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Application of SVD: Information Retrieval and Document Ranking

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Abstract

Information retrieval is the process of searching for information within a collection of documents most relevant to a user's query. Information retrieval algorithms are being used in many public libraries including university libraries to provide their patrons with access to books and documents. Web search engines are the most prevalent information retrieval applications. A certain form of vector space method was introduced and developed by analyzing so called term-by-document matrices as early as 1960. In the 1990s, an improved information retrieval system, latent semantic indexing (LSI), replaced the vector space model. It uses the singular value decomposition (SVD) of the term-by-document matrix and creates a low rank approximation from the SVD. This study will investigate the efficiency of the SVD as a search method by measuring accuracy after the approximation has been completed.

1 Introduction

Big data is an unavoidable obstacle for a mathematician in the 21st century. The process of efficiently and effectively analyzing big data sets has become increasingly important in a variety of scenarios: whether that be information a doctor receives from a wearable device that monitors glucose levels, the influence of social media in presidential elections, or, in our case, searching for documents in a large database. The technique we employ to deconstruct our data matrix into manageable pieces is the sin-

gular value decomposition. The end goal is to maintain the accuracy of a search within a large database while simultaneously making the search faster, more economical, and use less storage.

Structuring the Data

We begin by introducing a few definitions that will be used

Definition 1 A term by document matrix is a matrix of 1s and 0s whose rows represent terms in the title of a document and whose columns represent the documents themselves. If a 1 appears in position i, j , then term i is present in the title of document j .

Definition 2 The index of a term by document matrix is the set of terms that are chosen to represent the rows of the matrix. A streamlined index for the term by document matrix is crucial for an efficient search.

Definition 3 Deconstructing a word by removing suffixes, and occasionally prefixes, is a process called stemming.

The removal of frequently used words and articles as well as the mapping of words with affixes to their root words, *stemming*, will drastically reduce the size of your matrix and improve your search results in the end. This streamlining step is essential to the method of latent semantic indexing, which will be discussed in greater detail after we have built our matrix. Our matrix comes from a small library of ten books. Our index, after stemming, will consist of twelve terms. For example, the 3rd column represents *Linear Algebra and Its Applications, 4th Edition* by Gilbert Strang[3]; however, in the matrix it reads something like *Linear Algebra Apply 4th*. As you can see, the words *and*, *its*, and *edition* are removed from the title while the word *applications* has been mapped to the word *apply* in our term list. This is the matrix we will use throughout this article:

$$A = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 1 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

The Geometry of the Search

Definition 4 A document vector corresponds to a column vector in the term by document matrix. That is, each column of a term by document matrix matches to a document from the library from which the matrix was built.

The columns of an $m \times n$ term by document matrix can be viewed as n vectors inside of an m -dimensional space. The idea is simple, vectors (or documents) that point in the same direction have more words in common. A search of the data can also be viewed as a query vector, q , in the same space:

$$q = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \end{bmatrix}$$

Note that q is the book *Linear Algebra and Its Applications* in our matrix A . In effect, we are searching our small database for this book and related

books. The cosine of the angle between each of document vector, d_i , and q is calculated by solving the inner product formula explicitly for the cosine of the angle between the two vectors:

$$\begin{aligned} \|\mathbf{q}\|_2 \|\mathbf{d}_i\|_2 \cos \theta_i &= \mathbf{q}^T \mathbf{d}_i \\ \Rightarrow \cos \theta_i &= \frac{\mathbf{q}^T \mathbf{d}_i}{\|\mathbf{q}\|_2 \|\mathbf{d}_i\|_2}. \end{aligned}$$

The cosine of the angle between d_i and q will be called δ_i so that

$$\delta_i = \cos \theta_i = \frac{\mathbf{q}^T \mathbf{d}_i}{\|\mathbf{q}\|_2 \|\mathbf{d}_i\|_2}.$$

The δ_i values are placed into a row vector, δ , with each entry possessing values between 1 and 0. A δ -value of 1 means the query is the same as the document while 0 means d_i and q have no relation or are orthogonal. In essence, this is how to search a database for documents and rank them by their relevance to a query using the vector space method. These δ -values also allow for the implementation of a user tunable parameter which allows the user to broaden or narrow their search.

Latent Semantic Indexing

The Singular Value Decomposition (SVD) of a matrix is the essential tool for document ranking with LSI.[3],[1]

Theorem 1 Every $m \times n$ matrix A has a factorization in the form of $A = USV^T$, where U is an $m \times m$ orthogonal matrix of left-singular vectors, S is an $m \times n$ diagonal matrix containing the singular values, and V is an $n \times n$ orthogonal matrix of right-singular vectors. This is called the singular value decomposition (SVD) of a matrix. The singular values are the real, square roots of the eigenvalues belonging to both AA^T and $A^T A$ and the left- and right-singular vectors are the real-valued eigenvectors corresponding to the singular values in AA^T and $A^T A$ respectively.

Definition 5 Latent semantic indexing (LSI) is the application of the SVD specifically to a term by document matrix.

The SVD breaks a matrix down into three new matrices: U is the collection of left-singular column vectors, S is the collection of singular values ordered from greatest to least along the main diagonal, and V is the collection of right-singular column vectors. The vectors in U and V are ordered

$$S_3 = \begin{bmatrix} 2.102 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1.474 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1.052 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

By multiplying U , S_3 , and V^T back together we have a new, very dense matrix, A_3 , that now requires storage for double-precision data instead of 1s and 0s. This is known as a matrix's low-rank approximation. A quick note is that a *sparse* matrix is a matrix with a majority of the entries zero. A *dense* matrix is not sparse. If we were to store A_3 in its entirety we would actually increase the space required to store the matrix quite dramatically. For this reason, we choose to keep A_3 in the form of a sum of rank-1 matrices where the storage saving capabilities of the SVD are apparent. By keeping A_3 in this form, we minimize the amount of storage the matrix takes. Our original matrix, A , has been reduced to a rank-3 approximate form:

$$A_3 = \sigma_1 u_1 v_1^T + \sigma_2 u_2 v_2^T + \sigma_3 u_3 v_3^T$$

Where σ_i is the i^{th} singular value. The question remains, did A_3 retain enough information to produce effective searches? We searched our data with the original matrix, A , and query vector, q , and got these δ -values:

$$\delta = [.204 \ .289 \ 1 \ 0 \ .224 \ .816 \ 0 \ .224 \ .577 \ .447]$$

Notice the δ -values in the 3rd, 6th, and 9th positions (the three closest documents to our search). Finally, we search the new rank-3 matrix after latent semantic indexing and truncation:

$$\delta_3 = [.270 \ .206 \ .903 \ .090 \ .282 \ .896 \ -.054 \ .321 \ .857 \ .479]$$

The same three documents are returned in our search (and in the same order)!

Conclusion

It should be noted that the storage savings only come after we represent A as a sum of rank-1 matrices and is even more apparent when the database is much larger (think library sized). There is also shift after LSI from a matrix that is focused on local term weight to a matrix that is focused on global term weight; that is to say it matters less how important a term is to locating a specific document and it matters more how relevant a term is globally. What is the take away? The SVD is the poster-child for big data management; it extracts vital information from a matrix and ranks the information in order of importance all while presenting the data in an compact and concise way. We have achieved our end goal: retaining search accuracy while making a search more economical and reducing storage required to search a large database.

References

- [1] Berry, Micheal W. and Murray Brown. *Understanding Search Engines: Mathematical Modeling and Text Retrieval*, Murray Brown, 2005.
- [2] Langville, Amy N. and Carl D. Meyer. *Information and Web Search*, The Handbook of Linear Algebra, Edited by Leslie Hogben et al. Boca Raton: Chapman & Hall/CRC, 2007, pp. 63-1 – 63-14.
- [3] Gilbert Strang, *Linear Algebra and Its Applications*, 4th edition, Brook/Cole, 2006
- [4] <https://www.cs.cmu.edu/~venkatg/teaching/CStheory-infoage/book-chapter-4.pdf>

A Class of Inequalities in a Triangle with Cevians

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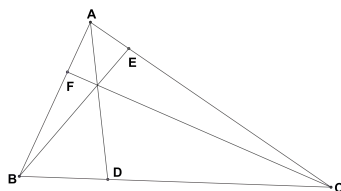
Abstract

In this paper we develop a few inequalities in a triangle with cevians in a general way and then in particular for specific centers of a triangle.

A *cevia* is a segment between a vertex of a triangle and a point which lies on the side opposite to that vertex, named after Giovanni Ceva (1647-1736) who published the following theorem in 1678 [2]:

Theorem 2 (Ceva) *In any triangle ABC , if AD, BE, CF are concurrent cevians then:*

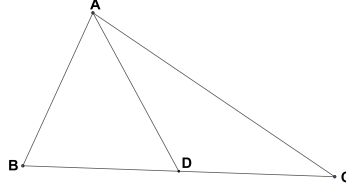
$$\frac{BD}{DC} \cdot \frac{CE}{EA} \cdot \frac{AF}{FB} = 1.$$



Here *concurrent* means that the three cevians intersect at a common point. In fact, the converse is also true: if $\frac{BD}{DC} \cdot \frac{CE}{EA} \cdot \frac{AF}{FB} = 1$, then the cevians are concurrent. Another important theorem we will use is due to Matthew Stewart:

Theorem 3 (Stewart) *If AD is a cevian in $\triangle ABC$ then:*

$$AD^2 \cdot BC = AB^2 \cdot DC + AC^2 \cdot BD - BD \cdot DC \cdot BC.$$



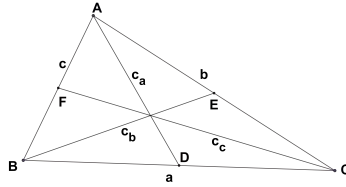
Finally, we recall the **Arithmetic-Geometric-Harmonic means inequality**: If $x, y > 0$ then:

$$\frac{2}{\frac{1}{x} + \frac{1}{y}} \stackrel{HM-GM}{\leq} \sqrt{xy} \stackrel{GM-AM}{\leq} \frac{x+y}{2}.$$

Our main result is the following:

Theorem 4 *In triangle ABC , let $D \in \overline{BC}$, $E \in \overline{AC}$, $F \in \overline{AB}$, be such that $BD = mDC$, $CE = nAE$, $AF = pBF$, for some $m, n, p > 1$, and let $AD = c_a$; $BE = c_b$, $CF = c_c$. Then:*

$$\frac{c_a c_b c_c}{(c^2 + mb^2)(a^2 + nc^2)(b^2 + pa^2)} < \frac{(m+1)(n+1)(p+1)}{64abc mnp}.$$



Proof. By Stewart's theorem we have:

$$AD^2 \cdot a = c^2 \cdot DC + b^2 \cdot BD - BD \cdot DC \cdot a. \quad (1)$$

Now, $BD + DC = a$ and $m \cdot DC + DC = a$ so that $DC = \frac{a}{m+1}$ and $BD = \frac{ma}{m+1}$. Substituting these into (1) we have:

$$AD^2 \cdot a = c^2 \cdot \frac{a}{m+1} + b^2 \cdot \frac{ma}{m+1} - \frac{a}{m+1} \cdot \frac{ma}{m+1} \cdot a.$$

Replacing AD by c_a in this last and then dividing by a , yields:

$$c_a^2 = \frac{c^2}{m+1} + \frac{b^2 m}{m+1} - \frac{ma^2}{(m+1)^2},$$

or

$$\frac{c^2 + b^2m}{m+1} = c_a^2 + \frac{ma^2}{(m+1)^2}.$$

From the AM-GM inequality we have

$$c_a^2 + \frac{ma^2}{(m+1)^2} > 2\sqrt{\frac{c_a^2 ma^2}{(m+1)^2}} = \frac{2ac_a}{m+1} \cdot \sqrt{m},$$

and by the GM-HM inequality:

$$\frac{2ac_a}{m+1} \cdot \sqrt{m} \geq \frac{2ac_a}{m+1} \cdot \frac{2}{1 + \frac{1}{m}} = \frac{4ac_a \cdot m}{(m+1)^2}.$$

Thus $\frac{c^2 + b^2m}{m+1} > \frac{4ac_a \cdot m}{(m+1)^2}$ or

$$\frac{c_a}{c^2 + mb^2} < \frac{m+1}{4am}. \quad (2)$$

Analogously:

$$\frac{c_b}{a^2 + nc^2} < \frac{n+1}{4bn} \quad (3)$$

and

$$\frac{c_c}{b^2 + pa^2} < \frac{p+1}{4cp}. \quad (4)$$

Therefore, by multiplying (2), (3) and (4)

$$\frac{c_a c_b c_c}{(c^2 + mb^2)(a^2 + nc^2)(b^2 + pa^2)} < \frac{(m+1)(n+1)(p+1)}{64abc mnp}.$$

■

Corollary 1 If $AD \cap BE \cap CF \neq \emptyset$ then:

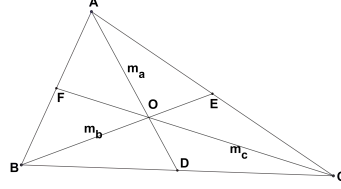
$$\frac{c_a c_b c_c}{(c^2 + mb^2)(a^2 + nc^2)(b^2 + pa^2)} < \frac{(m+1)(n+1)(p+1)}{64abc}.$$

Proof. By Ceva's theorem:

$$\frac{BD}{DC} \cdot \frac{CE}{AE} \cdot \frac{AF}{FB} = 1 \Rightarrow mnp = 1.$$

The result follows by replacing mnp by 1 in Theorem 3. ■

We now consider results of Theorem 1 that follow by considering specific notions of the “center” of a triangle. We begin with the *centroid* O, the common point of intersection between the medians of the triangle.



Corollary 2 In any triangle ABC the following relationship holds:

$$8abcm_am_bm_c < (a^2 + b^2)(b^2 + c^2)(c^2 + a^2),$$

where m_a, m_b , and m_c are the medians of $\triangle ABC$.

Proof. It is known that when $m = m = p = 1$ the cevians intersect at the centroid [1]. Thus $m_a = c_a, m_b = c_b$ and $m_c = c_c$ so, by Corollary 1,

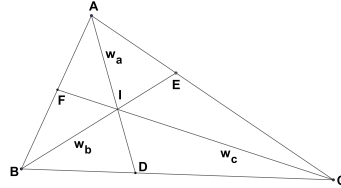
$$\frac{m_am_bm_c}{(c^2 + b^2)(a^2 + c^2)(b^2 + a^2)} < \frac{(1+1)(1+1)(1+1)}{64abc}$$

so that

$$8abcm_am_bm_c < (a^2 + b^2)(b^2 + c^2)(c^2 + a^2).$$

■

Another common notion of center for a triangle is the *incenter* I , the intersection of the angle bisectors of the triangle.



Corollary 3 In any triangle ABC the following relationship holds:

$$64abcw_aw_bw_c < (a+b)^2(b+c)^2(c+a)^2,$$

where w_a, w_b , and w_c are the lengths of the bisectors of $\triangle ABC$.

Proof. It is known that for the incenter, $m = \frac{c}{b}; n = \frac{a}{c}; p = \frac{b}{a}$ [1]. Setting $c_a = w_a, c_b = w_b$ and $c_c = w_c$ in Corollary 1,

$$\frac{w_aw_bw_c}{(c^2 + \frac{c}{b} \cdot b^2)(a^2 + \frac{a}{c} \cdot c^2)(b^2 + \frac{b}{a} \cdot a^2)} < \frac{(\frac{c}{b} + 1)(\frac{a}{c} + 1)(\frac{b}{a} + 1)}{64abc}$$

or

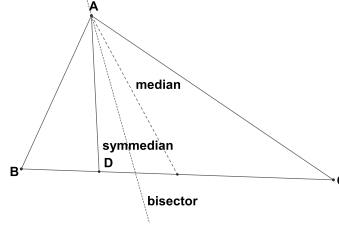
$$\frac{w_aw_bw_c}{abc(c+b)(a+c)(b+a)} < \frac{(c+b)(a+c)(b+a)}{64a^2b^2c^2}.$$

Therefore

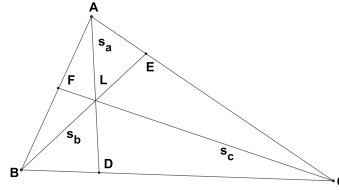
$$64abcw_a w_b w_c < (a+b)^2(b+c)^2(c+a)^2.$$

■

A *symmedian* of a triangle is formed by taking a median and reflecting it across the angle bisector from the same vertex.



Lemoine's point L is defined to be the intersection of the three symmedians of the triangle.



Corollary 4 In any triangle ABC the following relationship holds:

$$8abcs_a s_b s_c < (b^2 + c^2)(a^2 + c^2)(b^2 + a^2)$$

where s_a , s_b , and s_c are the lengths of the symmediands.

Proof. For Lemoine's point we have $m = \frac{c^2}{b^2}$, $n = \frac{a^2}{c^2}$ and $p = \frac{b^2}{a^2}$ [1] so, by Corollary 2,

$$\frac{s_a s_b s_c}{(c^2 + \frac{c^2}{b^2} \cdot b^2)(a^2 + \frac{a^2}{c^2} \cdot c^2)(b^2 + \frac{b^2}{a^2} \cdot a^2)} < \frac{(\frac{c^2}{b^2} + 1)(\frac{a^2}{c^2} + 1)(\frac{b^2}{a^2} + 1)}{64abc}$$

or

$$\frac{s_a s_b s_c}{2c^2 \cdot 2a^2 \cdot 2b^2} < \frac{\frac{c^2+b^2}{b^2} \cdot \frac{a^2+c^2}{c^2} \cdot \frac{b^2+a^2}{a^2}}{64abc}$$

and hence

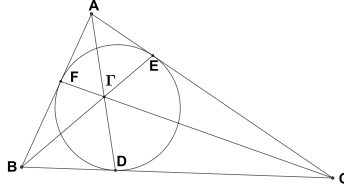
$$8abcs_a s_b s_c < (b^2 + c^2)(a^2 + c^2)(b^2 + a^2).$$

■

Remark. Using $s_a \leq m_a$, $s_b \leq m_b$, $s_c \leq m_c$ and Corollary 2:

$$8abcs_a s_b s_c \leq 8abcm_a m_b m_c < \prod (b^2 + c^2).$$

The *Gergonne point* Γ of a triangle is the point of intersection of the cevians to the points of tangency of the inscribed circle with the sides of the triangle.



Corollary 5 If $AD \cap BE \cap CF = \{\Gamma\}$, the Gergonne's point in triangle ABC , then:

$$\frac{AD \cdot BE \cdot CF}{\prod (s(b^2 + c^2) - bc(c + b))} < \frac{s^2}{64S^4}.$$

Proof. It is shown in [1] that for Gergonne's point $m = \frac{s-c}{s-b}$, $n = \frac{s-a}{s-c}$ and $p = \frac{s-b}{s-a}$ where $s = \frac{a+b+c}{2}$ is the semiperimeter of the triangle and S is the area. From Corollary 1 we have

$$\begin{aligned} \frac{AD \cdot BE \cdot CF}{\prod (c^2 + \frac{s-c}{s-b}b^2)} &< \frac{\prod (\frac{s-c}{s-b} + 1)}{64abc} = \frac{\prod (\frac{s-c+s-b}{s-b})}{64abc} \\ &= \frac{\prod (\frac{a}{s-b})}{64abc} = \frac{1}{64 \prod (s-b)}. \end{aligned}$$

Therefore

$$\frac{AD \cdot BE \cdot CF}{\prod ((s-b)c^2 + (s-c)b^2) \cdot \prod (\frac{1}{s-b})} < \frac{1}{64 \prod (s-b)}$$

so that

$$\begin{aligned} \frac{AD \cdot BE \cdot CF}{\prod (s(b^2 + c^2) - bc(c + b))} &< \frac{1}{64 \prod (s-b)^2} \\ &= \frac{1}{64} \cdot \frac{s^2}{s^2 \prod (s-b)^2}. \end{aligned}$$

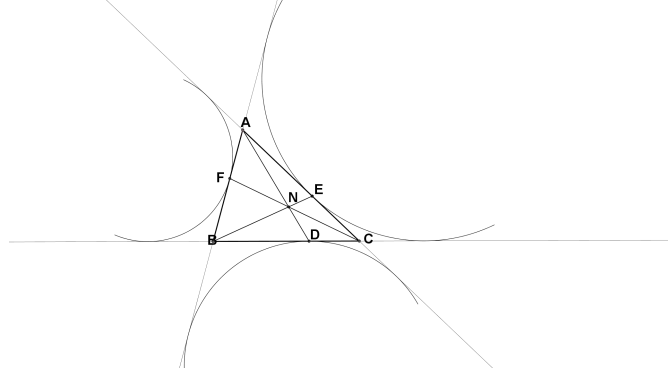
Using Heron's formula: $S = \sqrt{s(s-a)(s-b)(s-c)}$,

$$\frac{1}{64} \cdot \frac{s^2}{s^2 \prod (s-b)^2} = \frac{s^2}{64S^4}.$$

■

Nagel's point N is the point of intersection between the cevians formed by connecting each vertex to the point of tangency of the excircle at the

opposite side.



Corollary 6 If $AD \cap BE \cap CF = \{N\}$, the Nagel's point in triangle ABC , then:

$$\frac{AD \cdot BE \cdot CF}{\prod (s(b^2 + c^2) - bc(b + c))} < \frac{s^2}{64S^4}.$$

Proof. For Nagel's point, $m = \frac{s-c}{s-b}$, $n = \frac{s-a}{s-c}$ and $p = \frac{s-b}{s-a}$ [1]. Then, from Corollary 1,

$$\frac{AD \cdot BE \cdot CF}{\prod (c^2 + \frac{s-c}{s-b}b^2)} < \frac{\prod (\frac{s-c}{s-b} + 1)}{64abc}.$$

Hence

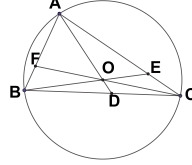
$$\begin{aligned} \frac{AD \cdot BE \cdot CF}{\prod (c^2(s-b) + b^2(s-c))} &< \frac{\prod (\frac{s-c+s-b}{s-b})}{64abc} \\ &= \frac{\prod (\frac{a}{s-b})}{64abc} = \frac{1}{64 \prod (s-b)}. \end{aligned}$$

Therefore, as in the previous corollary,

$$\begin{aligned} \frac{AD \cdot BE \cdot CF}{\prod (s(b^2 + c^2) - bc(c + b))} &< \frac{1}{64 \prod (s-b)^2} \\ &= \frac{1}{64} \cdot \frac{s^2}{s^2 \prod (s-b)^2} = \frac{s^2}{64S^4}. \end{aligned}$$

■

The *circumcentre* O of a triangle is the intersection of the segments from each vertex through the center of its circumcircle.



Corollary 7 In any acute triangle $\triangle ABC$ with $AD \cap BE \cap CF = \{O\}$, the circumcentre, the following relationship holds:

$$\frac{AD \cdot BE \cdot CF}{\prod (c^2 \sin 2B + b^2 \sin 2C)} < \frac{1}{64abc} \prod \left(\frac{\sin 2A + \sin 2C}{\sin^2 2B} \right).$$

Proof. In an acute triangle it is known that $m = \frac{\sin 2C}{\sin 2B}$, $n = \frac{\sin 2A}{\sin 2C}$ and $p = \frac{\sin 2B}{\sin 2A}$ [1]. Substituting these into Corollary 1 we have:

$$\frac{AD \cdot BE \cdot CF}{\prod (c^2 + \frac{b^2 \sin 2C}{\sin 2B})} < \frac{\prod (\frac{\sin 2C}{\sin 2B} + 1)}{64abc}.$$

so

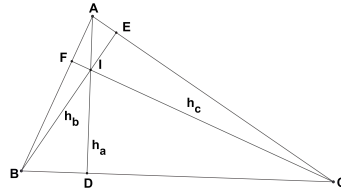
$$\begin{aligned} & \frac{AD \cdot BE \cdot CF}{\prod (c^2 \sin 2B + b^2 \sin 2C) \cdot \prod (\frac{1}{\sin 2B})} \\ & < \frac{1}{64abc} \prod (\sin 2B + \sin 2C) \cdot \prod (\frac{1}{\sin 2B}) \end{aligned}$$

and hence

$$\frac{AD \cdot BE \cdot CF}{\prod (c^2 \sin 2B + b^2 \sin 2C)} < \frac{1}{64abc} \prod \left(\frac{\sin 2A + \sin 2C}{\sin^2 2B} \right).$$

■

Finally, the *orthocentre* I of a triangle is the intersection of the three altitudes of the triangle.



Corollary 8 In any acute triangle $\triangle ABC$ the following relationship holds:

$$64abc \prod \left(\frac{h_a}{c^2 \tan B + b^2 \tan C} \right) < \prod \cot A (\tan B + \tan C).$$

Proof. In an acute triangle it is known that $m = \frac{\tan C}{\tan B}$, $n = \frac{\tan A}{\tan C}$ and $p = \frac{\tan B}{\tan A}$ [1]. Let $c_a = h_a$, $c_b = h_b$ and $c_c = h_c$. From Corollary 1

$$\begin{aligned} & \frac{h_a h_b h_c}{(c^2 + \frac{\tan C}{\tan B} b^2)(a^2 + \frac{\tan A}{\tan C} c^2)(b^2 + \frac{\tan B}{\tan A} a^2)} \\ & < \frac{(\frac{\tan C}{\tan B} + 1)(\frac{\tan A}{\tan C} + 1)(\frac{\tan B}{\tan A} + 1)}{64abc} \end{aligned}$$

so

$$\frac{64abc \prod h_a}{\prod (c^2 \tan B + b^2 \tan C) \prod (\frac{1}{\tan A})} < \prod (\tan C + \tan B) \prod \left(\frac{1}{\tan A} \right)$$

and hence

$$64abc \prod \left(\frac{h_a}{c^2 \tan B + b^2 \tan C} \right) < \prod \cot^2 A (\tan B + \tan C).$$

■

Remark. Using $h_a \leq s_a \leq m_a$; $h_b \leq s_b \leq m_b$; $h_c \leq s_c \leq m_c$ corollary 2 and (3) above:

$$8abch_a h_b h_c \leq 8abcs_a s_b s_c \leq 8abcm_a m_b m_c < \prod (a^2 + b^2).$$

References

- [1] Daniel Sitaru *Math Phenomenon*. "Paralela 45" Publishing House, Pitesti, Romania, 2016.
- [2] Alexander and Koeberlein, *Elementary Geometry for College Students*, Houghton Mifflin, 2007.

Editor's note: The following article poses an interesting question and presents solutions in certain special cases. While the nature of the question is not appropriate for the Problem Corner, if readers of *The Pentagon* are interested in extending these results, we will continue the discussion in future issues of this journal.

Sums of Divisors of Integers

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Abstract

We consider an additive property for the sum of the divisors of integers, inspired by a multiplicative property for the sum of the divisors of perfect numbers.

The Problem

Recall that given an integer n , the *sum-of-divisors function* is defined by

$$\sigma(n) = \sum_{d|n} d,$$

i.e. $\sigma(n)$ is the sum of the positive divisors of n . This function is multiplicative in the sense that if m and n are relatively prime, then

$$\sigma(mn) = \sigma(m)\sigma(n).$$

An integer n is *perfect* if and only if

$$\sigma(n) = 2n.$$

It follows that for integers m and n , the product mn is perfect if and only if

$$\sigma(mn) = 2mn.$$

Is there a way to characterize those integers m and n for which we have a

similar *additive* result, i.e. such that

$$\sigma(m) + \sigma(n) = 2(m + n)? \quad (5)$$

One way to get a sense of this situation is to consider fixing m and determining what is required of n in order to satisfy (1). In this case n must satisfy

$$\sigma(n) = 2n + 2m - \sigma(m). \quad (6)$$

Example 1 Suppose $m = 2$. Then we must have $\sigma(n) = 2n + 4 - 3 = 2n + 1$.

Similar results for various values of m are illustrated in the following table:

m	$\sigma(n)$
2	$2n + 1$
3	$2n + 2$
4	$2n + 1$
5	$2n + 4$
6	$2n$
12	$2n - 4$
13	$2n + 12$

We now consider two special cases.

Case 1. Suppose $n = 6p$ where p is a prime greater than 3 (so 6 and p are relatively prime). Then, by multiplicativity,

$$\sigma(n) = \sigma(6p) = \sigma(6)\sigma(p) = 12(p + 1) = 2n + 12.$$

From the table above we see that taking $m = 13$ we will have a pair of integers satisfying equation (1).

Example 2 Take $p = 7$ and $n = 6 * 7 = 42$. Then

$$\sigma(13) + \sigma(42) = 14 + 96 = 110 = 2(13 + 42).$$

Thus there are infinitely many pairs (m, n) for which $\sigma(m + n) = 2(m + n)$, in particular any pair of the form $(13, 6p)$ with $p > 3$ a prime. In fact, one can check that pairs of the form $(45, 6p)$ and $(76, 6p)$, $p > 3$ a prime, will satisfy (1) as well. Moreover, there are pairs $(13, n)$ which satisfy (1) where n is not of the form $6p$, $p > 3$ a prime - for instance $(13, 24)$.

More generally, if $n = kp$ where k is a perfect number and p is a prime which is not a factor of k , then

$$\sigma(n) = \sigma(k)\sigma(p) = 2k(p + 1) = 2n + 2k.$$

Using this in equation (2) above and solving for $\sigma(m)$, we see that for equation (1) to hold we must find an m such that

$$\sigma(m) = 2m - 2k. \quad (7)$$

For instance, if we let $n = 28p$ where p is a prime other than 2 or 7, we note that

$$\sigma(118) = 180 = 2(118) - 2(28),$$

so there are infinitely solutions to (1) of the form $(118, 28p)$, p a prime other than 2 or 7.

Case 2. Suppose $n = 2^k p$ for some positive integer k and prime $p > 3$. We can rule out many possible values of m by noting that if $m = 2p$, $p > 2$ a prime, then $\sigma(m + n) = 2(m + n)$ if and only if

$$2(2p + 2^k p) = 3(p + 1) + (2^{k+1} - 1)(p + 1) = (p + 1)(2^{k+1} + 2).$$

Solving this for p we find

$$p = 2^k + 1.$$

Since any odd prime greater than 3 is congruent to 1 or 2 modulo 3, we consider both cases.

1. $p \equiv 1 \pmod{3}$. Then we must have $2^k + 1 \equiv 1 \pmod{3}$ or $2^k \equiv 0 \pmod{3}$, which is impossible.
2. $p \equiv 2 \pmod{3}$. Here we must have $2^k + 1 \equiv 2 \pmod{3}$, which can only happen if k is even.

Questions for further exploration:

1. Can we characterize all pairs (m, n) such that

$$\sigma(m) + \sigma(n) = 2(m + n)?$$

2. Failing a complete characterization of all such pairs, what special cases (along the lines of those above) can be settled?
3. In particular, can it be shown that there are an infinite number of solutions to (1) of the form (m, kp) where k is a perfect number and p is a prime with $(k, p) = 1$?

Author's note: I would like to thank the editor and referee for suggestions to improve this paper.

The Problem Corner

Edited by Pat Costello

The Problem Corner invites questions of interest to undergraduate students. As a rule, the solution should not demand any tools beyond calculus and linear algebra. Although new problems are preferred, old ones of particular interest or charm are welcome, provided the source is given. Solutions should accompany problems submitted for publication. Solutions of the following new problems should be submitted on separate sheets before November 1, 2018. Solutions received after this will be considered up to the time when copy is prepared for publication. The solutions received will be published in the Fall 2018 issue of *The Pentagon*. Preference will be given to correct student solutions. Affirmation of student status and school should be included with solutions. New problems and solutions to problems in this issue should be sent to Pat Costello, Department of Mathematics and Statistics, Eastern Kentucky University, 521 Lancaster Avenue, Richmond, KY 40475-3102 (e-mail: pat.costello@eku.edu, fax: (859) 622-3051).

NEW PROBLEMS 808 - 819

Problem 808. *Proposed by Daniel Sitaru, “Theodor Costescu” National Economic College, Drobeta Turnu - Severin, Mehedinti, Romania.*

Prove that if $a, b, c \in [1, \infty)$ then

$$\frac{e^{a+b+c}}{e^{b/a+c/b+a/c}} \leq a^b b^c c^a \leq \frac{e^{ab+bc+ca}}{e^{a+b+c}}.$$

Problem 809. *Proposed by Daniel Sitaru, “Theodor Costescu” National Economic College, Drobeta Turnu - Severin, Mehedinti, Romania.*

Prove that if $a, b, c \in (2, \infty)$ then

$$\sqrt{2} \sum (\sqrt{a(b-2)} + \sqrt{b(a-2)}) < 3\sqrt{abc}.$$

Problem 810. *Proposed by Daniel Sitaru, “Theodor Costescu” National Economic College, Drobeta Turnu - Severin, Mehedinti, Romania.*

Compute $L = \lim_{n \rightarrow \infty} \frac{1}{n} \int_1^n \frac{x^4 + 4x^3 + 12x^2 + 9x}{(x+3)^5 - x^5 - 243} dx$.

Problem 811. *Proposed by Jose Luis Diaz-Barrero, School of Civil Engineering, Barcelona Tech - UPC, Barcelona, Spain.*

Let a, b, c be three positive integers. Prove that

$$a^{b+b+c+ca} \sqrt{a^{bc} b^{ca} c^{ab}} \leq \sqrt[3]{abc}.$$

Problem 812. *Proposed by Jose Luis Diaz-Barrero, School of Civil Engineering, Barcelona Tech - UPC, Barcelona, Spain.*

Let S be a finite set. Consider three partitions of S , each one with n elements:

$$A_1, \dots, A_n; B_1, \dots, B_n; C_1, \dots, C_n.$$

If for all $1 \leq i, j, k \leq n$, it holds that

$$|A_i \cap B_j| + |B_j \cap C_k| + |C_k \cap A_i| \geq n,$$

then prove that $|S| \geq \frac{n^3}{3}$. When does equality hold?

Problem 813. *Proposed by D.M. Batinetu-Giurgiu, "Matei Basarab" National College, Bucharest, Romania, Neculai Stanciu, "George Emil Palade" School, Buzau, Romania.*

Prove that if $a, b, c \in (1, \infty)$ then

$$\log_{ab^2c^2} a + \log_{a^2bc^2} b + \log_{a^2b^2c} c \geq \frac{3}{5}.$$

Problem 814. *Proposed by D.M. Batinetu-Giurgiu, "Matei Basarab" National College, Bucharest, Romania, Neculai Stanciu, "George Emil Palade" School, Buzau, Romania.*

Let the sequence $(a_n)_{n \geq 1}$, defined by $a_1 = 1, a_{n+1} = (n+1)!a_n$ for any positive integer n . Compute

$$\lim_{n \rightarrow \infty} \frac{\sqrt[2n]{n!}}{\sqrt[n^2]{a_n}}.$$

Problem 815. *Proposed by Marius Dragan, National College Mircea cel Batran, Bucharest, Romania, and Neculai Stanciu, "George Emil Palade" School, Buzau, Romania.*

Let a, b, c be positive real numbers such that $a^4 + b^4 + c^4 = 3$. Show

that

$$2(a^2 + b^2)(b^2 + c^2)(c^2 + a^2) \geq (a^2b^2 + b^2c^2 + c^2a^2 + abc)^2.$$

Problem 816. *Proposed by Stanescu Florin, Serban Cioclescu School, Gaesti, Romania.*

Determine the largest real number α with the property that for any function $f : [0, 1] \rightarrow [0, \infty)$ where the following hold:

1. f is convex and $f(0) = 0$;
2. there exists $\epsilon > 0$ with f differentiable on $[0, \epsilon)$ and $f'(0) \neq 0$;

the following inequality holds:

$$\int_0^1 \frac{x^2}{\int_0^1 f(t)dt} dx \geq \int_0^1 (x + \alpha) \cdot \frac{f(x)}{\left(\int_0^1 f(t)dt\right)^2} dx.$$

Problem 817. *Proposed by Stanescu Florin, Serban Cioclescu School, Gaesti, Romania.*

Consider the complex numbers a, b, c, d , all of modulus one, which have the following properties:

1. $\arg a < \arg b < \arg c < \arg d$;
2. $2\sqrt{|(b + ai)(c + bi)(d + ci)(a + di)|} - \sqrt{\frac{[(a-c)(b-d)]^2}{abcd}} = 4.$

Show that $\max \left\{ \left| 1 - \frac{i+4a^2}{i+8a(b-d)} \right|; \left| 1 - \frac{i+4b^2}{i+4b(a-c)} \right| \right\} \geq \frac{4}{\sqrt{17}}.$

Problem 818. *Proposed by Titu Zvonaru, Comanesti, Romania and Neculai Stanciu, "George Emil Palade", Buzau, Romania.*

Determine all positive integers a, b, c, d, x, y, z, t such that $a \neq b \neq c \neq d$ and $a + b + c = td$, $b + c + d = xa$, $c + d + a = yb$, and $d + a + b = zc$.

Problem 819. *Proposed by the editor.*

Billy has created a snowman with a base, torso, and a head all of which are spheres where the torso is smaller than the base and the head is smaller than the torso. The radius of each piece is a positive integer with the base

having a 12 inch radius. He decides that he wants to use the snow to make 3 similar and identical snowmen for his younger siblings. He discovers that he can do this. What are the radii of the original and smaller snowmen?

SOLUTIONS TO PROBLEMS 789 - 797

Problem 789. *Proposed by Daniel Sitaru, Colegiul National Economic Theodor Costescu, Drobeta Turnu – Severin, Mehedinti, Romania.*

In triangle ABC , let I = the incenter, O = the circumcenter, G = the centroid, and a, b, c the lengths of the sides. Prove that

$$\left(\sum IA\right) \left(\sum OA\right) \left(\sum GA\right) < (a+b)(b+c)(c+a).$$

Solution by the proposer.

By Visscher's theorem (1902) in a scalene triangle, the sum of segments MA, MB, MC , with $M \in \text{Int}(\triangle ABC)$ is less than the sum of any two length's sides. Thus

$$MA + MB + MC < a + b;$$

$$MA + MB + MC < b + c;$$

$$MA + MB + MC < c + a.$$

Then $(MA + MB + MC)^3 < (a+b)(b+c)(c+a)$ and hence $\sum MA < \sqrt[3]{(a+b)(b+c)(c+a)}$. Letting $M = I$; $M = O$; and $M = G$, respectively, you get

$$\sum IA < \sqrt[3]{(a+b)(b+c)(c+a)};$$

$$\sum OA < \sqrt[3]{(a+b)(b+c)(c+a)};$$

$$\sum GA < \sqrt[3]{(a+b)(b+c)(c+a)}.$$

Multiplying these inequalities together gives the desired result.

Problem 790. *Proposed by Daniel Sitaru, Colegiul National Economic Theodor Costescu, Drobeta Turnu – Severin, Mehedinti, Romania.*

Prove that if $a, b \in \mathbb{R}$ with $a < b$, then

$$\ln \left| \left(\frac{2 + \sin 2b}{2 + \sin 2a} \right) \right| \leq \frac{2\sqrt{3}}{3} (b - a).$$

Solution by Richdad Thuc, Hanoi, Vietnam.

Let $f(x) = \ln |2 + 2 \sin x|$. Then $f'(x) = \frac{2 \cos 2x}{2 + \sin 2x}$. By the Mean Value Theorem, there is a $c \in (a, b)$ with $f(b) - f(a) = f'(c)(b - a)$ or

$$\left| \ln \left(\frac{2 + \sin 2b}{2 + \sin 2a} \right) \right| \leq \frac{2 \cos 2c}{2 + \sin 2c} (b - a).$$

But

$$\frac{2 \cos 2c}{2 + \sin 2c} \leq \frac{2\sqrt{3}}{3} \Leftrightarrow \sqrt{3} \cos 2c - \sin 2c \leq 2 \Leftrightarrow \cos(2c + \frac{\pi}{6}) \leq 1,$$

which is clearly true.

Also solved by Abdelhak Maoukoul, Casablanca, Morocco; Ravi Prakash, New Delhi, India; Anas Adlany, El Zemamra, Morocco; Soumava Chakraborty, Kolkata, India; Kunihiko Chikaya, Tokyo, Japan; Morawo Maxwell, Nigeria; and the proposer.

Problem 791. Proposed by Jose Luis Diaz-Barrero, School of Civil Engineering, Barcelona Tech - UPC, Barcelona, Spain.

Determine whether the real number

$$\frac{\ln(11 + 5\sqrt{2})}{\ln(5 + 11\sqrt{2})}$$

is rational or not.

Solution by Jonathan Stacy, Belton, MO.

Suppose that the fraction is a rational, equal to m/n for some positive integers m and n . Then

$$n \ln(11 + 5\sqrt{2}) = m \ln(5 + 11\sqrt{2})$$

and, by log rules,

$$(11 + 5\sqrt{2})^n = (5 + 11\sqrt{2})^m.$$

Consider the ring

$$\mathbb{Z}[\sqrt{2}] = \{a + b\sqrt{2} | a, b \in \mathbb{Z}\}$$

with norm $N : \mathbb{Z}[\sqrt{2}] \rightarrow \mathbb{Z}$ defined by

$$N(a + b\sqrt{2}) = |a^2 - 2b^2|.$$

This norm is multiplicative so $N(xy) = N(x)N(y)$ for all $x, y \in \mathbb{Z}[\sqrt{2}]$.

Then

$$N(11 + 5\sqrt{2}) = |11^2 - 2 * 5^2| = 71$$

and

$$N(11 + 5\sqrt{2}) = 217 = 7 * 31.$$

By multiplicativity,

$$71^n = N(11 + 5\sqrt{2})^n = N(5 + 11\sqrt{2})^m = 217^m = 7^m * 31^m.$$

But 71 is a prime and this is impossible. By contradiction, the fraction must be irrational.

Also solved by Jeremiah Bartz, University of North Dakota, Grand Forks, ND; Missouri State University Problem Solving Group, Springfield, MO; and the proposer.

Problem 792. *Proposed by Jose Luis Diaz-Barrero, School of Civil Engineering, Barcelona Tech - UPC, Barcelona, Spain.*

Let $x_1, x_2, \dots, x_n$ be real numbers lying in the interval $(0, \pi/2)$. Prove that

$$\left(\frac{1}{n} \sum_{k=1}^n \sin x_k \right) \left(\frac{1}{n} \sum_{k=1}^n \cos x_k \right) \leq \frac{1}{2}.$$

Solution by Ioan Viorel Codreanu, Satulung, Maramures, Romania.

For any real number x_k , we have that $\sin^2 x_k + \cos^2 x_k = 1$. Then

$$n = \sum_{k=1}^n (\sin^2 x_k + \cos^2 x_k) = \sum_{k=1}^n \sin^2 x_k + \sum_{k=1}^n \cos^2 x_k.$$

Using the Cauchy-Schwarz inequality, we get

$$\sum_{k=1}^n \sin^2 x_k + \sum_{k=1}^n \cos^2 x_k \geq \frac{1}{n} \left(\left(\sum_{k=1}^n \sin x_k \right)^2 + \left(\sum_{k=1}^n \cos x_k \right)^2 \right).$$

For any two real numbers a and b , we have $a^2 + b^2 \geq 2ab$. So, we get

$$n \geq \frac{2}{n} \left(\sum_{k=1}^n \sin x_k \right) \left(\sum_{k=1}^n \cos x_k \right)$$

and conclude that

$$\left(\frac{1}{n} \sum_{k=1}^n \sin x_k \right) \left(\frac{1}{n} \sum_{k=1}^n \cos x_k \right) \leq \frac{1}{2}.$$

Also solved by Missouri State University Problem Solving Group, Spring-

field, MO; and the proposer.

Problem 793. Proposed by D.M. Batinetu-Giurgiu, “Matei Basarab” National College, Bucharest, Romania, Neculai Stanciu, “George Emil Palade”, Buzau, Romania.

If $a \in [0, \pi/4]$, compute $\int_0^a (x^2 - ax + a^2)(\ln(1 + \tan x \tan a))dx$.

Solution by Shivam Sharma (student), University of Delhi, New Delhi, India.

We know that if $f(x)$ is a continuous function defined on $[0, a]$, then

$$\int_0^a f(x)dx = \int_0^a f(a-x)dx.$$

The desired integral I is then

$$\begin{aligned} I &= \int_0^a ((a-x)^2 - a(a-x) + a^2)(\ln(1 + \tan(a-x) \tan a))dx \\ &= \int_0^a (a^2 + x^2 - 2ax - a^2 + ax + a^2)(\ln(1 + \frac{\tan a - \tan x}{1 + \tan a \tan x} \tan a))dx \\ &= \int_0^a (a^2 + x^2 - ax)(\ln(1 + \frac{\tan^2 a - \tan x \tan a}{1 + \tan a \tan x}))dx \\ &= \int_0^a (x^2 - ax + a^2)(\ln(\frac{1 + \tan^2 a}{1 + \tan a \tan x}))dx \\ &= \int_0^a (x^2 - ax + a^2)(\ln(1 + \tan^2 a))dx \\ &\quad - \int_0^a (x^2 - ax + a^2)(\ln(1 + \tan a \tan x))dx \\ &= 2 \int_0^a (x^2 - ax + a^2)(\ln(\sec a))dx - I. \end{aligned}$$

Thus

$$2I = 2 \int_0^a (x^2 - ax + a^2)(\ln(\sec a))dx$$

$$\text{or } I = (\ln(\sec a)) \int_0^a (x^2 - ax + a^2)dx,$$

$$\text{or } I = (\ln(\sec a)) \frac{5}{6}a^3.$$

Also solved by Ravi Prakash, New Delhi, India; Missouri State University Problem Solving Group, Springfield, MO; and the proposers.

Problem 794. *Proposed by D.M. Batinetu-Giurgiu, “Matei Basarab” National College, Bucharest, Romania, Neculai Stanciu, “George Emil Palade”, Buzau, Romania.*

Let a, b, c be positive real numbers. Prove that

$$(1+a)(1+b)(1+c) \geq \left(1 + \frac{2ab}{a+b}\right) \left(1 + \frac{2bc}{b+c}\right) \left(1 + \frac{2ca}{c+a}\right).$$

Solution by Titu Zvonaru, Comanesti, Romania.

Using the Cauchy-Schwarz Inequality and the GM-HM inequality we have

$$\begin{aligned} (1+a)(1+b) &\geq (1+\sqrt{ab})^2 \geq \left(1 + \frac{2ab}{a+b}\right)^2; \\ (1+b)(1+c) &\geq (1+\sqrt{bc})^2 \geq \left(1 + \frac{2bc}{b+c}\right)^2; \\ (1+c)(1+a) &\geq (1+\sqrt{ca})^2 \geq \left(1 + \frac{2ca}{c+a}\right)^2. \end{aligned}$$

Multiplying these and taking square roots gives the desired result.

Also solved by Ravi Prakash, New Delhi, India; Antonis Anastasiadis, Katerini, Greece; Ioan Viorel Codreanu, Satulung, Maramures, Romania; Angel Plaza, Universidad de Las Palmas de Gran Canaria, Spain; and the proposers.

Problem 795. *Proposed by Michal Kremzer, Glicice, Silesia, Poland.*

Let $\mathbb{Q}$ be the set of rational numbers. Does there exist a function $f : (\mathbb{Q} - \{0\}) \rightarrow (\mathbb{Q} - \{0\})$ so that $f(x) < f(3x) < f(2x)$ for all x in the set $(\mathbb{Q} - \{0\})$?

Solution by Missouri State University Problem Solving Group, Springfield, MO.

Yes, there is such a function. For x in $\mathbb{Q} - \{0\}$, write $x = 2^a 3^b y$ for some integers a and b and some $y \in \mathbb{Q} - \{0\}$ where the numerator and denominator of y are not divisible by either 2 or 3. Then the values a , b , and y are uniquely determined by x . Define f by

$$f(x) = f(2^a 3^b y) = 2a + b + 1/2.$$

Then

$$f(3x) = f(2^a 3^{b+1} y) = 2a + (b+1) + 1/2 = f(x) + 1,$$

and

$$f(2x) = f(2^{a+1}3^b y) = 2(a+1) + b + 1/2 = f(x) + 2.$$

Also solved by the proposer.

Problem 796. *Proposed by Kadir Altintas, Turkey and Leonard Giugiuc, Romania.*

If A, B and C are the angles of a triangle, prove that

$$\sqrt{6(1 + \cos A \cos B \cos C)} \geq 4 \cos \frac{A}{2} \cos \frac{B}{2} \cos \frac{C}{2}.$$

Solution by Neculai Stanciu, Buzau, Romania and Titu Zvonaru, Comanesti, Romania.

After squaring and using the formulas

$$\cos^2 \frac{A}{2} = \frac{1 + \cos 2A}{2};$$

$$\cos^2 \frac{B}{2} = \frac{1 + \cos 2B}{2};$$

$$\cos^2 \frac{C}{2} = \frac{1 + \cos 2C}{2};$$

$$\cos A \cos B \cos C = \frac{s^2 - (2R + r)^2}{4R^2};$$

$$\cos A + \cos B + \cos C = \frac{4R(R + r)}{4R^2};$$

$$\cos A \cos B + \cos B \cos C + \cos C \cos A = \frac{s^2 + r^2 - 4R^2}{4R^2},$$

the inequality from the statement becomes

$$6 + 6 \cos A \cos B \cos C \geq 2(1 + \cos A)(1 + \cos B)(1 + \cos C)$$

$$\Leftrightarrow 2 + 2 \cos A \cos B \cos C \geq \cos A + \cos B + \cos C + \cos A \cos B + \cos B \cos C + \cos C \cos A$$

$$\Leftrightarrow 2 + 2 \cdot \frac{s^2 - (2R + r)^2}{4R^2} \geq \frac{4R(R + r)}{4R^2} + \frac{s^2 + r^2 - 4R^2}{4R^2}$$

$$\Leftrightarrow s^2 \geq 12Rr + 3r^2.$$

and by the inequality of Gerretsen, i.e. $s^2 \geq 16Rr - 5r^2$, it suffices to prove that $16Rr - 5r^2 \geq 12Rr + 3r^2 \Leftrightarrow R \geq 2r$ (the inequality of Euler) which is true.

Also solved by Scott Brown, Auburn University, Montgomery, AL; Ioan Viorel Codreanu, Satulung, Maramures, Romania; and the proposers.

Problem 797. *Proposed by the editor.*

Let integer n be called a *consecutives concatenated* number when n is formed by concatenating two consecutive integers. For example, 67 and 1314 are consecutives concatenated numbers. 67 is prime, but 1314 is composite. It turns out there are lots of consecutives concatenated primes. Find a consecutives concatenated prime of 20 digits where the first integer of the two concatenated is divisible by $2^3 * 3^3$.

Solution by Jeremiah Bartz, University of North Dakota, Grand Forks, ND.

Let $m = 216k$ where k is a positive integer. Observe m is divisible by $2^3 * 3^3$ and is a 10-digit number if $4,629,630 \leq k \leq 46,296,296$. The concatenation of m and $m + 1$ gives the consecutive concatenated number n with 20 digits when $4,629,630 \leq k \leq 46,296,296$. Moreover, we see $n = (10^{10} + 1) 216k + 1$. A case-by-case inspection shows the smallest and largest consecutives concatenated primes are given respectively when $k = 4,629,631$ and $k = 46,296,287$, namely

$$n = 10,000,002,96,1000,000,297$$

and

$$n = 99,999,979,929,999,997,993.$$

Also solved by Zachary Morgan (student), Eastern Kentucky University, Richmond, KY; Ed Wilson, Eastern Kentucky University, Richmond, KY; and the proposer.

Citation for Dr. Joan E. Bell
The George R. Mach Distinguished Service
Award Recipient

April 7, 2017

The George R. Mach Distinguished Service Award is presented each biennium to an individual who has made major contributions to the Society. Nominations are solicited from the chapters and the National Council determines the recipient. The chapter with which the recipient is affiliated receives a monetary award of \$100.

I am pleased to announce that the recipient of the George R. Mach Distinguished Service Award for this biennium is Dr. Joan E. Bell.

Dr. Bell served as the corresponding secretary of the OK Alpha chapter at Northeastern State University for 30 years, from 1985 to 2014. During her tenure, she initiated 625 students and faculty members.

Under her leadership, the OK Alpha chapter:

- hosted many speakers, including alumni, professionals whose careers involve mathematics and professors from Northeastern and other universities, as well as students who presented senior math projects or research from REUs.
- increased the visibility of KME and mathematics both on and off campus by participating in campus events and by hosting a Math Fair for a small rural public school.
- submitted many solutions to problems from the Problem Corner in the Pentagon and other journals.
- encouraged camaraderie among its members by sponsoring social events that often included mathematical games or movies.

Dr. Bell has also received two teaching awards, one at her University and one from her section of the Mathematical Association of America.

The KME National Council is very much aware that the corresponding secretaries and faculty sponsors are the heart and soul of this organization. Dr. Bell is a prime example of a faculty member who committed **30 years** of service to KME and had a positive influence on hundreds of students. For this reason, we are very happy to present the George R. Mach Distinguished Service Award to Dr. Joan E. Bell.

Report of the 41st Biennial National Convention

Kappa Mu Epsilon

April 6-8, 2017

Evangel University, Missouri Theta

Springfield, Missouri

This 41st Biennial National Convention, sponsored in part by the American Mathematical Society and American Statistical Association, was held during April 6-8, 2017 at Evangel University, Springfield, Missouri, Host Chapter Missouri Theta.

Thursday, April 6, 2017

On Thursday evening, April 6th from 7-9 p.m. a Pizza Reception and Mixer was held in the Cantrell Student Union. Participants were able to pick up registration packets at this event. From 8-9 p.m., the National Council held a business meeting in the Cantrell Student Union.

Friday, April 7, 2017

Friday April 7th's activities began at 8 a.m. to 9 a.m. with coffee and continued registration in the Trask Hall 1st floor lobby. From 8:30-8:55 a.m., members of the Awards Committee held a meeting in Trask Hall Room 107. At 9 a.m. in Trask Hall Room 101 the first general session began, with KME President Rhonda McKee presiding.

KME President Rhonda McKee and Dr. Michael McCorcle, Evangel University Provost welcomed participants. Mark S. Hamner, KME Secretary, then called the roll. In attendance were 63 students and 24 faculty members, a total of 87 registrants, representing 17 chapters from eleven states (Alabama, Georgia, Kansas, Missouri, Nebraska, North Carolina, Oklahoma, Pennsylvania, Tennessee, Texas, and Virginia).

Chapters represented were Alabama Theta, Jacksonville State University; Georgia Zeta, Georgia Gwinnett College; Kansas Alpha, Pittsburg State University; Kansas Beta, Emporia State University; Kansas Delta, Washburn University; Missouri Alpha, Missouri State University; Missouri Beta, University of Central Missouri; Missouri Eta, Truman State University; Missouri Theta, Evangel University; Nebraska Beta, University of Nebraska- Kearney; North Carolina Zeta, Catawba College; Oklahoma Alpha, Northeastern State University; Oklahoma Epsilon, Oklahoma Christian University; Pennsylvania Mu, Saint Francis University; Ten-

nessee Gamma, Union University; Texas Gamma, Texas Woman's University; and Virginia Alpha, Virginia State University.

Ten talks, a 3-member graduate school panel discussion, and four workshops (each presented twice) were on the program.

Brian Hollenbeck, KME President-Elect of Kansas Beta, after conducting the filing of the delegates, recognized six chapters (Georgia Zeta, Missouri Eta, Nebraska Beta, North Carolina Zeta, Oklahoma Epsilon, Virginia Alpha) that were attending their first convention this century.

There was no old business.

Introduction of new business began with an update from the KME President, Rhonda McKee, on the attempts from the Nominating Committee to obtain two candidates to run for President Elect and Historian, as is customary, prior to the National KME Convention. The Nominating Committee was only able to find one candidate for each position. Nominations were invited from the floor but none were made. Although no additional nominations were made, ballots were handed out to the delegates with space for write-ins. Pedro Muño, chair of the nominating committee, introduced the two candidates.

- Introduction of candidate for President-Elect: Leah Childers, Kansas Alpha.
- Introduction of candidate for National Historian: Cynthia Huffman, Kansas Alpha.

Rhonda McKee, KME President, and Brian Hollenbeck, KME President-Elect, presided over the student paper presentations. Student paper presentations were held in Trask Hall.

The following Student papers were presented during the morning Session #1, 9:30 a.m.-10:20 a.m.: Trask Hall Room 101.

- *Modeling the Wind Resource of Southwest Kansas*, by Parker LaMascus, Oklahoma Epsilon, Oklahoma Christian University
- *Concerning the Growth of Animal Populations in Minecraft*, by Joshua Stucky, Tennessee Gamma, Union University
- *Algebraic Structure of Labeled Graphs Joined by j Edges*, by Shahriyar Roshan Zamir, Georgia Zeta, Georgia Gwinnet College

Between 10:25 a.m. and 10:40 a.m. there was a refreshment break in the Trask Hall 1st floor lobby.

The following Student papers were presented during the morning Session #2, 10:45 a.m.-11:55 a.m.: Trask Hall Room 101.

- *Global Stability Analysis of Zika Virus Dynamics*, by Hayley Hutson, Missouri Alpha, Missouri State University
- *A Curriculum Guide: Exploring Careers in STEM*, by Ashley Beard, Missouri Beta, University of Central Missouri
- *Coloring $\mathbb{R}^n$* , by Zach Bowen, Landis Duff, and Jacob Rowley, Kansas Alpha, Pittsburg State University
- *Application of SVD: Information Retrieval and Document Ranking* by Blake Jackson and Chris Mount, Alabama Theta, Jacksonville State University

Between 12 noon-12:15 p.m. a Group Photograph was taken at the outdoor Amphitheater.

Lunch was held between 12:15 p.m.-1:30 p.m. in the Cantrell Student Union Cafeteria. Concurrently the KME Resolutions Committee and the KME Auditing Committee met in the cafeteria.

From 1:45 p.m.-2:30 p.m., section meetings were held, The Faculty Section meeting was held in Trask Hall Room 101. The Student Section meeting was held in Zimmerman Hall Room 103.

Between 2:30 p.m. and 5:00 p.m. participants attended one of four workshops (prior signup required):

- (Zimmerman Hall Room 203) *Calculus Limits via Infinitesimals (they're easier!)* by Bryan Dawson, Tennessee Gamma, Union University
- (Zimmerman Hall Room 114) *Bell-y Math: Connections between Mathematics and Change Ringing* by Cynthia Huffman, Kansas Alpha, Pittsburg State University
- (Zimmerman Hall Room 113) *Shapes and Smiles* by John C.D. Diamantopoulos, Oklahoma Alpha, Northeastern State University
- (Zimmerman Hall Room 103) *Using R for Simulation and Studies* by Angela Crumer and Jason Shaw, Kansas Delta, Washburn University

From 7:00 p.m.-9:30 p.m. the convention banquet was held in Crusader Hall Rooms 115 A and B. Brian Hollenbeck, KME President-Elect, served as emcee. Following dinner, the recipient of the Mach Award was announced. This year's recipient was Dr. Joan E. Bell, Oklahoma Alpha. Dr. Bell served as the corresponding secretary of the OK Alpha chapter at Northeastern State University for 30 years, from 1985 to 2014. During her tenure, she initiated 625 students and faculty members. Eve Torrence, PME President and Professor of Mathematics at Randolph-Macon Col-

lege, Ashland, Virginia, gave the keynote address: A Mathematical Art Gallery Tour.

Saturday, April 8, 2017

Saturday April 8th's activities began between 8:00 a.m. and 8:30 a.m. with Registration and coffee in the Trask Hall 1st floor lobby.

Session #3 of the Student Presentations commenced at 8:30 a.m. in Trask Hall Room 101.

The following Student papers were presented during Session #3, 8:30 a.m.-9:25 a.m.:

- *Detecting Point Radiation Sources Using Distributed Sensors*, Chelsea Mitchell, Virginia Alpha, Virginia State University
- *Housing Market Time Series Analysis - Before and After Housing Bubble* by Katelynn Robinson, Kansas Delta, Washburn University
- *Elliptical Illusion* by Catherine Ross, Missouri Theta, Evangel University

Between 9:25 a.m. and 9:55 a.m. there was a refreshment break in the Trask Hall 1st floor lobby. Concurrently, the KME Awards Committee met in Trask Hall Room 107 and Regional meetings were held.

Between 10:00 a.m. and 10:40 a.m. a Career Panel Discussion was held in Trask Hall Room 101. Panelists included:

- Hope Moorhead, Graduate Student, University of Missouri
- Anna Tripi, Graduate Student, Missouri State University
- Dr. Leah Childers, Assistant Professor, Pittsburg State University

Following at 10:45 a.m., also in Trask Hall Room 101, the Second General Session began with President Rhonda McKee presiding. Convention Evaluation Forms were distributed and collected.

Elections were held for the positions of KME President-Elect and KME National Historian.

- Leah Childers, Kansas Alpha, was elected by unanimous acclamation and installed.
- Cynthia Huffman, Kansas Alpha, was elected by unanimous acclamation and installed.

Brian Hollenbeck of Kansas Beta completed his term as President-Elect and inherits the role of National KME President. Brian Hollenbeck was installed as National KME President by the outgoing President, Rhonda

McKee.

For the Continuation of New Business, the following national officers made reports:

- Doug Brown, Editor, *The Pentagon*
- Peter Skoner, Historian
- David Dempsey, Treasurer
- Mark S. Hamner, Secretary
- Brian Hollenbeck, President-Elect
- Rhonda McKee, President

Following the national officer reports were reports from the Faculty and Student Section Meetings, the Resolutions Committee, and the Auditing Committee. All reports are attached.

The report of the Awards Committee and presentation of awards were made. The top papers were:

- 2-4 *Application of SVD: Information Retrieval and Document Ranking*. Blake Jackson and Chris Mount, Alabama Theta, Jacksonville State University
- 3-2 *Housing Market Time Series Analysis - Before and After Housing Bubble* by Katelynn Robinson, Kansas Delta, Washburn University
- 2-3 *Coloring $\mathbb{R}^n$* , by Zach Bowen, Landis Duff, and Jacob Rowley, Kansas Alpha, Pittsburg State University

These students were awarded a \$100 check for their respective winning paper. In addition, a \$55 reimbursement for registration was given to each chapter for each talk as well as an additional \$200 for travel. The “People’s Choice Award,” which is selected by submitted votes of the attending KME student members, was presented to Blake Jackson and Chris Mount. The “People’s Choice Award” recipients received \$50, split between the presenters.

The convention concluded with the National Treasurer David Dempsey presenting checks for travel allowances to each chapter present.

Mark Hamner
National Secretary

Report of the National President

The KME National Council has been active and productive since the 2015 convention. We continue to meet regularly by conference call. Here are some highlights of our activities this biennium.

- Four new regional directors have been appointed. They are:
 - Donna Marie Pirich, New England region
 - Katherine Kime, North Central region
 - John Diamantopoulos, South Central region
 - Jamye Curry, Southeast region

The regional directors joined the National Council for a conference call meeting in November 2016.

- Doug Brown from Catawba College in North Carolina was appointed as the new Pentagon editor beginning in November, 2016.
- Six new chapters of KME have been installed this biennium.
 - Ohio Theta, Capital University. Installed April 24, 2015 by Pete Skoner
 - Georgia Zeta, Georgia Gwinnett College. Installed April 28, 2015 by David Dempsey
 - Illinois Kappa, Aurora University. Installed May 3, 2016 by Brian Hollenbeck
 - Missouri Xi, William Woods University. Installed February 17, 2016 by Rhonda McKee
 - Connecticut Gamma, Central Connecticut State University. Installed March 24, 2017 by Pete Skoner
 - Georgia Eta, Atlanta Metropolitan State College. Installed January 31, 2017 by David Dempsey
- Two regional conventions were held in 2016
 - The Great Lakes regional convention was held in conjunction with an MAA section meeting on April 8-9, 2016 at Ohio Northern University
 - The North Central regional convention was held April 1-2, 2016 at the University of Nebraska, Kearney
- I represented KME at the meeting of the Association of College Honor

Societies (ACHS) in February, 2017.

- A student at my university scanned all the hard copy initiation reports from all chapters, starting from the first initiation in 1931. We now have electronic copies of all initiation reports.
- The National Council has started communicating directly with students in some situations, including emails announcing national conventions, and social media posts on Facebook (Kappa Mu Epsilon (National Mathematics Honor Society)) and Twitter (@KMEMath).

My tenure on the KME National Council will come to an end at this convention. I began as National Secretary in 2000 and went on to serve as President Elect and then President. Serving on this Council has been a very pleasant and rewarding experience, mostly because of the people I've been privileged to work with, and whom I now call friends. I am especially grateful to Ron Wasserstein, Cynthia Huffman, and Don Tosh, recent members of the Council, and the current Council members, Brian Hollenbeck, Mark Hamner, David Dempsey, Pete Skoner, and David Gardner. All of you have had a positive impact on my life, and I am thankful for your friendship.

I also want to recognize all the hard work of the Pentagon editors and regional directors who put in countless hours to support this organization. Last, but certainly not least, I want to thank all the corresponding secretaries and faculty sponsors, who interact with and support the student members on a daily basis. Without you, this organization would not exist.

Rhonda McKee
National President

Report of the National President-Elect

This is my fourth year as President-Elect. I have really enjoyed my time as President-Elect as I have worked with excellent colleagues on the National Council as well as from the host chapters for the past three national conventions. I welcome Doug Brown, our new *Pentagon* editor, and say farewell to Pete Skoner and Rhonda McKee. Pete has been an excellent historian and I still refer to his history of KME compiled in 2013. Rhonda's remarkable 17 years of service on the council spans my entire time as a member of KME. She will be greatly missed, although I am sure I will be contacting her often with questions. I wish Pete and Rhonda all the best.

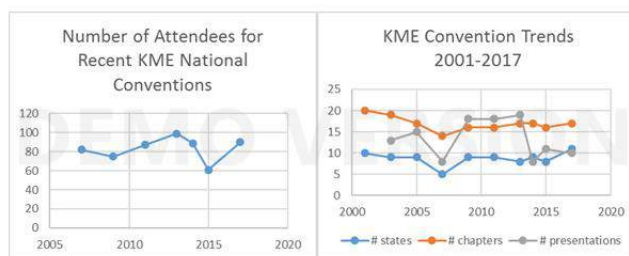
2017 National Convention

Kappa Mu Epsilon's 41st Biennial Convention, which is KME's 42nd national convention overall, is being held this weekend, April 6-8 in Springfield, Missouri. Our host chapter is Missouri Theta at Evangel University. There are 17 chapters in attendance from 11 states (Alabama, Georgia, Kansas, Missouri, Nebraska, North Carolina, Oklahoma, Pennsylvania, Tennessee, Texas, and Virginia). 10 presentations will be given by students from these chapters. There will also be a panel discussion and four workshops given over the course of the next two days. There are 90 KME members registered for the convention.

Once again, the AMS and the ASA have contributed \$500 each, which will be used to help defray the cost of student travel to the convention. We are certainly grateful for their support.

Finally, I would like to extend special thanks to Don Tosh, Dianne Twigger, and the Missouri Theta chapter for hosting this convention. Their efforts will make this convention a successful and enriching experience.

These charts show how this year's convention compares to other years.



In the 2000's, 54 different chapters have participated. Five have participated in all ten conventions. Six chapters are participating for the first time this century.

Brian Hollenbeck
President-Elect

Report of the National Secretary

Kappa Mu Epsilon, National Mathematics Honor Society initiated 2,601 new members in 131 chapters during the 41st Biennium that ended March 15, 2017. That brings the total membership of KME to 86,048. Twenty-Five active chapters did not report any initiates during the 41st biennium.

As National Secretary, I receive all initiation reports from chapters, make a record of those reports, up-date mailing list information for corresponding secretaries and forward copies of the reports to other officers. At the beginning of each new biennium, I prepare a new KME brochure. During an academic year, I send out supplies to each chapter. The supplies include information brochures, membership cards and one or two copies of the brochure "A Matter of Honor." When a college or university petitions for a new chapter of KME, I send out a summary of the petition, prepared by the president, to each chapter and receive the chapter ballots.

Mark Hamner
National Secretary

Report of the National Historian

It is with pleasure and hope that I submit my final report at the end of my fourth biennium of service as the National Historian of the Kappa Mu Epsilon National Mathematics Honor Society. It has been a pleasure to serve with the national and regional officers, with the corresponding secretaries and faculty sponsors of individual chapters, and with the many student officers through these short eight years. Moreover, it is with hope that I see this organization continuing to grow, thrive, and prosper for many more years to come.

Thank you all for your service, commitment, communication, and friendship. The passion and time all of you give contributes to this great organization that will celebrate our 86th anniversary since our founding on April 18, 1931, as we gather for our 42nd national convention. This 42nd national convention happens to be our 28th composite-numbered convention, our sixth pronic-number convention, the sixth convention number bracketed by twin primes, and according to *The Hitchhiker's Guide to the Galaxy* by Douglas Adams, the number 42 is the "Answer to the Ultimate Question of Life, the Universe, and Everything." Just to clarify, this would have been our 43rd national convention in 86 years, but two were not held during WWII, and then for the first time in 2014 we held a convention in an even-numbered year.

The primary function of the national historian is to solicit, collect, maintain and compile records of chapter activities, installation of new chapters, and other society activities that have historical significance. Distribution e-mail messages solicit Chapter News reports after every fall and spring semester. This regular messaging provides the opportunity to learn about chapter leadership changes and to maintain communication between the national society and the local chapters, hopefully helping to maintain the local leadership for each chapter and fulfill the mission of the organization to recognize students who excel in mathematics. The work of the National Historian is impossible without the aid of the corresponding secretaries for each chapter. Thank you for all that you do in serving the students at your institution, your local chapter, and the national organization.

During the past biennium from March 2015 to March 2017, 67 different chapters responded at least once to the chapter news request, a decrease from 73 in the previous biennium. Special mention goes to the following 16 chapters for their cooperation in responding to all four inquiries: AL Zeta, AL Theta, CT Beta, HI Alpha, IA Alpha, KS Delta, MD Delta, MI Delta, MO Alpha, MO Theta, NE Delta, NY Omicron, OH Theta, PA Mu,

TN Gamma, and VA Delta.

At the 39th national convention at Washburn University, the 82nd Anniversary *KME History and Information Booklet* was distributed. Since then, several sections of that document have been added to the KME home page, and updates were made periodically. Another updated and printed version is suggested for the 90th Anniversary in 2021.

A special thank you goes to the editors of *The Pentagon* during this biennium, initially Bro. Daniel Wisniewski, O.S.F.S., of the Pennsylvania Tau chapter, and more recently Doug Brown of the North Carolina Zeta Chapter. The edited Chapter News section is sent to the editor after each semester, and Brother Daniel and Doug have both been great to work with.

The records of the society were passed to me eight years ago by then historian Connie Schrock; they contain a file of chapter news reports and other correspondence for every chapter. Since I became historian in 2009, only electronic reports have been collected, and all those are stored electronically. All of the paper documents have also been scanned from nine boxes into electronic files stored in a separate folder for every chapter. The hope eventually would be to have a searchable electronic database of all chapter records, and to move the paper files into a national mathematics archive. Thank you all for allowing me to serve this wonderful organization!

Peter R. Skoner
National Historian

Report of the National Treasurer

41st Biennium (March 16, 2015 – March 15, 2017)

A Biennium Asset Report and Biennium Cash Flow Report are given below. The Asset Report shows biennium assets of **\$105,180.96**. The Cash Flow Report shows that we have an **asset gain of \$9,132.60 this biennium**.

BIENNIUM ASSET REPORT

Total Assets at beginning of 41st Biennium (March 16, 2015) \$96,048.36

Current Assets (Wells Fargo Bank)	
Checking	26,584.25
Savings	40,069.20
Time Account xxx7120	10,020.01
Time Account xxx7138	10,030.04
Time Account xxx7146	10,050.12
Time Account xxx7153	10,050.12
Total Current Assets (as of March 31, 2017)	\$106,803.74
- uncleared check #1538	- \$48.50
Total Current Register Assets (as of March 31, 2017)	\$106,755.24
- Activity since end of 41st Biennium (March 15, 2017) -	\$1,574.28
Total Assets (Register) at end of 41st Biennium	\$105,180.96

BIENNIUM CASH FLOW REPORT

Receipts	
Initiation fees received	50,450.00
Installation fees received	375.00
Interest income	328.43
Gifts & misc. income	1,704.04
Total Biennium Receipts	\$52,854.47
Expenditures	
Association of College Honor Societies	2,367.30
Administrative expenses	2,520.43
National Convention expenses	16,366.96
Regional Convention expenses	1,621.94
Certificates, jewelry & shipping	19,986.08
Pentagon expenses	579.00
Bank charges	64.02
Miscellaneous (overpayment)	50.00
Total Biennium Expenses	\$43,721.87
Biennium Cash Flow	\$9,132.60

The cash flow last biennium (13-15) was **\$7,047.15**. The National Council passed on part of this increase to the students and chapters by giving an extra amount for the 2015 National Convention (\$300 above normal allocations) and also giving travel allocations for the 2016 Regional Conventions (Reg. 2-Great Lakes & Reg. 4-North Central, \$100 to each chapter attending). Each chapter is also receiving an extra in their travel allocation for the 2017 National Convention (\$200), which will show up in the next biennium report. We have easily continued to meet our National Council goal of maintaining assets of at least \$40,000. The financial condition of Kappa Mu Epsilon is sound. We have added additional assurance by purchasing a fidelity bond insuring Kappa Mu Epsilon, Inc., against any losses resulting from dishonesty of the 5 main officers (however unlikely).

This is my first biennium as national treasurer, so I owe a big debt of gratitude to past treasurer Cynthia Huffman, who graciously “minded the store” while we got a new account set up during the summer of 2015, and who gave me detailed instructions on all facets of the treasurer’s job. I also want to thank my colleagues on the National Council (Rhonda McKee, Brian Hollenbeck, Mark Hamner, Pete Skoner, and David Gardner) for their untiring dedication. In addition, I give kudos to all of the corresponding secretaries who maintain such a vital role in Kappa Mu Epsilon. I am grateful for the opportunity to serve with such outstanding individuals in encouraging and recognizing students for accomplishments in mathematics.

David Dempsey
KME National Treasurer

Report of *The Pentagon* Editor

Introduced in 1941, *The Pentagon*, is the official publication of Kappa Mu Epsilon. Publication of student papers continues to be the focus of *The Pentagon*. Following tradition, papers given “top” status and other recognition by the Awards Committee at the KME National Convention are guaranteed an opportunity to be published. *The Pentagon* is now completely electronic and available for free online via the KME website: www.kappamuepsilon.org.

I have been the Editor of *The Pentagon* since November 2016. During the past year I have been corresponding with authors of potential articles for submission, and facilitating referee feedback and author corrections for upcoming issues. Since assuming this position, one issue (Spring 2016) of *The Pentagon* has been published and made available on the website. While overdue, the Fall 2016 issue is near completion, awaiting final typesetting, and my goal is to have Spring 2017 published prior to the end of the summer. The Problem Corner continues to be made available on the KME website ahead of publication of the full issue.

In addition to the normal course of business, over the next year I hope to update and add to the list of referees for *The Pentagon* as well as, in consultation with the members of the National Council, set and maintain a publication schedule for future issues. The latter will require a steady stream of articles from which to select, so assistance from the chapters in encouraging students to submit papers will be greatly appreciated.

Finally, I am very grateful to Daniel Wisniewski, the previous editor of *The Pentagon*, and the Associate Editors: Pat Costello, who organizes the Problem Corner for each issue, and Pete Skoner, who collects and prepares the KME News Items. Their patience and advice have been invaluable during this period of transition.

Doug Brown
Editor, *The Pentagon*

Report of the Audit Committee

Audit Committee Members:

Scott Thuong, Kansas Alpha, faculty, chair
Angela Crumer, Kansas Delta, faculty
Brianna Maybee, Missouri Theta, student
Chelsea Mitchell, Virginia Alpha, student
Jorge Rebaza, Missouri Alpha, faculty
Mackenzie Snyder, Missouri Beta, student

Audit Process

1. Prior to the national convention, Treasurer David Dempsey provided electronic copies of the biennium financial summary data to the committee chair to facilitate verification of asset account totals prior to the convention. The Audit Committee Chair subsequently contacted Wells Fargo Bank (Jacksonville, Florida) by telephone. The account balances for the Kappa Mu Epsilon Platinum Business Checking account, Platinum Business Savings accounts, and the four Time accounts were verified to correspond to the associated totals found on Treasurer Dempsey's biennium reports. This verification was conducted on April 5, 2017 for the balances as submitted by Treasurer Dempsey on April 3, 2017.
2. At the convention, Treasurer Dempsey provided the committee with a sturdy, heavy box with detailed documentation for receipt and payment transactions, monthly bank account statements and reconciliation documentation, expense reports, receipts, income information, as well as his own reports and summary for the full biennium. This financial documentation was perused by the committee for accuracy.
3. At the national convention, the Audit Committee Chair interviewed President Rhonda McKee and Secretary Mark S. Hamner to determine their impressions of the accuracy and completeness of the recording of the financial transactions throughout the biennium.

Findings

1. The bank information provided by Treasurer Dempsey (as of March 15, 2017) was verified by the committee chair on April 5 via a phone conversation with Mrs. Donna Kopet, of Wells Fargo Bank (Jacksonville, Alabama).
2. The committee spot checked the Secretary's report and corresponding

computer generated Treasurer's report and found no inconsistencies throughout. We talked to the Secretary who reported perfect compliance by Treasurer Dempsey on this subject.

3. The committee spot checked the expense payment reports and receipts provided and found no inconsistencies. The President expressed total satisfaction with the integrity of the process.
4. The committee inspected monthly financial institution statements, quarterly interest statements, and CD interest reports. We compared those to the Treasurer quarterly reports. We found complete consistency between bank statements throughout the biennium.

Recommendations

1. Information forwarded by the Treasurer to the committee chair prior to the national convention provides the opportunity for verification of assets in a careful, yet relaxed manner, and should be continued for future audit committees.
2. The internal checks built into the regular financial processing between the Treasurer, President, and Secretary provide an important safeguard to the integrity of the office of the Treasurer and help avoid the necessity of an expensive external audit. These ongoing internal audit processes should be continued and updated by the National Council as needed.
3. The organization files an electronic tax notecard annually even though no taxes are required and the committee recommends that this practice continue.

Commendations

1. The committee commends Treasurer David Dempsey for his excellent maintenance, management, and presentation of the financial records.
2. We further commend him for his valuable input and advice to this Audit Committee, and his helpful detailed written guidelines for the Audit Committee: a clear 4-step audit process.
3. The committee commends the national President, Secretary, and Treasurer for the manner in which they communicate and cooperate to maintain the internal checks that preserve the integrity of the office of Treasurer.

4. The committee commends the work of the previous audit committees, and is thankful for the sample reports provided by the Treasurer.

Scott Thuong
Chair, Audit Committee

Report of the Resolutions Committee

The Resolutions Committee consisted of:

- Parker LaMarcus, (student member from Oklahoma Epsilon chapter),
- Daniel Miradakis (student member from Alabama Theta chapter),
- Katie Jones (student member from Kansas Delta chapter),
- Samantha Orr (student member from Missouri Theta chapter),
- Bethany Morgan (student member from Missouri Alpha chapter),
- Georgette Searan (student member from Kansas Alpha chapter), and
- Steven Shattuck (faculty member from Missouri Beta chapter).

This Committee hereby proposes the following resolutions.

“Whereas the success of any undertaking relies heavily upon the dedication and ability of its leaders, be it resolved:

1. That this 41st Biennial National Convention express its gratitude
 - a. to Brian Hollenbeck (president-elect), Mark Hamner (national secretary), David Dempsey (national treasurer) and David Gardner (Webmaster);
 - b. to Pete Skoner for eight years of hard work and dedication to the office of national historian;
 - c. to Doug Brown for his service as editor of *The Pentagon*, Pete Skoner for his service as the Pentagon News Editor and Partick Costello for his work with the Problems Corner, and
 - d. to Pedro Muiño, Janye Curry, Donna Pirich, Katherine Kime and John Diamantopoulus for their service as regional directors.
2. That this national convention would like to acknowledge its appreciation to Cynthia Huffman and Leah Childers for their willingness to serve in the national officer positions that are opening this year.
3. That this Convention acknowledge the participation of the students and faculty who served on the Auditing, Awards, Nominating, and Resolutions committees, which is so essential for the success of the meeting.

“Whereas this organization has benefited for many years from her hours of dedication and work, be it further resolved that this Convention thank Dr. Rhonda McKee of Missouri Beta at the University of Central Missouri in Warrensburg, MO.

- She has served KME as corresponding secretary for 28 years,
- as a regional director of the North Central Region for two years
- as national secretary for nine years,
- as president-elect for four years, and
- as national president for four years

Her dedication and service has been truly appreciated. “Whereas the primary purpose of Kappa Mu Epsilon is to encourage participation in mathematics and the development of an appreciation for its beauty, be it further resolved:

1. That students, Parker LaMascus, Joshua Stucky, Shahriyar Roshan Zamir, Hayley Hutson, Ashley Beard, Zach Bowen, Landis Duff, Jacob Rowley, Chelsea Mitchell, Blake Jackson, Chris Mount, Katelynn Robinson, and Catherine Ross who prepared, submitted, and then presented their papers be given special commendation by this 41st Biennial Convention for their enthusiasm and dedication, and
2. That this Convention express its thanks
 - a. to Brian Dawson for the workshop “Calculus Limits via Infinitesimals(they’re easier!);”
 - b. to Cynthia Huffman for the workshop “Bell-y Math: Connections between Mathematics and Change Ringing;”
 - c. to John C.D. Diamantopoulos for the workshop “Shapes and Smiles;”
 - d. to Angela Crumer and Jason Shaw for the workshop “Using R for Simulation Studies;” and
 - e. to Eve Torrence for her keynote address “A Mathematical Art Gallery Tour” at the Friday night banquet.

“Finally, whereas Evangel University and the surrounding community of Springfield, MO has provided this Convention with gracious hospitality, be it resolved:

1. That this 41st Biennial Convention express its heartfelt appreciation to the Missouri Theta chapter for the thorough arrangements they have planned and carried out so successfully, and
2. to the American Mathematical Society and to the American Statistical Association, through whose grant support the operations of this Convention were augmented; and

3. That this Convention recognize and thank Dr. Don Tosh and Diane Twigger together with all the other members of Missouri Theta, who devoted their time and talents to ensure the success of this meeting.

These resolutions respectfully submitted,
Steven Shattuck, Chairperson

Report of the Awards Committee

The Awards Committee met to select the three award winners. These are:

- 2-4 *Application of SVD: Information Retrieval and Document Ranking*. Blake Jackson and Chris Mount, Alabama Theta, Jacksonville State University
- 3-2 *Housing Market Time Series Analysis - Before and After Housing Bubble* by Katelynn Robinson, Kansas Delta, Washburn University
- 2-3 *Coloring $\mathbb{R}^n$* , by Zach Bowen, Landis Duff, and Jacob Rowley, Kansas Alpha, Pittsburg State University

Respectfully submitted.
Brian Hollenbeck, Chairperson

Great Lakes Region-Director's Report

In the 2015-2017 biennium, my contributions to KME have focused on two related areas: the consolidation of the Regional Newsletter and the increased participation of local chapters in the society at large.

- Three years ago, I started an electronic newsletter within the region. My plan is that, eventually, the newsletter will serve as a means to exchange ideas about chapter activities and strengthen inter-chapter communication. It will also have reports on convention attendance and announcements about regional and national events. So far, contributions from chapters have been minimal.
- Participation by chapters of this region in national events is spotty. Only a few institutions, Central Michigan, Saint Francis University and more recently Bethany College, routinely attend national conventions. They have routinely collaborated in the successive editions of the newsletter.

On April 24, 2015, I attended with Dr Pete Skoner the installation of the Ohio Theta chapter at Capital University in Columbus Ohio. I was also the keynote speaker at the ceremony. In addition, I collaborated with Dr Skoner to arrange for a regional convention in Spring 2016. This was done in conjunction with the MAA Ohio Sectional Meeting. Five KME chapters attended this convention, held at the campus of Ohio Northern University on, April 8 -9, 2016. I have participated in the last 6 national conventions (including this one) and served in committees in each of them. In the 2015 National Convention, I chaired the Auditing Committee and, leading to this convention, I have served as chair of the Nominations Committee. I would have liked to increase the means of communication with the chapters. I had discussed this with the National Historian and he had suggested the possibility of data mining the chapter news for information. Unfortunately, several emails were sent to the chapters to seek out contributions to the newsletter, but I never received any responses. In my last annual convention, I discussed with the National Council the possibility of establishing direct lines of communication with the student officers in each chapter. I believed that this involvement would have increased the likelihood of chapter participation in regional and national activities. Unfortunately, I tried once to contact students directly, using the database provided to me by Pete Skoner, but I did not receive any responses either.

Pedro L. Muiño
Regional Director, Great Lakes Region

Faculty Sectional Meeting

President Rhonda McKee opened up the meeting about the purpose of section meetings: to share ideas. Participants introduced themselves.

- Expanding options on how to make payments to KME
 - For registration, fees, etc.
 - Should options include: Credit card/PayPal/checks
 - Should we include a small convenience charge?
 - Who gets notified after payment?
 - Fees for student checks may be a problem
- We have 156 active chapters, 17 chapters present—how can we get others to join/attend?
 - Reimburse travel for sponsors/incentivize sponsors
 - Better communication about monetary support available
 - Personal outreach
- Student Research-We recognize that students have opportunities for showcasing their research
 - Highlight or make The Pentagon well known
 - Holding a Fall Convention (Spring is packed with activities. Maybe February as alternative option, if kept in Spring)
- Successful things your chapters have done?
 - Host National KME (MO Theta)
 - Pie Your Professor (week after pi day) - I believe this generated \$200
 - Poster competitions
- How many have monthly meetings?
 - Varies! From once a month to every other week
- KME Marketing
 - Host videos on the website (ex. Number files)
 - Attractive way to draw students/create excitement
 - * Presentation of ourselves: students and professors

Rhonda McKee's concluding remarks focused on thanking the Corresponding Secretaries.

Student Sectional Meeting

1. Favorite events:
 - Pizza, games, and math-related movie nights
 - Math Day - middle/ high school math competition and scavenger hunt
 - Using punch cards to create Menger sponge (build upon to make larger)
 - Planetarium show - “Pi in the Sky” - mapping stars
 - First meeting of the year allow students to discuss their math-focused internships and/or jobs over the summer
2. Best fundraising events and service projects:
 - Fundraising
 - * Pi Day Bake sale
 - * Selling mugs with professor’s face and funny quote
 - * “Pi Your Professor”
 - * Selling old textbooks of professors
 - Service Projects
 - * Peer Mentoring/Tutoring in higher level math courses
 - * Partnering with campus-wide service days
 - * Donating to food banks
 - * “Trunk or Treat” (with all other orgs. on campus)
3. Recruitment strategies:
 - Send e-mails of qualifications and events to all math students
 - At beginning of the year, all majors meet individually
 - * Math opportunities are explained
 - * Or KME members can visit math classes to explain opportunity
 - Combine KME with Math Club
 - Making flyers/posters/personal invites
 - Student Activities fair

4. Methods to maintain involvement:
 - Having more relaxed/fun events
 - * Free food, movie/game nights
 - Math talks/presentations
 - * Math Magic
 - On/off campus events
 - Big and Little system (mentoring and bonding)
 - Having regular meetings (consistency)

Kappa Mu Epsilon News

Edited by Cynthia Huffman, Historian

Updated information as of July 2017

News of chapter activities and other noteworthy KME events should be sent to

Cynthia Huffman, KME Historian

Pittsburg State University

Mathematics Department

117 1701 S. Broadway

Pittsburg, KS 66762

or to

cjhuffman@pittstate.edu

KAPPA MU EPSILON

Chapter News

AL Beta – University of North Alabama

Corresponding Secretary – Ashley Johnson; 17 New Members

New Initiates – Grant Bentley, Derek Brown, Millainya Cammarata, Sydney Corum, Emma Fancher, Ashton Haralson, Chandler Hawkins, Nicholas Holley, Joshua Kent, Evan Lott, Brooke Maupin, Emma McFall, Anna Mosley, Samuel Oliver, Keeley Osborne, Kelsey Varner, and Jared Wood.

AL Gamma – University of Montevello

Chapter President – Jordan Romine; 13 Current Members; 8 New Members

Other Fall 2017 Officers: Anna Leinheiser, Vice President; Drew Mulinax, Secretary; Corresponding Secretary, Scott Varagona; and Faculty Sponsor, Michael Sterner.

AL Epsilon – Huntingdon College

Corresponding Secretary – Dr. William Young; 4 New Members

New Initiates – Kyle Lancaster, Mikal Webb, Taylor Blackwell, and Kim Holman.

AL Zeta – Birmingham-Southern College

Chapter President – Adam Pratt; 46 Current Members; 19 New Members

Other Fall 2017 Officers: Marjory Day, Vice President; Mary-Stewart Wachter, Secretary; Cynthia Kagambirwa, Treasurer; and Maria Stadnik, Corresponding Secretary and Faculty Sponsor.

This term KME sponsored a Pi Day Pizza Pie Party on Pi Day, March 14. KME officers also attended a meet-and-greet with underclassmen at a

campus-wide event to encourage them to declare majors on April 4. KME sponsored a Math Movie Night on April 26, where we had a viewing of the movie “Hidden Figures.” Lastly, at our initiation ceremony, we initiated 19 new members to KME and elected officers for next year.

New Initiates – McKenna Boyd, Scott Burchfield, Sophie Cheng, Turner Collins, Jake Cook, Garrett Hagood, Jessica Harvey, Stephen Paul Himic III, Daiqi Liu, Krishna Patel, Andrew Praytor, Jessyca Ray, Margot Rylee Segrest, John Michael Shirley, Elizabeth Sims, Andrea Vancil, Wenshang Wang, Zirui Wang and Blaire Woolverton.

AL Eta – University of West Alabama

Corresponding Secretary – Dr. Hazel Truelove; 12 New Members

New Initiates – Bailey Elizabeth Agee, Caren Betuin, Jacarius Brown, Audrey Cochrane, Caden Hannah, Ian Hester, Terrell Tae’Sean Malone, Savannah Payne, Hunter Ray, Griffin Ricketson, John Watkins, and Michael Whitlock.

AL Theta – Jacksonville State University

Chapter President – Daniel Miradakis; 50 Current Members; 28 New Members

Other Fall 2017 Officers: Becky Peters, Vice President; Jasmine Beaudette, Secretary; James Thompson, Treasurer; and Dr. David Dempsey, Corresponding Secretary and Faculty Sponsor.

On March 3, 2017, the Alabama Theta chapter initiated 27 new student members and 1 new faculty member. New members received their certificates, pins, and honor cords in a ceremony held on the 11th floor of Houston Cole Library. Spring activities included outings for bowling and Escape Zone (escaping from a room by solving puzzles), as well as several pizza and game nights. Prior to the KME National Convention, students Chris Mount and Blake Jackson gave a colloquium talk on rank ordering algorithms, in preparation for their presentation at the convention. In addition to these two students, AL Theta had 5 student members attend the convention.

New Initiates – Jacob Beam, Jake Bolton, Cory Bradley, Joel William Branham, Halea Faith Carr, Alison Nicole Cline, Amanda Crumpton, Laura Ashley DeBord, Katie Jordan Finlayson, Vijaya Gomp, Caelan Andrew Goss, RayAnne Elaine Hill, Megan Brooke Kilgore, Akira Andrea Kimbrough, Kaci Ann Kirk, Jordan Fisher Kittrell, Johnny Lin, Loren A. Moor, Andrew S. Petty, Joy Pinckard, Austin Matthew Powell, Colton Howard Prince, Holly Sparkman, Micaela Faye Truett, Alicia Underwood, Jared Underwood, Stefanie Watts, and Emily L. Weathers.

CA Epsilon – California Baptist University

Corresponding Secretary – James Buchholz; 22 New Members

New Initiates – Jared Adams, Dulce Bravo, Matthew Brungardt, Audrey Cella, Christopher Chen, Jenna Cray, Christina Cruickshank, Ethan Danskin, Stephen Dueck, Joyeuse Dufitumukiza, Madison Gallardo, Andrew Grasmick, Mark Holguin, Jordan Howard, Nathan

Kawaguchi, Connor Klein, Eliot Lu, Viviane Niyomwungeri, John Rizk, Michael Sutherland, Kylie Vari, and James Vest.

CT Beta – Eastern Connecticut State University

Corresponding Secretary – Mehdi Khorami; 475 Current Members; 13 New Members

New Initiates – Amanda S. Burkhart, Alysha M. Ciscone, Katherine T. Cutting, John A. Harakas, Thomas Locker, Emily A. Lorenzet, Lawrence L. McGill, Kara A. Noble, Kacey M. Pilver, Emily M. Reguin, Michael J. Underwood, Jiwen Zhang, and Robert D. Zielinski.

CT Gamma – Central Connecticut State University

Corresponding Secretary – Mihai Bailesteanu; 28 Current Members; 28 New Members

New Initiates – Marian F. Anton, Mihai Bailesteanu, Olivia Baillargeon, Nilay Nitin Bhatt, Jeffrey Blankenship, Nelson Castaneda, Rong Chen, Zoe Anne Cramer, Luke Robert D’Ascoli, Natalie Decker, Patrick Andrew Dzioba, Robert G. Johnston III, Frederic Latour, Heath W. Loder, Lilia Miller, Andrew S. Pelletier, Michael Israel Quinonez, Nicholas Pipino, Landon Renzullo, Rina Saliu, Ryan Schmidt, Rachel Schwell, Patryk Stolarz, Damian Szarwacki, David J. Thorne, Pedro R. Urbina, Peter C. Woolard, and Cassady Brooke Zipkin.

FL Beta – Florida Southern College

Corresponding Secretary – Susan Serrano; 9 New Members

New Initiates – Shelby Cain, Jade Green, Allison Howard, Jonathan Katz, Abigail Keck, Nicole Mattson, Cole McCormick, Dawn Phan, and Rebecca Smith.

FL Delta – Embry Riddle Aeronautical University

Corresponding Secretary – Jayathi Raghavan; 3 New Members

New Initiates – Michael Audia, Shealynn Cloutier-Bisbee, and McKenna James.

FL Gamma – Southeastern University

Chapter President – Erica Furtado; 53 Current Members; 7 New Members
Other Fall 2017 Officers: Other Spring 2017 Officers: Matthew Scales, Vice President; Briana Anson, Secretary; John White, Treasurer; and Dr. Berhane Ghaim, Corresponding Secretary and Faculty Sponsor.

New Initiates – Peace Ajale, Briana Anson, Erika Furtado, Mason Gore, Nathaniel Jordan, Nathaniel Sand, and Matthew Scales.

GA Beta – Georgia College and State University

Corresponding Secretary – Rodica Cazacu; 3 New Members

New Initiates – William D. Edmiston, Alec D. Powers, and Margo A. Rothstein.

GA Gamma – Piedmont College

Corresponding Secretary – Hope Menzel; 1 New Member

New Initiates – Taylor Cramsey.

GA Epsilon – Wesleyan College

Corresponding Secretary – Dr. Joe Iskra; 5 New Members

New Initiates – Peiwen Li, Liana Mikaelyan, Zhiyun Qiu, Xin Tang, and Jing Wu.

GA Zeta – Georgia Gwinnett College

Chapter President – Shahriyar Roshan Zamir; 47 Current Members; 3 New Members

Other Fall 2017 Officers: Bess Burnett, Vice President; Heather McAfee, Secretary; Antoinette Miezan, Treasurer; Dr. Jamye Curry, Corresponding Secretary; and Drs. Jenny Sinclair and Livy Uko, Faculty Sponsors.

This semester our chapter had 2 KME members to graduate, in which one will be attending graduate school at the University of Minnesota, Duluth.

New Initiates – Hye An, Matthew Stiller, and Hannah Duncan.

GA Eta – Atlana Metropolitan State College

Corresponding Secretary – Mulugeta Markos; 22 New Members

Other Fall 2017 Officers: ETC

The GA Eta Chapter had its installation ceremony on January 31, 2017. Welcome to the KME Family!

New Initiates – Bassam Abdulatif, Malik Buron, Toni Byrd, Gyuheui Choi, Simone Clark, Joseph Daniels, Shreyas Desai, James D. Dowdell, Anthonia Ekwuocha, Raghu Gompaa, Rama Hawaii, Jackson Henry, Dongwook Kim, Kwan Lam, Mulugeta Markos, Bruce McNeal, Lanessa Northcut, Joseph Patterson, Pitso Senalte, Leia Singh, Devante Singletary, and Noel Whelchel.

HI Alpha – Hawaii Pacific University

Chapter President – Andreas S. Koutsogiannis; 20 Current Members; 5 New Members

Other Fall 2017 Officers: Tara Davis, Corresponding Secretary and Faculty Sponsor

We had our initiation dinner on April 4, 2017.

New Initiates – Alex Chernauskas, Raymart de Asis, Sean Harding, Andreas S. Koutsogiannis, and Brian Spain.

IA Alpha – University of Northern Iowa

Chapter President – Jake Weber; 25 Current Members; 5 New Members

Other Fall 2017 Officers: Macey Winter, Vice President; Destiny Leitz, Secretary; Taryn Vanryswyk, Treasurer; and Mark D. Ecker, Corresponding Secretary and Faculty Sponsor

Our first spring KME meeting was held on February 28, 2017 at Professor Syed Kirmani's residence, where student member Destiny Leitz talked about her campus job as a research assistant for the Business Concierge Program in the Center for Business Growth and Innovation. Our second meeting was held on March 28, 2017 at Professor Mark Ecker's residence where student member Taryn Vanryswyk talked about her paper entitled "What Factors Determine the Age at which an NFL Player Retires?". Student member Heather Bavido addressed the spring initiation banquet with "Motherhood Wage Penalty in the US" on April 25, 2017. Our banquet

was held at Godfather's Pizza in Cedar Falls, where five new members were initiated.

New Initiates – Maria Ahrens, Treasure Divis, Abigail Goedken, Nicholas Mlodzik, and Hannah Pace.

IA Beta – Drake University

Corresponding Secretary – Lawrence Naylor; 3 New Members

New Initiates – Rachel Olsen, Ann Samuelson, and William Swanson.

IA Delta – Wartburg College

Corresponding Secretary – Brian Birgen; 7 New Members

New Initiates – Britney Fuller, Travis Gudenkauf, Ashlyn Jelinek, Kayla Phelps, Rebecca Waldman, Sarah Yotter, and Michael Zhang.

IL Zeta – Dominican University

Corresponding Secretary and Faculty Sponsor – Aliza Steurer; 18 Current Members; 4 New Members

The Illinois Zeta chapter initiated four new members this year. The initiation ceremony took place on Sunday, April 9, 2017. Guest speaker Dr. Melanie Pivarski from Roosevelt University gave a talk about data analysis and the NetFlix predictive modeling contest. New members and their families attended the ceremony and enjoyed the talk.

New Initiates – Mihaela Blanariu, Ph.D., Marissa Juarez, Laura Prout, and Victor Roman.

IL Theta – Benedictine University

Chapter President – Hannah Wangler; 15 Current Members; 4 New Members

Other Fall 2017 Officers: Kassy Candelaria, Vice President; Mary Kate Stewart, Secretary; Ayesha Quadri, Treasurer; Dr. Anthony DeLegge, Faculty Sponsor; and Dr. Thomas Wangler, Corresponding Secretary.

New Initiates – Rana Ahmad, Chris Grazioli, Katharine Howard, and Luke Kendall.

IL Kappa – Aurora University

Corresponding Secretary – Sebastian Wyman; 12 New Members

New Initiates – Gilberto Acosta-Rivera, Tomas Aguilar, Juliet Eklou, Sandra Gonzalez, Luis Leguer, Mitch Lody, Autumn Oley, Alicia Rotolo, Cory Thom, Nate Underwood, Maria Villalpando, and Caitlin Wisniowicz.

IN Beta – Butler University

Corresponding Secretary – Bill Johnston; 10 New Members

New Initiates – Justina Kaiser, Lauren Wiley, Charles Kovarik, Meredith Varner, John Anderton, Micah Brame, Emily Lawson, Lauren Briskey, R. Alexander Glickfield, and Anthony Gurovski.

IN Gamma – Anderson University

Corresponding Secretary – Courtney Taylor; 3 New Members

New Initiates – Christina Coats, Ashley King, and Samantha Stiers.

KS Alpha – Pittsburg State University

Chapter Presidents – Georgette Searan and Cole Hurley; 35 Current Members; 14 New Members

Other Spring 2017 Officers: Hayley Reynolds, Vice President; Zachary Bowen, Secretary; Amber Bartlett, Treasurer; Dr. Tim Flood, Corresponding Secretary; and Dr. Scott Van Thuong, Faculty Sponsor.

The Kansas Alpha section held joint monthly meetings with the Pittsburg State University Math Club in February, March, and April. At these meetings, participants enjoyed presentations over polynomial “magic” tricks, the cross ratio, and the 16th century mathematician Girolamo Cardano, respectively. In the April meeting, 15 new members we initiated. Kansas Alpha sent three faculty and three students to the 2017 KME National Meeting in Springfield, MO. Dr. Leah Childers was elected as President Elect and Dr. Cynthia Huffman was elected as National Historian. In addition, two student presenters, Landis Duff and Jacob Rowley, received a top presentation award for their presentation “Coloring $\mathbb{R}^n$.”

New Initiates – George Bookless, Alexis Carpino, Rylie Farrar, Jessica Hardy, Ethan Hartzell, Micah Hashman, Ryan Kellenberger, Mason McCreath, Jacob Petry, Sam Platt, Ruijie Shen, Angela Slater, Sharnnel Sumang, and Samantha Wright.

KS Beta – Emporia State University

Chapter President – Paige Nurnberg; 40 Current Members; 4 New Members

Other Spring 2017 Officers: CeJae Jordan, Vice President; Henry Weiner, Secretary; Anthony Gagliano, Treasurer; Tom Mahoney, Corresponding Secretary; and Brian Hollenbeck, Faculty Sponsor.

In the new KME Lounge at Emporia State University, our KME members have been making use of hundreds of old computer punch cards to create a level-2 Menger sponge.

New Initiates – Montana Garrison, Ce Jae Jordan, Paige Nurnberg, and Henry Weiner.

KS Delta – Washburn University

Corresponding Secretary and Faculty Sponsor – Kevin Charlwood; 5 New Members

New Initiates – Erik Bittner, Laura Crosswhite, Kaitlyn Jones, Katelyn Meyer, and Cory Petit.

MA Alpha – Assumption College

Corresponding Secretary – Joseph Alfano; 11 New Members

New Initiates – Veronica A. Beaupre, Meghan M. Cushing, Matthew P. Donaghey, Ashley E. Fagan, Daniel A. Heston, Ashley N. Lockwood, Marina Lundstrom, Zachary J. Shepard,

Michael J. Vayda, Carly T. Wheaton, and Alexandra L. Wuerfl.

MA Beta – Stonehill College

Corresponding Secretary – Timothy Woodcock; 9 New Members

New Initiates – Leyda Almodovar Velazquez, Catello Battinelli, Jason Dimmick, Sarah Finnigan, Jessica Gustafson, Lauren Hennessey, William Melahouris, Kelly Powers, and Matthew Young.

MD Alpha – Notre Dame of Maryland University

Chapter President – Chinwendu Nwokeabia; 25 Current Members; 17 New Members

Other Spring 2017 Officers: Bhavya Bhardwaj, Vice President; Justice Walrath, Secretary Hannah Woodworth, Treasurer; Charles Buehrle, Corresponding Secretary and Faculty Sponsor.

Below are items from MD Alpha:



New Initiates – Sarah Arafat, Bhavya Bhardwaj, Tram Anh Bui, Cassandra Carlson, Erika Deppenschmidt, Morgan Harter, Christa Jordan, Cassidy Keller, Abigail Noble, Victoria Oji, Christine Anne Roa, Sania Saeed, Katherine Salim, Sarishma Thapa, Justice Walrath, Hannah Woodworth, and Jin Hee Yi.

MD Delta – Frostburg State University

Chapter President – Rebecca Lee; 20 Current Members; 10 New Members

Other Spring 2017 Officers: James West, Vice President; Emma Seibert, Treasurer; Mark Hughes, Corresponding Secretary and Faculty Sponsor; and Frank Barnet, Faculty Sponsor

Ten new members were welcomed to the Maryland Delta Chapter during our Initiation Ceremony on February 26. The ceremony featured a lec-

ture by faculty member Dr. Sarah Dumnich on the hierarchy of infinities. During March, our chapter had a successful fundraiser with our Pi-Day Bake Sale. We had math videos and pizza for our March meeting. Our April meeting featured a presentation by faculty sponsor Dr. Frank Barnett on the upcoming solar eclipse. The April meeting also saw the election of our new officers: Sarah Sparks as President, Demetrick McDonald as Vice President, Zach Kline as secretary with Emma Seibert continuing as Treasurer. We finished the semester with our annual picnic.

New Initiates – Braden Ebersole, Zach Kline, Erikas Laignel, Joshua Mason, Demetrick McDonald, Becca Reimer, Sarah Sparks, Aili Wade, Alissa Whiteley, and Devon Zollinhofer.

MD Epsilon – Stevenson University

Corresponding Secretary – Benjamin Wilson; 5 New Members

New Initiates – Alexandra Culp, Thairen Dade, Rebecca Gruver, Courtney Hohn, and Jessica Rega.

MI Delta – Hillsdale College

Chapter President – Hannah Andrews; 52 Current Members; 13 New Members

Other Spring 2017 Officers: Linnet Mbogo, Vice President; Nathanael Meadowcroft, Secretary; Tanner Orion Wright, Treasurer; and Dr. David Gaebler, Corresponding Secretary and Faculty Sponsor

The Michigan Delta chapter held its Spring 2017 initiation on February 28, welcoming 13 new members to the ranks. We also held a screening of the Paul Erdős biopic *N Is a Number*, which drew several students from outside our usual math circle in addition to the KME regulars.

New Initiates – Emma Clifton, David Ditz, Jadon Lippincott, Amanda Marra, Olivia Mulley, Joshua Pautz, Jonathan Peters, Hannah Stumpf, Carrie Williams, Ryan Hutchinson, Mark Panaggio, Thomas Treloar, and Samuel Webster.

MO Alpha – Missouri State University

Chapter President – Rebecca Crow; 41 Current Members; 10 New Members

Other Spring 2017 Officers: Shannon Beardslee, Vice President; Symantha Campbell, Secretary; Sara Jones, Treasurer; and Jorge Rebaza, Corresponding Secretary and Faculty Sponsor

As every semester, we had three seminars:

- Seminar 1: Tuesday February 14th. Dr. Matthew Siebert (Chemistry Department, MSU), talked about “How much chemistry can a quantum chemist compute if he/she can do math?”. Pizza and soda were served.
- Seminar 2: Thursday March 6th. Dr. Ron Hearst (KY3 Chief Meteorologist), talked about “Relating life comfort and weather to mathemat-

ics”. Pizza and soda were served. The event was very special because Ron Hearst is a local TV star.

- Seminar 3: Tuesday April 4th. Dr. Les Reid (Mathematics Department, MSU), talked about “An invitation to problem solving”. Pizza and soda were served.

We also had an end-of-semester party on Thursday May 11th, the last day of classes. We had lots of games music, food, drinks, and desserts. Students informally present about their places of origin (especially, international students), with help from Google maps and images.

New Initiates – Ryan Bagby, Nathan Hartzler, Slate Hayes, Catherine House, Derek Lause, Zhenhao Li, Alec Neeson, Abraham Pascoe, Brittany Porter, and Gabriel Wallace.

MO Beta – University of Central Missouri

Chapter President – Madison Ultican; 23 Current Members; 8 New Members

Other Spring 2017 Officers: Christina Duerr, Vice President; Aaron Butz, Secretary; Nicholas Purcell, Treasurer; Ashley Beard, Historian; Rhonda McKee, Corresponding Secretary; and Steve Shattuck and Nicholas Baeth, Faculty Sponsors

Missouri Beta chapter had a great spring semester. We enjoyed many fun and interesting programs at our monthly meetings, including a game of Math Jeopardy. Mr. Shattuck and Dr. McKee accompanied a group of 10 students to the national convention in Springfield, where Ashley Beard presented a paper related to her honors project, which was a curriculum guide for exploring STEM careers.

New Initiates – Zak Davlin, Tyler Dunaway, Matthew Enlow, Jonathan K. Hunt, Sarah Hughes, Daniel Jedding, Juliana Ortiz, and Jacob Sauter.

MO Epsilon – Central Methodist University

Chapter President – Zac Adams; 6 New Members

Other Spring 2017 Officers: Marlow Case, Vice President; Emily Angell, 2nd Vice President; Emily Faust, Secretary; Miranda Weigand, Treasurer; and Pam Gordy, Corresponding Secretary and Faculty Sponsor

New Initiates – Emily Angell, Marlow Romano Case, Emilie Faust, Alexandra Hudelson, Adam Richterkessing, and Miranda Weigand.

MO Theta – Evangel University

Chapter President – Brianna Maybee; 23 Current Members; 6 New Members

Other Spring 2017 Officers: Brittany Knowlton, Vice President; and Don Tosh, Corresponding Secretary and Faculty Sponsor

Meetings were held monthly. In January we initiated 6 new members and elected new officers. In April we hosted the national convention of KME.

This generated a lot of excitement in the local chapter, and many of the members helped out with the convention logistics. One of our members, Catherine Ross, presented a paper at the conference. Also in April we had our end-of-year barbeque at the home of Dianne Twigger, where honor cords were presented to graduating members.

New Initiates – Sarah Bolick, Daniel Bowerman, Rebekah Chase, Katherine Crank, Heather Culbertson, and Sarah Elam.

MO Kappa – Drury University

Corresponding Secretary – Dr. Carol Browning; 8 New Members

New Initiates – Dr. Chris Branton, Geena Davis, Aidan Derossett, Rachel DeWeerd, Merri-
rick Johnson, Dan Maynard, Jeremy Ryan, and Anne Marie Schudy.

MO Xi – William Woods University

Corresponding Secretary – Chris Schneider; 6 New Members

New Initiates – Alexis Bailey, Briley Browning, Raymond Hune, James Rogers, Bailey M
Ward, and Kelsey Scherder.

MS Alpha – Mississippi University for Women

*Chapter President – Aastha Ghimire; 16 Current Members; 6 New Mem-
bers*

*Other Spring 2017 Officers: Sugam Bhattarai, Vice President; Sagarina
Thapa, Secretary; and Dr. Joshua Hanes, Corresponding Secretary and
Faculty Sponsor*

We had two meetings in the Spring one of which was our initiation and
held officer elections.

New Initiates – Roshan Adhikari, Joseph Burns, Mahima Katuwal, Rojit Paudel, Salin
Shakya, and Sagarina Thapa.

MS Gamma – The University of Southern Mississippi

Chapter President – Jesse Robinson; 11 New Members

*Other Spring 2017 Officers: Anna Wan, Faculty Sponsor; and Dr. Zhifu
Xie, Corresponding Secretary*

MS Gamma Chapter at the University of Southern Mississippi was reac-
tivated and eleven new members was initiated during the Spring 2017.
New student chapter officers are formed and they updated the Constitu-
tion/bylaws for the Kappa Mu Epsilon Chapter MS Gamma at the Univer-
sity of Southern Mississippi.

New Initiates –Katie Broadhead, Scott Geyer, Andrew Giovengo, Allyson Hancock, Mal-
lory Jennings, Jeremy Kirksey, Linton Scott Koch, Christen Leggett, Jesse Robinson, Co-

lette Nicole White, and Nya Williams.

MS Delta – William Carey University

Corresponding Secretary – Janie Bower; 4 New Members

New Initiates – Lillie Blackmon, Neetu Regmi, Priscila Renard, and Savannah Saucier.

MS Epsilon – Delta State University

Corresponding Secretary – Lee Virden; 4 New Members

New Initiates – Kaitlyn Bryant, Bryant McDuffie, Shawn Sanks, and Chelsea Pugh Townsend.

NC Epsilon – North Carolina Wesleyan College

Chapter President – Carolyn Davern; 10 Current Members; 15 New Members

Other Spring 2017 Officers: Monica Salazar-Reyes, Vice President; Bikash Thapa, Secretary; Michael Bhujel, Treasurer; and Bill Yankosky, Corresponding Secretary and Faculty Sponsor

New Initiates – Prince Akpoki, Brian Delane Alston, Beverly Ijeoma Anaele, Linda Cooper, Brent Dozier, Camelia K. Eldawy, Hannah Marie Ivester, Kayla Lavan, Joseph D. Lloyd, Maggie Rankin, Christopher Dachi Ruppenthal, Harold Don Russell III, Mark Sokolov, Reena Tamang, and Madeline Williams.

NE Alpha – Wayne State College

Chapter President – Justin Larsen; 15 Current Members

Other Spring 2017 Officer: Dr. Jennifer Langdon, Corresponding Secretary and Faculty Sponsor

This semester, in conjunction with the WSC Math Club, KME sponsored a math speaker (Dr. Alex Zupan), had a Pi Day cupcake fundraiser, fun night, a picnic to honor a departing faculty member, helped with the math contest, and made cards for children who are sick in the hospital.

NE Beta – University of Nebraska Kearney

Chapter President – Candy Smith; 11 Current Members; 6 New Members

Other Spring 2017 Officers: Shelby Study, Vice President; Alexis Stockton, Secretary; Kato Craig, Treasurer; and Dr. Katherine Kime, Corresponding Secretary and Faculty Sponsor

This spring, President Candy Smith and Dr. Kime attended the KME National Convention at Evangel University and served as awards judges. Our spring initiation, at which six students were initiated, was attended by five family members. Candy represented our chapter in front of student government, for the required periodic renewal of our recognition as a student organization. Of note, Amber Vlasnik, a 2008 UNK mathematics graduate and KME member who also served as KME President, was named 2017 Nebraska Teacher of the Year. She teaches at Lincoln High. Amber was the commencement speaker at UNK's spring graduation. We had three KME members graduate, and one will graduate in the summer. We have two-strand pink and grey honor cords that are available to our KME

graduates to wear over their robes, which give an attractive appearance.

New Initiates – Ryan Clark, Tiffany Collins, Brianna Deines, Kyle Glandt, Kyle Halsted, and Stephanie Slayden.

NE Delta – Nebraska Wesleyan University

Corresponding Secretary – Melissa Erdmann; 13 New Members

New Initiates – Kristen Benes, Matheus Bustamante, Christopher Elbracht, Jackson Hinze, Eric Kimberly, Carter Lyons, Andrew Maaske, Drew Marolf, Evan Marshall, Mackenzie Maschka, Trevor McKeown, Trey Seibel, and Amy Wahlmeier.

NH Alpha – Keene State College

Corresponding Secretary – Vincent J. Ferlini; 14 New Members

New Initiates – Nicholas Ahlgren, Maria Aiello, Kiera Bell, Riley Bunker, Chelsey Donato, Sarah Doubleday, Alexandra Figueroa, Melissa Kubacka, Elizabeth MacLeod, Caitlyn Parmelee, Adam Suits, Samantha Sullivan, Jordan Trzepacz, and Emily Wollert.

NJ Beta – Montclair State University

Corresponding Secretary – Jonathan Cutler; 15 New Members

New Initiates – Teri R. Bennett, Holly M. Caldes, Joseph Davila, Lindsey G. Filo, Toni Jassel, Kateryna Kaplun, Giancarlo Labruna, Paola C. Lazarte, Nicole Massoud, Hadeel Rahhal, Emily A. Rollman, Ilana R. Rost, Briana Ruzanski, Priscilla Seesman, and Allison Zale.

NJ Delta – Centenary University

Corresponding Secretary – Kathy Turrisi

The NJ Delta Chapter had its initiation ceremony on April 5, 2017. Welcome to the KME Family!

NY Iota – Wagner College

Corresponding Secretary – Marisa Scarpa; 9 New Members

New Initiates – Hamza Ahmed, Ali Alkhelaiwi, Omar Alhagiko, John Andersson, Isabel Marie Barbosa, Wendi Giang, Jennifer Haug, Julius Marter, and Adam O'Brien.

NY Kappa – Pace University

Corresponding Secretary – Shamita Dutta Gupta; 3 New Members

New Initiates – Eduardo Chan, Hongyu Lu, and Meng Xu.

NY Lambda – LIU Post

Chapter President – Christopher Guevara; 24 Current Members; 15 New Members

Other Spring 2017 Officers: Christian Nothdurft, Vice President; Erica Gershkowitz, Secretary; Michelle Arenella, Treasurer; and Corbett Redden, Corresponding Secretary and Faculty Sponsor

The NY Lambda chapter of KME held its annual banquet and initiation on April 23, 2017. On Thursday, April 13, 2017, our chapter of KME also sponsored an undergraduate math competition for students at LIU Post. This was second year organizing such a competition, and we had a good

turnout and positive response from participants.

New Initiates – Dalia Ahmed, Fawaz Alshammari, Alexander Czaban, Ryan Gioe, Paul Klika, John Lipovac, Alexandra Lynn, Benjamin Maire, Kirsten Manno, Anna Mikulin, Ashok Prabhu, Lisa Sala, Angelica Ventura, Patricia Barrett, and Songqun Zhang.

NY Mu – St. Thomas Aquinas College

Corresponding Secretary – Heather A. Rave; 6 New Members

New Initiates – Dundee Belford-Conklin, Brian Cawley, Dr. Meghan DeWitt, Abraham Gill, Matea Shuto, and Joseph Vogel.

NY Nu – Hartwick College

Corresponding Secretary and Faculty Sponsor – Gerald Hunsberger; 12 New Members

New Initiates – Liana Aharon, Mikaelan Cucciarre-Stuligross, Tyler Fish, Nicole Greenman, Foster Mann, Nicole Mehr, Madison Miller, Daniel Pelkey, Sony Sherpa, Gavin Smith, David Velez, and Ashley Werner.

NY Omicron – St. Joseph's College

Chapter President – Robert V. Dilworth; 36 Current Members; 23 New Members

Other Spring 2017 Officers: Kathrine A. Miller, Vice President; Frank D. Loglisci, Secretary; Christiana R. Morante, Treasurer; Dr. Elana Reiser, Corresponding Secretary; and Dr. Donna Pirich, Faculty Sponsor

Our chapter runs a free Math Clinic for high school students on Saturday morning. We provide free tutoring for approximately 200 local high school students each academic year. In addition we run fundraisers to support our charity (Victims of Domestic Abuse). At Christmas we had a Christmas Toy Drive and at Easter we assembled 80 Easter baskets for local children that have been victims of domestic abuse. Our Faculty Sponsor, Dr. Donna Marie Pirich, was honored by the New York State Assembly with the 2017 New York State Assembly Woman of Distinction Citation in recognition of her lifelong dedication to higher education and service to Long Island through her work with the New York Omicron Chapter of KME. We were recently featured in our College Newsletter: The New York Omicron Chapter of Kappa Mu Epsilon National Mathematics Honor Society at SJC gathered on Monday, April 10, to present New York State Assemblyman Al Graf and his Chief of Staff, KME/SJC Alum Doug Smith, with 80 Easter baskets to support children and families that are victims of domestic violence. KME members held several fundraisers over the course of the academic year to purchase supplies for the Easter baskets, as well as toys that were distributed to these children at Christmas. Donations were also received from members of the Dean's Service Circle. Assemblyman Graf expressed his sincere gratitude to KME/SJC: "I cannot say enough about the people that came here today and helped make this special event

a great success. What this means to the children and their parents is unexplainable, and I thank all those who donated their time and money.” Dr. Donna Marie Pirich, Faculty Sponsor and New England Regional Director of KME was also honored by the New York State Assembly at the gathering. She was presented with the 2017 New York State Assembly Woman of Distinction Citation in recognition of her lifelong dedication to higher education and service to Long Island.



New Initiates – Paola C. Acosta, Robert V. Dilworth, Danielle M. Fieseler, Brian F. Frejka, Raquel Kaufman, Frank D. Loglisci, Kathrine A. Miller, Christiana R. Morante, Brianna M. Motis, Jase Panebianco, Kristina M. Rodriguez, Bixia Chen, Maria Gentile, Joselyn Guaman, Genesis Jerez, Jiahuan Lin, Xia Lin, Lingling Liang, Matthew Ramirez, Rebeca Ramirez, Jessica Seliste, Charles Simione, and Victoria Stawowy-Mokos.

NY Pi – Mount Saint Mary College

Corresponding Secretary – Lee Fothergill; 8 New Members

New Initiates – Briana Breil, Sierra Calo, Alister Collins, Gaeun Kim, Heather Nicole Polgrean, Kayla A. Stevens, Eva VanDemark, and Michelle R. Wood.

NY Rho – Molloy College

Corresponding Secretary – Manyiu Tse; 14 New Members

New Initiates – Brianna Abatelli, Victoria Cifarelli, Elena D'Ambrosio, Nicholas DiGiuseppi, Victoria Gianatiempo, Kayla Gill, Noel King, Jacqueline Mannix, Daniella Mottola, Brittanie Naughton, Alexandra Rizzo, Kristiana Salerno, Stephanie Timmes, and Briana White.

OH Gamma – Baldwin Wallace University

Corresponding Secretary – David Calvis; 13 New Members

In Spring 2017 we received 13 new initiates into membership, bringing our chapter lifetime total to 981. Our officers for 2017-18 will be President

Corrinne Horvath, Vice President Stephen Osborn, and Secretary James Corkish.

New Initiates – Katelyn E. Botke, Kera D. Bradt, Matthew R. Bunn, James B. Corkish, Christen T. Ford, Bailey M. Frye, Maxwell J. Hicks, Rhea Mendiratta, Kyle S. Pellegrin, Thomas D. Rector, Erin M. Shepherd, Dustin L. Smith, and Katherine E. Wohlford.

OH Zeta – Muskingum University

Corresponding Secretary – Richard Daquila; 5 New Members

New Initiates – Ryan Burkhart, Maala Cox, Katie Rominger, Blake Roush, and David Stainbrook.

OH Eta – Ohio Northern University

Corresponding Secretary – Donald Hunt; 11 New Members

New Initiates – Addie Davis, Austin Frey, AJ Kurdys, Rachel Liebrecht, Dylan Joseph-Cole Myers, Kimberly Partridge, Kayla Lauren Rieman, Joseph Andrew Stomps, Emma Talley, Caleb R. Thomas, and Jacob R. Webb.

OH Theta – Capital University

*Chapter President – Julia Kunkel; 14 Current Members; 11 New Members
Other Spring 2017 Officers: Jennie White, Vice President; Nick Hernandez, Secretary; Jack Gedeon, Treasurer; Paula Federico, Corresponding Secretary; and Jonathan Stadler, Faculty Sponsor*

During the spring semester our chapter held two meetings, welcomed new members, and elected new officers for the next academic year. Our Initiation Ceremony was on Sunday April 9th, 2017. Our guest speaker was Mr. Michael Steward, graduate student from the Mathematics Department of The Ohio State University, who presented the “Adding Convex Polygons (and their connection to ring theory)”. After his presentation, eleven new members were initiated into our Chapter of KME. The elected officers for the 2017-1018 academic year are: Nick Hernandez (President), Sage Conger (Vice president), Tiffany Kempthorne (Recording Secretary), and Liza Lotz (Treasurer). Below are some pictures of the Initiation Ceremony:



Initiation Ceremony



New members of KME Ohio Theta

New Initiates – Sarah Bogen, Austin Burgett, Sage Conger, Shelby Fleshman, Gabrielle Genovesi, Kara Hines, Tiffany Kempthorne, Lisa Lotz, Nicholas Santos, Kathryn Stahl, and Mario Traina.

OK Alpha – Northeastern State University

Corresponding Secretary – Dr. Demetri Plessas; 6 New Members

New Initiates – Hannah G. Arnall, Grant J. Criger, Breeanna C. Cross, Joseph V. Jankowski

II, Robert A. Lee, and Daltun J. Pierce.

PA Alpha – Westminster College

Corresponding Secretary – Pamela Richardson; 9 New Members

New Initiates – John Clark, Skyler Hayes, Samuel Hockenberry, Shannon Joy, Alexander Michels, Gabriel Roman, Aaron Signer, Jamie Thompson, and Antonio Troese.

PA Gamma – Waynesburg University

Corresponding Secretary – James R. Bush; 5 New Members

New Initiates – ETCLaken Hart, Shawn Hughes, Jacob Restanio, Michael Siszka, and Forrest Hunter Six.

PA Epsilon – Kutztown University

Corresponding Secretary – Dr. Lyn McQuaid; 8 New Members

New Initiates – Stacey Hart, Shannon Golden, Robert Koch, Serena Mang, Diego Manzano-Ruiz, Karina Naugle, Charles Poli, and Jordan Russial.

PA Zeta – Indiana University of Pennsylvania

President – Victoria Jakicic; 16 Current Members; 8 New Members

Other Spring 2017 Officers: Melissa Reinhardt, Vice President; Sarah Settlemyre, Secretary and Treasurer; and Gary Stoudt, Faculty Sponsor and Corresponding Secretary

New Initiates – Courtlyn M. Adams. Lewis Dominguez. Victoria Jakicic. Cassidy Le Donne. Benjamin Phillian. Sarah E. Settlemyre, Danielle Siebert, and Jennifer Testa.

PA Theta – Susquehanna University

President – Abby Conway; 10 Current Members; 5 New Members

Other Spring 2017 Officers: Heather Porter, Vice President; Anton Soloviev, Secretary; and Kenneth Brakke, Faculty Sponsor and Corresponding Secretary

New Initiates – Karinna Hamme, Ryan Keller, Samantha Loh, Benjamin Van Riper, and Muhammad Zain.

PA Kappa – Holy Family University

Chapter President – Dominic McAllister; 6 Current Members; 1 New Members

Other Spring 2017 Officer: Sister Marcella Wallowicz CSFN, PhD, Corresponding Secretary and Faculty Sponsor

The PA Kappa Chapter held its annual initiation ceremony on Friday, April 8, 2017. Following the ceremony, there was the opportunity to socialize and enjoy refreshments provided by the University.

New Initiates – Brianna Scotto.

PA Lambda – Bloomsburg University of Pennsylvania

Corresponding Secretary – Eric Kahn; 11 New Members

New Initiates – Lauren Barrett, Megan Carey, Jon Dressler, Elizabeth Grego, Zachary Hostetler, Laura Josuweit, Ryan Kaslavage, Kristen Morley, Emily Rine, Lexa Sabo, and

Rachel Yenney.

PA Mu – Saint Francis University

Chapter President – David Madl; 79 Current Members; 38 New Members Other Spring 2017 Officers: Staci Shoemaker, Vice President; Nicholas Frank, Secretary; Hannah Boyd, Treasurers; Dr. Peter Skoner, Corresponding Secretary; and Dr. Brendon LaBuz, Faculty Sponsor

The Pennsylvania Mu Chapter held their annual initiation ceremony on Wednesday, February 15, 2017. The evening began with a prayer by Department Chair Dr. John Harris, was followed by dinner, continued with a presentation “Symmetries of a Snowflake” by Faculty Sponsor Dr. Brendon LaBuz, and was highlighted with the initiation ceremony for the 38 new members, the largest initiation class ever. Current members Lydia Mignogna and Jay Pillot spoke about their experiences attending a national KME conference. The annual Pi Day celebration was held on Thursday, March 16, 2017; faculty, students, and staff enjoyed taste testing an assortment of “pi” served by members of Kappa Mu Epsilon throughout the day. Two faculty members and four students attended the KME National Convention at Evangel University in Springfield, Missouri on April 6-8, 2017. KME students and faculty served as judges for the 2017 Pennsylvania Statistics Poster Competition, hosted for the ninth year by Saint Francis University. A large number of posters (564) were received, cash awards were given for first through fourth place in each of four grade level categories, and winning posters were submitted to the National Statistics Poster Competition, coordinated by the American Statistical Association.

New Initiates – Luis Aviles, Jr., Tori Benton, Brandon Buck, Pedro Luis De Moura Neto, Taylor Derhammer, Sean Donegan, Marcus Edwards, Brandon Fiume, Ry Gallagher, John Gaughan, Carly Gromel, Rachel Gruber, Ashley Hildebrand, Caleb Hogue, Tongyao Hu, Justin Hugo, Caitlin Kimberly, James McCulley, Sophie Murdock, Bryant Onkst, Kelsey Patterson, Simon Pitman, Carly Rickens, Ashley Rovder, George Ryan, Griffin Sangrey, Hannah Schorr, Jessica Schulte, Debbie Slovikosky, Megan Snider, Jan Sunter, Coleman Thompson, Vanessa Valovage, Staci Wolfe, John Woloschuk, Tanner Yawitz, Perez Youmbi, and Arlan Zelenky.

PA Nu – Ursinus College

Corresponding Secretary – Nicholas Scoville; 16 New Members

New Initiates – Marlena Arrigale, Mia Belmont, Damian Creasy, Chiara DeMelfi, Mara Fulmer, Xinyue Kang, Yuqing Liu, Elena Ngo, Faraha Rathod, Serena Schaefer, Vincent Sergi, Thomas Steyaert, Joshua Williams, Brett Wojtkowiak, Yang Yang, and Timothy Yarosh.

PA Xi – Cedar Crest College

Corresponding Secretary – Joshua Harrington; 6 New Members

New Initiates – Kristina Marotta, Amanda Childs, Victoria Eppright, Susanna Ogozaly,

Fadia Namous, and Nadia Namous.

PA Pi – Slippery Rock University

*Chapter President – Alex Barclay; 5 Current Members; 7 New Members
Other Spring 2017 Officers: John Yannotty, Vice President and Treasurer;
Alex Barclay, Secretary; Elise Grabner, Corresponding Secretary and Faculty Sponsor*

PA Rho – Thiel College

Chapter President – Jennifer Rickens; 9 Current Members; 5 New Members

Other Spring 2017 Officers: Jennifer Rickens, Vice President; Amanda Dobi, Secretary; Jesse Sealand, Treasurer; Dr. Jie Wu, Faculty Sponsor; and Dr. Russell Richins, Corresponding Secretary

The Pennsylvania Rho chapter of Kappa Mu Epsilon held several activities during spring of 2017, including monthly meetings, a pi day pie sale for charity, Math Zone tutoring in the library, and our annual initiation ceremony for new members.

New Initiates –Kylie Bish, Joshua Evjene, Nicholas Guzma, Nolan Mattson, and Sarah McConnell.

PA Tau – DeSales University

Corresponding Secretary – Brother Daniel P. Wisniewski, O.S.F.S.; 10 New Members

New Initiates – Jennie L. Cawley, Adam N. Desseyn, Jeffrey A. Julien, Nhu Le, Nicole H. Nguyen, Mary E. Orobono, Elizabeth E. Phillips, Matthew J. Reeder, Nicholas P. Speranza, and Christina N. Tran.

RI Beta – Bryant University

Chapter President – William Kelley; 52 Current Members; 24 New Members

Other Spring 2017 Officers: Emma Wieduwilt, Vice President; Nathaniel Morgan, Secretary; Owen Wrinn, Treasurer; John Quinn, Corresponding Secretary; and Alan Olinsky, Faculty Sponsor

Our KME chapter president, William Kelley, has passed four professional actuarial exams as a student which matches the largest number successfully completed by any of our majors while an undergraduate. Three students, two of whom are KME members, William Kelley and Joseph Paparelli, are sharing the Commencement Award for the highest GPA in the 2017 graduating class at Bryant.

New Initiates – Cassidy Anthony, Danica Butler, Elise Chen, Eleni Diakolambrianos, Anthony Distefano, Shannon Downey, Marissa Falcetti, Noelle Ferragamo, Ryan Fryer, Elijah Gonillo, Ryan Goyette, Molly Guinee, David Marold, Angela Melchionno, Jacob Mingola, Emily Morin, Matthew Picard, Matthew Rega, Tyler Talbot, Stephen Voyer, Elizabeth

Wardwell, Jake Wiener, Justin Wood, and Zhuochao Zhong.

TN Alpha – Tennessee Technological University

Corresponding Secretary – Andrew Hetzel; 30 New Members

New Initiates – Seth Agee, Ian Barclay, Morgan Brown, Ryan Calloway, Abigail Collier, Katrina Eccles, Joey Franklin, Brelyn Grant, Marlana Hatcher, Conner Hintze, Victoria Israel, William Johnson, Sara Kennedy, William Lundy, Tyler Luster, Casey McCormick, Mohera Narimetla, Jeff Neikirk, John Nelms, Ethan Nichols, Dakota Smith, Devin Smith, Dallas Stark, Elizabeth Terranova, Matthew Tinker, Daniel Turpin, Andrew Wade, AY York, Charles Young, and Isabela Zapanta.

TN Beta – East Tennessee State University

Chapter President – Ty Frazier; 10 Current Members; 3 New Members

Other Spring 2017 Officers: Hannah Greene, Vice President; Kyle Murphy, Secretary; Haley Russell, Treasurer; and Rodney Keaton, Corresponding Secretary and Faculty Sponsor

We met three times in the Spring 2017 Semester. A research talk was given by Prof. Robert Beeler, and a research talk was given by Prof. Rodney Keaton. In the third meeting, Ty Frazier and Hannah Greene both gave practice presentations for their Master's defense.

TN Gamma – Union University

Chapter President – Rachel Brewer; 29 Current Members; 6 New Members

Other Spring 2017 Officers: Joshua Stucky, Vice President; Amy Murdaugh, Secretary and Treasurer; Andrew Edmiston, Webmaster and Historian; Bryan Dawson, Corresponding Secretary; and Matt Lunsford, Faculty Sponsor

TN Gamma held its annual initiation banquet on April 3 at the Old Country Store. Faculty member Bryan Dawson and student Joshua Stucky attended the national convention later that same week. Stucky presented a paper on Minecraft animal populations at the convention.

New Initiates – Joanna Butcher, Mark Carbonell, Andie Clanton, Gabriel Garneau, Cole Le Mahieu, and YooJin Ashley Moon.

TN Delta – Carson-Newman University

Corresponding Secretary – Kenneth Massey; 5 New Members

New Initiates – Drew Dickenson, Shannone Paik, Aethann Herrell, Madison Herbert, and Pijus Mackevicius.

TN Zeta – Lee University

Corresponding Secretary – Caroline Maher-Boulis; 15 New Members

New Initiates – Lindsey Cash, Debolanle Dahunsi, Rachel Dawe, Stephen Kyle Elliott, Joanna Grzegorzolka, Lydia Karel, Mercy Kehinde-Ige, Matthew Reese Land, Christen Pe-

ters, and Rebekah Petrosky.

TX Gamma – Texas Woman’s University

Corresponding Secretary – Dr. Mark S. Hamner; 12 New Members

New Initiates – Miriam Baustista, Genova Chavez, Kahlán Edwards, Lauren Hassatt, Stephanie Lopez, Alex McNally, Quenna Njo, Patricia Puente, Hannah Rodriguez, Lacey Smith., Anh Tran, and Natalie Vazquez.

TX Eta – Hardin-Simmons University

Corresponding Secretary – Jessica Rieger; 8 New Members

New Initiates – Sydney Bemrick, Stephen Danser, Kourtney Holyfield, Montie Lackey, Ashley Pierce, Joshua Schneider, Brandi Turner, and Kade Wagner.

TX Kappa – University of Mary Hardin-Baylor

Corresponding Secretary – Peter H. Chen; 10 New Members

New Initiates – Alexandra Van Aller, Caleb Critz, Tyler Dent, Arleen Douglas, Cayce Dunham, Antoni Estranda, Curtis Graham, Christine Lee, Molly Rodeffer, and Jonathan Simmons.

TX Lambda – Trinity University

Corresponding Secretary – Dr. Hoa Nguyen; 263 Current Members; 14 New Members

New Initiates – Lauren Barrett, Megan Carey, Jon Dressler, Elizabeth Grego, Zachary Hostetler, Laura Josuweit, Ryan Kaslavage, Kristen Morley, Emily Rine, Lexa Sabo, and Rachel Yenney.

TX Mu – Schreiner University

Corresponding Secretary – Clint Coles; 10 New Members

New Initiates – Benjamin Banchs, Ben Benevides, Neal Bundrant, Daniel Gonzales, James Winchester Lewis, Kara Elaine Miller, Eduardo MuÃsosz, Juan P. Ortiz, Christopher Anthony Resendez, and Thomas Caleb Uptergrove.

VA Beta – Radford University

Chapter President – Cameron Leo; 21 Current Members; 18 New Members

Other Spring 2017 Officer: Eric P. Choate, Corresponding Secretary and Faculty Sponsor

New Initiates – Matthew Akers, Nicholas Abromitis, Sarah Becouvarakis, Jacob Britton, Joshua Carroll, Eric P. Choate, Zachary Cole, Jenna Foster, Stephen Foster, Hannah Graf, Jared Hidalgo, Cameron Leo, Rory McDaniel, Ryan Pfeiffer, Amy Smith, Rebecca Stephens, Patrick Tabachka, and Bailey Turman.

VA Gamma – Liberty University

Corresponding Secretary – Dr. Tim Van Voorhis; 31 New Members

New Initiates – Noah Bernier, Michael Burke, Mark Chauvette, Michael Crenshaw, Tyler Cypher, David DeRuiter, Devon Dockstader, Jacob Egan, Frederick Goebel, Honglin Gong, Christopher Hickman, Bradley Hoogerwerf, Jillianne Hook, Jessica Houseknecht, Taylor Iserman, Alan Lang, Ashley Moorman, Aaron Parlier, Nehemiah Pratt, Daniel

Reddy, Nicole Rogers, Kameron Rummel, Joshua Schellenberger, Caleb Taylor, Jesse Tetelbach, Stephen Thomas, Sabrina VanGorder, Richard Vojtisek, Jeffrey Walraven, Jessica Wernig, and Zachary Wickham.

WV Alpha – Bethany College

Chapter President – Alyssa K. Smydo; 18 Current Members; 9 New Members

Other Spring 2017 Officers: Robert A. Murano, Vice President; and Adam C. Fletcher, Corresponding Secretary and Faculty Sponsor

The chapter worked in conjunction with the Mathematics and Computer Science Club to host the eleventh annual Math/Science Day on campus. The chapter also sponsored the local chapter's induction ceremony of the Upsilon Pi Epsilon international computer science honor society in March and sent three student members and a faculty member to the Allegheny Mountain Section (MAA) Meeting in April.

New Initiates – Brittany M. Fullbright, Jordan David Hunkins, Thomas Elegant Law, Megan Elizabeth Nally, Ryan M. Nickerson, Jenna Skyler Nuth, Joseph Skylar Sawyer, Jacob David Stemmerich, and Cameron Jack Stish.

Active Chapters of Kappa Mu Epsilon

Listed by date of installation

Chapter	Location	Installation Date
OK Alpha	Northeastern State University, Tahlequah	18 Apr 1931
IA Alpha	University of Northern Iowa, Cedar Falls	27 May 1931
KS Alpha	Pittsburg State University, Pittsburg	30 Jan 1932
MO Alpha	Missouri State University, Springfield	20 May 1932
MS Alpha	Mississippi University for Women, Columbus	30 May 1932
NE Alpha	Wayne State College, Wayne	17 Jan 1933
KS Beta	Emporia State University, Emporia	12 May 1934
AL Alpha	Athens State University, Athens	5 Mar 1935
NM Alpha	University of New Mexico, Albuquerque	28 Mar 1935
IL Beta	Eastern Illinois University, Charleston	11 Apr 1935
AL Beta	University of North Alabama, Florence	20 May 1935
AL Gamma	University of Montevallo, Montevallo	24 Apr 1937
OH Alpha	Bowling Green State University, Bowling Green	24 Apr 1937
MI Alpha	Albion College, Albion	29 May 1937
MO Beta	University of Central Missouri, Warrensburg	10 Jun 1938
TX Alpha	Texas Tech University, Lubbock	10 May 1940
KS Gamma	Benedictine College, Atchison	26 May 1940
IA Beta	Drake University, Des Moines	27 May 1940
TN Alpha	Tennessee Technological University, Cookeville	5 Jun 1941
MI Beta	Central Michigan University, Mount Pleasant	25 Apr 1942
NJ Beta	Montclair State University, Upper Montclair	21 Apr 1944
IL Delta	University of St. Francis, Joliet	21 May 1945
KS Delta	Washburn University, Topeka	29 Mar 1947
MO Gamma	William Jewell College, Liberty	7 May 1947
TX Gamma	Texas Woman's University, Denton	7 May 1947
WI Alpha	Mount Mary College, Milwaukee	11 May 1947
OH Gamma	Baldwin-Wallace College, Berea	6 Jun 1947
MO Epsilon	Central Methodist College, Fayette	18 May 1949
MS Gamma	University of Southern Mississippi, Hattiesburg	21 May 1949
IN Alpha	Manchester College, North Manchester	16 May 1950
PA Alpha	Westminster College, New Wilmington	17 May 1950
IN Beta	Butler University, Indianapolis	16 May 1952
KS Epsilon	Fort Hays State University, Hays	6 Dec 1952
PA Beta	LaSalle University, Philadelphia	19 May 1953
VA Alpha	Virginia State University, Petersburg	29 Jan 1955
IN Gamma	Anderson University, Anderson	5 Apr 1957
CA Gamma	California Polytechnic State University, San Luis Obispo	23 May 1958
TN Beta	East Tennessee State University, Johnson City	22 May 1959
PA Gamma	Waynesburg College, Waynesburg	23 May 1959
VA Beta	Radford University, Radford	12 Nov 1959
NE Beta	University of Nebraska—Kearney, Kearney	11 Dec 1959
IN Delta	University of Evansville, Evansville	27 May 1960
OH Epsilon	Marietta College, Marietta	29 Oct 1960
MO Zeta	University of Missouri—Rolla, Rolla	19 May 1961

MD Alpha	College of Notre Dame of Maryland, Baltimore	22 May 1963
CA Delta	California State Polytechnic University, Pomona	5 Nov 1964
PA Delta	Marywood University, Scranton	8 Nov 1964
PA Epsilon	Kutztown University of Pennsylvania, Kutztown	3 Apr 1965
AL Epsilon	Huntingdon College, Montgomery	15 Apr 1965
PA Zeta	Indiana University of Pennsylvania, Indiana	6 May 1965
TN Gamma	Union University, Jackson	24 May 1965
IA Gamma	Morningside College, Sioux City	25 May 1965
MD Beta	McDaniel College, Westminster	30 May 1965
IL Zeta	Dominican University, River Forest	26 Feb 1967
SC Beta	South Carolina State College, Orangeburg	6 May 1967
PA Eta	Grove City College, Grove City	13 May 1967
NY Eta	Niagara University, Niagara University	18 May 1968
MA Alpha	Assumption College, Worcester	19 Nov 1968
MO Eta	Truman State University, Kirksville	7 Dec 1968
IL Eta	Western Illinois University, Macomb	9 May 1969
OH Zeta	Muskingum College, New Concord	17 May 1969
PA Theta	Susquehanna University, Selinsgrove	26 May 1969
PA Iota	Shippensburg University of Pennsylvania, Shippensburg	1 Nov 1969
MS Delta	William Carey College, Hattiesburg	17 Dec 1970
MO Theta	Evangel University, Springfield	12 Jan 1971
PA Kappa	Holy Family College, Philadelphia	23 Jan 1971
CO Beta	Colorado School of Mines, Golden	4 Mar 1971
KY Alpha	Eastern Kentucky University, Richmond	27 Mar 1971
TN Delta	Carson-Newman College, Jefferson City	15 May 1971
NY Iota	Wagner College, Staten Island	19 May 1971
SC Gamma	Winthrop University, Rock Hill	3 Nov 1972
IA Delta	Wartburg College, Waverly	6 Apr 1973
PA Lambda	Bloomsburg University of Pennsylvania, Bloomsburg	17 Oct 1973
OK Gamma	Southwestern Oklahoma State University, Weatherford	1 May 1973
NY Kappa	Pace University, New York	24 Apr 1974
TX Eta	Hardin-Simmons University, Abilene	3 May 1975
MO Iota	Missouri Southern State University, Joplin	8 May 1975
GA Alpha	State University of West Georgia, Carrollton	21 May 1975
WV Alpha	Bethany College, Bethany	21 May 1975
FL Beta	Florida Southern College, Lakeland	31 Oct 1976
WI Gamma	University of Wisconsin—Eau Claire, Eau Claire	4 Feb 1978
MD Delta	Frostburg State University, Frostburg	17 Sep 1978
IL Theta	Benedictine University, Lisle	18 May 1979
PA Mu	St. Francis University, Loretto	14 Sep 1979
AL Zeta	Birmingham-Southern College, Birmingham	18 Feb 1981
CT Beta	Eastern Connecticut State University, Willimantic	2 May 1981
NY Lambda	C.W. Post Campus of Long Island University, Brookville	2 May 1983
MO Kappa	Drury University, Springfield	30 Nov 1984
CO Gamma	Fort Lewis College, Durango	29 Mar 1985
NE Delta	Nebraska Wesleyan University, Lincoln	18 Apr 1986
TX Iota	McMurry University, Abilene	25 Apr 1987
PA Nu	Ursinus College, Collegeville	28 Apr 1987
VA Gamma	Liberty University, Lynchburg	30 Apr 1987
NY Mu	St. Thomas Aquinas College, Sparkill	14 May 1987

OH Eta	Ohio Northern University, Ada	15 Dec 1987
OK Delta	Oral Roberts University, Tulsa	10 Apr 1990
CO Delta	Mesa State College, Grand Junction	27 Apr 1990
PA Xi	Cedar Crest College, Allentown	30 Oct 1990
MO Lambda	Missouri Western State College, St. Joseph	10 Feb 1991
TX Kappa	University of Mary Hardin-Baylor, Belton	21 Feb 1991
SC Delta	Erskine College, Due West	28 Apr 1991
NY Nu	Hartwick College, Oneonta	14 May 1992
NH Alpha	Keene State College, Keene	16 Feb 1993
LA Gamma	Northwestern State University, Natchitoches	24 Mar 1993
KY Beta	Cumberland College, Williamsburg	3 May 1993
MS Epsilon	Delta State University, Cleveland	19 Nov 1994
PA Omicron	University of Pittsburgh at Johnstown, Johnstown	10 Apr 1997
MI Delta	Hillsdale College, Hillsdale	30 Apr 1997
MI Epsilon	Kettering University, Flint	28 Mar 1998
MO Mu	Harris-Stowe College, St. Louis	25 Apr 1998
GA Beta	Georgia College and State University, Milledgeville	25 Apr 1998
AL Eta	University of West Alabama, Livingston	4 May 1998
PA Pi	Slippery Rock University, Slippery Rock	19 Apr 1999
TX Lambda	Trinity University, San Antonio	22 Nov 1999
GA Gamma	Piedmont College, Demorest	7 Apr 2000
LA Delta	University of Louisiana, Monroe	11 Feb 2001
GA Delta	Berry College, Mount Berry	21 Apr 2001
TX Mu	Schreiner University, Kerrville	28 Apr 2001
CA Epsilon	California Baptist University, Riverside	21 Apr 2003
PA Rho	Thiel College, Greenville	13 Feb 2004
VA Delta	Marymount University, Arlington	26 Mar 2004
NY Omicron	St. Joseph's College, Patchogue	1 May 2004
IL Iota	Lewis University, Romeoville	26 Feb 2005
WV Beta	Wheeling Jesuit University, Wheeling	11 Mar 2005
SC Epsilon	Francis Marion University, Florence	18 Mar 2005
PA Sigma	Lycoming College, Williamsport	1 Apr 2005
MO Nu	Columbia College, Columbia	29 Apr 2005
MD Epsilon	Stevenson University, Stevenson	3 Dec 2005
NJ Delta	Centenary College, Hackettstown	1 Dec 2006
NY Pi	Mount Saint Mary College, Newburgh	20 Mar 2007
OK Epsilon	Oklahoma Christian University, Oklahoma City	20 Apr 2007
HA Alpha	Hawaii Pacific University, Waipahu	22 Oct 2007
NC Epsilon	North Carolina Wesleyan College, Rocky Mount	24 Mar 2008
NY Rho	Molloy College, Rockville Center	21 Apr 2009
NC Zeta	Catawba College, Salisbury	17 Sep 2009
RI Alpha	Roger Williams University, Bristol	13 Nov 2009
NJ Epsilon	New Jersey City University, Jersey City	22 Feb 2010
NC Eta	Johnson C. Smith University, Charlotte	18 Mar 2010
AL Theta	Jacksonville State University, Jacksonville	29 Mar 2010
GA Epsilon	Wesleyan College, Macon	30 Mar 2010
FL Gamma	Southeastern University, Lakeland	31 Mar 2010
MA Beta	Stonehill College, Easton	8 Apr 2011
AR Beta	Henderson State University, Arkadelphia	10 Oct 2011
PA Tau	DeSales University, Center Valley	29 Apr 2012

TN Zeta	Lee University, Cleveland	5 Nov 2012
RI Beta	Bryant University, Smithfield	3 Apr 2013
SD Beta	Black Hills State University, Spearfish	20 Sept 2013
FL Delta	Embry-Riddle Aeronautical University, Daytona Beach	22 Apr 2014
IA Epsilon	Central College, Pella	30 Apr 2014
CA Eta	Fresno Pacific University, Fresno	24 Mar 2015
OH Theta	Capital University, Bexley	24 Apr 2015
GA Zeta	Georgia Gwinnett College, Lawrenceville	28 Apr 2015
MO Xi	William Woods University, Fulton	17 Feb 2016
IL Kappa	Aurora University, Aurora	3 May 2016
GA Eta	Atlanta Metropolitan University, Atlanta	1 Jan 2017
CT Gamma	Central Connecticut University, New Britain	24 Mar 2017
KS Eta	Sterling College, Sterling	30 Nov 2017
NY Sigma	College of Mount Saint Vincent, The Bronx	4 Apr 2018
PA Upsilon	Seton Hill University, Greensburg	5 May 2018