VISUALIZATION OF HAJIME YOSHINO'S LOGICAL JURISPRUDENCE

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Abstract: *Hajime Yoshino's Logical Jurisprudence (LJ) is an important concept in legal informatics. Yoshino aims for a logic-based systematization in the legal domain. He focuses on legal reasoning and systematization. Inevitably, embracing law as a whole brings us to Hans Kelsen's Pure Theory of Law. In sum, three issues are important in LJ: logic, Kelsen and legal informatics. In this paper we aim to visualize the architecture of LJ. We suggest expanding this with legal ontologies and words. The granularity of word-phrase-sentence-text is about different methods which apply to different units.*

1. Introduction

This paper is inspired by Hajime Yoshino's presentations of his Logical Jurisprudence (LJ) theory at several conferences. The first time this is mentioned is the 1980s; recently at conferences ICAIL [YOSHINO 1995; 2011a], IRIS [YOSHINO 2012], FCASL [YOSHINO 2011b], etc. A pattern we use to visualize LJ is composed of two stages, the vertical one and the horizontal one (Figure 1). The two stages depict Hans Kelsen's categorical distinction between Is and Ought; see [KELSEN 1967, § 3ff.]. The irreducible Is-Ought duality corresponds to a very old mythical and religious duality between the Earth and Heaven or, in other words, between nature and spirit.
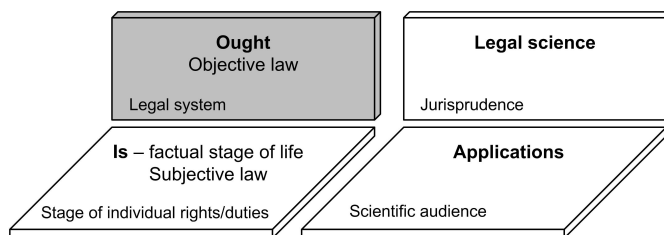

Figure 1: Vertical and horizontal stages. On the left the Is world is depicted by a horizontal stage and Ought by a vertical one

2. Introducing Yoshino's Logical Jurisprudence

Yoshino notes that there have been various theories of the systematization of law. For instance, when speaking about natural law theory Samuel Pufendorf [1672] tried to construct a deductive system of law. Pufendorf classified entities into *entia physica* and *entia moralia* and spoke about *impositio*. Thus the Is/Ought terminology was used (Figure 2).
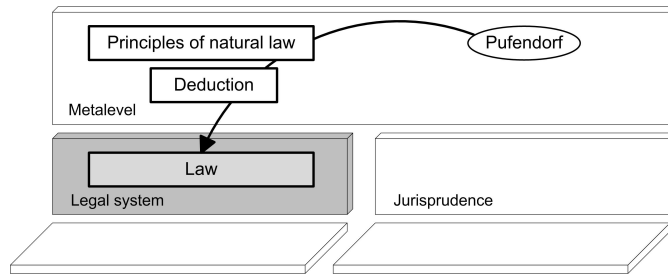
Figure 2: Samuel Pufendorf takes the principles of natural law and constructs a deductive system of law

Traditional legal concepts – on the vertical stage of law – are customary law, international law, constitution, legal hierarchy, etc. (Figure 3). Traditional juridical concepts – on the vertical stage of jurisprudence that concerns Yoshino – comprise legal philosophy, legal dogmatics and legal sociology. Yoshino is concerned with the right vertical stage – jurisprudence – not the left one (which depicts the law in an objective sense).
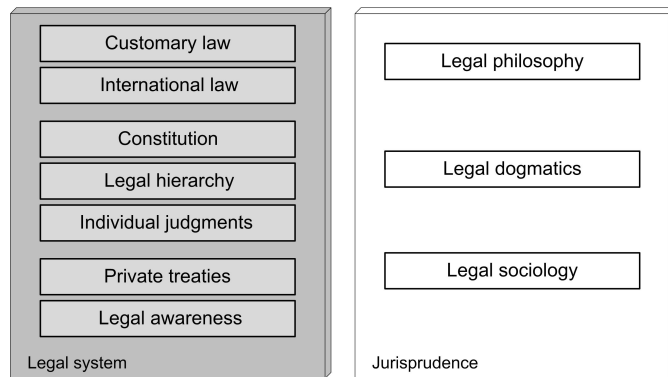

Figure 3: Traditional concepts on the vertical stages of objective law and jurisprudence

Kelsen's Basic Norm appears on the meta-level (Figure 4). The constitution, laws, statutes and individual decisions form a hierarchy; see [KELSEN 1967], part V, especially § 35. Kelsen speaks about a hierarchical structure of norms: *[W]hose highest level is the constitution whose validity is founded on the presupposed Basic Norm, and whose lowest level is made of the individual norms decreeing particular concrete behavior to be obligatory.* [KELSEN 1991, 258]

Yoshino departs from logic and the result of this is the concept of legal sentence (LS); see Figure 4. The latter appears on the vertical stage of jurisprudence, namely, Logical Jurisprudence. LSs are of a scientific nature, and could be called scientific sentences about law. LSs can serve in expert systems. Yoshino contributes to (1) scientific evolution and (2) new technical perspectives. Expert systems stand for computer applications that work for both the Is and the Ought worlds. Expert systems can add to both individual relationships on the Is stage and also legal workflows of the state such as e-government applications.
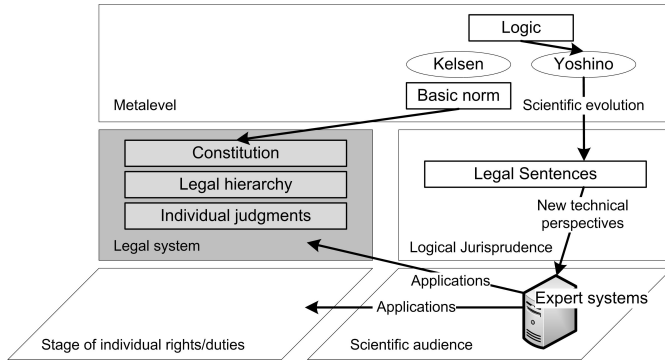
Figure 4: Kelsen's Basic Norm and Yoshino's Logical Jurisprudence (LJ)

3. Logical Jurisprudence

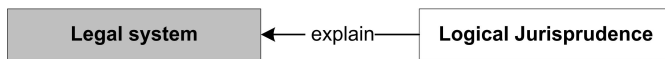Yoshino's Logical Jurisprudence tries to analyze and explain the whole legal system (Figure 5).

Figure 5: Logical Jurisprudence tries to explain a legal system

3.1. Legal Sentences

Logical Jurisprudence starts from legal sentences, not from norms (Figure 6 a). The traditional way to explain law and to make a bridge between the phenomenon of law and its formalisations works in the opposite direction: first try to understand the spirit of law, then formalise it. Yoshino (2011a, 121) writes that «legal sentences are composed of three alternative types»:

- Legal rule sentences (LRS) and legal fact sentences (LFS)
- Legal elementary sentences and legal complex sentences
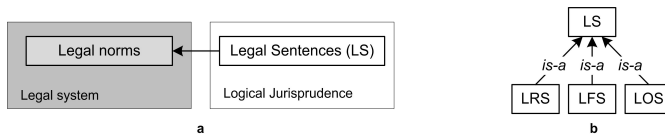- Legal object sentences (LOS) and legal meta-sentences (LMS)

Figure 6: From legal sentences to norms

We start by observing the following kinds of entities: LRS, LFS and LOS (Figure 7). First, legal rule sentences are in the world of Logical Jurisprudence, but describe legal rules that are in the Ought world. Second, legal fact sentences describe legal facts that are in the Is world. Third, legal object sentences also describe legal objects that are in the Is world. Here, obligations deserve special attention.

We see that LS serves as a description and can be treated as a string. Validity, i.e. a truth value, is concerned with legal meta-sentences. We treat LRSs, LFSs and LOSs as being in is-a relation with LSs (Figure 6 b). In the same way, LMRSs, LMFSs and LMOSs are in *is-a* relation with LMSs (see below). Strict categorizations are demanded in computing. However, black-and-white formalizations may not be appropriate in the legal

domain. Therefore grey zones exist: there is an open texture. However, theories should aim at conceptual purity.
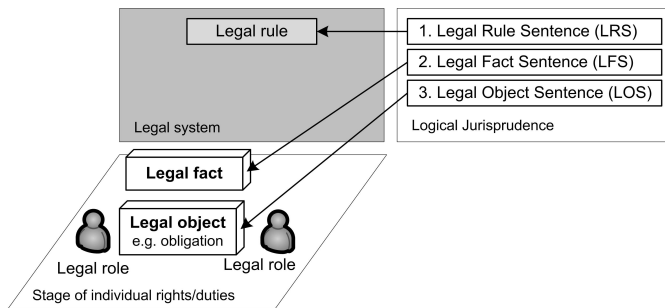

Figure 7: The three primary kinds of legal sentences in Logical Jurisprudence

LRS and LFS correspond to rule and fact in terms of logic programming. An example of an LRS structure is: *a(X) :- b(X), c(X,Y)*. Read: For all *X*, *X* becomes effective if *X* is an offer and *X* reaches the offeree. Legal rule sentences have the syntactic structure of rule as a hypothetical proposition, see, for example, Yoshino in ICAIL '11 (2011a, 121):

> CISG[1] *Article 15(1): An offer becomes effective when it reaches the offeree.*

This is represented by:

> *become_effective(offer(X,A), T) :- reach(offer(X,A), offeree(B,X), T)*

Legal fact sentences have, for example, the following structure: *b(x1), c(x1,y1)*. Read, for example, *x1* is *A*'s offer and it reaches *B* on April 5. Legal fact sentences have the syntactic structure of fact as a categorical proposition, e.g.:

> *A's offer reaches offeree B on April 5.*

This is represented: *reach(offer(o1,anzai), offeree(bernard,o1), April-05)*.

An LOS describes the obligations of a person, for example: *It is obligatory for A to deliver the goods to B*.

A *legal elementary sentence* (LES) is the smallest unit in legal sentences. An example is CISG Article 15(1) cited above. Another example is «One must drive a car at less than 100 km/hour on a highway». LESs play the role of atoms.

3.2.   Three Primitives: Legal Sentence, Validity and Inference Rule

Logical Jurisprudence works on the vertical stage of science (see Figure 7, right hand side). It aims, with a minimal number of elements, to explain the whole legal system, which is depicted on the left hand side of Figure 7. LJ starts with three primitives:

1. *Legal sentence.* Logical Jurisprudence considers that norm as a meaning (*Sinn*) in Ought does not exist. Thus, LJ starts from sentences.
2. *Validity* of legal sentences.
3. *Inference rule.* The *modus ponens* rule is used: $P{\rightarrow}Q, P \mathrel{|\!\!-} Q$. This is used for deduction from valid (in the sense of LJ) legal sentences.

The validity concept in Logical Jurisprudence is treated as scientific validity, i.e. a truth value in the world of science, *is_valid(sentence1, goal1, time1)*. This is shown further in Figure 8. It is not the same as Kelsen's

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[1]   The United Nations Convention on Contracts for the International Sale of Goods.

legal validity concept that refers to Ought. Yoshino speaks about the validity of legal sentences: *The concept of validity is to be conceived of as a truth concept. That a legal sentence is valid means that it is true in the legal discourse of the world. If a legal sentence which describes a legal state of affairs is valid, it means that the legal state of affairs exists in the legal world.* [Yoshino 2011a, 122]

We should note that the legal domain can allow such a formalisation to a certain degree, namely, in formalising the deduction in law. The reason is that statements in the legal domain can be defeated. Arguments can also be assigned different weights. The reasons may be different. For example, an authority which provides an argument has a greater weight. Hence, both the concept of validity (Kelsen's Ought) and the concept of truth are inherent to law.

A legal meta-sentence describes the validity of a legal sentence, for example:

> *'It is obligatory for A to deliver the goods to B' is valid on 2010-05-01.*

Note again that this is scientific validity – in the world of science (i.e. LJ), and not validity in the world of Ought, which is Kelsen's validity concept (Figure 8).
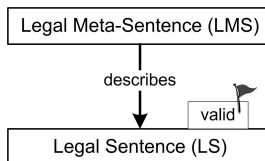

Figure 8: Validity of legal sentences

Formalising the concept of validity is central in Yoshino's research.[2] Hence, legal sentences (comprised of LRSs, LFSs and LOSs as above) are treated as syntactic entities – like strings. The validity of a legal sentence (i.e. whether it is true or false) is assigned through a legal meta-sentence. This is a natural way to model the world of discourse. The representation of a model of a world in formal logic includes a set of assertions which are held to be true. Then formal inference rules step in to model legal reasoning.

Yoshino introduces the terms legal meta-rule sentence (LMRS) and legal meta-fact sentence (LMFS). These describe the validity of an LMS or an LFS respectively.[3]

3.2.1. Connections of Legal Sentences

There are four kinds of connections of legal sentences:

1. 'and' (&)
2. Connection into a legal complex sentence (LCS)
3. Connection between LOS and LMS
4. Connection between LMS and LMS

3.2.1.1. Connector 'and'

The *and* (&) connector connects two legal sentences, e.g. *LS1 & LS2*. A structure of legal sentences can be built in this way. The structure is treated as a group of legal sentences and can be assigned a unique name.

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[2] Yoshino writes: «[L]egal rules must be applicable to the case. In other words, legal rules must be valid to solve the problem of the case. […] That a legal sentence is valid means that it is true in the legal discourse of the world. […] If a legal sentence which describes a legal state of affairs is valid, it means that the legal state of affairs exists in the legal world.» [Yoshino 2011a, 122]

[3] Yoshino writes: «A legal meta-rule sentence, which is applied to prove that a legal meta-sentence is valid, must also be valid. […] This can be done through the deduction from a legal meta-fact sentence declaring that the legal meta-rule sentence is valid or by the application of other legal meta-rule sentences. Therefore it is most important for the systematization of law to confirm legal meta-fact and rule sentences which make such deduction possible.» [Yoshino 2011a, 122]

3.2.1.2. Connection into a Legal Complex Sentence

A *legal complex sentence* (LCS) is composed of legal sentences, namely, a group of LSs, but the way they are connected is not specified. Hence, an LCS is treated as an aggregate. An LCS has a unique name, such as «*A-B* Contract», «The UN Convention», a part of statute, etc. (Figure 9 a).

An important feature of LCSs is that if an LCS is valid, every LS is valid. This formalises the meaning of abstract concepts like contracts, judgments, administrative orders, statutes, conventions, etc. We note that a legal complex sentence is treated as an aggregate (or a formula with the connective $\&$, e.g. *p1 & p2 & p3*).
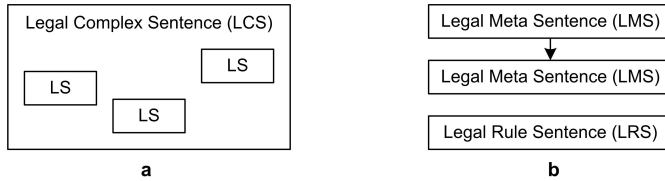

Figure 9: a) Legal complex sentence. b) Connection between LMS and LMS

3.2.1.3. Connection between Legal Object Sentence (LOS) and Legal Meta-Sentence (LMS)

A legal object sentence describes an object. An example of an object type is an obligation. Examples of LOSs are «*It is obligatory for A to deliver machinery to B*» or «*B must pay A the price of $58,000*».

We have found that in Yoshino's examples an LOS describes an individual legal object, not a general one. Examples speak about the obligations of individuals, for example, *Anzai*, *A*, *Bernard*, *B*.

The modus of a legal object, e.g. obligation or right, is expressed by a distinct predicate: *s1: is_obligatory(A, deliver(A,B,machinery))*. The time for the obligation to become valid and to terminate is also represented with predicates, for example, *s2: become_valid(s1, 2010-04-09)*, *s3: is_terminated(s1, 2010-05-01)*.

Both LOSs and LMSs can be represented with predicates. We also view predicates as expressions which can be represented as frames (or semantic nets) – for example, *deliver(sender, recipient, goods)*.

However, one can be surprised by the way Yoshino distinguishes rights from obligations. One may expect a right-duty duality. We would expect to treat an individual right and a duty in a similar way and to represent an individual right with an LOS, too. Yoshino probably focuses on objective (general) rights and subjective (individual) obligations (i.e. duties). He holds: *A legal sentence which describes one's right is, however, not a legal object sentence but a kind of legal meta-sentence, because it is a legal sentence to afford him a legal power to settle a legal sentence.* [Yoshino 2011a, 122]

Yoshino treats the accrual of the validity of a legal object sentence by exercising the right as a fundamental meta-rule sentence (FLMRS; see next sub-section), see [Yoshino 2011a, 123]:

> *r3aa2: If A has a right to require B to do Z at time T and A requires B to do Z at T, then a legal sentence «It is obligatory for B to do Z» becomes valid at T.*

The above rule asserts that a duty which is represented by a legal object sentence follows from a rule which represents the right. Yoshino (2012) analyses the concept of right in terms of legal meta-sentences. He aims to contribute to the «dynamic systematization of law.»[4]

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[4] Yoshino writes: «[T]he Hohfeldian logical formalization […] fails to adequately systematize the dynamic changes of rights and duties in relation to changes in time. In contrast, we propose a system of analysis that recognizes the inherent hierarchy between a right on the meta-level and a duty on the object level language.» [Yoshino 2012, 305]

3.2.1.4. Connection between LMS and LMS

A legal meta-sentence describes the validity of legal sentences. Some LMSs describe the validity of other LMSs [Yoshino 2011b, 27]. A connection is LMS-LMS (Figure 9 b). The following are two examples of legal meta-rule sentences:

> *CISG Article 1 (1): This Convention applies to contracts of the sale of goods between parties whose places of business are in different states: (a) when states are contracting states; or …*

> *CISG Article 23: A contract is concluded when an acceptance of an offer becomes effective.*

Positive legal meta-rule sentences, LMRSs, assist a fundamental meta-rule sentence (FLMRS; see further) as its sub-rule sentences to decide on the fulfilment of each requirement of the FLMRS. Hence, a connection between LMRS and LMRS is produced. If the validity of a positive LMRS is regulated by other positive LMRSs, the latter belong to a *higher meta-level* than the former [Yoshino 2011a, 123].

For terminological purity, an attempt could be made to give different names to the LMRSs mentioned above, which are on the higher meta-level, and other LMRSs, which are on the lower levels. Semantic differences can be probably be distinguished, too. However this may be difficult to formalize. The reason is that too many levels, or even a complicated hierarchical structure, can emerge.

3.2.2. Legal Inference

In Logical Jurisprudence, the *modus ponens* rule stands for the main inference rule. LRSs are deduced from the existence of legal rules in Ought; see arrow (1) in Figure 10. The LRSs obtained, and legal fact sentences, LFSs, are used to deduce legal object sentences, LOSs; see arrow (2). The LOSs obtained point to legal objects on the Is stage; see arrow (3).

Legal sentences are developed through the process of legal reasoning. Yoshino (2011b, 27–28) concentrates on two types of legal reasoning:

1. *Reasoning of legal justification*. This is based on deduction through modus ponens.
2. *Reasoning of legal creation* (or discovery). This is further divided into two parts:

   2.1. *abduction*. The inference rule *modus tollens* is applied;
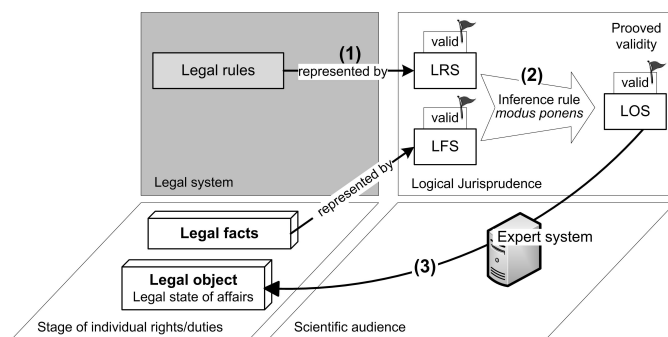   2.2. *induction*.

Figure 10: Legal inference

The legal sentence of a judgment may not be deduced from statutes and facts alone, but from the whole body of legal sentences including legal principles, cases, theories and implicit legal common sense. Therefore Yoshino emphasizes two ways of legal reasoning (2011b, 28):

1. *Concretization*. Statutory terms are made tangible by creating LRSs which describe inclusion relations.

2. *Systematization*. The sentences of legal principles are created and these enable us to bring mere collections of LSs into a unified, coherent deductive system.

3.3. Fundamental Legal Meta-Rule Sentence (FLMRS)

A *fundamental legal meta-rule sentence* (FLMRS) is implicitly taken for granted for all regulations. The following is an example from Yoshino (2011a, 122):

> *r0: A legal sentence is valid at time T, if and only if a legal sentence becomes valid before T and it is not the case that the sentence is terminated before T.*

Yoshino notes that event calculus provides a hint for this rule, and the rule is treated as the most fundamental FLMRS. It is represented as follows:

A legal sentence S is valid at the time T ⇔

> *(S becomes valid at time T1 before T) &* // First requirement
>
> *not (S is terminated after T1 and before T)* // Second requirement

Yoshino holds (2011a, 122) that all positive FLMRSs regulate the fulfilment of the first requirement (*S becomes valid*) or the second requirement (*S is terminated*) of *r0* above.

3.4. Legal Meta-Rule Sentence (BLMRS)

The validity of the final, highest legal sentence, whose validity cannot be deduced through the application of legal meta-rule sentences, is called the basic legal meta-rule sentence [Yoshino 2011a, 123]; see Figure 11. (Again, validity is considered as truth – in the realm of science). For example, in international law, LMRSs that regulate the validity of conventions must be assigned to the highest level [Yoshino 2011a, 123].

The *validity* of the basic legal meta-rule sentence is to be *presupposed*, or asserted as a fact sentence. Yoshino holds that a BLMRS is sometimes found in constitutions or conventions, but sometimes in theories of constitutions or conventions which explain the basis of their validity.
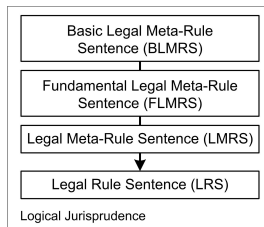

Figure 11: Basic Legal Meta-Rule Sentence (BLMRS)

4. Comparison of Yoshino's LJ with Kelsen's PTL

First, there is a similar solution at the top of the system: basic norm in Kelsen's Pure Theory of Law and BLMRS with FLMRS; see Figure 12.
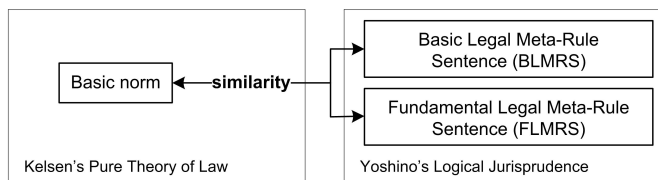

Figure 12: A similar solution at the top of the system

Second, Kelsen uses textuality while Yoshino uses logic. Yoshino allows a differentiation between juridical sentences. This is important in computer applications.

Third, Yoshino's Legal Object Sentences refer to legal objects on the Is stage of individual rights and duties (Figure 13, the left arrow). An example of modelling a hypothetical Anzai-Bernard legal case is provided in [YOSHINO 2011a, 124–125].
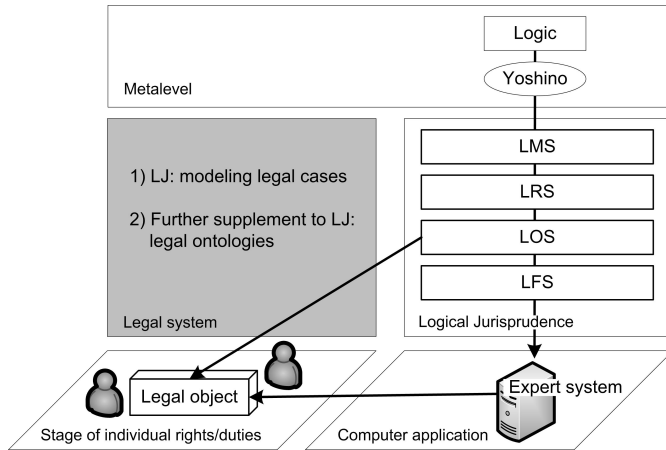

Figure 13: Legal Object Sentences refer to legal objects in Is; see the left arrow. Yoshino goes through logic, Logical Jurisprudence and expert systems to legal objects in Is; see the right arrow

Fourth, Yoshino departs from logic, and goes through Logical Jurisprudence – LMS, LRS, LOS, LFS – to expert systems which can contribute to legal objects in Is (Figure 13, the right arrow).

Fifth, we would add legal ontologies [CASELLAS 2011] as a further supplement. We think that Logical Jurisprudence can also contribute to ontologies [GUARINO ET AL. 2009].

5. Conclusions

Compound Legal Formula representation and Prolog remind us of the high expectations of knowledge engineers in the 1980s. Yoshino notes that a hint of the *r0* rule was obtained from [SERGOT ET AL. 1986]. However, nowadays the expectations of expert systems builders can be analysed from perspectives other than just logic programming; see e.g. [Leith 2010]. A critical perspective on the nature of law has to be taken by both the academic legal community and informatics. Yoshino's achievement is to stay within the mainstream of legal informatics. He contributes to building a bridge between law and informatics.

Yoshino is concerned with both legal reasoning and systematization. Logical Jurisprudence is about formalising them. Nowadays, we would suggest expanding these concerns with, first, legal ontologies and, second, words. We view the latter within the granularity of word-phrase-sentence-text. Different methods of legal informatics are applied to different units. Here we also refer to the research of Guido Tsuno (2011) on the legal lexicon.

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