Towards an Argument-based Model of Legal Doctrines in Common Law of Contracts

Phan Minh Dung Phan Minh Thang

Department of Computer Science, Asian Institute of Technology
GPO Box 4, Klong Luang, Pathumthani 12120, Thailand
dung,thangphm@cs.ait.ac.th

Abstract. We propose an argument-based framework for modelling contract dispute resolution as a two-level reasoning process where at the "object-level" the acceptability of certain beliefs and facts (also called factors in the literature) is established while at the metalevel the legal doctrines determine the risk allocation. We demonstrate how legal doctrines in common law of contract could be captured by completing partially specified contracts to represent the intended contracts that the parties would have agreed on had they foreseen the unexpected problems. We point out that the risk attitudes of contract parties (and hence the outcome of the dispute resolution) often are represented by their (credulous or skeptical) modes of reasoning. We also provide a sound metalevel proof system for the doctrines of contract breach and mutual mistake.

1 Introduction

Example 1. Imagine that your organization had contracted a software company to integrate the computer systems of its head office and a newly acquired business following a design from your IT department. The integration failed. Your organization sued the software company. The company argues that both sides have made a mistake in believing that the design is workable. It hence asks for relief of performance. How should the court rule ? Would it be possible to arbitrate such disputes online ?

Common law has a case-by-case basis. Naturally, reasoning with cases has been a primary focus in the research on legal reasoning in AI and Law. The main task in reasoning with cases is to construct a theory from past cases that produces the desired legal result and to persuade the judge of its validity [5, 18].

As the vast and increasing number of cases lead to many conflicting decisions and an increased uncertainty in the law, Restatements (First and Second) of Contracts have been proposed to "restate" clearly and precisely the principles and rules of common law [3] [1]. Restatements of Contract are accepted widely in America. The restatements are especially helpful when there are not many precedent cases similar to the case at hand, a situation that is characterstic of

[1] Restatement (Second) of Contract is a revision of Restatement (First)

e-commerce. The clear and precise presentation of the legal doctrines in Restatement Second (Rest 2d) makes it especially appropriate for formal modeling. Such model would make the intepretation of cases much easier and less arbitrary[2]. The legal doctrines in Restatement Second could be viewed as representing the principles, guideline and rules for constructing theories in reasoning with cases. It hence offers itself as a promising and natural platform for formalizing legal reasoning in contract disputes.

To resolve contract disputes the court often has to construct hypothetical contracts, also called intended contracts, to represent what the parties would have agreed on had they forseen the unexpected situations. Legal doctrines in contract laws provide rules and guidelines for determining risk allocation in intended contracts. The court's decision will then follow the terms of the risk allocation in the intended contracts.

A legal resolution of contract disputes could be viewed as a two-level reasoning process where at the "object-level" the acceptability of certain beliefs and evidence (also called factors) are established while at the metalevel the legal doctrines determine the risk allocation that is to an important degree dependent on the risk attitudes of the dispute parties characterized by whether they were credulous or skeptical reasoners at the time of making the contract.

Much work has been done in the literature to study computational models for different aspects of law and legal argument [1, 5, 12, 14, 13, 16, 17, 22]. The application of formal argumentation developed in AI to legal reasoning has also received considerable attention [2, 4, 5, 22]. Works done in [2, 4, 5] have extended the abstract argumentation framework in [9] with values and demonstrated convincingly that value-based argumentation frameworks provide a natural basis for modelling legal case-based reasoning. In [12], a rule-based system has been developed to assist decision makers on making decision in a dispute on offer and acceptance in contract law. Inspired by this line of works, we propose in this paper an unified framework for modeling both the legal doctrines as they are presented in Restatement Second of Contract and the object-level reasoning about factors. Our work could be seen as an attempt to combine the strengths of the works in [1, 12, 2, 4, 5] in one framework to offer something akin to a programming environment for contract dispute resolution. For this purpose, we employ assumption-based argumentation instead of abstract argumentation.

The paper is structured as follows. After a short introduction of the doctrine of mutual mistake and assumption based argumentation, contracts and contract contexts are introduced. We then model the legal doctrines in contract law by introducing the notion of contract completion. We focus on the doctrines for relief of performance, especially the mutual mistake and impossibility doctrines.

[2] At the end of the day, when a lawyer or a judge uses a past case as a model to make a judgement, he/she should establish both cases as instances of the same principle. It is hence helpful to accentuate such principles explicitely as Rest 2d has done.

2 The Doctrine of Mutual Mistake

The mutual mistake doctrine allows one party to rescind a contract because both parties have acted on a mistaken belief about an existing fact. The party seeking relief must show that 1) the mistake concerns a basic assumption on which the contract was based, and 2) the mistake has a major impact on the fairness of the contract , and 3) the risk of this type of mistake is not allocated to the party seeking relief. For illustration of the doctrine, we recall several famous court cases below [11].

Example 2. (Sherwood Case, Michigan, 1887) Walker, a cattle breeder, agreed to sell Sherwood, a banker, a cow (Rose 2nd of Aberlone) which both parties believe to be barren. The price was 80 USD. Prior to the delivery, Walker discovered that Rose 2d is pregnant and refused to deliver her. The market price of a pregnant cow was around 800 USD. Sherwood sued, prevailed in trial court but lost in appeal. The appeal court based its decision on mutual mistake.

Example 3. (Wood Case, Wisconsin, 1885) Clarissa Wood found a colourful stone. She was told it could possibly be a topasz. She asked Boyton, a jewellry dealer. Boyton was not sure either and offered to buy it for one dollar. Wood declined. But later she needed money and returned to sell it to Boyton for one dollar. Later it turned out to be a rough diamont worth around 700 dollars. Wood brought a court action for the return of the stone citing mutual mistake. The court agreed that there was a mutual mistake but still ruled in favor of Boyton though not quite clear reasons had been given.

Analyzing this case under the doctrine of mutual mistake, modern courts and scholars agree with the ruling for the reason of conscious ignorance meaning that Wood had known that there was a risk that the stone could be more valuable but still decided to sell it. Hence she should be allocated the risk of her decision.

Many modern courts and law schools advocate the allocation of risk based on efficiency as illustrated in the following case.

Example 4. (Stees v Leonard, Minnesota, 1874) Leonard, the defendant, had a contract with Stees to build a house following a given specification commissioned by Stees. But due to unforeseen soil conditions, the construction collapsed twice when it reached certain height. Leonard then refused to continue. Stees sued for breaching of contract. Leonard defended himself by reason of mutual mistake in not foreseeing the soil conditions and faulty specification. The court ruled in favor of Stees for reasons that although there was a mutual mistake, as an expert in this building business, Leonard is expected to foresee such conditions and to take appropriate measures. The failure to do so should be at the risk of Leonard.

The decision could be completely different if Stees has the resource and means to detect more cheaply than Leonard the soil conditions and the mistakes in the specification (see Bentley v State, Wisconsin, 1889 [11])

How should the dispute in example 1 be resolved ? The decision depends on many factors. If your organization does not have much expertise in IT then the software company would be the more efficient cost bearer and the decision could be in the favor of your organization (witness Stees v Leonard). But if your organization has a reputed software engineering department or has been warned about possible problems in the design before signing the contract then the ruling could very well be in favor of the defendant (witness Bentley v State).

3 Assumption-based Argumentation

This section provides the basic background on assumption-based argumentation, see [8, 9] for details.

An assumption-based argumentation framework (AAF) is a triple $(\mathcal{R}, \mathcal{A}, \overline{})$ where $\mathcal{R}$ is set of inference rules of the form $l_0 \leftarrow l_1, \ldots l_n$ (for $n \geq 0$), and $\mathcal{A} \subseteq \mathcal{L}$ is a set of assumptions, and $\overline{}$ is a (total) mapping from $\mathcal{A}$ into $\mathcal{L}$, where $\overline{x}$ is referred to as the *contrary* of x. If $\lambda \in \mathcal{A}$ and $\neg\lambda \in \mathcal{L}$ then $\overline{\lambda} = \neg\lambda$. Assumptions in $\mathcal{A}$ do not appear in the heads of rules in $\mathcal{R}$.

A **(backward) deduction** of a conclusion α based on (or supported by) a set of premises P is a sequence of sets $S_1, \ldots, S_m$, where $S_i \subseteq \mathcal{L}$, $S_1 = \{\alpha\}$, $S_m = P$, and for every i, where σ is the selected sentence in S_i: If σ is not in P then $S_{i+1} = S_i - \{\sigma\} \cup S$ for some inference rule of the form $\sigma \leftarrow S \in \mathcal{R}$. Otherwise $S_{i+1} = S_i$.

Given a set of propositions $X \subseteq \mathcal{L}$, and some $l \in \mathcal{L}$, $X \models l$ stands for "there exists a backward deduction for l from some $X' \subseteq X$". An *argument* in favour of a sentence x in $\mathcal{L}$ supported by a set of assumptions X is a (backward) deduction from x to X.

To determine whether a conclusion (set of sentences) should be drawn, a set of assumptions providing an "acceptable" support for the conclusion needs to be identified. Various notions of "acceptable" support can be formalised, using a notion of "attack" amongst sets of assumptions whereby X *attacks* Y iff X supports an argument in favour of some $\overline{y}$, $y \in Y$. Then, a set of assumptions is deemed *admissible*, iff it does not attack itself and it counter-attacks every set of assumptions attacking it; A maximally admissible set of assumptions is called a *preferred extension*.

Given an AAF $\mathcal{F}$, a proposition $\pi \in \mathcal{L}$ is said to be a *credulous consequence* of $\mathcal{F}$, denoted by $\mathcal{F} \vdash_{cr} \pi$ if there is a preferred extension E of $\mathcal{F}$ such that $E \models \pi$. π is said to be a *skeptical consequence* of $\mathcal{F}$, denoted by $\mathcal{F} \vdash_{sk} \pi$ if for each preferred extension E of $\mathcal{F}$, $E \models \pi$ holds.

For $X \subseteq \mathcal{L}$, by $\mathcal{F} \cup X$, we mean the AAF $(\mathcal{R}', \mathcal{A}, \overline{})$ where $\mathcal{R}' = \mathcal{R} \cup \{x \leftarrow\ | x \in X\}$.

4 Modeling Contracts and Contract Contexts

In this paper, we consider only disputes in sale or service providing contracts where seller or service provider are denoted as contractors while buyer and servvice requesters are called contractees.

We assume a language $\mathcal{L}$ containing a finite set of integers and a partial order $p \succ q$ between the integers representing that p is greater than q by orders of magnitude. We further assume that $\mathcal{L}$ also contains fluents and actions.

Definition 1. *A contract between contractor CO and contractee CE is modeled as a six-tuple $\Gamma = \langle CO, CE, T, \kappa, \pi, RA \rangle$ where*

1. *T identifies the transaction or service that contractor promises to perform.*
2. *κ specifies properties of T or of the environment of T*
3. *π describes the price of performing T*
4. *RA allocates risks among the contract parties and consists of rules of the form $\sigma \rightarrow CX$ stating that if condition σ holds at the time of making the contract then the risk is allocated to $CX \in \{CO, CE\}$.*

If the identities of contractor and contractee are clear from the context, we often simply denote a contract as a quadruple $\langle T, \kappa, \pi, RA \rangle$.

Let $\Gamma = \langle T, \kappa, \pi, RA \rangle$ be a contract between a contractor CO and a contractee CE. As the law allows contract parties to rescind a contract if for example there is mutual mistake at the time of making the contract, risk allocation clauses describe the exceptions to such possibilities. A clause $\sigma \rightarrow CX$ states that under the condition σ, CX is not allowed to rescind a contract even if there is mutual mistake. In other words, under the doctrine of mutual mistake, the semantics of the contract Γ states that under condition κ, the contractor CO is obliged to perform the transcation T for a price π paid by contractee CE. But the court could make exceptions by allowing either of the parties to rescind the contract if a mutual mistake has been made. But if a condition σ holds at the time of making the contract and the party asking to rescind the contract (denoted by CX) is the risk bearer under such condition (i.e. the rule $\sigma \rightarrow CX$ belongs to RA) then no such exception is granted. The determination whether the contract parties have made a mutual mistake depends on the context of the contract defined shortly below.

Example 5. The contract between Sherwood and Walker in the Sherwood case is represented by $\langle Walker, Sherwood, SaleOfCow, True, 80, \emptyset \rangle$ stating that a cow is sold to Sherwood for the price of 80 USD. No conditions and risk allocation are given.

Similarly, the contract between Wood and Boynton in the Wood case is represented by $\langle Wood, Boynton, SaleOfStone, True, 1, \emptyset \rangle$

Contracts with empty risk allocation components are written just by $\langle T, \kappa, \pi \rangle$ for short.

As discussed before, the semantics of contracts depend on their contexts characterized by the beliefs, expertises of the contract parties in the contract domains. Further contexts under different doctrines are different. In this chapter, we consider contexts under the doctrine of mutual mistake.

Definition 2. *A context under the doctrine of mutual mistake (or just context for short) of a contract $\Gamma = \langle T, \kappa, \pi, RA \rangle$ between contractor CO and* *contractee CE is defined as a 7-tuple* $\langle \delta, CK, KO, BO, KE, BE, Cost\rangle$ *where* CK, KO, BO, KE, BE *are AAFs and*

1. *δ is a fluent representing the unexpected condition causing the reconsideration of contract Γ.*
2. *CK describes a body of common market, social and legal knowledge about the contract domain at the time of making the contract established by the court, i.e. the contract parties may not be aware of much of it at the time of making their contract.*
3. *KO, KE describe respectively the general domain knowledge contractor CO and contractee CE are expected to know at the time of making the contract.*
4. *BO, BE contain the evidences and facts about the relevant beliefs of contractor CO and contractee CE respectively at the time of making the contract.*
5. *A cost function Cost specifies the cost of possible actions the contract parties could carry out to detect the unexpected condition δ.*

Example 6. (Sherwood Case, continued) The context of the contract in the Sherwood case is represented by $\langle Pregnant, CK, KO, BO, KE, BE\rangle$:

- $CK = (\mathcal{R}_0, \mathcal{A}, \overline{})$ with $\mathcal{A} = \{Barren\}$, and $\mathcal{R}_0$ consists of the following rules: $r_1 : Price(800) \leftarrow Pregnant$, and $r_2 : 800 \succ 80$, and $r_3 : \neg Barren \leftarrow Pregnant$. The intuition of $\mathcal{A} = \{Barren\}$ is that it is an accepted commonsense that cows are assumed to be barren unless there is explicit evidence to the contrary.
- $KO = KE = CK$, and $BO = BE = (\mathcal{R}_1, \mathcal{A}, \overline{})$ with $\mathcal{R}_1 = \mathcal{R}_0 \cup \{Price(80) \leftarrow Barren\}$ representing a situation where both Sherwood and Walker fully believed (by commonsense) that the cow is barren with a price tag of 80.
- There are no actions that the parties could do to check the pregnancy of the cow (note that the case happened in 1887)Hence no Cost function.

Example 7. (Wood Case, continued) The context of the contract in the Wood case is represented by $\langle Diamond, CK, KO, BO, KE, BE\rangle$:

- $CK = (\mathcal{R}_0, \mathcal{A}, \overline{})$ with $\mathcal{A} = \emptyset$ and $\mathcal{R}_0$ consists of the following rules: $r_1 : Price(700) \leftarrow Diamond$, and $r_2 : 700 \succ 1$, and $r_3 : False \leftarrow Topasz, Diamond$. The intuition of $\mathcal{A} = \emptyset$ is that commonsense does not make any assumption about this type of stones.
- $KO = KE = (\mathcal{R}_0, \mathcal{A}_1, \overline{})$ with $\mathcal{A}_1 = \{Topasz, \neg Topasz\}$ representing that both Wood and Boynton are not expected to know whether the stone is a topasz or not[3] .

[3] One can ask why not $\mathcal{A}_1 = \{\}$ or $\mathcal{A}_1 = \{Topasz, \neg Topasz, Diamond, \neg Diamond\}$. Wood has been told that the stone could be a Topasz. Hence she is aware that it could be either Topasz or not. Therefore, it is not possible that $\mathcal{A}_1 = \{\}$. The idea that the stone could be a diamond does not come up at all in the discussion between Wood and Boyton at the time of making the deal. Hence none of them could assume that it could be a Diamond. Therefore it is not possible that $\mathcal{A}_1 = \{Topasz, \neg Topasz, Diamond, \neg Diamond\}$.

– $BO = BE = (\mathcal{R}_1, \mathcal{A}_1, \overline{})$ and $\mathcal{R}_1 = \{Price(1) \leftarrow Topasz\}$, representing that both Wood and Boynton were not sure whether the stone is topasz or not, but accepted to trade it for the price of one dollar.

5 Intended Contracts

Contract parties often do not specify their contract completely. In a dispute, the court has to complete it with the terms that the parties would have agreed to had they negotiated over the unforeseen situation. In the following, we first define the notion of mutual mistake before giving the definition of the notion of complete intended contracts.

Definition 3. *Let $\Gamma_0 = \langle T, \kappa, \pi, RA \rangle$ be a contract between a contractor CO and a contractee CE and $CNT = \langle \delta, CK, KO, BO, KE, BE, Cost \rangle$ be a context of Γ_0.*

1. *We say that a* **mutual mistake** *has been made by both contract parties wrt CNT if there exists a condition λ, called the* **intended condition***, such that following conditions are satisfied:*
   (a) *$BO \vdash_{cr} \lambda$ and $BE \vdash_{cr} \lambda$, i.e. both parties believed that λ (possibly) holds at the time of making the contract.*
   (b) *$\lambda \models \kappa$, i.e. λ is a specific condition of κ.*
   (c) *$\{\delta\} \cup CK \vdash_{sk} \neg\lambda$, i.e. the parties made a mistake in believing that λ holds at the time of contract making.*
   (d) *$BO \cup \{\lambda\} \vdash_{sk} Price(\pi)$ and $BE \cup \{\lambda\} \vdash_{sk} Price(\pi)$, i.e. both parties accept price π under condition λ.*
2. *We say that the contact parties have made a* **mutual mistake violating a basic assumption** *wrt CNT if a mutual mistake has been made by the contract parties and one of the following conditions holds:*
   (a) *$\{\delta\} \cup CK \vdash_{sk} \neg T$, i.e T is not executable under δ.*
   For example, CO sells to CE an annuity (T) on some person P's life. Then P must be alive ($\lambda = alive$)[4]. But if if it turns out that P was already dead at the time of making the contract ($\delta = dead$) then CE can rescind the contract.
   (b) *If $CK \cup \{\delta\} \vdash_{sk} Price(p)$ then either $CK \vdash_{sk} p \succ \pi$ or $CK \vdash_{sk} \pi \succ p$.*

   Condition 2 determines that λ is a "basic assumption" in the sense that its non-satisfaction would either invalidate the transaction or service T or the market value of T is qualitatively different to π (by orders of magnitude) and hence one of the parties would not accept π as the contract price as it will suffer a significant loss.

Example 8. Let $\Gamma = \langle SaleOfCow, True, 80 \rangle$ be the original contract in the Sherwood case. Let CNT be the context defined in example 6. It is not diificult to check that a mutual mistake violating a basic assumption has been made where the intended condition is Barren.

[4] CK could contain a rule like $dead \rightarrow \neg annuity$

We have defined whether a mutual mistake has been made by the contract parties. But we have not determined the risk allocation for the unexpected situation. There are two principles. One is the conscious ignorance principle stating that if a party was aware that its knowledge is limited but still went ahead with the contract, this party should bear the risk of the contract [3]. The other principle is based on efficiency stating that risks should be allocated to the party that could bear it at the least cost [21].

Definition 4. *Let $\Gamma_0 = \langle T, \kappa, \pi, RA \rangle$ be a contract between a contractor CO and a contractee CE. A contract Γ_1 is called the* **complete intended contract** *of Γ_0 in the context $CNT = \langle \delta, CK, KO, BO, KE, BE, Cost \rangle$ if following conditions hold:*

1. *If a mutual mistake violating a basic assumption (with λ being the intended condition) has been made wrt CNT then $\Gamma_1 = \langle T, \lambda, \pi, RB \rangle$ where RB is obtained by adding risk allocation clauses to RA as follows:*
   (a) **Conscious Ignorance***:*
   Adding $\delta \rightarrow CO$ to RA if $BO \not\vdash_{sk} \lambda$ (i.e. the contractor does not fully believe in λ), and
   Adding $\delta \rightarrow CE$ to RA if $BE \not\vdash_{sk} \lambda$.
   (b) **Efficiency** *If a party could reasonably anticipate the unexpected situation δ more efficient than other party, this party should bear the risk. Formally, this doctrine is represented by*
      i. *$\delta \rightarrow CO$ is added to RA if there is some reasonable action α the contractor CO could do to detect δ, i.e. $\{\alpha\} \cup KO \vdash_{sk} \delta$, and for each reasonable action β that could be carried out by CE to detect δ, $Cost(\beta) \succ Cost(\alpha)$ holds.*
      An action α is said to be reasonable if its cost is acceptable wrt price of the contract, i.e. $\pi \succ Cost(\alpha)$.
      ii. *Similar conditions for assigning risk to CE*
2. *If no mutual mistake violating a basic assumption has been made wrt CNT then Γ_1, Γ_0 coincide*

Example 9. (Sherwood, continuation of example 8)

From $BO \vdash_{sk} Barren$ and $BE \vdash_{sk} Barren$, it follows that the principle of conscious ignorance does not allocate any risk to the contract parties. As there are no actions the parties could have carried out to check the pregnancy of the cow at the time of making the contract, no risk is allocated to the parties by the principle of efficiency. Therefore, no party should carry the risk of the cow being pregnant. The complete intended contract is $\Gamma_2 = \langle SaleOfCow, Barren, 80, \emptyset \rangle$.

The complete contract would have been different if this case happens in our time when cheap pregnancy tests are available. The knowledge base KO of Walker would contain a clause $pregnant \leftarrow test$ stating that a test will reveal that the cow is pregnant and the cost function satisfies $80 \succ Cost(test)$. According to the efficiency principle, Walker would have to bear the risk of the cow being pregnant, i.e. $\Gamma_2 = \langle SaleOfCow, Barren, 80, \{pregnant \rightarrow Walker\}$.

Example 10. (Wood, continued) Original contract: $\Gamma_0 = \langle SaleOfStone, True, 1\rangle$. The context CNT is given in example 7. As there are no actions the parties could have carried out to check the stone at the time of making the contract, no risk is allocated to the parties by the principle of efficiency. From $BO \vdash_{cr} \neg Topasz$ and $BE \vdash_{cr} \neg Topasz$, it follows that the principle of conscious ignorance allocates risk to both parties. Therefore, the complete intended contract is $\Gamma_2 = \langle SaleOfStone, Topasz, 1, \{diamont \rightarrow Wood,\ diamont \rightarrow Boynton\}$. Hence none of the parties could rescind the contract.

5.1 Contract Semantics under Doctrine of Mutual Mistake

Let $\Gamma_0 = \langle T, \kappa, \pi, RA\rangle$ be a contract between a contractor CO and a contractee CE and $\Gamma_1 = \langle T, \lambda, \pi, RB\rangle$ be the **complete intended contract** of Γ_0 in the context $CNT = \langle \delta, CK, KO, BO, KE, BE, Cost\rangle$. If no mutual mistake violating a basic assumption has been made then the contractor has to perform transaction T and the contractee has to pay a price π for it. If a mutual mistake violating a basic assumption has been made and there is no clause of the form $\delta \rightarrow CX$ in RB then CX could rescind the contract. Otherwise CX is not allowed to rescind the contract. If CX is not allowed to rescind the contract and its opponent insists to perform it then CO has to perform T and CE has to pay π.

6 The Doctrine of Impossibility

The impossibility doctrine allows one party to rescind a contract due to the occurrence of unexpected events that make the performance literally impossible. The party seeking relief must show that 1) the event occurred after the contract was made, and 2) the event has destroyed a basic assumption on which the contract was based, and 3) the risk of this type of mistake is not allocated to the party seeking relief. For illustration of the doctrine, we recall a famous court case below [11].

Example 11. (Taylor v Caldwell, 1863) The plaintiff hired the defendant's hall for concerts. After signing the contract but before the first concert a fire destroyed the hall. The court relieved the defendant from performing the contract for the reason that the fire has destroyed the hall, a basic assumption of the contract.

For reasoning with the doctrine of impossibility, the definition of contract is extended by adding clauses of the form $\epsilon \rightarrow CX$ for event ϵ and $CX \in \{CE, CO\}$ to the risk allocation component RA in contracts stating that if event ϵ happens then CX should bear the risk.

We assume that the language $\mathcal{L}$ contains a special event E denoting the event of contract signing and a binary relation $\epsilon_0 \sqsubset \epsilon_1$ between events stating that ϵ_0 happens before ϵ_1.

Definition 5. *The contexts of a contract under the doctrine of impossibility are defined as 5-tuples* $\langle \epsilon, CK, KO, KE, Cost \rangle$ *where* ϵ *represents an unexpected event, CK, KO, KE are AAFs and*

1. CK *describes a body of common knowledge established by the court whose purpose is to establish 1) whether event* ϵ *happened before or after the contract making, and 2) event* ϵ *has rendered the performance of the contract literally impossible.*
2. KO, KE *describe respectively the general domain knowledge contractor CO and contractee CE are expected to know at the time of making the contract.*
3. *A cost function Cost specifies the cost of possible actions the contract parties could carry out to prevent the unexpected event* ϵ *.*

Example 12. (Taylor Case, continued) The context of the contract in the Taylor case is represented by $\langle Fire, CK, KE, KO \rangle$ where $CK = (\mathcal{R}, \mathcal{A}, \overline{})$ with $\mathcal{A} = \{Hall\}$, $\overline{Hall} = \neg Hall$ and $\mathcal{R}$ consists of the following rules:
$\neg Performance \leftarrow \neg Hall$ and
$\neg Hall \leftarrow Fire$, and
$E \sqsubset Fire \leftarrow$
stating respectively that a necessary (i.e. basic) condition for performance is the existence of a hall and fire destroys hall and the fire happened after the contract signing.

$KO = KE = (\mathcal{R}_0, \mathcal{A}, \overline{})$ with $\mathcal{R}_0$ equals $\mathcal{R}$ minus the rule stating that the fire has happened after the contract signing.

Both parties could not do anything to forsee the fire and take precaution. Hence the cost function Cost is not defined.

A contract $\Gamma = \langle T, \kappa, \pi, RA \rangle$ is said to be **impossible** wrt context $CNT = \langle \epsilon, CK, KO, KE, Cost \rangle$ if following conditions are satisfied:

1. $CK \vdash_{sk} E \sqsubset \epsilon$
2. $CK \vdash_{sk} \neg T$

Let $\Gamma_0 = \langle T, \kappa, \pi, RA \rangle$ be a contract that is impossile wrt context $CNT = \langle \epsilon, CK, KO, KE, Cost \rangle$. A contract $\Gamma_1 = \langle T, \kappa, \pi, RB \rangle$ is called a **complete intended contract** of Γ_0 in the context CNT if RB is obtained by adding risk allocation clauses to RA following the efficiency principle as follows: If a party could prevent the unexpected event ϵ more efficient than other party, this party should bear the risk. Formally, this doctrine is represented by

1. $\epsilon \to CO$ is added to RA if there is some reasonable action α the contractor CO could do to prevent ϵ, i.e. $\{\alpha\} \cup KO \vdash_{cr} \neg\epsilon$, and for each reasonable action β that could be carried out by CE to prevent ϵ, i.e. $\{\beta\} \cup KE \vdash_{cr} \neg\epsilon$, $Cost(\beta) \succ Cost(\alpha)$ holds
2. Similar conditions for assigning risk to CE

Returning to the Taylor example, as both contract parties could not do anything to prevent the fire, the complete intended contact coincides with the actual one. Hence in this case, no party should bear the cost of the fire.

7 A Meta-Level Proof System for Legal Doctrines

In the Sherwood case, Sherwood sued Walker using the doctrine that a failure to performe a considered promise [5] constitutes a contract breach. The argument is based on the proposition that Walker has promised to sell the 2nd Rose to Sherwood for a price of 80 USD and has refused to perform it. To defend himself, Walker argued that though there was indeed a contract, but due to a mutual mistake the contract should not be carried out. As Sherwood does not counterargue against Walker's argument, his argument is defeated and the case is decided in favor for Walker.

In the following, we present a metalevel proof system capable to represent the kind of reasoning with the legal doctrines discussed above. We focus on the contract breach and mutual mistake doctrines.

1. Given a contract $\Gamma = (T, \kappa, \pi, RA)$ between a contractor CO and a contractee CE, a theory Th_Γ representing Γ consists of the following selfexplaining sentences
   $Contract(CO, CE, \Gamma),\ Transaction(T, \Gamma),\ Price(\pi, \Gamma),\ Conditions(\kappa, \Gamma)$
   together with a material implication $Happen(E) \rightarrow RiskAllocatedTo(CX, \Gamma)$ for each rule of the form $E \rightarrow CX$ is in RA.
2. The doctrine that a failure to perform a considered promise constitutes a breach of contract states that if CX is a party in a contract Γ then CX must perform his part of the bargain in the contract unless there are exceptions for him to rescind it. This doctrine is represented by two rules:

   $$\frac{Contract(CO, CE, \Gamma),\ Transaction(T, \Gamma),\ \neg Rescind(CO, \Gamma)}{Perform(CO, T)}$$

   stating that if CO is the contractor in contract Γ then CO must perform the transaction T of the contract unless there are exceptions for him to rescind it, and a similar rule requiring a contractee to pay

   $$\frac{\begin{array}{l}Contract(CO, CE, \Gamma),\ Transaction(T, \Gamma),\ Perform(CO, T)\\ Price(\pi, \Gamma),\ \neg Rescind(CE, \Gamma)\end{array}}{Pay(CE, \pi)}$$

3. The doctrine of mutual mistake provides a class of exceptions to the doctrine of contract breach when both parties make mistake. The doctrine of mutual mistake could be represented by the following rule

[5] A promise is considered if the promisor get something in return from the promisee for performing his/her promise. In the Sherwood case, the consideration consists of Sherwood paying Walker 80 USD

$$\frac{MutualMistake(\lambda, \mathit{\Gamma}), \quad ViolateBA(\mathit{\Gamma}), \quad \neg RiskAllocatedTo(CX, \mathit{\Gamma})}{Rescind(CX, \mathit{\Gamma})}$$

stating that

- it is a mutual mistake to believe that λ holds at the time of making contract (as it actually does not hold) and
- the contract violates a basic assumption and
- the risk of the mistake is not allocated to CX

4. We now introduce proof rules for establishing the mutual mistake. In the following BX stands for BE or BO and CX for CE or CO respectively.

   There are two belief predicates at the metalevel. One is a credulous belief where an agent chooses to believe in something though he is aware that the opposite may be true. The other is a skeptical belief where the agent is convinced that his belif is true in all possible worlds. The following rule makes use of credulous belief. The skeptical belief predicate will be used in the next rule.

   $$\frac{BX \vdash_{cr} \lambda, \quad \lambda \models \kappa}{CBelieve(CX, \lambda, \mathit{\Gamma})}$$

   This rule states that if we could establish that λ follows from the belief base of CX and λ is a specific condition of κ then we could draw a conclusion at the metalevel that CX believes (credulously) in λ as a condition of the contract, instead of κ.

   $$\frac{BX \cup \{\lambda\} \vdash_{sk} Price(\pi)}{SBelieve(CX, Price(\pi), \mathit{\Gamma})}$$

   This rule states that the judge could establish that CX is fully convinced that π is the right price for the contract $\mathit{\Gamma}$ if it could be proved that π is the price of the transaction T from the beliefs of CX.

5. The following rule states that the contract $\mathit{\Gamma}$ is based on a mutual mistake if it can be shown that the negation of λ follows from the facts and domain knowledge represented by CK at the time of making the contract and both contract parties believe (credulously) that λ holds at the time of making contract and they believe strongly (skeptically) that the price π is the right price for their transaction.

   $$\frac{\begin{array}{l} CK \cup \{\delta\} \vdash_{sk} \neg\lambda \\ CBelieve(CO, \lambda, \mathit{\Gamma}), \quad CBelieve(CE, \lambda, \mathit{\Gamma}), \\ SBelieve(CO, Price(\pi), \mathit{\Gamma}), \quad SBelieve(CE, Price(\pi), \mathit{\Gamma}), \end{array}}{MutualMistake(\lambda, \mathit{\Gamma})}$$

6. The following three rules establish that a basic assumption has been violated in the contract Γ.

$$\frac{CK \cup \{\delta\} \vdash_{sk} \neg T}{ViolateBA(\Gamma)}$$

This rule states that under condition δ, T is not executable.

$$\frac{CK \cup \{\delta\} \vdash_{sk} Price(p),\ \ p \succ \pi}{ViolateBA(\Gamma)}^{6} \qquad \frac{CK \cup \{\delta\} \vdash_{sk} Price(p),\ \ \pi \succ p}{ViolateBA(\Gamma)}$$

These two rules state that the price π stated in the contract Γ is a very unfair price for a transition T under condition δ.
7. The following rule represents the principle of conscious ignorance by stating that if the party CX is aware that the opposite of the condition of the contract may hold but still go ahead with making it then CX should bear the risk of his action.

$$\frac{BX \vdash_{cr} \neg\lambda}{RiskAllocatedTo(CX, \Gamma)}$$

8. The following rule captures a special case albeit probably a most frequent case, of the efficiency principle in allocating risk.

$$\frac{\begin{array}{l} Price(\pi, \Gamma) \\ \exists\alpha : KX \cup \{\alpha\} \vdash_{sk} \delta,\ \pi \succ Cost(\alpha), \\ \nexists\beta : \overline{KX} \cup \{\beta\} \vdash_{sk} \delta,\ \pi \succ Cost(\beta)^{7} \end{array}}{RiskAllocatedTo(CX, \Gamma)}$$

9. We write $Th_\Gamma \vdash_M \Phi$ if Φ could be derived from Th_Γ using the above defined proof rules wrt context $CNT = \langle \delta, CK, KO, BO, KE, BE, Cost \rangle$

It is not difficult to see that the proof system is sound for the doctrines of contract breach and mutual mistake.

Theorem 1. *Let $\Gamma = (T, \kappa, \pi, RA)$ be a contract between a contractor CO and a contractee CE and $CNT = \langle \delta, CK, KO, BO, KE, BE, Cost \rangle$ be a context of Γ. Assuming that the price for the concerned transaction is uniquely determined from the knowledge base CK, following assertions hold:*

1. *If $Th_\Gamma \vdash_M MutualMistake$ then a mutual mistake has been made by the contract parties wrt context CNT.*

[6] We assume that the price for the concerned transaction is uniquely determined from the knowledge base CK

[7] $\overline{KX}$ is the knowledge base of the opposite party of CX

2. *If* $Th_{\Gamma} \vdash_M MutualMistake \wedge ViolateBA(\Gamma)$ *then a mutual mistake violating a basic assumption has been made by the contract parties wrt context CNT.*
3. *If* $Th_{\Gamma} \vdash_M Rescind(CX, \Gamma)$ *then CX could rescind the contract* Γ *following the semantics defined in section 5.1.*

In general, the presented proof system is not complete due to the fact that to prove conscious ignorance, one should prove that $BO \not\vdash_{sk} \lambda$. Though $BO \vdash_{cr} \neg\lambda$ implies $BO \not\vdash_{sk} \lambda$, the reverse is not true. The trade-off here is that the computational complexity of $BO \vdash_{cr} \neg\lambda$ is NP-complete while that of proving $BO \not\vdash_{sk} \lambda$ is Π_2^p [7].

7.1 Dialogue Systems for Constructing Knowledge and Belief Bases

In legal proceedings, the knowledge and belief bases forming the contexts of legal doctrines are constructed incrementally by the parties during their exchanges of arguments. Such exchanges also consitute a proof of the facts and evidences that the dispute parties need to prove. There is a huge body of research on this topic in the literature [4, 13, 14, 22, 23, 19, 20]. These works could be extended to provide a mechanism for constructing the knowledge and belief bases and the proofs for object level proposition.

8 Conclusion and Future Work

We have proposed a novel new approach for modelling contract dispute resolution based on an argument-based model of doctrines stated in Restatement Second. We demonstrated the promises of the new approach by modelling two doctrines for relief of performance, the mutual mistake and impossibility doctrines. Other doctrines for relief of performance like the doctrine of impracticality and frustration of purpose could also easily be modelled within our framework. We also provide a metalevel proof system for reasoning with the doctrines of contract breach and mutual mistake. We leave the development of a proof system for doctrine of impossibilities as an execise to the readers.

Representing the legal doctrines at a meta level allows us to separate the argumentation about the doctrines from the argumentation about the facts and evidence, hence allowing an intuitive encapsulation of the latter and as a result providing a modular approach to the conflict resolution process as a whole. Therefore from a software engineering point of view, we believe that the approach proposed in this paper makes it possible to develop in a stepwise manner legal consultant systems about contracts. This approach would allow the consideration of more complicated forms of contracts with more elaborated semantics [24, 10, 15, 6].

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