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Course Providing System

A mini- project in the course
"Agent- oriented modelling and multi- agent systems"

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Introduction

The main idea of this project is to model a Course providing system allowing to provide additional learning courses to students based on their learning difficulties.
Course providing systems takes students academic progress as input, analyzes it, identifies problems with learning, finds relevant additional courses and provides them to a student as an output.

The system should be a representation of socio-technical multi-agent system, consisting of a cooperative work of different technical sub-systems(Educational result provider, Problem identifier, Course searcher, Course provider) and of humans(Teacher, Student) interacting with them.

Adhering to the principles of Agent-oriented Modeling, this project contains Motivation level models, System design level models and Prototype implementation using CPN Tools.

1 Motivation level

This section contains the following models from the motivation layer of conceptual space:
1. Goal model
2. Role models
3. Organizational model
4. Domain model

1.1 Goal Model

Goal model is a part of agent organization behavior analysis. It contains functional goals and also quality goals for agent roles. The goals are described hierarchically. The goal model for current project is depicted on Figure 1. In current project the main goal is to improve student's grades.
Teacher have to correctly insert grades to Educational results provider (ERP), which manages grades. Information in ERP are confidential and should be in time. Problem identifier goal is to identify possible deficiency in knowledge. If deficiency exist, course searcher search appropriate courses for student. Finally student receives studying materials.
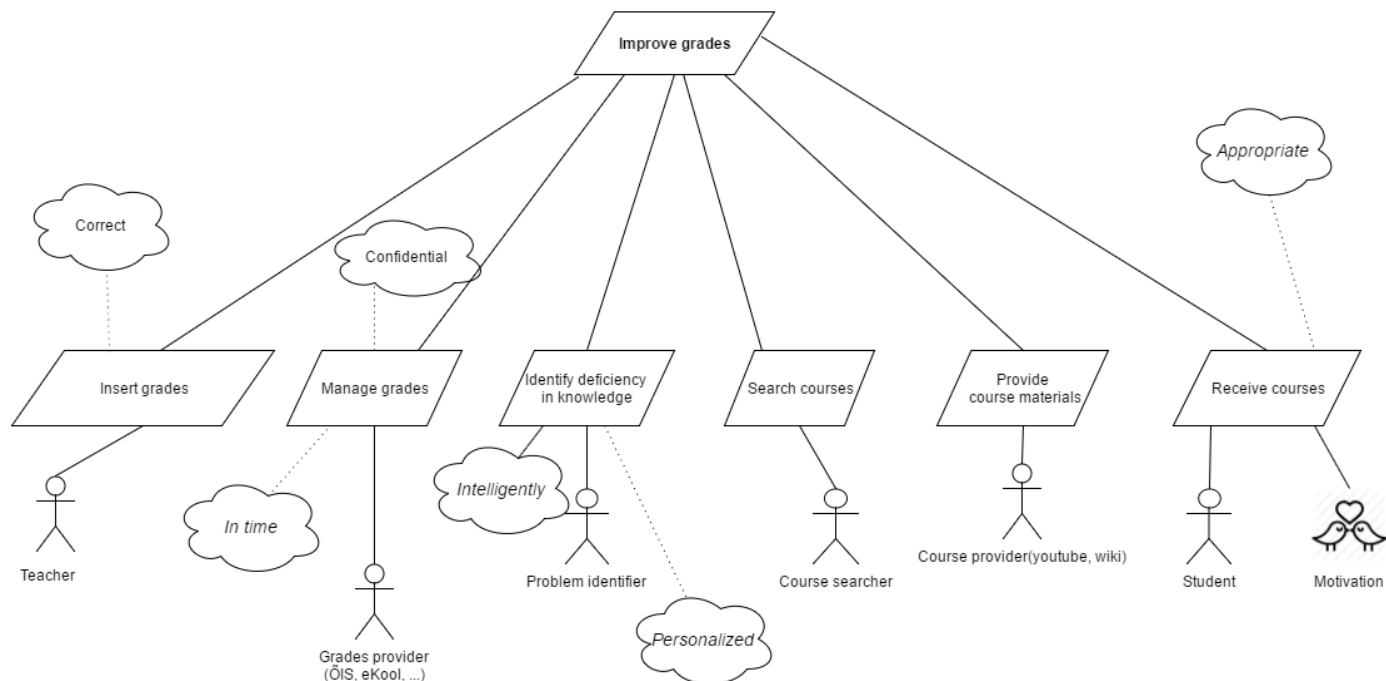

Figure 1: Goal model.

1.2 Role Model

This chapter contains 6 models(Teacher, Materials provider, Grades provider, Course searcher, Problem identifier, Student) interacting in the system with their description, list of responsibilities and constraints that the agent playing the role must perform in order for a set of goals and their associated quality goals to be achieved .

Role name	Teacher
Description	The role in Course Provider for evaluating students.
Responsibilities	• Inserts grades with description to grades provider
Constraints	• Grades must be objective • Grade description must be relevant

Role name	Materials provider(youtube, wiki, ...)
Description	Data warehouse with available educational materials
Responsibilities	• Provide course materials to course searcher
Constraints	• Course materials must be relevant

Role name	Grades provider(OIS, eKool, ...)
Description	The role of grade providing system
Responsibilities	• Collects grades • Stores grades • Provides grades
Constraints	• Data must be complete • Data must be available • System must be secure

Role name	Course searcher
Description	Course searcher role in Course Provider
Responsibilities	• Searches appropriate courses • Receives information from Course Provider • Generates course materials from received information • Provides course materials to student • Sends messages to student

Constraints	• Course searcher must filter search result • Search result is relevant • Search parameters must be relevant

Role name	Problem identifier
Description	Problem identifier is a role of Course Provider which analyzes student grades and identifies problems in field of study.
Responsibilities	• Collects grades with grades description from grades provider • Analyze students grades • Analyze students grades descriptions • Identify problem subject • Identify problem topic in subject • Provide information about problem to course searcher
Constraints	• Data must exist • Analyzation process must be personalized • Analyzation process must be intelligent

Role name	Student
Description	Student role in Course Provider
Responsibilities	• Gets grades • Receives courses
Constraints	

Table 1: Role model.

1.3 Organisation Model

Organisation model represent relationships between roles in Course providing system.
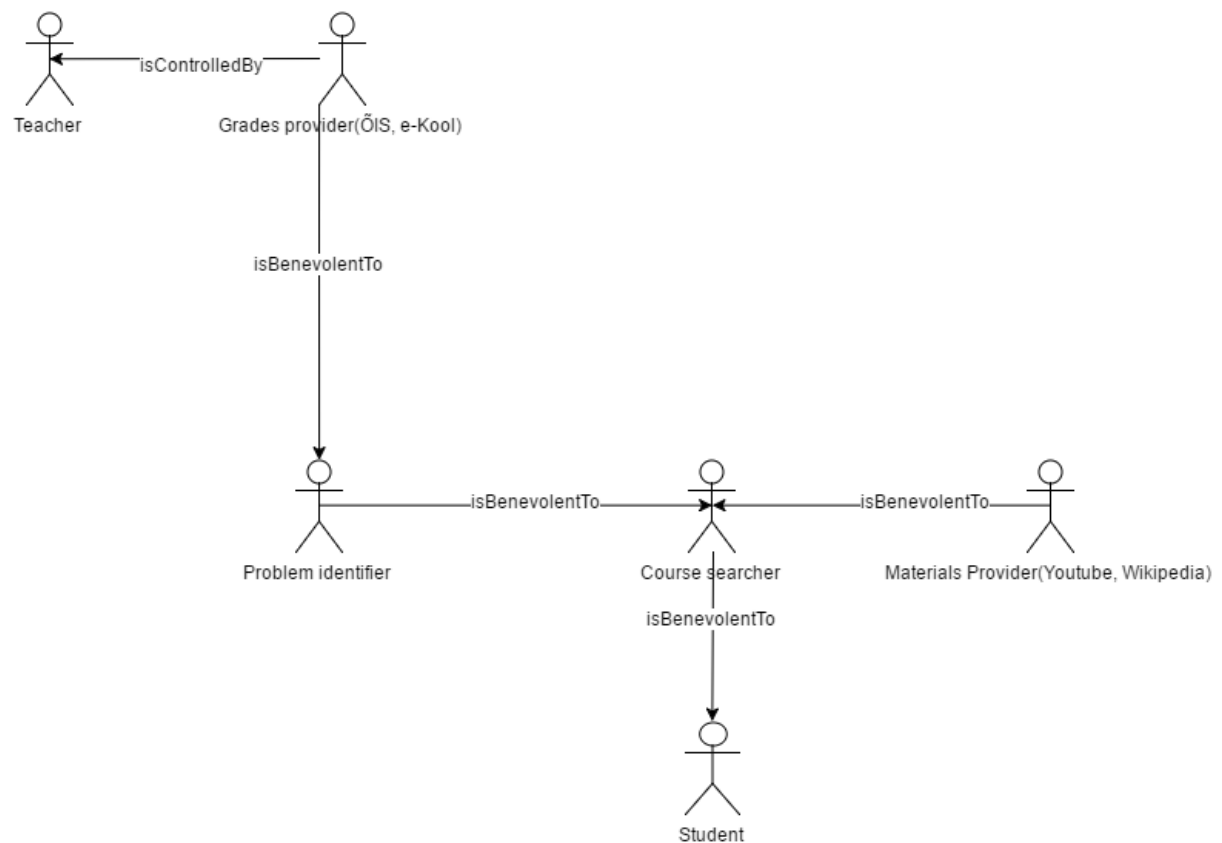

Figure 2: Organisation model.

1.4 Domain Model

Domain model represents systems knowledge using domain entities and relationships between them and roles.
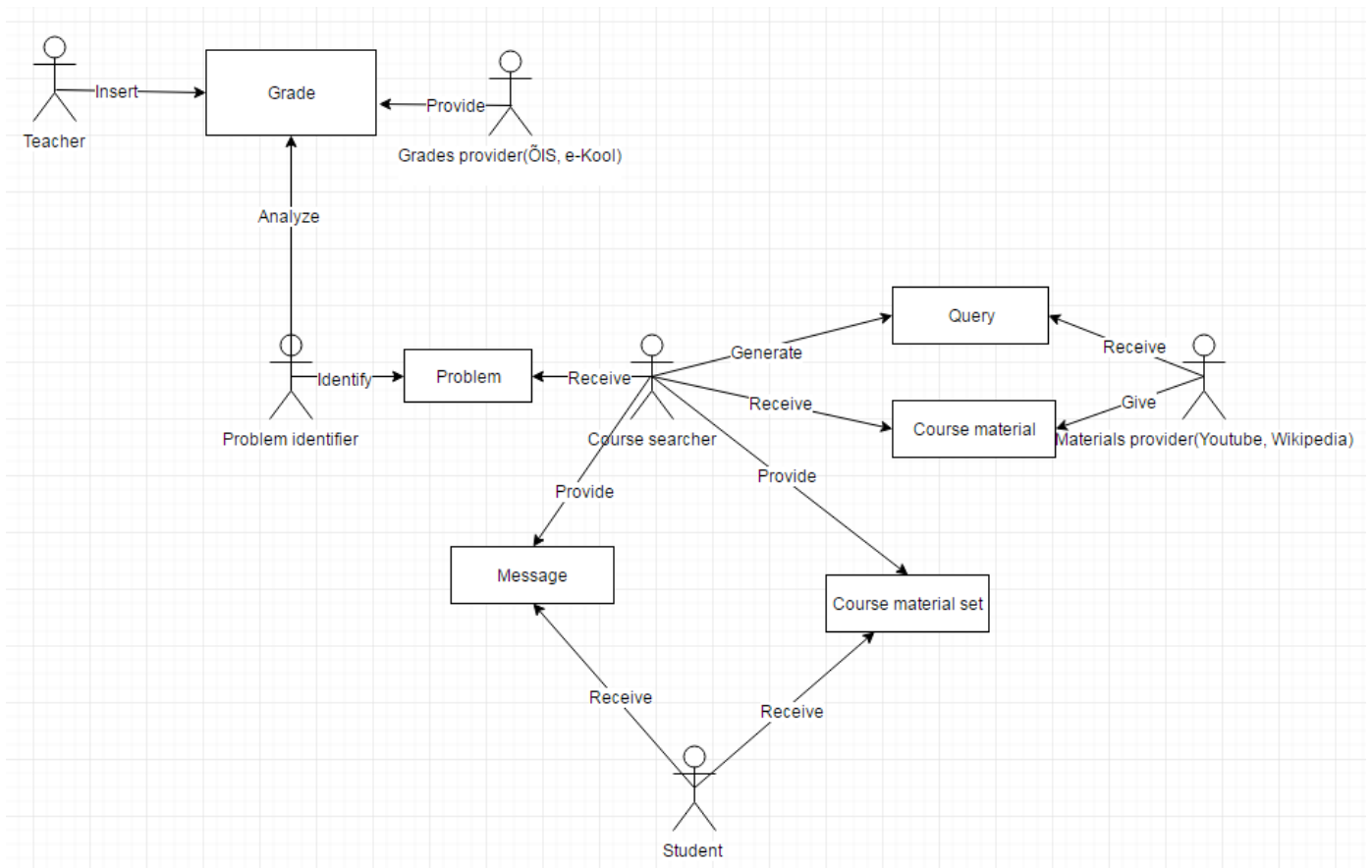
Figure 3: Domain model.

2 System design level

This section contains the following models of the system design layer:
1. Agent and acquaintance model
2. Interaction diagrams
3. Knowledge model
4. Behavior models

2.1 Agent Model

This model represent a transformation of abstract role models to concrete agents, which will be used in the system. Agent models contains Agent name, its corresponding roles and responsibilities

Agent name	Human agent
Roles	Teacher
Responsibilities	• Inserts grades with description to grades provider

Agent name	Human agent
Roles	Student
Responsibilities	• Gets grades • Receives courses

Agent name	Search agent
Roles	Problem identifier, Course searcher
Responsibilities	• Collects grades with grades description from grades provider • Analyze students grades • Analyze students grades descriptions • Identify problem subject • Identify problem topic in subject • Provide information about problem to course searcher • Searches appropriate courses • Receives information from Course Provider • Generates course materials from received

	information • Provides course materials to student

Agent name	Grades agent
Roles	Grades provider(OIS, eKool, …)
Responsibilities	• Collects grades • Stores grades • Provides grades

Agent name	Materials agent
Roles	Materials provider(youtube, wiki, …)
Responsibilities	• Provide course materials to course searcher

Table 2: Agent model.

2.2 Acquaintance Model

The agent and acquaintance model for the current project is depicted on Figure 4 and describes relationships between agent roles and agent types. Course searcher and Problem identifier roles are both mapped to Search agent. Also there are two roles of Human agent: Student and Teacher.

The model on Figure 4 also shows the interaction pathways between the agent types and the person. Human agent "Teacher" can only be in interaction with Grades agent. Search agent interact with all agent except Human agent "Teacher".
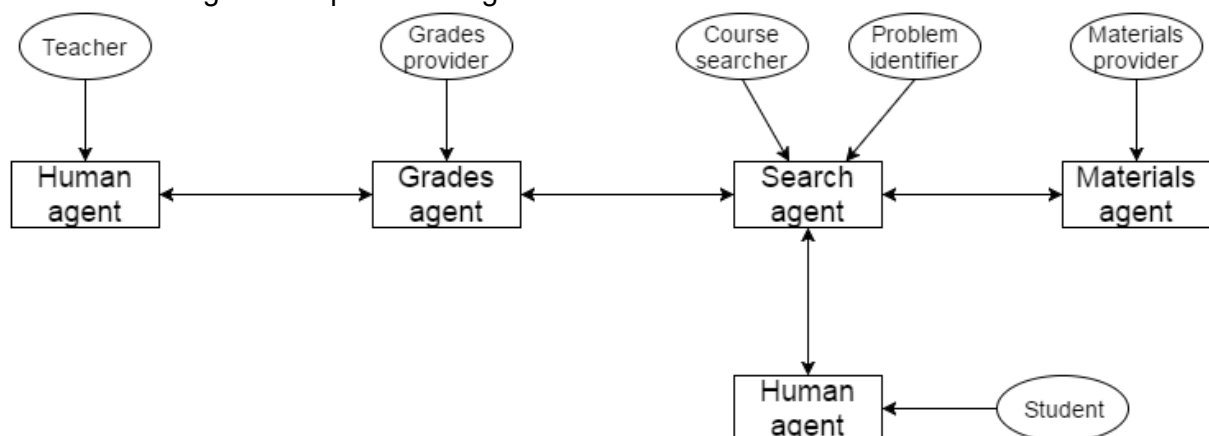

Figure 4: Acquaintance model.

2.3 Knowledge Model

Knowledge model is a part in agent organization information design. "It represents the knowledge that agent types have about their environments and about themselves. The

knowledge model for current project is depicted on Figure 5. The knowledge model is already a more elaborate model of information available for agent types, it has the same relationship framework as the domain model but here the information is represented in a more structured way in order to create the basis for the ontology of the" course providing domain. ("Smart home energy management" J.Kaugerand, J.Ehala, 2015)
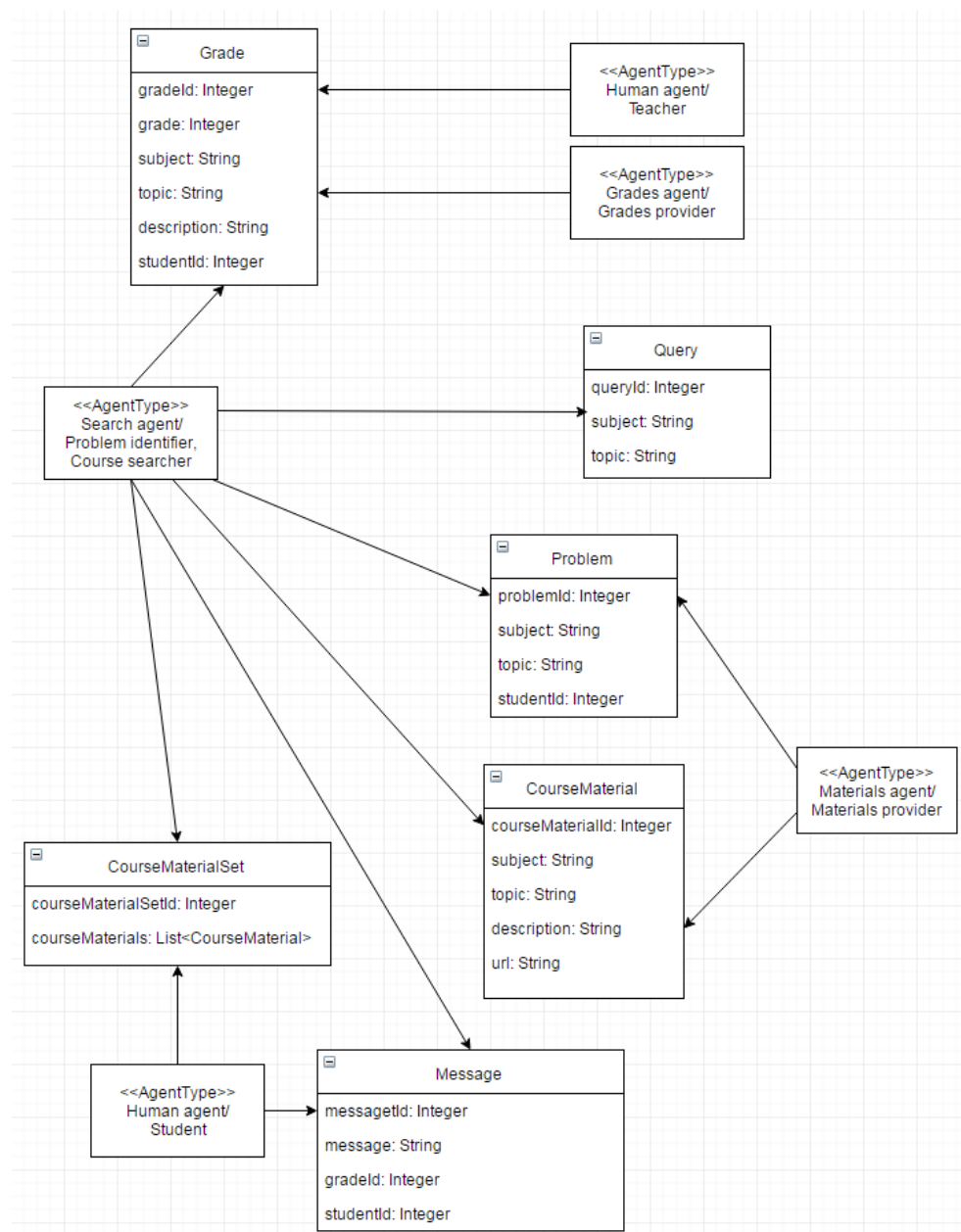

Figure 5: Knowledge model.

2.4 Interaction Model

Interaction Model represents an interaction pattern between agents.
As seen on Figures interactions in this model start with the teacher inserting the grade. Search agent ask for new grades from Grades agent. If Search agent gets new grade, it

updates the grade status in Grades agent. Search agent asks for materials from materials agent and receives materials. Last step is providing all course materials to Student.

1. Scenario (Student gets bad grade and gets studying materials):
- Teacher insert grade (<4)
- Search agent ask for grade
- Search agent update grade status in Grades agent
- Search agent search for materials
- Materials agent send materials to Search agent
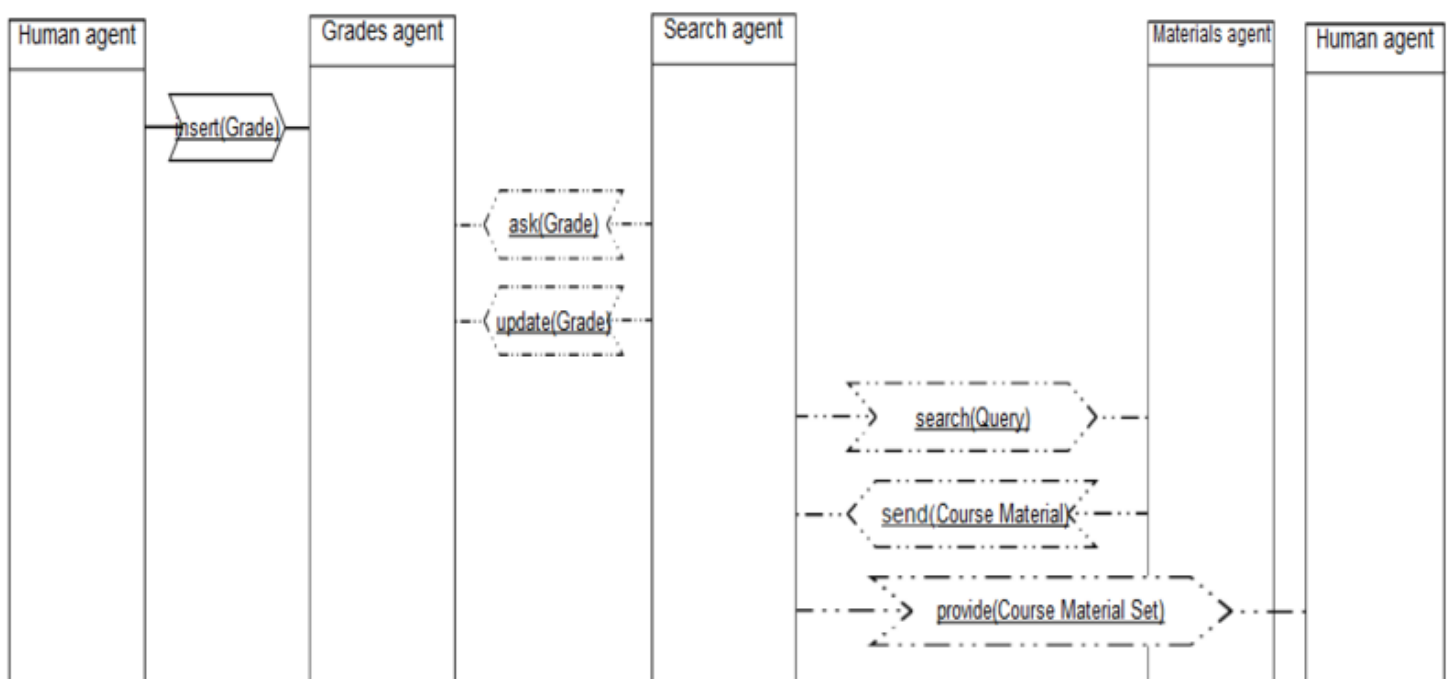- Search agent provide materials to student

Figure 6: Interaction model: student get bad grade and gets studying materials.

2 Scenario (Student gets good grade and do not have to get additional studying materials):
- Teacher insert grade (>3)
- Search agent ask for grade
- Search agent update grade status in Grades agent
- Search agent send message "You do not have to study additional" to student
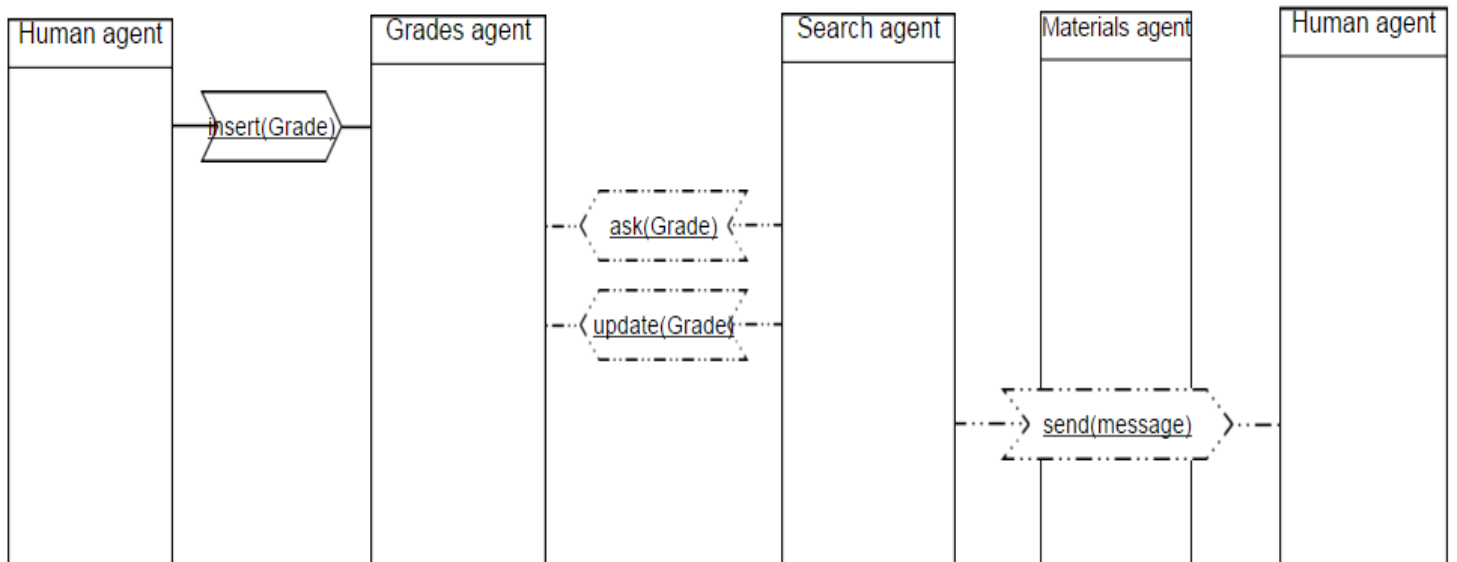
Figure 7: Interaction model: student get good grade and gets message.

Scenario 3 (Student gets bad grade but no materials found):
- Teacher insert grade (<4)
- Search agent ask for grade
- Search agent update grade status in Grades agent
- Search agent search for materials
- Materials agent send no materials to Search agent
- Search agent send message "You get bad grade, but we do not found materials for you" to student

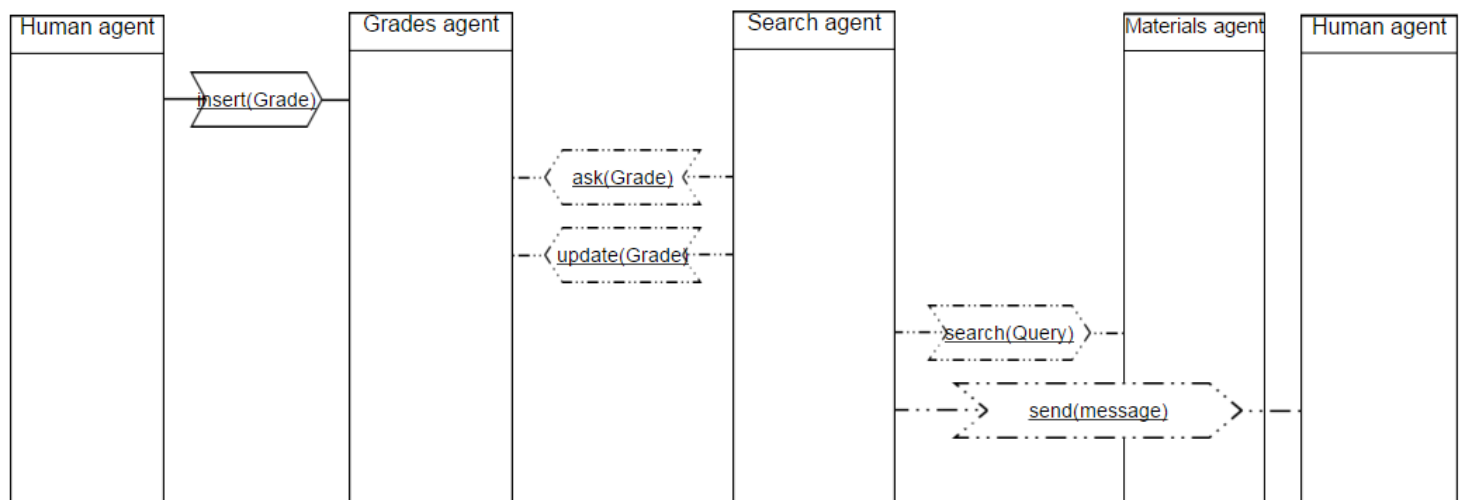Figure 8: Interaction model: student get bad grade but do not get materials.

2.5 Behaviour Model

In this section are gathered together 5 behaviour models, which represents, what an agent of a given type does in Course Providing system.

2.5.1 Rules:

- R1 - check if grade is <4
- R2 - check if there is any Materials Agents for request left
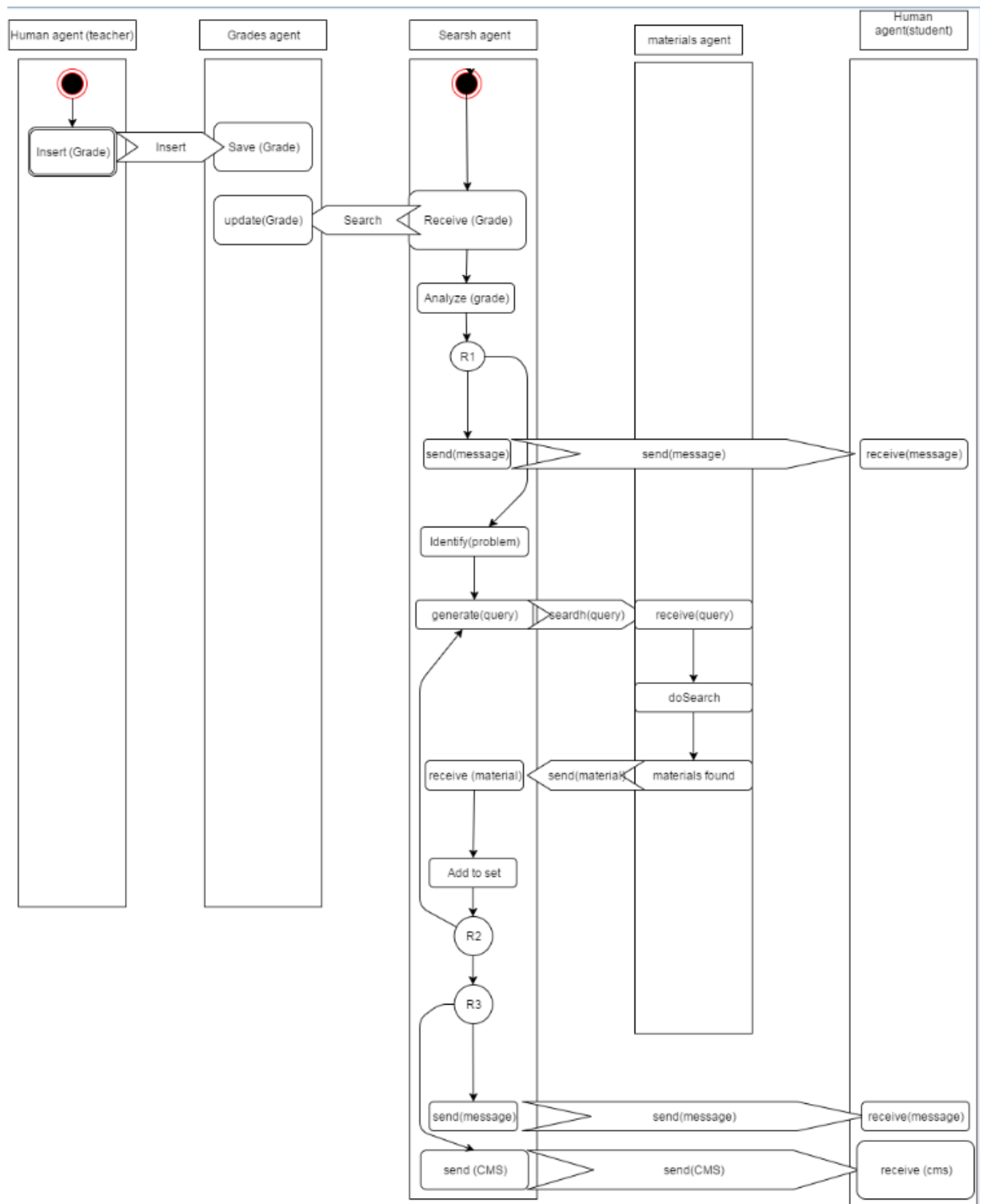- R3 - check if Course Material Set is empty

Figure 9: Behaviour model.

2.6 Behaviour Interface Model

Behaviour interface model contains main activities of Course providing system with their preconditions which must always be true before an execution of activity and postconditions which must be always true after execution of activity.

Precondition	Activity	Postcondition
- Teacher is authenticated	insert(Grade)	• Grade inserted
- Grade inserted - Register(DB) exists - Register(DB) is available - Grade subject not empty - Grade topic not empty	save(Grade)	• Grade available
- Grade available - Exists unanalyzed grades - Register(DB) available - Search Agent is authenticated	receive(Grade)	• Received grades
- Received grades - Required data is not empty(is complete)	analyze(Grade)	• Grade is analyzed • Problem existence found
- Grade is analyzed - Grade is 4 or 5	send(message)	• Message sended
-Message sended	receive(message)	• Message received
- Grade is analyzed - Problem existence found - Problem exists - Grade < 4	identify(Problem)	• Problems are identified
- Problems are identified	generate(Query)	• Query generated
- Query generated - Materials agent exist - Materials agent is available	receive(Query)	• Query received
- Query received - Query subject and topic not empty	doSearch(Query)	• Course Materials found
- Course Materials found	materials found	• Course Materials are relevant
- Course Materials are relevant	send(Course Material)	• Course Materials sended
Course Materials sended	receive(Course Material)	• Course Materials received

| - Course Materials received	addToSet(Course Material)	• Course Material is added to set
- Course materials set is empty	send(message)	• Message sended
- Message sended	receive(message)	• Message received
- Course Material is added to set - Course Material set not empty - No more Queries left	send(Course Material Set)	• Course Materials sent
- Course Materials sent	receive(Course Material Set)	• Course Materials received

Table 3: Behaviour interface model.

3 Realisation

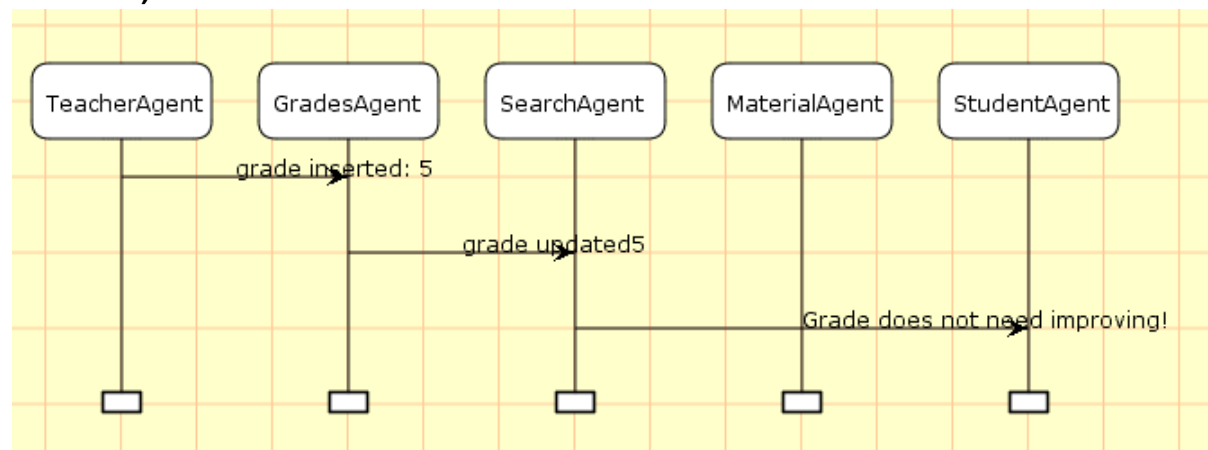## 3.1 CPN Message sequence chart

Message Sequence Charts (MSCs) is a visualization of system runs, showing communication between agents and their actions in the system.
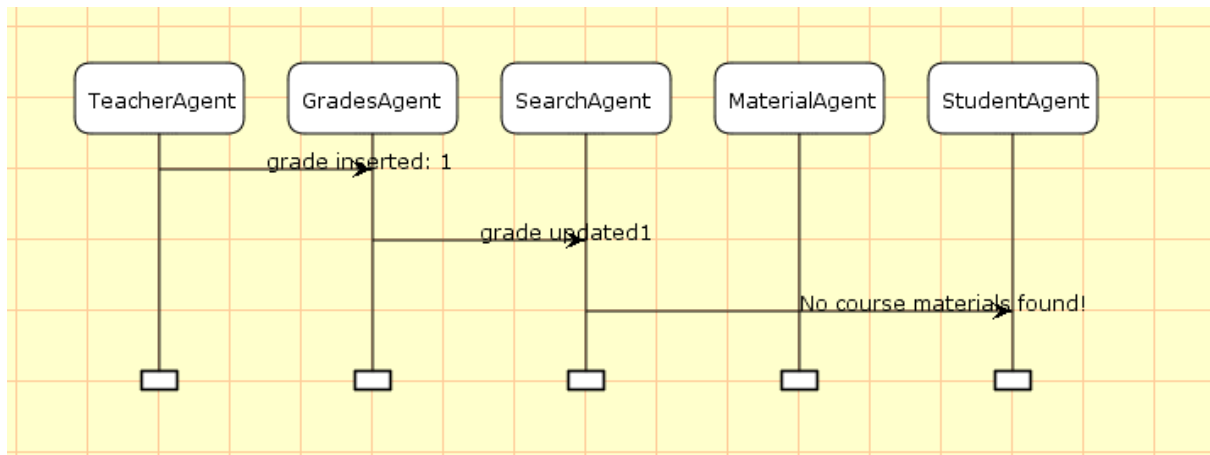
Scenario 1 (Student gets bad grade and gets studying materials):
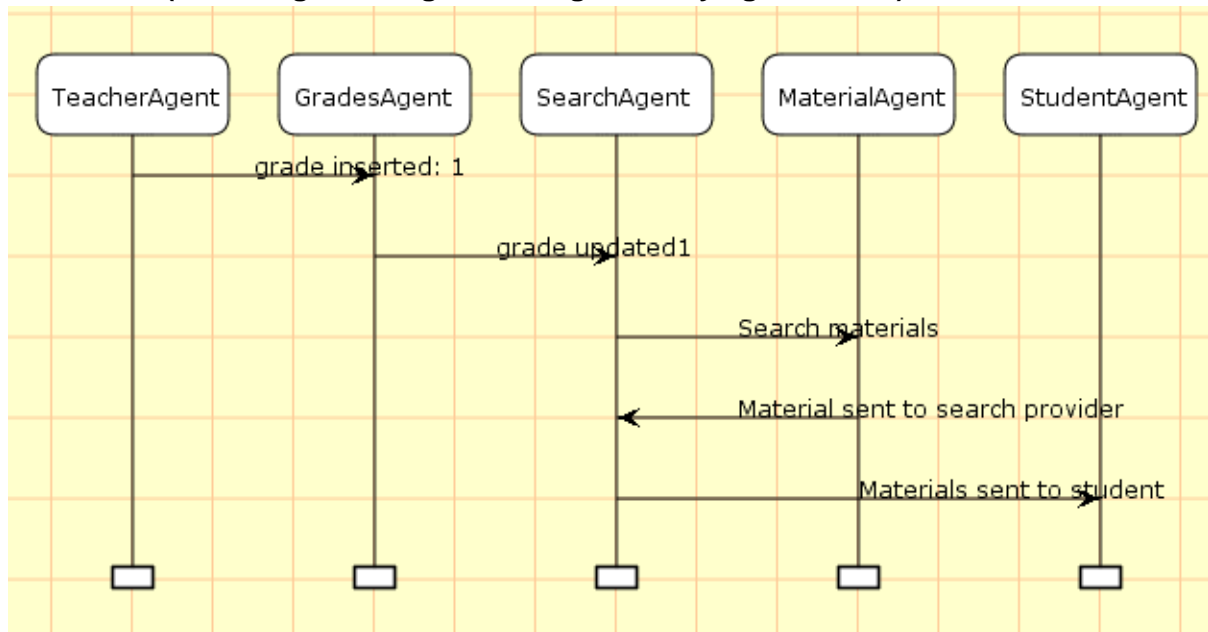
Scenario 2 (Student gets good grade and do not have to get additional studying materials):

Scenario 3 (Student gets bad grade but no materials found):

TeacherAgent   GradesAgent   SearchAgent   MaterialAgent   StudentAgent

grade inserted: 1

grade updated1

No course materials found!

3.2 Space state analysis

Space state analysis is a tool in CPN, used for verification AOM model.

Generated report:

```
 Statistics
------------------------------------------------------------------------

  State Space
    Nodes:  1264
    Arcs:   2073
    Secs:   66
    Status: Full

  Scc Graph
    Nodes:  1264
    Arcs:   2073
    Secs:   0
```

…

```
 Liveness Properties
------------------------------------------------------------------------

  Dead Markings
    24 [1264,1263,1262,1261,1260,...]

  Dead Transition Instances
    None

  Live Transition Instances
    None


 Fairness Properties
------------------------------------------------------------------------
    No infinite occurrence sequences.
```

4 Conclusion

During the project all goals were achieved. Was created and developed the idea of the system, which can provide additional courses to students with difficulties in learning. This system was modeled according to the principles of agent-oriented modeling. Also during this course team was introduced to a tool for simulation Colored Petri nets - CPN tools. This tool was used to implement a prototype of this system.

5 References

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8) http://maurus.ttu.ee/sts/wp-content/uploads/2016/02/Sample_MiniProject_2_Spring_2015.pdf "Ice Road" M.Aravina, V.Karolj, M.Nekrassova, T.M.Scheidt, 2015
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