

The Mathematical Sciences at The University of Texas at Dallas

DISD School of Science and Engineering

Nov 12th, 2022



What is Mathematics?

μαθημα

Mathema

Ancient Greek for

“That which is learnt”

Mathematics is the science of patterns

“A mathematician, like a painter or a poet, is a maker of patterns. If his patterns are more permanent than theirs, it is because they are made with ideas.”

G. H. Hardy, 1940

Some Major Areas of Mathematics

Algebra

Formulas

$$\begin{bmatrix} a & b \\ b & d \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} = \lambda \begin{bmatrix} u \\ v \end{bmatrix}$$

Geometry

Shapes



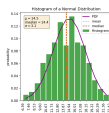
Calculus & Analysis

Functions
& Change

$$\frac{d}{dx} \int_a^x f(t) dt = f(x)$$

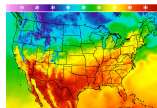
Probability & Statistics

Data
Modeling



Computational Mathematics

Algorithms for
Applications



Mathematics and Applications

- ① Mathematics developed for its own sake often finds applications in many fields
- ② Applications typically involve combining ideas from several areas of math

Example Application

Finding common patterns in brain anatomy from MRI scans can be used to detect Alzheimer's disease prior to the onset of symptoms.

Theorems and proofs are essential to applications

We must know what is true and why!

Undergraduate Degrees in Math @ UTD

650 undergraduate math majors

60 faculty

- B.S. in Mathematics, with specializations in
 - Applied Mathematics
 - Mathematics
 - Statistics
 - with UTeach Dallas option
- B.A. in Mathematics
- B.S. in Actuarial Science
- B.S. in Data Science (joint with Computer Science)
- Certificate in Data Science [5 courses]

With active learning, students:

- 1 Engage in mathematical reasoning
- 2 Solve problems with their fellow students
- 3 Explain their thinking to each other and the TA

“The structure of the problem sessions is the best I’ve ever seen. You get to learn by working with others. Allowing us to explain material with a TA’s guidance is highly beneficial.”

B.S. in Mathematics

- ① Coursework in all the major areas of mathematics
- ② Professors with UTD/state-level teaching awards
- ③ Fast-track BS/MS program [5 years total]
- ④ Putnam Mathematics Competition: 18/554 in 2015
- ⑤ Opportunities for undergraduate research
- ⑥ Great preparation for graduate school

Our graduates have gone to MS/PhD programs at

- Princeton University
- Johns Hopkins University
- University of Maryland
- University of California San Diego
- Georgia Tech
- Rutgers University
- UT Austin
- Southern Methodist University

Actuarial Science

Actuaries apply

- 1 Mathematics and statistics
 - 2 Economics and finance
 - 3 Government policies and management principles
- to **assess risk** in the insurance and finance industries.

Examples of sorts of work

- Project how a new auto-safety law changes insurance claims
- Estimate the benefit cost of a labor contract
- Project financial costs of an epidemic
- Analyze investment risk

The three legs of our Actuarial Science program

- 1 Academic preparation: Prep for ASA exams
- 2 Business preparation: Case studies and internships
- 3 Connection with industry: Networking in DFW region

UTD has an Society of Actuaries accreditation as a Center of Actuarial Excellence

- One of 35 in the world
- The only one in Texas and the Southwest U.S.

Where Do Actuaries Work?

- Insurance industry (Nationwide, BC/BS)
- Financial institutions (Merrill Lynch, Goldman Sachs)
- Consulting firms (Willis Towers Watson, Milliman)
- Government agencies (Department of Insurance, Social Security Administration)
- Accounting firms (KPMG, Pricewaterhouse Coopers, Deloitte, Ernst and Young)

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Data Science

Data Science combines

- Mathematics
- Statistics
- Computer Science
- Knowledge of application fields

to **extract knowledge** from large data sets.

Governments, companies and organizations use data science to inform high-level decisions.

The U.S. Bureau of Labor Statistics sees strong growth in data science and predicts the number of jobs will increase by about 28% through 2026, that is roughly 11.5 million new jobs.

— From a 2021 article in Towards Data Science

Computer Science

- Data Structures
- Big Data Management and Analytics
- Machine Learning

Statistics

- Probability; Mathematical Statistics
- Numerical and Statistical Computing
- Statistical Learning

Mathematics

- Advanced Calculus
- Linear Algebra
- Mathematical Analysis

UTDiscovery: Capstone Project

Student teams work with company and UTD mentors to

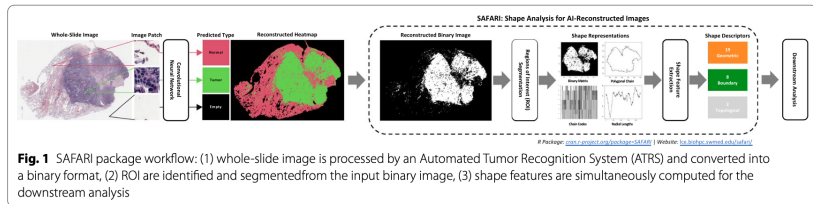
- Formulate a relevant problem
- Collect required data
- Develop necessary computational tools
- Find a solution
- Develop leadership & communication skills
- Network with companies

"... [the students'] ability to adapt in real time and identify & execute value-added next steps was truly remarkable to me — more so than with any other university program I've worked!"

— Raytheon Technologies Engineering Fellow

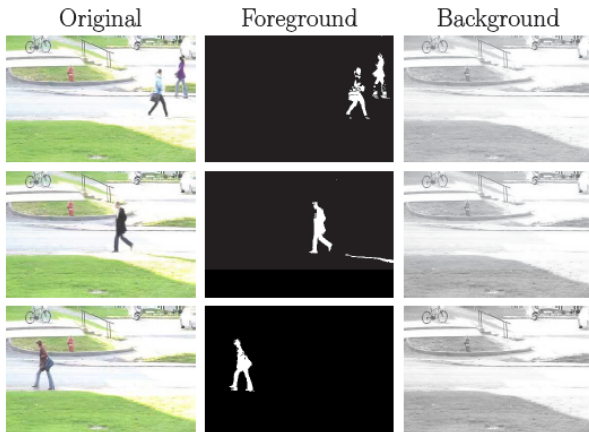
For more info contact datascience@utdallas.edu

Undergrad Research: Biostatistics



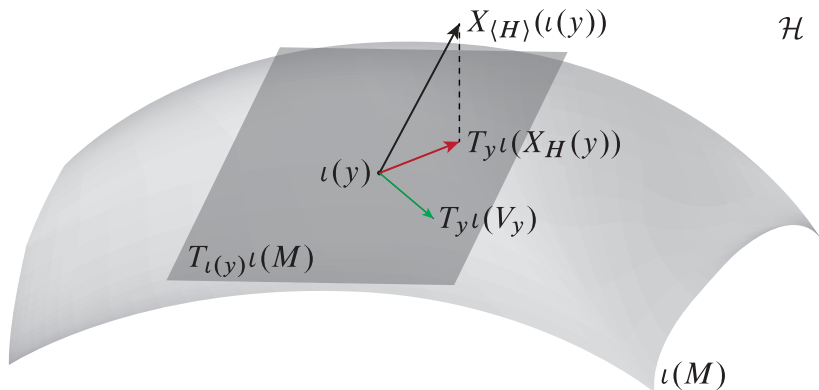
Esteban Fernandez, *“Extracting clinically meaningful features for the analysis of tumor pathology images”*

Undergrad Research: Comp. Math



Austin Luong, Kyu Shim, and Nikita Traynin,
"Accelerated robust principal component analysis for
video surveillance"

Undergrad Research: Geometry/Physics



Nolan King, "Hamiltonian Dynamics of Semiclassical Wave Packets in Electromagnetic Potentials"

Undergraduate Research: Algebra

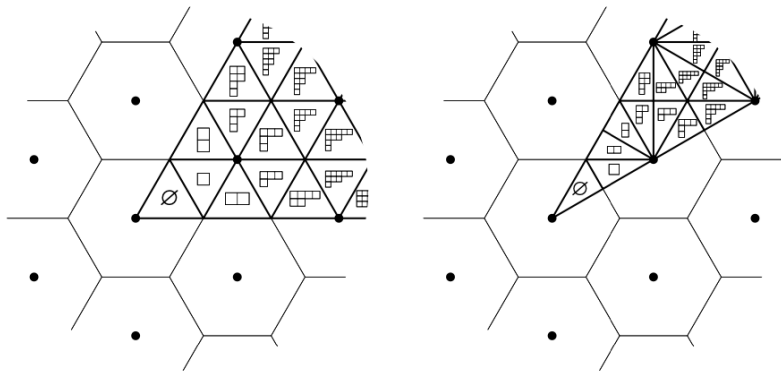


Figure 2. Left: correspondence between $\tilde{\mathfrak{S}}_3/\mathfrak{S}_n$ and 3-cores. Right: correspondence between $\tilde{W}(G_2)/W(G_2)$ and 3-cores.

Joshua Marsh, "Nesting Nonpartitions"

Employment outlook

Occupation	Median Pay 2021	Number Employed 2021	Projected Employed 2031
Actuary	\$105,900	28,300	34,200 Up 21%
Data Scientist	\$100,910	113,300	153,900 Up 36%
Mathematician	\$96,280	2000 [†]	2000
Statistician	\$96,280	34,200	45,300 Up 33%
Operations Research Analyst	\$83,360	104,200	128,300 Up 23%

† Mathematics majors are often qualified for advanced R&D positions in related fields.

Employers of Mathematicians

- Government Labs and Agencies
- Federally-Funded Contractors
- Engineering Research Organizations
- Computer Information and Software Firms
- Financial Service and Investment Management Firms
- Communications Services Providers
- Electronics and Computer Manufacturers
- Aerospace Industry
- Transportation Service Providers
- Producers of Petroleum and Petroleum Products
- Medical Device Companies
- Chemical or Pharmaceutical Manufacturers

There are many good entry-level jobs for mathematicians in the DFW region!