

The History and Context of the Digital Humanities in Russia

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This chapter outlines the history and context of the development of digital humanities (DH) in Russia, demonstrating various influences at play. We link the quantitative methods used to trace previous trends in scholarship, including mathematics and sciences, and modeling data and processes in the humanities. Each country is individual in the societal and intellectual contexts which encourage a field to emerge. This means that although the history of that field in various countries may look similar to outsiders, we are able to identify the lineage of intellectual approaches which continue to influence its methods and research.

Previous attempts to write histories of digital humanities were centered on Western theories and practices in the field, placing them in Western cultural and academic contexts. One line focused on Roberto Busa as an iconic founding father (Fiormonte, “Digital Humanities from Father Busa”; Jones, *Roberto Busa*; Terras and Nyhan, “Father Busa’s Female Punch Card Operatives”). Other narratives related digital humanities to computing practices and intentions in the second half of the twentieth century (Vanhoutte, “Gates of Hell”) or examined how researchers in the field institutionally organized their activities (Hockey, “History of Humanities Computing”; Terras, “Rob Wisbey”). Recent papers consider more localized histories, demonstrating the epistemological approach of the Italian school as opposed to the instrumental approach (Ciotti, “Dall’informatica umanistica”).

We argue that, in its origin, Russian digital humanities closely related to mathematics, sciences (in particular, biology), and systems approaches. This resulted in a stronger emphasis on finding structures and looking for patterns of systemic change rather than on constructing anthropological and sociological frameworks, developing data models, or focusing on hermeneutics—practices important for coding literary works in the digital humanities of continental Europe (Ciotti, “Dall’informatica umanistica”; Fiormonte, “Digital Humanities from Father Busa”). The stress on

evolutionary biology in Russian scholarship as a benchmark for future literary studies can be seen as a potentially important Russian contribution to digital humanities.

In support of our interpretation, we look at the literature covering the stages of development, incorporating many distinct concepts and methods. Close reading is augmented by looking at a range of references and tracing links to relevant publications, using standard information-seeking practices such as starting, chaining, browsing, differentiating, monitoring, and extracting (Ellis, “Behavioural Model”). Where researchers set up networks, formal or informal, we have grouped them around concepts and methodologies, and studied the infrastructure if it was available. We have also juxtaposed concepts, methodologies, and research groups working in different fields and looked for common elements among them.

The connection between Russian Formalism and digital humanities (Allison et al., *Quantitative Formalism*; Jockers, *Macroanalysis*; Moretti, *Distant Reading*; Stanford Digital University, *Russian Formalism*) relates to the tradition that originated following the strengthening of Russian mathematics at the turn of the nineteenth century, after the Moscow Mathematical Society was established in 1864.¹ The influence of this school on literary studies and linguistic computing (Figure 5.1) can be traced through the twentieth century from Boris Bugaev (1880–1934), writing under the name of Andrey Bely. He was the son of Nikolai Bugaev, who held one of the first chairs of the Moscow Mathematical Society.² Andrey Bely, poet, writer, and literary critic, introduced statistics to Russian poetry studies (Akimova and Shapir, “Boris Isaakovich Yarkho”; Giansiracusa and Vasilyeva, “Mathematical Symbolism”). He developed a quantitative approach to studying poetic rhythm in 1910, and started a society for applying statistics to the study of poetry (Semyonov, “Methods of Statistics”). This focus on formal structural elements was continued at the Moscow Linguistic Circle, active from 1915 to 1924, under its chair Roman Jakobson (1896–1982), a founder of structural linguistics working in Moscow, Prague, Copenhagen, and Boston.

Much of the current Russian approach to digital humanities is concerned with linguistics as an important source of classification tools for data modeling, for example in the Russian National Corpus (<http://www.ruscorpora.ru/>).³ However, linguistics did more than provide a set of formal features and a methodology to trace a formal technique in a literary work. It was an important initial influence, a novel method of literary studies as a part of a new scientific perspective in the early twentieth century (Tynjanov, “On Literary Evolution”; Yarkho, *Research Methods*). The Moscow Linguistic Circle included over sixty linguists and literary scholars.⁴ They held their meetings in Roman Jakobson’s flat in Moscow. Apart from its significant international influence, the society had an important impact on the development of Russian scholarship. Its traditions were continued in quantitative methods of studying poetry practiced in the second half of the twentieth century (Akimova and Shapir, “Boris Isaakovich Yarkho”; Bodrova, “Quantitative Methods”). Its influence shows in a major agenda of applying structural linguistics

Date	Event	Infrastructures Created as Consequences
1910	Andrey Bely publishes his statistical approach to studying meter and rhythm in poetry (Semyonov, "Methods of Statistics")	Rhythmical Circle to study rhythm in poetry in the early 1910s (Semyonov, "Methods of Statistics")
1914–1925	Moscow Linguistic Circle (1915–1924), prestructuralist ideas developed by Roman Jakobson and Nikolaj Trubetzkoy (Ivanov, "Early Structuralism"; Trubetzkoy, <i>Letters and Notes</i>)	Prague Linguistic Circle (1926–1953); the Linguistic Circle of Copenhagen (founded in 1931); the Linguistic Circle of New York (1943–1969), currently the International Linguistic Association
1936	Boris Jarkho's "Research Methods for Literary Studies" completed in Siberian exile	
1952	Mathematician Alexey Lyapunov gives the first Russian course in Computer Science to the students of Moscow State University	Lyapunov initiates establishing the working group in "Machine Translation" at the Institute of Mathematics, Russian Academy of Sciences in 1954 and Department of Structural Linguistics and Machine Translation at the Institute of Linguistics, Russian Academy of Sciences in 1960. Establishing the Department of Linguistics with a strong quantitative component at Moscow State University in 1960 is the next step in creating the infrastructure (Kulagina, "Alexei Lyapunov"; Uspensky, "On the Origin of the Tartu-Moscow School").
1954–1973	Alexey Lyapunov initiates <i>Cybernetics Journal</i> and Cybernetics Seminar at the Department of Mathematics, Moscow State University	Traditions of multidisciplinary studies, integrative thinking, and systems approaches developed at various institutions across the country (Pospelov, "How Computer Science Developed")
1960s	Mathematician Andrey Kolmogorov publishes his papers on studying rhythm and meter in poetry related to Andrey Bely's studies (Semyonov, "Methods of Statistics")	Lectures and discussions at Moscow State University, Moscow Mathematical Society, disputes at the Mathematical Congress in 1961, and multidisciplinary conferences in 1961 and 1963 (Uspensky, "On the Origin of the Tartu-Moscow School")
1977	Andrey Ershov, Lyapunov's colleague and student, speaks about the need to build the Computerized Corpus of the Russian Language at the conference on Natural Language Processing in 1978 in Pushchino near Moscow (Kraineva and Cheremnykh, <i>Life of a Computer Programmer</i>)	Department of the Computerized Corpus of the Russian Language established at the Institute of the Russian Language, Russian Academy of Sciences in 1986 (Kraineva and Cheremnykh, <i>Life of a Computer Programmer</i>)
2000–2004	Russian National Corpus	Vladimir Plungian initiates a working group that includes a variety of linguists and institutions to develop the Russian National Corpus in 2001 (Sitchinawa, "National Corpus")

Figure 5.1. Quantitative approaches and Russian linguistic/literary computing through the twentieth century.

to interdisciplinary cultural studies at Tartu University (Gasparov, “Between Methodological Strictness”).⁵

An important contextual difference in the development of digital humanities in Russia and in western Europe was that one line of Russian formal and structural studies focused on modeling processes. The polymath, literary scholar, and translator Boris Yarkho (1889–1942), a member of the Moscow Linguistic Circle, wrote in the 1930s:

Theoretically, literature can be perceived as a structure, not as a combination but as a system of proportions and relations between its properties. The system is perceived to be in a continuous movement, with properties (features) moving along the curves of various types, sometimes independently of each other, sometimes in pairs or sets of features. This, in turn, results in understanding the organic dynamics (change) in literature, with a variety of qualitative, quantitative and hierarchical concepts to follow. . . . The specifics of these concepts is, first, that they are very close to how contemporary science understands the concepts of life (organic world) and second, that most of these properties can be measured. (Yarkho, *Research Methods*, 6)

Yarkho’s publications were introduced to the Russian scholarly community by Mikhail Gasparov (“Boris Yarkho as a Literary Scholar”) and published as an edited volume in 2006 (Yarkho, *Research Methods*). English translations appeared in 2016 and 2019 (Yarkho, “Elementary Foundations,” “Speech Distribution”). A number of Russian scholars (see, for example, Akimova, “Humanities and Biology”; Akimova and Shapir, “Boris Isaakovich Yarkho”; Pilshchikov, “Franco Moretti”; Sobchuk and Shelya, “(Distant) Reading”) examine how the biological evolutionary thread in Yarkho’s works could be important for developing the humanities.

Yarkho’s *Research Methods for Literary Studies*, written in 1936, anticipated the approach of the Stanford Literary Lab not only in his “quantitative interpreting” (Underwood, “Genealogy of Distant Reading”) but also in his ability to see wider contexts and make bridges across disciplines. Yarkho’s method did not only rely on statistics and on tracing patterns in literary works. He introduced evolutionary biology to literary studies as “a model” (Akimova, “Humanities and Biology”; Venditti, “Comparing Research Methods”) and a means of advancing the field in the direction of a science:

As literary studies can be imagined as a life science, it is methodologically a part of biological disciplines. We are a product of nature and our works should stay in the general flow of life where the three main properties are variety, continuity and mutability. These properties are a foundation of my method. The method relies on comparison and statistics supported by experiments as sources of evidence.

Applying this method correctly leads to discovering so-called laws which should be interpreted similarly to biological laws, that is typical patterns (connections) which are not completely unconditional. (Yarkho, *Research Methods*, 7)⁶

Maxim Shapir, who edited Yarkho's book in 2006, shows that Yarkho had referred to evolutionary biology already in the 1920s, when he wrote that "a literary work should be studied as a biological organism, from its parts to the whole, and this whole can be defined exclusively as a combination of separate properties" (Shapir, "Editorial Note," 614).

This remark, that the whole is a combination of separate properties, is an example of classical reductionism much critiqued in biology (Brigandt and Love, "Reductionism in Biology"). The critique of Yarkho's reductionism in the 1920s argued that a literary work is larger than a combination of properties (Akimova and Shapir, "Boris Isaakovich Yarkho," xi). Recent critique in biology includes a call for integrative thinking that relies on feedback, regulation, and systems approaches (Fet, "Konrad Lorenz and Cybernetics"; Westerhoff and Palsson, "Evolution of Molecular Biology") because in a living system, parts interact to produce an effect of integration. Fet, for instance, refers to Konrad Lorenz and his approaches to studying complexity in living systems. In this framework, quantitative methodology is a final (or later) stage in advancing knowledge: a different type of mathematics (Berg, *On the Meaning, Content and Classifications*; Novikov, "Teaching Mathematics") or "qualitative mathematics" (Fet, "Konrad Lorenz and Cybernetics"), such as the qualitative theory of differential equations, catastrophe theory, and differential topology, is needed to study biological systems and complexity.

Yarkho's method was to look at the interaction of properties or "distinctive features" in Jakobson and Trubetzkoy's terminology and their change in time and across literary works, for example when building an ontology of genres. Winther ("Parts and Theories") connects the study of quantitative relations of properties and modeling to "formal biology," such as population genetics and theoretical ecology. If what Yarkho meant as a model for the humanities methodology was theoretical ecology (nonexistent in the 1920s), it is easy to understand the importance of modeling in the digital humanities, much discussed in recent years (Flanders and Jannidis, "Knowledge Organization and Data Modeling," *Shape of Data in Digital Humanities*; McCarty, *Humanities Computing*). Although the call to look deeper into modeling practices in DH relates to classifications rather than the processes of "variety, continuity and mutability" considered in detail by Yarkho (see the extract above), recent practices of distant reading (Jockers, *Macroanalysis*; Moretti, *Distant Reading*), studying system dynamics (Lincoln, "Continuity and Disruption"), or calls to build formal models to study how concepts change (Van Erp, "When to Store, What and How?") indicate some analogies for advancing to *The Origin of Species*. A deeper look into theoretical ecology and complexity studies with an emphasis on

feedback and the interaction of properties (Fet, “Konrad Lorenz and Cybernetics”) might be an optional direction that digital humanities could take.

Another example of observing changes and modeling processes is seen in the studies of rhythm and meter in Russian poetry done by Andrey Kolmogorov (1903–1987), an influential Russian mathematician teaching at the Moscow State University between 1931 and 1987. He organized a seminar and published several papers in this field in the early 1960s (Kolmogorov, *Studies in Poetry*; Semyonov, “Methods of Statistics”).

An interest in poetry and meter as an important component of literary studies in the early twentieth century, as compared to the end of the twentieth century (Goldstone and Underwood, “Quiet Transformations”), seems to be an international trend, with quantitative and statistical approaches in the field dating back to the 1860s (Bailey, “Russian Linguistic-Statistical Method”). Russian scholarship produced an excellent tradition of what Bailey calls “the Russian linguistic-statistical method.” Quantitative approaches to studying poetry have been a path traditionally pursued by Russian mathematicians or people connected with mathematics. Data modeling applied to Russian poetry resulted in a rigorous approach to building the Russian Poetry Corpus, as a part of the Russian National Corpus, where metadata fields include “type of rhyme” and “type of meter.” It is indeed strange that a scholarly digital edition of poetry based on the “Russian method” has not yet been developed in a country where studies of poetry have been consistently supported by research involving data models (see, for example, Gasparov, *History of Russian Poetry*; Kolmogorov, “Example of Studying Metre”; Rudnev, “History of Russian Poetic Meter”; Yarkho, “Elementary Foundations,” “Speech Distribution,” “Russian Short Plays and Interludes”). An explanation could be that an edition of this kind calls for developing an ontology integrating a variety of models.

The prehistory of the Russian National Corpus (Sitchinawa, “National Corpus”) goes back to Andrey Ershov (1931–1988), a computer scientist who made contributions in software development and cybernetics, working in Novosibirsk from 1960 to 1988. He was a student and colleague of Alexey Lyapunov (1911–1973), an influential Russian mathematician who developed computer science and cybernetics at the Institute of Mathematics of the Academy of Sciences (Siberian Branch) in Novosibirsk. Lyapunov initiated and coordinated several projects in machine translation and linguistic computing in the 1960s and 1970s.

The point here is not that mathematics sustained and influenced all Russian humanities (Bakhtin’s famous studies can provide an opposite example),⁷ or that the quantitative approach was also present in this part of the world in the 1960s and 1970s, but that it provided rigor, method, and consistency to the field. In addition, it stimulated the unfolding of the twentieth century as “the age of structuralism” (Gladky, “On Quantitative Methods”), which in Russia was limited to linguistics and poetic language, owing to local constraints and the influence of early twentieth-century traditions of Russian scholarship.

Modeling Processes versus Data Modeling

A specific feature of the Russian school was looking for formal (structural) components to interpret a literary work, bringing a wide interdisciplinary context to analysis and interpretation. The tradition was sustained during the twentieth century (Neklyudov, *Moscow-Tartu Semiotic School*) before Russian scholars turned to the digital humanities. The influence of social science and studies aimed at enlarging the literary canon is seen in a Russian project aimed at studying nineteenth-century literature to compare it with contemporary canons (Vdovin and Leibov, “Canonical Texts”). The authors propose to build a corpus of the texts included in nineteenth-century school readers and to study the changes using the grammatical and semantic markup employed in the Russian National Corpus. The idea relates to Moretti’s evolutionary theories, and to Russian traditions of observing the dynamics of a formal feature traceable to Yarkho’s papers written in the 1930s or Lyapunov’s interest to the evolution of structures and functions in complex systems (Lyapunov, “Cybernetics and Biology”).

The interest of Russian historians working in the field of history and computing at the turn of the century in synergetics, nonlinear systems, catastrophe theory, and simulation modeling (Borodkin, “Order and Chaos,” “Understanding Non-Equilibrium States”) may have come from a variety of sources, but it is also about modeling processes.

Modeling data in the Russian humanities has been less developed, resulting in a slow uptake of digitization processes (Kizhner et al., “Accessing Russian Culture Online”). Twentieth-century attempts to create scholarly editions using interpretive practices of the time (Bonch-Osmolovskaya, “Digital Edition of Leo Tolstoy Works”) call for a current need to build new epistemological foundations for contemporary scholarly editions, drawing on international practice. Although a detailed Text Encoding Initiative (TEI) guide was translated into Russian in 2008 (<https://web.archive.org/web/20161104075433/http://tei.it.ox.ac.uk/Talks/2008-08-kazan>), and details on methods can be obtained from the international community, making digital scholarly editions is still a limited pursuit. The lack of research in data modeling, and lack of corresponding projects in the humanities in Russia, obviously explain the lack of enriched digital scholarly editions, although some projects do exist of publishing digitized textual and visual collections.

A recent exception is a scholarly digital edition of the complete works of Leo Tolstoy (Bonch-Osmolovskaya, “Digital Edition of Leo Tolstoy Works”; Orekhov and Fischer, “91st Volume”). It includes a collection management system with metadata fields allowing the retrieval of geospatial, historical, and contextual objects or connections, building networks of people and concepts (Orekhov, “Volume 91”). The digital edition is a result of the Tolstoy Museum’s crowdsourcing project “All Tolstoy in One Click” (<http://www.readingtostoy.ru/>), in which volunteers corrected machine-readable copies based on the printed ninety-volume edition published from 1935 to 1958.

We can say that the Russian context of digital humanities in the twentieth century was very much about modeling processes and systems approaches. It can be observed in Boris Yarkho's premise of "variety, mutability and continuity" as the foundations of this methodology: discovering typical patterns in literary works using comparison and statistics; tracking changes in patterns across time and genres; using biology and systems approaches as benchmarks for future literary studies in the 1920s and 1930s. The trend is also seen in Andrey Kolmogorov's observations, using comparisons and statistics, about meter and rhythm: how rhythm changes across authors, genres, and poetic works from the 1940s to the 1960s. Alexey Lyapunov's work in the field of regulatory systems or cybernetics was applied to linguistic computing and systems biology. Between the 1950s and 1970s, Lyapunov edited the journal *Cybernetics*, which published papers in computer science, systems biology (including Kolmogorov's 1972 paper, "A Qualitative Approach to Mathematical Modeling of Population Dynamics"), structural linguistics, and machine translation. Lyapunov's focus on the evolution of structures and functions of complex systems (Lyapunov, "Cybernetics and Biology," 36), as applied to machine translation and systems biology in the 1960s, is evidenced by the four books he edited for the Cybernetics Monographs series.⁸

Digital Images as Representational Models

Obviously, digital images of heritage cultural artifacts, produced by two- or three-dimensional capture models, also represent objects of study for digital humanities, reducing its numerous parameters to a limited number of features. The advantages and disadvantages of this representational method for epistemic purposes are treated in a wide body of literature (see, for example, Garstki, "Virtual Representation"; Haegler, Müller, and Van Gool, "Procedural Modeling"; Remondino, "Heritage Recording and 3D Modeling"). In Russia, the capture of two-dimensional images (via photography) to reproduce cultural heritage dates back to the early twentieth century, when the images were used for museum outreach, research, and inventory purposes (Polulyakh, "Photo Capturing and Digital Technologies"). Print publications with images of artworks improved their standards of reproduction (Kizhner et al., "Accessing Russian Culture Online"): the quality of images and the scholarly apparatus accompanying visual editions in the 1970s and 1980s anticipated standards for digital publishing and the wider circulation of images using digital tools (Polulyakh, "Photo Capturing and Digital Technologies"; Sher, "Department of Museum Informatics"). High-quality two-dimensional and three-dimensional models are still produced for the images of museum paintings (Kizhner et al., "Accessing Russian Culture Online"), and three-dimensional and photogrammetric models of archeological objects (Pikov et al., "Touching an Ancient Stone").

The Relation with Digital Humanities in the West

We have seen how in Russia digital humanities has been linked to mathematics, sciences, and structural linguistics—in particular, to studying the evolution of structures and functions. This means that Russian digital humanities, in its origin, had very much to do with a research design in line with the “age of structuralism” (Gladky, “On Quantitative Methods”), and supported interpretation with patterns of structural elements and the relations between them.

Digital humanities often aims at coping with confirmation bias (Wason, “On the Failure to Eliminate Hypotheses”). Confirmation bias is a situation when scholars rely on confirming evidence without attempts to seek refuting evidence. Underwood (“Genealogy of Distant Reading”) shows that (social) sciences provide “experimental structures” and help us build research design around hypotheses, samples, and results, as opposed to other methodological traditions in the humanities. We have noted how in Russia, research methodology in this field was substantially sourced from the sciences: social science and anthropology played a minor role in the interplay of influences (Gasparov, “Between Methodological Strictness and Moral Appeal”). The Russian formal and structural school focused on linguistics, literary studies, and poetic language, following Ferdinand de Saussure’s line and differing from French structuralism of the 1960s, which generally related to cultural studies and anthropology.

A sustained interest in modeling and models in DH (Ciula and Eide, “Reflections on Cultural Heritage”; Eide, “Ontologies, Data Modelling, and TEI”; Flanders and Jannidis, “Knowledge Organization and Data Modeling,” *The Shape of Data in Digital Humanities*; McCarty, *Humanities Computing*) shows how important data modeling is for the field, as ontologies, data modeling standards, and collection management systems shape analytical tools. We can imagine the world of Western DH as a place where classifications and classificatory standards do not only form our understanding of the humanities but impose that understanding on the users of editions, collections, and data aggregators. The sustained interest of Russian scholars in modeling processes and dynamics across time and genres was very similar to that of scientists in Russia, who preferred modeling processes to building data models.⁹

We have demonstrated that the Russian tradition of digital humanities in the twentieth century was related to mathematics, linguistics, and the sciences, in particular to biology. We can say that Russian scholars such as Boris Yarkho, and scientists working in the humanities such as Alexey Lyapunov and Andrey Kolmogorov, were proponents of this rigorous and consistent research methodology. Gladky, a founder of Russian linguistic computing, argues that rigor and consistency are even more important for the field than applying quantitative methods. We can say that consistency was a major feature of research methodology in “the age of structuralism”

across the world, and no less so in Russian scholarship. A specifically Russian feature, however, was that this consistency originated in the framework of mathematics and biology. Biological foundations involved “variety, continuity and mutability” (Yarkho, *Research Methods*) or the evolution of structures and functions (Lyapunov, “Cybernetics and Biology”). As in Russian science, Russian scholars were much better at modeling systemic change (modeling processes) than at data modeling.

One of the consequences of this is the lack of digital scholarly editions of textual and visual data. Apart from linguists, few scholars experimented with data models involving new classificatory schemas. It was not a comprehensive practice when digitization and huge amounts of data entered the cycle of research in the 1990s. Among the exceptions are the data models behind the Russian National Corpus, data modeling in poetry, and the scholarly digital edition of Tolstoy’s complete works. The continuing popularity of Boris Yarkho’s ideas demonstrates that Russian DH may have further potential to draw on biology, theoretical ecology, and systems approaches in order to progress from Linnaean findings to Darwinian analogies. This seems implicit in Yarkho’s dream for the future of literary studies, or as we would say now, the future of digital humanities.

Alternative histories of DH seem to appear in various parts of the world, with their foundational figures representing a variety of approaches. The choice of foundational figures in a country as huge and diverse as Russia may seem arbitrary and even dangerous, as it may result from the preferences specific to a certain academic tradition or group of scholars. The history outlined in this chapter is only one in a number of discourses that can bring alternative approaches and methodologies to life; but all of them will serve to strengthen the study of digital humanities in Russia and across the world.

Notes

1. The influence of Russian Formalism on French Structuralism, and the strong theoretical relationships between them, were well documented in the 1970s (see, for example, DeGeorge, “From Russian Formalism to French Structuralism”; Erlich, “Russian Formalism”; Scholes, “Contributions of Formalism and Structuralism”).

2. Boris’s relations with his father and the influence of his academic environment on his development have been widely discussed (see, for example, Giansiracusa and Vasilyeva, “Mathematical Symbolism”; Janecek, *Andrey Bely*).

3. The National Corpus of the Russian Language includes over 600 million words. It was developed by linguists from the Russian Academy of Sciences and published online in 2004 (Sitchinawa, “National Corpus”).

4. Tynjanov and Schklovsky, famous for their contribution to Russian Formalism, were members of the Moscow Linguistic Circle (Shapir, “Editorial Note”).

5. Tartu University in Estonia, a part of Russia at that time, was a home for literary studies in the methodological tradition of looking at formal and structural features.

6. Akimova (“Humanities and Biology”) shows that “variety, continuity and mutability” was quoted from the Russian translation (published in 1935) of Ferdinand de Saussure’s *Cours de linguistique générale*.

7. See, for example, Gasparov, “Michael Bakhtin in the Russian Culture,” and Sedakova, “M. M. Bakhtin,” for discussions of the difference between Bakhtin’s views and Russian Formalism.

8. Mel’čuk, *Automatic Syntactic Analysis*; Iordanskaya, *Automatic Syntactic Analysis*; Ratner, *Regulatory Systems in Genetics*; Schmalgausen, *Cybernetics and Biology*.

9. Vorontsov (*Alexey Andreevich Lyapunov*, 195–96) writes that Russian biologists were not especially willing to build ontologies and develop taxonomical boundaries. This unwillingness persisted in the second half of the twentieth century.

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