Journal of Humanistic Mathematics

Volume 4 | Issue 2 July 2014

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Recommended Citation

Pinter, M. "How Do I Love Thee? Let Me Count the Ways for Syllabic Variation in Certain Poetic Forms," *Journal of Humanistic Mathematics*, Volume 4 Issue 2 (July 2014), pages 94-100. DOI: 10.5642/jhummath.201402.10 . Available at: https://scholarship.claremont.edu/jhm/vol4/iss2/10

How Do I Love Thee? Let Me Count the Ways for Syllabic Variation in Certain Poetic Forms

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Synopsis

The Dekaaz poetic form, similar to haiku with its constrained syllable counts per line, invites a connection between poetry and mathematics. Determining the number of possible Dekaaz variations leads to some interesting counting observations. We discuss two different ways to count the number of possible Dekaaz variations, one using a binary framework and the other approaching the count as an occupancy problem. The counting methods described are generalized to also count variations of other poetic forms with syllable counts specified, including haiku. We include Dekaaz examples and suggest a method that can be used to randomly generate a Dekaaz variation.

1. Introduction

While staying with my wife Robbie (who is an English Professor at Belmont) as she attended the annual Conference on College Composition and Communication in St. Louis during March 2012, I came across a pamphlet about a new poetic form called Dekaaz. The poetic form immediately interested me because it involved a specific syllable count per line. Whereas the haiku poetic form consists of three lines, with five syllables in the first and third lines and seven syllables in the second line, the Dekaaz form consists of three lines, with exactly two syllables in the first line, exactly three syllables in the second line, and exactly five syllables in the third line. Each line can contain one or more words.

For a few math examples, consider the following forms (the first two of which are Dekaaz and the third is a haiku).

Base two.
Binary.
One zero is two.

Zero.
Infinite.
All between we count.

Calculus topics.
Derivatives. Integrals.
Infinite series.

I was drawn in further by the claim made in the Dekaaz pamphlet that "*the possible combinations of single and multiple syllable words result in 128 possible variations.*" After convincing myself this claim was correct and that binomial coefficients were involved, I decided to pose the claim as a problem for our monthly Problem Solving Competition at Belmont along with a similar problem about the number of haiku variations. I eventually did submit the problems in February 2013. Other than that, I had not thought more deeply about the problem for about a year.

Our Problem Solving Competition problems are also posted on our website. For this reason the problem somehow came to the attention of Rachel Bagby, the person who created the Dekaaz form [1]. She contacted my wife about the problem (presumably because Robbie is an English Professor at Belmont), and my wife passed the contact along to me. After communicating with Ms. Bagby on several occasions throughout 2013, my interest in the problem deepened. I was also teaching a Combinatorics course during Spring 2013, so this provided more fuel for my pursuit. As a result, I will offer some observations about insights I gained from exploring the problem.

2. The Dekaaz Claim

I will provide two different ways to verify the claim made in the Dekaaz pamphlet, namely that "*the possible combinations of single and multiple syllable words result in 128 possible variations.*" I will also generalize the claim so that it applies to any number of lines with a specified number of syllables per line, including haiku variations specifically.

Proof I

Our first approach involves the use of bit strings. The idea for this approach was presented by Jack Streeter, one of my Combinatorics students in Spring 2013, as part of his solution to the posed problem. We represent the syllable structure of the words in a line of Dekaaz by a bit string where:

$$\begin{cases} \text{1 is the first syllable in a word, and} \\ \text{0 is a second or later following syllable in the same word.} \end{cases}$$

So, for example, we have the following:

10 is a two-syllable word

100 is a three-syllable word

1010010 is a line containing a two-syllable word, followed by a three-syllable word, and ending with a two-syllable word.

Thus, for an n-syllable line in a Dekaaz or Haiku (or any other form with specified number of syllables in a given line), the first bit will always be 1 and the remaining $n-1$ bits can be either 0 or 1. It follows that a line containing n syllables has 2^{n-1} possible variations.

Therefore, we have the following results:

(i) The total number of possible Dekaaz variations is $2^1 \times 2^2 \times 2^4 = 2^7$.

(ii) The total number of possible Haiku variations is $2^4 \times 2^6 \times 2^4 = 2^{14}$.

(iii) More generally, if there are k lines in the poem with a total of m syllables, the number of possible variations is 2^{m-k}.

Proof II

The second approach considers the syllable variations as an occupancy problem from combinatorics. For example, see [2]. In particular, we are placing identical objects (syllables) into distinct cells (words). We consider the cells distinct because a 4-syllable word followed by a 3-syllable word is different from a 3-syllable word followed by a 4-syllable word. Identical objects placed in distinct cells is Case 2 of the occupancy problems presented in [2]. Therefore, we count using combinations with repeats allowed.

Following the notation from [2], we will use $C(k, n)$ to denote *combinations*; in other words, $C(k, n)$ is the standard binary coefficient that counts the number of ways for selecting n distinct objects from a pool of k distinct objects. Similarly, we will use $C^R(k,n)$ to denote *combinations with repetition*; in other words, $C^R(k,n)$ will count the number of ways for selecting n objects from a pool of k distinct types of objects, with unlimited repetition of objects of any type allowed in a selection. Note that $C^R(k,n) = C(k+n-1,n)$.

For example, let us count the number of ways to have a line with seven syllables. The line will contain j words, with $1 \leq j \leq 7$. Thus, we are placing 7 identical objects into j distinct cells, with no cells left empty. For $j = 1, 2, \dots, 7$, we have:

$$\sum_{j=1}^{7} C^R(j, 7-j) = \sum_{j=1}^{7} C(6, 7-j) = \sum_{j=1}^{7} C(6, j-1) = \sum_{j=0}^{6} C(6, j) = 2^6.$$

For a line with n syllables and j words, we have $1 \leq j \leq n$, and

$$\begin{aligned}
\sum_{j=1}^{n} C^R(j, n-j) &= \sum_{j=1}^{n} C(n-1, n-j) \\
&= \sum_{j=1}^{n} C(n-1, j-1) \\
&= \sum_{j=0}^{n-1} C(n-1, j) \\
&= 2^{n-1}.
\end{aligned}$$

As in Proof I, we conclude that there are 2^7 Dekaaz variations, 2^{14} Haiku variations, and 2^{m-k} variations for a poem with k lines and m total syllables.

3. To Another Level?

The approach to counting described in Proof I suggests a way to randomly generate a Dekaaz variation by repeatedly flipping a fair coin. Each of the three lines, written as a binary string, will begin with 1. The remaining bits could then be determined by coin tosses. Say, for example, that we had the following sequence of coin toss outcomes:

First line:	$Heads$
Second line:	$Tails, Tails$
Third line:	$Heads, Tails, Heads, Heads$

Using the convention that $Heads = 1$ and $Tails = 0$, we would have generated the Dekaaz form:

First line:	1 1	(two one-syllable words)
Second line:	1 0 0	(a three-syllable word)
Third line:	1 1 0 1 1	(a one-syllable word followed by a two-syllable word followed by two one-syllable words)

The first example given in Section 1 above,

Base two.
Binary.
One zero is two.

has the indicated form. More generally, after a form is generated by coin tosses, then "participants" could be asked to write a Dekaaz with the generated form.

As director of the Teaching Center at Belmont, I have the opportunity to work with faculty members from across campus, including during our New Faculty Orientation. I intend to develop a group exercise where we will randomly generate Dekaaz forms and then write examples for whatever forms arise. Given that a Dekaaz is relatively easy to write (at least in terms of meeting the syllable and line requirements), the activity can serve as somewhat of an icebreaker and also provide an opportunity for all involved to present their "voice" in some small way. I believe this activity could also be used with groups of just about any kind (students, church groups, and so on).

The next example caused me to branch in a different direction:

Repeat.
Unending.
Repeat unending.

The syllable count structure of the Dekaaz form suggests a potential for recursion. We can imagine a fractal Dekaaz structure

A B
C D E
F G H I J

where each of A,B,C,D,E,F,G,H,I, and J is a Dekaaz. In other words, there is a meta-Dekaaz structure holding together ten individual Dekaaz. With a total of 30 lines and 100 syllables, we see from our work above that the number of possible variations here is $2^{100-30} = 2^{70}$. To this day, I have created only one example of this meta-form; the example, associated with a current popular book and film, incorporates neither mathematical ideas nor mathematical language.

4. Conclusion

If you like to count, and who doesn't, then the Dekaaz form is inviting to play with. If you have or will create Dekaaz examples, then you will want to consider an important point from Rachel Bagby. She indicates that speaking the written Dekaaz out loud to another living being is an essential step of Dekaaz creation — without it, the Dekaaz process is incomplete because it did not live in the voice as well as in the mind [1].

> Dekaaz and Haiku.
> Two, three, five. Five, seven, five.
> Count the syllables.
>
> Pascal.
> Triangle.
> Hidden in Dekaaz.
>
> Counting.
> Poetry.
> Both mathematics.
>
> Dekaaz.
> Speak it out.
> Mind and voice combine.

Acknowledgments

I am grateful to Rachel Bagby for spending time communicating with me by email and telephone. The more we talked, the more interested I became in digging deeper.

I am also grateful to my wife Robbie for the spirit of writing that she has constantly provided me and for helping me to see that poetry and mathematics have a great deal in common and much to offer each other.

References

[1] Rachel Bagby, *Bless Your Voice. Be the Song.* available at http://rachelbagby.com/dekaaz/, accessed May 1, 2014.

[2] Fred Roberts and Barry Tesman, *Applied Combinatorics*, Second Edition, Chapman and Hall/CRC, Boca Raton FL, 2008.

Author Biography

Mike Pinter has been in the Department of Mathematics and Computer Science at Belmont University since 1989. His primary teaching assignments include *Discrete Mathematics*, *Combinatorics*, *Introduction to Mathematical Reasoning* (offered as a Learning Community course linked with Introduction to Psychological Sciences), and *Analytics: Math Models* (the general education mathematics course for Honors Program students). Mike currently serves as the Director of the Belmont University Teaching Center.