# AUTOMATING THE DISPUTE RESOLUTION FOR B2B

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Abstract: The speed of supply chains formation requires new modes of resolving disputes within hard time constraints. Also, the design of punishment policies applied to specific domains linking agents' actions to material penalties is an open research issue. In our framework the principles of contract law are applied to set penalties: expectation damages, opportunity cost, reliance damages, and party design remedies, and they are introduced in the task dependency model (Walsh and Wellman, 2003). The trust is supported by providing arguments for each imposed penalty.

Keywords: artificial intelligence, agents, electronic contracts.

## 1. INTRODUCTION

The business process between firms comprises several stages: 1.discovery: agents find potential contracting partners; 2.negotiation: contract terms are determined through a communication process; 3.execution: transactions and other contract provisions are executed; 4.dispute resolution: computing the remedies in case of breach. In this work we are concerned primarily with the fourth aspect, and specifically with the process by which an automated dispute resolution mechanism can be configured to support a particular contract breach. The contribution of this work is a framework which bridges the gap between execution and computed remedies in case of contract exceptions. The development of Online Dispute Resolution (ODR) systems knew four stages (Tyler and Bretherton, 2003): hobbyist beginning with 1996 without a legal backing; experimental between 1997 and 1998 when especially scholars run pilot programs; entrepreneurial since 1999 when a number of firms have started to provide ODR services on the internet. Now, we are in an institutional phase, when many efforts come from the official bodies which are very motivated to increase the trust in such online services. The offered services include: arbitration, mediation, negotiation support, automated negotiation, or case appraisal. ODR has to following advantages (Bellucci, E.et al. 2003): lower costs, greater speed, more flexibility in outcomes, less adversarial, more informal, solution rather than blame oriented[1], private. The automation increases also fairness and efficiency in ODR.

Our interest consists in automating the dispute resolution process between firms. At the moment, the majority of providers offer services only for B2C. Knowing that 95% of money in e-commerce comes from B2B sector, we anticipate that automated conflict resolution even for B2B will be soon a reality. Moreover, 80% of judicial cases are considered simple enough to be resolved completely automated with the current technologies. The only existing ODR systems that are totally automated are those that offer a blind-bidding process for simple single issue two party cases. The challenge lies in providing automation that is intelligent and transparent at least for the involved parties. High automation is generally associated with law comprehension. In our view, comprehension is a need in order to increase the trust in the resolution process. Automating the conflict resolution could

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[1] That's why the ODR mechanisms are preferred by firms having long time business relations.

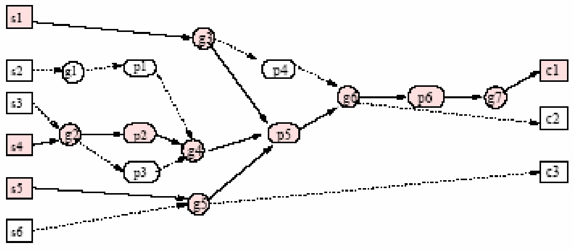


Fig. 1. Task dependency network: goods are indicated by circles, suppliers and consumers are represented by boxes, while producers by curved boxes.

have impact on several domains: e-commerce (B2C and B2B), judicial (algorithms like family-winner or SplitUp for computing the distribution of matrimonial property (Bellucci, E.et al. 2003).), or e-government (in EU, 45% of government services are fully automated online).By applying principles of contract law we provide a framework for computing penalties for B2B disputes and also a mechanism for explaining the imposed remedies. Because ODR services are solution and not blame oriented, they represents the best solution, from an efficiency point of view, for managing supply chain perturbations.

The main contribution of this paper consists in introducing penalties in task dependency network model. It also generates arguments for the imposed remedy and presents them to the parties in order to increase the trust of the process. The paper is organized as follows: in the next section we introduce contracts within the task dependency network model and in section 3 we describe the four types of remedies used in the market. In section 4 the functions used by the market for penalties are implemented. Sections 5 and 6 detail future experiments and related work.

## 2. PROBLEM SPECIFICATION

### *2.1 Task Dependency Network*

We adapted the task dependency network model (Walsh and Wellman, 2003) used in the analysis of the supply chain as follows: task dependency network is a directed, acyclic graph, (V,E), with vertices $V = G \cup A$, where: $G$ = the set of goods, $A = S \cup P \cup C$ the set of agents, $S$ = the set of suppliers, $P$ = the set of producers, $C$ = the set of consumers, and a set of edges E connecting agents with their input and output goods. With each agent $a \in A$ we associate an input set $I_a$ and an output set $O_a$: $I_a = \{ g \in G \mid \prec g, a \succ \in E \}$ and $O_a = \{ g \in G \mid \prec a, g \succ \in E \}$. Agent $a$ is a supplier if $I_a = \varnothing$, a consumer if $O_a = \varnothing$, and a producer in all other cases. Without any generalization lost, we consider that a consumer $c \in C$ needs a single item ($|I_c| = 1$) and every supplier $s \in S$ or producer $p \in P$ build one single item ($|O_s| = 1$ and $|O_p| = 1$). An agent must have a contract for all of its input goods in order to produce its output, named *presumable*[2] and denoted by $\widehat{p}$ . If we note $n_p = |I_p|$, the agent has to sign $n_p+1$ contracts in order to be a member in the supply chain. For each input good $g_k \in I_p$ the agent $p$ bids its own item valuation $v_p^k$. The auction for the good $g_k$ sets the transaction price at $p_k$. The agent's investments are $I_p = \sum_{k=1}^{n_p} p_k$ where $k$ is the winning input goods. We note by $I_p^g$ the agent's investments but without considering the investments made for the current good $g$. Similarly, we note all bids values submitted by the agent $p$ as $V_p = \sum_{k=1}^{n_p} v_k^p$ and this value without considering the bid for good $g$ as $V_p^g$ . For the output good, the agent $p$ signs a contract at reliance price $R_p$. We consider that there are no production costs and when perturbation or unexpected events occur, agents need protocols for repairing or reforming the supply chain. "Allowing decommitment without remedies rises the question of how to enforce that agents decommit only when they are in dead ends, and also does not address the fact that unilateral decisions for decommitment can potentially break the (possibly desirable) contracts of many other downstream producers" (Walsh and Wellman, 2003). Introducing remedies can reduce aggressive bidding and mitigate the potential problems.

### *2.2 Contracts*

The goods are transacted using the (M+1)st price auction protocol, which has the property to balance the offer and the demand at each level in the supply chain (otherwise the supply demand equilibrium cannot be achieved globally). It provides a uniform price mechanism: all contracts determined by a particular clearing are signed at the same price. In the contract $C = \prec a_s, a_b, g_i, P_c, t_{issue}, t_{maturity} >$, $a_s$ represents the seller agent, $a_b$ the buyer agent, $g_i$ the good or the transaction subject, $P_c$ the contract price, $t_{issue}$ is the time when the contract is signed and $t_{maturity}$ is the time when the transaction occurs. During experiments, a contract can be in one of the following states: active (between $t_{issue}$ and $t_{maturity}$ and no breach), violated (at the time of breach $t_{issue} \le t_{breach} \le t_{maturity}$) or performed (if no party breaches until $t_{maturity}$).

## 3. REMEDIES

According to (Vold *et al.*, 2002) there are five different philosophies of punishment from which all punishment policies can be derived: deterrence,

[2] Note that when someone breaches a contract with a presumable agent, he has to pay more damages.

retribution, incapacitation, rehabilitation and restoration. Retribution is most adequate for multi agent systems, as it considers that the contract breach should be repaired by a remedy as severe as the wrongful act. The remedies described in this section try to equal the victim's harm. In the first three cases, the system estimates the harm according to current market conditions, while in the last case, the agents themselves compute the damages and generate their own penalties.

*3.1 Expectation Damages*

The courts reward damages that place the victim of breach in the position he or she would have been in if the other party had performed the contract (Cooter R. and Ulen T, 2004). Therefore, in an ideal situation, the expectation damages do not affect the potential victims whether the contract is performed or breached. Ideal expectation damages remain constant when the promisee relies on the performance of the contract more than it is optimal.

*3.2 Reliance Damages*

Reliance increases the loss resulting from the breach of the contract. Reliance damages put the victim in the same position after the breach as if he had not signed a contract with the promisor or anyone else (Cooter R. and Ulen T, 2004). In an ideal situation, the reliance damages do not affect the potential victims whether the contract is breached or there was no initial contract. No contract provides a baseline for computing the injury. Using this baseline, the courts may reward damages that place the victims of breach in the position that they would have been, if they had never contracted with another agent. Reliance damages represent the difference between profit if there is no contract and the current profit.

*3.3 Opportunity Cost*

Signing a contract often entails the loss of an opportunity to make an alternative. The lost opportunity provides a baseline for computing the damage. Using this baseline, the courts reward damages that place victims of breach in the position that they would have been if they had signed the contract that would have been the best alternative to the one that was breached (Cooter R. and Ulen T, 2004). In the ideal situation, the opportunity cost damages does not affect the potential victims whether the contract is breached or the best alternative contract is performed[3]. If breach causes the injured party to purchase a substitute item, the opportunity cost formula equals the difference between the best alternative contract price available at the time of contracting and the price of the substitute item obtained after the breach.

[3] Opportunity costs and expectation damages approach equality as market approach perfect competition

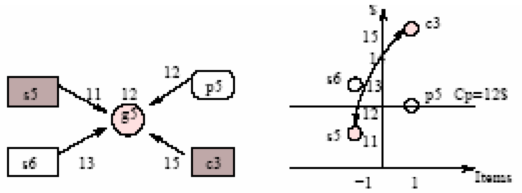


Fig. 2 Supplier-Consumer contract

*3.4 Party-Designed Remedies*

The contract might stipulate a sum of money that the breaker will pay to the party without guilt. These "leveled commitment contracts" (Sandholm and Lesser, 2001) allow self-interested agents to face the events that unfolded since the contract started. A rational person damages others whenever the benefit is large enough to pay an ideal compensation and have some profit, as required to increase efficiency. Game theoretic analysis has shown that leveled committed contracts increase the Pareto efficiency of contracts. One contract may charge a high price and offer to pay high damages if the seller fails to deliver the goods, while another contract may charge a low price and offer to pay low damages, the types of contracts separating the set of buyers and allowing "price discrimination."

## 4 CASE ANALYSIS

The conclusions from the last sections are: (i) The amount of expectation damages must place the victim in the same position as if the actual contract had been performed[4](ii) The amount of reliance damages must place the victim in the same position as if no contract had been signed; (iii) The amount of opportunity-cost damages must place the victim in the same position as if the best alternative contract had been performed; (iv) Party designed remedies specify themselves the amount of damages in case of a breach.

*4.1 No substitute*

Supplier-Consumer**:**

**The consumer breaches the contract:** In fig. 2a) the suppliers $s_5$ and $s_6$ want to sell good $g_5$ at price 11 and respectively 13, while the agents $p_5$, and $c_3$ try to buy it at prices 12 and 15. According to (M+1)st price protocol the transaction price is $P_c$ = 12$. The auction clears at every round. In fig. 2b) a single contract is signed: $C_{g5}^{1} = \prec s5, c3, g5, 12, t_{issue}, t_{maturity}>$ Consider that $c_3$ breaches the contract. In this case, the remedies will be:

[4] We assume that the rate of breach is low. Otherwise, it can be anticipated to some extent, and so the promisee can plan for breach, just as airlines and hotels plan for "no-shows (Cooter R. and Ulen T, 2004)."

*Expectation damages*: if the agent $c_3$ performs, the $s_5$'s estimated profit is the difference between the contract price $Pc = 12$ and its own valuation[5] $v_{a6}^{g5} = 11$ (victim valuation). The remedies compensate this value: $D_e = P_c - v^g_a$.
*Opportunity damages*: first, the auctioneer has to compute the opportunity cost $P_o$, which is the transaction cost in case the breacher was absent from the auction. In fig. 2, if agent $c_3$ is not present $P_o = 11$. The $s_5$'s bid is one who wins. The contract would be $C^l_{g5} = \prec s_5, p_5, g_5, 11, t_{issue}, t_{maturity} >$ and the agent's profit would be $P_o - v^g_a$ . But, when there is no contract for agent $s_5$, his profit would be null. The opportunity damages should reflect this. We define opportunity cost damage $D_{9o}$ which is received by the agent $a$ as: $D_o = max(P_o - v^g_a , 0)$
*Reliance damages*: if the victim does not have any input good, the supplier's investments in performing are null: $D_r = 0$.
*Party-designed remedies*: the remedies may be a fraction from the contract price ($D_p = \alpha \cdot P_c$) or a fraction from the expected profit ($D_p = \alpha \cdot D_e$) or constant ($D_p = C$). In each of the following cases, this type of remedies is computed in the same manner.

**The supplier breaches the contract:** Consider that $s_5$ breaches the contract $C^1_{g5}$.
*Expectation damages*: $D_e = v^g_a - P_c$.
*Opportunity damages*: if the breacher had not bid and the victim had signed a contract at the opportunity price $P_o$, than it's profit would have been $v^g_a - P_o$. If the victim has no contract when the breacher is not bidding, it receives no damages. Hence $D_o = max(v^g_a - P_o, 0)$ In the depicted case, if the agent $s_5$ had not existed, $c_3$ would have signed a contract with $s_6$ for an opportunity cost $P_o = 12$. Therefore, $D_o = 3$.
*Reliance damages*: because the client does not produce any output goods, its reliance is null: $D_r = 0$.

Supplier-Producer:

**The supplier breaches the contract:** Consider $C = \prec s_5, p_5, g_5, 12, t_{issue}, t_{maturity}>$ from fig. 3.
*Expectation damages:* Observe that the victim is a presumable agent because it has contracts for all its input goods. Its investments are $I_p = 5 + 9 + 12 = 26$ and $I^{g5}_p = 9+5 = 14$. The producer $p_5$ has also a contract for its output item, so $R_{p5} = 34$. Its profit is $R_{p5} - I_p = 8$. When bad contracts have been signed this value can be negative, therefore no damages are imposed. Otherwise, expectation damages are the difference between its bid and the contract price:

$$D_e = \begin{cases} \max(R_p - I_p, 0), \hat{p}, \exists R_p \\ v^g_p - P_c, otherwise \end{cases}$$

[5] (M+1)st price auction has the following property: the dominant strategy for each agent is to reveal its real valuation.

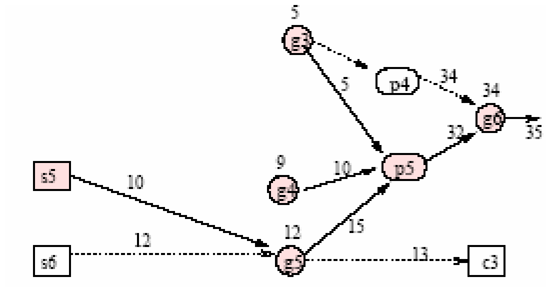


Fig. 3. Supplier-Producer contract

Recall $\hat{}p$ means that agent $p$ is presumable.
*Opportunity cost*: one seller less implies $P_o \geq P_c$.

$$D_o = \begin{cases} \max(R_p - I^g_p - P_o, 0), \hat{p}, \exists R_p, \exists P_o \\ v^g_p - P_c, \neg\exists\hat{p}, \exists R_p, \exists P_o \\ 0, \neg\exists P_o \end{cases}$$

which is equivalent to:

$$D_o = \begin{cases} \max(R_p - I^g_p - P_o, 0), \hat{p}, \exists R_p, \exists P_o \\ \max(v^g_p - P_c, 0), otherwise \end{cases}$$

*Reliance damages*:

$$D_r = \begin{cases} V^g_p - I^g_p - R_p - v^{g_0}_p), \hat{p}, \exists R_p \\ V^g_p - I^{g_k}_p, otherwise \end{cases}$$

Here $g_o$ is the output good of the agent $p$ and $I^{gk}_p$ represents all $k$ contracts signed for input goods, where $k < n_p$. In the depicted case $p_5$ is presumable and there is a contract with a buyer. Therefore, it has to receive, as a victim, the next reliance damages $Dr = V^{g5}_{p5} - I^{g5}_{p5} + R_{p5} - v^{g6}_{p5} = (10+5)-(9+5)+34-32 = 3$. In some cases damages can be higher than the contract value itself ($D_r \geq P_c$). According to current practice in law, these damages are the right ones if the victim gives a previous notification about the risks faced by the potential breacher. This is a clear situation when information propagation improves the supply chain performance. In the light of the above facts, their reliance damages should remain the mentioned ones if the victim has notified its partner, but should be maxim $P_c$ otherwise. Hence, we define $D'_r$ as:

$$D'_r = \begin{cases} D_r, breacher\,receives\,a\,notice \\ \min(D_r, P_c), otherwise \end{cases}$$

Producer-Consumer

**The consumer breaches the contract:** Consider the contract $C = \prec p_5, c_2, g_6, 34, t_{issue}, t_{maturity} >$ from fig. 4, where $c_2$ breaches.
*Expectation damages*:

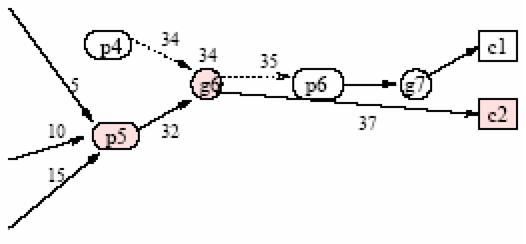

Fig. 4. Producer-Consumer contract

$$D_e = \begin{cases} \max(P_c - I_p^g, 0), \hat{p} \\ P_c - v_p^g, otherwise \end{cases}$$

In this case, $p_5$ is presumable and $D_e = 34 - (12 + 9 + 5) = 8$. Suppose the agent $p_5$ does not have any contract for one input good. Therefore, it is not presumable and it will receive $D_e = 34 - 32$. *Opportunity cost*: one buyer less implies $P_o \leq P_c$

$$D_o = \begin{cases} \max(P_o - I_p^g, 0), \hat{p}, \exists P_o \\ P_o - v_p^g, \neg\exists\hat{p}, \exists P_o \\ 0, \neg\exists P_o \end{cases}$$

*Reliance damages*: $D_r = V_p - I_p$.

### *4.2 Substitute*

The common law requires the promisee to mitigate damages. Specifically, the promisee must take reasonable actions to reduce losses occurred by the promisor's breach. The market can force the victim to find substitute items; in this case the imposed damages reflect only the difference between original contract and substitute contract[6]. With a substitute contract, the victim signs for the identical item, with the same deadline or $t_{maturity}$, but at a different price. Let *Ps* be the value of the substitute contract6. For the general case *Producer-Producer*, when **the buyer breaches the contract**, the equations become: *Expectation damages*:

$$D_e = \begin{cases} \max(P_c - I_p^g, 0), \hat{p}, \neg\exists P_s \\ P_c - v_p^g, \neg\hat{p}, \neg\exists P_s \\ \max(P_c, P_s), \exists P_s \end{cases}$$

*Opportunity cost*:

$$D_o = \begin{cases} \max(P_o - I_p^g, 0), \hat{p}, \exists P_o \neg\exists P_s \\ \max(P_o - v_p^g, 0), \neg\hat{p}, \exists P_o, \neg\exists P_s \\ \max(P_o - P_s 0), \exists P_s \end{cases}$$

[6] *Ps* comes from "spot market" while the original contract value refers to "future market".

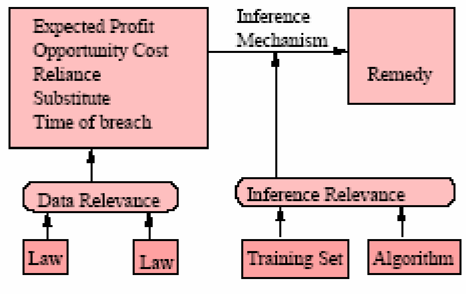

Fig. 5. Toulmin argument structure.

*Reliance damages*:

$$D_e = \begin{cases} V_p - I_p), \neg\exists P_s \\ \max(P_c - P_s, \exists P_s \end{cases}$$

## 5. PLANNED EXPERIMENTS

First, the framework can be used as a tool for automated online dispute resolution (ODR). There are three situations: (i) The market may have substantial authority, hence *one remedy is imposed to all agents*. In this case, the amount of penalties can be automatically computed with this framework. (ii) Consistent with party autonomy, *the agents may settle on different remedies at contracting time*. This approach increases the flexibility and efficiency, because the agents are the ones who know what type of remedy protects better their interests. (iii) *All the above remedies influence the amount of penalties*: in this approach the role of the framework is to monitor the market and collect data such as: the expected profit, the opportunity cost, the amount of investments made, if there is a substitute at $t_{breach}$. All these information are used as arguments when the dispute is arbitrated (Toulmin, 1958) in an architecture which combine rule base reasoning (laws) and case base reasoning (training set) as fig 5. We need a knowledge base with past cases from which the framework should be trained. Second, knowing the bids, the actual contracts, the amount of potential remedies, and the available offers on the market, the framework can identify situations in which for both agents is more profitable to breach the contract when a fortunate or an unfortunate contingency appears. It computes pairs of suggestions, helping to increase total welfare towards Pareto frontier. Third, as a simulation tool, the market designer may obtain results regarding the following questions: what types of remedies assured flexibility in the supply chain? or how information sharing influences total revenues or can be use to compute optimum reliance? In the prototype developed we are currently making experiments with different types of agents: low-high reliance, breach often-seldom, sharing information don't share, risk seeking-averse (when they are risk averse, the penalties do not need to be so high to make breachers behave appropriately).

## 6. RELATED WORKS

The task dependency network model was proposed (Walsh and Wellman, 2003) as an efficient market mechanism in achieving supply chain coordination. The authors analyze protocols for agents to reallocate tasks for which they have no acquired rights. However, this approach is rather a timeless-riskless economy. On real markets a firm seldom signs contracts with its buyers and its suppliers simultaneously. Moreover, the breach of a contract implies no penalties, which is an unrealistic assumption in real world. In contrast, in our model we used auctions, which end independently, and we introduce penalties in case of contract breaching. The role of sanctions in multi-agent systems (Pasquier *et. al.* ,2004) is the enforcement of a social control mechanism for the satisfaction of commitments. We focus only on material sanctions and we do not include social sanctions which affect trust, credibility or reputation. Moreover, we have applied four types of material remedies in a specific domain. The amount of remedies may depend on the time when the contract was Expectation damages, reliance damages, and opportunity have also been studied (Craswell R, 2000), (Cooter and Ulen, 2004), (Friedman D. D., 2000). The Toulmin argument structure was used in a framework for automated computing the distribution of matrimonial property (Bellucci, E.et al. 2003). The domain was modeled by extracting the relevant variables with the help of experts and a neuronal network was used as inference mechanism. We apply principles of contract law to determine the amount of remedies and, in our business scenario, data used for argumentation can be automatically extracted from the task dependency network.

## 7. CONCLUSIONS

This paper describes ongoing work on automating dispute resolution in a B2B context. The design of punishment policies applied to specific domains linking agents' actions to material penalties is an open research issue (Pasquier *et. al.,* 2004). The contribution of this paper contains two ideas. On the one hand, we apply the principles of contract law in the task dependency network model (Walsh and Wellman, 2003). As a result, we enrich that model by including different types of penalties when agents breach, thus bringing the model closer to the real world. On the other hand, the framework is useful for automated ODR. The data obtained can be used as arguments in a mediated dispute or the remedies can be computed in real time in case the agents agreed with the market policy.

A possible future work consists in a flexible representation of contracts and arguments in defeasible logic for the dispute resolution.


## ACKNOWLEDGEMENT

This work has been supported by the National University Research Council in Romania, projects 98/2003 and 240/2004.


## REFERENCES


European Commission (2005) Online availability of public services: how is Europe progressing? web based survey on electronic public services. Technical report, European Commission Directorate General for Information Society and Media.

Bellucci, E. and Zeleznikow J. (2003).The conflict between negotiation and litigation when building mediation decision support systems. In *ICAIL 2003 ODRWorkshop*, pages 51–60, Edinburgh, Scotland, UK.

Cooter R. and Ulen T (2004). *Law and economics*. Addison Wesley, Boston.

Craswell R (2000). Contract law: General theories. In B. Bouckaert and G. D. Geest, editors, *Encyclopedia of Law and Economics, Volume III. The Regulation of Contracts*, pages 1–24. Cheltenham.

Friedman D. D.(2000) *Law's Order*. Princeton University Press.

Pasquier P, Flores R. A., and Chaib-draa B. (2004). Modelling flexible social commitments and their enforcement. In *Engineering Societies in the Agents World*, Toulouse, France.

Sandholm T. W. and Lesser V.R. (2001). Leveled commitment contracts and strategic breach. *Games and Economic Behavior*, **35**:212–270.

Toulmin S.(1958) *The Uses of Argument*. Cambridge University Press.

Tyler M. C and Bretherton D.(2003). Seventy-six and counting: An analysis of ODR sites. In *Workshop on Online Dispute Resolution (ODR) during the International Conference on Artificial Intelligence and Law (ICAIL 2003)*, pages 13–28, Edinburgh, UK.

Vold G., Bernanrd T., and Snipes J.(2002). *Theoretical Criminology*. Oxford University Press, fifth edition.

Walsh W. and Wellman E.(2003). Decentralized supply chain formation: A market protocol and competitive equilibrium analysis. *Journal of Artificial Intelligence Research*, 19:513–567.