Upper-Division Pathways
“Routes with Relevance”

Need for new course offerings and pathways developed in partnership with other disciplines to address the ever expanding use of mathematics in the workplace and to better meet students’ academic and career goals
Basic Question

What problem are we trying to solve?

What opportunity are we trying to seize?
Tumor Profiling by Array Analysis


Slide credit: Timothy Triche
from Luca Cavalli-Sforza
Genes, Peoples and Languages
Attracting new investigators to neuroscience from the quantitative disciplines (physics, statistics, computer sciences, mathematics, and engineering), and training graduate students and postdoctoral students in quantitative neuroscience, should be high priority goals for the BRAIN Initiative.

--NIH BRAIN 2025: A Scientific Vision
A possibly apocryphal story

In physics, we don’t change the questions; we change the answers
In mathematics, the answers don’t change, but the questions people care about do
These questions in turn inspire new mathematics
The “Unreasonable Effectiveness of Mathematics”

- Prime Numbers -> Secure Internet Commerce
- Operators on Hilbert Space -> Quantum Mechanics
- Quaternions -> Satellite Tracking, Video Games
- Eigenvectors -> Google’s PageRank
- Stochastic Processes -> Black-Scholes
- Integral Geometry -> MRI and PET scans
- Connections -> Gauge Fields
The “Unreasonable Effectiveness of Applications”

- Electromagnetics -> Hodge Theory
- Nuclear Physics -> Random Matrix Theory
- Geosciences -> Chaotic Dynamical Systems
- Superconductivity -> Ginzburg-Landau Equation
- String Theory -> Gromov-Witten Invariants
- Condensed Matter -> Complex Systems
- Epidemiology -> Interacting Particle Systems
- Deep Learning -> ??

Mathematics evolves. This is one of the ways new “mathematical species” come into existence.
Quantitative Education for the 21st Century

- Do we have a vision as a profession about our educational mission?
- Such a vision should be nuanced: One size does not fit all
- The goal is coherence without uniformity
- An education that provides the foundation for a lifetime—relevant but not trendy
- How do we build capacity to carry out this vision?
A Few Questions

• What information do we need that we do not already have?
• What student populations are we trying to serve?
• What mathematical content and skills will prepare our students for the world they will live in?
• Can we shorten the time from discovery to entering the curriculum?
• What departments should we partner with?
• How do we move from individual-centered course innovation to systemic change?
• How to we scale up our successes?
• Where will the resources come from?
• How best do we forge a consensus for change?
What does our community need to move forward?

• Assistance in gathering relevant data?
• A way to develop and share syllabi, texts and materials?
• Professional development, improvement communities?
• Help in making the case for resources?
• A reward structure that encourages curricular innovation?
• Well-documented success stories?
• A way to scale up successful innovations?
Who is going to do this?

• Department chairs?
• Professional organizations?
• JPBM? CBMS?
• University administrations?
• Industry?
• Statewide commissions?
• All of the above?

And what is the right role for TPSE?
When should we do this?

NOW!

Thank You