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Petri net-based software component for modelling holistic and coordinated curriculum for IT-specialists' training

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The challenges of building holistic and coordinated university curriculum

are caused by the number of factors:

- Quick changes and renewing of technologies, social life, situation in employment market etc.
- International students and employees' mobility that demands International context of higher education
- Growth of information amount, knowledge expansion, renewing of knowledge, losing its urgency etc.
- Trends in contemporary scientific branches: synthesis of knowledge, interdisciplinary research with interpenetration of knowledge and cognitive methods, tools etc.

All the factors make urgent the search of new approaches to the curriculum building to provide holistic, interdisciplinary students' training.

The main problems to be solved are:

- how to shape integrative content of learning,
- how to provide modular structuring of curriculum disciplines with preserving links between knowledge,
- how to provide their coordinated learning throughout the modules of different curriculum disciplines for pre-service specialists' training

The purpose of the work

- Elaboration of some stages of design of the Petri nets-based software component for the holistic and coordinated curriculum building
- Highlighting its benefits for the pre-service IT-specialists at their vocational training

Theoretical framework of the work

- holistic educational paradigm
- authors' approach to the modelling of holistic and coordinated curriculum for the specialists' training based on knowledge representation models and Petri nets apparatus

Key characteristics of the holistic approach to curriculum design

(1)It is based on the revealed **mechanisms of knowledge integration** in scientific branches and in curriculum disciplines;

(2)It provides **technique of disciplines structuring** which trigs **the integration mechanisms realization**;

(3)It results in the **coordinated system of curriculum disciplines** preserving links between knowledge and making positive impact on the trainees' system of knowledge.

Technique of curriculum disciplines structuring

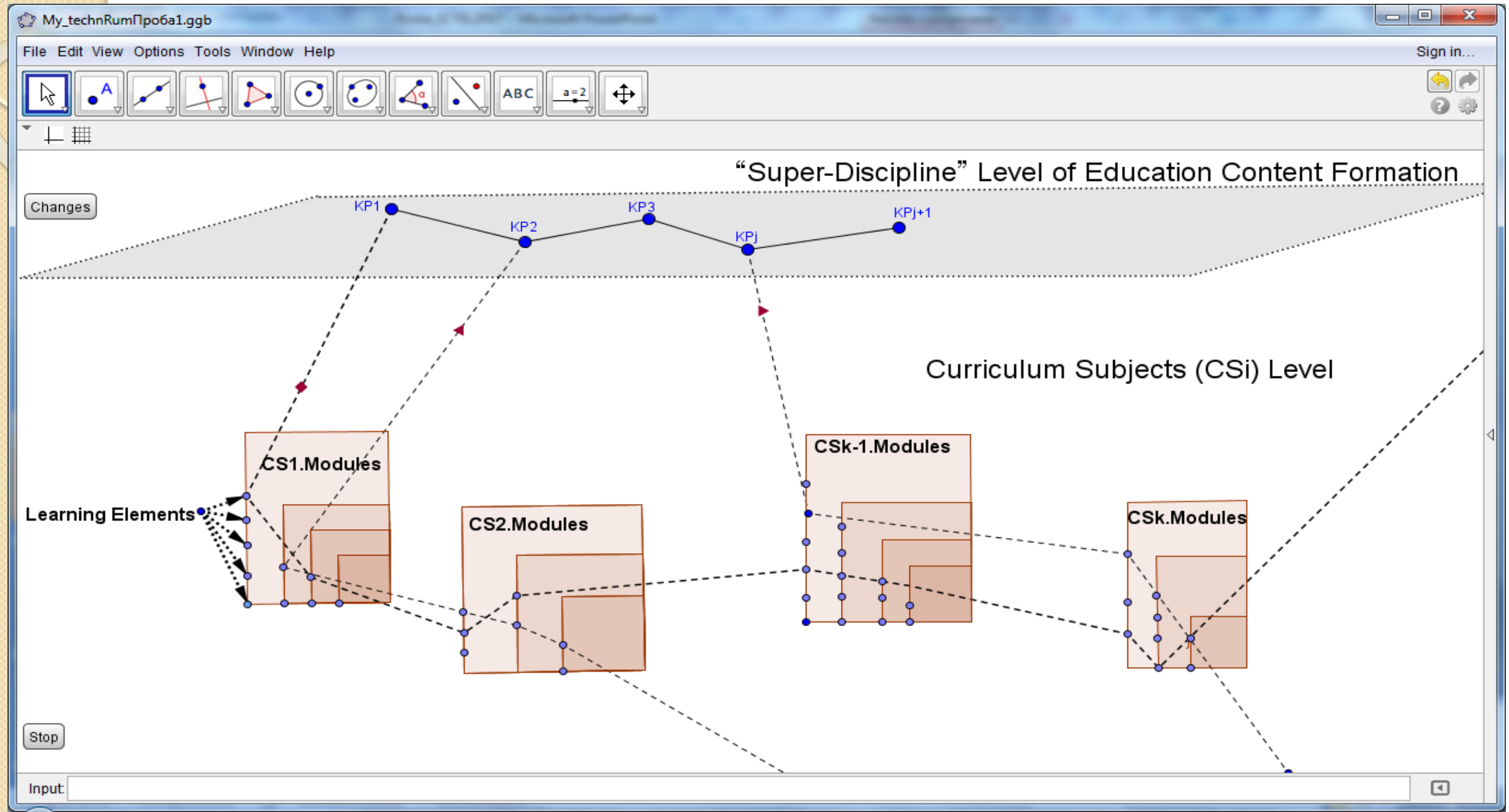
which must be done in order to get the modular structure of curriculum subjects keeping and spreading links between knowledge both inside a module and between modules and subjects of curriculum.

The technique we developed based on the **ideas** of the:

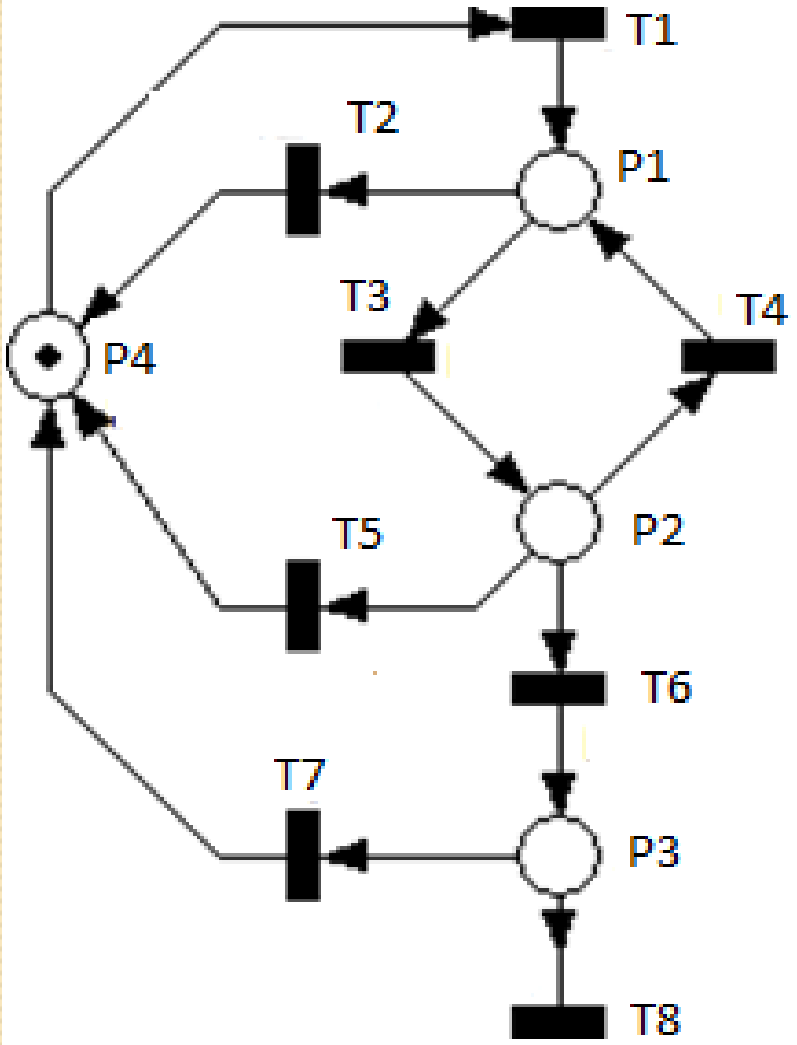
1) **multilevel construction of the content of learning**;
2) **multilevel knowledge generalization**;
3) **models of knowledge representation** of the Artificial Intelligence theory:

semantic networks (Quillian, 1967),
frame-based systems (Minsky, 1975),
their hierarchy and inheritance properties.

Coordinated and coherent system of curriculum subjects



Petri Net Modeling a LE Mastering



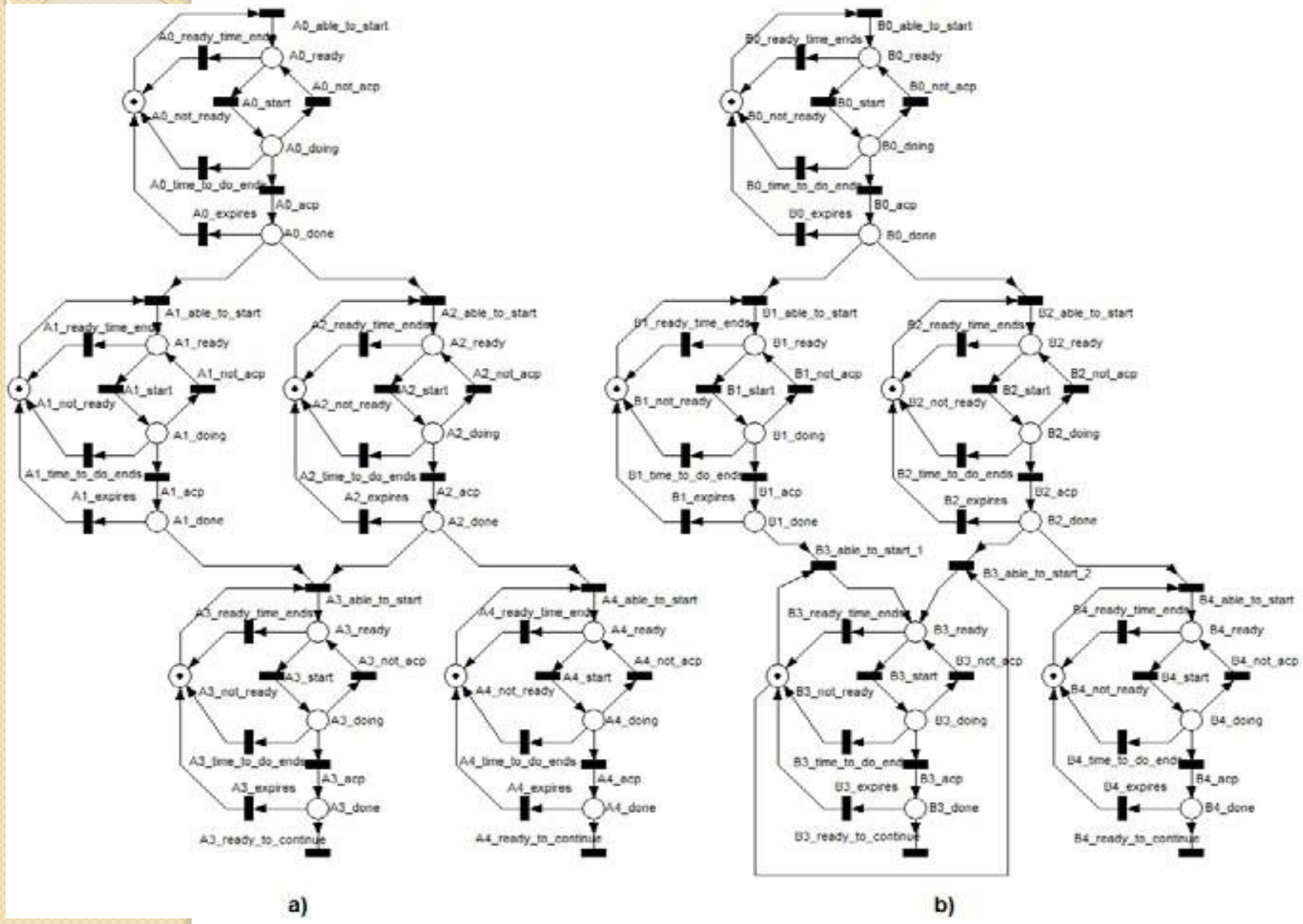
Petri net which simulates a LE mastering by the student is represented by four places and eight transitions.

The places represent the states of LEs as for their readiness to be learnt by students due to their relations precedence.

There is always one and only one token in the net, which means that only one of these places can be marked at a time.

The transitions simulate the events of start of LE's mastering; the process of its learning, regarding the academic time and its availability due to its precedence relations; and accomplishing.

Petri Net Modeling a Course



The Petri net representations of the two modules presented by common Petri nets after applying the rules presented before using the net addition operation, considering:

AND precedence for (a)

OR precedence for (b)

Software Module for the automatization of the Petri Nets Modelling of the Coordinated Curriculum (SMPNCM): the features of design

SMPNCM functionality

SMPNCM aims to provide the dynamic execution of the simulated process of the curriculum courses mastering by a potential specialist. It will enable both educational staff and a student to trace and learn this process.

Thus, the **SMPNCM functionality** at the exploitation level is focused on:

- preliminarily and in static way, **storing the Petri net execution graph** which declares when each task on the certain LE mastering has to be executed;
- successively in dynamic way, using the properties of Petri nets for **tracing the tasks already executed (already mastered LEs) and obtaining the list of tasks ready for execution (LEs which are available to be mastered by a trainee)** by leaving the Petri net to evolve.

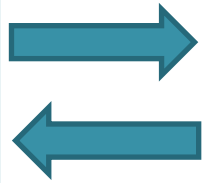
SMPNCM structure

Two core SMPNCM components : ***Tasks Manager*** **and** ***Coordinator*****.**

By the ***Task*** it is meant here ***a LE mastering*** by a student.

Tasks Manager component is aimed at performing the following:

1) starting the execution of each ***Task*** by notifying the ***Coordinator***;
2) detecting when a ***Task*** accomplishes its execution and notifying the ***Coordinator***;
3) quiring the ***Coordinator*** for the list of exactuable ***Tasks***.



Coordinator component is responsible for:

1) managing a data structure implementing the Petri net execution graph;
2) getting the notification of a ***Task*** start (termination);
3) evolving the net graph status consequently.

Interaction of *Tasks Manager* and *Coordinator*

By the ***Task*** it is meant here ***a LE mastering*** by a student.

Tasks Manager quires the ***Coordinator*** for the list of exactuable ***Tasks***

list of executable *Tasks*

Coordinator checks the status of the net graph, provides the ***Tasks Manager*** with the list of executable *Tasks*.

If the list is empty and no other *Tasks* are available for execution, ***Tasks Manager*** is waiting for the new exacutable ***Tasks***.

If the list is not empty, the ***Tasks Manager*** triggers the execution of each ***Task*** in the list and notifies the ***Coordinator*** of each execution.

When the ***Coordinator*** gets a notification from the ***Tasks Manager***, it evolves the status of the net execution graph.

Tasks Manager waits for the accomplishment of a ***Task***, and notifies the ***Coordinator*** about this event.

Benefits of using Software Module for Petri Nets modelling of the curriculum

The functionality of SMPNCM allows both educational staff and a student:

- to trace and explore the process of the curriculum mastering;
- to see and analyze the place of each LE in the modules and in the whole curriculum according to its links and precedence relations;
- to trace the LEs that have been mastered and will be necessary for mastering other set of LEs;
- to build individual study plan for students, to compare the equivalence of educational programs etc.
- Besides, the SMPNCM modelling can be used by the educational staff at the stage of tutoring process design to pick up relevant learning and project-driven activities in order to create students' holistic system of knowledge and skills.

Benefits of using Petri Nets modelling of the curriculum for IT-specialists' training

The built and realized model by the SMPNCM enables

- to simulate the mastering of the university curriculum as a family of disciplines which are sensitive to the quick changes in volatile IT industry with immediate spreading of renewed requirements to the specialists in these branches throughout all of the modules and with simultaneous preserving of the proper links.
- to regard the disciplines evolution and appearing new ones with their including into the flexible curriculum excluding the unnecessary repetition and academic time saving.

Thus, it is helpful in terms of individualizated IT-specialists' training and building their personal educational path.

Questions time!

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