Logical Reasoning as Argumentation,
Or: How Lessons from the Law
Are Changing Artificial Intelligence

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Lecture 1: Argumentation and Artificial Intelligence
An overview is given of how ideas from argumentation theory have been picked up in artificial intelligence. The focus will be more on general ideas and approaches, and less on formal detail.

Lecture 2: Argumentation in the law: case-based and rule-based
In the law, argumentation is central. Two kinds of argument-based reasoning are prominent. In the first kind, precedent cases are followed by analogy; in the second, rules are applied when their conditions are fulfilled.

Argumentation with Rules and with Cases

Topics:
Reasoning with Rules
Case-based Reasoning

Goals:
Acquire knowledge about reasoning with rules
Acquire knowledge about case-based reasoning
Acquire insight into the relations between reasoning with rules and case-based reasoning

Literature:
Van Eemeren et al. (in preparation). Sections 11.8, 11.9

Machines can decide legal cases (?)

Deciding legal cases consists of applying the law.
The law consists of rules.
Machines can apply rules.

THEREFORE:
Machines can decide legal cases.
**Some hard questions**

Deciding legal cases consists of applying the law.
- Is applying the law sufficient for deciding cases?
- How does one apply the law?

The law consists of rules.
- Does it?
- Where are they?

Machines can apply rules.
- Can they?

**THEREFORE:**
Machines can decide legal cases.
- Well, I don't know!

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**Working hypothesis:**

Deciding legal cases can be automated.

**Research agenda:**

Find out how!

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**Disruption speak**

Richard Susskind:
*The Future of Lawyers: From Denial to Disruption*

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Harvard conference 2014
Disruptive Innovation
in the Market for Legal Services

“Watson is almost certainly the most significant technology ever to come to law”
IBM’s Watson playing Jeopardy

“This 2-word phrase means the power to take private property for public use: it’s ok as long as there is just compensation”

“Watson is almost certainly the most significant technology ever to come to law”

Legal tech exists
Legal tech exists, but is it disruptive?

Study Grant Act (WSF18+)
Hurdles

1. Legal reasoning is rule-guided, rather than rule-governed.
2. Legal terms are open textured.
3. Legal questions can have more than one answer, but a reasonable and timely answer must be given.
4. The answers to legal questions can change over time.

Rissland 1988 on Gardner 1987
Harvard Journal of Law and Technology

The subsumption model

Facts (given)  \rightarrow  Rules (given)  \rightarrow  Legal consequences

Montesquieu (1689-1755): The judge as 'bouche de la loi'

The theory construction model

Facts (initial version)  \rightarrow  Evidence (initial version)  \rightarrow  Legal consequences (initial version)  \rightarrow  Facts (final version)  \rightarrow  Evidence (final version)  \rightarrow  Legal consequences (final version)

Before disruption is at all possible:

Information technology will have to adapt to legal information processing

Argumentation

Eminent domain

This 2-word phrase means the power to take private property for public use; it's ok as long as there is just competition.
Prediction: The suspect is guilty as charged

This machine provides correct predictions in 95% of all cases (Cf. data collected by the Netherlands Bureau of Statistics)
### The two faces of Artificial Intelligence

<table>
<thead>
<tr>
<th>Expert systems</th>
<th>Adaptive systems</th>
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<tbody>
<tr>
<td>Business rules</td>
<td>Machine learning</td>
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<tr>
<td>Open data</td>
<td>Big data</td>
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<tr>
<td>IBM's Deep Blue</td>
<td>IBM's Watson</td>
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<tr>
<td>Complex structure</td>
<td>Adaptive structure</td>
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</tbody>
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**Knowledge tech**
- Foundation: logic

**Data tech**
- Foundation: probability theory

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### Law and artificial intelligence

The tension in the law between *legal security* on the one hand and *justice* on the other is related to the *gof-ai* vs. *new-ai* dichotomy.

The former are top-down and focus on explicit knowledge (rules, logic), the latter are bottom-up and use implicit knowledge (discretion, case analogy, learning, self-organisation).

The law has a long history of struggling with this tension and developed pragmatic approaches.

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### Legal codes

Example:

Art. 300 of the Dutch Criminal Code
1. Inflicting bodily harm is punishable with up to two years of imprisonment or a fine of the fourth category.
2. When the fact causes grievous bodily harm, the accused is punished with up to four years of imprisonment or a fine of the fourth category.
3. []
**Precedents**

Example:
Supreme Court July 9, 2002, NJ 2002, 499
Theft requires the taking away of a good. Can one steal an already stolen car? The Supreme Court’s answer is: yes.

**Reasoning with rules and with cases**

Rule-based reasoning:
Apply general rules
Example: John is a thief. (There is a rule that) Thieves are punishable. THEREFORE: John is punishable.

Case-based reasoning:
Follow analogous cases
Example: John is a thief. (There is a precedent in which) Peter was punishable as a thief. THEREFORE: John is punishable.

**Overview**

Legal decision making
Rule-based reasoning: rules & principles
Case-based reasoning: Hypo
Case-based reasoning: entangled dialectical arguments
Are case-based and rule-based reasoning logically different?

**Reasoning with rules**

\[ d_1: \text{x is a contract} \Rightarrow \text{x only binds its parties} \]
\[ d_2: \text{x is a lease of house} \Rightarrow \text{x binds all owners of y} \]
\[ d_3: \text{x is a lease of house y} \land \text{tenant has agreed in x that x only binds its parties} \Rightarrow \text{x only binds its parties} \]

contract lease of a house:
both \( d_1 \) and \( d_2 \) seem to apply; application of \( d_2 \) blocks \( d_1 \) (by a form of specificity defeat)
also tenant has agreed that only parties are bound: application of rule \( d_3 \) blocks the application of rule \( d_2 \), hence the application of \( d_1 \) is no longer blocked

Prakken 1997

**Reason-Based Logic**

\[ \text{punishable: thief(x) } \Rightarrow \text{punishable(x)} \]
Thief(john)
THEREFORE Applicable(thief(john) \Rightarrow \text{punishable(john)})

This gives a reason that the rule ought to be applied. If there are no reasons against the rule’s application, this leads to the obligation to apply the rule. Reasons are weighed, but not numerically.

Hage 1997

**Dworkin (1978): rules versus principles**

Legal rules seem to lead directly to their conclusion when they are applied.

Legal principles are not as direct, and merely give rise to a reason for their conclusion.
Dworkin (1978): rules versus principles

<table>
<thead>
<tr>
<th>Application</th>
<th>Rule</th>
<th>Principle</th>
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<tr>
<td>Decision</td>
<td>Independent</td>
<td>Dependent</td>
</tr>
<tr>
<td>Merging</td>
<td>Independent</td>
<td>Dependent</td>
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Example

Mary's bike is stolen.
John buys the bike from the thief.
Who owns the bike?

Both Mary and John have a reasonable claim to the bike:
Ownership is not broken by theft.
Buying gives ownership.

The law provides rules to resolve conflicting principles in a generic way instead of case by case.

An integrated model of rules and principles

The differences between rules and principles are merely a matter of degree.

Rules and principles have the same logical structure, but have different behavior in actual reasoning.


A rule and its underlying principles

A rule replaces its underlying principles when it applies
Case-based reasoning

Case-based reasoning is a common type of argumentation in the law, in which legal conclusions are drawn on the basis of previously decided cases.

If some decided case is sufficiently similar to the case at hand, then under the doctrine of stare decisis one should not depart from that decision, and the same conclusion should hold.

Issue:
Can a dismissal be voided?

Precedent case:
+ The employee’s behavior was always good
- There was a serious act of violence
Outcome: + (voided)

Current case:
+ The employee’s behavior was always good
- There was a serious act of violence
+ The working atmosphere was not affected
Outcome: ?
Case-based reasoning

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Ashley’s HYPO (1990)

Factors are generalised facts pleading for or against an issue.

Cases are treated as sets of factors.

For precedent cases, the outcome is known.

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Approaches to the modeling of case-based reasoning

<table>
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<th>Rule extraction method</th>
<th>Case comparison method</th>
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<tr>
<td>(1) Extracting rules from decided cases</td>
<td>(1) Selecting relevant case facts</td>
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<tr>
<td>(2) Showing that rule conditions are satisfied</td>
<td>(2) Establishing an analogy between cases</td>
</tr>
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- (3a) Applying extracted rules to the case at hand
- (3b) Pointing out exceptions to extracted rules
- (3a) Following decided cases in the case at hand
- (3b) Distinguishing decided cases from the case at hand

Roth 2003

Approaches to the modeling of case-based reasoning

Models of case-based reasoning either focus on case comparison, but do not make explicit which conclusions could be drawn by following analogous cases or focus on rule extraction, thereby obscuring the role of case analogy.

Dialectical arguments and case-based reasoning

The present approach focuses on case comparison and makes explicit which conclusions can be drawn by following analogous cases.

Cases are compared in terms of the dialectical arguments that occur in them.

Dismissal-Can-Be-Voided (6:682 BW)
Always-Behaved-Good-Employee (6:611 BW)
Always-Arrived-On-Time

Pressing-Ground-For-Discussion (6:678 BW)
Acted-In-Self-defense (45.5e)
Serious-Act-Of-Violence

Approaches to the modeling of case-based reasoning

Models of case-based reasoning either focus on case comparison, but do not make explicit which conclusions could be drawn by following analogous cases or focus on rule extraction, thereby obscuring the role of case analogy.
Entangled dialectical arguments

Dialectical arguments can contain both reasons for and reasons against conclusions (internal conflicts).

A statement can be supported or attacked by more than one reason (accrual).

It can be supported or attacked that a statement supports or attacks another statement (entanglement).


Case comparison in terms of dialectical arguments

There is more dialectical support for c in the problem case, so c should follow by analogy with the settled case.

The same analysis can be done using Hypo's expressiveness.

Factors and non-factors: the comparison basis

Comparison outcomes depend on the particular division made between factors and non-factors.

Arguing for a change of this division can downplay or emphasize distinctions.
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Rules and precedents

Rules and precedents as formal sources of law (Hart’s rules of recognition)

Role depends on jurisdictional sphere

Legal systems

Comparative law research (MacCormick & Summers 1997):

- Rules and precedents are both significant sources
- This does not depend on whether precedents are officially considered to be formally binding
Logical differences?
To what extent are there logical differences between the role of rules and precedents when deciding cases?
Is deciding cases logically different in a legal system with only rules and in one with only precedents?
Existing formal models seem to take the logical distinction for granted.

Rule application
There is a rule with conditions A, B, C, ... and conclusion Z.
In the current case, the conditions A, B, C, ... are fulfilled.
THEREFORE
Conclusion Z follows.

Precedent adherence
There is a precedent with A, B, C, .... as relevant factors for conclusion Z.
The current case matches the relevant factors A, B, C, ... of the precedent.
THEREFORE
Conclusion Z follows.

Side comments
1. The technique used is that of semi-formal argumentation schemes
2. Schemes are defeasible
3. The schemes are not meant to be an absolutely correct/exact/unique representation
4. Scheme specification can be bent towards a context and goal


Logically, the basic patterns are equal
A, B, C, ... --> Z
A, B, C, ...
------------
Z

A, B, C, ...

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Tech is disrupting the law.

The law is disrupting tech.

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Lecture 3: Argumentation and evidence: Combining arguments, scenarios and probabilities
For deciding about the facts in a criminal case, different normative frameworks aiming at the prevention of erroneous reasoning have been proposed: arguments, scenarios and probabilities. The normative frameworks are characterized and their relations investigated, for instance by discussing how arguments and scenarios can be studied using Bayesian networks.

http://www.ai.rug.nl/~verheij/ssa2016/

For more information on rules and principles, see:

For more information on case-based reasoning with an entangled factor hierarchy, see:

For more information on the relation between rule-based and case-based reasoning, see: