

ANALOGICAL METHODS IN LEGAL INFORMATICS

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Abstract: *The law occurs in a dual mode: a basic mode and an expert mode. In the basic mode, people predominantly experience the law in a situational and not a textual way. The people on the street move according to the consuetudinary law. In the expert mode, the law goes up textually to the professional lawyer. It becomes mostly about argumentation in professional language rather than natural language. Digitalisation encompasses both these modes. The extent to which digitalisation is visible is another issue. We argue that analogical thinking continues to be important in law and that this must be considered in legal informatics.*

1. Introduction

Digitalisation in the domain of law encompasses both modes of the law – the basic mode and the expert mode – and changes, at the least, its technical foundation. In the basic mode, people are living their everyday lives and are governed primarily by customary law. Ordinary people predominantly experience the law in a situational and not a textual way. The behaviour that is parallel to the law is important to them. People do not know the text of the highway code, but instead they know its content, which is conveyed to them in various ways. In the expert mode, the law goes up textually to the professional lawyer, and indirectly also to the layman involved in a case. It becomes mostly about argumentation, which takes place in professional language rather than natural language.

The extent to which digitalisation becomes visible on the surface is another question. In this paper, the proposal is argued that analogical thinking continues to play a very important role in law and that this must also be taken into account in legal informatics.

In order to define the term «analogue method», we consider the quality «analogue» to have the same meaning as in the term «analogue signal».¹ The word «analogue» refers to a *continuous* representation and «digital» refers to a *discrete* representation.

The terms «analogical method» and «analogue method» (in British English, or «analog method» American English) may be distinguished. However, we find that they have a sense in common – there is an analogy

¹ «An analog signal is any continuous signal for which the time-varying feature (variable) of the signal is a representation of some other time varying quantity, i.e., *analogous* to another time varying signal. For example, in an analog audio signal, the instantaneous voltage of the signal varies continuously with the pressure of the sound waves. It differs from a digital signal, in which the continuous quantity is a representation of a sequence of discrete values which can only take on one of a finite number of values», Wikipedia, https://en.wikipedia.org/wiki/Analog_signal (accessed on 19 November 2019).

relationship between the state of an analogue device and the model; see [MACLENNAN 1994, 422].² For this reason, the term «analogical method» (in a broad sense) appears in the title. The term «analogical method» in a narrow sense is also discussed (see section 6) in relation to how «an analogy is evaluated in terms of source-target similarity» [BARTHA 2019, 6].

In legal argumentation, the qualities to be subsumed are often continuous and not discrete. However, the human vs. machine dichotomy, rather than the continuous vs. discrete dichotomy, is central to legal informatics. This human/machine dichotomy can be related to the analogue/digital dichotomy.

This paper continues our earlier explorations of legal informatics; see [ČYRAS/LACHMAYER 2019; ČYRAS/LACHMAYER/SCHWEIGHOFER 2016].

2. A framework for the analysis of digitalisation in legal informatics

We will explain the framework of concern sequentially, using three pictures. First comes a *situationally reactive schema* (Figure 1 a). A subject appears in a situation. The subject receives an input from the environment and reacts with an output. The schema is situational because the input-output behaviour depends on the situation. The schema is analogue. The subject can be modelled as an agent³ [RUSSELL/NORVIG 2003, 32].

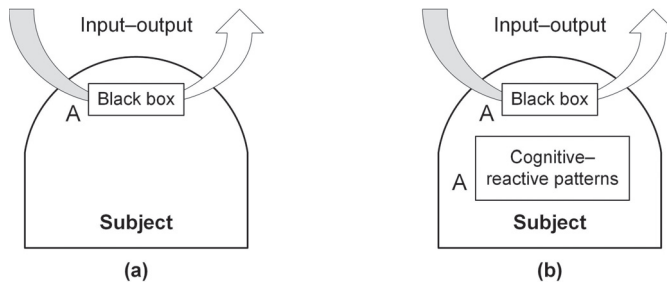


Figure 1: (a) Situationally reactive schema; (b) cognitive-reactive schema

Next, this schema is supplemented with *cognitive-reactive patterns* (Figure 1 b). The subject recognises the input and interprets it accordingly. Suppose, for instance, the subject sees a friend or a foe. The subject’s reaction is not chaotic, but is driven by a cognitive-reactive pattern. The meaning of the reaction, or the decision, is in accordance with to this pattern. Cognitive subsumption occurs first, then normative subsumption. The schema is analogue.

The schema is now supplemented with spoken language (Figure 2). Language is a collectively developed cultural phenomenon. Communication requires a collectively standardised means. Language changes the interpretation of the input. Language means that there is a difference between this schema and the cognitive-reactive schema, which can also be attributed to animals. The grammar of the language is assigned to a meta-level (see, further, Figure 3).

Next, written language supplements the schema (Figure 2). Verbal writing (e.g. Latin) and pictorial writing (e.g. Chinese) are distinguished. Continuous, analogue, properties prevail in pictorial writing. Here, iconic properties outweigh discrete properties. However, discrete properties prevail in verbal writing and grammar. Syntax makes the language stricter. The system of Arabic numerals (a positional base 10 system) has advantages over the system of Roman numerals. The binary numeral system, with two digits, 0 and 1, demonstrates artificial notations.

² MACLENNAN begins by asking what «analogue» means: «On one hand, the term «analog» suggests that there is some special relationship (an analogy) between that state of an analog device and the system it’s modeling; on the other hand, in most people’s minds the terms «analog» and «digital» are synonymous with «continuous» and «discrete» [MACLENNAN 1994, 422].

³ «[A]nything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators» [RUSSELL/NORVIG 2003, 32].

Next comes communication (Figure 2). Pictures, speech and writing can be communicated, directly to a receiver or via different media such as print, television or computer. Language can be objectivised and thus becomes an object. Various technologies can be used in communication. Acoustic-visual media are typical ones. Mechanisation and digitalisation take place. Besides human-human communication there are also human-machine communication and machine-machine communication. Languages are being developed. Technical languages, algorithmic languages and logical notations are created.

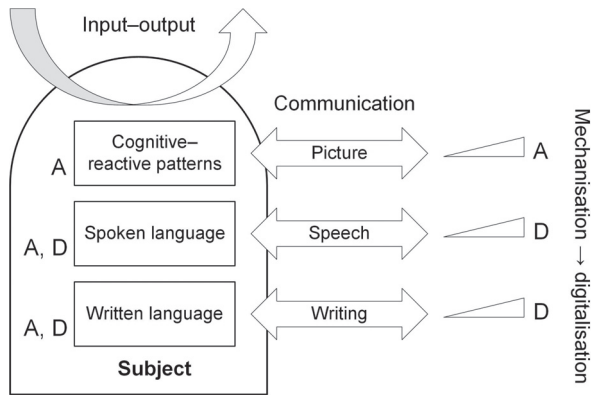


Figure 2: Supplementing the schema with language, communication and mechanisation/digitalisation

The subjects embrace things (including those in the internet of things), persons and also hybrid entities such as robots, autonomous cars and electronic organisations (Figure 3). These hybrid entities can act in a similar way to persons. Analogue/digital analysis of the subjects may tackle various aspects.

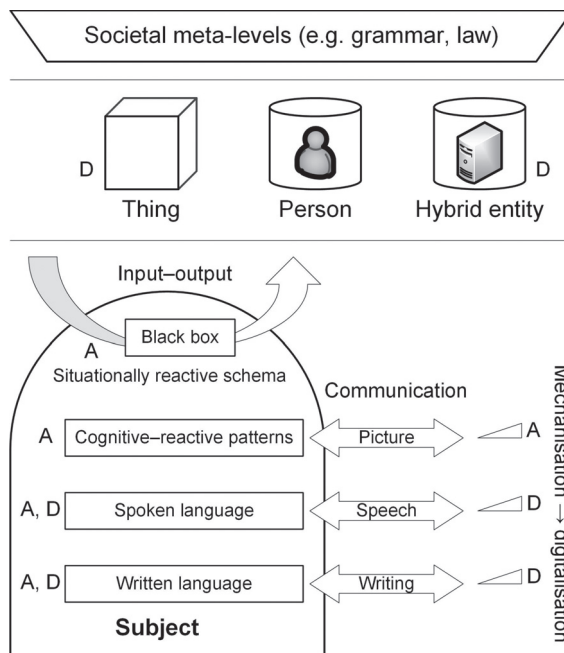


Figure 3: The framework for digitalisation analysis in legal informatics

On a societal meta-level, different frames can be distinguished, such as the grammar of the language or the law (Figure 3 on the top). The legal frame is explored in legal informatics, too. For instance, the legal status of robots or electronic organisations is an issue.

3. The analogue vs. digital dichotomy

Brain neurons transmit electrochemical signals. At the physical level, thus, brain processes are electrochemical. Therefore the word «analogue» is better suited than the word «digital» for describing brain processes. The reason is that electrochemical models are commonly understood to involve differential equations and thus continuous representations. Computer processors, however, are digital. At the low physical level of description we see no conflict between analogue and digital. There are several reasons for this. First, «[i]n matters of formality, interpretability, and so forth, analog computation and digital computation are not essentially different» [MACLENNAN 1994, 421]. The second reason is that people communicate with computers through language. Language allows both continuous and discrete models to be represented in digital computers. Moreover, both continuous and discrete interaction styles are possible in human-computer interaction (HCI). Examples of interaction styles are command line interfaces, menus, natural language, question/answer and query dialogues, form-fills and spreadsheets, WIMP (window, icon, menu, pointer), point and click, and three-dimensional interfaces.

The human vs. machine dichotomy, rather than the continuous vs. discrete one, is stressed in this paper. We hold that the distinction between humans and machines is one reason for separating human intelligence and artificial intelligence (AI). Human intelligence in its entire scope cannot be automated with computers. Human intelligence is essential in legal methods, where the idea of constructing a subsumption machine (*Subsumptionsautomat*, or «mechanistic judge») is rejected [OGOREK 1986, 212, 292 ff]. The application of the law has to avoid formalism (mechanistic approaches). Wisdom is required to solve a hard case, and this is beyond the representation of knowledge in the form of clear-cut rules in computers.

4. Human-computer interaction (HCI)

The analogue vs. digital dichotomy can be illustrated by considering clocks. The languages used for setting analogue and digital clocks are:⁴

- Task language. Set time to a certain value;
- Input language. Wheel vs. buttons;
- System language. Mechanical movement vs. integrated circuits; and
- Output language. Minute and hour hands vs. liquid-crystal display.

When speaking about cognition, mental models (imagined worlds) are neither continuous nor discrete. Mental models are characterised in higher-level terms. In HCI, cognition has been described in terms of specific kinds of processes that include attention, perception and recognition, memory, learning, reading, speaking and listening, and problem solving, planning, reasoning, and decision making [SHARP/PREECE/ROGERS 2019, 103]. Examples of cognitive level issues can be considered.⁵

⁴ See FRANZ KURFESS' course «Human-Computer Interaction», file 486-W19-05-Interaction-Styles.pdf, slide 20, <http://users.csc.calpoly.edu/~fkurfess/Courses/486/W19/> (accessed on 19 November 2019), 2019.

⁵ For example: «What information do users need to develop a strategy for performing a particular task? Do they need absolute or particular values? [...] What is the user's mental model of the interface and task (which will often differ from the designer's or the observer's mental model of the same interface and task)? [...] How can users tell if things are not going well? What feedback do they get? What strategies are available to the user when the system goes wrong? How can we ensure that users do not lose their ability to perform the task manually as a result of automation?» [RITTER/BAXTER/CHURCHILL 2014, 21].

The human-computer interface can be described as the point of communication between the human user and the computer (see Wikipedia, https://en.wikipedia.org/wiki/Human%E2%80%93computer_interaction). User interfaces (UIs) can take many forms, but always accomplish two fundamental tasks: (1) communicating information from the machine to the user, and (2) communicating information from the user to the machine.⁶ Additional UI layers may interact with one or more human senses, including: tactile UI (touch), visual UI (sight), auditory UI (sound), olfactory UI (smell), equilibrium UI (balance), and gustatory UI (taste) (see Wikipedia, https://en.wikipedia.org/wiki/User_interface).

External cognition is concerned with explaining how we interact with external representations (e.g. books, web pages, maps, diagrams, or notes). The questions raised are:

- What cognitive benefits and processes are involved?
- How do these representations extend cognition? and
- What technologies can we develop to help people carry out complex tasks (for example, learning, problem solving, and decision-making)?

see [SHARP/PREECE/ROGERS 2019, section 4.3 «Cognitive frameworks», 121–134].

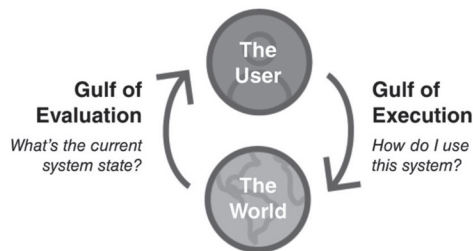


Figure 4: Bridging the gulfs; see [Sharp/Preece/Rogers 2019], chapter 4, slide 56, www.id-book.com

The term «gulf» describes the gaps that exist between the user and the interface (Figure 4). The gulf of execution is the distance from the user to the physical system. The gulf of evaluation is the distance from the physical system to the user. Bridging these gulfs can reduce the cognitive effort required to perform tasks. We hold that the human vs. machine dichotomy, rather than the continuous vs. discrete one, is the main reason for these gulfs.

5. Methods in legal informatics

SCHWEIGHOFER [2015] proposes the 8 views / 4 methods / 4 syntheses model of legal data science. This model describes eight different representations of a legal system and four computer-supported methods of analysis, which lead to a synthesis, or a consolidated and structured analysis of a legal domain; this synthesis is (1) a commentary or electronic legal handbook; (2) a dynamic electronic legal commentary (DynELC); (3) a representation for citizens; or (4) a case-based synthesis. The eight views (or representations of law) are: (1) the text corpus view; (2) the metadata view; (3) the citation network view; (4) the user view; (5) the logical view; (6) the ontological view; (7) the visualisation view; and (8) the argumentation view. The four methods are: (1) interpretation (searching, reading, and understanding); (2) documentation (searching and processing); (3) structural analysis (both conceptual and logical); and (4) facts analysis.

Each element of this model, that is, each of the eight views, four methods and four syntheses appears at a high level of abstraction. Therefore the analogue/digital dichotomy would not characterise them properly. On the

⁶ See FRANZ KURFESS' course «Human–Computer Interaction», note 4, file 486-S19-01-Intro.pdf, slide 15.

one hand, for example, interpretation as a method is a mental activity. On the other hand, documentation as a method is associated with computers and therefore digital properties prevail. The visualisation view, one of the eight views, has both analogue and digital qualities.

Analogue means open-textured and fuzzy. Legal terms are open-textured. In legal subsumption, while a fact is matched with a norm, if a property to be matched, that property is often continuous. Such a property may be modelled as a linguistic variable and represented as a fuzzy set; see [ZADEH 1975] and https://en.wikipedia.org/wiki/Fuzzy_set.⁷ For example, suppose we have a discourse set U that is an interval of real numbers from a to b . The compatibility function c (the membership function) is continuous. Each $u \in [a, b]$ is mapped to a real number in the interval $[0, 1]$. Thus a linguistic variable may obtain discrete syntactic values, but each value is associated with a continuous compatibility function.

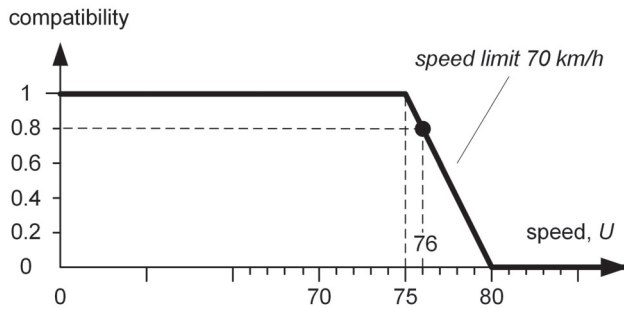


Figure 5: Compatibility function for speed limit 70 km/h

Suppose there is a speed limit norm and a syntactic value *speed limit 70 km/h* (Figure 5). Suppose that the limit of 70 km/h is tolerated up to 75 km/h, then the compatibility function reduces linearly to 0 at speed 80 km/h. For example, if you drive at 75 km/h the compatibility is 1, but if you drive at 76 km/h the compatibility is 0.8. If you drive at 80 km/h or faster, the compatibility is 0.

Fuzzy qualities prevail in situations that are regulated by norms. Consider, for example, the schematic representations of air traffic situations that are shown in Figure 6. Fuzzy qualities prevail in all four situations, although some elements are shown with discrete values.

6. Different mantra in information visualisation

Legal visualisation differs from information visualisation. The latter deals with mass data, such as the presentation of goods and services to potential customers who wish to search for a particular item.

A principle of information visualisation is usually known as the visual-information-seeking mantra: «Overview first, zoom and filter, then details-on-demand» [SHNEIDERMAN 1996, 337]. SHNEIDERMAN proposes a type by task taxonomy. The seven tasks that need to be supported are: (1) Overview: Gain an overview of the entire collection; (2) Zoom: Zoom in on items of interest; (3) Filter: Filter out uninteresting items; (4) Details-on-demand: Select an item or group and get details when needed; (5) Relate: View relationships among items; (6) History: Keep a history of actions to support undo, replay, and progressive refinement; (7) Extract: Allow extraction of sub-collections and of the query parameters.

⁷ ZADEH writes: «By a *linguistic variable* we mean a variable whose values are words or sentences in a natural or artificial language. For example, *Age* is a linguistic variable if its values are linguistic rather than numerical, i.e., *young, not young, very young, quite young, old, not very old* and *not very young* [...] The meaning of a linguistic value X is characterized by a *compatibility function*, $c: U \rightarrow [0, 1]$, which associates with each u in U its compatibility with X . Thus, the compatibility of age 27 with young might be 0.7, while that of 35 might be 0.2» [ZADEH 1975, 199].

The object of legal visualisation is a legal meaning. Legal reasoning and subsumption need to be supported.

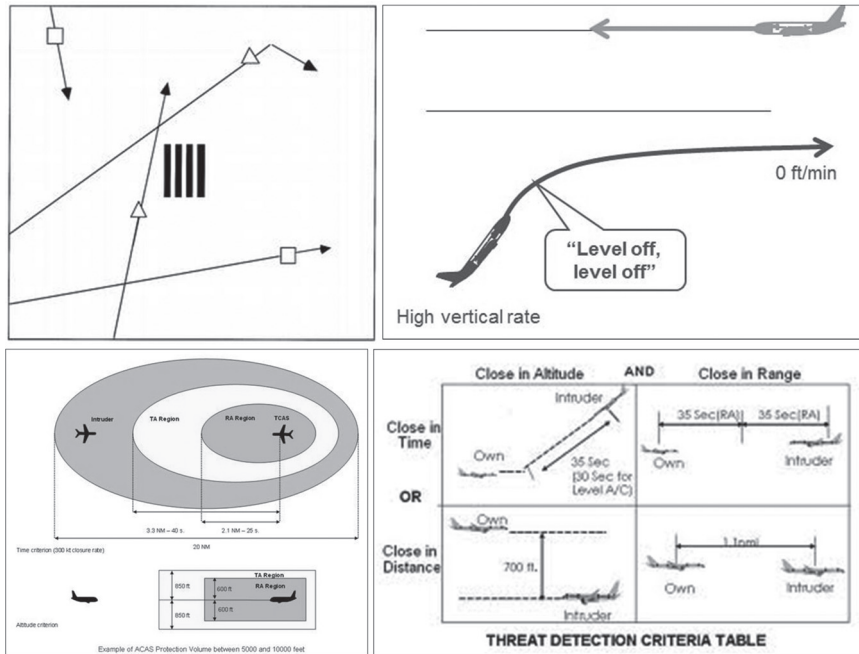


Figure 6: Sample representations of four air traffic situations. Fuzzy qualities prevail

7. Reasoning by analogy in law

The term «analogical method» is related to the noun «analogy» (Aristotle’s *analogia*) rather than to the distinction between continuous and discrete. West’s Encyclopedia of American Law [LEHMAN/PHELPS 2008]⁸ links the terms «analogy» and «reasoning by analogy» with case law. BARTHA [2019] examines analogy and analogical reasoning⁹ and contrasts models and analogies:

[M]odels are tools for prediction and explanation, whereas analogical arguments aim at establishing plausibility. If we broaden our perspective beyond analogical *arguments*, however, the connection between models and analogies is restored. [BARTHA 2019, 6]

Legal informatics contributes to the development of models. Structural legal visualisations are visual models of legal meaning. Moreover, legal informatics is concerned with computational models. These computer representations serve as analogues of phenomena in society.

⁸ «An analogy denotes that similarity exists in some characteristics of things that are otherwise not alike. In a legal argument, an analogy may be used when there is no precedent (prior case law close in facts and legal principles) in point. Reasoning by analogy involves referring to a case that concerns unrelated subject matter but is governed by the same general principles and applying those principles to the case at hand», <https://legal-dictionary.thefreedictionary.com/analogy> (accessed on 19 November 2019).

⁹ BARTHA writes: «An *analogy* is a comparison between two objects, or systems of objects, that highlights respects in which they are thought to be similar. *Analogical reasoning* is any type of thinking that relies upon an analogy. An *analogical argument* is an explicit representation of a form of analogical reasoning that cites accepted similarities between two systems to support the conclusion that some further similarity exists.» [BARTHA 2019, 1].

8. Conclusion

We believe that analogical methods are important in legal informatics. Digitalisation encompasses both the basic mode and the expert mode of law. In the use of analogical methods, digitalisation may be visible to different extents.

Analogical qualities prevail in legal situations. The continuous vs. discrete dichotomy would not properly characterise the methods of legal informatics. Analogical methods are grounded in the distinction between humans and machines.

An example of an analogue representation is a fuzzy set with a continuous compatibility function. A linguistic variable may take discrete syntactic values, but each value is linked with a continuous compatibility function. Each of the eight views, four methods and four syntheses in SCHWEIGHOFER's model is a high-level concept. Each of these elements is related more closely to cognition than to the analogue/digital (continuous/discrete) dichotomy problem in computationalism.

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