Study of Conceptual Bases of Software Functioning for the Representation of Deliberative Argumentation

Elena Lisanyuk [0000-0003-0135-4583] and Dmitry Prokudin [0000-0002-9464-8371]

St Petersburg State University, 7/9 Universitetskaya emb., 199034 St Petersburg, Russia
e.lisanuk@spbu.ru, d.prokudin@spbu.ru

Abstract. Deliberative reasoning is widely used in various fields of human activity. In the modern information society, the use of methods of deliberative argumentation is associated with the development and use of appropriate application software, which is intended for visualization and modeling of intellectual activity to solve various types of practical problems, as well as argumentation. At the same time, various software designed for modeling and representation of argumentation explicitly or implicitly contains its conceptual grounds for argumentation. In this study, based on the identification of software intended for the simulation of deliberative reasoning, analysis of its purpose and main functions, the conceptual foundations of their functioning are determined, which is the initial stage for the formulation of a body of criteria for evaluating this software and its subsequent classification. The authors propose two preliminary independent classifications based on conceptual grounds, which are significant characteristics for the classification of the corresponding software.

Keywords: Deliberative Reasoning, Conceptual Bases, Software, Modeling, Representation.

Introduction

Deliberative argumentation is a kind of practical argumentation about actions. In contrast to the theoretical argumentation with its objective to prove the truthfulness of a proposition, the deliberative argumentation focuses on the rationale for what has to be done or what we should do in a given situation. Along with the actions which the deliberative argumentation aims at justifying and the propositions by means of which it intends to justify those actions, it also involves norms, goals and values as the atomic elements of the deliberative arguments. For that reason, it finds wide application in various fields of human social practices, including political, legal, moral, religious and everyday life.

In the context of creating of the software for the representation of deliberative argumentation, its main difference from the theoretical argumentation consists in two aspects, technical and conceptual. The technical difference amounts to the fact that for the modelling of the deliberative argumentation, there is a need for a wider expressive power of the formal languages and ontologies in order to take into account the intentions, goals, norms, values, etc., in addition to the descriptive propositions conveying

facts, which exhaust the atomic elements of the theoretical arguments [16]. The conceptual difference lies in the distinction between the argumentation as a competition among justifications, which belongs to the field of modeling reasoning in general, manipulating knowledge bases and information that make up the cognitive direction in the computer science where information reliability and truthfulness if the key criteria for wining that competition, and the decision- making as a strategy and tactics of behavior belonging to the field of psychology and management where the key criteria for wining is effectiveness in terms of means-ends or resources-ends relations.

The selection and classification of the software based on these aspects is the final goal of our study. At its initial pilot stage, we conducted a preliminary selection of the software for the representation of the argumentation and reasoning in general by separating it from the software used for manipulating knowledge bases and information. At the second stage, we set the task of selecting and classifying the software for modeling the deliberative argumentation. The outcomes of those two stages of our study will be incorporated into the final classification of the software. Here we talk about general approaches in the second stage.

In the contemporary information society, modeling of the deliberative argumentation is connected to the development and use of the special software applications, which is designed to visualize the intellectual activity in solving the practical questions of various kinds by means of reasoning and argumentation. This means that most software applications abstract from the above conceptual distinctions and embrace the reasoning and the decision-making altogether. Decision-making support methods for the intellectual activity with the elements of deliberation using the information and communication technologies find their application in various fields of the human activity: medicine [19], public policy and e-democracy [5, 13], scientific or academic argumentation (including technical, medical and humanities) [22], education, business and other fields [24, 27].

The contemporary research varies in considering different aspects of the software application. Analysts and practitioners have developed the techniques for the application of such software, which is reflected in numerous publications, for example [9, 10, 12, 13, 24, 27].

As a rule, when analysts focus on the software products for determining the possibilities of their application for modelling argumentation, they seldom correlate them with the concepts of argumentation. At the same time, the rationale for analysts to look for the software of that kind refers mostly to training the critical thinking and other soft skills, and to a lesser extent to its use in business analytics, law, management of complex social systems – to the key areas of practical application of the software in question, where conducting evidence-based reasoning based on knowledge and argumentation is at stake. Although some analysts examine the aspects of using such software in the applied fields [7], the theoretical foundations implemented in the software for modeling argumentation, deliberative reasoning and mind mapping are considered superficially. In addition, the available results of those studies cover restricted amount of the existing software, and no reasons are given for the selection they make. Most of the existing classifications are based on the experience of applying the software rather than on the examining the conceptual foundations of the software, and they mainly consider

the methodology of their application in various educational practices. Therefore, in the contemporary studies, there is a challenge for the theoretically substantiated body of the software evaluation criteria with respect to modeling arguments, deliberative reasoning in a broad sense and for the mind mapping.

Many Russian authors focus on creating the software for modeling the plausible reasoning rather than on modeling reasoning in general, which seems to be a more promising approach to solving the problem of the adequacy of modeling of the software. This problem amounts to selecting the software appropriate to the objectives of its application which implies taking into account the conceptual foundations of the software at issue, contrary to selecting it on the basis of the software availability and IT-brand fashion. An influential contribution to the development of the concept of argumentation as plausible reasoning was made by the school of Viktor Finn [1], whose research group created several algorithms for the automated solution of problems through non-deductive, probable and abductive, reasoning [8]. Russian researchers are developing concepts of plausible reasoning as applied to the intellectual and expert systems, including the deliberative systems (decision making), as well as databases, within the framework of which the argumentative reasoning functions as a special competence of highly intelligent agents [25]. They develop the bodies of the methods for discourse analysis of the Internet discussions on socially significant topics, and propose to study them in one of the aspects of the deliberative reasoning - from the perspective of agreement or disagreement with values, norms, etc. [21].

The software designed to model and represent the argumentation is based on diverse conceptual foundations of the argumentation which are visible in the software explicitly or implicitly. Our study aims at determining the conceptual foundations of how such software functions, which is the initial stage for formulating of a body of the evaluation criteria for this software and its subsequent comprehensive classification. We intend to determine those foundations by means of identifying the software designed to model deliberative argumentation, analyzing its purpose and basic functions.

In the development of such a classification we confine ourselves to the following objectives:

- the development of proposals for solving the problem of the theoretical gap between the concepts of argumentation formulated as a result of its research studies and the concepts explicitly or implicitly implied in a number of the software systems and the software applications designed for the modeling and representation of argumentation. Most of those systems and applications have descriptive character: they are limited to the visualization of argumentative dialogs (disputes) and offer no mechanisms for their solutions which highlights the relevance of establishing those particular aspects of deliberation the definite software visualizes;
- to draw the conceptual borderlines between the three approaches: the modeling of argumentation as kind of intellectual cognitive activity aimed at identifying the consistency or soundness of the views of the parties on the issue at stake; visualization of the critical and deliberative reasoning by applied methods of the mind mapping, and the mind mapping as the sets of graphical tools of representing information, including reasoning, using associative diagrams;

- to provide the academic, research and educational community with a tool for the effective selection of the software systems and applications for use in research and educational activities where the deliberative argumentation plays significant role;
- to suggest the methodological support by formulating recommendations for the creation of the domestic software systems and applications for modeling arguments which would respond to the local needs in an adequate linguistic and dialectical setting.

1 Identification of the conceptual foundations of the software for deliberative reasoning and argumentation

In the earlier pilot study, we selected the software designed for modeling, analysis and teaching of argumentation and critical thinking skills [17, 18]. We considered the purpose and the aspects of the application of the software for formulating meaningful criteria for distributing the software into the following categories: the type of reasoning or interactions modelled by the software; the kind of interactions – monological, or agentless, dialogical with two or more agents; whether the software takes into account the logical correctness of reasoning; whether it discriminates between the descriptive and non-descriptive information; whether it has the functions of heuristic search of solutions. With respect to the software application for solving practical tasks, taking those aspects into account allows to separate the software into the following three groups: modeling arguments in a broad sense; analysis and visualization of the processes of generating and evaluating the argumentative discourse - this software can be effectively used for teaching academic writing skills; solving practical tasks based on the use of argumentation, for example, in the field of legal or moral argumentation. Accordingly, the selected software was divided into several main categories in accordance with its following purpose:

- modeling of argumentation;
- visualization of critical and deliberative reasoning;
- mind mapping.

After that we grouped the selected software systems and applications into several categories according to the following methods:

- we have used some of the software for a long time in the educational process and determined some of its conceptual foundations;
- some of the software systems and applications are widely used and their characteristics are described in the educational and research publications;
- developers of some software give their own descriptions of its functional properties.

For example, *Carneades* and *Rationale* software applications that we widely use in the educational process have clear descriptive objective of representing argumentation in a definite way, although many researchers view those applications as based on the argu-

mentation model of S. Toulmin, which has normative character with respect to constructing arguments and their performance in the dialogs. Moreover, the concepts of argumentation implemented in *Carneades* and *Rationale* are different from each other albeit both are descriptive. *Carneades* software supplements Toulmin's argumentation model with some types of defeasible reasoning which the original model lacks. *Rationale* adds to the model two kinds of evaluations of the arguments, the quantitative estimates of the argument strength (poor, good, undefined) and the qualitative estimates of the arguments based on the establishment of their meaningful sources (data, statistics, expert opinions, etc.), as well as the templates for generating arguments in the text. Recently, *Rationale* developers have proposed a new application for modeling decision-making *b'cisive*, which is based on the concept of deliberative protocol [4]. *b'cisive* developers position it for visualization of arguments in the deliberations and decision making altogether, by which with they explicitly avoid drawing distinctions between them.

Some software programs are no longer supported or developed. These include, for example, *Araucaria* software, which we classified for use for the purpose of modeling arguments and deliberative reasoning, but in 2006 the developers stopped supporting it and switched to developing their new web-based software OVA (http://ova.arg-tech.org), designed for argumentation mapping for the analysis and modeling of argumentation in the text. Contrary to *Araucaria*, OVA discriminates the sorts of arguments in terms of their kinds, strength and functions in the dialog. The discrimination is realized by the sets of argumentation schemes available at user's choice (for example, Walton presumptive inference, Rutgers SALTS, Cornell, Dundee illocutionary, Second order illocutionary, Basic conflict, Extended Conflict, Deductive inference). Those sets have been proposed by the research groups and can be used for mapping the argumentation in texts originating from various subject areas. In terms of logic, the sets of the argumentative schemes include deductive and a variety of non-deductive arguments. Users may choose to identify the arguments they are mapping by other criteria like speech acts, dialectical role, rhetorical shape, etc.

From what was said above we conclude that the software designed for modelling argumentation sensitively varies in the degrees and the ways of implementation of the concepts of argumentation on which it is based, including the cases when the software products differently implement the same concepts. For example, *Rationale* software users need no prerequisite knowledge about the analysis or structure of the argument is for starting to work with it. The visualization of argumentation by *Rationale* is close to its intuitive mapping and reflect the basics of the theories which are normally given in standard textbooks on argumentation. *Rationale* supports generating argumentative texts in the vein of design thinking, as well as the multivariate assessment of the effectiveness of argumentation. OVA does not support the latter two options. In contrast, in OVA software, the users have to choose the argumentation schemes themselves, and they have to be aware of the dialectical concept of argumentation implemented in OVA for being able to construct their maps with OVA.

As a part of our study, we single out into a separate group the software systems and platforms used to support the deliberative democracy such DemocracyOS, Democracy

2.1, Loomio, OpaVote, Delib, Decidim [2, 11], which promote deliberations as a necessary tool for generating and shaping public opinion as well as for formulating of the political agenda and observing the controversial issues in the political decision-making. Those systems are the social online platforms or forums, they provide the digital and technical tools for polls, opinion exchange, debates and discussions, statistical analysis and visual representation of its results.

They are designed for supporting decision-making for state and municipal management and are often employed for similar governmental purposes. In those systems the decisive analytical function is assigned to humans who, however, may choose rely on the systems' AI analytical potential, too. Enhancing that potential of AI in the vein of substituting humans at the analytical chair of those software platforms is a relevant subject of concern for many apologists of wider implementation of AI and the natural language processing (NLP) technologies in the deliberative democracy for analyzing public discourse and decision making [20]. The platforms for the deliberative democracy pay no special attention to the kinds and sorts of argumentation performed there, and it is impossible to identify the conceptual grounds of argumentation implemented in them.

We propose two preliminary classifications of the software and give the theoretical descriptions of the aspects of argumentation for creating such software. At the first step, we divide the software into two groups, depending on whether they are descriptive formalisms, platforms, protocols, or ontologies, that visualize the argumentative reasoning of their users, or normative systems that simulate what conclusions should be drawn, what assumptions are recommended to accept or what decisions have to be taken given the rationale visualized by the software (Table 1).

Note that we call the platforms, protocols, or ontologies altogether formalisms and place them into one group with respect to their functional capability to represent discussions where argumentation is used as one of the tools, which means that for this classification we abstract from their diverse functional capabilities in how those representations are realized in each of them. At the second step, we identify two groups of theoretical concepts laid down by their developers in the corresponding software, depending on whether it supports the visualization of the modifiable (defeasible) reasoning or not (Table 2).

Note that the criteria we have chosen for the two groupings give the independent groups despite the fact that they overlap, and we see it impractical to create a generalized classification, since we propose to use those criteria and groupings for different practical purpose. The descriptive vs normative groups are meant for guiding the users in finding an appropriate software for their tasks regarding reasoning in general; the modifiable vs non-modifiable groups are meant for doing so with respect to argumentation of the definite kinds. Perhaps, the only purpose those two groups of the criteria are both equally suitable is their further development, and generally the development of the software and its classification, since those criteria and groupings make explicit some of the software essential properties.

Table 1. Descriptive and normative software applications

Protocols \ ontologies \ platforms	Normative software applications
Software applications for vizualising argumentation (Carneades, Rationale, b'cisive)	modelling of the defeasible reasoning (DeLP, DefLog)
Platform for deliberations and informal discussions (D-BAS)	modelling argumentation with AI systems (ArgTools, Dung-O-Matic)
Platform for collective problem finding and solving	Modelling of probable inferences with modifiable assumptions PITA
Ontology of argumentation for some kinds of reasoning	Modelling of cognitive reasoning for rational agents OSCAR
Protocol for argumentation about actions ATR	Modelling argumentation in dialog by a two-agent game Convince Me
System of plausible argumentation	

Table 2. Software applications for modifiable and non-modifiable reasoning

Non-modifiable (monotonous)	Modifiable (non-monotonous)
St. Toulmin descriptive model of argumentation (Carneades, Rationale, b'cisive)	modelling of defeasible reasoning (defeasible reasoning) (DeLP, DefLog)
Formalised model for informal dialogs with implicit arguments D-BAS	Modelling of argumentation with the AI-systems (ArgTools, Dung-O-Matic)
IBIS (Issue-Based Information System) an approach to explanatory argumentation proposed by V. Kunz and H. Rittel for cjlltctive problem finding and solving (QuestMap, Compendium)	Modelling of probable inferences with modifiable assumptions PITA
Ontology of argumentation for some kinds of reasoning	Modelling of cognitive reasoning for rational agents OSCAR
Modelling argumentation in dialog as a two-agent game Convince Me	Protocol for argumentation about actions ATR
	System of plausible argumentation

The relevance of the software classification which we are developing with respect to its conceptual foundations is that it will enable the users to choose the software regarding their practical goals in a more rational way with respect to solving the tasks of argument analysis and its digital mapping. Another aspect of the relevance is that the classification will respond to the new educational challenges in the teaching of skills of practical argumentation and deliberative reasoning in various fields of human activity. For example, at St. Petersburg State University, the Digital Transformations of Argumentation in Science module is included in the general compulsory course 'Digital Culture'. As part of the module, master students study argumentation digital mapping using Rationale and OVA software and apply it to solving the tasks with the help of practical argumentation. In this vein, they develop applied competencies in digital argumentation mapping, deliberative reasoning, defense and criticism of arguments.

Note that along with the software solutions that we have studied and described here, there are other software systems and platforms that implement mechanisms of deliberation, argumentation, and support for intellectual activity. However, they bear theoretical character and are described only in the research papers (for example, ProGraph, ConArg2), or there are no links either to the websites of their developers or to the software itself. Therefore, those software products are most likely ongoing development or test versions, which lack information or functional performance for determining their capabilities and describing their key properties, including the conceptual basis for their construction.

Conclusion

At the current stage of the study, we have identified two grounds for classifying the software designed for analyzing reasoning - on the basis of the descriptive or normative approach to modelling deliberations and with respect the modifiable or non-modifiable character of argumentation at issue, which form the foundation of the classification of the software we are intended to develop. Those grounds are independent of each other and are both essential properties of the software we focus on.

In the future, we are going to develop a comprehensive classification of the software designed for modeling and representing argumentation, in which we will identify its key conceptual foundations that will enable us to form large groups of the software. We will consider the differences in the implementation of these concepts in the software as its functional properties and separate them into a special characteristic, which will make users' selection of the software more justified with respect to the tasks they wish to solve by means of it.

For the practical approbation of the results obtained we will conduct an applied study. As part of that study, we plan to select an example of a text with a description of a problem solved by means of practical argumentation. We will model that argumentation first with the help of OVA or OVA+ software, which will be a sample for the further modelling by means of two other software applications for analyzing argumentation. Those applications will be selected on the basis of the alternative conceptual grounds compared to OVA. In the selection of those software applications we will take into account the demand in the research community based on the results of the quantitative analysis of the research publications and accessibility both in terms of licensing and availability for the users. This comparative modelling will enable us to clarify the results obtained by our classification and to verify the recommendations for further development of the software we are intended to formulate as another result of our study.

Acknowledgement. The reported study is funded by RFBR according to the research project #20-011-00485-a.

References

1. Anshakov, O.M., Skvortsov, D.P., Finn, V.K.: On the axiomatizability of multivalued logics associated with the formalization of plausible reasoning. In: Logicheskie issledovaniya, pp. 222-247. Nauka, Moscow (1993). [In Russian].
2. Aragón, P., Kaltenbrunner, A., Calleja-López, A., Pereira, A., Monterde, A., Barandiaran, X.E., Gómez, V.: Deliberative Platform Design: The Case Study of the Online Discussions in Decidim Barcelona (2017). ArXiv:1707.06526.
3. Arshinskiy, L.V.: Features of the inference engine of the plausible reasoning modeling system "Heraclitus". Information and mathematical technologies in science and management. 2, 18-29 (2016). [In Russian].
4. Atkinson, K., Bench-Capon, T.: Practical reasoning as presumptive argumentation using action based alternating transition systems. Artificial Intelligence. 171, 855–874 (2007).
5. Davies, T., Chandler, R.: Online deliberation design: Choices, criteria, and evidence. In: Nabatchi ,T., Weiksner, M., Gastil, J., Leighninger, M. (eds.). Democracy in motion: Evaluating the practice and impact of deliberative civic engagement, 103-131. Oxford univ. press, Oxford (2013).
6. Dung, P.: On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming, and n–person games. Artificial Intelligence. 77, 321–357 (1995).
7. Easterday, M. W., Kanarek, J., Harrell, M.: Design requirements of argument mapping software for teaching deliberation. In: Davies, T., Gangadharan, S. P. (Eds.). Online deliberation: Design, research, and practice, pp. 317-323 (2009).
8. Finn, V.K.: Plausible reasoning in intelligent systems such as DSM. In: Avtomaticheskoe porozhdenie gipotez v intellektual'nykh sistemakh, pp. 10-48. VINITI RAN, Moscow (2009). [In Russian].
9. Gelder, T. van: Using argument mapping to improve critical thinking skills. In: Davies, M., Barnett, R. (eds). The Palgrave Handbook Critical Thinking in Higher Education, pp. 183-192. Palgrave Macmillan, US (2015).
10. Gordon, T.F.: An Overview of the Carneades Argumentation Support System. In: Tindale, C.W., Reed, C. (eds.). Dialectics, Dialogue and Argumentation. An Examination of Douglas Waltons Theories of Reasoning, pp. 145-156 (2010).
11. Grassle, S.: Digital tools for participatory democracy. GovLab Blog March, 5 (2015). http://thegovlab.org/digital-tools-for-participatory-democracy.
12. Janier, M., Lawrence, J., Reed, C.: "OVA+: an Argument Analysis Interface". In: Parsons, S., Oren, N., Reed, C., Cerutti, F. (eds). Proceedings of the Fifth International Conference on Computational Models of Argument (COMMA 2014), pp. 463-464. IOS Press, Pitlochry (2014).
13. Klein, M., Iandoli, L.: Supporting Collaborative Deliberation Using a Large-Scale Argumentation System: The MIT Collaboratorium. In: Proceedings of the Eleventh Directions and Implications of Advanced Computing Symposium and the Third International Conference on Online Deliberation (DIAC 2008/OD 2008), pp. 5-12. Berkeley, California (2008).
14. Krauthoff T., Meter C., Baurmann M., Betz G., Mauve M.: D-BAS-A Dialog-Based Online Argumentation System. In: Computational Models of Argument: Proceedings of COMMA 2018, pp. 325-336. (2018). DOI: 10.3233/978-1-61499-906-5-325.
15. Kunz W., Rittel H.: Issues as elements of information systems. Working Paper No. 131, Institute of Urban and Regional Development, Univ. of California, Berkeley, Calif. (1970).
16. Lisanyuk, E.N. Argumentation and persuasion. Nauka, St.Peterburg (2015). [In Russian].

17. Lisanyuk, E.N., Prokudin, D.E. Models of teaching argumentation using software. Logiko-filosofskie shtudii. 13(2), 217-218 (2016). [In Russian].
18. Lisanyuk, E.N., Prokudin, D.E.: Classifying software for argumentation modelling. In: Proceedings of International Conference «Internet and Modern Society» (IMS-2017), St. Petersburg, June, 21–23, 2017. ITMO University, pp. 11-13 (2017). http://ojs.ifmo.ru/index.php/IMS/article/view/516 [In Russian].
19. Mahadevan, N., A. Dubey, D. Balasubramanian, Karsai G.: Deliberative, search-based mitigation strategies for model-based software health management. In: Innovations in Systems and Software Engineering, pp. 1-26. Springer, London (2013).
20. Mejia, M.: How can digital tools support deliberation? Join the conversation! In: Medium. 2020. April, 10. (2020). https://medium.com/participo/how-can-digital-tools-support-deliberation-join-the-conversation-2f0622bda62a.
21. Misnikov Yu.G., Filatova O.G., Chugunov A.V.: Electronic interaction between the authorities and society: areas and methods of researches. St. Petersburg State Polytechnical University Journal. Humanities and Social Sciences. 1 (239), 52-60 (2016). DOI: 10.5862/JHSS.239.6 [In Russian].
22. Online Deliberation: Design, Research, and Practice. Davies T., Gangadharan S.P. (eds.). CSLI Publications, Stanford, (2009).
23. Pollock, J.: Cognitive Carpentry. A Blueprint for How to Build a Person. MIT Press, Cambridge (1995).
24. Schneider, D., Voigt, C., Betz, G.: Argunet: A software tool for collaborative argumentation analysis and research. In: Paper presented at the 7th Workshop on Computational Models of Natural Argument (CMNA 2007). Hyderabad, India (2007).
25. Vagin, V.N., Golovina, E.Yu., Zagoryanskaya, A.A., Fomina, M.V.: Reliable and plausible conclusion in intelligent systems. Vagin, V.N., Pospelov, D.A.. (eds). Fizmatlit, Moscow (2004). [In Russian].
26. Vagin, V.N., Morosin, O.N.: Software implementation of an argumentation system with justification degrees. Software & Systems 1, 21–27 (2015). DOI: 10.15827/0236-235X.109.021-027 [In Russian].
27. Visualizing argumentation: software tools for collaborative and educational sense-making. Kirschner, P.A., Buckingham, S., Simon, J. (eds). Computer supported cooperative work. Springer-Verlag, London; New York (2003). DOI:10.1007/978-1-4471-0037-9.
28. Zagorulko, Yu.A., Garanina, N.O., Borovikova, O.I., Domanov, O.A.: Argumentation modeling in popular science discourse using ontologies. Ontology of Designing. 9.4(34), 496-509 (2019). DOI: 10.18287/2223-9537-2019-9-4-496-509 [In Russian].