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Editorial

Mathematics and Poetry—Epilogue for a Special Issue

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The Special Issue "Mathematics and Poetry, with a View towards Machine Learning", started with three guiding questions from the guest editor:

- What are the similarities (and differences) between mathematical problems and poetic works?
- What kind of mathematical problems can be solved by computers?
- Could computers write poetry with the help of Machine Learning techniques?

Further clarifications on the connections and intermediate levels between mathematics and poetry followed, as recalled below.

The Fields Medalist Cedric Villani explores these topics in his book, "Mathematics is the Poetry of Science" (2020). A great lover of poetry, he insists that the two are intrinsically linked in their aim of both tackling the complexities of our reality as well as distancing us from it.

The recipient of the "Golden Wreath" for 2019, the main award of the "Struga Poetry Evenings", the Romanian poet Ana Blandiana, has written poetry inspired from scientific concepts.

In a series of papers on the meetings between the famous poet Nichita Stănescu and the Academician Solomon Marcus, by the author of this Special Issue (see *Caiete Critice* 3/2018, etc.), several intermediate levels between mathematics and poetry are considered.

The above three questions could be considered in the framework of the Big Data Theory and of Machine Learning. For example, Sophia is a robot developed by Hanson Robotics who participated in many high-profile interviews. Hanson designed Sophia to be a suitable companion for the elderly at nursing homes, but it can also be used while treating coronavirus-infected people. If this type of robot could improvise poetry or solve some basic mathematical problems, it could be a better companion.

Now, changing the perspective one could imagine a dialog in which an important poet asks Sophia:

> *"Little dollface robot, / what will you make of yourself / in this world we are making?"*
>
> (Little robot, by Margaret Atwood)

The following could be a tentative answer:

> *"It's up to educators to teach our young people to care about each other and the world, so we can all work together to build a bright future for everyone."*
>
> (Sophia the Robot, Facebook, Thursday, 14 April 2022)

At this moment, there are four published papers (with a total of 61 pages) and a planned paper. We will list the published papers in alphabetical order, and we will give shorts abstracts for them. Finally, the planned paper is listed.

1. *Calin, O. "Statistics and Machine Learning Experiments in English and Romanian Poetry"*—23 pages, [1]

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Citation: Nichita, F.F. Mathematics and Poetry—Epilogue for a Special Issue. *Sci* **2022**, *4*, 19. https://doi.org/10.3390/sci4020019

Received: 18 April 2022
Accepted: 26 April 2022
Published: 12 May 2022

This paper presents a quantitative approach to poetry, based on the use of several statistical measures (entropy, informational energy, N-gram, etc.) applied to a few characteristic English writings. We found that the English language changes its entropy as time passes, and that entropy depends on the language used and on the author. In order to compare two similar texts, we were able to introduce a statistical method to asses the information entropy between two texts. We also introduced a method of computing the average information conveyed by a group of letters about the next letter in the text. We found a formula for computing the Shannon language entropy and we introduced the concept of N-gram informational energy of a poem. We also constructed a neural network, which is able to generate Byron-type poetry and to analyze the information's proximity to the genuine Byron poetry.

Keywords: entropy; Kullback–Leibler relative entropy; recurrent neural networks; machine learning

2. *Kalkan, T.; Nichita, F.F.; Oner, T.; Senturk, I.; Terzier, M. "Mathematics and Poetry · Yang–Baxter Equations, Boolean Algebras, and BCK–Algebras"*—5 pages, [2].

The potential of the areas between mathematics and poetry is explored. Some definitions and results needed for construction of solutions of the Yang–Baxter equation are recalled. A new duality principle is presented and Boolean coalgebras are introduced. A section on poetry dedicated to the Yang–Baxter equation is presented, and a discussion on a poem related to a mathematical formula follows. The final section presents conclusions and further information on the studied topics.

Keywords: Yang–Baxter equation; Boolean (co)algebra; BCK–algebra; poetry.

3. *Planat, M.; Aschheim, R.; Amaral, M.M.; Fang, F.; Irwin, K. "Graph Coverings for Investigating Non Local Structures in Proteins, Music and Poems"*—13 pages, [3].

Structural similarities in three different languages are explored (the protein language whose primary letters are the amino acids, the musical language whose primary letters are notes, and the poetry language whose primary letters are the alphabet). For proteins, the non local (secondary) letters are the types of foldings in space; for music, one is dealing with clear-cut repetition units called musical forms and for poems the structure consists of grammatical forms (names, verbs, etc.).

In this paper, it is shown that the mathematics of such secondary structures relies on certain finitely presented groups. The number of conjugacy classes of a given index of such a group (also the number of graph coverings over a base graph) are found to be close to the number of conjugacy classes of the same index of a free group.

In a concrete way,

- The group structure of a variant of the SARS-CoV-2 spike protein is explored;
- The musical forms employed in the classical and contemporary periods are studied;
- The group structure of a small poem in prose by Charles Baudelaire and that of the Bateau Ivre by Arthur Rimbaud are investigated.

Keywords: protein structure; musical forms; poetry; graph coverings; finitely generated groups; SARS-CoV-2; Arthur Rimbaud

4. *Nichita, F.F. "Mathematics and Poetry · Unification, Unity, Union"*—10 pages, [4]

We consider a multitude of topics in mathematics where unification constructions play an important role: the Yang–Baxter equation and its modified version, Euler's formula for dual numbers, means and their inequalities, topics in differential geometry, etc. It is interesting to observe that the idea of unification (unity and union) is also present in poetry. Moreover, Euler's identity is a source of inspiration for the post-modern poets.

Keywords: Yang–Baxter equation; Euler's formula; dual numbers; UJLA structures; classical means inequalities; poetry.

5. *Bucciarelli, R.; Bucciarelli, F.; Savarese G.; Tortoriello, F.S. "Dante Alighieri in Italian language linguistic analysis – Scientific validation of graphs"*—planned paper.

In the digital universe, a plurality of languages has led us to develop new communication models. This research consists of the following aspects:

(1) A study of the features of the cantiches of Dante Alighieri's Divine Comedy interpolated with a focus on classical texts in Latin and Greek to find points of contact in style and rhetoric and then explain linguistic mechanisms through phonetic and syntactic morph analysis of the chosen traits, performed by a team of experts;
(2) Language environments for the production of automated features and automatic similarity processing;
(3) Implementation of the Digital Intelligence W. Tool, a latest-generation software technology.

The Special Issue "Mathematics and Poetry, with a View towards Machine Learning" could be considered a success.

From the qualitative point of view, the authors, affiliated to important institutions (from three continents), made significant contributions on a seemingly difficult theme.

For example, some structural similarities in three different languages were explored: the protein language, the musical language, and the poetry language (these could lead to further philosophical discussions). Moreover, experiments to generate poetry using machine learning techniques were shown to be successful, and poems related to the mathematical universe were proposed.

New collaborations between mathematicians from different countries were initiated, and several theorems were appreciated and cited.

Some of these papers were also sent to important poets and writers, and we received positive feedback. Let us mention a book by Ruxandra Cesereanu, "Sophia Romania", which was published by the Max Blecher Publishing House in 2021.

From the quantitative point of view, out of eight submitted papers, four papers were already published, and a fifth paper will be published soon. Almost all the proposed keywords were used, and the total number of printed pages is expected to exceed 64 pages. So, we would like to recommend the publication of a printed volume of the Special Issue "Mathematics and Poetry, with a View towards Machine Learning" (similar to some related volumes [5–7]). Furthermore, we propose a continuation of this Special Issue, with a Special Issue on Mathematics and Literature.

Conflicts of Interest: The author declare no conflict of interest.

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