Finding the Punchline: On Applications of Graph Theory and Combinatorics in Canadian 'Pataphysical Poetry

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Abstract—Looking at the works of Canadian poets bpNichol and Christian Bök examined are the applications of graph theory and combinatorics to 'pataphysical poems. A 'pataphysical poem is one which is seen as poetry which mocks science. However, these poems require knowledge of mathematics on the part of the poet. An analysis of bpNichol's Sixteen Lilypads uses elements of graph theory and provides a new reading method. Given is the result that the poem Probable Systems 15 has no solution for a variety of chosen bases and theorizes about the implications this makes to seeing a poem as an equation. Further applications of mathematics and computers to the analysis of poetry are speculated upon.

Index Terms—Humanities, Combinatorial mathematics, Graph theory

I. INTRODUCTION

The use of computers and mathematics is an emerging area when it comes to the critical analysis of poems. Various examples of computer applications for the creation of poetry exist (e.g. [1], [2], and [3]). However critical analysis of poems via mathematical techniques is rather limited. The examples mostly have been made by poets with limited degrees of success of their adoption[4] or have automated analysis techniques which have already existed, such as concordances[5]. Concordances place analogous sentences or words together to assist in analysis of word choice and writing style. It is natural for their preparation to be automated for a large corpus of work. Beyond an ironic critical discourse called 'Pataphysical poetry, there is no literature about Canadian poems that uses mathematical techniques for analyzing the meaning of a poem or the intent of the poet. In order to show that mathematical methods can be applied to some Canadian poetry, applied are various methods to individual poems. The problem is addressed one poem at a time instead of using a large corpus because it extremely difficult to clearly and concisely translate the methodologies of such academically distant arts as computer science and poetry. Therefore, the dialogue instigated must be started with small pieces that professionals in multiple disciplines can understand. In the case of this paper, the relevance of graph theory to reading bpNichol's poem Sixteen Lilypads is addressed. Also, further analysis of another poem by bpNichol Probable System 15[6] will demonstrate how his corpus can be used to further develop our poem-by-poem approach to a multidisciplinary form of mathematical literary criticism.

II. BACKGROUND

'Pataphysical poetry provides a mocking look at science from the perspective of Canadian poets. Christian Bök[7] gives an excellent overview of current 'pataphysical thought and explains it as a joke which uses scientific and mathematical methods in order to mock the constraints that science places upon itself, mostly the philosophy of the existence of a truth. Scientists must respond to 'pataphysics with a more earnest application of mathematics. Therefore, these jokes can be examined and the scientist can find where the true science and mathematics is used in their construction. Ergo, scientists are finding the punchline expanding a multidisciplinary field for applied research.

The use of graph theory has not been undertaken for the literary analysis of poetry. However, a recent example of the application of graphs has been applied to creating rhyme graphs to be used for historical pronunciation reconstruction[8]. We will look at a poem which naturally transforms into a graph and then give a method of reading the poem which has not been explored by current literary critics due to knowledge constraints outside of their normal academic domain. In a previous work, Brown et al.[9] introduced bpNichol's use of alphametics, a letter puzzle, in his Probable Systems series of works. These results will be expanded upon for bpNichol as well as provide speculation about the works of Christian Bök which use alphametics.

We will provide some mathematical definitions for professionals and artists who wish to know how our methodology works on a disciplinary level.

A simple graph \( G(V, E) \) is a non-empty set \( V \) of vertices or nodes and a set \( E \) of unordered pairs of elements of \( V \), called edges. A subgraph \( G(V_s, E_s) \) is a graph where \( V_s \subseteq V \) and \( E_s \subseteq E \). An edge \( e \in E \) is said to be incident to a vertex \( v \in V \) if one of the elements in \( e \) is \( v \). A walk in a graph is an alternating sequence of vertices and edges, beginning and ending with a vertex, in which each edge is incident with the vertex immediately preceding it and the vertex immediately following it. A path is a walk in which each vertex is distinct. A Hamiltonian path is a path where each vertex is visited exactly once. See [10] for an introductory reference.

The idea of a cryptarithm and alphametic will be applied. Cryptarithms are mathematical games with arithmetical op-
Our problem is a multidisciplinary problem of poetic literary analysis and cryptography that the Canadian poet bpNichol suggested in the nineteen sixties. bpNichol argued in his essay Statement that “We have come up against the problem, the actual fact, of diversification, of finding as many exits as possible from the self (language/communication exits) in order to form as many entrances as possible for the other . . . The other [the reader] is the key, often for the need/desire to communicate”[12]. Based on many of his poems and his critical writing, we are convinced that bpNichol meant to include mathematical problems in his poetry as more than merely semantic riddles or ‘pataphysical jokes.

Using bpNichol’s terminology, then Sixteen Lilypads is a poem, and as a poem it is an exit from bpNichol’s self. Many patterned solutions in order to find an entrance where examined. That is to say, tried where multiple cryptographic approaches to read the poem in a way that we could argue communicates a meaning between the poet and us, who are readers with a mathematical lens for reading with graph theory. We are “the other” and we are going to use math to form entrances, because we are also “the key” reading like cryptographers. One successful attempt will be demonstrated “to reach [ourselves] and the other through the poem by as many exits and entrances as possible”[13]. Although, from now on, the terminology will be more of that of the mathematician or computer scientist, than bpNichol’s postmodern terminology.

Our hypothesis is that the key that bpNichol wants the other to find is actually a set of walks for imaginary frogs to follow. In graph theory the walks that bpNichol created are in fact Hamiltonian paths. Through the poem Sixteen Lilypads[14] we are readers who consider recognizing Hamiltonian paths as a legitimate response to bpNichol’s essay Statement[13]. Statement proposed a poetic that uses language interesting to our aesthetics and to mathematical theory. bpNichol expanded his ideas so that “[n]o matter where [the poet] moves or which ‘field’ he chooses to work in, he is always a poet and his creations can always be looked upon as poems.” This is taken to mean that bpNichol was inviting us to treat his poems with whatever disciplines the reader sees as necessary to reach an understanding. As an added layer of our analysis, the words “moves” and “fields” used by bpNichol become a pun in Sixteen Lilypads which can be read as a sort of visual pun where the word frog moves from one square field to another, losing or gaining letters as it moves.

In the case of a frog hopping across a swamp, a path can be seen being traced by how the frog would decide to hop on all of the lilypads, in that a graph’s vertices are lilypads and edges that mark the frog’s possible hops. Fig. 1 shows this transformation of the poem into a graph.

Note that read is a poem, about a word, that is four letters long; that word is frog. In this poem, the word is turned into the components of a graph that also represents the surface of a swamp. The square size and shape of the swamp-graph is determined by the size of the word frog. That frog has four letters is mathematically significant. For example, you could not use a three letter word or five letter word to create a square graph. If we have $n$ letters, we can choose to either use a letter for each position in the word frog, or we can substitute a letter with a question mark the way bpNichol has. The number of ways this can be done is $2^n$. This number must be a perfect square. If bpNichol had decided to use the word frogs instead of frog then there would be 32 arrangements of question marks and letters. The square root of 32 is not a natural number, i.e. 32 is not a perfect square, and so this poem cannot be created. The first three non-trivial integer amounts of letters for which such an arrangement could be made are: 2, 4, and 6 letters. For a poem, two is uninteresting and a 64 element grid would be rather large.

The following assumptions about how a frog moves in the swamp-graph are made. Two vertices in the graph are connected by the edge if a frog can move from one node to the other in either an orthogonal or diagonal hop. The graph is undirected as a frog is allowed to hop back and forth between lilypads unrestricted.

Hamiltonian Paths are plotted by reducing the poem into an undirected graph, followed by looking at the subgraph of each letter.

Each letter in frog has a corresponding frog. There is an $\ell$-frog that moves one lilypad at a time, a $r$-frog that moves...
one lilypad at a time, and so on. Each lettered frog can move
to each of its pads via a Hamiltonian path, see Fig. 2 for an
example of each letter. Note that there can be successful
Hamiltonian paths other than the ones shown.

B. Intentionality in Operation

Hamiltonian Paths were chosen as our preferred solution
because intentionality can be found in them. The intent found
mimics the movement of a frog that jumps to one lily pad at a
time. These paths cannot be found for each of the positions
as a question mark frog. The question mark letters \( r \) and
\( g \) each have at least one square which is entirely bounded
by the letter, see Fig 3, dark gray for \( r \) and light gray
for \( g \). The subgraphs that contain those question marks are
not connected and therefore no Hamiltonian paths can exist
for the question marks. The lack of a question mark path
therefore is a challenge to readers. The reader must decide
what the lack of a path means.

We posit that the lack of question mark paths proves in-
tentionality because frogs cannot leap to a non-frog pad or in
other words, \( f \)-frog cannot hop to \( ?r?g \) (Fig. 1 — the lower
right corner). Returning to using bpNichol’s terminology,
because unknowns \( ? \) prevent the us from finding a “key”
in the form of a pathway, a frog cannot be read appearing
there. Of course, this assuming that bpNichol means for the
\( ? \) to be read as the confusion or absence of language (the
confusion and absence of a frog). The \( ? \) is much like asterisks
protecting a password, or the \( ? \) in a regular expression
representing a wildcard. Given that the question marks in
the poem substitute or hide letters in \( \text{frog} \), this is a justified
critical reading.

The application of graphing techniques to \textit{Sixteen Lilypads}
is a similar fusion of mathematics and literary criticism
to what has been done by poets and cryptographers alike
for centuries, notably in the history of the I Ching\[15\].
The original King Wen arrangement of the I Ching from
circa 1100 BCE includes some patterns but the overall
arrangement is inscrutable. In 1060 CE, King Shao Yung had
an arrangement that was orderly and based on combinatorics;
so for the I Ching there is a lexicographical ordering. This
is an example of the 1060 CE editor of the I Ching to place
mathematical order on an otherwise chaotic or semantic,
esthetic arrangement of symbols. Looking at the bpNichol
poem we can find various partially successful aesthetic
patterns, e.g. the four corner locations are in juxtaposition
of their symbols. However, by finding a successful operational
view of the poem via Hamiltonian paths, we have moved
away from seeing an aesthetic but random arrangement like
the King Wen arrangement of the I Ching symbols and
toward seeing an aesthetic but intentional reading like the
King Yung arrangement.

\textit{Sixteen Lilypads} presents a two dimensional field and
a metaphorical frog that presents an exit from the poem
and encodes an entrance into bpNichol’s thought process.
Shown is a level of intentionality in the poem and this is
a solution which satisfies bpNichol’s condition that there is
“the need/desire to communicate” where Hamiltonian paths
provide a “key.”

IV. CRYPTARITHMS AND ALPHAMETICS

One interesting alphametic poem is bpNichol’s \textit{Probable
System 15}\[6\] which is a long division where symbols such
as women and churches take the place of numbers\(^1\). Though

\(^1\)Available online at http://archives.chbooks.com/online_books/zygal/68.html
our computer searches using the algorithm found in [16] and [9], we have found there exists no solutions for this poem in bases 8–12. Moving higher than this for a search would require an intolerable amount of computer processing based upon what bpNichol had at the time.

It fits better into the reading of Probable System 15 as 'pataphysics for there to be no solution, mocking the symbolism where we can do math with Arabic numerals but not with women or churches as seen in the original poem. There could be a solution in higher bases, however, it is Occam’s razor which saves us from this speculation. In making a mocking poem about long division it would be far more likely that a poet would create one which is not solvable in base 10 than to purposely make one in some higher base then check to ensure it doesn’t work in base 10. This unlikely use of base as part of a joke was also credited to the Hitchhiker’s Guide to the Galaxy[17] in which one of the characters makes a mistake of saying that $6 \times 9 = 42$. Readers pointed out that this is true, in base 13, $6_{13} \times 9_{13} = 42_{13}$. Douglas Adams is said to have responded to this observation with “I may be a sorry case, but I don’t believe jokes in base 13.” However, we also can show that bpNichol was mindful of the bases of number systems as shown though his 'pataphysical works. Probable Systems 9[18] uses a long division in the form of a based alphabet, what is assigning each letter as a base to a numerical system by the ordinal value of a letter. The Probable Systems series of poems is full of other allusions to such bases; number 15 is in many ways a pinnacle.

More applications to the findings of alphametics appear in the works of Christian Bök, a Canadian poet and critical theorist. His use of alphametics is seen in Crystallography[19] where there is not only uses of Cryptarithms (WORD = DIAMOND looking at the ordinal value of letters), but examples of Lewis Carroll’s method of changing one letter at a time to get another word. By looking at the frequencies of letters and at the chains of connections, such as the examples in [20], made in the graph we can discover a method of attaching a difficulty in the construction of such poems. That is how many paths are there between two words, or was the poem a longest path between words. These metrics might allow for statements not just about the meaning of the poem but about the construction, similar to the analysis of rhyming patterns or metre[21], which are both applications of permutations and combinations[15].

V. CONCLUSION

This analysis of Sixteen Lilypads and Probable Systems 15 suggests that bpNichol’s literary criticism contains references to mathematical concepts that have been unexpected in traditional literary scholarship. His poetry and the poems he influenced are sites for mathematicians to begin contributing more seriously to literary theory and discussions of Canadian literature. Conversely, the methods for analysis and level of mathematical engagement that we applied to our reading of Sixteen Lilypads are likely part of a quiet, ongoing human-istic dialogue between poets, literary critics, mathematicians and computer scientists.

By operationalizing the way the four letter word frog can be graphed, the poem Sixteen Lilypads by the Canadian poet bpNichol can be analyzed. The meaning of the poem is that of the paths through the graph, which shows connections between bpNichol’s poetry and graph theory.

Canadian 'pataphysical works can have interesting mathematical techniques used in their construction. Current literary criticism has ignored this fact for the most part and has been focused on the ‘meaning’ of a poem as it is viewed. However, by not looking at the method of construction, they have missed parts of the meaning, e.g. the hopping frog. For the analysis of these poems, the request of contributions by mathematicians or computer scientists is necessary.

REFERENCES