Visualization of optimal path selection in the career route management system

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Abstract

The article is devoted to the development of a career route management system and visualization results this work. The system is based on the construction a graph of vacancies and solving the optimization problem finding the shortest route to the selected top of this graph. Potential users of system are recruitment agencies and job seekers.

An important element of the software system that simulates the career opportunities of applicants is a means of visualizing the results of finding the optimal path in the career graph. Effective representation of the graph allows you to create a convenient visual form that displays global career prospects of the applicant, and also gives the opportunity to conduct virtual manipulation with possible alternatives to the optimal path. The article describes the components of the software system responsible for the construction of a career graph and the search for the optimal path. 3Ds MAX program was used to visualize the model.

Keywords: modeling, attributed graphs, interactive visualization, job graph, optimal career route.

Introduction

Currently, in the field of recruiting, the task of preparing a formal resume by applicants is relevant. The personnel management Department staff spends considerable time processing each resume, and applicants are forced to repeatedly confirm their competence in interviews. Personnel "management service personnel" evaluate personnel according to the following criteria:

- possibility of adapting,
- career growth,
- objectives and achievements,
- incentives and rewards,
- training and development.

You can offer a similar assessment and applicants for vacancies or potential vacancies in other departments.[3]

Consider the management process for those who are part of the personnel management system at three main levels:

1. company level (determined by the top management of the company);
2. level of a certain division (determined by the heads of departments);
3. level of a certain position (largely carried out by the employee). [2]

To facilitate the search for vacancies, there are many services that also allow personnel management services to select new personnel for their companies.

Note the most popular:

1. HeadHunter.ru - at the moment is one of the best online resources for job search and recruitment, as well as the most common in Russia. The competitive advantage of this service is a flexible system of setting the degree of confidentiality of the resume.[5]
2. SuperJob is one of the leading Russian Internet services focused on job search and recruitment. The competitive advantage of the service is the use of artificial intelligence algorithms in its work.[6]

In General, the solutions are almost identical to each other, although they have certain advantages and disadvantages. Common shortcomings include the lack of a clear formalization skills and knowledge of the applicant, as well as requirements for vacancies.

The elimination of these shortcomings will solve the following problems for applicants and employers:

1. Reduction time of search by the applicant work suitable to it on a specialty.
2. Reduce time for the human resources Department to find a staff member suitable for open positions.
3. Significant savings of financial and time resources for the applicant and the employer.

Visualization tools are used to improve the convenience of working with system and correct interpretation of its results. As is known, graphs are a universal means of graphic representation of information. The data on which the graph is built has different degrees of structure and complexity, ranging from simple situations where a single attribute is stored at the top of a graph to complex situations where multiple attributes can be stored at the top of the graph. The graph, which is used by the described system, belongs to the second case, so interactive visualization is used for its interpretation. Interactive visualization transforms a set of static visual representations of data elements into a continuous process of user interaction with the system, implemented with the help of adequate visual displays. The user can receive, explore, analyze and manipulate data using a convenient navigation system.

Currently, there are not so many systems in the field of recruiting that use visualization tools in the process. For example, the article [7] considers a variant of the system based on the display of the results obtained by the methods of data analysis, and the construction graph of the relationship skills. Of interest is the product Peoplesoft Talent Manager of Oracle [8], which does not directly use graph models in its work, but automatically builds various charts and schemes for the analysis of statistical data.

The article briefly describes the basic principles of building a software system and the methods of visualization, as well as a model of career graph and the optimal path for the applicant.

1. Basic principles of the program Hiring Machine

When developing algorithms for career route management, a multi-level system of criteria was used [4]. The basis for the implementation of the components of the career path selection system, responsible for the construction of the graph of vacancies and search for the optimal path, laid the mathematical principles of graph theory. The model of the job graph has the structure:

- Node corresponds to the state of the applicant and displays the professional competence of the person in the performance of certain tasks and functions. The state is characterized by a variety of competencies, each of which has an assessment corresponding to the skills and knowledge within this competence. We introduce the assumption: career competence of a person is cumulative, that is, over time, all the skills and knowledge either increase or are replenished with new ones, but do not decrease;
- Arc corresponds to the transition from one node to another by improving the professional competencies of the applicant. The increase is the result of training courses with the subsequent consolidation of the acquired skills and knowledge while working in a certain position in the organization.
- Also, the job graph has the following properties:
- Deliberateness. The weight of the edge is the profit calculated by the following formula: $e_k = S_k - \sum_i M_{ki}$, where S_k is the salary for the position, and M_{ki} is the cost of the i-th training program necessary for the transition;

- Acyclicity. The job graph does not have a contour. That is, you cannot get into the same state again.
- Customer focus. Professional competencies are cumulative, that is, in the column of vacancies, it is possible to increase existing competencies or add new competencies to the existing ones of the applicant.
- Start node. The job graph has an initial vertex, which characterizes the state applicant at the time of building a career graph. The initial node does not have any arcs entering it.
- End node. The job graph has a final vertex that characterizes the desired state of the job seeker corresponding to the position job seeker wants to achieve. The end node has at least two incoming arcs, and only one outgoing arc that enters the end node (the end node is self-closed). The weight of the closed arc corresponds to the salary of the target position.

2. Description of source data

The input data for the program was received from the project's HR-employees working on the creation of a career path selection system. They include information taken from the real applicant, as well as a set of vacancies entered into the system. In the future, the applicant is called "Employee X". Data on training and vacancies are taken from information services for job search.

We assume that "Employee X" is in the initial state with the following professional competencies:

Professional competence	Quantitative assessment (max 5)
Java	1

The target vacancy for "Employee X "is the position of" development Manager L " with a salary of 150,000 rubles per month. In order to fill a vacancy, the applicant must have the following competences:

Professional competence	Quantitative assessment (max 5)
Java	5
Git	5
HTML	5
SQL	5
Engineering	5
Project management	5

The model of the career graph obtained as a result use of the career path selection system is presented in image 1.
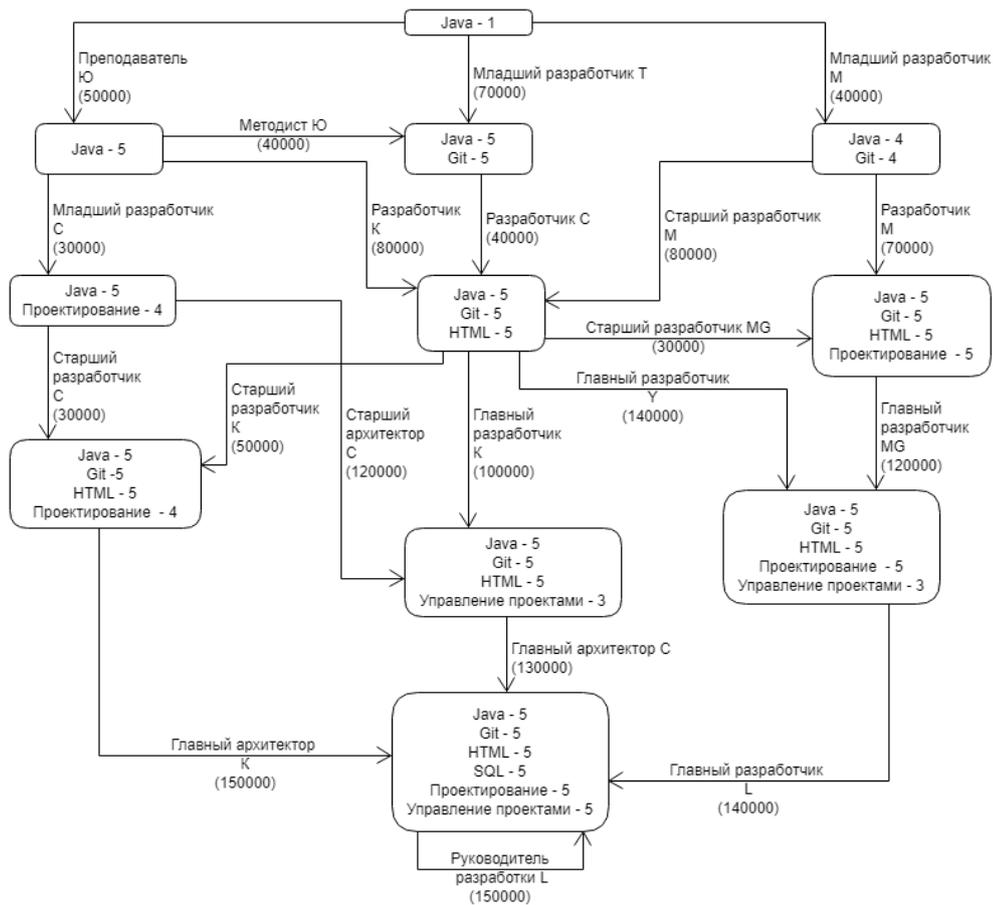
Image 1. A two-dimensional image of a model's career graph

The image of a career graph, built in a two-dimensional plane, allows you to objectively evaluate the results of the system.

3. Three-dimensional visualization using external software packages

The latest version of the career path selection system uses the 3Ds MAX package to provide a three-dimensional visual representation of the results of career graph modeling. 3ds MAX package is an effective tool for data analysis and has a user-friendly interface. The 3Ds MAX package is multi-functional and has advanced 3D modeling, rendering and animation capabilities.[1]

Image 2 shows the results of three-dimensional visualization of the career graph of the applicant "Employee X".
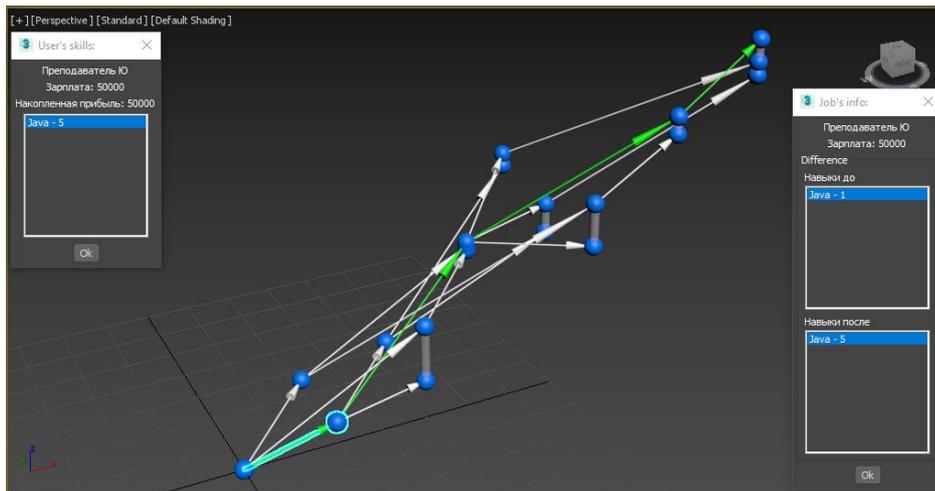
Image 2. Result of rendering in 3ds Max

As a result of the rendering, a spatial image of the job graph was obtained, which presents the following elements:

- Blue spheres-status of the applicant. In the upper left corner of the "User's skills" window, you can see the professional competencies corresponding to the currently selected state, as well as the vacancy that allows you to achieve the selected state and the profit calculated for it.
- Arrows-jobs needed to move from one state to another. In the lower right corner of the window "Job's info" indicates the name of the position and the salary corresponding to this work, as well as the potential change in the level of competence of the applicant for this position. The green arrow will highlight the best path you need to take to reach the target node.
- Translucent cylinder. Used to connect vertices corresponding to the same States (the same set of competencies). The height of the cylinder – the amount in rubles, which can get the applicant when choosing the best alternatives (image 3).

- X coordinate of the node-corresponds to the length of the longest path in the job graph to this node.
- Y-coordinate of the node-corresponds to the number of the alternative at the XOM step.
- Z-coordinate of the node-corresponds to the accumulated profit of the applicant in the process of passing through the career graph.

Navigating a career graph allows you to choose alternative ways to reach the top. For example, in figure 3 you can see that you can get into the state (Java – 5; Gt – 5; Design – 5; HTML – 5; project Management - 5) in two different ways, one of them is more profitable for 40,000 rubles. On the other hand, if the applicant for some reason, the company "MG" is preferable to "Y", the applicant "Employee X" can choose and not the best way.
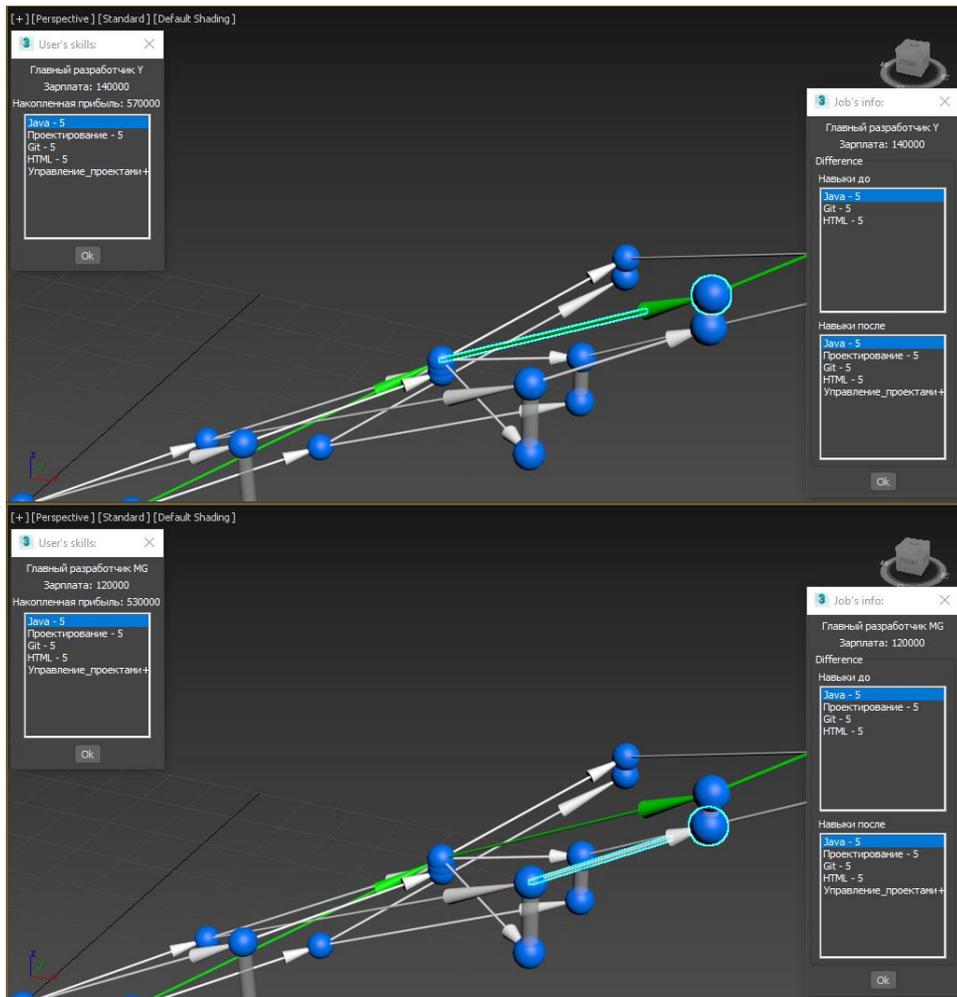
Image 3. Comparison alternatives achieving the same status of the applicant

If the applicant is an "Employee X" is not important, the difference in accumulated profit, then turning to the screen "the view from the top (Top)", is shown in image 4, it is possible to obtain an image similar to the scheme of career graph, presented in image 1.
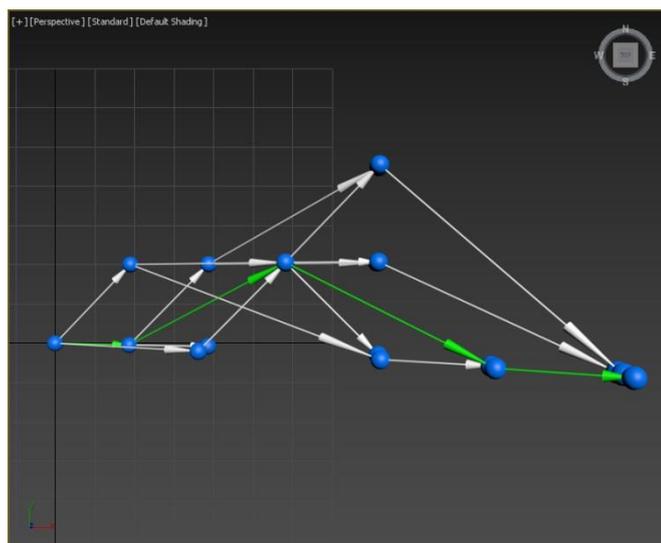

Image 4. Displaying the graph of vacancies in the "Top" mode

4. Conclusion

Visualization as an effective way of data analysis is used in the process of many software products. To visualize the results of the search for the optimal path in the career graph used software package 3Ds MAX, this has extensive functionality. Visual representation of data in the system allows the applicant to comprehensively analyze the career graph, and, if necessary, choose an alternative path based on personal preferences. In addition, it is possible to visually assess the superiority of one option over another, including in material terms.

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