Normative Systems

The meeting point between Jurisprudence and Information Technology?

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Main thesis

- We shall see that Jurisprudence and IT
  - Have some commonalities of concepts and issues
  - Deal with them in similar ways
  - They may be slowly pulling together

Normative Systems

- The term *normative system* is being used in the literature with different definitions
- A much cited book by Alchourron and Bulygin bears this title, and claims application to social sciences only
  - Loosely defines norms as statements that relate cases to solutions

General importance of normative system

- Jones and Sergot wrote in 1990:
  - “at the appropriate level of abstraction, **law**, **computer systems**, and many other kinds of organisational structure may be viewed as instances of *normative systems*
  - “we use the term to refer to any *set of interacting agents* whose behaviour may be usefully regarded as governed by norms
  - “norms *prescribe how the agents ought to behave* and specify how they are *permitted* to behave and what their *rights* are

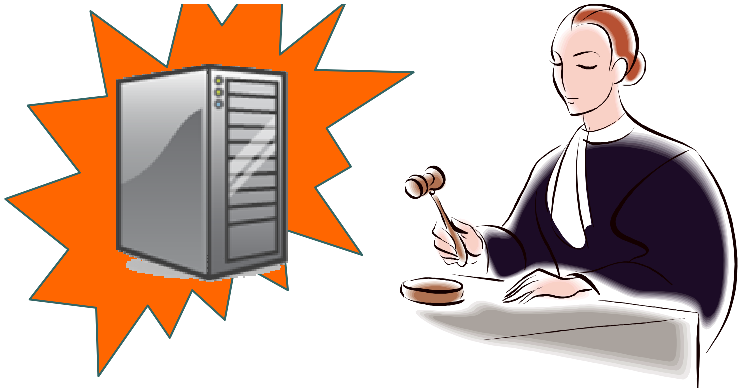
Two corrections, perhaps?

- Jones and Sergot wrote in 1990:
  - Normative systems:
  - “we use the term to refer to any set of interacting agents whose behaviour may be usefully regarded as governed by norms
  - “norms prescribe how the agents ought to behave and specify how they are *permitted* to behave and what their *rights* are

Set of norms?

Excessive reliance on deontic concepts?

Forces



- The behavior of computer systems is of increasing legal relevance
  - Security
  - E-commerce, E-contracts
  - IT governance
- Ideally, it should be possible for law and regulations to be directly implemented in computer policies,
  - these should automatically change as the law changes
- This will force the law to be more precise, at least in certain areas

More forces

- Computer networks will be like social systems, with their own norms (policies)

Deontic Logic

- Deontic logic is a modal logic of obligation and permission
- Based on the observation that the De Morgan laws apply to these concepts:

not obligatory not P = P is permitted
not permitted not P = P is obligatory

Def.: forbidden P = P is not permitted
Def.: X has a right = State has obligation to X

Deontic logic in normative systems

- It is often assumed that norms are expressed in deontic logic
  - See previous statement by Jones and Sergot
- BUT…

The study of elementary normative forms

- As biologists can learn much by studying elementary life forms, we can learn much by studying elementary normative forms
  - Firewalls
  - Hammurabi code

Hammurabi code

(3700 years ago)

If any one steals cattle or sheep, or an ass, or a pig or a goat, if it belong to a god or to the court, the thief shall pay thirty fold;
if they belonged to a freed man of the king he shall pay tenfold;
if the thief has nothing with which to pay he shall be put to death

This code is written strictly in Event-Condition-Action (ECA) style

Event, condition, action

If any one steals cattle or sheep, or an ass, or a pig or a goat,

if it belong to a god or to the court,

the thief shall pay thirty fold

A question is whose action this is:
The judge's? The thief's?

Firewalls

```
DROP all  --  nuisance.com  anywhere
```

A rule in a Linux *router* to drop packets having any (“all”) protocol, that come from node “nuisance.com” and go anywhere

Also trigger-condition-action

Rules

- Thus, the most elementary normative systems are simply made of *rules*:
  - Given such a behaviour, and such a situation, such is the resulting action
  - **Norms can exist without the notion of obligation**

Enter deontic logic with Moses' law

8. Thou shalt not steal

We have gained abstraction (this covers a dozen articles from Hammurabi code)

But lost specificity

- ***What happens if one steals?***
- ***How to enforce?***

This is a requirement to be implemented

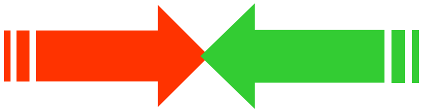
Rules and Requirements

- We have identified two normative styles
  - Rule style
  - Requirement style
- This is consistent with the distinction between *requiremen*t and *implementation* in Software Engineering

- There are of course other styles

Consistency

Are there incompatible norms for the same situations?



Cases…

- Inconsistency between requirements
- Inconsistency between rules and requirements
- Inconsistency between rules

  - The second case is often solved by giving the priority to the requirement

Inconsistency in law

- Inconsistency is one of the major issues for lawyers and judges
- It is often dealt with by showing that apparently incompatible rules deal with different cases
  - Although its origin may be an error…

Inconsistency in sets IT policies: it’s an error

- It can be an implementation error
  - In the spec or in the implementation
    - **The method to avoid these has been to rigorously check specs and implementations**
      - **Software Engineering, Formal methods**

- Or it can be a Feature Interaction problem
  - Methods have been ad-hoc
    - **We’ll get back to this**

What does inconsistency mean in norms?

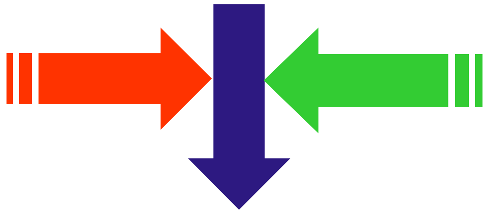
- In classical logic, a single inconsistency invalidates the whole system, anything becomes derivable
  - (A and not A) = False and anything can be derived from False
    - Which btw means that an inconsistent system is complete!
- However in practice inconsistencies in sets of rules are dealt with by trying to ‘isolate and fix’ the inconsistent rules
  - Logics to justify this exist

Detection of inconsistency

- Theorem provers
- Satisfaction algorithms
  - Tool Alloy http://alloy.mit.edu/
- Algorithms are NP-complete (or worse) but a lot can be done if few variables are involved
  - In many practical cases we have seen, the problem was treatable

Completeness

Are all cases covered?



Examples of incompleteness

- **A set of rules can be incomplete if some aspects of the requirements are not covered**
- **E.g. Canadian charter of rights protects the right to life**
  - **However Canada has no law about abortion**
    - **Is Canada's law incomplete wrt requirements?**
- **Requirements can be *implicit***
  - **E.g. does the Hammurabi code cover *all* cases of theft?**
    - **This question makes sense even though Hammurabi did not know Moses' law, because he covers several cases of theft**
    - **Similarly, in common law requirements are induced from cases, i.e. rules**

Incompleteness in IT

- IT has standard ways to deal with incompleteness:
  - The default solution
    - For every program, set of rules, etc. we know what will happen in the case where none of the specified conditions is true
  - However this might not correspond to the specification or the *intention* of the user

Incompleteness in law

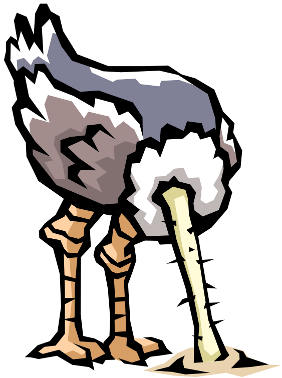
- The lawyer’s reasoning wrt incompleteness is totally different
- There will be attempts to derive rules
  - From requirements
  - From similar rules
    - Which means inducing the requirements from similar rules
- Only if this fails, then the IT approach is taken
  - Situation not covered by law, nothing to do

Some common research topics

- Defeasible logic and meta-rules
- Feature interactions
- Ontologies

Defeasible Logic

Applies to both consistency and completeness

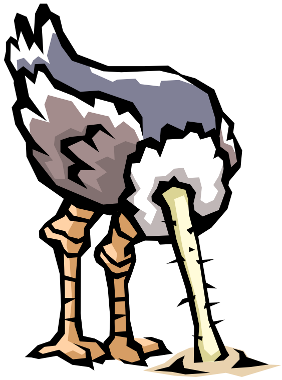


Priority among norms in firewalls

- In firewalls, the rules are scanned top-down
  - The first applicable norm is applied and all following ones are ignored
- So is solved the problem of several applicable rules (policy interaction)
- This can't be justified easily:
  - The order of axioms is not important in logic
  - The order of norms is not important in law
    - although **later** norms can abrogate earlier ones

Defeasible Logic

- **A non-monotonic logic proposed by Donald Nute. In defeasible logic, there are three types of propositions:**
  - **Hard rules**
    - **specify that a fact is *always* a consequence of another;**
      - ***All birds have wings***
  - **Defeasible rules**
    - **specify that a fact is *typically* consequence of another;**
      - ***All birds fly***
  - **Defeaters**
    - **specify *exceptions* to defeasible rules.**
      - ***Ostriches don't fly***
  - ***Before applying a defeasible rule, check for defeaters!***



Defeasible logic by priorities

- R1: Professor(X) => Tenured(X)
- R2: Visiting(X) => Non-Tenured(X)

  - Is a Visiting Professor tenured?
  - Which one is the defeater?

    - One common way to answer is to give priorities to rules, most probably here R2>R1

Firewall example

- In a firewall, the first applicable rule defeats all following ones
  - R1>R2>R3…
- So all rules are defeasible by a previous one
  - Legal theory and IT have independently discovered the same problem, and solved it in similar ways

Meta-rules

- A normative system can also include meta-rules, to decide which rule(s) should be defeated in case of inconsistency
  - Priority rule can be considered a meta-rule
  - In XACML: access control language
  - It is possible to specify *combining algorithms*
    - **Deny override**
    - **Permit override**
    - **Etc.**

Meta-rules in law

- lex specialis derogat legi generali
- lex posterior derogat legi priori
- lex superior derogat legi inferiori
  - A law can be overridden by
    - a more special one,
    - a posterior one,
    - or a superior one

Another application: *Closure* norm

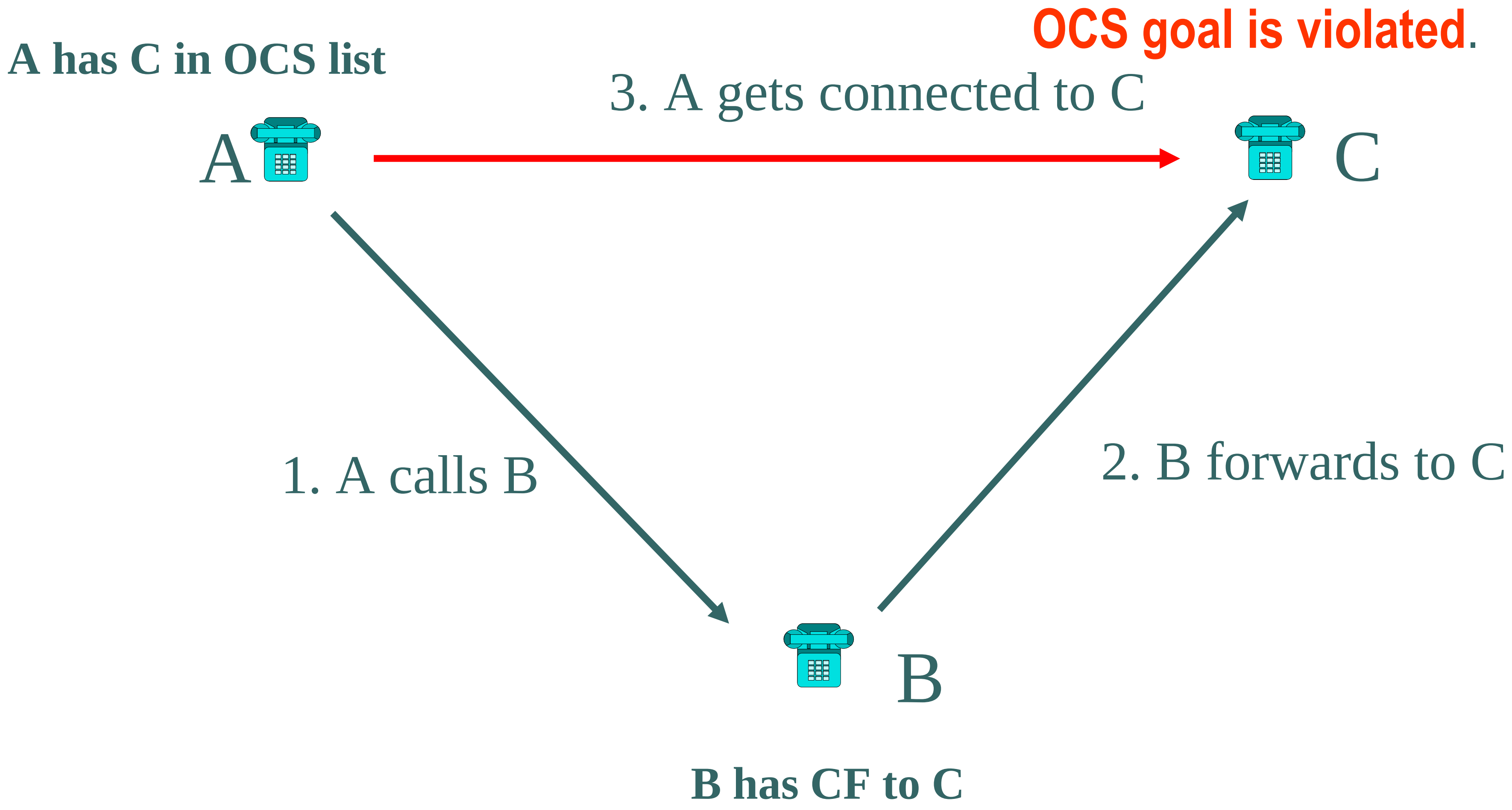
- A closure norm is a norm that makes a system complete, e.g.
  - In Cisco firewalls, all packets for which there is no rule are rejected
    - Similar to a legal system where all behaviours that are not explicitly allowed are forbidden
  - In Linux firewalls, the rule is opposite
    - A ‘more liberal’ legal system
      - Nulla poena sine lege

Closure norm
as defeasible norm

- In defeasible logic, a closure norm is a norm that exists in the system, but can be defeated by any other norm (G.Governatori)
  - It applies only if no other norm applies
- If defeasible logic is not used, it is a norm that applies when the negation of the premises of all other norms holds
  - Difficulty in constructing this negation, it changes as the set of norms changes

Feature Interactions

OCS: Originating Call Screening
CF: Call Forward



Feature Interaction

- Multi-user feature interaction, i.e. resolution of conflicts between agents resulting from conflicting goals, is precisely the subject of law!
- This suggests that in order to solve FIs in IT systems we’ll have to develop the equivalent of generally recognized laws

Wired-in solution

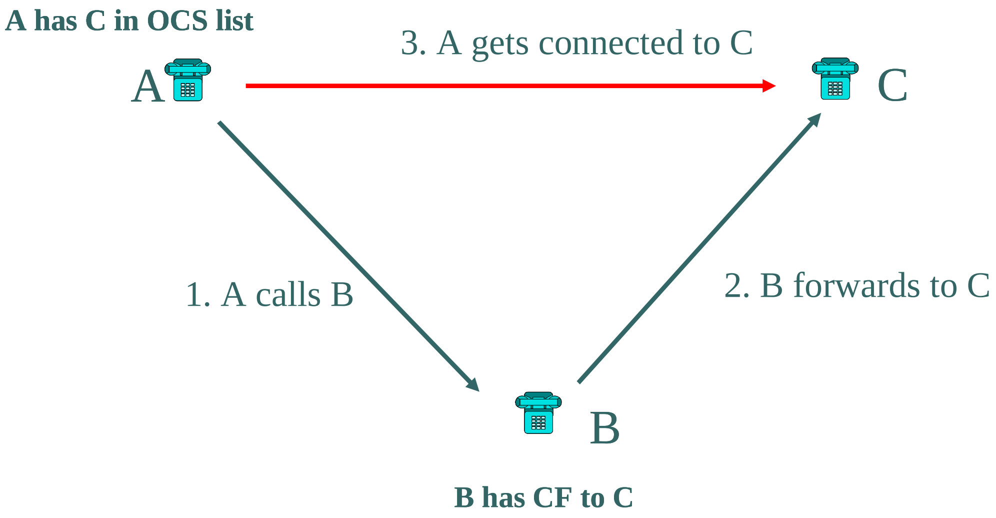
- The law, even common sense, knows perfectly how to deal with this, why don’t we?
  - If Alice lends a book to Bob, and Bob wants to lend it to Carla, of course he must check first with Alice!
  - If Alice delegates a task to Bob, and Bob wants to delegate it to Carla, of course he must check with Alice
- In computing we are haven’t really developed a culture yet…
- Very slowly, we’ll have to develop *principles:*
  - *Ownership, delegation…*
  - Who owns a connection, when can it be delegated…

Trusted third party (TTP)

- In ‘real life’, arbitrators, judges, notaries are essential to prevent and solve feature interaction
- And so they must be in computer communications
  - TTPs to apply FI resolution policies
- In some implicit way, connecting parties will have to recognize the jurisdiction of a TTP

OCS-CF Interaction with TTP

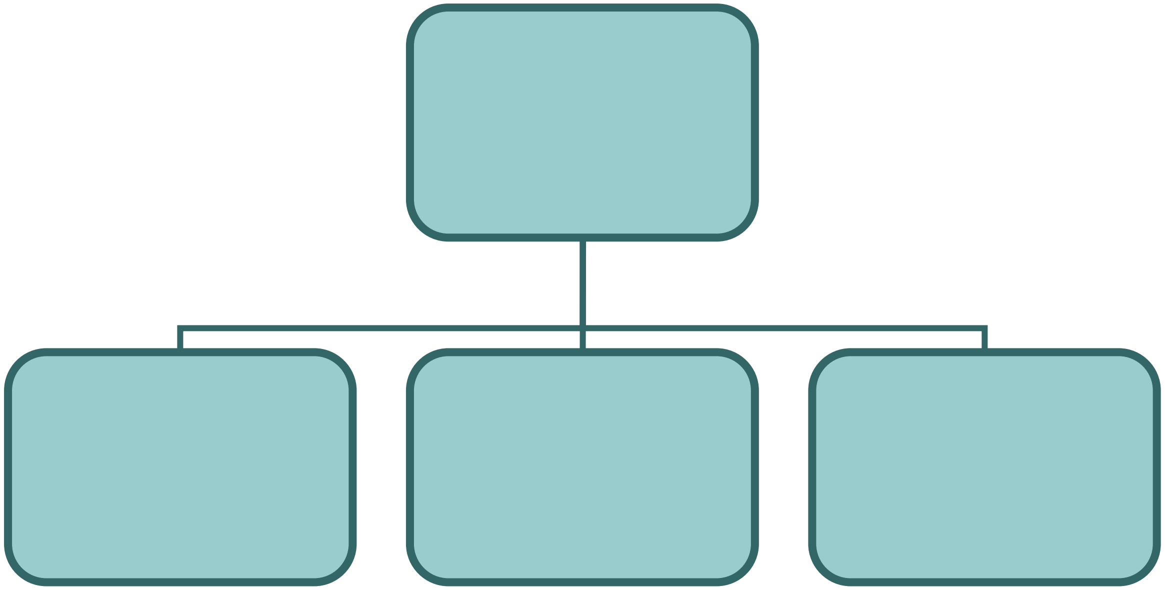
- Parties will keep TTP informed of their intentions, asking for approvals
- CF will be ‘disapproved’ by TTP



TTP Present and Future

- At present, TTPs are not much used, except for authentication
- Users tend to trust the other party they are dealing with, which often has conflicting interests
- Application areas:
  - Web services
  - E-commerce, E-contracts in particular

Ontologies



Ontologies (in CS sense…)

- In legal systems, just as in IT policies, there is yet another type of norm, the *definitional* norm.
  - Wikipedia: *An ontology is typically a hierarchical data structure containing all the relevant entities and their relationships and rules within that domain (e.g. a domain ontology).*

Ontologies as generators

- We can have a norm saying that theft is punished in a certain way, then definitions saying that certain behaviours are theft
  - Another way to bridge betw. Moses and Hammurabi…
- In a company, we can program the switchboard with the company’s organizational tree
  - Then we can have a rule such as:
    - **When an employee is absent, calls for him go to the supervisors**
  - This can generate dozens of rules
- Enterprise security systems are built on enterprise ontologies
  - E.g. Role-based Access Control (RBAC)

Conclusions

- Many concepts are common between Jurisprudence and IT
- Forces exist that will draw the two areas closer in the long run
- Conceptual consolidation is desirable and will surely occur
- Much is to be learned from such consolidation, in both fields