Search of Method for Analyzing "Viability" of Innovative Projects

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***Abstract*—Questions of "viability" evaluation of innovation projects are considered in this article. As a method of evaluation Hidden Markov Models are used. Problem of determining model parameters, which reproduce test data with highest accuracy are solving. For training the model statistical data on the implementation of innovative projects are used. Baum-Welch algorithm is used as a training algorithm.**

***Keywords:* Innovative project, Hidden Markov model, Baum-Welch algorithm, project viability.**

I. INTRODUCTION

Nowadays, there are many innovative projects in different fields of science. Some of them do not find the application and implementation.

Innovative projects is a complex systems of interdependent and interrelated resources, time limitations and persons aimed at achieving specific goals and objectives for the priority areas of science and technology [1].

The aim of this research is to determine the "viability" of innovative projects.

"Viability" in this study refers to the probability of innovative projects will be implemented.

The relevance of the study due to the following factors:

- A large number of innovative projects presented in the various programs;
- The need to determine parameters of the "ideal" innovative project, i.e. such a project, which will be implemented in the future for sure.

The definition of "viability" will give probabilistic predictions about the prospects for the implementation of this innovative project; it will assess the financial risks and other factors related to the innovative project.

The objectives of the study are:

- Description of the innovation project lifecycle;
- Search and analysis of necessary baseline data;
- Search of method for determining the "viability" of the innovation project;
- Assessing of possibility of using this method for the evaluation of "viability".

To evaluate the "viability" of these projects, data of the projects, which participate in programs "UMNIK" and "START", implemented by the Foundation for Assistance to Small Innovative Companies in the scientific and technical sphere are used. Thus, the "viability" can be defined as a likelihood that projects will pass all stages in "UMNIK" and "START" programs and subsequently will be successfully implemented.

II. INNOVATIVE PROJECT AS AN OBJECT OF STUDY

The general concept of the innovation project and its life cycle is given in [2].

Main phases of the innovation project lifecycle include:

1) Pre-investment phase - performing of various studies for planning innovation project;
2) Investment phase - preparation of documentation for the implementation of an innovative project;
3) The phase of tenders and contracts - contracts for the supply of various equipment and performance of works are making;
4) Phase of the project implementation – plans and schedules of works on the project are developing;
5) The final phase of the project - innovative project closes, the launch of the facility and the start of implementation of the product, analyzes the results of the work.

As for the analysis are only available data on the participation of innovative projects in the Russian programs "UMNIK", "START" and "UMNIK to START", in this study under the lifecycle of the innovative project to be understood passage of the project cycle stages of participation in these programs and further implementation.

The "UMNIK" is a federal Russian program to promote the development of youth innovation projects [3]. Only individuals (program focuses mainly on young professionals with no experience in business) participate in the program. The program consists of several stages, presented in Fig. 1.

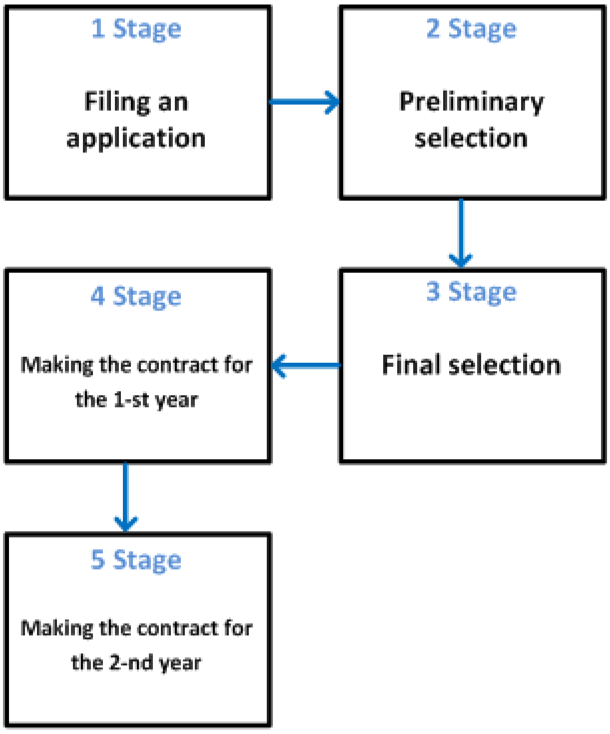

Fig. 1. Structure of the program "UMNIK".

To participate in the program one shall submit a request to the organizing committee, which is considered in several stages. Organizing Committee chooses from among the most promising applications and forwards them to the pre-selection. As part of the pre-selection of the applicant is a project in the internal report. As a result of reports of the commission shall decide on the admission of the participant to the next stage or reject the application. The next stage is the final selection, in which the reports are heard preliminary selection of the winners. According to the results of the final selection addressed the issue of providing funding. The winner is awarded a contract with a small innovative company for one year, during which the project is implemented. In the first, the Party shall provide a report on the results of which addressed the issue of the extension of funding for the second year.

The program "START" is a federal Russian program to promote the development of small innovative companies [4]. Participate in the program only to legal entities. The structure of the "START" program is presented in Fig. 2.

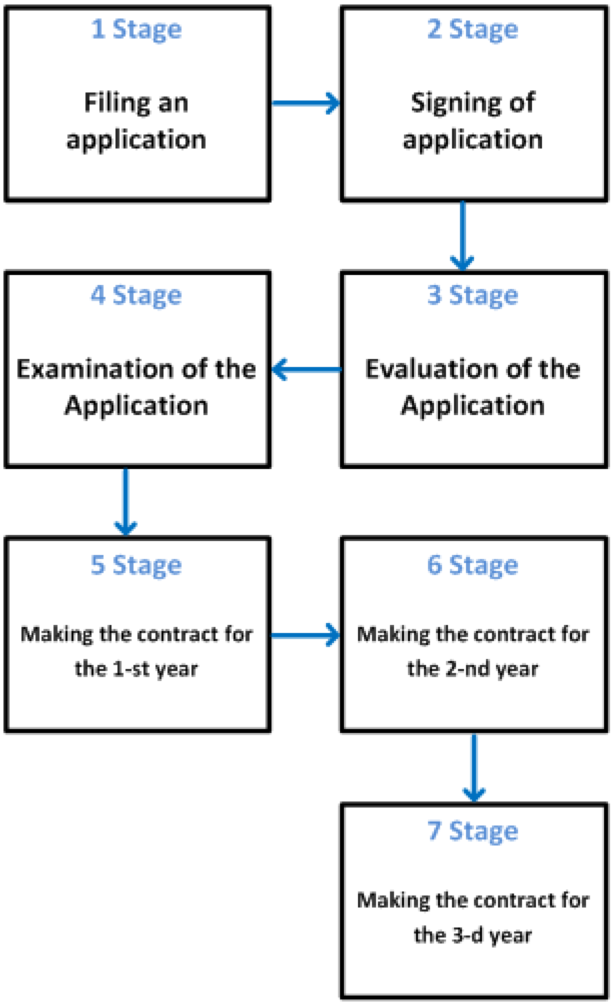

Fig. 2. Structure of the program "START".

To participate in the program one shall submit a request to the organizing committee. After that committee considers this request in several stages. Organizing Committee chooses from among the most promising applications and takes them into consideration. This application is no longer available for editing. The next step is the evaluation of the application according to different criteria, application requirements deviate inappropriate. As part of the examination of the application, the Committee shall select the most promising projects for financing, as well as the possibility of holding a full-time hearing, for a more detailed examination of the application. With the project, successfully passed examination of the application is a contract for one year, during which will be further development of the project. In the first year of funding decision is made to continue funding the project, as well as the party attracted extra-budgetary investment for the development of its project for the second year. The result of the second year of the project, a decision to continue or refuse funding for a third year.

The "UMNIK to START" is a youth innovation projects program, which allows the winners to participate in the "START" program [5]. Participate in the program winners of the program "UMNIK" who are willing to create a small innovative company to participate in the "START" program. Structure "UMNIK to START" program is presented in Fig. 3.

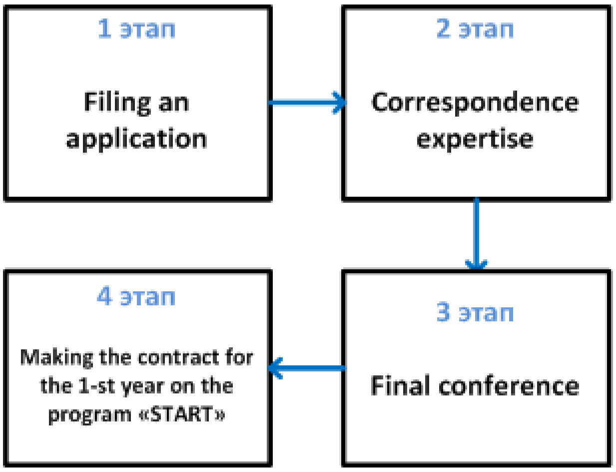

Fig. 3. Structure of the program "UMNIK to START".

To participate in the program "UMNIK to START" winners "UMNIK" programs submit an application to the Organizing Committee, considered at several stages. At the stage of the examination of correspondence to select the most promising innovative projects. The decisive step in this program is the final conference, which decision is the conclusion of a contract for the first year of the program "START".

III. Search of Method for Determining the "Viability" of the Innovative Project

Search and analysis of methods for assessing the probability of realization of innovative projects was conducted in the study. A result of analyzing method of hidden Markov models was chosen.

Markov process - random process in some system called a Markov, if the probability of transition of the system to a new state depends only on the state of the system at the moment and does not depend on when and how the system has passed in this state. More details Markov process is considered in [3][4].

Hidden Markov model - a model of the process in which the process is considered to Markov, the unknown, in which state S_i of the system (status hidden), but each state S_i can with some probability b_{ioj} produce an event o_j that can be seen. Hidden Markov model is described in [5][6].

Based on these determinations, it can be concluded that the process described above can be considered as a Markov process, because it contains a finite number of discrete states, the transitions between them take place at regular intervals, and for each possible transition to determine the probability that a constant transition.

Initially, it is possible to describe only the structure of the Markov model, transition probabilities are unknown. The transition probabilities can be found indirectly by using data on the implementation of the projects. Thus, can use a hidden Markov model to solve this problem.

IV. Search and Analysis of Training Data

It is necessary to have input data for training a model in this research. The input data were selected reports the Foundation for assistance development of small companies in the scientific and technical sphere for the years 2010-2013.

Data about total amount of projects participated in the program "UMNIK", amount of projects, which are gone out to the program START and amount of contracts are made on the program UMNIK to START are presented in the Table I.

Data about total amount of projects participated in the program "START" and contracts are made every year on this program are presented in the Table II.

Analysis of input data takes place on various parameters, such as:

- The number of submitted and accepted applications for participation in the programs;
- Funding for each program ("UMNIK", "UMNIK to START" and "START");
- The number of applications submitted for each specific topic;
- Features the most successful projects.

The selected data is suited to train the model, but they are not enough for obtaining high-quality results and answer the question about the "viability" of specific projects.

For obtaining of more adequate results need to be introduce additional parameters, such as:

- The implementation of cost;
- The complexity of implementation (Number of people and the number of hours to be spent on project);
- Significance (Evaluation the significance and necessity of the project for the real work).

In finished form, such data cannot be obtained since a part of them is intellectual property, and the other part is not calculated on a straight statistical authorities. In this regard, it is necessary to calculate this data based on indirect indicators (e.g., macro parameters).

TABLE I
Statistical data about projects and contracts of program "UMNIK" during the period 2007-2013

Program UMNIK	2007	2008	2009	2010	2011	2012	2013
Amount of participants	804	1037	1334	1533	1910	1841	1986
Project, which are gone over to the program START	43	48	50	65	61	68	63
Amount of contracts made on the program UMNIK to START	-	-	-	-	-	52	68

TABLE II
Statistical data about projects and contracts of program "START" during the period 2007-2013

Program "START"	2007	2008	2009	2010	2011	2012	2013
Amount of applications	1430	1480	1533	2068	1812	1938	1639
Making the contract for the first year	380	400	450	488	537	495	499
Making the contract for the second year	82	77	63	143	165	177	181
Making the contract for the third year	17	31	27	33	46	71	70

V. Assessing of the Possibility of Applying the Method of Hidden Markov Models for the Evaluation of "Viability"

Usually, when working with a hidden Markov model, there are three tasks.

1) Definition of probability of occurrence of a sequence of observations O = o_1, o_2, ..., o_T model λ = (A, B, Π).

2) Selection of chain state Q = q_1, q_2, ..., q_T which best fits the available observation sequence O, for given λ and O.

3) Determination of the model parameters λ = (A, B, Π), ensuring maximum probability P[O|λ].

More detailed given tasks described in [6][7].

In this research, solved the third problem. To solve this problem requires a sequence of input data. Structure of Markov model must be known. It is necessary to determine the initial probability of each state and transition probabilities between states in this model.

In this research use the following structure Markov model based on the input data structure (Fig. 4).

The states described in the model, based on the stage of the program, described in Section 1.

The program "UMNIK" - states 1-8;

The program "UMNIK to START" - states 9-12;

The program "START" - states 13-22.

States of program "UMNIK":

1 – Filling an application and appeal to the regional government;

2 – The deviation of the application by the regional government;

3 – Preliminary selection of applications (presentation);

4 – Final selection;

5 – Conclusion of an employment contract with a small innovative company for 1 year (financing);

6 – Termination of R & D funding;

7 – Continuation of R & D funding for 2 years;

8 – Continuation of work on the project.

States of program "UMNIK to START":

9 – Filing an application;

10 – Extramural expertise;

11 – Deviation of application;

12 – Final conference.

States of program "START":

13 – Filing an application;

14 – Evaluation of application;

15 – Deviation of application;

16 – Examination of application;

17 – Making the contract for the first year;

18 – Presenting a project;

19 – Making the contract for the second year;

20 – Termination of the contract;

21 – Making the contract for the third year;

22 – Continuation of the work small innovative companies.

To solve this problem use the Baum-Welch algorithm, similar to the EM-algorithm. Description EM-algorithm presented in [8][9]. Detailed description of Baum-Welch algorithm is given in [6][10].

Brief overview of the Baum-Welch algorithm:

For given a set of states: $S=\{S_1,S_2,\dots,S_N\}$ and a set of observation symbols: $V=\{v_1,v_2,\dots,v_M\}$, model $\lambda=(P,O,\pi_1)$ is defined, where

$P=[p_{i,j}]$ - Probabilities of state transition;

$O=[o_j(m)]$ - Probabilities of observation;

$\pi_1=(\pi_{1,i})$ - Initial state probabilities.

Algorithm consists of two steps:

At the first step from the known parameters of the model probability of being at time t in state S_i ($\gamma_t(i)$) and probability of being at time t in state S_i and at time t+1 in state S_j given the observation sequence and the model ($\xi_t(i,j)$) are calculated using following formulas:

$$\xi_t(i,j)=P(q_t=S_i,q_t+1=S_j|O,\lambda)$$

$$\gamma_t(i)=\Sigma\ \xi_t(i,j)$$

At the second step model λ are compute based on values $\gamma_t(i)$, $\xi_t(i,j)$ then re-computing of similarity given and calculated λ are performed.

Then the first step is repeated using the calculated. For multiple repetition of this procedure, probability of coincidence the calculation of function with the original one increases. The algorithm converges in the moment when the probability stops changing.

In this research:

Set of states: $S=\{S_1,S_2,\dots,S_N\}$ – the state of the program shown in Fig. 4;

Set of observation symbols: $V=\{v_1,v_2,\dots,v_M\}$ – known data on innovative projects (the number of projects, contracts are made, etc.);

Model $\lambda=(P,O,\pi_1)$.

It is necessary to determine: probabilities of state transition, probabilities of observation and initial state probabilities.

These parameters will be calculated in the future.

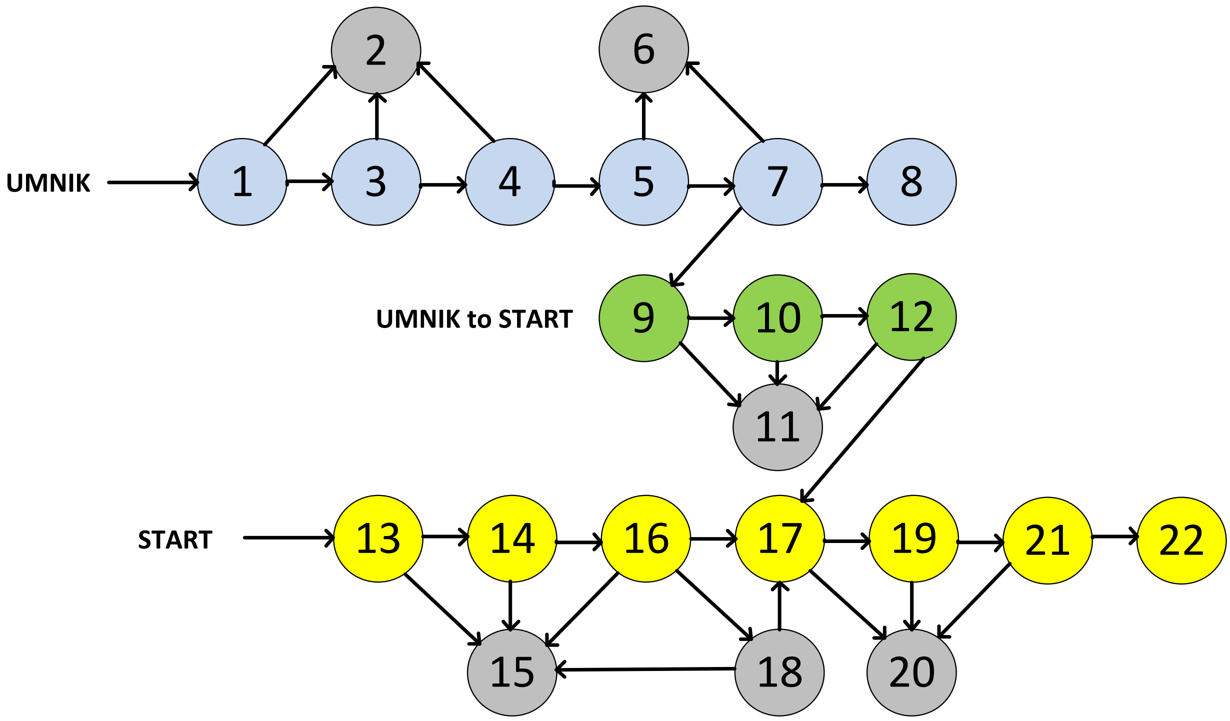

Fig. 4 - The structure of the Markov model.

VI. Conclusion

Analysis of method of innovative projects "viability" evaluation was carried out in the research. It was found that the method of hidden Markov models is suitable for solving this problem, in particular, Baum-Welch algorithm can be used for this task. This algorithm has been briefly described, the assumptions and constraints was considered.

In future it is planned to prepare of test data based on information about the functioning of the federal program to promote the development of innovative projects. Estimation of the transition probability between the phases of the programs presented in the Markov model will be implemented based on these data. Statistics for several years will be used for determining the average value of the transition probability between states described in the model. Based on this, transition probability deviation corridors for the following measurements will be found. The corridor, in which the minimum and maximum values of the transition probability for the projects, moving through stages of implementation, are laid, will be defined using the Baum-Welch algorithm.

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