S. Holm, A. Austeng, K. Iranpour, J. Hopperstad, Sparse sampling in array processing, Chapter 19 in "Sampling theory and practice", (F. Marvasti Ed.), Plenum, N.Y., (2001)

S. Kirkpatrik, C. Gelatt, M. Vecchi, Optimization by simulated annealing, Science, vol. 220, 4598, (1988), 671-680.

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A MATHEMATICAL APPARATUS FOR ONTOLOGY SIMULATION. SPECIALIZED EXTENSIONS OF THE EXTENDABLE LANGUAGE OF APPLIED LOGIC[1]

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Abstract: A mathematical apparatus for domain ontology simulation is described in the series of articles. This article is the second one of the series. It describes a few specialized extensions of the extendable languages of applied logic that was described in the first article of the series. A few examples of some ideas related to domain ontologies and formalization of these ideas using the language are presented.

Keywords: Extendable language of applied logic, ontology language specification, specialized extensions of the extendable language of applied logic.

ACM Classification Keywords: I.2.4 Knowledge Representation Formalisms and Methods, F4.1. Mathematical Logic

Introduction

The definition of the extendable language of applied logic was given in [Kleshchev et al, 2005]. This definition consists of the kernel of the language and of its standard extension only. When the semantic basis is extended for particular applications the following two classes of elements are possible. The elements of the first class can be impossible or undesirable to be defined by means of the kernel of the language and by extensions built. On the contrary, the elements of the second class can be naturally defined by means of the kernel and extensions built. The elements of the first class are described in specialized extensions in the same form that is used in the description of the kernel of the language and of its standard extension. A specialized extension of the language defines elements of the semantic basis that are necessary for a comparatively narrow class of applications. Because the same specialized extensions can be used in different applications such extensions have names. Every particular language of applied logic contains the kernel and usually the standard extension and possibly some specialized extensions. By this means, every particular language of applied logic is characterized by a set of extension names rather than a signature. A signature is introduced by a particular logical theory represented by

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such a language. Therewith, propositions of the theory can associate values (interpretation) or sorts with names (elements of the signature) or can restrict possible functions of interpretations for these names according to the interpretation of other names. In turn, every theory has a name. The parameters of the name are the names of the extensions of the language that are used for describing the theory. Other theories represented by their names also can be elements of the theory.

This article describes a few specialized extensions of the languages and a few examples of some ideas related to domain ontologies and formalization of these ideas using the language.

1. Specialized Extension “Intervals” of the Language of Applied Logic

Every specialized extension of the language has a name. In the representation of a logical theory it must be indicated which extensions of the language are used in this representation. In this paragraph the specialized extension *Intervals* is defined.

The terms of the extension are:

1. [ ]R, and also $J_{\alpha\theta}$([ ]R) is the set of all possible intervals of real numbers; $J_{\alpha\theta}$([ ]R) does not depend on an interpretation function α and on an admissible substitution θ;

2. R[t_1, t_2], where t_1 and t_2 are terms; $J_{\alpha\theta}$(R[t_1, t_2]) is the set of all the real numbers which are not less than $J_{\alpha\theta}(t_1)$ and are not greater than $J_{\alpha\theta}(t_2)$; the value of the term exists if both $J_{\alpha\theta}(t_1)$ and $J_{\alpha\theta}(t_2)$ are numbers and $J_{\alpha\theta}(t_1) \le J_{\alpha\theta}(t_2)$;

3. R(t_1, t_2], where t_1 and t_2 are terms; $J_{\alpha\theta}$(R(t_1, t_2]) is the set of all the real numbers which are greater than $J_{\alpha\theta}(t_1)$ and are not greater than $J_{\alpha\theta}(t_2)$; the value of the term exists if both $J_{\alpha\theta}(t_1)$ and $J_{\alpha\theta}(t_2)$ are numbers and $J_{\alpha\theta}(t_1) < J_{\alpha\theta}(t_2)$;

4. R[t_1, t_2), where t_1 and t_2 are terms; $J_{\alpha\theta}$(R[t_1, t_2)) is the set of all the real numbers which are not less than $J_{\alpha\theta}(t_1)$ and are less than $J_{\alpha\theta}(t_2)$; the value of the term exists if both $J_{\alpha\theta}(t_1)$ and $J_{\alpha\theta}(t_2)$ are numbers and $J_{\alpha\theta}(t_1) < J_{\alpha\theta}(t_2)$;

5. R(t_1, t_2), where t_1 and t_2 are terms; $J_{\alpha\theta}$(R(t_1, t_2))is the set of all the real numbers which are greater than $J_{\alpha\theta}(t_1)$ and are less than $J_{\alpha\theta}(t_2)$; the value of the term exists if both $J_{\alpha\theta}(t_1)$ and $J_{\alpha\theta}(t_2)$ are numbers and $J_{\alpha\theta}(t_1) < J_{\alpha\theta}(t_2)$;

6. R[t, ∞), where t is a term; $J_{\alpha\theta}$(R[t, ∞)) is the set of all the real numbers which are not less than $J_{\alpha\theta}(t)$; the value of the term exists if $J_{\alpha\theta}(t)$ is a number;

7. R(t, ∞), where t is a term; $J_{\alpha\theta}$(R(t, ∞)) is the set of all the real numbers which are greater than $J_{\alpha\theta}(t)$; the value of the term exists if $J_{\alpha\theta}(t)$ is a number;

8. R(-∞, t], where t is a term; $J_{\alpha\theta}$(R(-∞, t]) is the set of all the real numbers which are not greater than $J_{\alpha\theta}(t)$; the value of the term exists if $J_{\alpha\theta}(t)$ is a number;

9. R(-∞, t), where t is a term; $J_{\alpha\theta}$(R(-∞, t)) is the set of all the real numbers which are less than $J_{\alpha\theta}(t)$; the value of the term exists if $J_{\alpha\theta}(t)$ is a number;

10. I and also $J_{\alpha\theta}$(I) is the set of all the integers; $J_{\alpha\theta}$(I) does not depend on α and θ;

11. [ ]I and also $J_{\alpha\theta}$([ ]I) is the set of all possible intervals of integers; $J_{\alpha\theta}$([ ]I) does not depend on α and θ;

12. I[t_1, t_2],where t_1 and t_2 are terms; $J_{\alpha\theta}$(I[t_1, t_2]) is the set of all the integers which are not less than $J_{\alpha\theta}(t_1)$ and are not greater than $J_{\alpha\theta}(t_2)$; the value of the term exists if $J_{\alpha\theta}(t_1)$ and $J_{\alpha\theta}(t_2)$ are numbers and $J_{\alpha\theta}(t_1) \le J_{\alpha\theta}(t_2)$;

13. I[t, ∞), where t is a term; $J_{\alpha\theta}$(I[t, ∞)) is the set of all the integers which are not less than $J_{\alpha\theta}(t)$; the value of the term exists if $J_{\alpha\theta}(t)$ is a number;

14. I(-∞, t], where t is a term; $J_{\alpha\theta}$(I(-∞, t]) is the set of all the integers which are not greater than $J_{\alpha\theta}(t)$; the value of the term exists if $J_{\alpha\theta}(t)$ is a number;

15. inf(t), where t is a term; $J_{\alpha\theta}$(inf(t)) is the minimal element of the set $J_{\alpha\theta}(t)$; the value of the term exists if $J_{\alpha\theta}(t)$ is a set of numbers that has the minimal element;

16. sup(t), where t is a term; $J_{\alpha\theta}$(sup(t) is the maximal element of the set $J_{\alpha\theta}(t)$; the value of the term exists if $J_{\alpha\theta}(t)$ is a set of numbers that has the maximal element.

The extension defines no new types of formulas.

3. Specialized Extension "Mathematical Quantifiers" of the Language of Applied Logic.

The terms of the extension are:

1. a quantifier construction (Σ (v_1: t_1)…(v_m: t_m) t) (quantifier of summation); $J_{\alpha\theta}$((Σ (v_1: t_1)…(v_m: t_m) t)) is equal to the sum of the values $J_{\alpha\theta}(t)$, where θ belongs to the set of admissible substitutions for (v_1: t_1)…(v_m: t_m); the value of the term exists if $J_{\alpha\theta}(t)$ is a number for every admissible substitution θ for (v_1: t_1)…(v_m: t_m);

2. a quantifier construction (Π (v_1: t_1)…(v_m: t_m) t) (quantifier of multiplication); $J_{\alpha\theta}$((Π ((v_1: t_1)…(v_m: t_m) t)) is equal to the product of the values $J_{\alpha\theta}(t)$, where θ belongs to the set of admissible substitutions for (v_1: t_1)…(v_m: t_m); the value of the term exists if $J_{\alpha\theta}(t)$ is a number for every admissible substitution θ for (v_1: t_1)…(v_m: t_m);

3. a quantifier construction ($\cup$ (v_1: t_1)…(v_m: t_m) t) (quantifier of union); $J_{\alpha\theta}$(($\cup$ (v_1: t_1)…(v_m: t_m) t)) is equal to the union of the values $J_{\alpha\theta}(t)$, where θ belongs to the set of admissible substitutions for (v_1: t_1)…(v_m: t_m); the value of the term exists if $J_{\alpha\theta}(t)$ is a set for every admissible substitution θ for (v_1: t_1)…(v_m: t_m);

4. a quantifier construction ($\cap$ (v_1: t_1)…(v_m: t_m) t) (quantifier of intersection); $J_{\alpha\theta}$(($\cap$ (v_1: t_1)…(v_m: t_m) t)) is equal to the intersection of the values $J_{\alpha\theta}(t)$, where θ belongs to the set of admissible substitutions for (v_1: t_1)…(v_m: t_m); the value of the term exists if $J_{\alpha\theta}(t)$ is a set for every admissible substitution θ for (v_1: t_1)…(v_m: t_m).

The formulas of the extension are:

1. a quantifier construction (& (v_1: t_1)…(v_m: t_m) f) (quantifier of conjunction); $J_{\alpha\theta}$((& (v_1: t_1)…(v_m: t_m) f)) is true if and only if all the values $J_{\alpha\theta}(f)$ are true when θ belongs to the set of admissible substitutions for (v_1: t_1)…(v_m: t_m); the formula has a value if $J_{\alpha\theta}(f)$ has a value for every admissible substitution θ for (v_1: t_1)…(v_m: t_m);

2. a quantifier construction ($\vee$ (v_1: t_1)…(v_m: t_m) f) (quantifier of disjunction); $J_{\alpha\theta}$(($\vee$ (v_1: t_1)…(v_m: t_m) f)) is true if and only if at least one of the values $J_{\alpha\theta}(f)$ is true when θ belongs to the set of admissible substitutions for (v_1: t_1)…(v_m: t_m); the formula has a value if $J_{\alpha\theta}(f)$ has a value for every admissible substitution θ for (v_1: t_1)…(v_m: t_m).

4. Examples of Applied Logical Theories and Their Models

Here a few examples of some ideas related to domain ontologies and formalization of these ideas will be presented.

Example 1. An applied logical theory "Definition of partitions (ST, Intervals, Mathematical quantifiers)". This applied logical theory contains only value descriptions for names.

(1.1.1) partitions $\equiv$ ($\cup$ (n: I[1, ∞)) {(v: R $\Uparrow$ (n + 1)) (& (i : I[1, n]) π(i, v) < π(i + 1, v))})

"Partitions" means the set of all possible partitions of the set of real numbers into intervals; every partition is a finite strictly increasing sequence of numbers.

(1.1.2) element $\equiv$ (λ (partition: partitions) (i: I[0, length(partition) - 1]) π(i + 1, partition))

"Element" is a function; its arguments are a partition v and an integer i in the range from 0 to the number of elements in the partition v; its result is the i-th element of the partition v.

(1.1.3) interval $\equiv$ (λ (partition : partitions) (i: I[1, length(partition)-1]) R[element(partition, i-1), element(partition, i)])

"Interval" is a function; its arguments are a partition v and an integer i in the range from 0 to the number of elements in the partition v; its result is the interval consisting of all the real numbers between the (i - 1)-th and the i-th elements of the partition v.

It is obvious that this applied logical theory has no models since it contains no ambiguously interpreted names.

Example 2. An applied logical theory “T1(ST, Intervals, Mathematical quantifiers)”, represents a model for a simplified ontology of medical diagnostics: T1(ST, Intervals, Mathematical quantifiers) = <{Definition of partitions}, SS>, where SS is the following set of propositions.

The value descriptions for names

(2.1.1) sets of values $\equiv$ ({ } N) $\cup$ ([ ]I) $\cup$ ([ ]R)

“Sets of values” means the set of possible value ranges for all signs; these ranges can be sets of names (ranges of qualitative values), integer-valued and real-valued intervals (ranges of quantitative values).

The sort descriptions for names.

(2.2.1) sort signs: { }N

“Signs” means a finite set of medical sign names.

(2.2.2) sort diseases: { }N

“Diseases” means a finite set of disease names.

(2.2.3) sort possible values: signs $\rightarrow$ sets of values

“Possible values” means a function that takes a sign and returns its possible value range.

(2.2.4) sort normal values: signs $\rightarrow$ sets of values

“Normal values” means a function that takes a sign and returns its normal value range.

(2.2.5) sort clinical picture: diseases $\rightarrow$ { } signs

“Clinical picture” is a function that takes a disease and returns a subset of the set of signs, which is the clinical picture of the disease.

(2.2.6) sort number of dynamics periods: {(disease: diseases) (sign: clinical picture(disease))} $\rightarrow$ I[1, ∞)

“Number of dynamics periods” is a function that takes a disease and a sign from the clinical picture of the disease and returns the number of dynamics periods of the sign for the disease.

(2.2.7) sort values for a dynamics period: {(disease: diseases) (sign: clinical picture(disease)) (index of dynamics period: I[1, number of dynamics periods(disease, sign)])} $\rightarrow$ sets of values

“Values for a dynamics period” means a function that takes a disease, a sign from the clinical picture of the disease and an index of a dynamics period of the sign for the disease and returns a set of values of the sign, which are possible during the dynamics period.

(2.2.8) sort upper bound: {(disease: diseases) (sign: clinical picture(disease)) (index of dynamics period: I[1, number of dynamics periods(disease, sign)])} $\rightarrow$ I[0, ∞)

“Upper bound” is a function that takes a disease, a sign from the clinical picture of the disease and an index of a dynamics period of the sign for the disease and returns an upper bound of the duration of the dynamics period.

(2.2.9) sort lower bound: {(disease: diseases) (sign: clinical picture(disease)) (index of dynamics period: I[1, number of dynamics periods(disease, sign)])} $\rightarrow$ I[0, ∞)

“Lower bound” is a function that takes a disease, a sign from the clinical picture of the disease and an index of a dynamics period of the sign for the disease and returns a lower bound of the duration of the dynamics period.

(2.2.10) sort diagnosis: diseases

“Diagnosis” is the disease which the patient is ill with; in this model diagnosis can be either a disease or healthy.

(2.2.11) sort partition for a sign: clinical picture(diagnosis) $\rightarrow$ partitions

“Partition for a sign” is a function that takes a sign from the clinical picture of the disease, which the patient is ill with and returns a partition of the patient's time axis.

(2.2.12) sort moments of examination: signs $\rightarrow$ { }I[0, ∞)

Moments of examination means a function that takes a sign and returns a set of time moments at which the sign of the patient was examined; the time is measured by an integer amount of hours from the beginning of the patient's examination.

(2.2.13) (sign: signs) sort sign: moments of examination(sign) $\rightarrow$ possible values(sign)

Every term belonging to set “signs” means a function (process) that takes a moment of examination of the sign and returns the value of the patient's sign at the moment; any value of this kind is a possible value of the sign.

The restrictions on the interpretation of names.

(2.3.1) (sign: signs) (normal values(sign) $\neq \varnothing$) & (normal values(sign) $\subset$ possible values(sign))

For any sign its set of normal values is a nonempty proper subset of its set of possible values.

(2.3.2) clinical picture(healthy) = $\varnothing$

Clinical picture of healthy contains no signs.

(2.3.3) (disease: diseases) (sign: clinical picture(disease)) (index of dynamics period: I[1, number of dynamics periods(disease, sign)]) (values for a dynamics period(disease, sign, index of dynamics period) $\neq \varnothing$) & (values for a dynamics period(disease, sign, index of dynamics period) $\subseteq$ possible values(sign)) & (upper bound(disease, sign, index of dynamics period) > lower bound(disease, sign, index of dynamics period))

For any disease, for any sign from the clinical picture of the disease and for any dynamics period of the sign, the set of values of the sign possible in the dynamics period is a nonempty subset of the set of possible values of the sign; upper bound of the dynamics period is greater than its lower bound.

(2.3.4) (disease: diseases) (sign: clinical picture(disease)) ($\vee$ (index of dynamics period: I[1, number of dynamics periods(disease, sign)]) values for a dynamics period (disease, sign, index of dynamics period) $\cap$ (possible values(sign) \ normal values(sign)) $\neq \varnothing$)

For any disease and for any sign from the clinical picture of the disease, the set of values of the sign possible at least in one dynamics period contains values, which are not normal for the sign.

(2.3.5) (sign: signs \ clinical picture(diagnosis)) (moment of examination: moments of examination(sign)) sign(moment of examination) $\in$ normal values(sign)

For any sign not belonging to the clinical picture of the disease the patient is ill with, the value of the sign can be only normal at any time moment.

(2.3.6) (sign: clinical picture(diagnosis)) length(partition for a sign(sign)) = number of dynamics periods(diagnosis, sign) + 1

For any sign from the clinical picture of the disease the patient is ill with, the number of intervals in the patient's partition for the sign is equal to the number of dynamics periods for the sign and disease.

(2.3.7) (sign: clinical picture(diagnosis)) (index of dynamics period: I[1, number of dynamics periods(diagnosis, sign)]) (moment of examination: moments of examination(sign) $\cap$ interval(partition for a sign(sign), index of dynamics period)) sign (moment of examination) $\in$ values for a dynamisc period(diagnosis, sign, index of dynamics period)

For any sign from the clinical picture of the disease the patient is ill with, for any dynamics period of the sign and for any moment of examination belonging to the dynamics period, the value of the sign examined at the moment is a possible value for the dynamics period.

(2.3.8) (sign: clinical picture(diagnosis)) (index of dynamics period: I[1, number of dynamics periods(diagnosis, sign)]) sup(interval(partition for a sign(sign), index of dynamics period)) – inf(interval(partition for a sign(sign), index of dynamics period)) $\in$ R[lower bound(diagnosis, sign, index of dynamics period), upper bound(diagnosis, sign, index of dynamics period)]

For any sign from the clinical picture of the disease the patient is ill with and for any dynamics period of the sign, the duration of the dynamics period is greater than the lower bound and less than the upper bound of the dynamics period.

Example 3. A model of the applied logical theory of example 2 represented by a set of value descriptions for names.

(3.1.1) signs $\equiv$ {strain of abdomen muscles, blood pressure, daily diuresis}

Only three signs are considered: strain of abdomen muscles, blood pressure and daily diuresis.

(3.1.2) diseases ≡ {healthy, pancreatitis}

Only two diseases (states) are considered: healthy and pancreatitis.

(3.1.3) possible values ≡ (λ (sign: {strain of abdomen muscles, blood pressure, daily diuresis}) /(sign = strain of abdomen muscles ⇒ {presence, absence}), (sign ∈ {blood pressure, daily diuresis} ⇒ {normal, high, low})/)

The possible values of strain of abdomen muscles are presence and absence; those of blood pressure and daily diuresis are normal, high and low.

(3.1.4) normal values ≡ (λ (sign: {strain of abdomen muscles, blood pressure, daily diuresis}) /(sign = strain of abdomen muscles ⇒ {absence}), (sign ∈ {blood pressure, daily diuresis} ⇒ {normal})/)

The normal value of strain of abdomen muscles is absence; that of blood pressure and daily diuresis is normal.

(3.1.5) clinical picture ≡ (λ (disease: {healthy, pancreatitis}) /(disease = healthy ⇒ ∅) (disease = pancreatitis ⇒ { strain of abdomen muscles, blood pressure, daily diuresis})/)

The clinical picture of healthy is empty; the one of pancreatitis consists of strain of abdomen muscles, blood pressure and daily diuresis.

(3.1.6) number of dynamics periods ≡ (λ (v: {<pancreatitis, strain of abdomen muscles>, <pancreatitis, blood pressure>, <pancreatitis, daily diuresis>}) /(π(1,v) = pancreatitis & π(2,v) ∈ {strain of abdomen muscles, blood pressure, daily diuresis} ⇒ 2)/)

For pancreatitis the number of dynamics periods of strain of abdomen muscles, blood pressure and daily diuresis is equal to 2.

(3.1.7) values for a dynamics period ≡ (λ (v:{<pancreatitis, strain of abdomen muscles,1>, <pancreatitis, strain of abdomen muscles, 2>, <pancreatitis, blood pressure, 1>, < pancreatitis, blood pressure, 2>, <pancreatitis, daily diuresis, 1>, <pancreatitis, daily diuresis, 2>}) /(v=<pancreatitis, strain of abdomen muscles,1> ⇒ {absence}), (v = <pancreatitis, strain of abdomen muscles, 2> ⇒ {presence}), (v = <pancreatitis, blood pressure,1> ⇒ {normal}), (v = <pancreatitis, blood pressure, 2> ⇒ {high}), (v = <pancreatitis, daily diuresis, 1> ⇒ {low}), (v = <pancreatitis, daily diuresis,2> ⇒ {normal})/)

For pancreatitis the value of strain of abdomen muscles in the first dynamics period can be only absence;in the second dynamics period the one can be only presence; the value of blood pressure in the first dynamics period can be only normal; in the second dynamics period the one can be only high; the value of daily diuresis in the first dynamics period can be only low; in the second dynamics period the one can be only normal.

(3.1.8) upper bound≡ (λ (v: {<pancreatitis, strain of abdomen muscles, 1>, <pancreatitis, strain of abdomen muscles, 2>, < pancreatitis, blood pressure, 1>, < pancreatitis, blood pressure, 2>, <pancreatitis, daily diuresis, 1>, <pancreatitis, daily diuresis, 2>}) /(v = <pancreatitis, strain of abdomen muscles, 1> ⇒ 48), (v = <pancreatitis, strain of abdomen muscles, 2> ⇒ 144), (v = <pancreatitis, blood pressure, 1> ⇒ 24), (v = <pancreatitis, blood pressure, 2> ⇒ 144), (v = <pancreatitis, daily diuresis, 1> ⇒ 72), (v = <pancreatitis, daily diuresis, 2> ⇒ 144)/)

For pancreatitis the upper bound of the first dynamics period of strain of abdomen muscles is equal to 48; the one of the second dynamics period is equal to 144; the upper bound of the first dynamics period of blood pressure is equal to 24; the one of the second dynamics period is equal to 144; the upper bound of the first dynamics period of daily diuresis is equal to 72; the one of the second dynamics period is equal to 144.

(3.1.9) lower bound ≡ (λ (v: {<pancreatitis, strain of abdomen muscles, 1>, <pancreatitis, strain of abdomen muscles, 2>, <pancreatitis, blood pressure, 1>, <pancreatitis, blood pressure, 2>, <pancreatitis, daily diuresis, 1>, <pancreatitis, daily diuresis, 2>}) /(v = <pancreatitis, strain of abdomen muscles, 1> ⇒ 24), (v = <pancreatitis, strain of abdomen muscles, 2> ⇒ 1), (v = <pancreatitis, blood pressure, 1> ⇒ 1), (v = <pancreatitis, blood pressure, 2> ⇒ 1), (v = < pancreatitis, daily diuresis, 1> ⇒ 48), (v = <pancreatitis, daily diuresis, 2> ⇒ 1)/)

For pancreatitis the lower bound of the first dynamics period of strain of abdomen muscles is equal to 24; the one of the second dynamics period is equal to 1; the lower bound of the first dynamics period of blood pressure is equal to 1; the one of the second dynamics period is equal to 1; the lower bound of the first dynamics period of daily diuresis is equal to 48; the one of the second dynamics period is equal to 1.

(3.1.10) diagnosis ≡ pancreatitis

The diagnosis of the patient is pancreatitis.

(3.1.11) partition for a sign≡ (λ (sign: {strain of abdomen muscles, blood pressure, daily diuresis}) /(sign = strain of abdomen muscles ⇒ <0, 40, 70>), (sign = blood pressure ⇒ <0, 20, 70>), (sign = daily diuresis ⇒ <0, 50, 70>)/)

The first dynamics period of strain of abdomen muscles is completed in 40 hours and the second one is completed in 70 hours after the beginning of the patient's examination; the first dynamics period of blood pressure is completed in 20 hours and the second one is completed in 70 hours after the beginning of the patient's examination; the first dynamics period of daily diuresis is completed in 50 hours and the second one is completed in 70 hours after the beginning of the patient's examination.

(3.1.12) moments of examination ≡ (λ (sign: {strain of abdomen muscles, blood pressure, daily diuresis}) /(sign = strain of abdomen muscles ⇒ {12,36,60}), (sign = blood pressure ⇒ {12,60}), (sign = daily diuresis ⇒ {36,60})/)

Strain of abdomen muscles is examined in 12, 36 and 60 hours after the beginning of the patient's examination; blood pressure is examined in 12 and 60 hours after the beginning of the patient's examination; daily diuresis is examined in 36 and 60 hours after the beginning of the patient's examination.

(3.1.13) strain of abdomen muscles ≡ (λ (moment of examination: {12,36,60}) /(moment of examination ∈ {12, 36} ⇒ absence), (moment of examination = 60 ⇒ presence)/)

In 12 and 36 hours after the beginning of the patient's examination the value of strain of abdomen muscles is absence; in 60 hours after the beginning of the patient's examination its value is presence.

(3.1.14) blood pressure ≡ (λ (moment of examination: {12, 60}) /(moment of examination = 12 ⇒ normal), (moment of examination = 60 ⇒ high)/)

In 12 hours after the beginning of the patient's examination the value of blood pressure is normal; in 60 hours after the beginning of the patient's examination its value is high.

(3.1.15) daily diuresis ≡ (λ (moment of examination: {36,60}) /(moment of examination = 36 ⇒ low), (moment of examination = 60 ⇒ normal)/)

In 36 hours after the beginning of the patient's examination the value of daily diuresis is low; in 60 hours after the beginning of the patient's examination its value is normal.

Conclusions

In this article a few specialized extensions for the language of applied logic have been described. Every specific language is characterized by a set (perhaps empty) consisting of the standard extension and specialized extensions. Also a few examples of some ideas related to domain ontologies and formalization of these ideas using the language have been presented.

References

[Kleshchev et al, 2005] Kleshchev A.S. and Artemjeva I.L. A mathematical apparatus for ontology simulation. An extendable language of applied logic. // In International Journal Information Theories & Applications. 2005.

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