

Approach to the Formation and Visualization of the Competency Profile of the Staff of Organizations Using the UGVA Method

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Abstract. Decision support as part of the task of managing the human capital of organizations largely depends on the extent to which the decision-maker possesses the relevant information about summarized characteristics of the employees and departments. Formation of competency profiles of employees and their visualization by Data Mining methods allows to obtain justification for decisions, even if the profession does not have clear standards and evaluation criteria. The paper considers formation of the competency profile model on the example of the research and teaching staff of organizations and visualization of profiles in the form of anthropomorphic images using the method of the Unified Graphic Visualization of Activity (UGVA). The step-by-step formation of images in UGVA notation and the approach to their analysis for decision-making are described. The competency profiles of the staff members of the Applied Physics and Space Technologies department in Siberian Federal University are shown using their activity database. The results of the analysis of the profiles and the identified patterns are presented. The conclusion provides recommendations on the use of UVGA method for visualization of competency profiles in organizations, its prospects and limitations on its use.

Keywords: Decision Support Systems · competency profile · Data Mining · cognitive visualization · UGVA Method

1 Introduction

The effective functioning of any organization primarily depends on its employees. Therefore, management of human and intellectual capital is directly related to the methods of improving the performance of individual employees, departments and organizations as a whole [15]. But in order to set a management task, it is necessary to record the data on employees' performance, generalize these data taking into account their dynamics and present them in such a way that it is possible to make a well-reasoned management decision. For this purpose, special

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models and visualization tools are used to form a profile of an employee and the whole staff.

Recording of performance indicators and competencies of employees largely depends on the profile of the organization's activity. The indicators are especially sensitive for humanitarian professions, as there are no clear and generally recognized output rates and methods of performance evaluation [17]. As a rule, staff assessment begins with the formation of individual competency profiles (CP), which are then generalized. As an object of study, let us consider the research and teaching staff of a higher educational institution as bright representatives of a "weakly standardized" profession (i.e., teacher and research worker).

The competency profile of employees of an educational organization has its own specifics: working with people, different abilities to pedagogy and research activity, delayed effect on the evaluation of results, specific types of expertise, non-obvious indicators of commercial return, etc. In Russia Federation the specifics of centralized financing, difficulties of cooperative work (especially of international nature), specifics of mentality are added to this. For this reason, it was decided to consider the use of artificial intelligence methods and cognitive visualization tools (data Visualization from Data Mining [8]) to form CPs.

Analysis of CPs in educational institutions allows to reveal hidden patterns and justify many management decisions. For example, [6] describes how ontological modeling allows assessing the state of a department and identifying its hidden potential. But it is possible only when the data are collected promptly, comprehensively and they have been verified. Further it is necessary to generalize these heterogeneous data and use some complex method of visualization, i.e. "see" the hidden patterns. Let us consider one of the approaches to the formation of the CP and its visualization, which allows to increase the level of reasoning of staffing decisions.

2 Existing Solutions

Methods of assessing CPs and similar indicators result in the formation of a set of generalized quantitative/qualitative characteristics of employees [2,20], departments [6] and organization [1] as a whole. As a result, a profile is formed, in the structure of which it is necessary to combine all the indicators: this allows to perceive the data entirely, to form an image for comparison with similar profiles.

Since Miller's constraints [10] are true for most people (including analysts), the use of data concentration mechanisms is required. In this case, arrays of numbers (time series) and tables significantly lose out to visualization tools [14]. Based on the specifics of physiology, visual concentration is most naturally perceived by humans. Figure 1-a-c shows examples of several profiles summarizing characteristics within organizational structures.

Works in the field of data visualization highlight a number of approaches to concentrating data in the form of graphical images. Let us consider the following: star charts, Chernoff faces, clustering, mapping, dashboards, semantic networks



(a) (b) (c) (d)

Fig. 1. Profiles of characteristics of one employee (a, [20]), group (b, [11]), profession (c, [16]) and organization (d, [1])

and ontologies, conceptual and mental maps, cognitive maps of knowledge diagnosis and the Unified Graphic Visualization of Activity (UGVA) method. To compare these methods, we use the following characteristics:

1. Convergence to a flat image
2. Integrity of the image
3. Possibility to compare multiple images at the same time
4. Scalability (e.g., employee-department-organization)
5. Ease of interpretation
6. Possibility to reflect the dynamics of indicators
7. Combining an integral assessment and a variety of individual characteristics
8. Ease of implementation

The performance assessment results and research examples are shown in Table 1). It shows that a more or less comprehensive approach for the selected characteristics can be implemented using UGVA notation (including the indicators of the research and teaching employees). The purpose of this study is to show the essence and principles of applying the UGVA notation for assessing the CPs of employees of research and educational departments of organizations. For this purpose, we will briefly describe the approach to the formalization of data on the research and teaching employees, the UGVA method and its adaptation to the display of CP data (Sect. 3); we will consider an example of using the proposed approach in the educational and training department of the university (Sect. 4); analyze the results of the study and formulate recommendations for the use of CP visual representation (Sect. 5). We conclude with the prospects of the method development and our plans for its further application.

3 Method

3.1 Conceptualization of the Subject Area

The applied value of the CP in knowledge management of the organization depends on how systematic the approach to the formation of the factor space of fixed indicators is. Formalization of information for formation of employees' CPs can be conditionally divided into the following categories:

Table 1. Characterization of different graphic notations for CP visualization

Visualization method	Example	1	2	3	4	5	6	7	8
Star charts	[20]	V	V	V	–	V	–	–	V
Chernoff faces	[3]	V	V	V	–	V	–	–	∼V
Clustering	[8]	V	-	-	-	∼V	–	–	∼V
Mapping in the low-dimensional space	[7]	V	V	V	∼V	∼V	–	–	–
Dashboards	[4]	V	-	-	∼V	V	V	∼V	V
Semantic networks, knowledge graphs and ontologies	[6]	∼V	–	–	–	∼V	–	∼V	∼V
Conceptual and mental maps	[12]	V	∼V	–	–	V	–	–	∼V
Cognitive maps of knowledge diagnosis	[19]	V	V	–	V	V	∼V	–	–
UGVA method	[21]	V	V	V	∼V	V	V	V	∼V

1. requirements of the professional plan (typical competencies, work functions, areas of labor activity) and data on compliance of a particular employee with them (including violation of work discipline, safety, etc.);
2. specifics of work organization at a particular employer's facility (secrecy regimes, industry experience, admission regimes for certain types of work, forms of issuing and reporting on work assignments, business trips, etc.) and data on compliance of a particular employee with them;
3. personal work experience (by place of employment and profession) and the results of employee assessment for compliance with it (including career progression);
4. educational experience (diplomas of education, professional development courses) and the practice of its application in the performance of labor duties;
5. declared personal goals and expectations and facts confirming the compliance of the employee's behavior with them;
6. professional initiatives (participation in unplanned activities, mentoring) and their results;
7. self-assessment of the employee as a staff member (integration into the corporate culture) and feedback from colleagues/management;
8. social contacts of the employee within the work or educational team (their role, significance, sustainability) and the reflection of these contacts on the activity results;
9. other data about the person (family status, gender, age, psychological characteristics, etc.).

In essence, the CP should correlate expectations (through the introduction of a metric factor space and scaling in it) and reality (manifestation of the

person's indicators in this space). It is important to remember, however, that the interpretation of the data should depend on to whom the CP is intended to be demonstrated (the "point of view" of the various persons of interest on the profile). Obviously, it is difficult to collect the entire list of data presented about each employee. Therefore, a preliminary analysis is made to form the CP and it forms a basis for decision made about the particular configuration of the collected data and methods of their interpretation, generalization and visualization.

Having made a system analysis of the research and teaching staff activity, we have revealed the structure of activity of departmental staff, the central categories of which are teaching and educational activity, research and project activity, expert activity. Figure 2 shows the conceptual map of the factor space of the activity data of the research and teaching staff (conceptualization is given in SysML notation according to ISO/IEC/IEEE 42010:2011). Since it was important to find out how the department looks from the point of view of the head (head of the department), the whole organization and the partner enterprise (the organization that forms the request for specialists on the regional labor market), only a part of the possible categories of data was included in the CP.

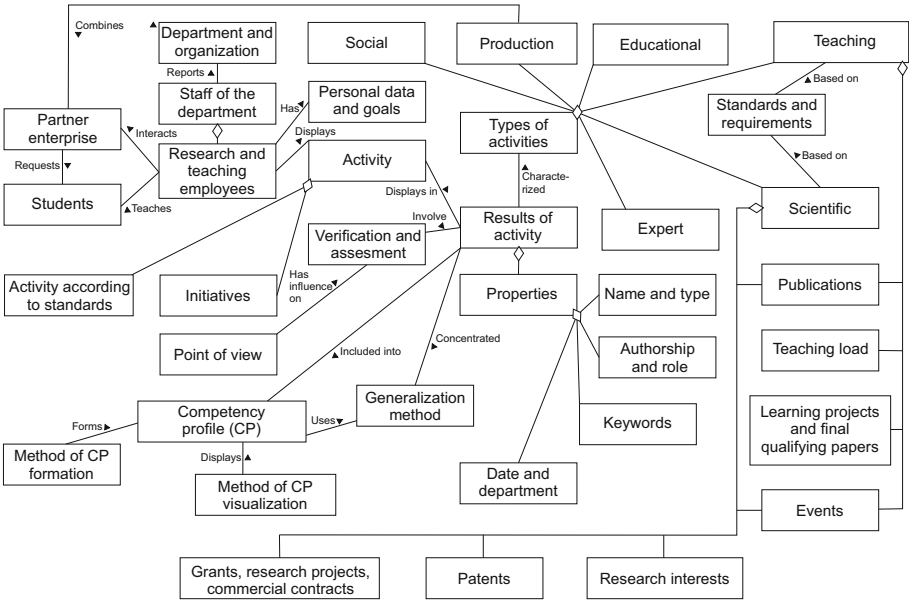

Fig. 2. Conceptual diagram of data on the activity of the research and teaching employees for concentration within the CP

The CP for a department implies the formation of a profile model, collection of primary data, compilation of the profile and its analysis, and making management decisions. In the framework of this study, we are most interested in the stages of profile model formation and its analysis on the basis of cognitive

visualization tools. In this case, the dynamics of indicators (activity), reflecting the specifics of the employee's activity, is put into the structure of the image.

Since one of the central characteristics of a CP is competency, it is important to determine the method to be used for its quantitative assessment. We are going to rely mainly on the method presented in [20]. Therefore, the more data on the employee's activity we manage to record, the more confidence we will have in the result of testing each hypothesis about the development of this or that competency.

3.2 The Model of the Profile of Research and Teaching Staff of the Department

Having chosen the research and teaching employees as an object for CP formation, let us distinguish the main groups of activity indicators that we will be interested in within the framework of this study:

- personal qualification (S_1) – activity, which will include indicators related to the profession (education, professional development courses, length of employment, authority in the team, etc.);
- teaching activity (S_2) – activity that will include indicators related to work experience in the educational institution (teaching, work with students, educational initiatives, preparation of teaching materials and e-courses);
- research activity (S_3) – activity related to the research interests of the employee or students supervised by her/him (participation in research projects, results of intellectual activity, research initiatives, research collaborations);
- expert activity (S_4) – (participation in commercial projects, board memberships, expertise, consulting employers, integration into the real production process, training postgraduate students).

In order to identify the activity facts themselves, a questionnaire is formed, including indicators of the research and teaching employees for the reporting period (usually a year or half a year). The following data are recorded for each activity (event):

- employees and their affiliation with departments/organization;
- name of the activity, its type and time of the event (date or just year);
- keywords (entered by the employee or automatically extracted from the name);
- additional vector of characteristics specific to each activity type.

An illustrative example of primary data of different types is given in Table 2. Such data form a database of events, which should be further generalized and visualized as part of the CP.

In the initial phase of analysis, generalization can be done for each indicator separately. Let's consider, for example, keywords, which we will turn into

Table 2. Example of primary data to be collected to form the CP

Employee's Name	Activity's Name	Type	Affiliation	Year	Keywords	Specification
John	IT course	My education	Univ.	2023	computer, programming, C++	Sertificat #=21
Marry and Peter	Article #284	Science	Univ.	2024	satellite, ballistic trajectory	DOI=10.1/5, Journal=LNCS
Tom	Patent #45	IP	Factory	2022	solar battery, reliability	Number= 123, Type= industrial design
Marry	Stud. dissertation	Education	Univ.	2023	automatization, regulation, correction engine	Title= Development of a method for automatic regulation of the navigation satellite correction engine, Regime= Secret, Date=June 28 2023

concepts (by analogy with HumaNeTrust [13]). Let employee i has j indicators, each of which is characterized by k keywords. Then the undirected graph G_{ij} will be given by a set of concepts N_k and a set of links R_{ijk}. The set of graphs of one research and teaching staff $G_i =< G_{ij}, R_{ijk} >$ forms an individual concept graph, where at each intersection of nodes of subgraphs, 1 is added to the weight of a node, and at intersection (overlapping) of edges, 1 is added to the thickness of an edge. The result is a graph abstracted from specific achievements, characterizing the specificity of research and teaching interests. The coloring of the graph substructures can be done based on the selected keyword, year, type of achievement, employee affiliation or some combination of them. Taking this approach a step further, it is possible to color a subgraph formed by any combination of the above conditions, including addition and intersection operations. If the graph $G =< G_{ij}, R_{ijk} >$ denotes the set of subgraphs G_i of a department/organization, then individual employees can become the basis for coloring. In this case, it becomes possible to track the contribution of an individual, group, or their joint types of indicators relative to the entire disposition in the department/organization (to the general graph). Figure 3 shows an example of such a graph for a university department.

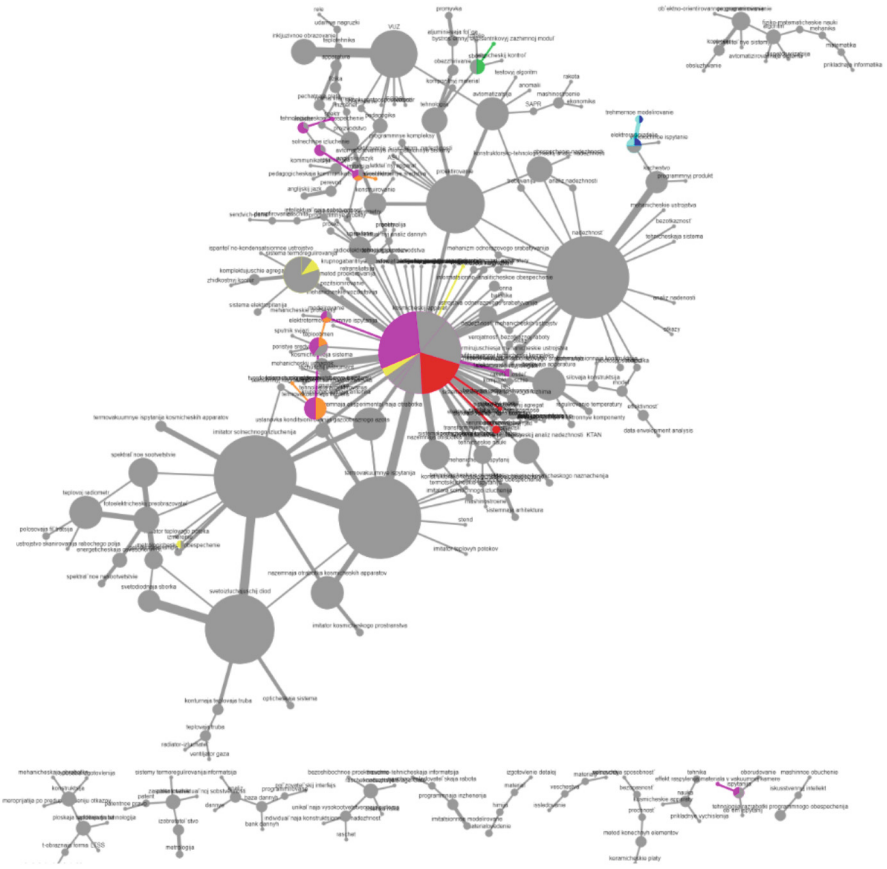

Fig. 3. General graph of the department by employee activity keywords (patents are highlighted)

The use of the mechanism of indicator-based construction of the graph allows to obtain interesting results within the framework of the CP of the employee team, but they do not give a comprehensive picture. Since the set of indicators is not homogeneous and there are many of them (it is practically Big Data), the search for patterns should be complex. This leads to the need to use a more efficient way of data convolution.

Concentration of heterogeneous attribute data can be described in general terms in the form of the following sequence of operations:

1. representation of the flow of activity precedents in the form of vectors having a group specification (each vector a priori belongs to one or more competency groups S_m);
2. estimation of each vector for its influence on the manifestation of an attribute from the groups S_m;

3. summarizing and scaling of estimates of the contribution of the influence of each vector to the total estimate for each attribute;
4. normalization of the obtained estimates and their grouping in accordance with the distinguished S_m;
5. calculation of indicators of balance between the elements S_m.

This process was described in more detail in [21] (see the diagram in Fig. 5) and analyzed by an example. In that paper the estimation was performed by an expert (manual input of coefficient values). Here it is reasonable to implement the operation #2 in automatic mode, operating with collections of production rules (knowledge base). The estimations obtained in this case for a set of compared objects should be presented to the person who makes the decisions. As the analysis of graphic Data Mining methods of data generalization and concentration has shown (see Table 1), the UGVA method has a potential to be applied to visualization of CPs with generalized heterogeneous attributes.

3.3 Methodological Approach to Visualization

The Unified Graphic Visualization of Activity (UGVA) method is an approach to visual representation of a profile of a complex multi-parametric object expressed as an anthropomorphic image in order to show the features of its functional (activity) and structural parameters dependent on them, as well as to compare such profiles [18]. The sets of compared objects in UGVA notation are shown in Fig. 4: the competency profiles of a group of master's students are located on the left, the competency profiles of six enterprise employees are located on the right. When forming such images in this graphic notation, the following sequence of steps should be implemented:

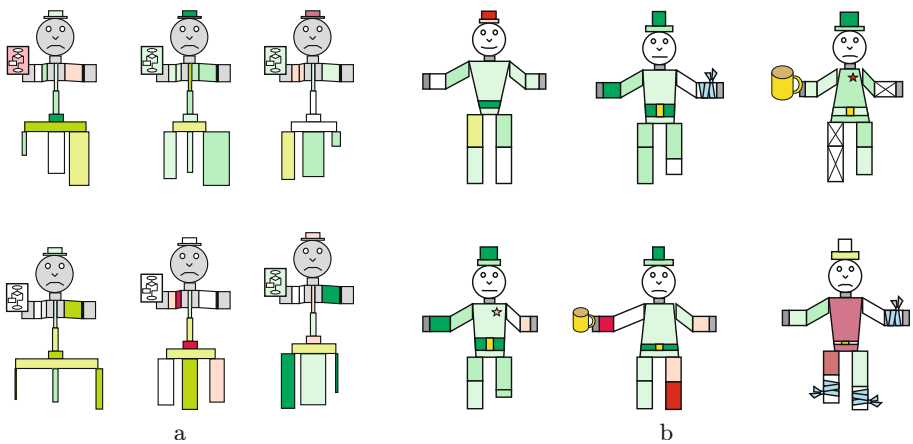

Fig. 4. Examples of comparable objects in UGVA notation: university students and enterprise employees

1. to prepare a framework diagram of the profession by specifying axis types and symmetry types (sketch or framework);
2. to describe the structural scheme of the activity (profession) in the form of an anthropomorphic image reflecting the activity of parameters (structural image);
3. to adapt the image for a particular department/organization (basic image);
4. to form an image for each employee (image of a particular object);
5. to overlay data on current generalized indicators and their dynamics on the image of an employee (image with overlaid data);
6. to contrast a set of images within the employee team to search for patterns, features, to compare and make subsequent decisions (depends on the research task).

An example of applying the UGVA method to support the educational process when implementing ITS-based e-learning was described in detail in [21]. Therefore, here we will focus on the formation of an anthropomorphic image of the research and teaching employees based on a set of activity indicators S_m.

We will correspond a part of the anthropomorphic image (see structural image in Fig. 5-a to each group of indicators S_m. The upper horizontal (evaluative) stratum includes the parameters of the balance between the four main activity groups (encoded in the "emotion" of the image, the parameter μ) and position (radius of the head circumference, the parameter σ). The middle horizontal stratum reflects data on educational activities (on the left), on professional requirements (in the middle), on the employee's research activities but without individual work with students (on the right). Similarly, the lower horizontal stratum reflects educational and research activity, but realized in interaction with individual students or small project groups. Vertically, the strata related to educational and research activities are highlighted with red and green boundaries. Each block of the image has two segments: the segment located closer to the body reflects data for the past reporting period, the segment located further from the body reflects the current period (in Fig. 5-a they are colored green and blue, respectively). Dotted boxes mark the areas of additional parameters (artifacts). According to the classification from [18] the image will have the configuration $\lambda 6Bit$. Turning a basic image into an image of a particular object is a task associated with the consideration of the actual data set on the activity of the research and teaching employees within a particular department/organization.

Interpretation of an employee's CP image, as well as in the Chernoff faces method [3], involves perception of proportions and color, which convey the specificity of each person's activity for the reporting period. But in UGVA notation, facial expression is an integral estimate of the balance μ of the main groups of CP indicators (the algorithm of calculating the balance value is given in [21]). Let's consider the work with CP images in UGVA notation on the example.

4 Case Study

The Department of Applied Physics and Space Technologies in Siberian Federal University as of the beginning of 2024 is chosen as an object for forming the CP

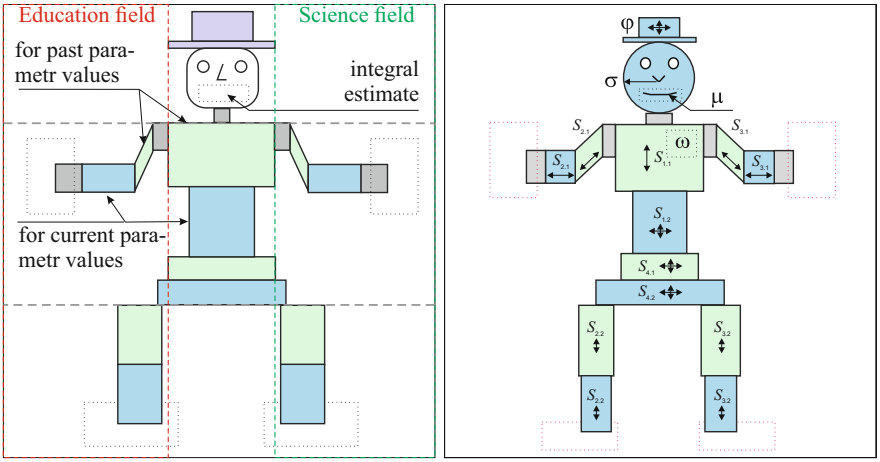

Fig. 5. Structural image of the CP for the research and teaching employees (as a profession) and basic image for the staff of the Department of Applied Physics and Space Technologies (Color figure online)

of employees and the department. It prepares master's students in three technical specialties corresponding to the regional request of the rocket and space industry enterprise JSC Information Satellite Systems (the base enterprise engaged in satellite production). There are 21 research and teaching employees working at the department, 78% of which are also employees of the basic enterprise engaged in high-tech production. In this connection, the visualization model should provide the possibility to evaluate the image from three points of view: in relation to the department (view from the inside), in relation to the whole university (view on the subordinate department) and in relation to the partner enterprise (view from the industry customer on the training of highly qualified specialists). Figure 3 shows the graph of key words of activities of the research and teaching staff of the department (more than 2000 nodes) highlighting the direction of patents for the last 5 years. But we are interested in CP in the form of an anthropomorphic image in UGVA notation.

The transition from the basic image to the image of a particular object (i.e., from Fig. 5-a to Fig. 5-b) was facilitated by the following data specification:

- the degree of interaction between the employee and the base partner enterprise is reflected through the headdress in the evaluation stratum (the parameter φ);
- the presence and effectiveness of educational work is indicated through the artifact badge (the parameter ω);
- availability of active grants with the partner enterprise through the department is shown through the limb artifact on the right side of the image;

– the presence of graduate students is shown through the limb artifact on the left side of the image.

Color coding on the images is used in a scale from green to red with a transition through white in the center: red color indicates low quality of activities in the current group of indicators, green color indicates high quality, white color reflects neutral value, and transitions from white to red or green show the degree of deviation of attribute assessments from neutral.

To accumulate data on the activities of the research and teaching employees, an information system was developed. It was filled with data for the last period of the department's work (from 2018 to the beginning of 2024). The total number of activities of different types in the database amounted to more than 2000. A special analytical module was created for automatic formation of graphs and anthropomorphic images in UGVA notation.

Here is an example for four employees of the department, whose CP data are displayed in the form of anthropomorphic images in UGVA notation (see Fig. 6).

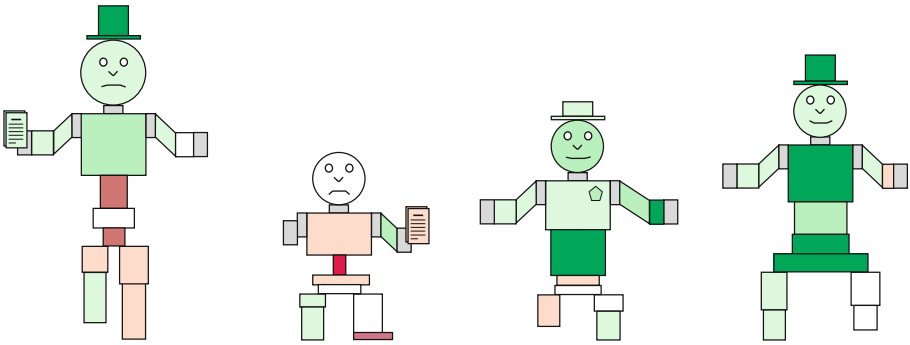

Fig. 6. Example of CP images in UGVA notation for four employees of the department

The image of the first employee (Doctor of Engineering Sciences, professor, holding a managerial position at the partner enterprise) characterizes his activity as follows: educational activity is minimal and stable (he supervises some master's and postgraduate students), there is little research activity, scientific works with students are of low quality. Personal professional growth is minimal, the expert activity is little if any. The balance of activity groups S_m is 0.43, which confirms the unbalanced proportions of the anthropomorphic image in the UGVA notation.

By analogy, we can characterize the activity of other employees. To compare the images of CPs, it is necessary to display them in a single space (as in Fig. 6) and, knowing the principles of image interpretation, to identify the necessary attributes. For example, the images of four employees show that their research work with master's students is rather weak, and the presence of a scientific laboratory (the second image reflects the activity of its head) does not contribute to this.

5 Data Analysis and Results

The proposed approach to CP visualization made it possible not only to take a snapshot of the current state of the activity of the research and training staff of the Department of Applied Physics and Space Technologies, but also to obtain a rationale for decisions related to personnel management. The most significant of them are the following:

- to motivate the most active employees with bonuses based on the dynamics of objective indicators;
- to identify the main and secondary directions in scientific research of employees and correlate them with the development plans of the department (including the justification of "scientific schools");
- to identify social ties within the staff team;
- to identify hidden patterns (strategies) in the approaches to publishing research articles by different employees;
- to evaluate the effectiveness of the work of scientific advisers with students in the implementation of master's theses in the context of each of the three domains of study;
- to analyze the degree of "usefulness" of the employees in relation to the goals of the department, the whole university and the partner enterprise.

The last item implied the presence in the image of a detailed mode of data output to the image, reflecting the affiliation of the employee when declaring certain types of activities (e.g., scientific publications and patents): for example, Fig. 7 shows the images of the employee with indicators that have different contribution to the goals and plans of the department (left), the whole university (center) and the partner enterprise (right). The analysis of these and other results in graphical form obtained by the decision-maker allowed the new head of the department (a new employee who just took office at the beginning of the 2023/2024 academic year) to orient more quickly in the peculiarities of the research and teaching staff and to obtain arguments for decision-making.

Despite the high degree of automation and the availability of interactive tools for working with graphs and anthropomorphic images in UGVA notation, we encountered the following significant difficulties in implementing the project:

- not all research and teaching employees conscientiously entered data on their activities (omissions were discovered during the verification process);
- verification of special methods for assessing precedents in terms of contribution to groups S_m for certain indicators resulted in contradictory feedback from the research and teaching employees (there was a systematic tendency to overestimate the significance of the results of their own activity);
- a number of indicators important for management were never recorded (e.g., assessment of satisfaction with working conditions by Q12-Human Sigma [5] or [9], and use data on participation in projects outside the department);

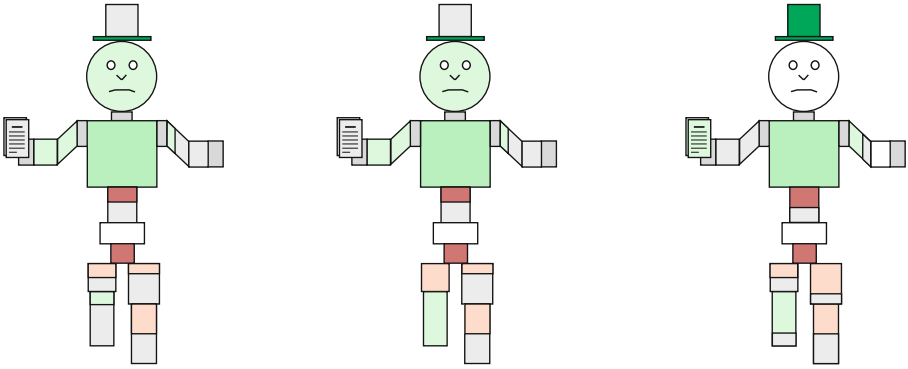

Fig. 7. Display of one employee's CP with details regarding different points of view

– the lack of competency profiles of master's students integrated into the information system (following the example of [21]) and the lack of elaboration of the CPs of entire domains of study reduced the analytical potential of the proposed approach.

The experience gained allows us to formulate the following recommendations for working with anthropomorphic images reflecting CPs of employees of organizations:

– while emphasizing strata and lines of symmetry in the image try to balance them relative to the center of symmetry (they should be visually comparable, and the balance between them is achievable and desirable);
– allow the employee to see the image of his/her CP, as well as its place in the summary map of anthropomorphic images of the department, using it as a motivation tool;
– document in detail the description of the image structure and the methodology of calculating indicators, making them available in an interactive interaction with the user;
– do not apply the same basic images for different professions, even in the same department;
– when highlighting different points of view on the image, use those indicators that show contradictions in their interpretation (this will make the result illustrative and practically useful);
– do not limit yourself to one method of visualization, if there is a reason to apply several of them (the combination of approaches can give the best result).

The beneficial effect of using UGVA notation to analyze CPs at the Department of Applied Physics and Space Technologies in Siberian Federal University can be improved and we will continue to work in this direction.

6 Conclusion

The use of cognitive visualization tools to represent and analyze competency profiles reflects the general trend in applying the Data Mining approach to big data. Employee teams of research and educational organizations are not an exception. Our proposed approach to formalize the CP of an employee and visualize it in the Unified Graphic Visualization of Activity (UGVA) notation has shown its usefulness for decision makers. We plan to continue this research in the following directions: expansion of the list of factors to be taken into account in the CP; integration of the department profile with the CPs of students; expansion of the points of application of the approach to other departments (in particular, those departments that function purposefully to provide personnel with higher qualification to our common partner enterprise).

The visualization of profiles in UGVA notation allows to work with profiles of various objects and structures outside of research and education organizations. Similarly, it can be applied to form CPs of employees and subdivisions of industry enterprises. We are also actively working in this direction.

References

1. Alekhin, A., Alekseev, O.: Organizational balance as a key to enterprise reorganization. Vestnik Plekhanov Russian Univ. Econ. **19**(5), 190–205 (2022). https://doi.org/10.21686/2413-28292022-5-190-205, in Russian
2. Blömeke, S., Kaiser, G., König, J., Jentsch, A.: Profiles of mathematics teachers' competence and their relation to instructional quality. ZDM **52**, 329–342 (2020)
3. Chernoff, H.: The use of faces to represent points in k-dimensional space graphically. J. Am. Stat. Assoc. **68**(342), 361–368 (1973). https://doi.org/10.1080/01621459.1973.10482434
4. Few, S.: Information dashboard design: The effective visual communication of data. O'Reilly Media, Inc. (2006)
5. Fleming, J.H., Asplund, J.: Human sigma: managing the employee-customer encounter. Gallup Press (2007)
6. Gavrilova, T., Kuznetsova, A., Lesheva, I.: On the issue of the development of ontologies of scientific and academic work. In: XXI National Conference of Artificial Intelligence, vol. 1, pp. 60–67. Print-Express, Smolensk, Russia (2023) (In Russian)
7. Gorban, A.N., Zinovyev, A.: Fast and user-friendly non-linear principal manifold learning by method of elastic maps. In: 2015 IEEE International Conference on Data Science and Advanced Analytics (DSAA), pp. 1–9. IEEE (2015). https://doi.org/10.1109/DSAA.2015.7344818
8. Han, J., Kamber, M., Pei, J.: Data mining concepts and techniques third edition. Morgan Kaufmann Ser. Data Manag. Syst. **5**(4), 83–124 (2011)
9. Hogan, R.: Hogan development survey manual. Hogan Assessment Systems Tulsa, OK (2009)
10. Miller, G.: The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychol. Rev. **63**(2), 81–97 (1956)
11. Pareto, L., Snis, U.L.: An interactive visualization model for competence management: an integrative approach. In: Proceedings of I-KNOW, vol. 7, pp. 440–447. Citeseer (2007)

12. Peer, M., Brunec, I.K., Newcombe, N.S., Epstein, R.A.: Structuring knowledge with cognitive maps and cognitive graphs. Trends Cogn. Sci. **25**(1), 37–54 (2021)
13. Pouydebat, O., Courtin, C., Bemmami, K.E., Gardet, E., Habchi, G.: Automation of competences extraction-humanetrust: an experimental computer system used in an academic laboratory. In: CIGI-Qualita21: Conférence Internationale Génie Industriel QUALITA-Grenoble (2021). https://hal.science/hal-03203592/document
14. Qin, X., Luo, Y., Tang, N., Li, G.: Making data visualization more efficient and effective: a survey. VLDB J. **29**, 93–117 (2020)
15. Rezaei, F., Khalilzadeh, M., Soleimani, P.: Factors affecting knowledge management and its effect on organizational performance: Mediating the role of human capital. Adv. Hum.-Comput. Interact., 16 (2021). https://doi.org/10.1155/2021/8857572, article ID 8857572
16. Różewski, P., Prys, M.: How to visualize the competence: the issue of occupational information network visualization. Proc. Comput. Sci. **192**, 4845–4852 (2021). https://doi.org/10.1016/j.procs.2021.09.263
17. Simpson, B., Revsbæk, L.: Doing Process Research in Organizations: Noticing Differently. Oxford University Press (2022)
18. Uglev, V.: Unified graphic visualization of activity (UGVA) method. In: Novel and Intelligent Digital Systems 2022. LNNS. pp. 255—265. Springer (2022). https://doi.org/10.1007/978-3-031-17601-2_25
19. Uglev, V., Gavrilova, T.: Cross-cutting visual support of decision making for forming personalized learning spaces. In: Novel and Intelligent Digital Systems 2022. LNNS. pp. 3–12. Springer (2022). https://doi.org/10.1007/978-3-031-17601-2_1
20. Uglev, V., Shangina, E.: Assessment and visualization of course-level and curriculum-level competency profiles. In: International Conference on Computational Science and Its Applications. LNCS, pp. 478–493. Springer (2023). https://doi.org/10.1007/978-3-031-37105-9_32
21. Uglev, V., Sychev, O.: Evaluation, comparison and monitoring of multiparameter systems by unified graphic visualization of activity method on the example of learning process. Algorithms **15**(21) (2022). https://doi.org/10.3390/a15120468