Upper-Division Pathways
"Routes with Relevance"
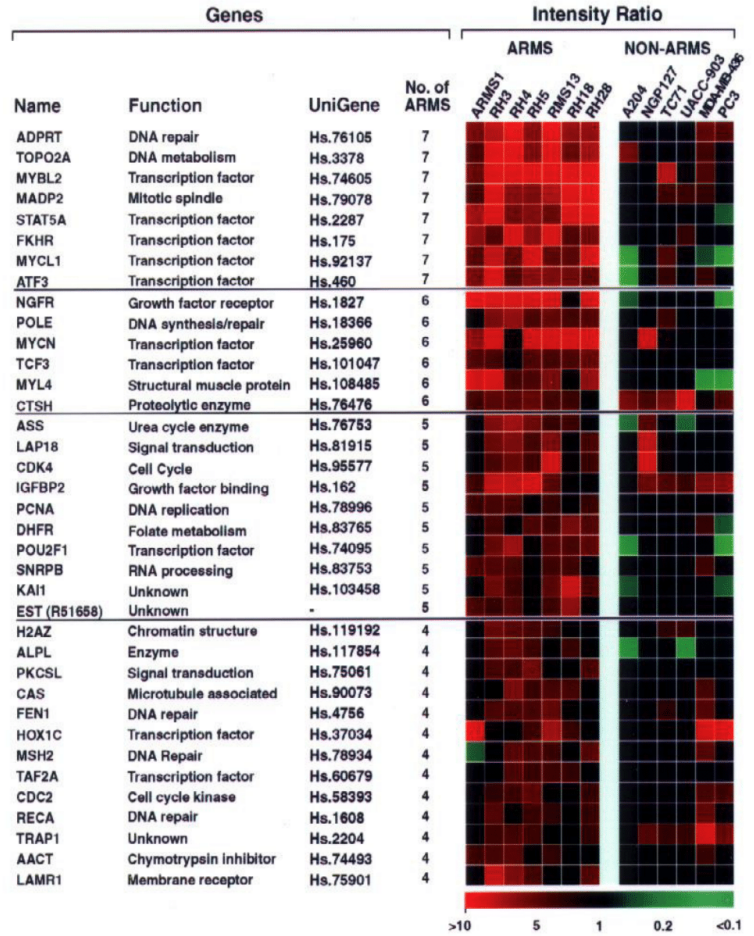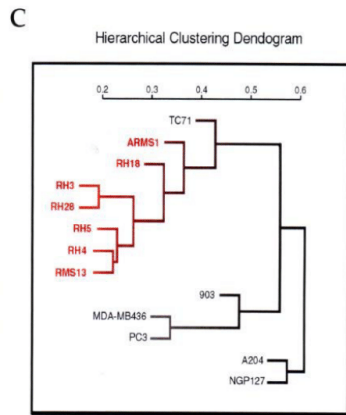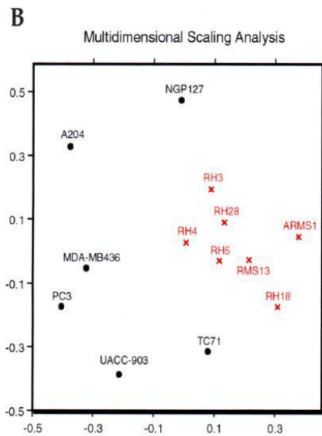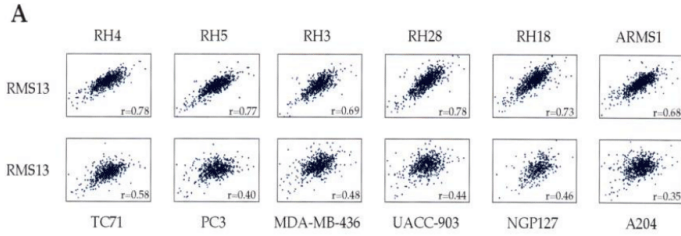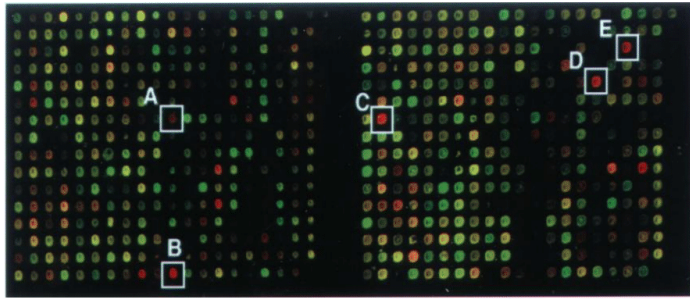
Need for new course offerings and pathways developed in partnership with other disciplines to address the ever expanding use of mathematics in the workplace and to better meet students' academic and career goals

Basic Question

What problem are we trying to solve?

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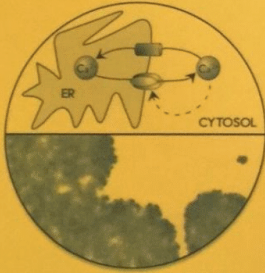
Tumor Profiling by Array Analysis

A

	RH4	RH5	RH3	RH28	RH18	ARMS1
RMS13	r=0.78	r=0.77	r=0.69	r=0.78	r=0.73	r=0.68

	TC71	PC3	MDA-MB-436	UACC-903	NGP127	A204
RMS13	r=0.58	r=0.40	r=0.48	r=0.44	r=0.46	r=0.35

B — Multidimensional Scaling Analysis

C — Hierarchical Clustering Dendogram

Genes / Intensity Ratio

Name	Function	UniGene	No. of ARMS
ADPRT	DNA repair	Hs.76105	7
TOPO2A	DNA metabolism	Hs.3378	7
MYBL2	Transcription factor	Hs.74605	7
MADP2	Mitotic spindle	Hs.79078	7
STAT5A	Transcription factor	Hs.2287	7
FKHR	Transcription factor	Hs.175	7
MYCL1	Transcription factor	Hs.92137	7
ATF3	Transcription factor	Hs.460	7
NGFR	Growth factor receptor	Hs.1827	6
POLE	DNA synthesis/repair	Hs.18366	6
MYCN	Transcription factor	Hs.25960	6
TCF3	Transcription factor	Hs.101047	6
MYL4	Structural muscle protein	Hs.108485	6
CTSH	Proteolytic enzyme	Hs.76476	6
ASS	Urea cycle enzyme	Hs.76753	5
LAP18	Signal transduction	Hs.81915	5
CDK4	Cell Cycle	Hs.95577	5
IGFBP2	Growth factor binding	Hs.162	5
PCNA	DNA replication	Hs.78996	5
DHFR	Folate metabolism	Hs.83765	5
POU2F1	Transcription factor	Hs.74095	5
SNRPB	RNA processing	Hs.83753	5
KAI1	Unknown	Hs.103458	5
EST (R51658)	Unknown	-	5
H2AZ	Chromatin structure	Hs.119192	4
ALPL	Enzyme	Hs.117854	4
PKCSL	Signal transduction	Hs.75061	4
CAS	Microtubule associated	Hs.90073	4
FEN1	DNA repair	Hs.4756	4
HOX1C	Transcription factor	Hs.37034	4
MSH2	DNA Repair	Hs.78934	4
TAF2A	Transcription factor	Hs.60679	4
CDC2	Cell cycle kinase	Hs.58393	4
RECA	DNA repair	Hs.1608	4
TRAP1	Unknown	Hs.2204	4
AACT	Chymotrypsin inhibitor	Hs.74493	4
LAMR1	Membrane receptor	Hs.75901	4

ARMS: ARMS1, RH3, RH4, RH5, RMS13, RH18, RH28

NON-ARMS: A204, NGP127, TC71, UACC-903, MDA-MB436, PC3

Intensity Ratio: >10   5   1   0.2   <0.1

Khan, et al: Cancer Res, Nov. 1998

Slide credit Tiimothy Triche

Computational Cell Biology

ER

CYTOSOL

Christopher P. Fall   Eric S. Marland
John M. Wagner   John J. Tyson
Editors

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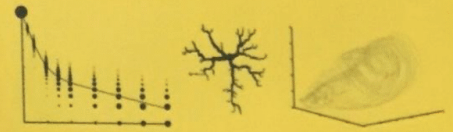## Probabilistic Graphical Models for Genetics, Genomics, and Postgenomics

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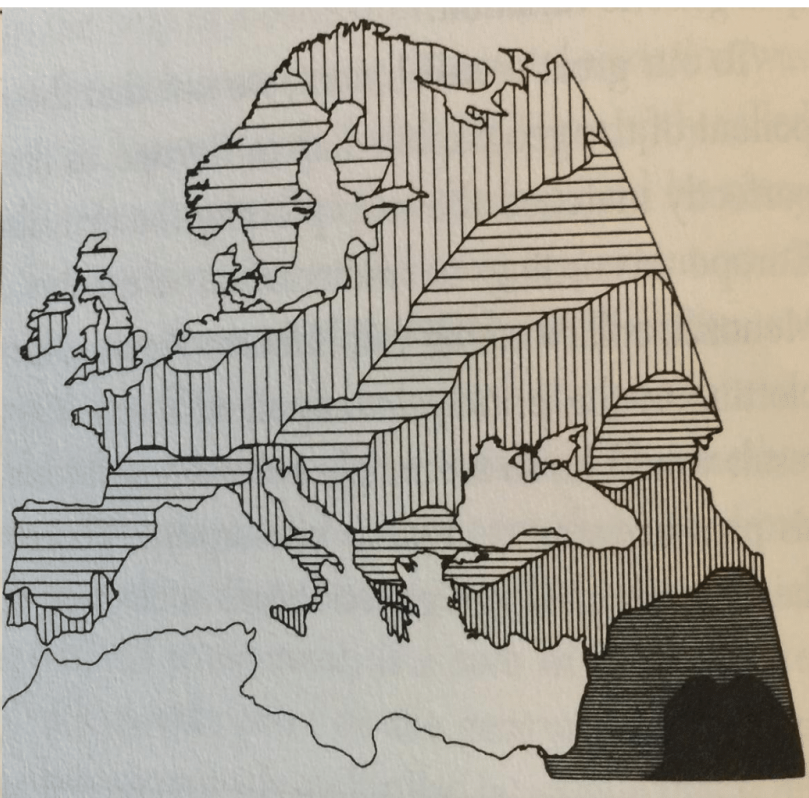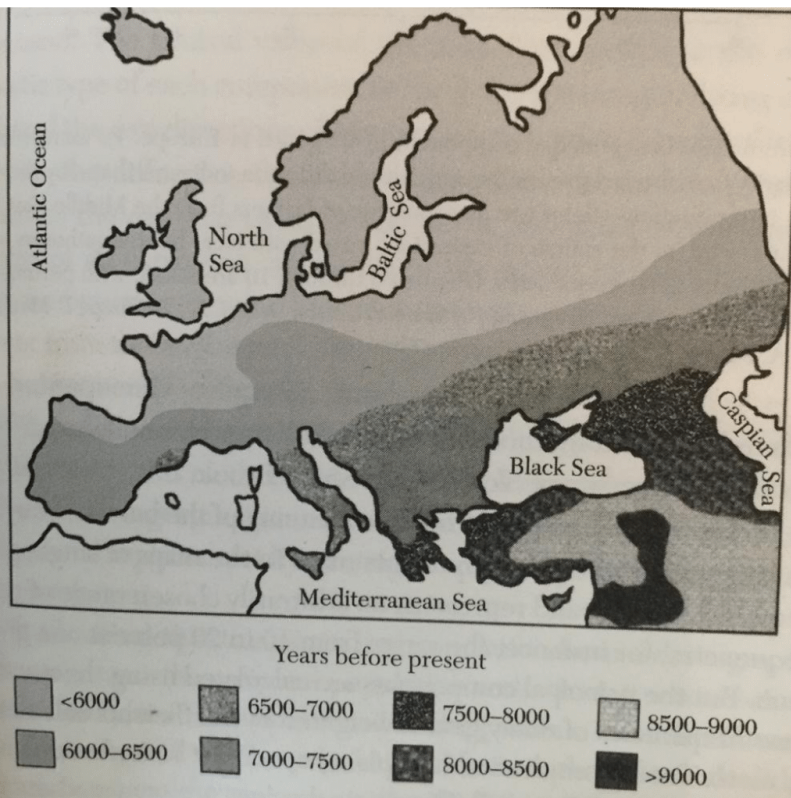
Modeling in Biopharmaceutics, Pharmacokinetics, and Pharmacodynamics
Homogeneous and Heterogeneous Approaches

Panos Macheras
Athanassios Iliadis

Springer

Atlantic Ocean

North Sea

Baltic Sea

Black Sea

Caspian Sea

Mediterranean Sea

Years before present

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6000–6500	7000–7500	8000–8500	>9000

from Luca Cavalli-Sforza
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Mathematics and Democracy

DESIGNING BETTER VOTING
AND FAIR-DIVISION PROCEDURES

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SCHELLING'S GAME THEORY

HOW TO MAKE DECISIONS

ROBERT V. DODGE

AN
INTRODUCTION
TO THE
THEORY OF
**MECHANISM
DESIGN**

TILMAN
BÖRGERS

with a chapter by
DANIEL KRÄHMER and
ROLAND STRAUSZ
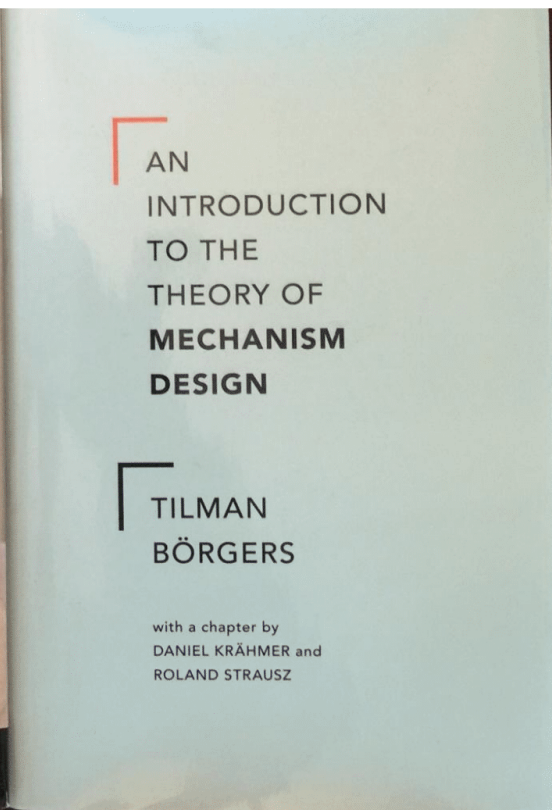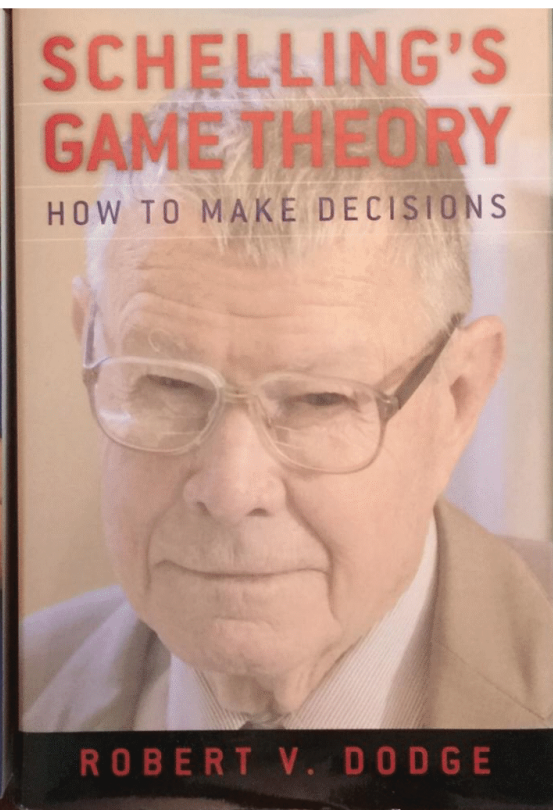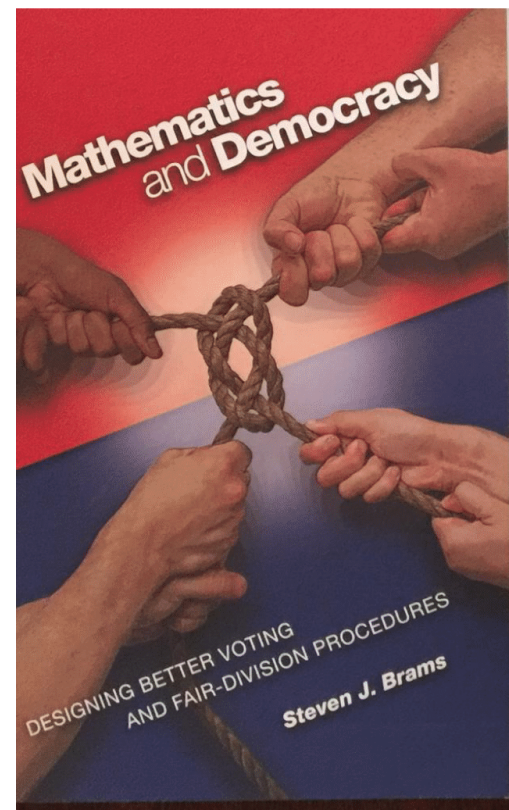
Attracting new investigators to neuroscience from the quantitative disciplines (physics, statistics, computer sciences, mathematics, and engineering), and training graduate students and postdoctoral students in quantitative neuroscience, should be high priority goals for the BRAIN Initiative.

--NIH BRAIN 2025: A Scientific Vision

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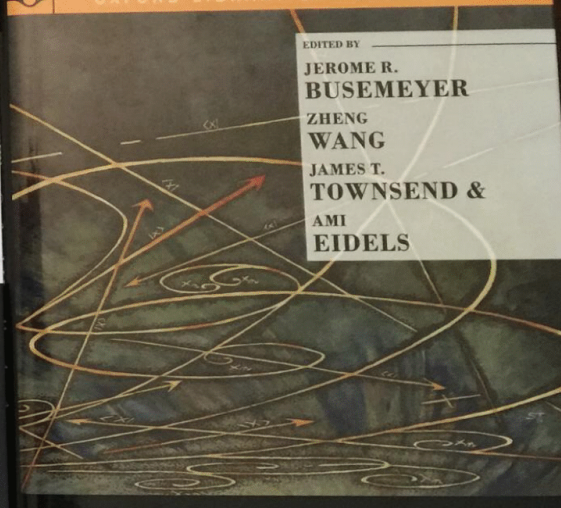
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Corporate Finance, Risk Management,
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NETWORKS
CROWDS
AND MARKETS

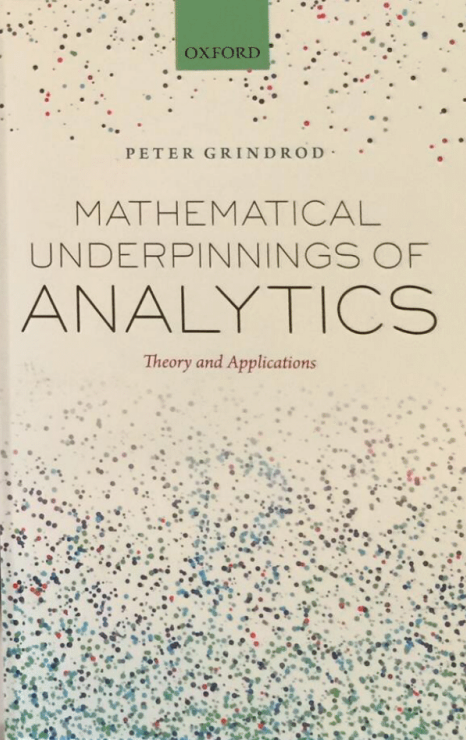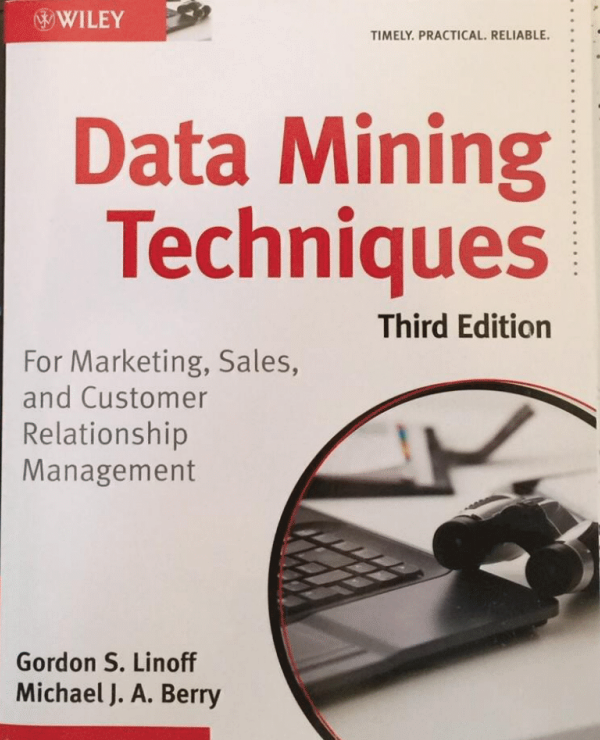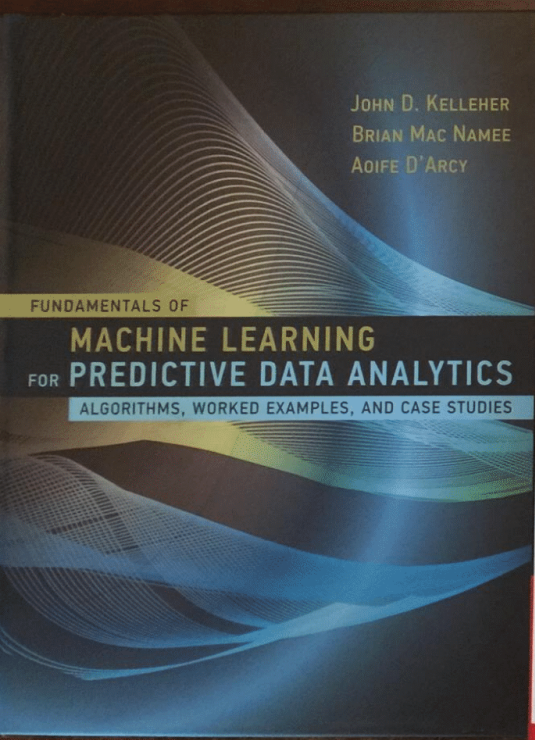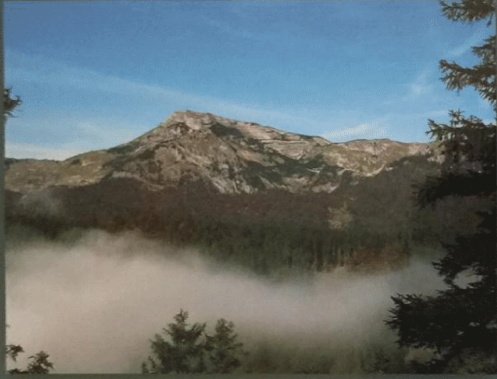Reasoning about a Highly Connected World

DAVID EASLEY
and
JON KLEINBERG

CAMBRIDGE
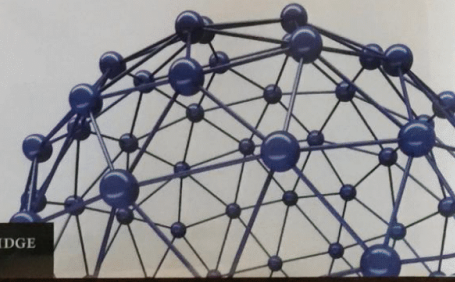
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The Oxford Handbook of
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FUNDAMENTALS OF
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FOR **PREDICTIVE DATA ANALYTICS**
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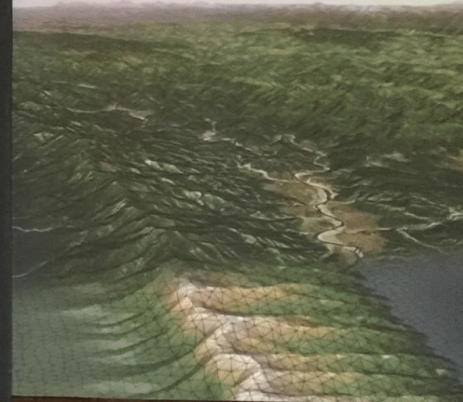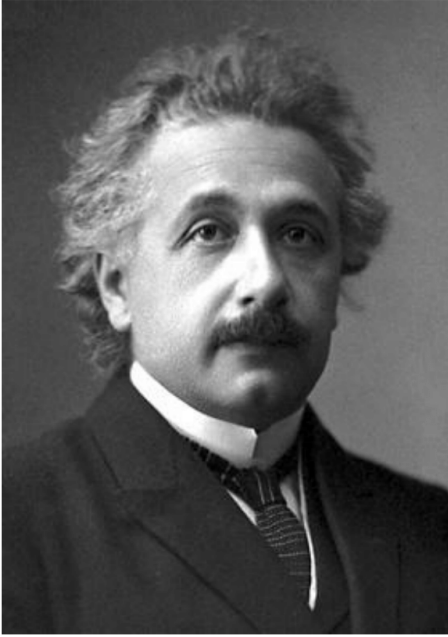
Rudy Slingerland and Lee Kump

MATHEMATICAL MODELING
of Earth's Dynamical Systems

A Primer

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!
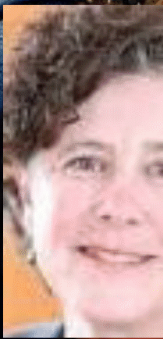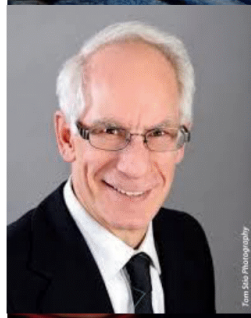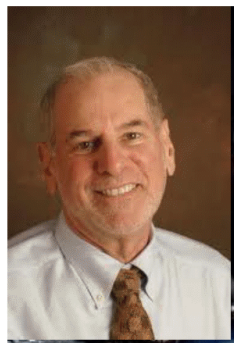
Relation to LD Efforts

- LD Goal: Make Math a gateway, not a barrier
- Question: A gateway to what?
- UD Goal: From gateway to UD pathway
- LD Goal: Get students on track to complete their degree
- Question: It is great to complete a degree, but what is the value of the degree you complete?
- UD Goal: "Routes with Relevance" leading to more satisfying lives and productive careers

Data Gathering

- Better information about who takes our courses and why, and about potential demand for new pathways

- A nuanced picture of the employment picture and what mathematical knowledge is in demand

- This will go forward in tandem with development of new pathways

TPSE's Mathematics Advisory Group

- Department chairs and others in a position to effect change
- Have been advising TPSE and helping to plan and lead TPSE workshops
- A source of "news from the front lines"
- Helpful in reaching consensus about what types of change are needed
- We will supplement the MAG with new partners in the BING sector, professional organizations, umbrella organizations for university administrators

Regional Design Workshops

- A collaborative effort to imagine, build and implement a new UD pathway
- Will involve regional departments, with involvement of significant employers of mathematicians in the region
- Will employ modern design principles, which include techniques to bypass existing preconceptions, an iterative pattern of development, participation of users, early and frequent testing
- One output will be "improvement communities" centered around the new pathway

When should we do this?

NOW!

Thank You