VCU Biostatistics Information Session

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School of Population Health
What is Biostatistics?

• Statistics applied to the collection, analysis, and interpretation of biological data and especially data relating to human biology, health, and medicine – Meriam-Webster

• Biostatistics is the discipline concerned with how we ought to make decisions when analyzing biomedical data. It is the evolving discipline concerned with formulating explicit rules to compensate both for the fallibility of human intuition in general and for biases in study design in particular. – Berger, & Rosser Matthews, 2006
Biostatistics in Public Health

• Biostatistics touches every facet of Public Health
  – Collaboration
    • Cancer
    • Chronic Diseases
    • Environment
    • Statistical Genetics
    • Human Growth & Development
  – Methodological development
    • New statistical methods/study designs
VCU Department of Biostatistics

• We are housed in the VCU School of Population Health (SOPH)
  – The SOPH was formed in July, 2023 with the expectation of becoming an approved School of Public Health

• VCU Biostatistics has been around a bit longer than the SOPH!
  – 1958: Division of Biometry forms in the Medical College of Virginia (MCV)
  – 1969: VCU formed from MCV – RPI merger; began recruitment of MS and PhD students
  – 1972: Officially changed names to the Department of Biostatistics
  – 2013: Introduced the PhD and MS in Genomic Biostatistics
  – 2023: Joined the VCU School of Population Health as a founding department
VCU Biostatistics Faculty Members

• There are 17 full-time faculty members in the department
  – The areas of expertise and methodological development for these faculty covers all areas of biostatistics in public health

• The next few slides highlight some of our faculty members and their areas of expertise
Sensor & Metabolic Chamber Data

- Shanshan Chen, PhD
- Ekaterina Smirnova, PhD
Computational Genomics

- Mikhail Dozmorov, PhD
- Jinze Liu, PhD
- Katarzyna Tyc, PhD
Spatial Data Analysis

• David Wheeler, PhD
• Dipankar Bandyopadhyay, PhD
Clinical Trial Design

Adaptive Design

– Nolan Wages, PhD
– Roy Sabo, PhD
– Robert Perera, PhD
Image Analysis

- Nitai Mukhopadhyay, PhD
Missing Data

- Yongyun Shin, PhD

Longitudinal Latent Variable Models Given Incompletely Observed Biomarkers and Covariates

Chunfeng Ren and Yongyun Shin
Department of Biostatistics, Virginia Commonwealth University, Richmond, Virginia 23219

\[
\begin{bmatrix}
Y_{1t} \\
Y_{2t}
\end{bmatrix} =
\begin{bmatrix}
X_{1t} \\
0
\end{bmatrix}
\begin{bmatrix}
\beta_1 \\
\beta_2
\end{bmatrix} +
\begin{bmatrix}
Z_{1t} & 0 \\
0 & I_{p2}
\end{bmatrix}
\begin{bmatrix}
b_{1t} \\
b_{2t}
\end{bmatrix} +
\begin{bmatrix}
\varepsilon_{1t} \\
0
\end{bmatrix} +
\begin{bmatrix}
a_{1t} + c_{1t} \\
0
\end{bmatrix},
\]

(7)

\[
\begin{align*}
Y_{1t} &= \frac{B_1}{S_1} \\
X_{1t} &= \begin{bmatrix} I_{p1} \\ 0 \end{bmatrix} \\
Z_{1t} &= \begin{bmatrix} B_1 \otimes I_{j} \\ 0 \\ 1_{k_b} \otimes I_{p_1} \end{bmatrix}
\end{align*}
\]

\[
\begin{align*}
b_{1t} &= \begin{bmatrix} b_{11} \\ b_{21} \end{bmatrix} \\
\varepsilon_{1t} &= \begin{bmatrix} \varepsilon_{11} \\ \varepsilon_{21} \end{bmatrix} \\
a_{1t} &= \begin{bmatrix} a_{11} \\ 0 \end{bmatrix}
\end{align*}
\]

\[
\begin{pmatrix}
c_{1t} \\
0
\end{pmatrix}
\]

where \( \text{var}(b_{11}, b_{21}) = \begin{pmatrix} \tau_{11} & \tau_{12} \\ \tau_{12} & \tau_{22} \end{pmatrix} \)
VCU Biostatistics Programs of Study

• We offer two programs of study and a total of five tracks within the two programs
  – PhD
    • Traditional Track
    • Optional Genomics Concentration
  – MS
    • Traditional Track
    • Genomics Concentration Track
    • Clinical Research Concentration
VCU Biostatistics Coursework

• All Programs
  – Biostatistical Computing
  – Mathematical Statistics I
  – Analysis of Biomedical Data I and II
  – Clinical Trials
  – Consulting
  – Seminar
  – Scientific Integrity
VCU Biostatistics Coursework

• The traditional and genomics MS track also require:
  – 12 hours of elective credits
  – Genomics track also requires Fundamentals of Molecular Genetics (or other relevant course) Statistical Methods for High-Throughout Genomic Data I and II (which reduces the number of elective hours)

• The PhD Program further requires:
  – Mathematical Statistics II
  – Biostatistical Methods I and II
  – Advanced Inference
  – Mixed Models and Longitudinal Analysis*
  – Multivariate Analysis^
  – Survival Analysis
  – Statistical Methods for High-Throughout Genomic Data I and II^

*Required only for traditional Biostatistics Track
^Required only for Genomics Track
Qualifying Examinations

Applied Exam
MS and PhD Program

Courses: Biostatistical Computing, Clinical Trials, Analysis of Biostatistical Data I and II

Timing:
End of summer following completion of program courses (typically end of first year)

Learning Goals Assessed:
• Application of Statistical Methods
• Computational Skills
• Written Communication Skills

Exam Type:
• Take-Home, Open-Book, 1-Week
• Set by Assessment Committee
• Focuses on single contextual “topic”
• IMRaD-Style write-up of methods and results
• Writing and coding taken into account
Qualifying Examinations

Theoretical Exam
PhD Only

Courses:
- Mathematical Statistics I and II, Biostatistical Methods I and II

Timing:
- Summer Year 2

Learning Goals Assessed:
- Theoretical and Methodological Acumen

Exam Type:
- In-Class and Timed
- Set by course instructors
- Similar to problems from class
Dissertation Proposal Defense

• **Timing:**
  – Begin as soon as possible after Applied and Theoretical Qualifiers are passed
  – End no later than December of 4th year (3.5 academic years)

• **Components:**
  – Written proposal
    • Grant Proposal (F31)
    • Dissertation-Style Manuscript (no-page limit)
  – Oral defense to dissertation committee
    • Oral presentation (with slides) followed by Q&A from the committee
Dissertation Defense

• Components:
  – Original Research
    • Methodological research in biostatistics, genomics, bioinformatics
    • Faculty mentorship
  – Written Dissertation
    • Usually consists of three or more publishable papers
    • At least one must be submitted for peer review
  – Oral Defense
    • Part 1: Public presentation: ~45 minute presentation/~15 minute discussion
    • Part 2: Private defense: Committee members ask questions

Timing: When dissertation research is completed – usually end of 5th year
Why VCU?

- The Experiential Learning Emphasis
  - Didactics
  - Biostatistical Consulting Laboratory (BCL)
  - Student Summer Training Program
Didactics

• The coursework balances standard didactic learning with the development of professional skillsets

• Introduces other important aspects of being a professional biostatistician
  – Consulting
  – Manuscript review
  – Scientific writing and presentation
  – Seminars
BIOS 603 Sequence

- The biostatistical consulting sequence includes three different sections
  - Section 1 – Academic Writing (Basics of writing techniques, scientific writing, and revision)
  - Section 2 – Consulting Laboratory
  - Section 3 – Manuscript Review (learn the peer review process by reviewing preprinted or medical statistical papers)
Biostatistical Consulting Laboratory

• Hands on consulting experience
  – In-person meetings with clinical investigators
  – Small group presentations and team learning
  – Design, analysis and coding experience
  – Report generation

• BCL TAs
  – Supervises projects
  – Engages in administrative work and outreach
Summer Student Training Program

- Students are paired with faculty mentor to work on applied or methodological project
- Often used as precursor to dissertation research
Funding

• Currently, we do not provide funding for MS students

• For PhD students, qualified applicants are invited to an open house early in the spring semester
  – Within a week, applicants will be notified if they have been offered admission with funding
  – Funding includes:
    • Tuition and fees (Currently $46,563)
    • Health Insurance
    • Laptop
    • Annual Stipend (Currently $34,000)
After Graduation

- Some of the Employers of our recent graduates include:
  - Proctor & Gamble
  - Pfizer
  - GSK
  - Abbvie
  - Siemens
  - PharPoint
  - Emmes
  - FDA
  - United Network for Organ Sharing (UNOS)
  - US Military Academy
  - Medical University of South Carolina (MUSC)
  - University of Alabama-Birmingham (UAB)
  - VCU Health
Admission Requirements

• For Both the MS and PhD Programs, Prerequisites Include:
  – Calculus and Multivariable Calculus
  – Linear Algebra
  – Concepts of Statistics
  – Introduction to Probability theory

• The GRE is Suggested for MS Applications and Required for PhD Applications
How to Apply

• Go to the following link or use the QR code:
  – https://admissions.vcu.edu/apply-to-vcu/

• Feel Free to Browse our website:
  – https://biostatistics.vcu.edu/

• If you have questions, feel free to contact:
  Beth Ann Howard
  Education Coordinator
  (804) 827-2049
  howardea@vcu.edu
Discussion

Visualization of Collatz Conjecture suggested by Edmund Harriss