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Preventing disputes: preventive logic, law & technology

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Chapter 1

The Art of Preventive Law

Aristotle Onassis, a Greek entrepreneur, was one of the most successful shipping tycoons of the Twentieth Century [Evans, 1986] [1]. Onassis (1900-1975) used Preventive Law to secure himself and his business from financial losses. The following narrative demonstrates how he *accomplished* this when his opponents planned to cause his business in Peru to suffer severe financial losses. The opponents were some shipping businessmen and a few law enforcers from FBI and CIA (in the narrative provided below they are called 'we') [2].

We knew that Onassis's fleet had the habit to fish in illegal waters of Peru. As a consequence, we planned with the Peruvian Government to seize his fleet. The Government sent out ships and an aircraft, which actually bombed the waters around the factory ship. They certainly strafed the ship with machine gun fire and they forced the boat back into harbor with the captures. The Peruvians were very nasty about it, gave a huge fine and said they needed three million dollars to let Onassis's fleet go again. The night that this happened we were believing that we now had killed the monster. Much to our amazement we saw and learned that he had anticipated this whole thing by booking for disasters at Lloyd's of London. So, all in all, we watched him make a profit. He got 15 million dollars in insurance money and three thousand each day that he was out of the whaling operation. Thus, he made an enormous amount of money and he was just laughing all the way to the bank.

[1] To avoid all confusion with names and also to make them more familiar, we mention the first name of a person at the first occurrence together with the family name, when we believe it is supportive for the understanding of the text.

[2] Robert Mayhew, former FBI agent, CIA consultant and expert investigator acting on behalf of Onassis's opposition, and Dr. Ray Gambell, Secretary of International Whaling Commission, produced for the BBC, (1994), *Aristotle Onassis 'The Golden Greek'*, B.B.C. Documentaries, min. 36:14 (for readability reasons the oral text used has been slightly paraphrased).

1.1 My Motivation

This narrative illustrates the art of Preventive Law (see Definition 1.1).

Definition 1.1 – ***Preventive Law***

> ***Preventive law*** is a *method* that minimises the likelihood of the occurrence of disputes, or in case they occur it exploits their impact, and strengthens legal rights and duties.

The author became aware of this concept through Onassis's lawyer, Tryfon Koutalidis [3] [Papinianus, 2003]. Koutalidis often provided short legal memoranda to Onassis or other people working for him. When there were no pressing issues on the table, Onassis would call for gym-time. During gym-time, the businessman, lawyer, and other directors of his business examined hypothetical scenarios to secure themselves from potential risks that could arise. In this process, Preventive Law developed into a practice, where legal risks were discussed and secured. Reading more about Onassis inspired me (Georgios Stathis) during my study to find applications of preventive law in particular jurisdictions and in legal theories. It motivated me to investigate whether *the best way to resolve any dispute is to prevent it from happening*. This challenging idea stimulated me and others in my direct neighbourhood to examine the power of Preventive Law.

1.2 The Academic Start

Brown (1950) was the first to introduce the concept in academic circles via his book *Preventive Law* [Brown, 1950]. However, until today, Preventive Law has not fundamentally advanced from the perspective of preventing legal problems. Indeed, several academics have attempted to improve the theory of Preventive Law, but without much success. Even with the use of computer technology, it did not significantly change. Then, all of a sudden the disciplines of Law, Computer Science, Data Science, and Artificial Intelligence (AI) (see Definition 1.2 [High-Level Expert Group on AI, 2019]) were combined.

[3] Most of the applications of Preventive Law concerning Onassis's business were to prevent financial risks. For this reason, and because he was educated on applying Preventive Law by Onassis, Mr. Tryfon Koutalidis claims with a smile that he graduated from the 'Onassian University of Financial Contracts'.

*Definition 1.2 – **Artificial Intelligence***

> ***Artificial Intelligence*** refers to systems designed by humans that, given a complex goal, act in the physical or digital world by perceiving their environment, interpreting the collected structured or unstructured data, reasoning on the knowledge derived from this data, and deciding the best action(s) to take (according to pre-defined parameters) to achieve the given goal.

Soon the world was facing the dawn of *legal technologies* [4] and the arrival of *Intelligent Contracts* (iContracts) (see Definition 1.3 [5]).

*Definition 1.3 – **Intelligent Contract***

> An **intelligent contract** or **iContract** is a contract that is fully executable without human intervention.

Our research aims to pave the way to the conceptualisation of *Preventive Legal Technology* (PLT), which is a central outcome of the research (see Definition 1.4).

*Definition 1.4 – **Preventive Legal Technology***

> ***Preventive Legal Technology*** is a methodology concerned with use of legal technology within the context of preventive law with the purpose of promoting the intelligent prevention of disputes.

1.3 A Practical Start: Avoiding Legal Costs

Assume that a legal problem occurs between two parties who are subject to a legal agreement. Both sides may experience costs, e.g., by psychological pressure, legal and financial support, reputation damage, or loss of time. The allocation of costs will always affect one or sometimes both parties of the legal agreement, depending on the legal problem itself and how or when it will be resolved. At least one party will incur (1) the *procedural* costs connected with the legal problem, and potentially, (2) the *liability* costs from the hazardous event that triggered the legal problem [6]. In total, legal costs are frequently quite large and

[4] Examples are to be found in the advanced courses for the Ministry of Justice and Security, the Public Prosecution and others: see Leiden Legal Technologies Program (LLTP), Leiden Centre of Data Science and The Centre for Professional Learning (LCDS and CPL), 2021.

[5] `https://bravenewcoin.com/insights/pamela-morgan-at-bitcoin-south-innovating-legal-systems-through-blockchain-technology`

[6] Often, legal problems and their formal adjudication also incur relationship costs among the parties; these can include curtailing possible future transactions of mutual benefit.

they primarily appear as dispute resolution costs [7], even in the world's most advanced jurisdictions [Susskind, 2019]. This is why commentators opine that we need *new ways* to resolve and avoid disputes [Katsh and Rabinovich-Einy, 2017]. A major reason why legal costs are so high is that the structure of legal systems invites dispute *resolution* and not dispute *prevention* [Barton, 2009]. All in all, legal costs give rise to a need for preventive law.

1.4 Towards Proactive Practices

While innovation is accelerating and induces rapid changes around the world, the legal system is—to a large extent—still relying on traditional processes established over the course of the past few centuries [Barton, 2016]. The disconnection between *innovation* and *tradition* in the legal system is particularly amplified by the introduction of more complex technologies [De Franceschi and Schulze, 2019]. As a result, we see that each year the development of laws increases in *number* and the resolution of legal problems significantly grows in *complexity* [Katz et al., 2020]. One of the consequences of the growing legal complexity is a problem that has recently arisen: how can the legal needs of millions of people be safeguarded? [Susskind, 2008].

As Susskind somewhat later remarked, in some court systems there are staggering backlogs of court cases (e.g., 100 million in Brazil and 30 million in India—according to the Organisation for Economic Cooperation and Development (OECD), fewer than 50 percent of people on earth live under the protection of the law) [Susskind, 2019]. Indeed, in his 1996 book *The Future of Law*, Susskind already predicted that with technology our approach to legal problems will switch from *problem solving* to *problem prevention*, through the use of proactive facilities supporting Legal Risk Management (LRM) [Susskind, 1996]. There he stated that our legal system is subject to the paradox of *reactive legal services* [8]; a paradox which in his opinion would be replaced by *proactive*

[7]Usually, dispute resolution costs are a percentage of the liability costs. The best available research estimates that liability costs as a fraction of the Gross Domestic Product (GDP) are equal to 2.3 percent in the United States of America (US[A]) (429 Billion Dollars [US Chamber Institute for Legal Reform, (2018), Costs and Compensation of the US Tort System, instituteforlegalreform.com, p.1] in 2016) and 0.63 percent (Best available number derived from US Chamber Institute for Legal Reform, (2013), International Comparisons of Litigation Costs, instituteforlegalreform.com, p.2) in Euro zone (85.8 Billion Dollars [Calculated 0.63 percent of 2011 Euro zone GDP 13.6 Trillion Dollars as recorded at countryeconomy.com, (2011), Euro Zone GDP – Gross Domestic Product] in 2011). An economic analysis looking beyond GDP to socio-economic consequences is even more relevant to highlight the costs of dispute resolution with higher accuracy.

[8]The paradox of reactive legal services addresses that in order to recognise the need for legal help at the right time one should be a lawyer, however, since most people in need of legal help are not lawyers, they can hardly recognise, especially at the right time, the need for legal help;

practices induced by technology [Susskind, 1996]. What we can observe now is that, since 1996, when Susskind first made the prediction, until today the legal system has not notably changed. Taking into consideration the massive case backlog, it would be reasonable to state that the legal system still seems to be more *reactive* than *proactive*.

1.5 Preventing Legal Problems

Assuming someone attempts to apply preventive law to *prevent legal problems*, then there is still a high likelihood for legal problems to *further develop* instead of diminish. The first elementary framework for the prevention of legal problems was introduced by Brown [Brown, 1950]. Dauer later added a schematic approach to Brown's observations by stating that prevention can be applied at three intervals to manage legal risk, i.e., *before*, *during*, and *after* damage occurs [Dauer, 2008]. Dauer's systematic analysis resulted in a matrix [Barton, 2009]. Barton called it Dauer's matrix and refined it considerably [Barton, 2002] [Barton, 2006] (see Table 1.1).

Currently, most literature focusses on the *mindset* and *application* of Preventive Law. This book contains many examples in a variety of domains, one of which is iContracts (see Section 1.6). Indeed, there is a range of specialised exceptions, which only partially help people prevent legal problems. They come from the fields of *proactive law* [Haapio and Siedel, 2013] and *Legal Risk Management* [Esayas and Mahler, 2015]. In general, the reasons behind the lack of a substantive number of methods or approaches to prevent legal problems are unclear (indeed, they form a part of our research).

Whatever the case may be, at this moment we observe a research gap in the literature between (1) a *direct application* of preventive law and (2) the use of *practical methods* that explain how to prevent legal problems. The practical methods are currently felt as mostly lacking.

According to the literature, the most advanced methods for preventing legal problems focus on contract risk management [Haapio and Siedel, 2013]. So, our research is centred around *contract automation* (see Section 1.6) [Stathis et al., 2023d, Stathis et al., 2024].

which results to lawyers providing more reactive legal services than proactive.

Table 1.1: Dauer Matrix

	Direct Parties	**Third Parties**	**Government Regulation or Facilitation**	**Physical Environment**
1a. Planning: Imagine the risks				
1b. Planning: Imagine various structures and methods to prevent problems from arising				
2. Addressing Problems: Use early warning systems and resulting information to prevent problems from escalating into "disputes"				
3. Dispute Resolution: Take steps to resolve disputes fairly and efficiently, using a succession of methods				
4a. Feedback and Follow-up: Anticipate and foreclose adverse spill-over effects of the resolution itself				
4b. Feedback and Follow-up: Feedback the nature of the problem and dispute to Step 1, the planning process				

1.6 Contract Automation

Recently, the field of contract automation has experienced three major innovations. The first one is the digitalisation of contract management (hereinafter *digital contracts*), where certain contractual processes are digitised, such as signing, drafting, storing, reviewing, sharing, and analysing contracts [Timmer, 2019]. The second innovation regards the rise of *smart contracts* demonstrating that parties can reach and execute agreements via programming [Kolvart et al., 2016]. Today, we face the dawn of the third innovation, namely *intelligent contracts*. iContracts introduce a hybrid approach between human and computer interventions that aim to achieve full automation with self-executing contracts [Mason, 2017]. iContracts introduce state-of-the-art innovations in the space of contact automation due to their compliance with Hybrid AI's four development dimensions: (1) environment, (2) purpose, (3) collaboration, and (4) governance) [Huizing et al., 2020]. Our investigation relies on two AI technologies: *Ontology Engineering* (see Definition 1.5 for Ontology [Feilmayr and Woss, 2016] and Definition 1.6 for Ontology Engineering [Gal, 2009]) and *Large Language Models* (LLMs) (see Definition 1.7 [9]).

Definition 1.5 – ***Ontology***

Ontology is a formal, explicit specification of a shared conceptualisation that is characterised by high semantic expressiveness required for increased complexity.

Definition 1.6 – ***Ontology Engineering***

Ontology engineering is the set of activities that concern the ontology development process, the ontology life cycle, and the methodologies, tools and languages for building ontologies.

Definition 1.7 – ***Large Language Models***

Large Language Models (LLMs) are a category of foundation models trained on immense amounts of data making them capable of understanding and generating natural language and other types of content to perform a wide range of tasks.

[9] https://www.ibm.com/topics/large-language-models

1.7 Problem Statement and Six Research Questions

In this thesis we are motivated by preventive law and are interested in investigating how it is possible to prevent disputes, with contractual disputes as the main case study.

1.7.1 Problem Statement

The shift towards the automated prevention of disputes paradigm generates multiple questions related to multiple disciplines including, non-exclusively, Law, Logic and AI. Based on this observation, we formulate the following Problem Statement (PS) in a sufficiently open manner to invite multi-disciplinary research, combining the aforementioned disciplines.

PS: *To what extent is it possible to automate the prevention of disputes?*

To address the PS, we will decompose it into six tractable Research Questions (RQs).

1.7.2 Six Research Questions

Starting with iContracts as a concrete case study for this research, we will investigate *contract automation*. While examining the contracting process from an end user perspective it became apparent to us that end users spend much time during contracting focussed on communications. Moreover, due to lack of widely adopted contract risk management methodologies, the interplay between communications and risk during contracting is mostly not interlinked.

Below we introduce six RQs. Given the complexity of the matter, especially within the context of automation, the need for semantic specificity is born. In contract automation, ontology (see Definition 1.5 and 1.6) design can assist the clarification of the relation of communications and risk. Below we introduce two new specialised ontologies: (1) the Onassis Ontology and the (2) Enriched Bow-Tie Ontology (EBTO), which are described in detail in Chapter 2 (Onassis Ontology) and Chapter 3 (EBTO).

Research Question 1

From the perspective of an end user the technological innovation mentioned above is only interesting when it is more useful than existing alternatives. Therefore, an important criterion is that the resultant quality provided during contracting is equal to or greater than that of a legal expert. Moreover, it is important that all stages of contracting are taken into consideration, including all risks therein, from initial communications and drafting (when contracting parties exchange information with each other) up to execution and reporting (when the performance of parties in the execution of contract is evaluated).

With these criteria in mind, RQ1 is formulated as follows.

> **RQ1:** *To what extent is it possible to develop an ontology to automate contracts with communications and risk data?*

Chapter 2 discusses RQ1 and the extent to which it is possible via the Onassis Ontology, defined in Chapter 2 as an ontology for contract automation based on communications and risk data.

Research Question 2

While developing the ontology for communication and risk automation, it became apparent that no consensus exists for managing contract risk. It is evident that the view at a risk management level differs from the view at an ontology design level. Currently, the most advanced methodology for managing contract risk is the Bow-Tie Method [10] (see Chapter 3). By investigating the application of the Bow-Tie Method on contract risk we can explore the limitations of contract risk analysis and thereafter the degree to which contractual disputes are preventable. Therefore, the design of a specific ontology for the management of risk, including contract risk, based on the Bow-Tie Method should be deeply investigated.

Accordingly, the second RQ is a as follows.

> **RQ2:** *To what extent is it possible to translate the Bow-Tie Method into a visualisation of an ontology for contract risk management without altering the bow-tie structure?*

Chapter 3 discusses RQ2 and the extent to which it is feasible via the Enriched Bow-Tie Ontology (EBTO). This is an ontology for managing risk, including contract risk, designed in accordance with the Bow-Tie Method. After the Onassis Ontology it is the second ontology we design and introduce in this research.

Research Question 3

Developing an ontology that aims to provide an improved alternative to end users would be insufficiently validated without taking into consideration the *perspective* of end users. By analysing the options of end users involved in contracting, we may observe that one of the main functions of a legal expert during

[10] https://www.wolterskluwer.com/en/solutions/enablon/bowtie/expert-insights/barrier-based-risk-management-knowledge-base/the-bowtie-method

end user communications is the *explanation of risk*. That is particularly important provided the binding consequences that legal decisions may carry. Hence, the impact of visualisation of risk to end users during the communications stage of a contract should be solidly trustworthy (see Definition 4.2 in Chapter 4).

From these observations, we arrive at our third RQ.

> **RQ3:** *To what extent is it possible to improve user trustworthiness for Intelligent Contracts via the visualisation of risk during legal question-answering?*

Chapter 4 addresses RQ3 and the extent to which it is possible via an explorative survey. The survey examines the level of the end user's trustworthiness. It is based on the visualisation of risk during contracting to end users via the EBTO.

Research Question 4

For our research, it holds that the most important element of the Bow-Tie Method for successful prevention is the *identification of proactive controls* during risk management. An expert will arrive at (1) proactive controls when (2) a hazardous event and (3) a risk source is identified (the data of (1) are called "Proactive Control Data" or "PCD", and data (1) (2) and (3) together are called "Proactive Data"). From an ontology design *perspective*, it is vital to clarify whether PCD can be programmed. Yet, programming PCD should not occur in a vacuum. Their impact as well as their quality should be both understood by the designer as well as by the user.

Hence, we arrive at RQ4.

> **RQ4:** *To what extent is it possible to generate quality Proactive Control Data to improve an Intelligent Contract?*

Chapter 5 addresses RQ4. It discusses the extent to which it is possible via the development of a prototype of the Onassis Ontology and the Enriched Bow-Tie Ontology structures, to perform a Large Language Model (LLM) (see Definition 1.7) experiment as well as the application of the Logocratic Method (LM) (see Chapter 5). All in all, we speak of a scientific method for (a) the analysis of arguments, (b) the quality assessment and (c) the evaluation of PCD.

Research Question 5

Beyond the investigation of contract risk management via an ontology, it is vital to examine (a) the extent to which PLT can be developed and (b) the relationship between ethics, preventive law and technology, in particular in light of AI developments. Currently, we see two important topics in Ethics and AI research. They are the development of *explainable* and *trustworthy* AI. Hence, an interesting and intriguing question arises on whether it is possible to develop an explainable and trustworthy PLT. If that is indeed possible, then we are able to trust the decisions of PLT.

Consequently, we arrive at RQ5.

> **RQ5:** *To what extent is it possible to develop an explainable and trustworthy Preventive Legal Technology?*

Chapter 6 discusses RQ5 and the extent to which it is possible via the application of the EBTO on multiple legal technology case studies to point to the legal and ethical gaps in the development of explainable and trustworthy PLT.

Research Question 6

Looking beyond academic research, the application of iContracts in the market becomes imperative. The promise of iContracts is that it will solve some serious challenges that either physical or digital or smart contracts are facing. For the acceleration of the adoption of iContracts in the market we examine Large Language Models (LLMs) (see Definition 1.6). Hence, we investigate the extent to which LLMs can help in improving user adoption of iContracts.

Consequently, we arrive at RQ6.

> **RQ6:** *To what extent is it possible to accelerate the adoption of Intelligent Contracts with Explainable Large Language Models?*

Chapter 7 discusses RQ6 and the extent to which fast market adoption is possible via the clarification of iContracts relative to physical, digital and smart contracts. After identifying the market adoption gap, Chapter 7 examines where LLMs can help in accelerating their adoption rate. For the precise meaning of *explainable* we refer to Chapter 6.

1.7.3 Research Methodology

The topic of automating contractual dispute prevention is complex. Focussing only on legal aspects leads to legal solutions. Similarly, a purely computational approach yields only computational answers. Therefore, effectively addressing the Problem Statement requires a multifaceted approach, prompting us to adopt a multidisciplinary research methodology. Our research methodology can be broken down into six main categories, as detailed below.

1. Literature
2. Analysis
3. Case Studies

4. Visualisation
5. Engineering
6. Experiment

Each RQ is addressed in a separate chapter, tailored to answer that specific question. Literature and analysis are the main categories that are consistently used in answering each RQ. As for case studies, the methodology was used in answering each RQ, except RQ2. The visualisation methodology was employed in answering RQ2 and RQ3. Engineering was used in answering RQ1 and RQ4. Experiments were used in answering all RQs. Due to the multi-disciplinary nature of the research the specific research methodology categories used to answer each RQ are detailed in the relevant chapter.

1.8 Research Contributions

For readability purposes, we will list below the six main contributions of our research. The six contributions are discussed in the Chapters 2 to 7, respectively.

- *Contribution 1 (Chapter 2)* We will design an ontology (Onassis Ontology) for contract automation that shows that automation based on communications and risk data is possible and essential for iContracts, even though the inclusion of communications and risk data in automation is currently absent in existing LegalTech solutions.

  Communications and risk data contribute to the development of effective and responsible contract automation that reduces the need for the physical involvement of legal experts. We will show that is possible to design an ontology that demonstrates how the reduction mentioned above is practically feasible. Surprisingly, even in the world's largest LegalTech solutions database no available solution focusses on this subject.

- *Contribution 2 (Chapter 3)* We will design an ontology (Enriched Bow-Tie Ontology [EBTO]) for risk management, including contract risk management, that leverages the Bow-Tie Method for scaling and cross-referencing risk management purposes.

  The traditional Bow-Tie Method design is based on a cause-sequential order that helps, justifiably, in explaining cause and effect risk management in an analytical manner. From a technological perspective, designing based on node-sequential order is necessary for scaling the application of the method in large and complex contexts that require scalability and cross-referencing.

Such a design assists with (a) the analysis and (b) the visualisation of risk management, and (c) the extraction of semantic relationships.

- *Contribution 3 (Chapter 4)* We will show that risk visualisation during legal-question answering improves the end user's trustworthiness by 6.9 (as derived from a scale of 1 to 10).

  Let us assume there is a trustworthiness scale from 1 to 10. Scale 1 refers to a Graphical User Interface (GUI) *without any* risk visualisation that end users are called upon to use during legal-question answering. Scale 10 refers to a legal expert who is explaining with *ultimate specificity* to end users the risk involved in a potential contract during the communication stage. By visualising the EBTO to end users and conducting an explorative survey we will show that an average end user assigns a trustworthiness level of 6.9 to a GUI that explains the risk during the legal-question answering.

- *Contribution 4 (Chapter 5)* We will show that (a) the generation of Proactive Control Data is possible, (b) their impact on contract drafting is significant, and (c) measuring their quality assessment and evaluation is possible.

  First, the generation of PCD is possible and that is executed by programming a prototype of the Onassis Ontology and the Enriched Bow-Tie Ontology structures. Second, we conduct an LLM experiment showing the significant impact of PCD on contract drafting. Third, the quality assessment and evaluation becomes possible with the application of the Logocratic Method (by using the virtue of arguments framework on PCD).

- *Contribution 5 (Chapter 6)* We will show that developing an explainable and trustworthy Preventive Legal Technology is possible, by focussing on rule-based explanations.

  By explaining the decisions of PLT, we achieve a higher degree of *trustworthiness* because explicit explanations improve the level of transparency and accountability. Trustworthiness is an *urgent topic* in the discussion on (a) doing AI research ethically and (b) accounting for the regulations. For this purpose, we highlight the limitations of rule-based explainability for PLT. Explaining the AI decisions for small PLT domains is shown to be possible, with direct effects on trustworthiness due to the increased transparency and accountability.

- *Contribution 6 (Chapter 7)* We will show that LLMs can contribute in the acceleration of the market adoption of iContracts.

  With the application of LLM technology on specific challenges of iContracts we combine both technologies so that they can handle the market adoption challenge. Moreover, we will show (a) how iContracts relate to the previous contracting technologies and (b) why the combination of LLMs and iContracts has a unique advantage relative to the previous technologies, mainly by their use of communications and risk data analysis automation.

1.9 Thesis Overview

In Chapter 1, we introduced the *art of preventive law* and how it motivated the author to investigate the power of prevention. Then we provided a summary of developments in the theory of preventive law and introduced the topic of the research: Preventive Legal Technology. After introducing its main function, the avoidance of legal costs, we showed how preventive law develops methods for the prevention of legal problems. So far, contract automation is the most advanced field for preventing legal problems. Our research used iContracts, the latest revolution in contract automation, as the main case study. We formulated our PS, and decomposed it into six RQs. After intensive research we arrived accordingly at six contributions. The remainder of the thesis is given below.

- **Chapter 2** answers RQ1 resulting in Contribution 1. The content of the chapter corresponds to the publications by

  Stathis, G., Trantas, A., Biagioni, G., de Graaf, K. A., Adriaanse, J. A. A., and van den Herik, H. J. (2024). Designing an Intelligent Contract with Communications and Risk Data. *Springer Nature Computer Science (SNCS): Recent Trends on Agents and Artificial Intelligence*, 5(709). https://doi.org/10.1007/s42979-024-03021-x

  and

  Stathis, G., Trantas, A., Biagioni, G., van den Herik, H. J., Custers, B., Daniele, L., and Katsigiannis, T. (2023d). Towards a Foundation for Intelligent Contracts. *In the Proceedings of the 15th International Conference on Agents and Artificial Intelligence (ICAART)*, 2:87–98.

- **Chapter 3** answers RQ2 resulting in Contribution 2. The content of the chapter corresponds to the publication by

  Stathis, G., Biagioni, G., Trantas, A., van den Herik, H. J., and Custers, B. (2023b). A Visual Analysis of Hazardous Events in Contract Risk Management. *In the Proceedings of 12th International Conference on Data Science, Technology and Applications (DATA)*, 1:227–234.

- **Chapter 4** answers to RQ3 resulting in Contribution 3. The content of the chapter corresponds to the publication by

Stathis, G., Trantas, A., Biagioni, G., and van den Herik, H. J. (2023c). Risk Visualisation for Trustworthy Intelligent Contracts. *In the Proceedings of the 21st International Industrial Simulation Conference (ISC), EUROSIS-ETI*, pages 53–57.

- **Chapter 5** answers RQ4 resulting in Contribution 4. The content of the chapter corresponds to the publication by

  Stathis, G., Biagioni, G., de Graaf, K. A., Trantas, A., and van den Herik, H. J. (2023a). The Value of Proactive Data for Intelligent Contracts. *World Conference on Smart Trends in Systems, Security and Sustainability (WorldS4), Intelligent Sustainable Systems, Springer Lecture Notes in Networks Systems (LNNS)*, 803:107–125.

- **Chapter 6** answers RQ5 resulting in Contribution 5. The content of the chapter corresponds to the publication by

  Stathis, G. and van den Herik, H. J. (2024). Ethical & Preventive Legal Technology. *Springer AI and Ethics*. https://doi.org/10.1007/s43681-023-00413-2.

- **Chapter 7** answers RQ6 resulting in Contribution 6. The content of the chapter corresponds to the publication by

  Stathis, G. (2024b). Explainable Large Language Models & iContracts. *In the Proceedings of the 16th International Conference on Agents and Artificial Intelligence (ICAART)*, 3:1378–1385.

- **Chapter 8** entails the conclusions of the thesis, in three distinct sections. We (1) answer the six research questions, (2) provide an answer to the problem statement, and (3) discuss potential directions of future work.

- **Chapter 9** provides a collection of reflection statements for the purpose of clarifying how non-experts in legal technology can apply this thesis in legal practice.

Most of the papers presented in this thesis were produced as a joint collaboration between the supervisors, the PhD candidate and a domain-expert research team. Discussions on research topics and how to handle the problems described were addressed as a team, in principle between the supervisors and the candidate. The writing was performed primarily by the candidate who is the main author of each paper, incorporating the commentary provided by the supervisors and the domain-experts. The implementation of the experimental designs and gathering of the results were performed by the candidate, except in cases where domain-expertise was necessary. Then, the domain-experts provided their contributions. The specific contribution of each domain-expert is provided in the acknowledgments section under each article.

Moreover, each domain-expert provided explicit contribution statements to Leiden University's evaluation committee to further clarify and secure the validity of their contributions. Finally, in compliance with the evaluation committee's request, each chapter includes the explicit contribution of each domain-expert in accordance with Elsevier's *CRediT Author Statement* guidelines [11].

[11] https://www.elsevier.com/researcher/author/policies-and-guidelines/credit-author-statement