayes' theorem An algebraic formula for estimating the probabilities of some underlying event by using knowledge of some consequences of it that are observed.

belief The notion held by one player about the strategy choices of the other players and used when choosing his own optimal strategy.

best alternative to a negotiated agreement (BATNA) In a bargaining game, this is the payoff a player would get from his other opportunities if the bargaining in question failed to reach an agreement.

best response The strategy that is optimal for one player, given the strategies actually played by the other players, or the belief of this player about the other players' strategy choices.

best-response analysis Finding the Nash equilibria of a game by calculating the best-response functions or curves of each player and solving them simultaneously for the strategies of all the players.

best-response curve A graph showing the best strategy of one player as a function of the strategies of the other player(s) over the entire range of those strategies.

best-response rule A function expressing the strategy that is optimal for one player, for each of the strategy combinations actually played by the other players, or the belief of this player about the other players' strategy choices.

binary method A class of voting methods in which voters choose between only two alternatives at a time.

Black's condition Same as the condition of **single-peaked preferences**.

Borda count A positional voting method in which the electorate indicates its order of preference over a slate of alternatives. The winning alternative is determined by allocating points based on an alternative's position on each ballot.

branch Each branch emerging from a node in a game tree represents one action that can be taken at that node.

brinkmanship A threat that creates a risk but not certainty of a mutually bad outcome if the other player defies your specified wish as to how he should act, and then gradually increases this risk until one player gives in or the bad outcome happens.

cheap talk equilibrium In a game where communication among players (which does not affect their payoffs directly) is followed by their choices of actual strategies, a cheap talk equilibrium is one where the strategies are chosen optimally given the players' interpretation of the communication, and the communication at the first stage is optimally chosen by calculating the actions that will ensue.

chicken A game where each player has two strategies, say Macho and Wimp, such that [1] both (Macho, Wimp) and (Wimp, Macho) are Nash equilibria, [2] of the two, each prefers the outcome where he plays Macho and the other plays Wimp, and [3] the outcome (Macho, Macho) is the worst for both.

chicken in real time A game of chicken in which the choice to swerve is not once and for all, but where a decision must be made at any time, and as time goes on while neither driver has swerved, the risk of a crash increases gradually.

coercion In this context, forcing a player to accept a lower payoff in an asymmetric equilibrium in a collective action game, while other favored players are enjoying higher payoffs. Also called **oppression** in this context.

collective action problem A problem of achieving an outcome that is best for society as a whole, when the interests of some or all individuals will lead them to a different outcome as the equilibrium of a noncooperative game.

commitment An action taken at a pregame stage, stating what action you would take unconditionally in the game to follow.

common value An auction is called a common-value auction when the object up for sale has the same value to all bidders, but each bidder knows only an imprecise estimate of that value. Also called **objective value**.

compellence An attempt to induce the other player(s) to act to change the status quo in a specified manner.

compound interest When an investment goes on for more than one period, compound interest entails calculating interest in any one period on the whole accumulation up to that point, including not only the principal initially invested but also the interest earned in all previous periods, which itself involves compounding over the period previous to that.

Condorcet method A voting method in which the winning alternative must beat each of the other alternatives in a round-robin of pairwise contests.

Condorcet paradox Even if all individual voter preference orderings are transitive, there is no guarantee that the social preference ordering generated by Condorcet's voting method will also be transitive.

Condorcet terms A set of ballots that would generate the Condorcet paradox and that should together logically produce a tied vote among three possible alternatives. In a three-candidate election among A, B, and C, the Condorcet terms are three ballots that show A preferred to B preferred to C; B preferred to C preferred to A; C preferred to A preferred to B.

Condorcet winner The alternative that wins an election run using the **Condorcet method**.

constant-sum game A game in which the sum of all players' payoffs is a constant, the same for all their strategy combinations. Thus, there is a strict conflict of interests among the players—a higher payoff to one must mean a lower payoff to the collectivity of all the other players. If the payoff scales can be adjusted to make this constant equal to zero, then we have a **zero-sum game**.

contingent strategy In repeated play, a plan of action that depends on other players' actions in previous plays. (This is implicit in the definition of a strategy; the adjective "contingent" merely reminds and emphasizes.)

continuation The continuation of a strategy from a (noninitial) node is the remaining part of the plan of action of that strategy, applicable to the subgame that starts at this node.

continuous distribution A probability distribution in which the random variables may take on a continuous range of values.

continuous strategy A choice over a continuous range of real numbers available to a player.

contract In this context, a way of achieving credibility for one's strategic move by entering into a legal obligation to perform the committed, threatened, or promised action in the specified contingency.

convention A mode of behavior that finds automatic acceptance as a focal point, because it is in each individual's interest to follow it when others are expected to follow it too (so the game is of the assurance type). Also called **custom**.

convergence of expectations A situation where the players in a noncooperative game can develop a common understanding of the strategies they expect will be chosen.

cooperative game A game in which the players decide and implement their strategy choices jointly, or where joint-action agreements are directly and collectively enforced.

coordination game A game with multiple Nash equilibria, where the players are unanimous about the relative merits of the equilibria, and prefer any equilibrium to any of the nonequilibrium possibilities. Their actions must somehow be coordinated to achieve the preferred equilibrium as the outcome.

Copeland index An index measuring an alternative's record in a round-robin of contests where different numbers of points are allocated for wins, ties, and losses.

credibility A strategy is credible if its continuation at all nodes, on or off the equilibrium path, is optimal for the subgame that starts at that node.

custom Same as **convention**.

decay Shrinkage over time of the total surplus available to be split between the bargainers, if they fail to reach an agreement for some length of time during the process of their bargaining.

decision An action situation in a passive environment where a person can choose without concern for the reactions or responses of others.

decision node A decision node in a decision or game tree represents a point in a game where an action is taken.

decision tree Representation of a sequential decision problem facing one person, shown using nodes, branches, terminal nodes, and their associated payoffs.

descending auction An open-outcry auction in which the auctioneer announces possible prices in descending order. The first person to accept the announced price makes her bid and wins the auction. Also called **Dutch auction**.

deterrence An attempt to induce the other player(s) to act to maintain the status quo.

diffusion of responsibility A situation where action by one or a few members of a large group would suffice to bring about an outcome that all regard as desirable, but each thinks it is someone else's responsibility to take this action.

discount factor In a repeated game, the fraction by which the next period's payoffs are multiplied to make them comparable with this period's payoffs.

discrete distribution A probability distribution in which the random variables may take on only a discrete set of values such as integers.

disjoint Events are said to be disjoint if two or more of them cannot occur simultaneously.

distribution function A function that indicates the probability that a variable takes on a value less than or equal to some number.

dominance solvable A game where iterated elimination of dominated strategies leaves a unique outcome, or just one strategy for each player.

dominant strategy A strategy X is dominant for a player if, for each permissible strategy configuration of the other players, X gives him a higher payoff than any of his other strategies. (That is, his best-response function is constant and equal to X.)

dominated strategy A strategy X is dominated for a player if there is another strategy Y such that, for each permissible strategy configuration of the other players, Y gives him a higher payoff than X.

doomsday device An automaton that will under specified circumstances generate an outcome that is very bad for all players. Used for giving credibility to a severe threat.

Dutch auction Same as a **descending auction**.

effectiveness condition A lower bound on the probability of fulfillment in a brinkmanship threat, expressed as a function of the probability of error, showing the lower limit of risk that will induce the threatened player to comply with the wishes of the threatener.

effective rate of return Rate of return corrected for the probability of noncontinuation of an investment to the next period.

efficient frontier This is the northeast boundary of the set of feasible payoffs of the players, such that in a bargaining game it is not possible to increase the payoff of one person without lowering that of another.

efficient outcome An outcome of a bargaining game is called efficient if there is no feasible alternative that would leave one bargainer with a higher payoff without reducing the payoff of the other.

English auction Same as an **ascending auction**.

equilibrium A configuration of strategies where each player's strategy is his best response to the strategies of all the other players.

equilibrium path of play The **path of play** actually followed when players choose their rollback equilibrium strategies in a sequential game.

evolutionary game A situation where the strategy of each player in a population is fixed genetically, and strategies that yield higher payoffs in random matches with others from the same population reproduce faster than those with lower payoffs.

evolutionary stable A population is evolutionary stable if it cannot be successfully invaded by a new mutant phenotype.

evolutionary stable strategy (ESS) A phenotype or strategy that can persist in a population, in the sense that all the members of a population or species are of that type; the population is evolutionary stable (static criterion). Or, starting from an arbitrary distribution of phenotypes in the population, the process of selection will converge to this strategy (dynamic criterion).

expected payoff The probability-weighted average (statistical mean or expectation) of the payoffs of one player in a game, corresponding to all possible realizations of a random choice of nature or mixed strategies of the players.

expected utility The probability-weighted average (statistical mean or expectation) of the utility of a person, corresponding to all possible realizations of a random choice of nature or mixed strategies of the players in a game.

expected value The probability-weighted average of the outcomes of a random variable, that is, its statistical mean or expectation.

extensive form Representation of a game by a game tree.

external effect When one person's action alters the payoff of another person or persons. The effect or spillover is **positive** if one's action raises others' payoffs (for example, network effects) and **negative** if it lowers others' payoffs (for example, pollution or congestion). Also called **externality** or **spillover**.

externality Same as **external effect**.

external uncertainty A player's uncertainty about external circumstances such as the weather or product quality.

first-mover advantage This exists in a game if, considering a hypothetical choice between moving first and moving second, a player would choose the former.

first-price auction An auction in which the highest bidder wins and pays the amount of her bid.

fitness The expected payoff of a phenotype in its games against randomly chosen opponents from the population.

focal point A configuration of strategies for the players in a game, which emerges as the outcome because of the convergence of the players' expectations on it.

free rider A player in a collective-action game who intends to benefit from the positive externality generated by others' efforts without contributing any effort of his own.

game An action situation where there are two or more mutually aware players, and the outcome for each depends on the actions of all.

game matrix A spreadsheetlike table whose dimension equals the number of players in the game; the strategies available to each player are arrayed along one of the dimensions (row, column, page, . . .); and each cell shows the payoffs of all the players in a specified order, corresponding to the configuration of strategies that yield that cell. Also called **game table** or **payoff table**.

game table Same as **game matrix**.

game tree Representation of a game in the form of nodes, branches, and terminal nodes and their associated payoffs.

genotype A gene or a complex of genes, which give rise to a phenotype and which can breed true from one generation to another. (In social or economic games, the process of breeding can be interpreted in the more general sense of teaching or learning.)

Gibbard–Satterthwaite theorem With three or more alternatives to consider, the only voting method that prevents strategic voting is dictatorship; one person is identified as the dictator and her preferences determine the outcome.

gradual escalation of the risk of mutual harm A situation where the probability of having to carry out the threatened action in a probabilistic threat increases over time, the longer the opponent refuses to comply with what the threat is trying to achieve.

grim strategy A strategy of noncooperation forever in the future, if the opponent is found to have cheated even once. Used as a threat of punishment in an attempt to sustain cooperation.

hawk–dove game An evolutionary game where members of the same species or population can breed to follow one of two strategies, Hawk and Dove, and depending on the payoffs, the game between a pair of randomly chosen members can be either a prisoners' dilemma or chicken.

histogram A bar chart; data are illustrated by way of bars of a given height (or length).

impatience Preference for receiving payoffs earlier rather than later. Quantitatively measured by the discount factor.

imperfect information A game is said to have perfect information if each player, at each point where it is his turn to act, knows the full history of the game up to that point, including the results of any random actions taken by nature or previous actions of other players in the game, including pure actions as well as the actual outcomes of any mixed strategies they may play. Otherwise, the game is said to have imperfect information.

impossibility theorem A theorem that indicates that no preference aggregation method can satisfy the six critical principles identified by Kenneth Arrow.

incentive-compatibility condition (constraint) A constraint on an incentive scheme or screening device that makes it optimal for the agent (more-informed player) of each type to reveal his true type through his actions.

independent events Events Y and Z are independent if the actual occurrence of one does not change the probability of the other occurring. That is, the conditional probability of Y occurring given that Z has occurred is the same as the ordinary or unconditional probability of Y.

infinite horizon A repeated decision or game situation that has no definite end at a fixed finite time.

information set A set of nodes among which a player is unable to distinguish when taking an action. Thus, his strategies are restricted by the condition that he should choose the same action at all points of an information set. For this, it is essential that all the nodes in an information set have the same player designated to act, with the same number and similarly labeled branches emanating from each of these nodes.

initial node The starting point of a sequential-move game. (Also called the **root** of the tree.)

instant runoff Same as **single transferable vote**.

intermediate valuation function A rule assigning payoffs to nonterminal nodes in a game. In many complex games, this must be based on knowledge or experience of playing similar games, instead of explicit rollback analysis.

internalize the externality To offer an individual a reward for the external benefits he conveys on the rest of society, or to inflict a penalty for the external costs he imposes on the rest, so as to bring his private incentives in line with social optimality.

intransitive ordering A preference ordering that cycles and is not **transitive**. For example, a preference ordering over three alternatives A, B, and C is intransitive if A is preferred to B and B is preferred to C but it is not true that A is preferred to C.

invasion by a mutant The appearance of a small proportion of mutants in the population.

irreversible action An action that cannot be undone by a later action. Together with observability, this is an important condition for a game to be sequential-move.

iterated elimination of dominated strategies Considering the players in turns and repeating the process in rotation, eliminating all strategies that are dominated for one at a time, and continuing doing so until no such further elimination is possible.

leadership In a prisoners' dilemma with asymmetric players, this is a situation where a large player chooses to cooperate even though he knows that the smaller players will cheat.

locked in A situation where the players persist in a Nash equilibrium that is worse for everyone than another Nash equilibrium.

majority rule A voting method in which the winning alternative is the one that garners a majority (more than 50%) of the votes.

majority runoff A two-stage voting method in which a second round of voting ensues if no alternative receives a majority in the first round. The top two vote-getters are paired in the second round of voting to determine a winner.

marginal private gain The change in an individual's own payoff as a result of a small change in a continuous-strategy variable that is at his disposal.

marginal social gain The change in the aggregate social payoff as a result of a small change in a continuous-strategy variable chosen by one player.

mechanism design Mechanism design is the process by which a principal in a principal–agent problem devises the rules of their game to provide optimal (from the principal's perspective) incentives for the agent.

median voter The voter in the middle—at the 50th percentile—of a distribution.

median voter theorem If the political spectrum is one-dimensional and every voter has single-peaked preferences, then [1] the policy most preferred by the median voter will be the Condorcet winner, and [2] power-seeking politicians in a two-candidate election will choose platforms that converge to the position most preferred by the median voter. (This is also known as the **principle of minimum differentiation**.)

mixed method A multistage voting method that uses plurative and binary votes in different rounds.

mixed strategy A mixed strategy for a player consists of a random choice, to be made with specified probabilities, from his originally specified pure strategies.

monomorphism All members of a given species or population exhibit the same behavior pattern.

moral hazard A situation of information asymmetry where one player's actions are not directly observable to others.

move An action at one node of a game tree.

multiplication rule If the occurrence of X requires the simultaneous occurrence of *all* the several independent $Y, Z, \ldots$, then the probability of X is the *product* of the separate probabilities of $Y, Z, \ldots$

multistage procedure A voting procedure in which there are multiple rounds of voting. Also called **rounds**.

mutation Emergence of a new genotype.

Nash cooperative solution This outcome splits the bargainers' surpluses in proportion to their bargaining powers.

Nash equilibrium A configuration of strategies (one for each player) such that each player's strategy is best for him, given those of the other players. (Can be in pure or mixed strategies.)

negatively correlated Two random variables are said to be negatively correlated if, as a matter of probabilistic average, when one is above its expected value, the other is below its expected value.

neutral ESS An evolutionary stable strategy (ESS) that persists in a population but that can coexist with a small number of mutants having the same fitness as the predominant type.

never a best response A strategy is never a best response for a player if, for each list of strategies that the other players choose (or for each list of strategies that this player believes the others are choosing), some other strategy is this player's best response. (The other strategy can be different for different lists of strategies of the other players.)

node This is a point from which branches emerge, or where a branch terminates, in a decision or game tree.

noncooperative game A game where each player chooses and implements his action individually, without any joint-action agreements directly enforced by other players.

nonexcludable benefits Benefits that are available to each individual, regardless of whether he has paid the costs that are necessary to secure the benefits.

nonrival benefits Benefits whose enjoyment by one person does not detract anything from another person's enjoyment of the same benefits.

norm A pattern of behavior that is established in society by a process of education or culture, to the point that a person who behaves differently experiences a negative psychic payoff.

normal distribution A commonly used statistical distribution for which the **distribution function** looks like a bell-shaped curve.

normal form Representation of a game in a game matrix, showing the strategies (which may be numerous and complicated if the game has several moves) available to each player along a separate dimension (row, column, etc.) of the matrix and the outcomes and payoffs in the multidimensional cells. Also called **strategic form**.

objective value Same as **common value**.

observable action An action that other players know you have taken before they make their responding actions. Together with irreversibility, this is an important condition for a game to be sequential-move.

off-equilibrium path A path of play that does not result from the players' choices of strategies in a subgame-perfect equilibrium.

off-equilibrium subgame A subgame starting at a node that does not lie on the equilibrium path of play.

open outcry An auction mechanism in which bids are made openly for all to hear or see.

opponent's indifference property An equilibrium mixed strategy of one player in a two-person game has to be such that the other player is indifferent among all the pure strategies that are actually used in his mixture.

oppression In this context, same as **coercion**.

pairwise voting A voting method in which only two alternatives are considered at the same time.

partially revealing equilibrium A perfect Bayesian equilibrium in a game of incomplete information, where the actions in the equilibrium convey some additional information about the players' types, but some ambiguity about these types remains. Also called **semiseparating equilibrium**.

participation condition (constraint) A constraint on an incentive scheme or a screening device that should give the more-informed player an expected payoff at least as high as he can get outside this relationship.

path of play A route through the game tree (linking a succession of nodes and branches) that results from a configuration of strategies for the players that are within the rules of the game. (See also **equilibrium path of play**.)

payoff The objective, usually numerical, that a player in a game aims to maximize.

payoff table Same as **game matrix**.

penalty We reserve this term for one-time costs (such as fines) introduced into a game to induce the players to take actions that are in their joint interests.

perfect Bayesian equilibrium (PBE) An equilibrium where each player's strategy is optimal at all nodes given his beliefs, and beliefs at each node are updated using Bayes' rule in the light of the information available at that point including other players' past actions.

perfect information A game is said to have perfect information if players face neither strategic nor external uncertainty.

phenotype A specific behavior or strategy, determined by one or more genes. (In social or economic games, this can be interpreted more generally as a customary strategy or a rule of thumb.)

playing the field A many-player evolutionary game where all animals in the group are playing simultaneously, instead of being matched in pairs for two-player games.

pluralistic ignorance A situation of collective action where no individual knows for sure what action is needed, so everyone takes the cue from other people's actions or inaction, possibly resulting in persistence of wrong choices.

plurality rule A voting method in which two or more alternatives are considered simultaneously and the winning alternative is the one that garners the largest number of votes; the winner needs only gain more votes than each of the other alternatives and does not need 50% of the vote as would be true in **majority rule**.

plurative method Any voting method that allows voters to consider a slate of three or more alternatives simultaneously.

polymorphism An evolutionary stable equilibrium in which different behavior forms or phenotypes are exhibited by subsets of members of an otherwise identical population.

pooling equilibrium A perfect Bayesian equilibrium in a game of asymmetric information, where the actions in the equilibrium cannot be used to distinguish type.

pooling of types An outcome of a signaling or screening game in which different types follow the same strategy and get the same payoffs, so types cannot be distinguished by observing actions.

positional method A voting method that determines the identity of the winning alternative using information on the position of alternatives on a voter's ballot to assign points used when tallying ballots.

positive feedback When one person's action increases the payoff of another person or persons taking the same action, thus increasing their incentive to take that action too.

positively correlated Two random variables are said to be positively correlated if, as a matter of probabilistic average, when one is above its expected value, the other is also above its expected value, and vice versa.

present value (PV) The total payoff over time, calculated by summing the payoffs at different periods each multiplied by the appropriate discount factor to make them all comparable with the initial period's payoffs.

price discrimination Perfect, or first-degree, price discrimination occurs when a firm charges each customer an individualized price based on willingness to pay. In general, price discrimination refers to situations in which a firm charges different prices to different customers for the same product.

primary criterion Comparison of the fitness of a mutant with that of a member of the dominant population, when each plays against a member of the dominant population.

principal The principal is the less-informed player in a principal–agent game of asymmetric information. The principal in such games wants to design a mechanism that creates incentives for the more-informed player (agent) to take actions beneficial to the principal.

principal–agent (agency) problem A situation in which the less-informed player (principal) wants to design a mechanism that creates incentives for the more-informed player (agent) to take actions beneficial to himself (the principal).

principle of minimum differentiation Same as part [2] of the **median voter theorem**.

prisoners' dilemma A game where each player has two strategies, say Cooperate and Defect, such that [1] for each player, Defect dominates Cooperate, and [2] the outcome (Defect, Defect) is worse for both than the outcome (Cooperate, Cooperate).

private value A bidder's individual valuation of an object available at auction. Also called **subjective value**.

probabilistic threat A strategic move in the nature of a threat, but with the added qualification that if the event triggering the threat (the opponent's action in the case of deterrence or inaction in the case of compellence) comes about, a chance mechanism is set in motion, and if its outcome so dictates, the threatened action is carried out. The nature of this mechanism and the probability with which it will call for the threatened action must both constitute prior commitments.

probability The probability of a random event is a quantitative measure of the likelihood of its occurrence. For events that can be observed in repeated trials, it is the long-run frequency with which it occurs. For unique events or other situations where uncertainty may be in the mind of a person, other measures are constructed, such as subjective probability.

promise An action by one player, say A, in a pregame stage, establishing a response rule that, if the other player B chooses an action specified by A, then A will respond with a specified action that is costly to A and rewards B (gives him a higher payoff). (For this to be feasible, A must have the ability to move second in the actual game.)

proportional representation This voting system requires that the number of seats in a legislature be allocated in proportion to each party's share of the popular vote.

proxy bidding A process by which a bidder submits her maximum bid (**reservation price**) for an item up for auction and a third party takes over bidding for her; the third party bids only the minimum increment above any existing bids and bids no higher than the bidder's specified maximum.

prune To use rollback analysis to identify and eliminate from a game tree those branches that will not be chosen when the game is rationally played.

punishment We reserve this term for costs that can be inflicted on a player in the context of a repeated relationship (often involving termination of the relationship) to induce him to take actions that are in the joint interests of all players.

pure coordination game A coordination game where the payoffs of each player are the same in all the Nash equilibria. Thus, all players are indifferent among all the Nash equilibria, and coordination is needed only to ensure avoidance of a nonequilibrium outcome.

pure public good A good or facility that benefits all members of a group, when these benefits cannot be excluded from a member who has not contributed efforts or money to the provision of the good, and the enjoyment of the benefits by one person does not significantly detract from their simultaneous enjoyment by others.

pure strategy A rule or plan of action for a player that specifies without any ambiguity or randomness the action to take in each contingency or at each node where it is that player's turn to act.

quantal-response equilibrium (QRE) Solution concept that allows for the possibility that players make errors, with the probability of a given error smaller for more costly mistakes.

rank-choice voting Another name for **single transferable vote**.

rational behavior Perfectly calculating pursuit of a complete and internally consistent objective (payoff) function.

rational irrationality Adopting a strategy that is not optimal after the fact, but serves a rational strategic purpose of lending credibility to a threat or a promise.

rationalizability A solution concept for a game. A list of strategies, one for each player, is a rationalizable outcome of the game if each strategy in the list is rationalizable for the player choosing it.

rationalizable A strategy is called rationalizable for a player if it is his optimal choice given some belief about what (pure or mixed strategy) the other player(s) would choose, provided this belief is formed recognizing that the other players are making similar calculations and forming beliefs in the same way. (This concept is more general than that of the Nash equilibrium and yields outcomes that can be justified on the basis only of the players' common knowledge of rationality.)

refinement A restriction that narrows down possible outcomes when multiple Nash equilibria exist.

repeated play A situation where a one-time game is played repeatedly in successive periods. Thus, the complete game is mixed, with a sequence of simultaneous-move games.

reputation Relying on the effect on payoffs in future or related games to make threats or promises credible, when they would not have been credible in a one-off or isolated game.

reservation price The maximum amount that a bidder is willing to pay for an item.

reserve price The minimum price set by the seller of an item up for auction; if no bids exceed the reserve, the item is not sold.

response rule A rule that specifies how you will act in response to various actions of other players.

reversal paradox This paradox arises in an election with at least four alternatives when one of these is removed from consideration after votes have been submitted and the removal changes the identity of the winning alternative.

reversal terms A set of ballots that would generate the **reversal paradox** and that should together logically produce a tied vote between a pair of alternatives. In a three-candidate election among A, B, and C, the reversal terms are two ballots that show a reversal in the location of a pair of alternatives. For example, one ballot with A preferred to B preferred to C and another with B preferred to A preferred to C should produce a tie between A and B.

risk-averse A decision maker (or a player in a game) is called risk-averse if he prefers to replace a lottery of monetary amounts by the expected monetary value of the same lottery, but now received with certainty.

risk-neutral A decision maker (or a player in a game) is called risk-neutral if he is indifferent between a lottery of monetary amounts and the expected monetary value of the same lottery, but now received with certainty.

robustness A measure of the number of sets of voter preference orderings that are nondictatorial, satisfy independence of irrelevant alternatives and the Pareto property, and also produce a transitive **social ranking**.

rollback Analyzing the choices that rational players will make at all nodes of a game, starting at the terminal nodes and working backward to the initial node.

rollback equilibrium The strategies (complete plans of action) for each player that remain after rollback analysis has been used to prune all the branches that can be pruned.

root Same as **initial node**.

rounds A voting situation in which votes take place in several stages. Also called **multistage**.

salami tactics A method of defusing threats by taking a succession of actions, each sufficiently small to make it nonoptimal for the other player to carry out his threat.

sanction Punishment approved by society and inflicted by others on a member who violates an accepted pattern of behavior.

screening Strategy of a less-informed player to elicit information credibly from a more-informed player.

screening devices Methods used for screening.

sealed bid An auction mechanism in which bids are submitted privately in advance of a specified deadline, often in sealed envelopes.

secondary criterion Comparison of the fitness of a mutant with that of a member of the dominant population, when each plays against a mutant.

second-mover advantage A game has this if, considering a hypothetical choice between moving first and moving second, a player would choose the latter.

second-price auction An auction in which the highest bidder wins the auction but pays a price equal to the value of the second-highest bid; also called a **Vickrey auction**.

selection The dynamic process by which the proportion of fitter phenotypes in a population increases from one generation to the next.

self-selection Where different types respond differently to a screening device, thereby revealing their type through their own action.

semiseparating equilibrium Same as **partially revealing equilibrium**.

separating equilibrium A perfect Bayesian equilibrium in a game of asymmetric information, where the actions in the equilibrium reveal player type.

separation of types An outcome of a signaling or screening game in which different types follow different strategies and get the different payoffs, so types can be identified by observing actions.

sequential moves The moves in a game are sequential if the rules of the game specify a strict order such that at each action node only one player takes an action, with knowledge of the actions taken (by others or himself) at previous nodes.

shading A strategy in which bidders bid slightly below their true valuation of an object.

shilling A practice used by sellers at auction by which they plant false bids for an object they are selling.

signaling Strategy of a more-informed player to convey his "good" information credibly to a less-informed player.

signal jamming A situation in a signaling game where an informed player of a "bad" type mimics the strategy of a "good" type, thereby preventing separation or achieving pooling. This term is used particularly if the action in question is a mixed strategy.

signals Devices used for signaling.

simultaneous moves The moves in a game are simultaneous if each player must take his action without knowledge of the choices of others.

sincere voting Voting at each point for the alternative that you like best among the ones available at that point, regardless of the eventual outcome.

single-peaked preferences A preference ordering in which alternatives under consideration can be ordered along some specific dimension and each voter has a single ideal or most-preferred alternative with alternatives farther away from the most-preferred point providing steadily lower payoffs.

single transferable vote A voting method in which each voter indicates her preference ordering over all candidates on a single initial ballot. If no alternative receives a majority of all first-place votes, the bottom-ranked alternative is eliminated and all first-place votes for that candidate are "transferred" to the candidate listed second on those ballots; this process continues until a majority winner emerges. Also called **instant runoff** or **rank-choice voting**.

social optimum In a collective-action game where payoffs of different players can be meaningfully added together, the social optimum is achieved when the sum total of the players' payoffs is maximized.

social ranking The preference ordering of a group of voters that arises from aggregating the preferences of each member of the group.

spillover effect Same as **external effect**.

spoiler Refers to a third candidate who enters a two-candidate race and reduces the chances that the leading candidate actually wins the election.

strategic form Same as **normal form**.

strategic game See **game**.

strategic misrepresentation of preferences Refers to strategic behavior of voters when they use rollback to determine that they can achieve a better outcome for themselves by not voting strictly according to their preference orderings.

strategic moves Actions taken at a pregame stage that change the strategies or the payoffs of the subsequent game (thereby changing its outcome in favor of the player[s] making these moves).

strategic uncertainty A player's uncertainty about an opponent's moves made in the past or made at the same time as her own.

strategic voting Voting in conformity with your optimal rational strategy found by doing rollback analysis on the game tree of the voting procedure.

strategy A complete plan of action for a player in a game, specifying the action he would take at all nodes where it is his turn to act according to the rules of the game (whether these nodes are on or off the equilibrium path of play). If two or more nodes are grouped into one information set, then the specified action must be the same at all these nodes.

subgame A game comprising a portion or remnant of a larger game, starting at a noninitial node of the larger game.

subgame-perfect equilibrium (SPE) A configuration of strategies (complete plans of action) such that their continuation in any subgame remains optimal (part of a rollback equilibrium), whether that subgame is on- or off-equilibrium. This ensures credibility of all the strategies.

subjective value Same as **private value**.

successive elimination of dominated strategies Same as **iterated elimination of dominated strategies**.

surplus A player's surplus in a bargaining game is the excess of his payoff over his BATNA.

terminal node This represents an end point in a game tree, where the rules of the game allow no further moves, and payoffs for each player are realized.

threat An action by one player, say, A, in a pregame stage, establishing a response rule that, if the other player B chooses an action specified by A, then A will respond with a specified action that is damaging to B (gives him a lower payoff) and also costly to A to carry out after the fact. (For this to be possible, A must have the ability to be the second mover in the actual game.)

tit-for-tat (TFT) In a repeated prisoners' dilemma, this is the strategy of [1] cooperating on the first play and [2] thereafter doing each period what the other player did the previous period.

transitive ordering A preference ordering for which it is true that if option A is preferred to B and B is preferred to C, then A is also preferred to C.

trigger strategy In a repeated game, this strategy cooperates until and unless a rival chooses to defect, and then switches to noncooperation for a specified period.

type Players who possess different private information in a game of asymmetric information are said to be of different types.

ultimatum game A form of bargaining where one player makes an offer of a particular split of the total available surplus, and the other has only the all-or-nothing choice of accepting the offer or letting the game end without agreement, when both get zero surplus.

uniform distribution A common statistical distribution in which the **distribution function** is horizontal; data are distributed uniformly at each location along the range of possible values.

utility function In this context, a nonlinear scaling of monetary winnings or losses, such that its expected value (the expected utility) accurately captures a person's attitudes toward risk.

variable-threat bargaining A two-stage game where at the first stage you can take an action that will alter the BATNAs of both bargainers (within certain limits), and at the second stage bargaining results in the Nash solution on the basis of these BATNAs.

Vickrey auction Same as **sealed bid** auction.

Vickrey's truth serum Our name for the result that, in a second-price, sealed bid auction, it is every bidder's dominant strategy to bid her true valuation.

winner's curse A situation in a common-value auction where, although each person may make an unbiased estimate of the value, only the one with the highest estimate will bid high and win the object and is therefore likely to have made an upward-biased (too high) estimate. A rational calculation of your bidding strategy will take this into account and lower your bid appropriately to counter this effect.

Yankee auction An auction in which multiple units of a particular item are available for sale; bidders can bid on one or more units at the same time.

zero-sum game A game where the sum of the payoffs of all players equals zero for every configuration of their strategy choices. (This is a special case of a **constant-sum game**, but in practice no different because adding a constant to all the payoff numbers of any one player makes no difference to his choices.)