

Integrating Natural Language and Formal Analysis for Legal Documents

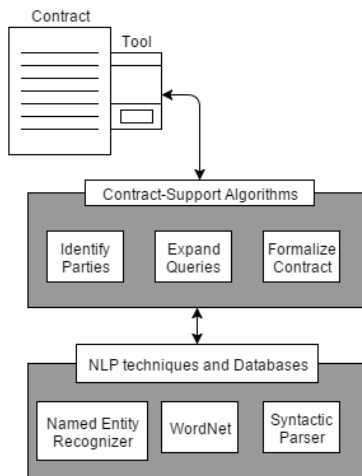
Shaun Azzopardi¹ Albert Gatt² Gordon J. Pace¹

¹Department of Computer Science, ²Institute of Linguistics,
University of Malta

September 2016

- ▶ Legal document analysis is a rich field (classification algorithms, analysis of language and formatting use etc.).
- ▶ However practical tools available to legal professionals are limited, although computational intelligence has been harnessed efficiently for other professionals (e.g. AutoCad for architects and engineers).
- ▶ Many possible formal representations of legal documents (e.g. deontic logic) that allow one to reason about them, but missing techniques to go from text to formal logic automatically.
- ▶ We detail a proof-of-concept tool that leverages NLP tools for the formal analysis of contracts, while also providing other useful features.

Tool Architecture



- ▶ Integrated in Word
- ▶ Every feature presented as a task pane, or through a context menu.

Features:

- ▶ Legal Document Cross-referencing
- ▶ National Company Database Search
- ▶ Related Word Search
- ▶ Conflict Analysis Search

Legal Document Cross-Referencing

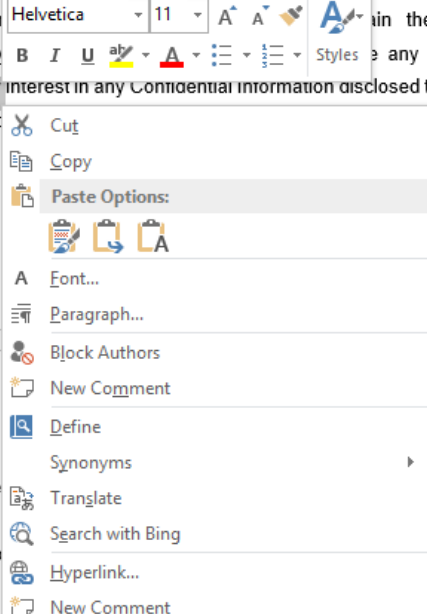
The screenshot shows a Microsoft Word document titled "Two-Way Confidentiality Agreement.docx". The ribbon includes FILE, HOME, INSERT, DESIGN, PAGE LAYOUT, REFERENCES, MAILINGS, REVIEW, VIEW, and DEVELOPER. A sidebar on the left contains "Search in Laws" with sub-items "Keywords", "Identify Parties", and "Entities Mentioned", and a "Tools" section. The main document text contains two numbered paragraphs:

5. All Confidential Information, without limitation, shall remain the personal and proprietary property of Discloser. Recipient shall not acquire any licence or other intellectual property interest in any Confidential Information disclosed to it by Discloser. Further disclosure of Confidential Information shall not result in any obligation to grant Recipient any right in or to said Confidential Information.

6. At any time upon request by Discloser, Recipient shall immediately return to Discloser all Confidential Information it has received from Discloser, including but not limited to all notes and reports which may have been made regarding said Confidential Information, and all copies thereof. Recipient may retain one copy of each item of Confidential Information received by it hereunder and notes regarding the same, provided that said copy shall be retained and used solely for compliance purposes and shall be held in Recipient's confidential and secured files under the same standards.

On the right, a "Search Laws of Malta" sidebar is open. It features a search input field containing "intellectual property" and a "Search" button. Below the input is an "Include S.L." checkbox and an "Advanced Search" button. A list of search results is displayed, with "Cap. 414 - Intellectual Property Rights (Cross-..." selected. Other results include "Cap. 488 - Enforcement of Intellectual Property...", "Cap. 415 - Copyright Act", "Cap. 327 - Education Act", "Cap. 123 - Income Tax Act", "Cap. 497 - Public Administration Act", "Cap. 12 - Code of Organization and Civil Procedure", "Cap. 413 - Equal Opportunities (Persons with Di...", "Cap. 444 - Malta Council for Culture and the Ar...", "Cap. 500 - Services (Internal Market) Act", "Cap. 511 - Malta Libraries Act", "Cap. 164 - Police Act", "Cap. 458 - Medicines Act", "Cap. 13 - Commercial Code", "Cap. 378 - Consumers Affairs Act", "Cap. 9 - Criminal Code", and "Cap. 16 - Civil Code".

Legal Document Cross-Referencing

5. All Confidential Information is the personal and proprietary property of the Discloser and shall remain the property of the Discloser. No recipient shall have any licence or other interest in any Confidential information disclosed to it by Discloser. Further disclosure of Confidential information shall be at the discretion of the Discloser. Recipient shall have no obligation to grant any right in Confidential information to any third party.
6. At any time upon request, the Discloser shall return to the Recipient all Confidential Information, and all notes and reports containing Confidential Information, and all copies thereof, and shall delete all copies of Confidential Information from its systems and devices. The Recipient shall be responsible for the return of Confidential Information and shall not be limited to the return of Confidential Information of each item of Confidential Information.
- 

Language-Support Algorithms

- ▶ These features are supported through a number of off-the-shelf NLP packages:
 - ▶ Syntax tree parser (Stanford parser)
 - ▶ Lexical database (WordNet)
 - ▶ Keyword Extraction
 - ▶ Named Entity Recognizer
 - ▶ Legal Documents & Company Database
- ▶ Dependency injection is used to allow for these to be easily updated by the user with any other implementation, without the need to edit any source code.

Contract-Support Algorithms

- ▶ The logic behind each feature is also encapsulated in separate modules, with the same benefits.
 - ▶ Contract Structure/Clause Recognizer
 - ▶ Query Expansion
 - ▶ Related Laws and Company Search
 - ▶ Formal Analysis Module

- ▶ *Provided the passenger satisfies any local airport regulations and checks, when at the boarding gate, the passenger should board the plane. If this is violated, they should return to the check-in desk.*
- ▶ *If the passenger is at the boarding gate, the passenger should not be carrying any weapons, otherwise the passenger should leave the airport.*

- ▶ Two or more parties involved.
- ▶ List of definitions and clauses.
- ▶ Clauses can be obligations, permissions or prohibitions (i.e. norms), e.g. renter is obliged to pay rent.
- ▶ Clause can be structured in a certain way, that places certain conditions on their activation (e.g. renter is obliged to pay rent, on the first day of the month).

Given an action a and a party p :

- ▶ Obligations $\rightarrow O_p(a)$
- ▶ Permissions $\rightarrow P_p(a)$
- ▶ Prohibitions $\rightarrow F_p(a)$

Given an action a and a party p :

- ▶ Obligations $\rightarrow O_p(a)$
- ▶ Permissions $\rightarrow P_p(a)$
- ▶ Prohibitions $\rightarrow F_p(a)$

- ▶ Conditionals $\rightarrow [a]C$
- ▶ Sequential Composition $\rightarrow C \triangleright C'$ [If C is satisfied then C' is active]
- ▶ Reparation $\rightarrow C \blacktriangleright C'$ [If C is violated then C' is active]

Given an action a and a party p :

- ▶ Obligations $\rightarrow O_p(a)$
- ▶ Permissions $\rightarrow P_p(a)$
- ▶ Prohibitions $\rightarrow F_p(a)$

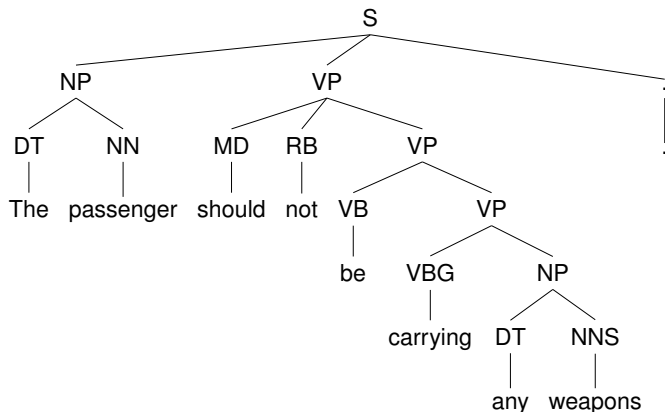
- ▶ Conditionals $\rightarrow [a]C$
- ▶ Sequential Composition $\rightarrow C \triangleright C'$ [If C is satisfied then C' is active]
- ▶ Reparation $\rightarrow C \blacktriangleright C'$ [If C is violated then C' is active]

- ▶ Satisfied Contract $\rightarrow \top$
- ▶ Violated Contract $\rightarrow \perp$

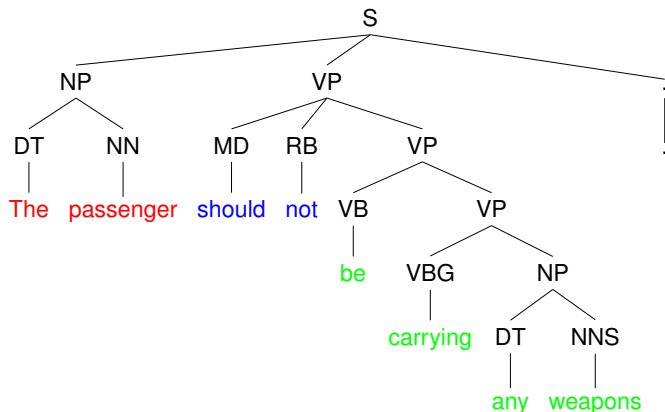
Formal Analysis - 'Translation' Algorithm

- ▶ Entity recognition -> Party names
- ▶ Constituency parser -> Structure of sentence
- ▶ Tree patterns -> Formal clauses

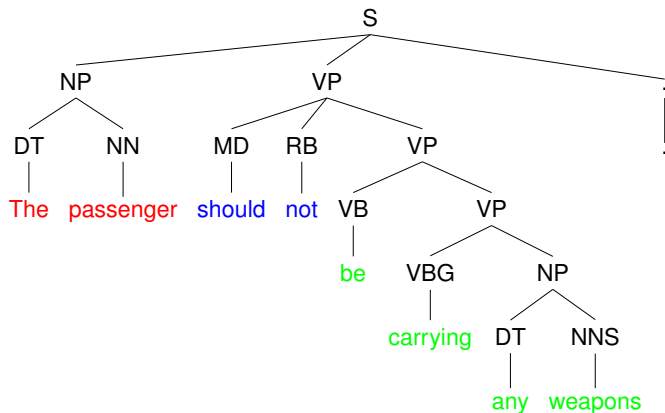
Formal Analysis - 'Translation' Example



Formal Analysis - 'Translation' Example



Formal Analysis - 'Translation' Example



$F_{passenger}(carryWeapons)$

Formal Analysis - Conflict Detection

- ▶ *Provided the passenger satisfies any local airport regulations and checks, when at the boarding gate, the passenger should board the plane. If this is violated, they should return to the check-in desk.*
- ▶ $([atGate]O_p(satisfes) \triangleright O_p(boardPlane)) \blacktriangleright O_p(desk)$
- ▶ *If the passenger is at the boarding gate, the passenger should not be carrying any weapons, otherwise the passenger should leave the airport.*
- ▶ $([atGate]O_p(noWeapons)) \blacktriangleright O_p(leave)$

Formal Analysis - Conflict Axioms

Two contracts are said to be in conflict if there is no trace that satisfies both at the same time. The conflict relation is denoted by \bowtie , so that that C and C' are conflicting is denoted by $C \bowtie C'$. Note also that we denote two mutually exclusive actions as $a \bowtie a'$.

Axioms:

$$\vdash P_p(a) \bowtie F_p(a) \quad (1)$$

$$\vdash O_p(a) \bowtie F_p(a) \quad (2)$$

$$a \bowtie a' \vdash O_p(a) \bowtie O_p(a') \quad (3)$$

$$a \bowtie a' \vdash O_p(a) \bowtie P_p(a') \quad (4)$$

$$C \bowtie C' \vdash C' \bowtie C \quad (5)$$

$$C \bowtie C' \wedge C' \equiv C'' \vdash C \bowtie C'' \quad (6)$$

Formal Analysis - Conflict Detection

- ▶ *Provided the passenger satisfies any local airport regulations and checks, when at the boarding gate, the passenger should board the plane. If this is violated, they should return to the check-in desk.*
- ▶ $([atGate]O_p(satisfes) \triangleright O_p(boardPlane)) \blacktriangleright O_p(desk)$
- ▶ *If the passenger is at the boarding gate, the passenger should not be carrying any weapons, otherwise the passenger should leave the airport.*
- ▶ $([atGate]O_p(noWeapons)) \blacktriangleright O_p(leave)$

Contract	TP	TN	FP	FN	Precision	Recall	F_1	$F_{0.5}$
C14	14	33	5	2	0.739	0.875		
C21	9	170	56	0	0.139	1		
C41	16	61	9	0	0.64	1		
C69	12	37	4	0	0.75	1		
C199	5	37	18	10	0.217	0.333		
Results					0.497	0.842	0.625	0.541

Table: Formalizing norms evaluation.

- ▶ Formalisation can be augmented using dependency parsing, and more types of analyses can be employed (e.g. detecting useless clauses).
- ▶ Results can also be made precise through detecting definitions in document.
- ▶ More useful features can be added, e.g. template management, versioning system (WIP) etc.

Conclusions

- ▶ Law is an area of the humanities where NLP tools have yet to make a noticeable impact.
- ▶ We implemented a contract-drafting aid tool as a Word add-in, integrating both natural language and contract-focused analyses within it.
- ▶ We show how syntactic parsing can be employed to (naively) translate a contract text into a deontic logic model.
- ▶ Tool was tested with lawyers and notaries, with positive feedback on legal documents and company cross-referencing.