Modelling of alliance networks in innovation ecosystem

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Abstract. Knowledge generation and diffusion in the modern digital economy as well as innovation process implying novelty technologies, products and services promotion on the market are considered. Production function included R&D or knowledge term regarded as moving force in the self-organizing process of network alliances composition. The model of the networks alliances composition based on the knowledge profile of the firms and measures their similarity or dissimilarity and quadratic programming with binary variables is proposed. Results of the modeling with genetic programming algorithm for partner selection are presented. In paper, we used quadratic methods of programming method as possible way for partner selection. The results of genetic algorithm are discussed in conclusion as possible way for including increment of production function due to new partner's attraction.

Keywords: alliance network, simulation, partner selection, algorithms, ecosystem

1 Introduction

"Knowledge-based economy" is economy that directly based on the creation, distribution and application of knowledge and information. Although knowledge has long been an important factor in economic growth, economists are now exploring ways to incorporate more directly knowledge and technology in their theories and models. "New growth theory" reflects the attempt to understand the role of knowledge and technology in driving productivity and economic growth. [1]

In such conditions, the sense of production function definition is changing. Incorporating knowledge into standard economic production functions is not an easy task, as this factor defies some fundamental economic principles, such as scarcity.

The most significant increment of production function is determined by innovation process and novelty of the production. An innovation process is very complex one it consists from several stages and at each stage it demands large amount of energy and different resources from innovator that is from authors, startups or small or medium enterprises (SME). Innovation begins with new scientific research, progresses sequentially through stages of product development, production and marketing, and terminates with the successful sale of new products, processes and services. It is recognized now that ideas for innovation can stem from many sources, including new manufacturing capabilities and recognition of market needs. Innovation can assume many forms, including incremental improvements to existing products, applications of technology to new markets and uses of new technology to serve an existing market. [2]

Inter organizational alliances thus accord advantages to startups that are usually associated with the privilege of advanced age, including access to strategic and operational knowhow, possession of stable exchange relationships and innovative capabilities, external endorsement of its operations and the perceived quality and reliability of its products and services among potential customers, suppliers, employees, collaborators and investors.

The remainder of this paper is organized as follows. Section 2 describes the main components of knowledge economy; the problems of partner's selection are described in Section 3. Section 4 explains criteria of partner selection and models. Section 5 presents of application of multi-valued logic. Finally, we present our performance results, related work and conclusion.

2 The main components of knowledge economy

2.1 Knowledge transfer and dissemination

The science system, essentially public research laboratories and institutes of higher education, carries out key functions in the knowledge-based economy, including knowledge production, transmission and transfer. Traditional production functions focus on labor, capital, materials and energy; knowledge and technology are external influences on production. Now analytical approaches are being developed so that knowledge can be included more directly in production functions. Investments in knowledge can increase the productive capacity of the other factors of production as well as transform them into new products and processes. In addition, since these knowledge investments are characterized by increasing (rather than decreasing) returns, they are the key to long-term economic growth.

The network characteristic of the knowledge-based economy has emerged with changes to the linear model of innovation. The traditional theory held that innovation is a process of discovery which proceeds via a fixed and linear sequence of phases. In this view, innovation begins with new scientific research, progresses sequentially through stages of product development, production and marketing, and terminates with the successful sale of new products, processes and services. It is now recognized that ideas for innovation can stem from many sources, including new manufacturing capabilities and recognition of market needs. Innovation can assume many forms, including incremental improvements to existing products, applications of technology to new markets and uses of new technology to serve an existing market. Innovation requires considerable communication among different actors – firms, laboratories, academic institutions – as well as feedback between science, product development, manufacturing, which are presented on Fig. 1.

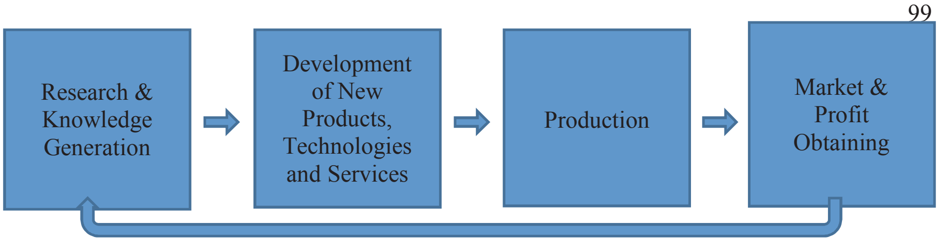

Fig. 1. The main stages of knowledge movement from generation to market

In the knowledge-based economy, firms search for linkages to promote inter-firm interactive communication and for outside partners and networks to provide complementary assets. These relationships help firms to spread the costs and risk associated with innovation among a greater number of organizations, to gain access to new research results, to acquire key technological components of a new product or process, and to share assets in manufacturing, marketing and distribution. As they develop new products and processes, firms determine which activities they will undertake individually, in collaboration with other firms, in collaboration with universities or research institutions, and with the support of government.

All this activity is frequently lumped together as research and development, but it represents premarket activity by a variety of agents, including public scientific institutions, universities, lone inventors, and firms. It is only when stage production is reached, at the point where there is a marketable product or new process, that innovation is achieved. This phase of commercialization triggers the start of another chain of events, broadly characterized as diffusion, which covers the widespread adoption of the new product or process by the market. It is also vital to understand that there is feedback between the various stages: innovation is rarely a linear progression through the stages shown. There is also feedback between the diffusion and innovation stages. As consumers, or other firms, start using the innovations, they often adapt or improve them, or relay information on how to do so back to the innovating firms.

2.2 SME business creation and maintenance

One of the conditions of competitiveness of Russian companies on international markets, ensure the high economic growth, improved quality of life and the realization of national priorities is the effective use of results of fundamental scientific research and development in the commercial sector of the economy. In these conditions, great importance is the development of innovative potential of the economy, defined by a set of necessary technical, production, organizational, marketing and financial operations and ensure the implementation of effective innovations in the economy and the social sphere. The development of innovative co-component of the economy is the object of priori-priority attention from the authorities.

In an innovation economy, competitive advantages are largely determined by Innovations and competitive application of knowledge. For the birth of new technologies and innovative solutions involves the embodiment of ideas to life in the real economic environment where there are both positive and negative factors, the tales of developing into the formation of the innovation. On the other hand, moderately hostile competitive environment may develop grandiose ideas and technologies, eliminating at the same time weak and the devil is a promising solution.

The following conditions are favorable environment for the successful incubation of new technologies:

- creative entrepreneurial environment; the presence of research institutes as tools of cultivation; the availability of highly qualified workforce; support R&D for small businesses; the availability of venture capital; stimulating entrepreneurial climate;
- access to affordable zones for entrepreneurial activity in the field of innovation;
- access to various information; international availability.

However, large companies from time to time lose sight of emerging innovative technologies. They are not able to follow all the new technologies and trends, therefore, are forced to seek other methods of innovative development. One such method is the absorption of small companies with innovative technologies.

Merge and absorption can be categorized in groups on structure of economic relationship and on the nature of integration: horizontal, vertical, patrimonial and conglomerate.

Also, merges and absorption can be sectioned on friendly and unfriendly, and on a local sign – on national and transnational.

Among the possible reasons and motives of merges and absorption the following can be allocated:

- possibility of achievement of synergetic effect;
- the aspiration to increase quality and efficiency managements;
- business diversification;
- asset-stripping – purchase of the company for its subsequent sale in parts for extraction profits;
- tax motives – the absorbed company can possess essential tax benefits;
- personal motives of managing directors;
- aspiration to a gain of a larger share of the market;
- production efficiency rising;
- taking new technologies which are owned by the company purpose;
- hunting behind talented shots.

2.3 Knowledge capital production function

Traditional "*production functions.*" focus on labor, capital, materials and energy; knowledge and technology are external influences on production. Now analytical approaches are being developed so that knowledge can be included more directly in production functions. Investments in knowledge can increase the productive capacity of the other factors of production as well as transform them into new products and processes. And since these knowledge investments are characterized by increasing (rather than decreasing) returns, they are the key to long-term economic growth.

Some kinds of knowledge can be easily reproduced and distributed at low cost to a broad set of users, which tends to undermine relationships or investing substantial resources in the codification and transformation into information private ownership. Investment in knowledge is a primary source of productivity growth. Firms invest in R&D and related activities to develop and introduce process and product innovations that enhance their productivity.

Knowledge capital is considered to by innovation output measured as the percentage of innovation sales to total sales. We will then try to establish the existence of a relationship between innovation and productivity by applying econometric methods that correct for estimation problems inherent to the statistical features of the data. The theoretical framework for the study is Codd-Douglas production function with two variables expressed as [3]:

$$Q_{jt} = Ae^{\alpha t}X^{\beta}K^{\gamma}\varepsilon^{jt} \quad (1)$$

Where Qit rate of productivity of the firm j at moment t . X is a vector of input variable and K is research and development (R&D). The parameter α is a measure of the rate of disembodied technical change, β is the elasticity of production about a vector of standard inputs such as labor, human capital, physical capital, and so forth, γ is the elasticity of production with respect to change R&D, ε is the error term, and A is a constant measuring firm efficiency. It is quite common to express the above relation in logarithmically or the first difference of the variable.

The focus is whether innovation contributes to the explanation of differences in productivity growth among firms, when controlling for physical capital, human capital, firm size, types of output and other characteristic factors relevant to the firm's performance. It should be noted that a priori we expect a positive relationship between innovation and productivity growth. Hence, the key variables in this study are value added

per employee, the share in the firm's total sales that is related to innovative products partly or totally developed by the firm, innovation investment as a share of total sales, human capital, a proxy for physical capital and firm size defined by employment.

In the paper [4] the authors assume the regional of firms' production function including knowledge capital as an input follows:

$$Y_{jt} = A(K_{jt})K_{jt}^{\alpha_K}L_{jt}^{\alpha_L} \quad e^{u_j+v_j+\varepsilon_{jt}} \quad (2)$$

where j represents the cross-section (the region or firm) and t the period Yjt indicates the output. A() is the function of knowledge capital KNjt , Kjt and Ljt represent the capital stock and labour input at time t in region j respectivety, αK and αL represent the coefficients of elasticity and labour input at the provincial level, respectivety, ui and vi indicate the cross-section and time dimension on economic growth, εit is random error term.

In the paper [5] the authors see the first goal of the paper thus to relax the assumptions on the R&D process that are at the center of the knowledge capital model. They are recognizing the uncertainties in the R&D process in the form of shocks to productivity. They model the interactions between current and past investments in knowledge in a flexible fashion. This allows to better assess the impact of the investment in knowledge on the productivity of firms. A firm carries out two types of investments, one in physical capital and another in knowledge through R&D expenditures. The investment decisions are made in a discrete time setting with the goal of maximizing the expected net present value of future cash flows. The firm has the Cobb-Douglas production function:

$$y_{jt} = \beta_0 + \beta_l l_{jt} + \beta_k k_{jt} + \omega_{jt} + \varepsilon_{jt}, \quad (3)$$

where y_{jt} is the log of output of firm *j* in period *t*, l_{jt} the log of labor, and k_{jt} the log of capital. Capital is the only fixed (or \dynamic") input among the conventional factors of production, and accumulates according to

$$K_{jt} = (1 - \delta)K_{jt-1} + I_{jt-1} \quad (4)$$

This law of motion implies that investment Ijt-1 chosen in period t-1 becomes productive in period t.

The productivity of firm j in period t is ωjt as “unobserved productivity" since it is unobserved from the point of view of the econometrician (but known to the firm). Productivity is presumably highly correlated over time and perhaps also across firms. In contrast, εjt is a mean zero random shock that is uncorrelated over time and across firms. The firm does not know the value of εjt at the time it makes its decisions for period t.

2.4 Innovation ecosystem

Achievement of synergetic effect, agrees (for example) it turns out to many researches of one of the first purposes of most the companies, performing operations on merges and absorption. Both companies conducted active work on the market of receptor medicines in various therapeutic areas, and their production was complemented. For each company the merge purpose the taking technologies of other company was.

We have experience in the biotechnologies based on bioproteins which Monsanto before merge didn't own. Was result of merge existence of necessary quantity of practices for laboratory clinical trials, also results of research and development for the resultant company with simultaneous decrease of time spent on researches improved.

The discovery of the concept of innovation ecosystem should be started with the definition of the basic element of economic analysis, which in our case is innovation. Innovations represent a fundamental basis of historical development of economic systems both on macro-level (national economy) and on the regional level. The term ‘innovation’, per the popular Shumpeter (1927) concept, identifies innovation as ‘the critical dimension of economic change.’ He argued that economic change revolves around innovation, entrepreneurial activities, and market power.

In innovation economy, competitive advantages mainly depend on innovations and viable knowledge management. Also, the definition of innovation as the main economic resource postulates the necessity of defining a socio-economic structure of economy. The ability to create and implement innovations is an essential criterion of revenue generation and realization (D. J. Jackson, 2014).

Researches and practitioners mark the ever-growing importance of the concept of innovation ecosystem when describing corporate innovation processes. In special economic literature, it has been argued that an analogy between natural ecosystems and innovation ecosystems is necessary due to inability of applying traditional models. Also, they are needed for identifying some successful strategies of innovation development on national levels. The models studying interrelations between innovation activity inputs and outputs need to be expanded beyond the scope of analyzing research and development (R&D) investment policies and numbers of registered patents. The concept of ecosystems combines various views on open innovations, crowd-sourcing, strategic management, economics, system theory and biological analogies, metaphors and comparisons with natural ecosystems.

D. J. Jackson (2014) states that the fundamental aim of ecosystem studies is the expansion of the system elements' possibilities to transform successfully knowledge into innovations during cooperation between the entities of the system. To give start to innovations, the ecosystems should be designed in accordance with many conditions: natural, structural, organizational and cultural.

In this regard, the role of a friendly ecosystem becomes extremely important. Under the term ecosystem we understand a system that holds all living entities in some area as well as their physical environment where all the elements operate as a unit. D-J. F. Kamann and P. Nij kamp (1988), mention the following terms of a prosperous environment for incubation of new technologies successfully:

- creative business environment;
- research institutes should operate as mechanisms of innovation fostering;
- skilled professional work force;
- start-ups should be supported with R&D investments;
- access to venture capital;
- access to cheap zones of entrepreneurial innovation activity;
- access to various sources of information;
- international access.

3 The problem of selecting partners and key stages of the process

By attracting new partners or to join the alliance company launches a new product, improves the competitive quality of the existing product, thereby increasing profits, attracting new technologies, new knowledge and competencies, reduce costs.

Partner selection is one of the most critical alliance capabilities in the establishment of alliances. The right choice of partner has been identified in numerous studies as a precondition for alliance success. Designing a partner selection process including steps, criteria, tools and success factors, appears to be vital for alliance success. The application of analytic and systematic methods in partner selection could increase the success rate of partnerships. This study suggests that partner selection process is an important alliance capability and has a significant influence on alliance performance.

Firms undertake strategic alliances for many reasons: to enhance their productive capacities, to reduce uncertainties in their internal structures and external environments, to acquire competitive advantages that enables them to increase profits, or to gain future business opportunities that will allow them to command higher market values for their outputs. Partners choose a specific alliance form not only to achieve greater control, but also for more operational flexibility and realization of market potential. The main steps in partner selection process are listed on Fig. 2.

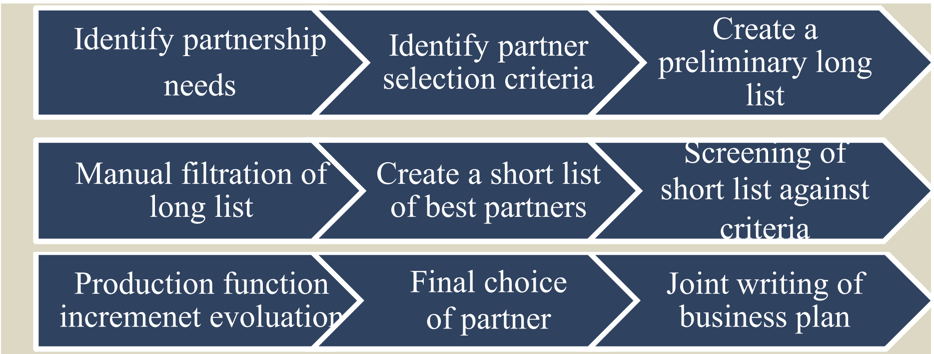

Fig. 2. The main steps in partner selection process

Their expectation is that flexibility will result from reaching out for new skills, knowledge, and markets through shared investment risks. The generic needs of firms seeking alliance as cash, scale, skills, access, or their combinations, then by their strategic intentions. A decision to cooperate is not a responsive action, but is fundamentally a strategic intent, which aims at improving the future circumstances for each individual firm and their partnership as a whole. [6]

The Main Motives to Enter a Strategic Alliance:

- Knowledge exchange
- Gaining access to new technology, and converging technology
- Learning & internalization of tacit, collective and embedded skills
- Cost sharing, pooling of resources
- Developing products, technologies, resources
- Complementarity of goods and services to markets.

It is only when stage is reached, where there is a marketable product or new process, that innovation is achieved. This phase of commercialization triggers the start of another chain of events, broadly characterized as diffusion, which covers the widespread adoption of the new product or process by the market. It is also vital to understand that there is feedback between the various stages: innovation is rarely a linear progression through the stages shown. There is also feedback between the diffusion and innovation stages.

What is concerning SMEs, within their limited resources, SMEs must find ways to achieve production economies of scale, to market their products effectively, and to provide satisfactory support services. Collaborating with other organizations is one method. SMEs are flexible and more innovative in new areas, but can lack resources and capabilities. But strong ties with larger firms can limit opportunities and alternatives for SMEs, and innovative SMEs are more likely to make external networks with other SMEs or institutions such as universities and private research establishments.

Based on these modes, we will in this research a number of collaboration models using various combinations of actors, their roles, and the strength of their ties. While alliances with large firms have often benefited SMEs, they can also oblige SMEs to share their technological competence with the large firms, leading to increased flexibility for the large firms, thus negating a major comparative advantage of the SMEs. As a result, as SMEs gain opportunities to collaborate with large firms, they lose opportunities to compete against them. SMEs may also be required to produce a cheap product to meet the large firms' lowest specifications, thus delaying further innovation on the part of the SMEs.

For us it is important to underline that, alliances foster the exchange of knowledge between firms: by joining their technological resources, firms can enlarge their knowledge bases faster than they could do individually. Finally, firms can share the costs and risks of a project, especially when this is expensive or with uncertain outcome.

The right choice of partner has been identified in numerous studies as a precondition for alliance success. Designing a partner selection process including steps, criteria, tools and success factors, appears to be vital for alliance success. The application of analytic and systematic methods in partner selection could increase the success rate of partnerships.

Based on these modes, we can design a number of collaboration models using various combinations of actors, their roles, and the strength of their ties: the dominant models involving SMEs. At the exploration stage, SMEs are most likely to use external partnerships so they can concentrate on retaining high levels of internal competence in a limited number of technology areas though they show a preference for networking with public research institutes and universities because of the fear of giving away their technology to competitors. But at the exploitation stage, SMEs attempt to create value by entering supplier–customer relations with large firms, outsourcing agreements or strategic alliances with other SMEs. [6]

While alliances with large firms have often benefited SMEs, they can also oblige SMEs to share their technological competence with the large firms, leading to increased flexibility for the large firms, thus negating a major comparative advantage of the SMEs. Thus, as SMEs gain opportunities to collaborate with large firms, they lose opportunities to compete against them. SMEs may also be required to produce a cheap product to meet the large firms' lowest specifications, thus delaying further innovation on the part of the SMEs.

4 Partners selection criteria, strategy and optimization model

We can differ enterprises' profile or by specification (nomenclature) of product produced or by set of patent used in the production process per the International Classification of Patents (ICP) [7]. The set of patents, used in the production process is forming knowledge base of the enterprise and its knowledge profile. So, we can assume that every firm F_j, $j = 1, 2...N$ may be associated with a vector Z_j consisting of M components $(z_{j1}. z_{j2},...z_{jM})$ (each of which represents role of the knowledge or patent category (technological classes) i, $i= 1,2,...M$ in the production function. As we explain below, these vectors can in turn be associated with a metric knowledge space in which the collaborations occur. Thus, we define the knowledge profile of a firm in the knowledge space as:

$$Z_j = (z_{j1}, z_{j2},\ldots,z_{lM}) \text{ , j, r} =\{1,2,\ldots N\}; \text{ i} =\{1,2,\ldots M\} \quad (5)$$

In order to evaluate difference between two enterprises' profiles in the knowledge space we use the Euclidean metric:

$$d_{jr} = |Z_j - Z_r| = \sqrt{\sum_{i=1}^{M}\left(z_{ji} - z_{ri}\right)^2} = \sqrt{\sum_{i=1}^{M}\left(\Delta_{jri}\right)^2} \quad (6)$$

Consider formal description of the problem of alliance team formation We will define an alliance as network or a set of nodes, (the firms), and links between them. We assume that algorithm of partner's selection for decision making about joining the pair of the firms uses the Δ_{jri} value. Let us accept expression (3) as starting formula for production function definition. If every patent technological class add some value, the products output we will modify production function as:

$$y_j = \beta_0 + \beta_l l_j + \beta_k k_j + \sum_i^M \lambda_i \xi_{ji}, \text{ where } 0 \le \lambda_i \le 1,\ \xi_{ji} = \ln z_{ji} \quad (7)$$

$y_{jt} = \beta_0 + \beta_l l_{jt} + \beta_k k_{jt} + \omega_{jt} + \varepsilon_{jt} + \sum_i^M \lambda_i \xi_{jit}$ – production function of the firm F_j at moment t

$y_{rt+1} = \beta_0 + \beta_l l_{rt+1} + \beta_k k_{rt+1} + \omega_{rt+1} + \varepsilon_{rt+1} + \sum_i^M \lambda_i \xi_{rit+1}$ production function of the firm Fj at moment t +1 after substitution firm F_r patent technological class values. Then, if

$$\beta_l l_{jt} = \beta_l l_{rt+1},\ \beta_k k_{jt} = \beta_k k_{rt+1},\ \omega_{jt} = \omega_{rt+1},\ \varepsilon_{jt} = \varepsilon_{rt+1}, \quad (8)$$

we get:

$$y_{rt+1} - y_{jt} = \Delta y_{jrt} = \sum_i^M \lambda_i \xi_{rit+1} - \sum_i^M \lambda_i \xi_{jit} = \sum_i^M \lambda_i (\xi_{rit+1} - \xi_{jit}) = \sum_i^M \lambda_i (\Delta \xi_{jri}) \quad (9)$$

We accept this value as measure of utility of the (F_j,F_r) partners pair.

Suppose that including one additional partner F_j into alliance costs for logistics and communication v_i unit and exist restriction of total Q units for including expense. The decision maker selects members from N candidate members to form a team so that to satisfy the constraints: $\sum_r^M v_r^M x_r \le Q$ and at the same time to ensure maximum of total production function increment due to new partners attraction. Let us consider the task more formally.

For each partners pair (F_j, F_r); $r, j = 1,2,\ldots, N$.

Then we can define

$$\psi_{ij} \text{ just as } \psi_{jr} = \Delta y_{jr}^{M} \tag{10}$$

We suppose that greater ψ_{jr} is, and then the new candidate member utility is higher. According to the overall values of alliance productions, function increment the following optimization model is built to select the most preferred members from N alternatives, satisfying constraints:

Maximize $\Phi = \sum_{j}^{N} \sum_{r \neq j}^{N} \psi_{jr}\, x_j x_r$

subject to $\sum_{r}^{M} v_r^{M}\, x_r \leq Q$, where $x_j,\ x_r \in \{0,1\}$,

$j, r = (1,2,\ldots,N)$.

The described model was realized by genetic algorithm. Below is presented the algorithm of the program on Python language. Total algorithm-schema contains 4 steps.

This model is a 0-1 quadratic programming problem. It is presented step-by-step as follows:

Step 1 Initializing. Input the necessary parameters which contain the number of genetic generations, population size, crossover and mutation probability, and generate the initial parent population. Then calculate the corresponding fitness values of the individuals.

Step 2 Selecting, crossover and mutating. Apply binary tournament selection strategy to the current population, and generate the offspring population with the predetermined crossover and mutation probabilities.

Step 3 Combination. Combine initial population and current, and select population size optimal individuals to generate the next population, per the fitness values of the individual in the frontiers.

Step 4 Stopping. If number of genetic generations is reached, return the individuals (solutions) in population of the next generation and their corresponding objective values as the Pareto-(approximate) optimal solutions and Pareto-(approximate) optimal fronts.

Otherwise, go to **Step 2.**

It is well-known that there exists a lot of software packages and programs for genetic programming.

The specific of our approach is that this program is assumed a part of program complex that including programs for production function increment estimate when new partners are added. For convenience, we decided to make small simple unit for execution of this project.

The program contains the next components:

a) Input data entering.

   Input data incudes:

   1. Initial graph of main point connection with potential partners

2. Increments of production function data for every partner in the initial graph
3. Values of costs connected with log
4. Selection for attentional partner's incorporation into the alliance

The input interface is presented on Fig.3:

```
[1.0, 2.0, 7.0, 8.0, 1.0, 1.0, 1.0, 1.0, 0.0, 0.0]
Assign the usefulness of each partner from 1 to 101?
1
Assign the usefulness of each partner from 1 to 102?
2
Assign the usefulness of each partner from 1 to 103?
3
Assign the usefulness of each partner from 1 to 104?
4
Assign the usefulness of each partner from 1 to 105?
5
Assign the usefulness of each partner from 1 to 106?
6
Assign the usefulness of each partner from 1 to 107?
7
Assign the usefulness of each partner from 1 to 108?
8
Assign the usefulness of each partner from 1 to 109?
4
Assign the usefulness of each partner from 1 to 1010?
3
[1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 4.0, 3.0]
```

Fig. 3. Interface of input data entering

b) The algorithm of data processing includes initial population creation and testing it for utility value computing, initial population modification by application mutation of components and crossover. The next population estimation by utility calculating. Selection and including the best string in population. And repeating the cycle for the selection the best population.
c) The resulting data are represented as graph connecting main point with partner selected total estimate of utility of partners' combination selection and expenses

Different representations of the partner selection are presented on Fig. 4:

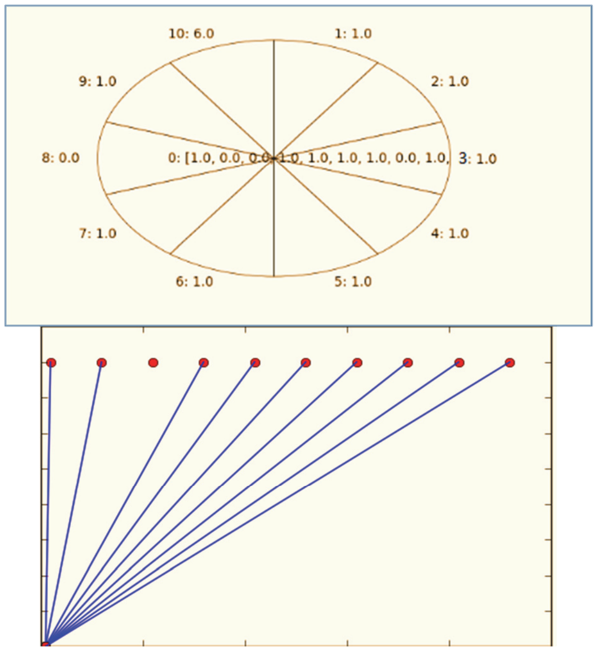

Fig. 4. Graph of pairs selection by algorithm

The correction of authorism is checked on test data. The program is selecting the best partners satisfying constraints.

The research presents a new method to solve the alliance formation problem using the individual and collaborative information. A 0-1 programming model is built to select optimum set of members. The derived solution set of the model can be used to support the decision of the alliance formation. The proposed method considers not only the individual information of members but also the collaborative information between members. It reflects comprehensive information of candidate members in member selection. It also helps to reduce uncertainty regarding cooperation among the potential members. The model can be embedded in the decision support system and process the complex decision problem of partner selection for alliance teams using both the individual and the collaborative information.

5 Conclusions

In this article, as far as we know, for the first time we proposed to use as a criterion for the choice of a partner increment of a production function and to determine this task as a task of binary square programming. It is important to note that we tried to consider in an increment of a production function process of receipt of new knowledge by alliance due to joining of new partners.

We plan to develop an algorithm and to enhance it regarding assessment of an increment of a production function, but it will demand validation and verification of model on real examples.

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