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ORIGINAL ARTICLE

Negotiation processes: an integrated perspective

Rudolf Vetschera

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Abstract The paper provides a comprehensive survey of process models of negotiations. We consider models of the substantive process of offer exchange, as well as models focusing on communication content in negotiations, both at the level of individual actions and interactions, and at more aggregate levels. These different models are integrated into a comprehensive framework, and open areas for research are identified.

Keywords Negotiation · Process · Offers · Communication

Introduction

Negotiations are a ubiquitous activity, which takes place in many areas of professional as well as private lives, "from relations of children on the playground to international relations" (Carnevale and Pruitt 1992, p. 532) and thus "everybody negotiates" (Young 1991, p. 1). Negotiation can be defined as "a process in which two or more independent, concerned parties may make a collective choice, or may make no choice at all" (Kilgour and Eden 2010, p. 2).

Negotiations are one means of resolving conflicts. They are not the only method for conflict resolution, conflicts could also be resolved by the use of force, or through arbitration by some higher level of authority. In contrast to the two (often undesirable) alternatives, negotiation relies solely on the parties involved, and their ability to reach an agreement which is acceptable to all of them. There is nothing like a "unilateral negotiation". Consequently, negotiators (and researchers studying

R. Vetschera (✉)
Department of Business Administration, University of Vienna, Bruenner Strasse 72, 1210 Vienna, Austria
e-mail: rudolf.vetschera@univie.ac.at

negotiations) have to deal with the inherent complexity of human nature and human behavior. Even a negotiator who intends to behave completely rational and in some sense optimal cannot realistically presume that his or her opponents will always act in a similar way. Therefore, negotiation research (in particular if it aims at supporting negotiators) typically takes what Raiffa (1982) has called a dual prescriptive—descriptive perspective: on one hand, support to increase the rationality of the supported negotiator can build on prescriptive theories like decision analysis or game theory, on the other hand prediction of the opponents' behavior must be based on insights about actual human behavior (Bazerman and Neale 1991; Sebenius 1992; Malhotra and Bazerman 2008). Research on negotiation therefore integrates results from economics, decision analysis and operations research on one hand with results from (social) psychology, sociology and related disciplines on the other hand.

The multidimensionality of negotiations is reflected in the actions negotiators take during the process. On one hand, a negotiation can be viewed as an exchange of offers, and offers can be seen as the core of any negotiation (Tutzauer 1992). On the other hand, negotiators do much more than just make offers: they try to influence their counterparts' perceptions of the problem, the offers they are making, and even themselves, sometimes by "sweet talking" them into taking a certain perspective, sometimes by outright threats. Apart from the substantive dimension involved in the resolution of those issues about which the parties have a conflict, negotiations also have a relationship dimension which determines the climate between parties for the ongoing negotiation, and perhaps also for future interactions (Curhan et al. 2010). Although this distinction has sometimes been addressed in literature, using different labels like, e.g., "task domain" vs. "relationship domain" (Olekalns and Weingart 2003), most existing literature focuses exclusively on one dimension. The main aim of this paper is to provide a comprehensive overview of models from both perspectives. In line with current negotiation research, we focus on different views of the process by which negotiators reach an outcome (which might be an agreement or not). A large part of the variance found in negotiation outcomes can only be explained by processes, and not by context or initial conditions (Olekalns and Weingart 2008).

Negotiations thus involve both a prescriptive and a descriptive dimension, and a substantive as well as relationship-oriented dimension. They can also be viewed both from an individual and from a group perspective, and important processes occur at both levels. On one hand, negotiation is defined as a collective decision process. As there is no unilateral negotiation, there is also no unilateral agreement at the end of a negotiation (although each party can, on its own, unilaterally terminate a negotiation in disagreement). A negotiation can therefore be seen as a process at the group level, in which the parties mutually influence each other and which, in successful negotiations, converges toward some point of agreement. On the other hand, each move being made during this process is the result of a decision of one negotiator, and thus of an individual decision process. Individual decision processes thus shape the process at the group level and factors influencing the quality of individual decisions, like cognitive biases individuals might have (Tversky and Kahneman 1974) will influence the group process and its outcomes.

In the present paper, we will use this dichotomy of negotiations as collective decision processes on one hand, and negotiation processes as the outcome of individual decision processes on the other hand, to structure our survey of research on negotiation processes. Viewing the entire negotiation process as one decision process reflects a macro or global perspective (Koeszegi and Vetschera 2010; Olekalns and Weingart 2003), while individual decisions or interactions reflect a micro- or local perspective. Section "Macro-level: negotiations as joint decision processes" will focus on a macro-perspective of the entire negotiation, and Section "Micro-level: single decisions within negotiations" on a micro-perspective of individual interactions. Based on these surveys of existing research, Section "Integration" will then identify promising future research areas before Section "Conclusions" concludes the paper with a brief summary.

Macro-level: negotiations as joint decision processes

Substantive models of the negotiation process

Many models developed in different areas like economics, game theory, or computer science, attempt to represent the substantive side of negotiations. These models can be classified according to several dimensions (Oliva and Leap 1981). One obvious dimension for any type of analytical modeling is the purpose of the model, whether the model takes a descriptive perspective and aims to provide a realistic picture of negotiation processes, or a prescriptive or even normative perspective and aims to inform negotiators about their optimal behavior. In the context of negotiations, a normative perspective can refer to just one negotiator who is supported in satisfying his or her interests, or to both sides by defining fair outcomes.

As we have already argued, a blend of descriptive and prescriptive views is often appropriate in a negotiation context. We will therefore use more technical criteria to classify substantive models of the negotiation process. An important dimension to distinguish different negotiation settings is the number of issues being negotiated and in particular whether there is only one issue (like price in the negotiation about the purchase of a standard good), or there are multiple issues (like the many other clauses that a purchasing contract might contain, such as terms of delivery, terms of payment, warranties, etc.). Moving from single to multiple issues has profound consequences for the characteristics of a negotiation problem. Single-issue negotiations by definition involve a conflict of interests. If all parties would prefer to change an issue in the same direction, there would be no need for negotiation. Single-issue negotiations thus are distributive. However, they do not necessarily form a zero sum game. Although the gain of one party involves a loss to the other party, in the case of nonlinear value functions for the issue, it is still possible to make concessions which increase the total utility of both parties.

Multi-issue negotiations differ from single-issue negotiations not only because of the higher complexity involved. They also might offer additional potential for integrative behavior. Because of different preferences, some outcomes of the

negotiation might be preferred by all parties to other outcomes. Moving to a dominant outcome can make everybody better off. This has direct consequences for the negotiation process. In single-issue negotiations, a negotiation process can only be based on concessions: each party starts from a position which is most favorable to itself and over time reduces its demand until a point is reached at which demands from all parties can be satisfied and an agreement is found.

A similar process is possible in multi-issue negotiations, although steps here can involve trade-offs, in which a party gives in in less important issues in order to improve its position in other, more important issues (Filzmoser and Vetschera 2008). Multi-issue negotiations also make a very different type of negotiation process possible, in which parties start from a solution which is not attractive to either party, and jointly look for improvements. This type of process is often referred to as a single negotiation text (SNT) type of negotiation (Raiffa 1982). Other authors use different labels for these two types of negotiation processes, they are referred to as "concession based" vs. "Pareto improvement seeking" (Teich et al. 1994), or "concession based" vs. "joint gains seeking" (Ehtamo and Hämäläinen 2001). These two process types are illustrated in Fig. 1.

Approaches to multi-issue negotiation are sometimes also classified according to whether all issues are treated simultaneously, or sequentially one issue after the other (Teich et al. 1994), and by the preference model employed to aggregate between issues. In particular, some approaches require an explicit preference model, e.g., in the form of a utility function, while others are based on interactive methods and involve only a partial preference model, if any at all (Ehtamo and Hämäläinen 2001).

In very general terms, Lopes and Coelho (2010) distinguished between four elements of a concession strategy:

- The *initial offer* made by a negotiator;
- a rule determining when to *quit* the negotiation;

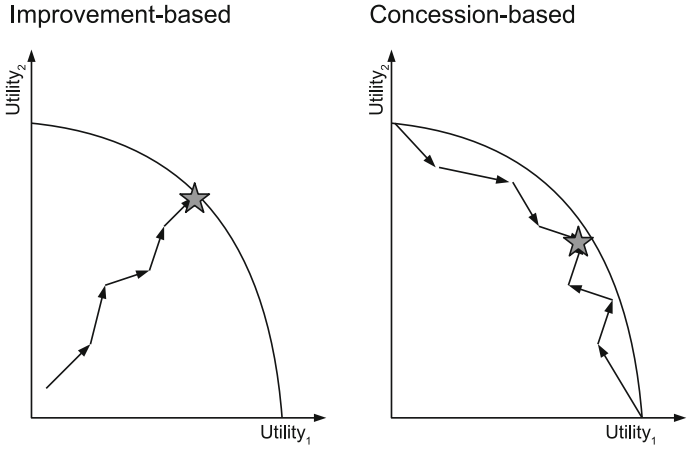

Fig. 1 Improvement-based versus concession-based negotiation processes

- a rule when to *accept* the opponent's offer,
- and a rule for preparing *counter-offers*.

Existing research so far has mainly dealt with the generation of offers (both first offers and counter-offers). The remaining two aspects are usually dealt with only implicitly. Acceptance of the opponent's offer is often considered as an option once the counter-offer to be sent to the opponent would generate a lower utility than the offer from the opponent (Filzmoser 2010). The option of terminating a negotiation is usually not explicitly considered.

Concession-based processes of single-issue negotiations

Approaches to model bargaining processes about a single issue date back even before the development of game theory. Harsanyi (1956) provided a first interpretation of earlier bargaining models, developed mainly for wage bargaining, in game theory terms. The model does not strictly refer to single-issue negotiations, but is formulated in terms of utilities and thus can be considered to be unidimensional.

This model in a way already takes a mixed prescriptive–descriptive perspective that was much later introduced by Raiffa (1982). The central element of the model is the decision of one party whether to accept the opponent's proposal, or insist on (and perhaps later modify) one's own proposal. The opponent's reaction to the proposal is modeled as a random event, thus introducing a behavioral component in the model (since the opponent is not represented as a strictly rational subject, whose reactions could be predicted with certainty).

Denote the offer made by party $i \in \{1,2\}$ by x_i and the utility which party i derives from an offer x by $u_i(x)$. Party 1 will then insist on its own offer if

$$u_1(x_2) < (1 - p_2)u_1(x_1) + p_2 0 \tag{1}$$

where p_2 is the (subjective) probability of party 1 that party 2 will break off the negotiations rather than accept party 1's offer x_1, leading to a utility of zero for both sides. From this inequality, a critical probability p_2 can be calculated and it is assumed that the party for whom that critical probability is lower will make a concession in order to roughly equalize critical probabilities. The process can be shown to converge to the Nash bargaining solution.

Although the model provides a testable hypothesis of how bargainers would proceed, there is only scarce empirical evidence about it. One exception is the work of Fandel (1985), who applied the model to wage bargaining in Germany and found evidence that actual bargaining processes resemble the pattern predicted by this model.

While the Harsanyi–Zeuthen–Hicks model itself has not been subject to much empirical research, the concept of a concession curve which it implies has been adopted both in empirical negotiation research and, from a more prescriptive perspective, in the design of autonomous negotiation agents. In Harsanyi–Zeuthen–Hicks bargaining, the concession which a party makes depends on the current state of the negotiation, i.e., the current offers from both sides (or more precisely, the

utility these offers provide to the parties). The concessions made during a negotiation can also depend on other factors. Faratin et al. (1998) distinguished three types of concessions (and concession functions):

- *Time-dependent* concessions, in which the amount of concessions changes during the process of the negotiation independently of the other party's actions;
- *Resource-dependent* concessions, which depend on the amount of resources available to a negotiating agent, and in particular the pressure towards reaching an agreement caused by the lack of resources; and
- *Behavior-dependent* or *imitative* concessions, which reflect the opponent's behavior.

To a certain extent, these factors match the factors which empirical research on concession making by human negotiators (surveyed, e.g., in Carnevale and Pruitt 1992; and in Teich et al. 1994) has identified. Time, and in particular time pressure, is an important factor. Matching the opponent's behavior is also an important strategy, but empirical research here has found that matching behavior changes in the course of a negotiation: in the middle of a negotiation, the opponent's concessions are frequently reciprocated, while in early and late stages, mismatches are more frequent and, e.g., large concessions of one side lead to smaller, rather than larger concessions from the opponent (Carnevale and Pruitt 1992, p. 546). In addition to these factors, behavioral research has also established the influence of negotiator characteristics like reservation and aspiration levels, or the fact that a negotiator bargains on behalf of some constituents rather than for himself or herself as important factors (Carnevale and Pruitt 1992; Teich et al. 1994).

The concept of resource-dependent concessions has not yet been used outside the field of autonomous negotiation agents. The importance of reciprocity in social interactions is widely acknowledged in the economic literature (Fehr and Gächter 2000; Sethi and Somanathan 2003). In the context of negotiations, reciprocity can refer to positive as well as negative behavior. Most studies addressing the impact of reciprocating negative behavior focus on the relationship dimension of negotiations and will be discussed in section "Communication and behavior at the micro level". In the context of concessions, empirical research found evidence for the size of concessions being reciprocated (Smith et al. 1982), as well as strong counter-reactions if the norm of reciprocity is violated (Maxwell et al. 2003). However, the observed correlation between the concessions of both parties could also be attributed to a reinforcement process (Wall 1981): if in return to a comparatively large concession, one party only receives a small concession, this party will likely discontinue this behavior, and reduce its concessions. If, on the other hand, a large concession is rewarded by a large concession from the other side, there is a positive re-enforcement effect and the behavior will continue.

The interdependence of offers from both sides and in particular reciprocity are also at the focus of several formal models of the bargaining process. The "Simple model of negotiations" developed by Bartos (1977) considers negotiations without integrative potential. Thus all efficient solutions lie on a straight line in two-dimensional utility space connecting the extreme positions of the two parties. In this case, the Nash bargaining solution (Nash 1950) corresponds to the mid-point along

this line between the minimum acceptable utility levels of both sides (which, taken together, form the disagreement point). Since both parties move along the efficient frontier, the utility level of one party is a linear transformation of the utility level of the other party. This means that each party can assess, using just its own utility values, whether the opponent has reciprocated its concession, without explicitly knowing the opponent's utility function. Obviously, if both parties start from initial offers maximizing their own utility (under the condition that it is acceptable also to the other party), and make equal concessions, the process will terminate at the Nash solution. By assuming a linear relationship between the two utility levels, the model transforms a bargaining situation in two-dimensional utility space in essence to bargaining about a single issue (which is alternatively measured in the utility values of both parties).

A different approach to modeling reciprocity was taken by Tutzauer (1986). This model describes the offer process of both sides as a dynamical system. It interprets an offer of one side as a response to the previous offer of the other side, represented by an *offer–response function*. An agreement corresponds to a fixed point of the offer–response function, i.e., an offer to which the other side would respond with the same offer. Bargaining is assumed to take place in a one-dimensional space, therefore an offer–response function f maps an open interval $A \subset \Re$ onto the same interval. For a given fixed point $\alpha = f(\alpha)$ of the offer–response function, denoted by $B_1 = \{x \in A : x < \alpha\}$ the set of outcomes more favorable to party 1 than α and by $B_2 = \{x \in A : x > \alpha\}$ the set of outcomes more favorable to party 2. Tutzauer (1986) formulates three requirements for an offer–response function:

- The *principle of alteration*, according to which both parties make alternating offers. This implies that $f(B_1) \subseteq B_2$ and $f(B_2) \subseteq B_1$.
- The principle of *good faith bargaining*, which requires that the sequence of offers made by each party is either monotonically increasing (for party 1) or decreasing (for party 2), i.e., that each side in each step makes a concession toward the potential agreement.
- The principle of *weak reciprocity*, which links the size of concessions to each other by requiring that for any pair of offers $x^{(1)}$, $x^{(2)}$ from the same side (i.e., either $x^{(1)}, x^{(2)} \in B_1$ or $x^{(1)}, x^{(2)} \in B_2$) which fulfill the condition $|x^{(1)} - \alpha| < |x^{(2)} - \alpha|$, the condition $|f(x^{(1)}) - \alpha| < |f(x^{(2)}) - \alpha|$ must also hold, i.e., the response to a "soft" offer $x^{(1)}$ (which is closer to the agreement) must also be softer than the response to the tough offer $x^{(2)}$.

Although this model provides a concise analytical framework for describing offer processes and generates testable hypotheses, it has never been applied in empirical studies apart from the original paper (Tutzauer 1986). There, elliptical offer–response functions of the form $f(x) = b\sqrt{1 - x^2/a^2}$ were found to fit empirical concession data quite well.

Another very general model of the concession process was developed by Balakrishnan and Eliashberg (1995). According to their model, concessions depend on two forces: a resistance force and a concession force. The resistance force summarizes all factors that cause a negotiator not to make (large) concessions, and

depends on the power of the negotiator as well as the distance between current offer and aspiration level. The further away the negotiator currently is from his or her aspirations, the larger the resistance. The concession force depends on time pressure and distance to the concession point, i.e., the point where no concessions are made any more. Both forces are modeled as the product of the relevant distance and some other factors representing personal attitudes of the negotiator. The model also takes into account interactions between parties, since the concession point is iteratively updated taking into account previous concessions from the opponent.

Time-dependent concession functions were used in several empirical studies to identify features determining the outcome of negotiations or to classify negotiator behavior. Nastase (2006) applied machine learning algorithms to several features of concession curves like the number of local minima and maxima, or the steepness of the curve (concession rate) at the beginning and the end of the negotiation to identify features which allow to distinguish failed from successful negotiations. Their results indicate that, apart from having a larger number of interactions, negotiations are more likely to lead to an agreement if the concession curve contains many maxima, and if the largest concession takes place in the first two-thirds of the negotiation. Ludwig (2008) used the overall shape of concession curves (concave, convex, or linear) to classify negotiator behavior and found a close correspondence between the shape of the concession curve and types of negotiators according to the widely used Thomas–Kilman typology. Negotiators classified as "competing" in the Thomas–Kilman model have a concave concession curve starting with low concessions and conceding more only at late stages. For negotiators classified as "compromising", a convex concession curve starting with high concessions was expected, and negotiators having the accommodating style were assumed to have a linear concession pattern with roughly constant concession rates. Empirical data analyzed by Ludwig (2008) showed that for all three types, over 60 % of the concession curves had the expected shapes. In a similar analysis, Carbonneau and Vahidov (2012) used different shapes of concession curves to classify negotiator behavior as collaborative, aggressive or neutral. Kersten et al. (2012) found that concession curves mostly have a hyperbolic shape, starting with high concession rates which gradually decrease over time.

The effect of different concession patterns on the opponent's behavior was studied by Tan and Trotman (2010). They confronted subjects with concessions of identical total size distributed differently across the negotiation. They found that gradual or late concessions were reciprocated by larger concessions from the opponent than concessions made in the beginning. Early concessions also led to lower satisfaction of the opponent than concessions at the end, and lower willingness to cooperate in the future than gradual concessions.

All these studies dealt with the concession behavior of individual negotiators. A problem in the analysis of concession processes is that it is difficult to aggregate concession curves across negotiations, since negotiators make their offers at varying points in time, and each negotiation also might contain a different number of offers. Previous studies therefore used fixed patterns (Tan and Trotman 2010) or analyzed only first offers (Moran and Ritov 2002; Johnson and Cooper 2009a), the first and last two offers (Mannix and Neale 1993) or total concessions (Johnson and Cooper

2009a; Kersten et al. 2012) to make data comparable. Other studies considered the absolute or relative number of concessions compared to offers which increased a negotiator's demand or left it unchanged (Filzmoser and Vetschera 2008; Kersten et al. 2012). Kersten et al. (2012) classified concession into single- or multi-issue concessions, but also calculated the frequency of these types of concession only as an aggregate value across the entire negotiation.

To overcome this problem, Vetschera and Filzmoser (2012) proposed an interpolation approach called standardized interpolated path analysis (SIPA), which uses interpolated values of offer processes at fixed (standardized) points in time. The state of a negotiation at each point in time is modeled by a four-dimensional vector representing the utility values which the offers of both sides provide to both sides. This state vector is assumed to be changing continuously. Each offer is seen as an observation of this process revealing the utility values associated with offers of one side at this point in time. Values of the state vector are linearly interpolated between offers. Thus, the entire state vector can be calculated at fixed intervals, e.g., at the end of each quarter of the negotiation. State vectors at these time points can then be compared and aggregated across negotiations.

Figure 2 illustrates this approach. Denote the offers made by the two parties by x_1 and x_2 and the two utility functions by u_1 and u_2. The entire process is described by the four values $(u_1(x_1), u_2(x_1), u_1(x_2), u_2(x_2)$. Figure 2 shows a brief process in which both parties make only two offers, player 2's offers follow offers from player 1. Between the offers, utility values are linearly interpolated, so after each third of the negotiation, the current state is described by the utility values marked by circles.

From the four utility values, other measures of the process, like joint utility $\mathrm{JU}(x_i) = u_1(x_i) + u_2(x_i)$ or utility imbalance $\mathrm{UI}(x_i) = |u_1(x_i) - u_2(x_i)|$ can be calculated. Using this method, Vetschera and Filzmoser (2012) were, for example,

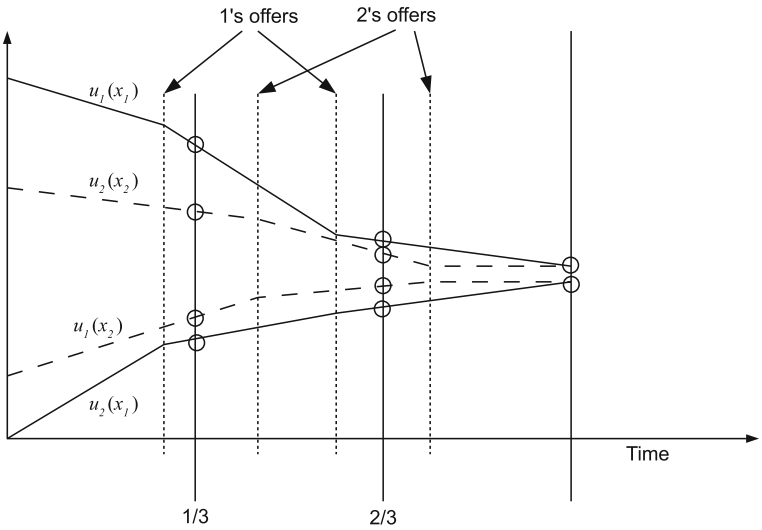

Fig. 2 Standardized interpolated path method (SIPA)

able to show that in experiments, negotiators on average destroyed rather than created value during the later stages of the process.

Concession-based processes of multi-issue negotiations

Research combining multi-criteria decision-making with group decisions and negotiations has a long tradition, many papers and also surveys on this subject were already published in the 1980s (Hwang and Lin 1987; Kilgour and Eden 2010). Korhonen et al. (1986, p. 592) distinguish three ways in which a formal model might be used to support group decisions and negotiations:

1. by providing a formal representation of the problem;
2. by structuring the process; and
3. by identifying possible compromise solutions.

Many of the methods that were developed in this area combine the second and third approach by building upon interactive methods of multi-criteria decision-making. These methods structure the solution process for a multi-criteria decision problem in the form of a dialog between the decision-maker and the system. In each step, the decision-maker provides some information about his or her preferences, the system calculates one or several possible solutions using this information, and the decision-maker then can revise or more precisely specify the preference information in order to improve the solution(s).

It is a quite straightforward idea to replace the single decision-maker in this scenario by several persons and use a similar approach for group decision-making or negotiation. Often the distinction between negotiations and other forms of group decision-making is not very clear in this stream of literature. In particular, it is often (implicitly or explicitly) assumed that at the end of the process, all involved parties will agree on one final solution. Since multi-criteria models were developed to deal with conflicting criteria, these methods are also applicable to any level of conflict between the parties involved.

One of the earliest references in this stream of literature is Contini and Zionts (1968). They developed a simple bargaining model, in which all parties involved start by demanding the utility of their most preferred feasible outcome. By gradual concessions, they reach a point on the Pareto frontier at which utility demands of all parties are compatible. Contini and Zionts (1968) argue that the existence of any (not necessarily Pareto optimal) solution that would immediately be imposed on the group once any party refuses to make further concessions is sufficient to maintain a positive concession rate. The model is not a multicriteria model in the strict sense, since it is formulated only in the space of decision variables and of utility levels. However, utility levels could also be interpreted as multiple objectives, and the generalization to some intermediate objective functions is straightforward.

Most later models retain the idea of individual aspiration levels (in terms of utility objective values), but replace the static imposed solution by some dynamically generated solution proposals. Franz et al. (1987, 1992) use the SIMOLP method of Reeves and Franz (1985). In a problem involving n objective functions, this method uses n Pareto-optimal points to define a hyperplane in

objective space. By maximizing the corresponding linear combination of objectives, another Pareto-optimal point is generated and the decision-makers are asked to replace one of the original points by the new point. Thus the subset of the efficient frontier under consideration shrinks, and the method converges to the most preferred solution. In a group context, only ordinal information (a ranking of the $n + 1$ candidate solutions) is requested from parties, and a compromise ranking is obtained by a mathematical programming model which minimizes deviations from the rankings provided by group members. An empirical validation of this approach in a group decision context (involving only a low level of conflict between parties) was performed by Lewis and Butler (1993), who found it to generate efficient solutions very quickly in computer simulations, but actual decision-makers had less confidence in the results than when using a less structured approach.

Another example of the application of an interactive multicriteria method to a group decision/negotiation setting is the method proposed by Korhonen et al. (1986), which modifies the multicriteria method of Zionts and Wallenius (1976). This method is based on the Simplex algorithm and in each step asks decision-makers to identify the most preferred neighboring basic solution. Since this involves only binary choices between the current basis and each neighboring basis, this step can be performed by group voting. Group choices imply a weight vector, which is then used to find the next candidate solution.

Rather than working with individually optimal solutions, the NEGO system developed by Kersten (1985) uses individual demands, which need to be fulfilled and thus provide lower bounds on utilities. Concessions are made by lowering demands until all demands can be satisfied. If demands are not sufficiently lowered to reach a solution acceptable to all parties, the system makes a proposal taking into account both the demand levels and aspirations in terms of individual optima.

All these methods involve some kind of restricted search of the Pareto surface, which can be seen as a bargaining process moving from a wide range of different (individually preferred) solutions towards a single compromise. Similar concepts are still used in more recent methods (e.g., Jaramillo et al. 2005).

While these methods work directly in objective space, and let parties define their aspirations and preferences in terms of objective values, other approaches start from bargaining models in utility space and extend them to the case that utilities of all parties depend on multiple attributes. A given utility level of a party can be obtained by different combinations of attribute values. In formulating an offer with a given utility, the party thus has to decide on which (out of several equivalent) attribute values to propose. The eAgora system (Chen et al. 2005) first proposes a concession level for each step and then five potential offers, which are as close as possible to the desired concession level. The user then can pick one of them as his or her offer.

Other approaches aim to find offers which are similar to previous offers made by the opponent. If the opponent's preferences are unknown to the focal negotiator, formulating an offer which most closely resembles the opponent's last offer increases the likelihood that a concession is actually beneficial to the opponent. Faratin et al. (2002) used a fuzzy similarity metric to identify similar offers. Vetschera et al. (2012) integrated the distance to a reference solution (which could be the opponent's last offer, the focal negotiator's last offer, or a linear combination

of both) into a model to propose offers, which also takes into account desirable characteristics of the concession process like value creation or reciprocity.

In contrast to this rather broad range of theoretical research, empirical evidence on concession making in different issues is rather scarce. Vetschera (2007) studied the impact of various properties of a negotiator's utility function, in particular the weights assigned to issues and the shapes of marginal utility functions on concession behavior and found that higher weights and convex marginal utility functions led to tougher initial offers and smaller concessions in the respective issues.

A comparison of concessions across issues was performed by Vetschera et al. (2012). They found that negotiators usually have one issue in which they make almost no concessions, and this fact does not impede the chances to reach an agreement. Likewise, even in failed negotiations, parties typically made quite large concessions in at least one issue. The difference between successful and failed negotiations therefore depends on concessions across a range of issues.

One aspect of concessions in multi-issue negotiations that has received some attention in empirical research is log-rolling, i.e., the exchange of concessions in an issue which is of less importance to a negotiator for gains in a more important issue. At the aggregate level of entire negotiations, researchers have studied factors leading to (more) log-rolling behavior, as well as the impact of log-rolling on negotiation outcomes. Thompson (1990) studied whether experienced negotiators engage more in log-rolling than inexperienced negotiators. Operationalization of log-rolling is a critical issue in such studies. In the experiments of Thompson (1990), subjects were provided with a fixed payoff schedule indicating points for each possible outcome of each issue. This schedule contained two issues with widely different weights for both parties, which were therefore prime candidates for log-rolling. The extent of log-rolling present in each negotiation was measured by considering the joint score of both negotiators in these two issues.

To study the impact of log-rolling on negotiation outcomes, Qu and Cheung (2012) provided subjects with a support tool which recommended log-rolling offers. Subjects provided with this tool (and following its suggestions) achieved agreements with higher joint utilities than subjects who had no access to this tool.

Improvement-based processes of multi-issue negotiations

Negotiation processes based on the joint improvement of an inefficient starting solution have been studied mostly from a prescriptive perspective, and several support systems have been proposed for such negotiation processes.

A thorough theoretical analysis of such processes in the context of multicriteria bargaining problems is given by Bronisz et al. (1988). They describe an iterative process in utility space, which starts at the disagreement point, and in each step makes a pareto-improvement to the preliminary solution. Increases in individual utilities in each step are limited to a fixed fraction of the interval between the current solution and the ideal point (which would simultaneously maximize the utility of all players). They prove that this process converges to a nondominated solution, which fulfills among others the properties of Pareto optimality, symmetry, and invariance

under positive affine utility transformations and thus is comparable to other axiomatically founded bargaining solutions like the Nash solution (Nash 1950) or the Raiffa–Kalai–Smorodinsky solution (Kalai and Smorodinsky 1975). This concept is extended to multiple criteria by considering the utopia point for each player, which corresponds to the player's most preferred nondominated solution in objective space. This approach was implemented in an interactive system (Lewandowski 1989).

The method of joint gains (Ehtamo et al. 1999b; Ehtamo and Hämäläinen 2001) comes close to a literal implementation of the SNT procedure. Given a jointly accepted, but dominated point in criteria space, a mediator proposes several alternative solutions in the neighborhood of this point. The parties indicate which of these solutions they prefer to the current tentative agreement. If the intersection of the sets indicated by the parties is empty, the current solution is approximately Pareto optimal. Otherwise, the jointly preferred alternative solutions all indicate possible directions for joint improvement, from which the mediator selects one. After a step in this direction, the next iteration begins. This method relies on a mediator, who could be replaced by a computer program. However, the mediator in this approach plays a central role in determining which efficient solution is ultimately reached, because the direction of improvement chosen by the mediator in each step influences the entire process. The center of the cone defined by the jointly improving alternatives is proposed as a fair improvement direction.

A somewhat different approach is taken in constraint proposal methods (Teich et al. 1995; Ehtamo et al. 1999a; Ehtamo and Hämäläinen 2001). These methods use economic concepts to characterize Pareto-optimal solutions. In a multicriteria bargaining problem, the marginal rates of substitution between issues must be the same for all parties. For a problem with two issues, this can be graphically represented in the classical Edgeworth box, where the bargaining set (of Pareto-optimal solutions) is formed by all points at which indifference curves of the two parties touch each other. Constraint proposal methods seek to establish a common tangent between the indifference curves of all parties. If such a common tangent (or in the general case a common tangent hyperplane) is found, the point at which it intersects with indifference curves of both parties is a Pareto-optimal point. The method proceeds by first specifying an arbitrary reference point, and an arbitrary hyperplane through that reference point. The parties then determine their optimal solutions on that hyperplane. If the optimal solutions coincide, a Pareto-optimal point has been found. Otherwise, the reference point and constraint hyperplane are adjusted for the next iteration. The approach requires a neutral party to specify the reference point and hyperplane. However, these are largely technical tasks, so this role can be performed by a computer program. The main advantage of these methods is that the parties do not have to reveal their preferences to the neutral party, they only have to indicate their most preferred solution on the hyperplane.

Each choice of reference point will generate a different Pareto-optimal solution. Apart from the fact that they are Pareto optimal, the solution proposals generated by this method do not exhibit any specific properties. In fact, it can be shown (Ehtamo et al. 1999a), that every Pareto-optimal solution can be generated by this method. Therefore, these methods only make it possible to demonstrate to the parties that the

possibility for joint improvements exists, but they do not guide them toward particular solutions.

Communication and behavior in negotiation processes

Dimensions and analysis of communication

Negotiator communication and behavior encompasses more than just making offers. Furthermore, a negotiator's goals are not necessarily focused only on the immediate (economic) outcome of the negotiation to which the offers refer. In terms of economic outcomes, a negotiator's goals and consequently strategy can be classified either as an integrative strategy aimed at creating value, or as a distributive strategy aimed at claiming value and maximizing the share of the negotiator in what is essentially perceived as a pie of fixed size. In addition to these outcome-oriented goals, negotiators can also have relationship-oriented goals referring to the future relationship of the parties. Olekalns and Weingart (2003) classify these into affiliation goals of strengthening a positive relationship, and disaffiliation goals representing a negotiator's aim to weaken or terminate a relationship.

Early empirical studies on communication in negotiations focused on the distinction between integrative and distributive strategies. For example, Weingart et al. (1993, 1996) used a classification scheme in which they classified multi-issue offers, providing information on priorities, and requesting information on priorities as integrative tactics. In contrast, single issue offers, providing and requesting information about specific preferences, substantiation of one's own position, and questioning the opponent's substantiation of his or her position were considered as distributive tactics. A comprehensive survey of other coding schemes employed for the analysis of negotiations at that time is provided by Harris (1996).

Later research (Olekalns et al. 2003) complemented this distinction, which was then labeled strategic orientation of communication, by another dimension called strategic function, which distinguished between information-oriented and action-oriented communication. The resulting four types of communication acts are illustrated in Fig. 3

Communication acts classified as distributive information present position statements and facts supporting one party's own position. Integrative information refers to all information which supports log-rolling and the identification of mutually beneficial improvements, i.e., exchange of information on priorities or interests. Claiming value refers to all information acts aiming at improving one negotiator's position, like single issue offers (which, by definition, cannot involve log-rolling), substantiation or the use of threats. Creating value refers to multi-issue offers, creative solutions and other actions which increase the joint utility of both sides.

Although negotiators can mix different strategies in their communication, negotiation processes often contain phases in which one strategy is dominant. Therefore, Brett et al. (2003) further extended this framework and considered breakpoints as a third type of strategic actions. Breakpoints serve to transform

Strategic function	Strategic orientation	
	Distributive	Integrative
Information	Distributive information	Integrative information
Action	Claiming value	Creating value

Fig. 3 Types of communication according to Olekalns et al. (2003)

negotiations from one dominant strategy to another. Breakpoints thus could mean a shift from distributive to integrative behavior, or vice versa.

In order to analyze negotiation processes, communication acts must be mapped onto these (or other) dimensions. For this purpose, methods of content analysis (Krippendorff 1989) are usually employed. Content analysis can be defined as "…an approach of empirical, methodological controlled analysis of texts within their context of communication" (Mayring 2000). A useful framework for applying content analysis to negotiation processes was developed by Srnka and Koeszegi (2007). They suggest performing the analysis in two steps. In order to enable an unambiguous classification, the negotiation is first split into different *thought units*. A thought unit is a piece of communication, i.e., a part of a speaking term, or a part of a message in written or electronic negotiations, in which the sender presents a single thought or concept. Thought units are thus based on content and do not necessarily reflect grammatical structures. A thought unit can be part of a sentence, or can encompass several sentences, as long as they refer to the same idea. In the second step, each thought unit is assigned to exactly one category of communication content. The categories used are developed in an iterative way, starting from a theoretically founded scheme, which is then if necessary adapted to the specific research question as well as to particularities of the negotiations being analyzed. Often, main categories based on a scheme like the one presented in Fig. 3 are further subdivided to specific sub-categories to allow for a finer classification of thought units on one hand, but also for analysis at a more aggregate level of main categories on the other hand.

Process models

Different methods have been developed in literature to describe negotiation processes via the different types of communication used by the negotiators over time. The two major types of models are *stage models* and *episodic models* (Holmes

1992; Weingart and Olekalns 2004; Koeszegi and Vetschera 2010). Stage models presume that negotiation processes pass through a common sequence of distinct stages. Each stage is characterized by a certain focus, which implies a similar mix of communication acts in all negotiations at the same stage. In contrast, episodic models split negotiation processes into different episodes, which have a clear focus on one type of activities. In contrast to stage models, the sequence of episodes might differ from negotiation to negotiation, and negotiation processes can pass through several similar episodes separated by episodes of a different character. Episodic models therefore offer a richer and more detailed picture of negotiation processes, but at the cost of incomparability of processes of different negotiations. Consequently, empirical research has focused on stage models, which are more easily comparable across negotiations.

First approaches in that direction considered only two phases, moving from a more competitive to a more collaborative stage (Adair and Brett 2005). Later models separated these phases further. Most of these models exhibit a similar structure consisting of three phases (Holmes 1992), which are sometimes separated into different sub-phases. In his survey of these models, Holmes (1992) labels the three main phases as *initiation*, *problem solving* and *resolution*. In the initiation phase, parties identify their differences and position themselves for the upcoming bargaining process. The problem-solving phases contain the actual bargaining, in which parties exchange information, substantiate their positions, and via concessions move towards an agreement. The resolution phase contains the final formulation of the agreement, resolution of details left open in the previous phase, and the execution of the agreement (Holmes 1992, p. 86–87). Holmes (1992) found the same basic structure both in prescriptive and in descriptive models of the bargaining process, although the distinction between phases is more clearly emphasized in prescriptive models, while descriptive models consider more gradual transitions between phases.

The two-phase structure of early models was further elaborated into a four-phase model by Adair and Brett (2005). In the four phases of their model, negotiations move back and forth between more competitive and more cooperative behavior. The four phases are labeled (Adair and Brett 2005):

1. Relational positioning
2. Identifying the problem
3. Generating solutions
4. Reaching agreement.

Since little factual information is known initially, the first phase of *relational positioning* is characterized by communication directed at the relationship dimension of the negotiation. In particular, affective persuasion, which is based on status, relationship and other contextual factors (Adair and Brett 2005, p. 36) is used to establish the negotiators' positions towards each other. At the same time, the main orientation of negotiators as cooperative or competitive becomes visible through the signals sent in this phase.

The second phase (*Identifying the problem*) is characterized by a more cooperative attitude and a high level of information exchange. In particular, Adair

and Brett (2005) hypothesize that in this phase, more exchange of preference information takes place than in other phases. The third phase (*generating solutions*) begins the actual exchange of offers, and additional factual information is used to influence the opponent. Adair and Brett (2005, p. 36) thus describe it as "a distinct, energetic, even passionate stage, with parties shifting between a focus on integrating information and influencing the outcome". In the fourth phase (*reaching agreement*), parties posses sufficient information about each other's preferences to make offers which on one hand bring them closer to agreement, and on the other hand maximize their share in the outcomes.

While stage models thus provide a general "template" for negotiation processes, they do not answer the question when a negotiation process moves from one stage to the next. In empirical studies, this question is often answered pragmatically by assuming that all stages are of equal length (either in clock time or in terms of communication acts), and all communication acts falling in a given time interval are assumed to belong to the same phase. To overcome the assumption of equal phase lengths, Koeszegi et al. (2011) developed a method to determine stage transitions endogenously from the content of each phase. The method splits negotiations at points at which the structural dissimilarity between neighboring phases attains a (local) maximum. Denote by $s_i^{(k)}$ the share of communication acts of type i (e.g., claiming value) in stage k of the process. Dissimilarity between phases k and $k + 1$ is then measured by

$$D = \sum_i \left(s_i^{(k)} - s_i^{(k+1)} \right)^2 \tag{2}$$

and the split between the two phases is assumed to occur at the point which maximizes D. Since a phase containing just one communication unit of a certain type would be maximally different from the rest of the negotiation, a minimum phase length is used in estimating the split point. For models containing more than two phases, several split points can be determined either in a hierarchical way (splitting the negotiation first into two main phases, which are then split further), or directly. Since theoretical phase models often predict specific differences between subsequent phases, differences in the shares of communication acts can be weighted in (2) in order to split negotiations at a point at which the changes expected from theory occur. Using this approach, Koeszegi et al. (2011) were able to show that negotiations typically consist of phases of different length, and that the average length of phases depends on several factors, for instance the mode of communication a support system allows.

The transition between phases can not only be identified from the content of adjacent phases, but also from characteristics of the transitional communication acts at the phase transition. Since this approach involves a micro-perspective dealing directly with individual acts, we will discuss it in the following section.

Micro-level: single decisions within negotiations

Substantive models at the micro-level

From a substantive point of view, the most basic element of a negotiation process is an offer made by one party. Taking a dynamic perspective, an offer cannot be seen in isolation, but must be compared to the previous offer of the negotiator (if one exists). The move in the negotiator's position between two offers is a *bargaining step*.

Several classifications of bargaining steps have been proposed in literature. Some classifications view bargaining steps only from the perspective of the focal negotiator making the offer, other classifications take into account the perspectives of both sides.

In single-issue negotiations, or when evaluating offers in terms of utility values, bargaining steps can be classified into steps which increase a negotiator's utility, decrease it, or leave it unchanged. Typologies which are based only on the perspective of one negotiator usually consider a multi-issue bargaining situation to develop more differentiated types of steps. Two equivalent classifications (naming steps differently) were developed by Filzmoser and Vetschera (2008) and by Gimpel (2007). They distinguish four types of steps, based on the change of utility levels within single issues:

- In a *concession* step, the negotiator reduces his or her utility in at least one issue, without improving the position in any issue.
- In a *demand step* (labeled "step back" by Gimpel 2007), the negotiator increases own utility in at least one issue, and does not decrease it in any issue.
- A *trade-off step* combines the two previous types, thus utility is increased in at least one issue and also decreased in at least one issue, possibly leaving some issues unchanged.
- In an *insistence step* (similarity step), all issues are left unchanged.

Filzmoser and Vetschera (2008) analyzed the impact of these step types on negotiation outcomes. They found that negotiations in which concessions and trade-offs were used were significantly more likely to reach an agreement than negotiations in which these step types were not used, while usage of insistence steps reduced the likelihood of agreement. Although one would expect tough bargaining tactics to lead to more efficient outcomes, the opposite was the case and negotiations containing insistence or demand steps were also less likely to reach an efficient agreement.

These step types consider only the impact of a bargaining step on the focal negotiator's own utility. Other classification schemes take into account utility changes to both sides. Since utility to either side can be increased, decreased, or stay constant in a step, a total of nine possible steps can be distinguished. Kersten et al. (2012) analyzed the distribution of these nine step types in negotiations against competitive or cooperative partners. They found that in negotiations against competitive partners, concession steps which resulted in a loss of utility for both sides occur significantly more often than in negotiations with cooperative partners.

One possible explanation is that in cooperative negotiations, parties develop a better understanding of each other's preferences. Hindriks et al. (2007) proposed to combine some of these nine steps and developed a classification scheme of only six types shown in Table 1.

So far, no classification has been proposed which takes into account both utility changes in different issues, as well as the different effects of concessions on the two parties in general. As a particular step type, Ritov and Moran (2008) introduced the concept of a "gambit step", which they defined as a bargaining step in which a negotiator in one issue proposes value which is even better for the opponent than the value demanded by the opponent in that issue. They showed that the presence of such gambit offers in a negotiation improved the possibility of reaching a Pareto-optimal agreement, but gambit offers were rarely made at all, even by experienced negotiators.

A particularly important offer in any negotiation is the first offer made. The effect of first offers on the following negotiation process has been analyzed in several empirical studies. Again it is possible to distinguish between single-issue and multi-issue negotiations. Johnson and Cooper (2009b) studied the effect of first offers on the ensuing concession behavior of the opponent in the context of a single-issue negotiation between a buyer and a seller. They interpreted the first offer made by a party as a first concession with respect to a hypothetical starting point in which that party receives its best possible outcome. The two parties bargained over lottery tickets, so due to differences in risk attitudes, Pareto-improvements were possible. They found that, in computer-based negotiations, second movers (i.e., the party making the second offer) did not reciprocate concessions made by the first mover but that there was a negative relationship between first mover and second mover concessions. The same effect continued throughout the negotiation, leading to a negative influence of the first mover's initial concession on the total concession of the second mover. They explained this result as a power effect arguing that a tough offer (i.e., low concession) of one party in the first step would indicate a high power status, leading the other party to give in more during the following negotiation.

The effect of initial offers on concessions in multi-issue negotiations was studied by Vetschera (2007), who found a substitution effect between initial offers and the following concessions by the same negotiator within each issue. However, the regression coefficient between the amount demanded in first offers and the following concessions was significantly smaller than one, indicating that utility gained from a tough first offer is not completely lost in the following concessions.

Table 1 Classification of bargaining steps according to Hindriks et al. (2007)

Own	Opponent		
	Decrease	Same	Increase
Decrease	Unfortunate	Concession	Concession
Same	Unfortunate	Silent	Nice
Increase	Selfish	Selfish	Fortunate

In a multi-issue negotiation, the structure of offers is also important. Moran and Ritov (2002) considered first offers, which are very different across issues, as "log-rolling" offers. In a log-rolling first offer, a negotiator demands his or her optimal value in some issues, and gives in considerably in other issues, rather than giving in a little across all issues. However, they found that such log-rolling initial offers were not seen as particularly attractive by the opponents, and also did not induce log-rolling behavior on part of the opponents.

All these models focus on single bargaining steps, but do not analyze whether concession behavior of a negotiator follows a consistent pattern throughout a negotiation. Analyzing concession behavior of negotiators empirically leads to difficult estimation problems, since the concessions of both sides mutually influence each other. This mutual interdependence is a general problem in the empirical analysis of negotiation data and concerns not only concessions, but also the attitudes of negotiators towards each other, or towards the system or communication channels they are using (Turel 2010). One approach to deal with these problems is the Actor–Partner interdependence model (APIM) (Kenny 1996; Cook and Kenny 2005) illustrated in Fig. 4.

The APIM considers two individuals, the actor and the partner, and their mutual interaction. According to the model, the action of one party i at time t (denoted by x_i^t) depends on the actor's own action at time $t - 1$ (the actor effect a) as well as the partner's action at time $t - 1$ (the partner effect p). Both actor and partner effects exist for both parties. Applied to the context of negotiations, this would mean that the concessions of both parties depend on their own previous concessions, as well as their respective opponent's previous concession. The error terms ε_1 and ε_2 of both side's concessions at the same time are assumed to be correlated, which implies that also their behavior in previous time periods (which is explained by the same model) is correlated. Hierarchical regression models are used to take this correlation into account.

The APIM was applied to offers in negotiations by Vetschera and Filzmoser (2013). They considered the concessions of one party in a bargaining step as a dependent variable, which was assumed to depend on the same negotiator's previous concession and the gain received from the opponent's previous concession. The model also contained the phase of the negotiation in which that step was made and experimental treatment conditions as additional variables. Results showed a negative autoregressive effect indicating that concessions tend to stabilize over time

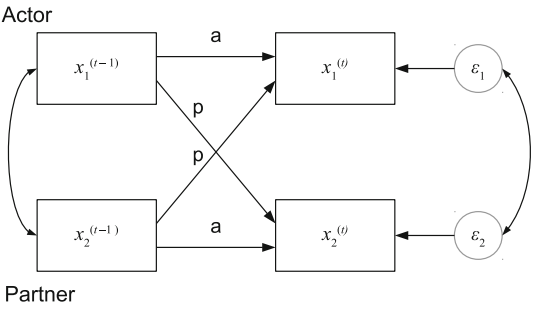

Fig. 4 Actor–Partner interdependence model (adapted from Cook and Kenny 2005)

(large concessions being followed by smaller concessions and vice versa). However, no reciprocity effect was found in that study, the partner effect was not significant.

Communication and behavior at the micro-level

Communication behavior at the micro-level consists of single acts by the parties. However, these acts also cannot be seen in isolation, and researchers therefore often analyze sequences of acts from both sides and their mutual relation as basic building blocks of negotiation processes.

Reciprocity is a central concept in this line of research. Reciprocity can refer to different aspects of communication acts, to their formal characteristics as well as their content at different levels of granularity.

Volkema et al. (2011) used formal criteria like the length of text messages sent in e-mail negotiations, or the presence of formal vs. informal salutations and found a high level of reciprocity at this level in the initial messages exchanged in a negotiation. For example, short opening messages were typically responded to with short messages. They also found that the style and the willingness to reveal information in the following negotiation were significantly influenced by the initial messages. However, the level of formal reciprocity they studied did not have a significant impact on outcome measures like joint utility or the fact that negotiation reached an agreement.

Most studies focus on reciprocity of content, which can be classified, for example, according to the criteria shown in Fig. 3. Focusing on strategic orientation at a quite general level, Mintu-Wimsatt and Calantone (1996) found that a negotiator's problem-solving attitude strongly depends on the perceived attitude of the opponent. A later study (Mintu-Wimsatt and Graham 2004) confirmed this effect in an international context, and also found a strong impact on negotiator satisfaction. However, they did not analyze possible effects on the substantive outcome of the negotiation. Not only the presence of reciprocity has an effect of negotiations, not reciprocating cooperative attitudes of one side can have a negative effect (Maxwell et al. 2003).

Most coding schemes employed to analyze communication in negotiations further separate the types shown in Fig. 3 into sub-types, which also allow for a finer categorization of behavioral sequences. Olekalns and Smith (2003) used such a finer classification to distinguish two types of sequences: a *reciprocal sequence* occurs if one type of (distributive or integrative) behavior is responded to by exactly the same type of behavior. For example, reciprocal cooperative behavior occurs if a message providing priority information of one negotiator is responded to by a message in which the other negotiator also provides information about his or her priorities. In contrast, *complementary behavior* occurs if a message is responded to by a message which has the same strategic orientation (i.e., cooperative or competitive), but is of a different kind (for example, if the response to revealing priority information does not reveal priority information, but makes a positive contribution to managing the negotiation process). Olekalns and Smith (2003) studied the relationship of these patterns to negotiation context (the composition of negotiating dyads of socially vs. self-oriented negotiators) and negotiation outcomes

in terms of joint gains and found significant interaction effects between dyad composition and behavioral sequences.

These studies mainly focused on reciprocation (or lack thereof) of positive behavior like providing personal information or information about preferences. In many conflicts one can also observe a conflict spiral of escalating reciprocation of negative behavior like threats or verbal abuse. The development of such conflict spirals and methods to break them were analyzed by Brett et al. (1998).

Both reciprocal and complementary sequences do not change the strategic orientation of the negotiation process. Using the information vs. action framework of Fig. 3, Olekalns et al. (2003) defined three types of transitions which correspond to fundamental changes in the negotiation process:

- *Strategic function transitions* are sequences which switch from action to information or vice versa, but do not change the strategic orientation (e.g., a value creating communication is answered by integrative information);
- *Strategic orientation transitions* change the strategic orientation while remaining within the same strategic function (e.g., integrative information is responded to by distributive information); and
- *Double transitions*, which change both strategic orientation and strategic function.

Brett et al. (2003) extended the classification of strategic functions by considering breakpoints as a specific type of function. This highlights the fact that in order to be successful, a transition in strategic orientation must also be reciprocated by the opponent. If one party changes from distributive to integrative orientation, but the other party continues to act in a distributive way, the transition fails and the party initiating the transition will likely revert to distributive behavior.

Such transitions can readily be identified within a single negotiation. For statistical analysis, more general models are needed. Brett et al. (1998) introduced an important definition of reciprocal behavior, which strongly shaped the way reciprocity was later on measured in negotiation research. They operationalized reciprocation as a situation in which "the probability of an act conditional on the partner's prior act is greater than the base-rate probability of the act" (Brett et al. 1998, p. 411). Using this definition, it is natural to analyze interaction sequences in negotiator communication using Markov chain models, in which states correspond to a negotiator using a certain type of communication (according to, e.g., the scheme developed by Olekalns et al. 2003) and consequently the use of certain interaction patterns is reflected in high transition probabilities between the corresponding states. Such Markov chain model were, for example, used by Olekalns et al. (2003) to study the occurrence of reciprocal and complementary sequences, and their effects on negotiation outcomes.

These studies used standard Markov chain models, in which each type of message a negotiator might send is considered to be the indicator of a state the negotiators are in. Turan et al. (2011) suggested additionally using hidden Markov models, in which the actual state is assumed to be an unobservable variable, and the different messages are only stochastically related to these states. They also proposed

using other methods from machine learning like inverse reinforcement learning, but did not apply these methods to actual data.

Integration

The preceding sections have shown that many building blocks for a comprehensive model of negotiation processes already exist in literature. Figure 5 puts these building blocks into a comprehensive framework, and also indicates possible relations between these building blocks, which could form starting points of future research.

At the micro-level of individual interactions between the parties, this framework extends the APIM model by taking into account that behavior of negotiators consist of substantive offers as well as communication aimed at building and improving the relationship between parties. These interactions at the micro-level shape characteristics of the negotiation process at more aggregate levels, the meso-level of phases and the macro-level of the entire process, which then lead to certain negotiation outcomes. The framework shown in Fig. 5 emphasizes the role of interactions between parties at the micro-level. Obviously, the interdependence of actions from both sides at the micro-level will also create similar interdependencies at the aggregate levels, and both actor and partner effects might exist between as well as within phases. Consequently, if one models negotiations only at an aggregate level, an APIM-like model to represent interaction effects across phases can provide an adequate structure. However, these interdependencies result from interactions at the micro-level, and the aim of Fig. 5 is to highlight the importance of such a micro-level foundation of aggregate models.

Figure 5 identifies several relationships (identified by the numbers ⟨1⟩ to ⟨6⟩) between these constructs, which are important for understanding the complexity of

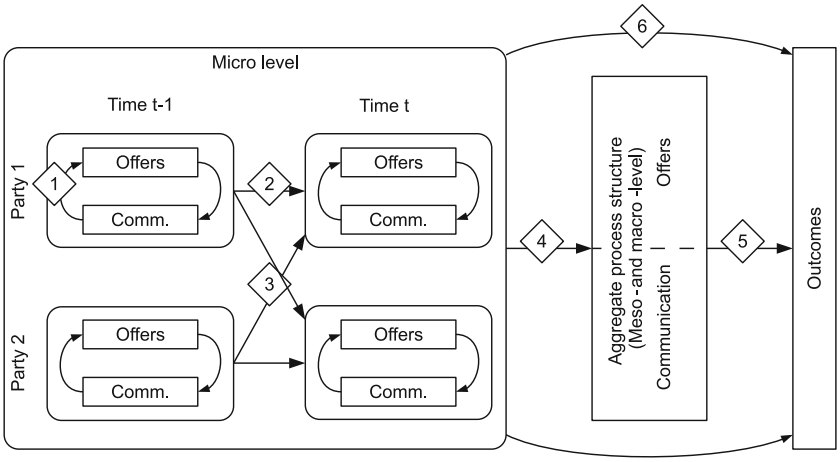

Fig. 5 Integrated framework

negotiation processes. Some of these relationships have already been considered in literature, some could open new perspectives for research on negotiations.

The first relationship ⟨1⟩ concerns the connections between substantive offers and relationship-oriented communication of one party. Research so far typically has focused either on offers, or on verbal communication between parties, but the connections between these two dimensions of the negotiation process have rarely been addressed. Even research looking at both dimensions often has done so by interpreting one dimension from the perspective of the other. For example, Adair et al. (2007) have studied the use of offers as a means to convey preference information in different cultures. Building on the tradition of communication-oriented negotiation research, they considered the timing of offers in the negotiation process, but not the specific values involved.

Previous research has identified different types of bargaining steps as well as different types of communication content. So one question that could obviously be asked is which kind of communication accompanies which types of bargaining steps, or concessions of which size. While one can reasonably assume that, for example, insisting or demanding bargaining steps will be accompanied by competitive rather than cooperative communication, this relationship has so far not been thoroughly studied in literature. If such relationships could be established, they could possibly lead to the development of a unified classification of bargaining behaviors that encompasses both the substantive and the relationship dimension. Such a classification could then be used as input to more elaborate models for a comprehensive analysis of negotiation processes.

This could extend the relationship between the two dimensions of negotiations to a dynamic perspective, as indicated by relationship ⟨2⟩. There, one could analyze whether certain types of communication acts are likely to precede or follow certain types of bargaining steps or concessions. Some hypotheses concerning such relationships could readily be formulated. For example, trade-off steps might require a previous exchange of information about the priorities of issues in order to be able to take into account value differences between parties. Nevertheless, detailed studies of this relationship, which would, for example, identify about which issues preference information is exchanged and then trace whether following trade-off steps actually refer to these issues and make use of the knowledge gained, are lacking so far.

This kind of analysis naturally extends to the relationship of communication acts by the two parties, as indicated in relationship ⟨3⟩. One obvious question that can be asked in this context is whether specific communication acts by one party invoke particularly large (or small) concessions from the other side, and vice versa, which communication acts typically follow certain concessions patterns (or other step types like for instance insistence).

Once the multidimensional nature of communication in negotiations is explicitly taken into account, consistency between the dimensions also becomes an issue. Communication of negotiators simultaneously involves both dimensions, but not necessarily in a consistent way. For example, a large concession could be accompanied by a comparatively rude, threatening statement; or cooperative statements could accompany rather tough offers. Such inconsistency could create

confusion in the opponent, which implies that it could also be employed as a tactical device. The issue of consistency between words and deeds has so far received little attention in literature (for an exception, see Volkema et al. 2011), but is an important topic in the actual conduct of negotiations.

The micro-level behavior in both the substantive and the relationship dimensions then needs to be aggregated to more comprehensive measures of the negotiation process like phases at the meso-level or characteristics of the entire process at the macro-level. The question of aggregation has so far only scarcely been addressed even within each dimension. Concerning communication types, the endogenous phase model of Koeszegi et al. (2011) provides one rare example of an explicit aggregation model. No phase models have so far been proposed for the offer process, so there are also no explicit models for aggregation to the meso-level.

Concerning the substantive dimension, aggregation to the level of the entire negotiation is typically made by forming averages, for example, the average concession across an entire negotiation. Concerning offer processes, more elaborate concepts like the shape of concessions curves are also used. Thus we find very different aggregation mechanism in the two domains, and a comprehensive model of negotiation processes also would have to bridge the gap between these different ways of forming aggregate models.

The relationship of process characteristics to outcomes ⟨5⟩ is perhaps the best studied among all the relationships indicated in Fig. 5. However, most of the previous literature focuses on only one dimension. This specific perspective not only refers to the characteristics of negotiation processes analyzed, but also to the outcome dimensions which are taken into account. Studies which deal with the negotiation process at a substantive level also consider economic outcomes of the negotiation, like efficiency or Pareto-optimality (e.g., Filzmoser and Vetschera 2008), while studies focusing on contents of information exchange and relationship often consider other outcome criteria like achieving an agreement at all (e.g., Pesendorfer and Koeszegi 2006).

Only few studies cross this boundary between communication content and the substantive dimension of negotiations. For example, Hyder et al. (2000) studied the impact of substantiation of a negotiator's position on the efficiency of offers and argued that substantiation would bind considerable mental capacity of negotiators and consequently makes it less likely that they are able to reach a Pareto-optimal solution. They showed experimentally that reducing the amount of substantiation (which they achieve in their experiment by presenting the problem in a highly abstract way that left no room for explaining positions) resulted in more integrative bargaining behavior and consequently more efficient solutions.

Most empirical studies so far considered only the effect of some aggregate characteristics of the negotiation process on outcomes, for example, the average usage of some communication acts or bargaining steps. However, there is also some evidence that single interactions, or interactions during a short part of the negotiation, can have a considerable effect on the outcome of the entire negotiation, as indicated by relationship ⟨6⟩ in Fig. 5. Short parts of the entire negotiation

Table 2 Possible research questions in negotiation processes

Relationship	Research questions
1. Substantive and relationship domains in individual actions	Which communication acts do accompany specific types of bargaining steps?
	How consistent are negotiators across different process dimensions?
2. Individual actions over time	Which communication acts precede/follow specific types of bargaining steps or concessions?
	How consistent are negotiators over time?
3. Interactions between parties in substantive and relationship domains	Which communication acts of one party trigger specific types of bargaining steps by the other party?
	What is the effect of consistency/inconsistency between substantive and relationship communication on the other party's behavior?
4. Aggregation of micro-processes	How can different phases in the negotiation be distinguished from micro-level interactions?
	Do specific interactions trigger transitions between phases?
5. Aggregate process characteristics and outcomes	Which aggregate process characteristics have which effect on (economic and behavioral) outcomes?
6. Impact of micro-characteristics on outcomes	Do specific interactions have a distinct effect on outcomes?
	What is the relative importance of aggregate process characteristics and single interactions for determining outcomes?

process are often referred to as "thin slices". Using such a "thin slices" approach, Curhan and Pentland (2007) were able to predict the outcomes of negotiations both in terms of individual and joint outcomes using speech data like activity levels or engagement from just the first 5 min of face-to-face negotiations with a high level of accuracy.

Even single interactions can have a strong effect on outcomes, as is the case with the tactics to break conflict spirals studied by Brett et al. (1998). Such singular events often take the form of turning points (Putnam 2004), which take the entire negotiation to a different level by, e.g., viewing the entire problem being negotiated from a different perspective.

Given the collective evidence on both the impact of aggregate process characteristics, and of single (or few) interactions within a negotiation process, an obvious and still untackled research question concerns the relative strength of these two effects. Under which conditions will single interactions be able to change the outcome of the entire process, and which properties could make aggregate process characteristics so strong that the whole process can no more be altered by single incidents?

Table 2 summarizes some research questions that can be posed with respect to the six relationships identified in Fig. 5.

Conclusions

Negotiations are complex phenomena, this is also evident from the fact that many different scientific disciplines deal with this problem from very different perspectives. The aim of this paper was to span at least a few bridges across some of the gaps between these disciplines, with a particular focus on two gaps:

1. Interpreting negotiations as rational, economic processes aiming at an efficient outcome in terms of utility values to all parties involved vs. negotiations as communication processes, in which two parties try to influence each other and the decisions they are making, but also build a relationship.
2. Negotiation processes as a puzzle composed of many offers, interactions, and speech acts vs. the big picture of a negotiation process reflecting the overall strategies and behaviors of parties.

The survey presented in this paper provides a clear evidence of the high level of sophistication achieved in modeling individual parts of the entire puzzle. The challenge that lies ahead is to fit those pieces together in order to obtain the entire picture. A journal like EJDP, that aims at integrating an OR-based perspective on rational decision-making with a process perspective, seems uniquely suited to accompany this exciting journey.

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