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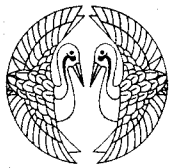

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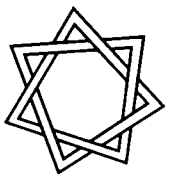

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COMPUTER ANALYSIS OF THE LAWS OF HAMMURABI: BASIC CONCEPTS*

Introduction

We indicate with the term "computer analysis" a fairly specialized form of analysis based on formal logic and modelling of the text under investigation [1]. The model of the text is a formal description of its contents. It is constructed by a researcher or, in our case, a historian. The object of modelling a selected body of texts on the basis of the concepts they advance and their internal conceptual hierarchy is to establish a formal system of information about a concrete historical period or phenomenon. We are thus able to use the computer to systematize and analyse what we learn through our research. One of the most important results of such analysis is a body of information that reflects this knowledge and can subsequently be analysed automatically and used. One example of such use is searching and selection on the basis of a logical conclusion drawn from what we know. In our case, the laws of Hammurabi and accompanying documents have been chosen for analysis.

The Laws of Hammurabi (Code of Hammurabi) is the accepted scholarly name for the most important and largest legal text from ancient Mesopotamia. The text was drawn up in Akkadian (now a dead language) in the eighteenth century B.C. and later written in cuneiform on stone stelas set up in Babylon and other important Mesopotamian cities. The text of the Laws circulated until the very end of "cuneiform" culture in the form of copies on clay tablets. The only stone stela with the text of the Laws to have come down to us was discovered by archaeologists at the beginning of the twentieth century in South West Iran, home to the ancient state of Elam. The Elamites brought it there as a war trophy after one of their raids on Babylonia several centuries after the Laws were made public. The Elamites carved off a part of the text on the stela, most likely intending to carve in its place a triumphal inscription, but for some reason did not complete their task. The resultant lacuna in the text has only been partially filled on the basis of clay-tablet copies, as all copies are to some degree partial or defective.

The first scholarly publications on the Laws of Hammurabi, translations into modern languages and more or less extensive commentary appeared soon after the Laws were discovered. New publications continue to appear as new fragments of the text are discovered, our knowledge of the Akkadian language improves, and progress is made in the interpretation of the text. One should note that the first publisher divided the text into three sections: Prologue, Laws, and Epilogue. The Prologue and Epilogue contain the religious basis for Hammurabi's power, his rights and obligations as lawgiver and keeper of Truth and Justice (the two concepts were personified as deities), explain the reason for promulgating the Laws and bestow blessings on future rulers who will observe them and curses on those who would break them. They are written in high style, intentionally archaic even for the time of their composition. They belong to the genre of prose literature. At the present stage of our work, these two sections are not amenable to formal analysis. But the text of the laws is written in dry, precise, strictly formalized language; it forms a perfect subject for our purposes, although some circumstances complicate our task.

The goal of the present work is to demonstrate with a few examples certain basic principles of using formal logic in text analysis, its possibilities and difficulties. Subsequent instalments will examine the particular features of the documents analysed, treat the basic elements and characteristics of the formal language used to define textual models, and provide examples of models.

We relied on the MAZE database administration system, which allows for the collection of texts, their formal description, indexing, conceptual dictionaries, and a network of associative links between texts to produce a hypertext and reveal the conceptual dimension of this hypertext [2]. The system allows for the entry and processing of three types of information:

— texts and their formal description in textual form;

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— conceptual information drawn by the system from the descriptions of texts or set by the researcher;

— dictionaries and indices to the texts.

Texts are built up in a card-catalogue system. Along with traditional subject headings and hypertexts, the card catalogue allows one to construct and process card networks linked by preset binary relations. This gives the researcher a chance to determine the associative links between the texts. Practice shows the usefulness of these methods; for example, in carrying out various types of semiotic research [3].

1. Basic characteristics of the text to be analysed

The text's first publisher divided the Laws into individual "paragraphs", or "articles", numbering them in accordance with his understanding of the text and his ideas, very subjective though, of how many paragraphs might be contained in the lacuna. The actual text, however, is divided into columns and lines. They are, as far as we can tell, determined unrelated to content, intended instead to make the cuneiform easier to place and more attractive. The first publisher's paragraph divisions are not always logical: some of them could be further divided, others could be linked. But this division has long been accepted, so any departure from it would seriously impair our ability to use the vast existing literature on the Laws of Hammurabi where references to the text are given by column, line and paragraph number. The number of paragraphs in the lacuna remains unknown. Nonetheless, for the purposes of formal analysis it would be very convenient to divide the text into the smallest legally relevant segments, which we propose to call norms. Thus, each paragraph (article) would contain one or more norms. References to norms would contain the number of the norm and the paragraph.

The question of the text structure, or the question of the principle of the order of individual norms and paragraphs within the Laws, is extremely important, and still remains a matter of controversy. We suggest that the norms and paragraphs are grouped into larger "sections" in accordance with the subject of regulation, which is understood very broadly. The transition from one norm to another (their meaning connection) is by association — two neighbouring norms and two neighbouring paragraphs treat one and the same subject, though they might do so in entirely different ways. We remind readers that the original contains only semantic divisions; each new norm is introduced with the word "if". The present work treats the first "section", which consists of five paragraphs. It formulates the basic principles of administration of justice, acting as a purely legal introduction to the more concrete paragraphs and norms to come. It is for this reason that it lacks associative transitions from one norm to another and to the next section. Moreover, to understand the following one must take into account that the law of ancient Babylonia is purely empirical and pre-theoretical. It formulated none of the general principles or abstract legal concepts that our era takes for granted — for example, the principle of the law's exhaustive completeness or the concepts of legal capacity and capability (these were only formulated centuries later by Roman jurists). But one can claim that Babylonian jurists in some sense understood (or, at least, felt) their importance and meaning. Unable to formulate them as abstract concepts, they conveyed them casuistically, presenting the general concept as a concrete case. It may thus seem strange that the Laws begin by establishing the punishments for a false accusation of murder or sorcery and how a court should investigate such accusations, yet do not contain any norms for the punishment for actual sorcery or murder. But this was presumed to be clear to all. The general principles that can be formulated for the preceding on the basis of the text of the First section are:

1) A court trial begins with a declaration by the plaintiff (who is also the accuser).

2) Proof in court consists of the testimony of witnesses and documents, and if "earthly" proofs are absent, divine justice in the form of an oath or ordeal (trial by River; other texts indicate that other forms of ordeal existed). Either the court or the law establishes which of the sides and / or witness must swear an oath or undergo ordeal.

3) Once delivered, a verdict cannot be reviewed by the same court on the same basis; a judge who performs such a review is removed from his office (Babylonian jurists understood the principle formulated by Roman law as non *bis in eadem re*, but expressed it, as we have explained, casuistically).

Properly speaking, paragraph 7 belongs in this section as well; it establishes a general rule with a concrete case: someone who has acquired something in some fashion from a slave or "son of a person" (a minor) is punished as a thief (in other words, a slave or "son of a person" is not legally capable). In our text, however, this paragraph occupies its place not in error, as many authors believe, but in strict accordance with the associative principle: the preceding paragraph concerns the punishment for thievery.

We must formulate several other basic principles that we will use in analysing the text. Since Babylonian law, like other ancient legal systems, did not divide law into criminal, civil, procedural, etc., and trials were an adversary proceeding (initiated by one of the parties, with each party obligated to prove the correctness of its assertions), the parties are called, in accordance with their roles, "plaintiff" and "defendant". Each concrete norm replicates the form of the so-called "Omen lists" — a special type of text that foretold the future on the basis of events or phenomena that had already occurred: if event A had taken place (in our case, the disposition of a given norm), then event B must take place (the sanction for the given norm). Each norm, therefore, includes disposition A (some hypothetical situation of legal relevance) and sanction B (indication of the obligatory legal consequences of this situation). These consequences occur in the form of a legal verdict that establishes the validity of a demand or accusation. The disposition, in other words, contains the point at issue, whatever it may be: (a) a property dispute; (b) a violation of a law. The trial presumes the participation of judges, plaintiffs, who are either victims or accusers, defendants, who can be victims in the case of a baseless accusation or demand, and witnesses. The category of sanctions includes: (a) punishment imposed on a person; (b) the obligation to

perform or not perform certain actions; (c) permission to perform an action. Damages, in turn, could be material or caused to a person, although the dividing line between these types of damages was in practice indeterminate, as the Babylonians considered property part of the person of its owner (only Roman law developed abstract concepts of property and ownership). The first two types of sanctions, if the disposition dealt with damages caused by one person to another, could correspond to the principle of talion, where the defendant suffers the same harm that he has caused (or meant to cause) the plaintiff, the defendant being found guilty of causing real or virtual damage (the latter in the case of a false accusation or perjury).

These are the basic concepts we will use in our formal description of the norms of the Laws. The language of description is a metalanguage in relation to natural language, allowing us to use either the original text or a translation into any natural language, as long as the translation corresponds to the original, of course.

2. Basic principles of textual modelling

Formal description occupies a central place in the general technique of formal-logical text analysis. Descriptions are drawn up by researchers and can contain both information about concepts employed in the texts and models of texts. Any concept is formally defined as a class of objects that possess common attributes. For any concept, one can indicate the classes to which it belongs, its own subclasses, attributes, and the meanings of its attributes. Descriptions of data constructed in accordance with these principles are called conceptual models. In our descriptions we will use the formal language developed and implemented in the MAZE system [4].

The model of the text is written down as a sequence of statements of the formal language. A statement can contain an assertion about relations between objects in the conceptual model and either takes the form of a rule that establishes the dependence of relations or represents a query to the knowledge base. Statements are separated by the sign **;**.

The following types of objects can be defined: concepts (classes, sets), concrete objects (individuals), links, numbers. The object type is clearly indicated in its designation. For example, class and individual designations are written in the letters of the Russian or Latin alphabet; moreover, the final element in an individual designation must be one of two signs: **$** or **#**, which distinguish individual and class designations. Numbers and underscores (_) can be used along with letters in class or individual designations.

EXAMPLE 1.

norm, disposition, D1, capital_case — designations of concepts (classes of individuals);

Balmunamhe$, thief# — designations of individuals.

We note that the sign **$** is used when it is necessary to introduce a general designation that applies to the entire body of texts. In our example, we use the name **Balmunamhe$** to designate a concrete person who is thus designated in all the texts. The sign # means "some" (in our case some concrete thief) and the designation's sphere of application is limited by this sign to the text in which it is used. In various texts the designation **thief#** will indicate various concrete thieves.

A relation of belonging for individual **I$** or subclass **Sc** to some class **C** is called a relation of concretisation and is designated by the sign **:**. The belonging of individual **I$** (or subclass **Sc**) to class **C** is written **C: I$** (or **C: Sc**). We say in this case that individual **I$** (or subclass **Sc**) concretises class **C**.

EXAMPLE 2. Norms of the Laws reflect the precise social and class division of Babylonia's inhabitants. Free Babylonians and slaves had fundamentally different statuses and rights; the term "person" in norms is bound to the designation of free people, in turn divided into two classes — free community members with full rights (*awīlums*) and the people of the king (*muškēnums*). By concretising, we can record this fact as follows:

inhabitant_of_Babylonia:*awīlum*;
inhabitant_of_Babylonia:*muškēnum*;
inhabitant_of_Babylonia:slave;

As a result, we introduce into the information system four new concepts, designated as "**inhabitant_of_Babylonia**", "***awīlum***", "***muškēnum***", "**slave**", and linked by concretisation. We note that in our model, thanks to the formal sense of a concretization relation, any representative of the class *awīlum*, *muškēnum* or slave is also a representative of the class **inhabitant_of_Babylonia**.

In terms of rights, degree of defence before the law, and types of obligations to the state, free inhabitants of Babylonia were divided into "state" or "royal" people — *muškēnums* (lacking full rights and serving the king) and commune members with full rights — *awīlums*. Continuing the model, we can record that within the *muškēnum* class there were subclasses of people differentiated by type of service:

person: *muškēnum*; person: *awīlum*;
***muškēnum*: *rēdum*; *muškēnum*: *ba'irum*;**
***muškēnum*: payer_of_income;**

Through concretisation we establish a hierarchy of concepts, where one and the same concept can occupy a place in various hierarchies.

A class is made up of individuals (instances) that possess certain attributes. The presence of attribute **P** among all items in class **C** is represented as **C(P)**. Each representative of class **C** has the concrete (although it may not be indicated) expression (value) of attribute **P**, where this value is an item of class **P**.

Any concretisation of a class entails specifying the characteristics of the class. With the statement **Sc(P.Sp)** we clearly indicate that for class **Sc** attribute **P** is concretised by values of class **Sp**, and any item in class **Sc** can have as a value for attribute **P** only an item of class **Sp**. Consequently, with the statement **Sc(P.Sp)** we establish a concretisation relation between class **P** and class **Sp**.

EXAMPLE 3. All free inhabitants of Babylonia had to perform duties of taking part in common construction and irrigation projects and to pay tribute. The class **general_duties** can be described as an attribute of any concrete inhabitant of Babylonia with full rights:

***awīlum* (general_duties);**
general_duties:construction;
general_duties:irrigation;
general_duties:economic;

*Muškēnum*s formed a separate class by virtue of their carrying out royal service, for which they received a land allotment (house, field, garden) or reward in kind:

***muškēnum*(special_duties, land_allotment, reward);**
special_duties:military;
special_duties:production;
***rēdum*(special_duties.military);**
***ba'irum*(special_duties.military);**

Before moving on to the modelling of concrete concepts connected with the norms of the Laws, we will have to define one more extremely important type of relations in the formal language for modelling texts — conceptualisation. Conceptualisation relations are used when it is necessary to describe the structure of a concept by indicated the objects that make up the structure and their relations within the structure. Conceptualisation relations allow us to examine sets of assertions about objects as a whole object that can enter into relations with other objects. In the formal text this set of statements is set off by brackets. The construction **object {set of assertions}** is intended to model such situations. We will use the term "object conceptualisation" to designate a bracketed set of statements that apply to the object indicated in the construction. The relations given by this set are called entering into the conceptualisation.

EXAMPLE 4. As was noted above, each concrete norm in the Laws takes the form omen. It makes sense to construct the model of a norm as some trial of law determined by the nature of events or phenomena. The skeletal situation consists of two classes of objects: the disposition and the sanction that results from the disposition. Attributes of the disposition are the complaint that forms the crux of the trial, the plaintiff who advances the corresponding complaint, the defendant to whom the complaint is addressed, witnesses and the court's conclusion on the factual aspect of the case. This conclusion could be decisive, recognizing the basis or baselessness of the complaint, or it could rely on the results of an ordeal imposed by the court or the norm on the plaintiff or defendant. The documents use as ordeal an oath, trial by River, and legal duel. Two attributes of the ordeal are of key importance: who undergoes it and its result. Two outcomes of the ordeal are possible: death or survival. The norms of the laws propose four types of sanctions: punishment for a violation of law, permission to perform or not to perform an action (for example, extend a contract), a ban on certain actions and an imposition (of a fine, for example):

disposition(complaint,plaintiff,defendant,
witness,established,verdict);
established:proved;established:unproven;
verdict:ordeal(person_tried,result);
ordeal:trial_by_River;
sanction(object_of_sanction):punishment:execution;
sanction:imposition:fine;

This is enough to record models of two norms not found in the text of the Laws but active and known by custom to all inhabitants of Babylon. One of them concerns the punishment for murder (**PM**); the other, punishment for sorcery (**PS**):

norm:PM{disposition(complaint.murder,
defendant.accused#,established.proved);
sanction:execution(object_of_sanction.accused#)};

norm:PS{disposition(complaint.sorcery,
plaintiff.accused#,established.proved);
sanction:execution(object_of_sanction.accused#)};

Two comments follow on the designations used in EXAMPLE 4: (a) concrete cases are instances for the class **norm**. Its subclasses **PM** and **PS** are formed from cases, the dispositions of which are represented by grounded accusations of murder and sorcery; (b) for each concrete instance in class **PM** (**PS**) there is some instance in the disposition class with some concrete complaint of the class murder (sorcery). Also concrete and juxtaposed with individuals of class **PM** (**PS**) are the defendant of the class **accused**, a resolution of the class **proved** and a sanction of the class **execution**. The fact that the defendant in the disposition and sanction is one person is noted with the sign #.

The definitions of norms examined below were drawn up in accordance with the texts of the Laws and on the basis of the concepts already introduced. In defining them, the following agreements were accepted:

a) Each norm contains a description of one disposition and one sanction. A section of the Laws that contains several dispositions is represented by a corresponding number of norms. Various sanctions may be indicated for a general disposition in the text of the section (an example might be sections where the content of the sanction depends on the outcome of an ordeal). In such cases the section situation is described with several norms.

b) It makes sense to indicate the section of the Laws to which a designated norm corresponds in the designation of the class the norm represents. The structure we have selected for designating norms takes the form **N**_"section"_"norm", where the space designated by "section" gives the section number in the text of the Laws and the place designated "norm" gives the number of the norm within the section.

EXAMPLE 5. We present models of the first five sections of the Laws. These sections formulate the basic principles of administration of justice. The text is given in V. A. Jakobson's translation [5]. For easy comparison with the original, the text of the Laws gives in parenthesis the number of each fifth line in the original.

§1. (26) If a person has accused (another) person and raised against him an accusation of murder, but (30) not established [his guilt], the accuser is to be killed.

norm: N_1{
disposition(
complaint.murder,
plaintiff.accuser#,
established.unproven);

§2. If a person an accusation of sorcery (35) against (another) person has raised, but not established [his guilt], he against whom the accusation of sorcery was raised, to the River (40) must go and must undergo trial by River, and if the River takes him, his accuser his (45) house can appropriate; but if the River cleanses this person (of this accusation) and he remains unharmed, (50) he who raised against him the accusation of sorcery is to be killed (and) he who underwent trial by River can appropriate the home of (his) accuser.

```
norm: N_2_1{
    disposition(
            complaint.sorcery,
            plaintiff.accuser#,
            defendant.accused#,
            verdict: trial_by_River(
            tried.accused#,
            result.died));
    sanction: transfer_of_property(
from.accused#,
            to.accuser#)};

norm: N_2_2{disposition(
            complaint.sorcery,
            plaintiff.accuser,
            defendant.accused#,
            verdict: trial_by_River(
            tried.accused#,
            result.survived));
    sanction: transfer_of_property(
            from.accuser#,
            to.accused#);
    sanction: execution
    (object_of_sanction.accuser#)};
```

§3. (57) If a person in a trial of law for bearing witness (60) about a crime has spoken, but did not confirm the spoken word, (then) if this trial (65) is a trial over life (and death), the person shall be killed.

```
norm:N_3{
    disposition(
            complaint.trial_capitale_case,
            witness.person#
            established.unproven);
    sanction:execution(object_of_sanction.person#)};
```

§4. (68) If for bearing witness (VI, 1) about grain or money he has spoken, responsibility for this trial (5) he must bear.

```
norm: N_4:={
    disposition(
            complaint.property_matter,
            witness.person#,
            established.unproven);
    sanction: punishment_for_matter
    (object_of_sanction.person#)};
```

§5. If the judge has resolved his case (and) delivered a verdict, (10) has ordered a document with a seal prepared, and then changed his verdict, this judge (15) should be exposed for changing a settled matter and the complaint, which for this matter (20) was presented, he should satisfy twelvefold, and in the assembly from the chair (25) of a judge he should be forced to rise, and he should not return and with judges in the court (30) he should (no longer) sit in session.

```
norm: N_5{
    disposition(
            complaint.changing_legal_verdict(
                    case.property_case,
                    amount_of_suit.sum),
            defendant.judge#,
            established.proved);
    sanction: property_punishment(
                    object_of_sanction.judge#,
                    amount.sum_12);
    sanction: removal_from_office
    (object_of_sanction.judge#)};
```

Only five principles of the justice system are specially set off in the system of legislation declared by the text of the Laws: punishment for false accusation, punishment for perjury, talion, the punishment of "equal for equal", ordeal as a means of establishing the truth when "earthly" proofs are impossible (the case of sorcery is a fine example), a judge's review of an earlier verdict. Interestingly, the punishment for perjury is set in accordance with the principle of talion; in the next section we will show the consequences this has in the general formal system of knowledge on the texts of the Laws.

3. Queries and rules

Models of texts and accompanying information are gathered and systematized in the knowledge base. At any stage in the process we can direct a query on the concepts, relations between them, or models in which these concepts occur [6]. The most frequently used query is in the form of a list of statements in the formal language provided with a "**?**": **? statement;** or **? (list of statements)**.

The query means: "Does the knowledge base contain facts that support the statement contained in the query?" An important difference between statements in queries and analogous statements in models of texts is that in queries in place of a class or individual designation we can put a variable. In such a case, we ask: "Are there values for the variables in the query which make the statement true, and if they exist, what would they be?" Unlike the (constant) class and individual designations we have already used, variables begin with a "**!**".

EXAMPLE 6. Let us assume that our knowledge base contains the facts given in examples 1—5. The query **?inhabitant_of_Babylonia:!X** would produce the answer: **(X=*awīlum*; X=*muškēnum*; X=slave)**, and the query **? disposition(!X)** the answer **(X=complaint; X=plaintiff; X=defendant; X=witness; X=verdict; X=established)**.

A more complicated query would concern norms of the Laws where the complaint of the disposition and the sanction contain the concept **loss_of_life**:

? (norm: !X{disposition(complaint: !Y); sanction: !Z}; loss_of_life:!Y; loss_of_life:!Z)

At the current stage of our knowledge base we will receive a negative answer because the concept **loss_of_life** is missing in our knowledge base. But if augment the base with the definitions

loss_of_life: execution; loss_of_life: murder;
loss_of_life: capitale_case;

we will obtain the following answers: **(X=PM; Y=murder; Z=execution)**, **(X=H_1; Y=murder; Z=execution)**, **(X=H_3; Y=capitale_case; Z=execution)**.

The answer to a question cannot always be obtained as a result of a direct review of the statements in the knowledge base. We may, for example, be interested in the norms of Laws where the sanctions are subject to the abovementioned principle of talion. In order to organize a search for an answer to this question, we need to construct a small system of concepts and rules, an "ad hoc theory" to seek out the required answer. The construction of a rule in our formal language takes a fairly traditional form: **** consequent ← antecedent**, where the consequent and antecedent are statements in the formal language [7].

EXAMPLE 7. In our knowledge base we will define **talion** as a subclass of norms. We need to define the concepts and rules that the knowledge base will use to determine whether concrete norms in the Laws belong to this subclass. Obviously, we can only assign to the **talion** class those norms where the disposition speaks of damage inflicted by one party in the trial on another party. We designate the corresponding concept as **damage** and define it as an element in the conceptualisation juxtaposed with the norm:

damage(subject_of_damage, object_of_damage);

The principle of talion can then be formulated as follows: "A norm belongs to the **talion** class if the subject that inflicts some damage according to the disposition of this norm is the object of a sanction of the same norm in the form of equivalent damage".

****talion: !CN←**
(norm: !CN {damage: !Z(subject_of_damage.!X);
sanction: !S(object_of_sanction.!X)} !Z:!S);

In looking for an answer to the query **? talion: !X**, the knowledge base will try to use this rule, automatically replacing the original query with whatever is supplied by the rule's antecedent.

In order to carry out a search on the new query, one must know how to identify norms that deal with some form of damage. The task here is to take into account various situations where damage is inflicted:

a) The complaint of the disposition belongs to one of the subclasses of the **damage** class and is well-grounded — damage is inflicted by the defendant.

**** !CN{damage: !X(subject_of_damage.!D}←**
(!CN{disposition(complaint.!Y,defendant.!D,
established.proven)}; !X:!Y);

b) The complaint of the disposition belongs to one of the subclasses of the **damage** class and is unfounded. In this case, we can speak of "virtual" damage which the plaintiff, as well as the witnesses he calls, attempts to inflict on the defendant with a false accusation or false testimony in an attempt to impose a sanction. We can establish the type of damage by finding the norm that establishes the sanction if the complaint is satisfied:

****false_accusation:!CN{damage:**
!S(subject_of_damage.!Z,object_of_damage.!D}←
(norm: !CN{disposition(plaintiff.!Z,
complaint.!P,defendant.!D,
established:unproven)};
norm:!CN1{disposition(complaint.!P1,
established:proved);
sanction:!S1};
damage:!Q;!Q:!P; !Q:P1; damage:!S; !S:!S1);
****perjury: !CN{damage:**
!S(subject_of_damage.!Z, object_of_damage.!D)}←
(norm: !CN{disposition(witness.!Z,
complaint.!P,defendant.!D,
established: unproven)};
norm:!CN1{disposition(complaint.!P1,
established:proved);
sanction:!S1};
damage:!Q; !Q:!P; !Q:P1; damage:!S; !S:!S1);

In addition to the rules, we must augment the knowledge base with information about the concepts that are part of the **damage** class:

damage:loss_of_life;
damage: property_damage;
property_damage:property_case;
property_damage:punishment_for_matter;

Now, when searching for an answer to the query

(norm: !CN{damage: !Z(subject_of_damage.!X);
sanction: !S(object_of_sanction.!X)}; !Z:!S);

the knowledge base will use rules a) and b) to select norms where the dispositions contain some form of damage and establish its inflictor; it will then review the selections and chose those sanctions that impose on the inflictor equivalent damage.

The remaining issue is ordeal. The validity of a complaint, as was noted, is here established according to the results of a (physical) trial. We can present this circumstance in the knowledge base with two rules:

a) The complaint of the disposition in the norm is valid and the sanction belongs to the class **loss_of_life** if the defendant who undergoes the trial dies as a result.

!CN{disposition(established:proved);
sanction:execution(object_of_sanction.!X))}←
(norm:!CN{disposition(defendant.!X);
verdict:trial_by_River(tried.!X,result.died)});

b) The complaint against the defendant in the disposition of the norm is considered invalid if he survives the trial.

!CN{disposition(established:unproved)}←
(norm:!CN{disposition(defendant.!X);
verdict:trial_by_River(tried.!X,result.survived)});

The presence in the knowledge base of the norms **N_2_1**, **N_2_2** and the last two rules renders superfluous the earlier definition of the norm **NS**, since the information given by this norm is automatically derived from the latter definitions.

Conclusion

It follows from the preceding that the search system presented here differs from traditional search systems in its focus on the "meanings" of the modelled texts rather than the key words they contain. It allows one to reveal the logical structure of texts and the information they contain. Since the system itself functions purely on the basis of formal logic, the results may differ from those obtained through the heuristic methods typical of human researchers. Sometimes these results are quite intelligent, though sometimes rather surprising. Nonsense answers also occur; they point to insufficiently exact formulations of rules and statements and help to identify the errors that result from inexact human thought. In other words, the proposed system and the researchers that use it can act as opponents, helping each other to overcome mutual shortcomings.

The information contained in the system is a formal description of a specific subject. It is structured in such a way that one can set up any samples and any juxtapositions within the system. Should the system prove workable, it could be applied to similar topics such as the analysis of any legal texts, or even any texts that have a clearly defined formal-logical structure.

Notes

1. V. A. Jakobson, "Computer Assyriology", *Manuscripta Orientalia*, IV/4 (1998), pp 55—9; G. V. Lezin, K. K. Boiarskiĭ, E. A. Kanevskiĭ, A. I. Popova, "Analiz tekstov: predstavlenie i obrabotka kontseptual'noĭ informatsii" ("Text analysis: presenting and analysing conceptual information"), in *Trudy Mezhdunarodnogo seminara Dialog '97 po komp'iuternoĭ lingvistike i eë prilozheniiam* (Moscow, 1997), pp. 170—4; see also K. K. Boiarskiĭ, E. A. Kanevskiĭ, G. V. Lezin, A. I. Popova, "Formalizatsiia znaniĭ v gumanitarnykh issledovaniiakh" ("The formalization of knowledge in humanities research"), in *Ėkonomiko-matematicheskie issledovaniia: matematicheskie modeli i informatsionnye tekhnologii* (St. Petersburg, 1999), pp. 248—63.

2. For the MAZE database, see Lezin, Boiarskiĭ, Kanevskiĭ, Popova, "Analiz tekstov". For the English version of the article, see G. V. Lezin, K. K. Boiarsky, E. A. Kanevsky, A. I. Popova, "Programming of texts conceptual treatment", *Manuscripta Orientalia*, III/2 (1997), pp. 42—8.

3. V. V. Emel'ianov, "Ispol'zovanie kartoteki MAZE dlia ustanovleniia semantiki drevnego kalendaria (na primere kalendaria iz g. Nippura)" ("The use of the MAZE card index to establish the semantics of an ancient calendar (on the basis of a calendar from the city of Nippur)"), in *Informatsionnye tekhnologii v gumanitarnykh i obshchestvennykh naukakh*, issue 7 (St. Petersburg, 1997), pp. 1—9.

4. See Boiarskiĭ, Kanevskiĭ, Lezin, Popova, "Formalizatsiia znaniĭ".

5. "Zakony Khammurapi" ("Laws of Hammurabi"), trans. and commentary by V.A. Jakobson, in *Khrestomatiia po istorii Drevnego Vostoka* (in print).

6. Cf. Boiarskiĭ, Kanevskiĭ, Lezin, Popova, "Formalizatsiia znaniĭ".

7. See *ibid.*