Panel on Approaches to Program Development

What Can I Do With a BS Degree in Mathematics Besides Teach? Declining Interest in Undergraduate Mathematics

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Jackson, Mississippi
Entry Level Jobs for BS Mathematics Holders:
Cryptographer. ...
Mathematician. ...
Economist. ...
Actuary. ...
Financial planner. ...
Investment analyst. ...
Statistician. ...
Operations research analyst
Data Analyst

<table>
<thead>
<tr>
<th>Quick Facts: Mathematicians and Statisticians</th>
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<tr>
<td><strong>2018 Median Pay</strong></td>
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<td><strong>Typical Entry-Level Education</strong></td>
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<td><strong>Work Experience in a Related Occupation</strong></td>
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<td><strong>On-the-job Training</strong></td>
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<td><strong>Number of Jobs, 2016</strong></td>
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<td><strong>Job Outlook, 2016-26</strong></td>
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<td><strong>Employment Change, 2016-26</strong></td>
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Multiple Pathways to a BS Degree in Mathematics- For a Data Centric and Cyber Society- AI World

Curriculum and Course Revision for a 21st Century Workplace

• The current attention to big data and the demand for college graduates with data skills is the underlining purpose for our proposed curricula changes in the entry-level courses which we think will result in students being better prepared for jobs requiring computational and statistical skills.
• The new design focuses on providing mathematically substantive options for students who are not headed to calculus - College Algebra Pathways.
• The current college algebra course serves two distinct student populations:
  (1) the overwhelming majority for whom it is a terminal course in mathematics, needed to fulfil the general education requirement, and
  (2) the relatively small minority for whom it is a gateway to further mathematics. Neither group is well-served by the ongoing version of the college algebra course. New Pathways will be effective for the majority of the student population as well as focus on the calculus sequence to ensure that pathways to it remain a high priority, as calculus is central to most further study in the mathematical and statistical sciences.
## Timeline

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<td>1. Articulation between Department faculty and their colleagues from other departments.</td>
<td>1. Full development of the two courses.</td>
<td>1. Courses listed in the catalog and offered</td>
<td>1. New degree pathways and curricula developed.</td>
<td>Offering of new degree pathways.</td>
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<td>2. Structural draft of the two courses redesigned from Math 111 and or Math 112. Accomplished</td>
<td>2. Coursed approved for the 2020-2021 academic year. Accomplished</td>
<td>2. Revision of the Mathematics curriculum begins.</td>
<td>2. IHL approval sought and received</td>
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References


The UBM at Jackson State University, Mississippi
Interdisciplinary Training of Undergraduates in Biological and Mathematical Sciences with Emphasis on Marine Coastal Science

The Research Theme for the First Cohort: The Landscape Level Analysis on Distribution, Dispersal, and Phylogenetic Relationship of Selected Aquatic Organisms

Sub Projects
- Detection and Mapping of Aquatic Plants using Remote Sensing
- Phylogenetic Relationship of Seagrass Populations
- Genome Bioinformatics
- Analysis of the Distribution of Genes in a Large Population

Understanding Variation in Plant Reflectance in Shallow Water

**Reflectance of Water Plant Parts**

<table>
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<tr>
<th>Wavelength (micrometer)</th>
<th>Reflectance (%)</th>
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<tr>
<td>400.13</td>
<td>579.14</td>
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<tr>
<td>491.13</td>
<td>665.54</td>
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<tr>
<td>579.14</td>
<td>750.32</td>
</tr>
<tr>
<td>665.54</td>
<td>833.4</td>
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**Genome Bioinformatics**

- Objective: To analyze the distribution of genes in a large population
- Methodologies:
  - Analysis of Nucleotide Sequence Data
  - Pairwise Comparison

**Mathematical Modeling**

- Objective: To develop a widely applicable algorithm to distinguish aquatic vegetation in shallow and coastal waters
- Methodologies:
  - Stability analysis
  - Computer simulations

**Close-range Hyperspectral Remote Sensing**

- Four undergraduate students from Biology and Mathematics (Angelique Carter, Ashley...) have been participating in this research
- Objective: To improve the capability of Monitoring and Detection of Aquatic Vegetation
- Rationale: Close range hyperspectral data obtained through controlled experiments would detect subtle changes in a narrow spectral range; this information will be used to develop a widely applicable algorithm to distinguish aquatic vegetation in shallow and coastal waters.

**RESULTS**

- The reflectance of healthy water hyacinth ranged between 50-60%.
- The flower and red leaf colors also altered the plant reflectance patterns in the visible colors.
- The high NIR reflectance was still observed in the flower petals and red leaves.

**Implication of Finding for Model Development**

- Remote detection of SA V can be improved if the information on the two NIR peaks
- The green peak around 560 nm increased with the water depth increase
- For both clear and eutrophic water, the reflectance of SA peaks at approximately 560, 715, and 795–815 nm.
- The lowest reflectance at wavelengths > 750 nm increased with depth.

**Other Funding for the Research and Contact Information**

- NSF, NOAA through National Estuarine Research Reserve
- UBM Scholars and their activities
- USDA-ARS Coastal and Estuarine Sciences Program
- Summer Field Courses

**Molecular Genetics and Bioinformatics**

- Gene structure comparison of AQP1 and AQP4 of human, mouse, rat, and zebrafish
- Phylogenetic relationship of seagrass populations

**Phylogenetic Relationship of Seagrass Populations**

- Objective: To generate substantial data to determine the phylogenetic relationship of the populations of Ruppia maritima L. from sites along the coasts of Mississippi, Louisiana, and Alabama.
- Methods:
  - Analysis of Nucleotide Sequence Data
  - Phylogenetic relationships will be calculated using MEGA 5.1 packages

**CONTACTS**

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- Williams.SCHOLARS@jsums.edu

**Summer Field Courses**

- The ocean UBM scholars take 5-week summer marine science courses and field trips in June 2006 at the Gulf Coast Research Laboratory at Ocean Springs, Mississippi.

**Curriculum Development**

- Introduction to Mathematical Modeling
- Math 495P, Math 497P
- Additional and their applications
- Introduction to marine biology
- Stability of Linear systems
- Basic Probability concepts
- Variance of random variables
- Introduction to marine science
- Statistical and change in species
- Differentiation and eigenvalues
- General linear difference equations
- General linear difference equations
- Differentiation and system of linear difference equations
- Derivative methods for first-order difference equations
- Orthogonal methods for first-order difference equations
- Orthogonal methods for first-order difference equations
- Introduction to Markov

The JU-UBM Scholars and their activities
OBJECTIVES

- Train 30 HBCU mathematics faculty each year for two years to gain expertise in integrating the Mathematica software in the teaching and learning of calculus and upper division mathematics courses.
- Participating faculty will engage one mathematics major per year in a year-long research experience and place the student in a summer research experience at other institutions.
- Train participating faculty to develop Mathematica course guidelines and manuals integrating programming with Mathematica and course delivery.
- Engage 30 mathematics majors in undergraduate research in mathematics with Mathematica from the participating universities and colleges.

CONTACTS:

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- Roosevelt Gentry
- Tor A. Kwembe
- Jana Talley
- Celestin Wafo Soh

Program External Evaluator:
Carol Livingston
University of Mississippi, Oxford, Mississippi

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Summer 2012 Inaugural Meeting
Mathematics Department Chairs and Wolfram Research, Inc.

Workshop Instructors
- Roosevelt Gentry, Ph.D., Professor of Mathematics
- Celestin Wafo Soh, Ph.D., Associate Professor of Mathematics
- Zhenbu Zhang, Ph.D., Associate Professor of Mathematics

Interactive Classroom Environment

Undergraduate Students, Analyze, Visualize and Document their Research Results

• Generate graphical solutions to research problems and Mathematica programming files
• Develop documents, reports, presentations, and articles with Computable Document Format (CDF) player for dynamic interaction and visualization
• Learn how to drive content and generate results live
• Develop interactive models for simulating aneurysm evolution, growth and rupture

Courseware and Projects

• Calculus
• Single Variable
• Multivariable
• Ordinary Differential Equations
• Linear Algebra
• Partial Differential Equations
• Dynamical Systems
• Mathematical Modeling and Simulations
• Course Guide with Mathematica
• Mathematica Course Modules
• Undergraduate Research Projects
• Abstract Algebra
• Number Theory and Cryptography
• Bioinformatics and Genome Science
• Integrate CDF player modules in the lesson plans
Program Summary

The focus of the project is to design efficient pedagogical pathways of utilizing big data to educate the next generation of mathematics and statistics undergraduates to confront emerging challenges in computational and data-enabled science and engineering (CDS&E). The project is interdisciplinary involving mathematics, Statistics, Bioinformatics, and Meteorology and integrates research, education, training, and faculty professional development/outreach.

Research Objectives

❖ Engage 28 undergraduate majoring in mathematics, statistics, biology and meteorology in a year-long collaborative CDS&E research for a minimum of two years under the supervision of an interdisciplinary team of faculty mentors

❖ Guide participating students to place in summer undergraduate research in CDS&E at HEC centers

Ongoing Research Activities

❖ Climate Modeling
❖ Option Pricing: Statistical & Computational Comparison with the Black-Scholes equation
❖ DNA Sequence Alignment and Comparison with Mathematica
❖ Energy Balance Climate Models
❖ Stock Market Model

Objectives

❖ Build a culture of training the next generation of mathematics and statistics majors to become interdisciplinary collaborators and promote the value of mathematical and statistical thinking in advancing CDS&E

❖ Develop new pedagogical approaches of teaching mathematics and statistics courses that complements lecturing with experimentation where students engage in hands-on activities with cyberinfrastructure (CI) enabling technologies

❖ Establish and sustain a Statistical Lab (LISA-QED) as a CI resource center and

❖ Establish a Bachelor’s degree program in statistics and revised non-calculus upper level undergraduate mathematics courses to integrate CDS&E

Project Outcomes

❖ BS degree in statistics established Fall 2014
❖ CDS&E Ph.D. Program Concentration in Computational Mathematics and Statistical Sciences established Fall 2014
❖ BS Statistics Curriculum developed
❖ CDS&E Ph.D. Curriculum Developed

Sequence Alignment Algorithms

❖ Ongoing Research Activities

❖ Establish a Bachelor’s degree program in statistics and revised non-calculus upper level undergraduate mathematics courses to integrate CDS&E

Energy Balance Climate Models

❖ Fall, Spring, and Summer CDS&E Training Workshops for faculty
❖ CI Days Events-CDS&E Conferences
❖ Faculty and Students Field Trips to High End Computing (HEC) sites

PI: Tor A Kwembe, Ph.D., Professor of Mathematics
Co-PIs: Carmen Wright, Ph.D., Assistant Professor of Mathematics
• Xing Yang, Ph.D., Assistant Professor of Statistics
• Zhenbu Zhang, Ph.D., Associate Professor of Mathematics
• Remata Reddy, Ph.D. Associate Professor of Meteorology
Strategic Partnership for Advanced Cyber Infrastructure @ Minority Serving Institutions (SPACI@MSIs)

June 6, 7-8, 2018, GA Tech Hotel and Conference Center, Atlanta, Georgia

Advancing Research Computing and Data in MSIs- A Jackson State University Experience: 9:00am
Deborah F. Dent, Tor A. Kwembe and Michael Robinson

Computational and Data Enabled Science and Engineering (CDS&E):
- Infrastructure: High Performance Computing (HPC)
- High Throughput Computing (HTC)
- Cyber Security
- Big Data/Data Science

Drives Research

Grand Challenges
- Advanced New Materials
- Prediction of Climate Change
- Hazard Analysis and Management
- Understanding Biological Systems
- Cancer Detection and Treatment
- Computational Chemistry

Enables Discoveries

Computer Science, Statistics, Mathematics, Machine Learning, and Application Domains

Harnessing the Data Revolution
- CDS&E Ph.D. Program
- MS in CDS&E
- BS Computer Science-Data Science
- Data Science Minor
- BS Statistics

Institutional Initiatives
- Infusing Technology in the Curriculum
- Course Redesign-Computer Assisted Teaching and Learning
- Online Courses
- Online Degree Programs
- iPad Initiatives
- Digital Library
- Online Advising and Registration
- JSU Apps
- Internet of Things (IoTs)
- Paperless Organization
Challenges for Designing Multiple Pathways to the BS Mathematics Degree

- Faculty Buy in
- Student Recruitment
- Faculty Shortage
- Budgetary
- Faculty Professional Development
- Too Much Work
- Globalization and Universality

- Online Degree/Certificate Programs- Coursera-
  https://www.coursera.org/