⇒ *second domain**:
metric finite semantic space

metric finite semantic superspace'
⇒ *first domain**:
*inclusion of metric finite semantic spaces**
⇒ *second domain**:
metric finite semantic space

A metric finite syntactic space can be constructed by [4] according to the string processing model and metric definitions given in [5].

pseudometric
⇒ *explanation**:
[A pseudometric is a function of two arguments that takes values on a (linearly) ordered group support, is non-negative, symmetric, and satisfies the triangle inequality.]

psudometric space
⇒ *explanation**:
[A pseudometric space is a set with a function of two arguments defined on it, which is a pseudometric [16] taking values on the ordered the support of the group.]

pseudometric finite semantic space
⇒ *explanation**:
[A pseudometric finite semantic space of the SC-code is a pseudometric space with a finite support whose elements are designations (sc-elements), and the value of the pseudometric cannot be determined through the incidence relations of elements without taking into account their semantic type.]

Some models of more complex structures that take into account non-factors [17] associated with space-time have been successfully proposed in [4]. The proposed models rely on a representation capable of expressing the semantics of variable notation and operational semantics by extended means of the alphabet. To build such models, in addition to the extended alphabet tools, it is proposed to rely on models that describe the processes of integration and formation of knowledge [18], on knowledge specification tools [3], [4], focused on consideration of finite structures, which allow proceeding with consideration of complex metric relationships within the semantic space meta-model (see Fig. 2).

The possibility of considering the metric in the semantic space allows speaking about the semantic metric, which, along with activity, scaling, interpretability, and the presence of a complex structure and coherence, is a hallmark of knowledge.

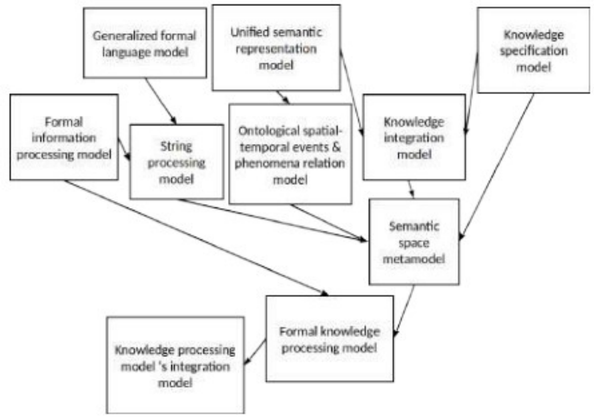

Figure 2. Models providing integration.

semantic metric
:= [semantic similarity]
⇒ *explanation**:
[Semantic metric is a metric defined on signs and quantitatively expressing the proximity of their meanings.]

In addition to factual knowledge (facts), rules are usedin knowledge bases.Within logical models of knowledge processing, rules are represented as logical formulas. Thus, the transition to the integration of such types of knowledgeas (logical) rules allows talking about the integration ofknowledge processing models (problem-solving models).

III. Integration of logical processing models as problem solving models

In order to solve the problem of integrating problem-solving models, the concept of a formal model for knowledge processing is proposed, which is a development for the concept of a formal model of information processing. The approach is used in the works of V. Kuzmitsky [19] and A. Kalinichenko [20]. A meta-model for the integration of formal models of knowledge processing is proposed.

The integration of knowledge processing models boils down to the following steps:

- For each state of the integrating model, its one-to-one (i) representation is constructed in the model of the unified semantic representation of knowledge.
- Next, a mapping π of this representation to a set of sc-texts immersed in a metric semantic subspace is constructed, and a one-to-one mapping i of operations $i\,(\rho)$ of this model to operations ρ on sc-texts from this set is constructed, so that:

$$i \circ i^{-1} \subseteq I = \{\langle x, x\rangle \,|\, \exists y\, \langle x, y\rangle \in i^{-1} \cup i\}$$

$$i^{-1} \circ i \subseteq I$$

$$\forall\rho\left(i^{-1}\circ i\circ\rho\circ i\circ i^{-1}=\rho\right)$$

$$\forall\rho\exists i(\rho)\left(\pi^{-1}\circ i^{-1}\circ\rho\subseteq i\circ\pi\circ i(\rho)\right)$$

$$\forall\rho\exists i(\rho)\left(i\circ\pi\circ i(\rho)\subseteq\rho\circ i\circ\pi\right)$$

$$\forall\rho\exists i(\rho)\left(\rho=i\circ\pi\circ i(\rho)\circ\pi^{-1}\circ i^{-1}\right)$$

$$\forall\rho\exists i(\rho)\left(i(\rho)=\pi^{-1}\circ i^{-1}\circ\rho\circ i\circ\pi\right)$$

- Syntactic relations are distinguished on the elements of sc-texts.
- Interpretation functions are built on the states of the original model (in projective semantics) or on their representation in sc-texts (in reflexive semantics).
- The metric is set in accordance with the metric of the metric semantic subspace.
- In addition to the specified requirements, additional requirements τ and σ can be specified in accordance with a given scale on the set of states of the integrating information processing model: bijection (trivial order), out-degree, in-degree, etc.

$$\forall\rho\exists i(\rho)\left(\rho\circ\tau=i\circ\pi\circ i(\rho)\circ\pi^{-1}\circ i^{-1}\right)$$

$$\forall\rho\exists i(\rho)\left(i(\rho)\circ\sigma=\pi^{-1}\circ i^{-1}\circ\rho\circ i\circ\pi\right)$$

It should be noted that in the previous article [21], the mapping requirements were considered to be quite strong ($\tau = I$ and $\sigma = I$):

$$\forall\rho\exists i(\rho)(\rho\subseteq i\circ\pi\circ i(\rho)\circ\pi^{-1}\circ i^{-1})$$

$$\forall\rho\exists i(\rho)(i(\rho)\subseteq\pi^{-1}\circ i^{-1}\circ\rho\circ i\circ\pi)$$

The current text contains proposal for weakening these requirements. Other additional requirements (including the quantitative properties of the information) may also be taken into account.

Let us consider some examples (Fig. 3–25).

From the point of view of topological properties, for each state of the model, there is its topological closure with respect to the set of operations. Moreover, these topological properties are preserved during integration. Thus, integration is a continuous mapping. However, for classical logical models of information processing, it is known that the closure with respect to deducibility is not topological closure (not additive):

$$[S]\cup[T]\neq[S\cup T]$$

The seeming contradiction can be resolved if we notice that in the first case, the elements of the closure are

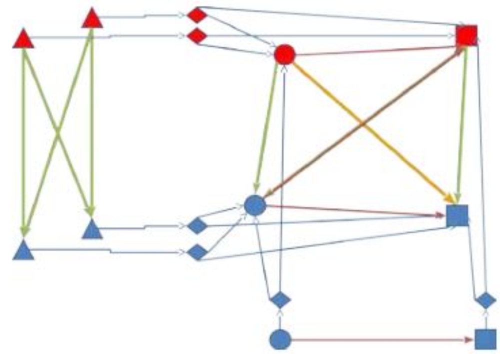

Figure 3. The reconvergent integration of non-deterministic knowledge processing operation as non-deterministic one ((green) vertical lines) with the divergent integration of deterministic knowledge processing operation as non-deterministic operation one ((red) horizontal lines). Rhombuses are subtext (substates). Triangles and the bottom blue disk and square are states of integrating models. Others disks and squares are the states (text) of the integrated model.

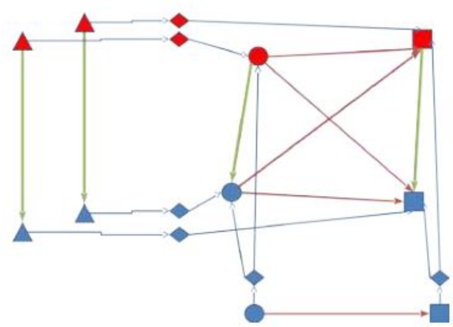

Figure 4. The convergent integration of deterministic knowledge processing operation as deterministic one ((green) vertical lines) with the divergent integration of deterministic knowledge processing operation as non-deterministic operation one ((red) horizontal lines). Rhombuses are subtext (substates). Triangles and the bottom blue disk and square are states of integrating models. Others disks and squares are the states (text) of the integrated model.

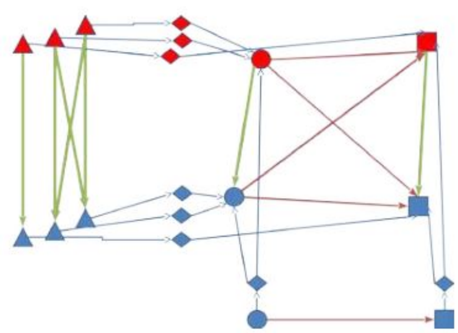

Figure 5. The reconvergent integration of non-deterministic knowledge processing operation as deterministic one ((green) vertical lines) with the divergent integration of deterministic knowledge processing operation as deterministic operation one ((red) horizontal lines). Rhombuses are subtext (substates). Triangles and the bottom blue disk and square are states of integrating models. Others disks and squares are the states (text) of the integrated model.

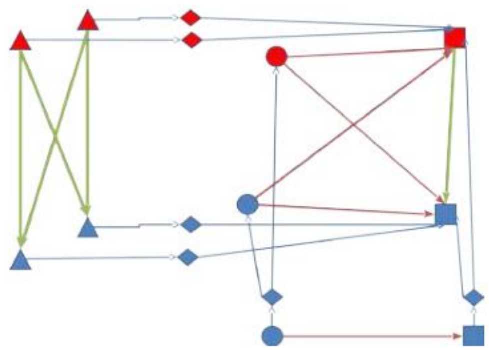

Figure 6. The convergent integration of non-deterministic knowledge processing operation as deterministic one ((green) vertical lines) with the divergent integration of deterministic knowledge processing operation as deterministic operation one ((red) horizontal lines). Rhombuses are subtext (substates). Triangles and the bottom blue disk and square are states of integrating models. Others disks and squares are the states (text) of the integrated model.

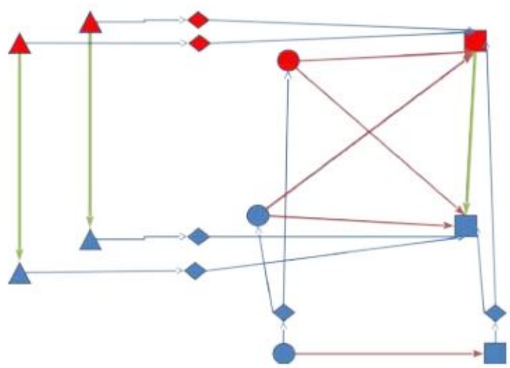

Figure 7. The convergent integration of ndeterministic knowledge processing operation as deterministic one ((green) vertical lines) with the divergent integration of deterministic knowledge processing operation as deterministic operation one ((red) horizontal lines). Rhombuses are subtext (substates). Triangles and the bottom blue disk and square are states of integrating models. Others disks and squares are the states (text) of the integrated model.

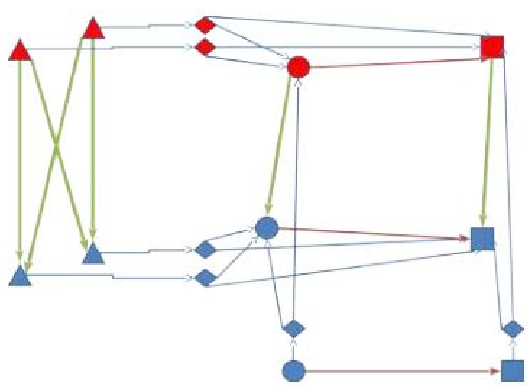

Figure 8. The reconvergent integration of non-deterministic knowledge processing operation as deterministic one ((green) vertical lines) with the divergent integration of deterministic knowledge processing operation as deterministic operation one ((red) horizontal lines). Rhombuses are subtext (substates). Triangles and the bottom blue disk and square are states of integrating models. Others disks and squares are the states (text) of the integrated model.

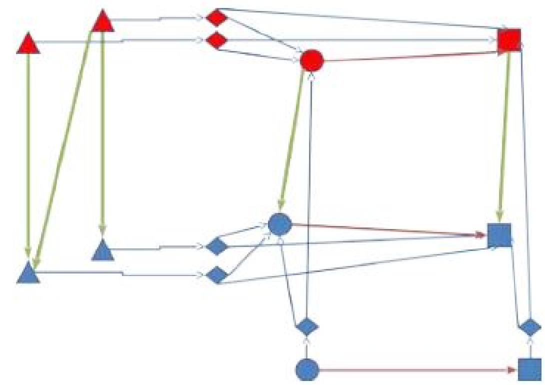

Figure 9. The asymmetrical reconvergent integration of non-deterministic knowledge processing operation as deterministic one (green lines) with the divergent integration of deterministic knowledge processing operation as deterministic operation one (red lines).

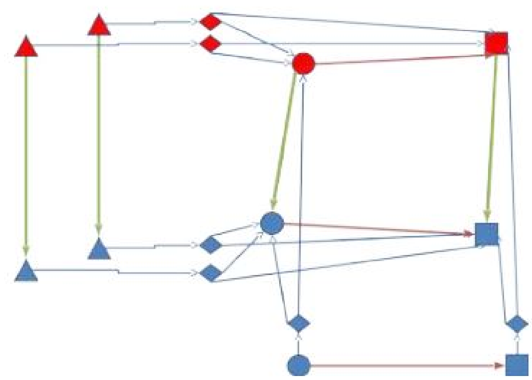

Figure 10. The reconvergent integration of deterministic knowledge processing operation as deterministic one (green lines) with the divergent integration of deterministic knowledge processing operation as deterministic operation one (red lines).

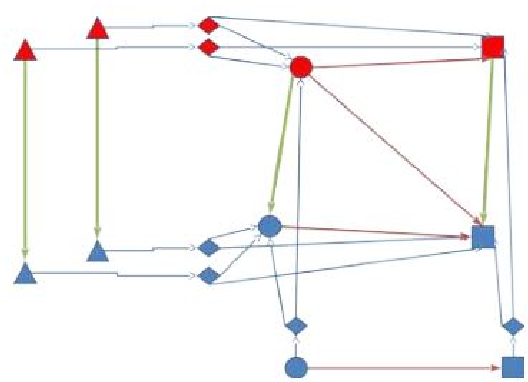

Figure 11. The reconvergent integration of deterministic knowledge processing operation as deterministic one (green lines) with the asymmetrical divergent integration of deterministic knowledge processing operation as non-deterministic operation one (red lines).