

December 6, 2023

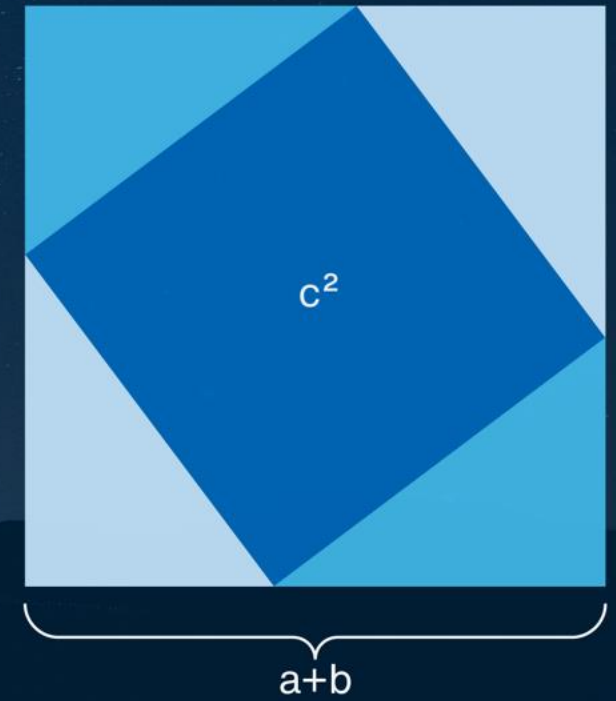
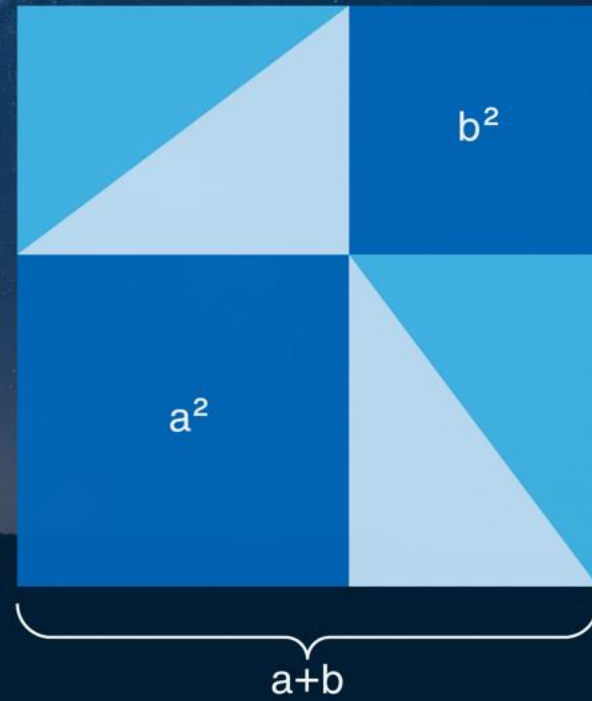
Math Changes Everything

The Importance of Mathematics to the U.S.:
An Industry Perspective

Alan Lee
CTO, Analog Devices Inc.







$$a^2 + b^2 = c^2$$

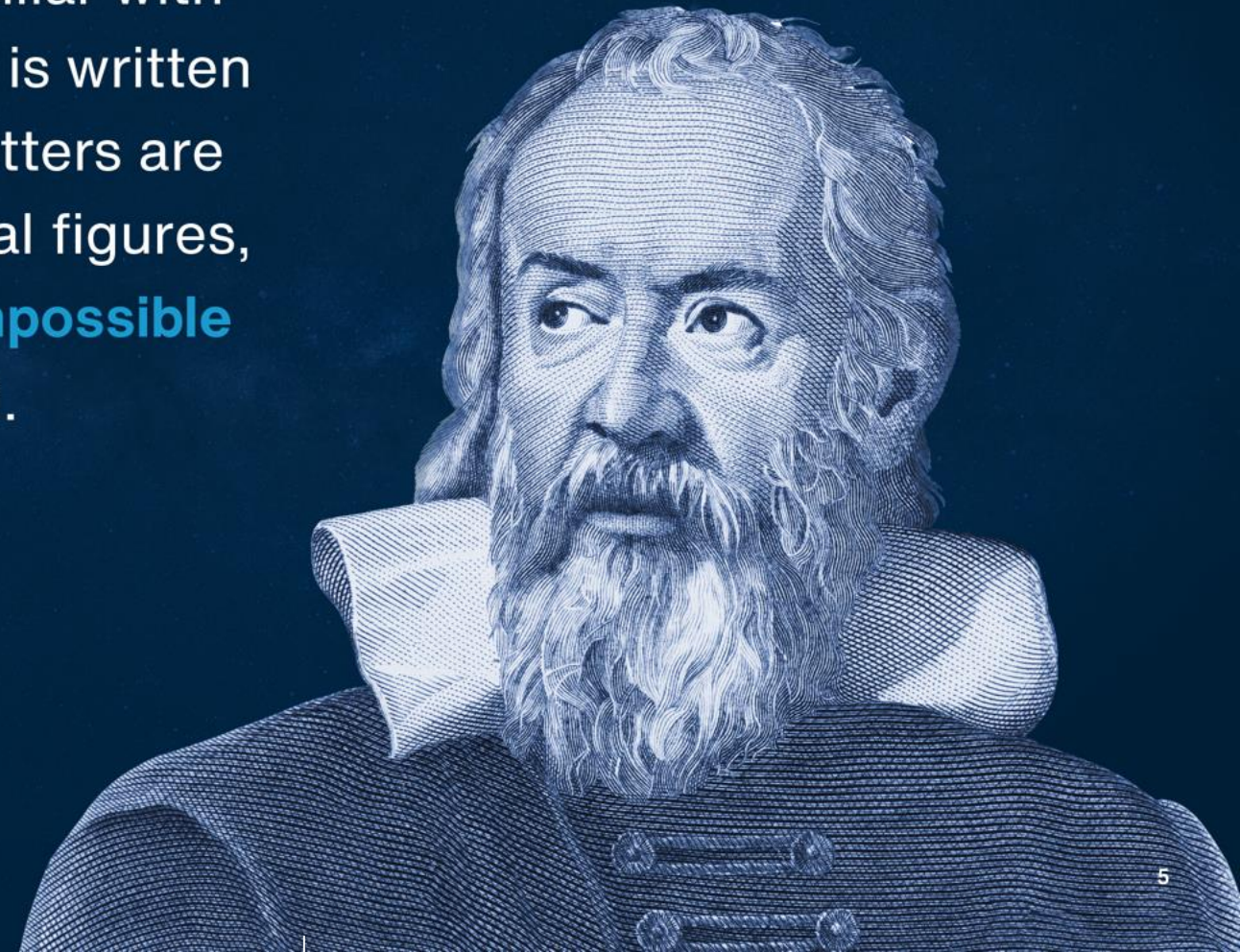
Mathematics, a *human* endeavor.

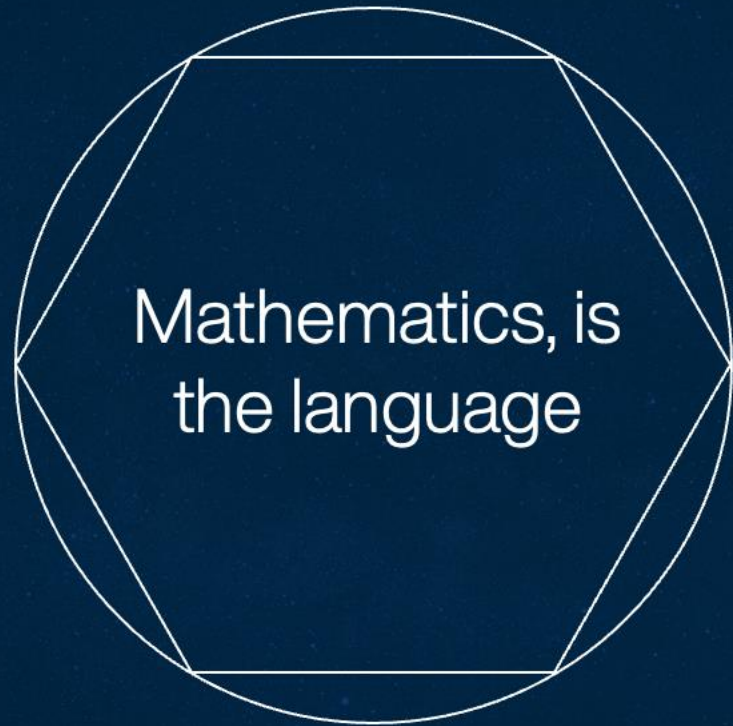


The **universe** cannot be read until we have learnt the **language** and become familiar with the characters in which it is written. It is written in **mathematical language**, and the letters are triangles, circles and other geometrical figures, without which means it is **humanly impossible** to comprehend a single word.

Galileo Galilei

OPERE IL SAGGIATORE, P. 171.

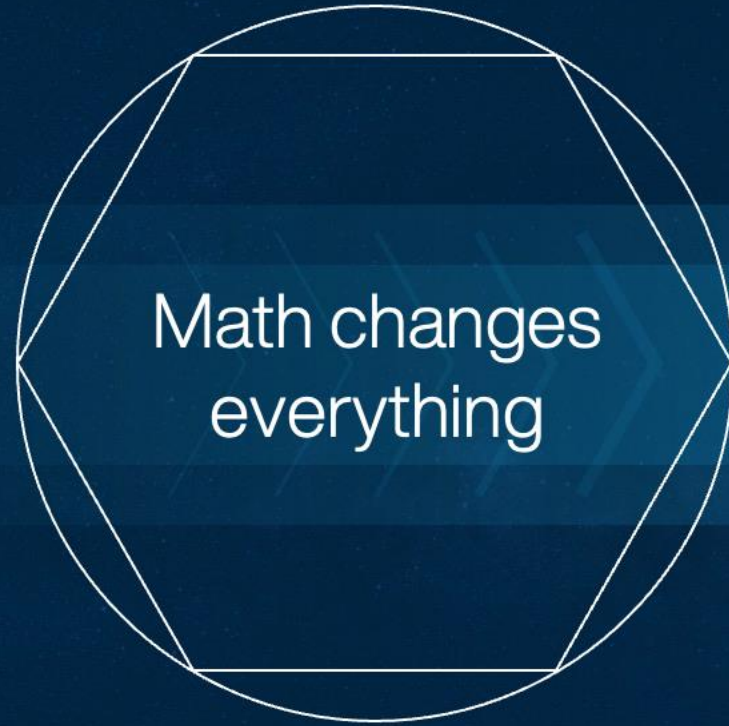




Mathematics, is
the language

of **Transformation**

Humans



Math changes
everything

Transformation

Julia
Robinson

Hilbert's
Tenth
Problem

Prosperity
Computability

Rivest, Shamir & Adleman



RSA
Encryption

Security
Data Protection

Terry Tao &
Emmanuel
Candès



Compressive Sensing

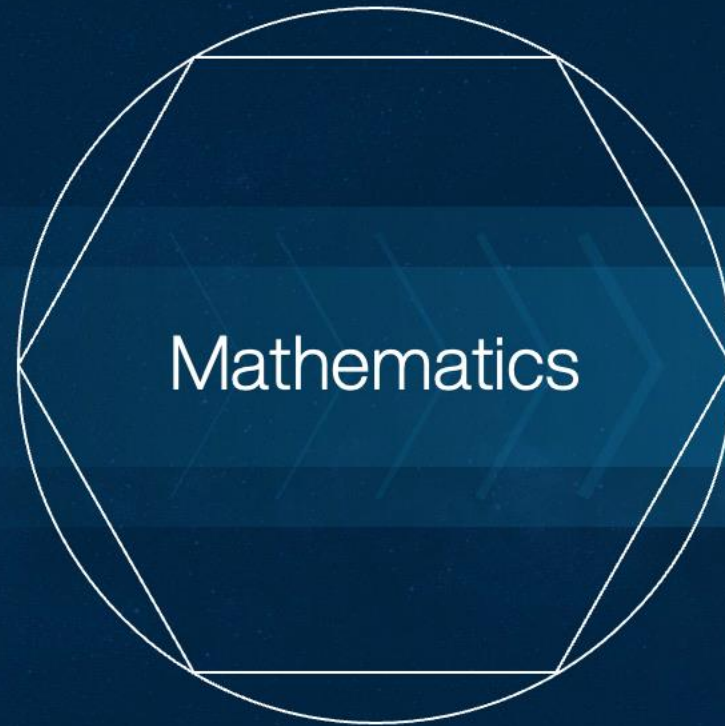
Health of Human
MRI scanning

Karen
Uhlenbeck

Calculus
of Variations

Health of Planet
Geometric Analysis
Modern Physics

Humans



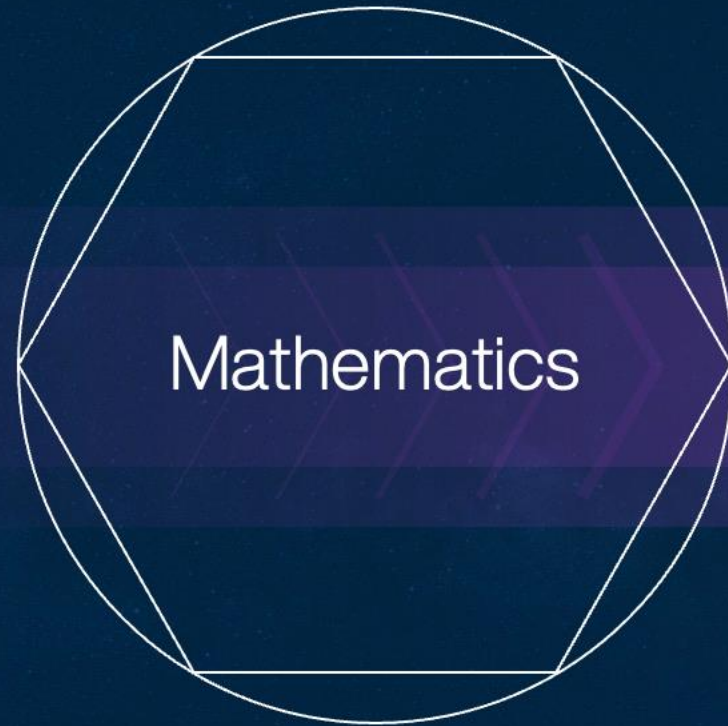
Prosperity

Security

Health of Human

Health of Planet

Humans



Prosperity

Security

Health of Human

Health of Planet



Math fuels

Innovation

Problem Solving

Quantitative Analysis

Modeling & Simulation

Optimization

Data Analysis

From algorithms to AI,
mathematics fuels
breakthroughs.

Math drives an

Innovation Ecosystem

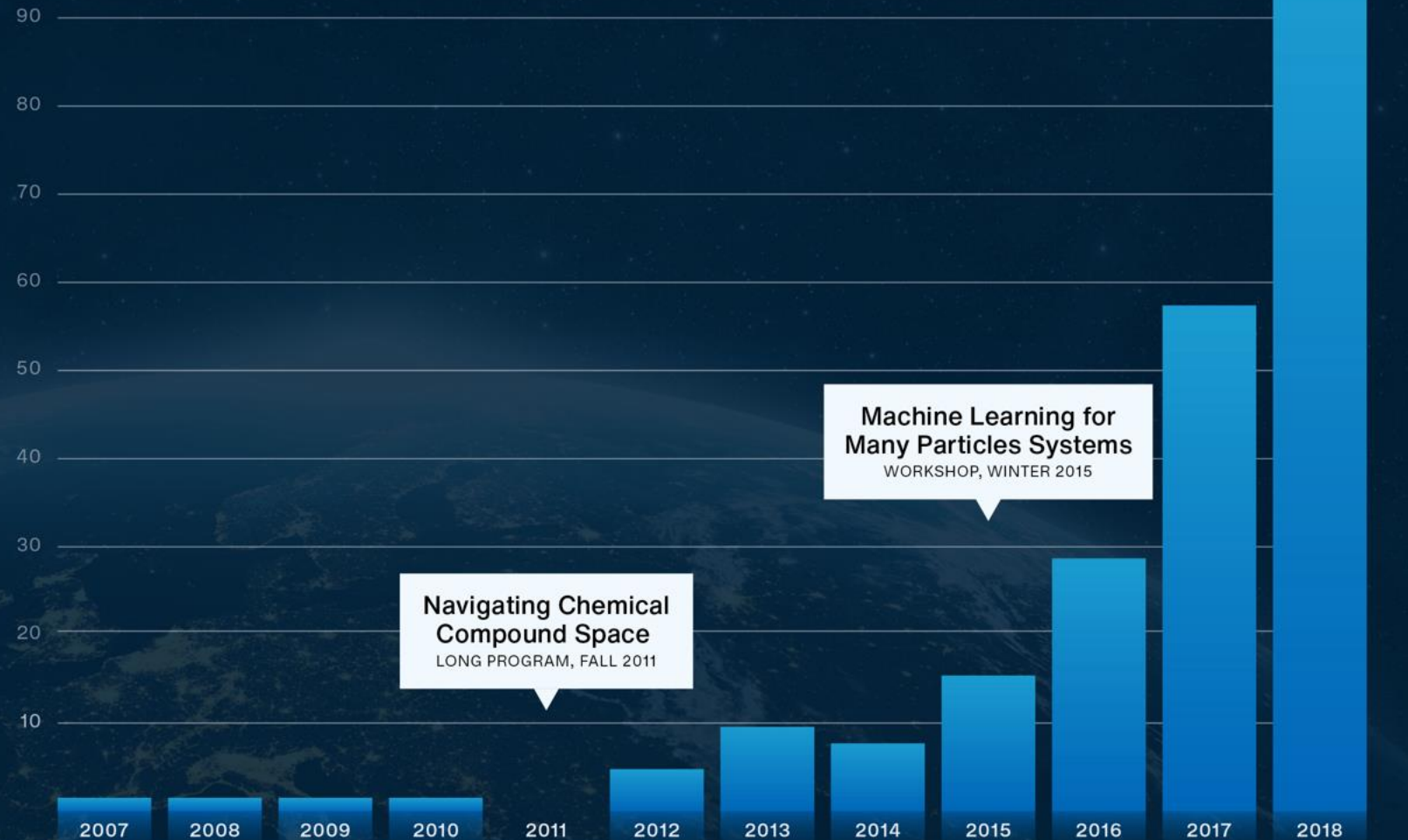
Fostering Collaboration

Accelerating Discovery

Accelerating **discovery** with AI for materials science.

IPAM

Number of publications per year on ML & density functional theory¹



1. Anatole von Lilienfeld based on 11/2018 Web of Science Data

Math is the foundation of our

Workforce & Education

Gateway to a skilled workforce

Math teaches analytical thinking, decision making, creativity and cross-disciplinary collaboration

Foundation of STEM

Math is the common language, and only discipline that can stand independently

Growing and Attracting Top Talent

Investment in math is critical for U.S. technology leadership

Others are strategically investing in **mathematics** education.

STEM graduates as a share of all tertiary education degree recipients in selected countries in 2022 (in percent)*



Math is the cornerstone of

Economic Growth

Technology

Finance

Manufacturing

Math is the basis for

Artificial Intelligence

AI is the result of advanced algorithms, the availability of massive data, and access to high-performance computation.

Math is the foundation of our

Financial Systems

Most trading is electronic and automated .

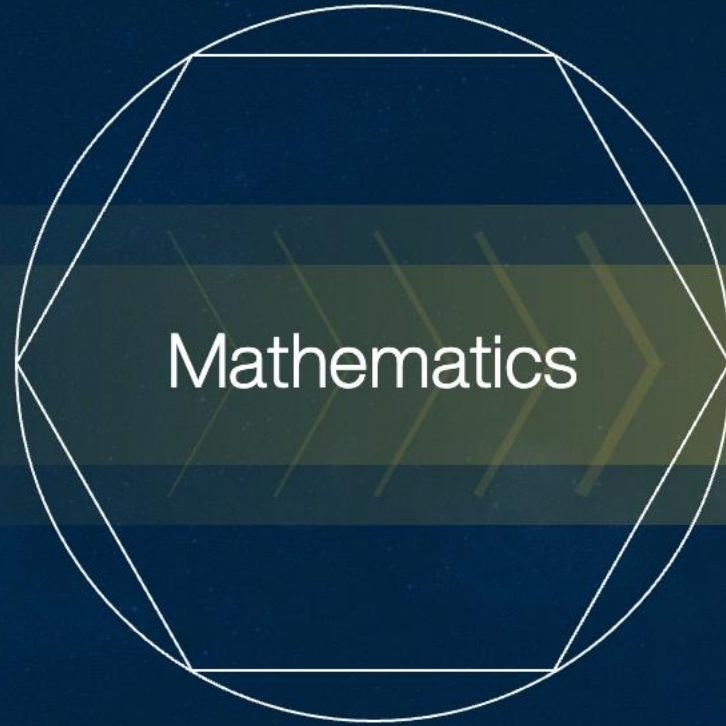
The international banking system depends on math.

Math revolutionizes

Manufacturing, Transport, & Infrastructure

Math models drive optimal resource utilization, traffic flow modeling, route and schedule optimization, infrastructure design, logistics management, safety analysis, and much more...

Humans



Mathematics

Security

Prosperity

Health of Human

Health of Planet



Math

Security

Modern Defense

Nuclear Capability

Cybersecurity

Network Awareness

Math changes

Modern Defense

Physical & Cyber Battlefields

Advancements in math required to model complex battlefields.

Hybrid Threat Neutralization

Large-scale simulation capabilities needed to generate strategies & tactics.

Disrupting Large-Scale Attacks

Game theoretical methods for building effective strategies.

Math supports

Nuclear Capability

Detect Nuclear Testing Worldwide

Signal processing enables the U.S. to identify nuclear testing events.

Maintaining Nuclear Capability

HPC-driven models help us understand aging of nuclear weapons.

High-Altitude Defense

Driven by targeting & detection algorithms.

Math enables Cybersecurity

Data Protection

Math is the underlying basis of encryption, fundamental in making and breaking data protection.

Network Resilience

Math models simulate and analyze network structures, aiding in design process.

Intrusion Detection & Prevention

Math algorithms analyze network traffic patterns to identify anomalies.

Vulnerability Assessment

Math-driven tools determine potential weaknesses and guide corrective measures.

Math enhance our

Network Awareness

**Thwart Terror
Networks**

**Limit Foreign
Social Media Influence**

**Geospatial
Awareness**

Math helps

Thwart Terror Networks

Math models and algorithms, can aid in uncovering and dismantling terror networks by revealing key nodes and identifying structural patterns.



Math helps

Limit Foreign Social Media Influence

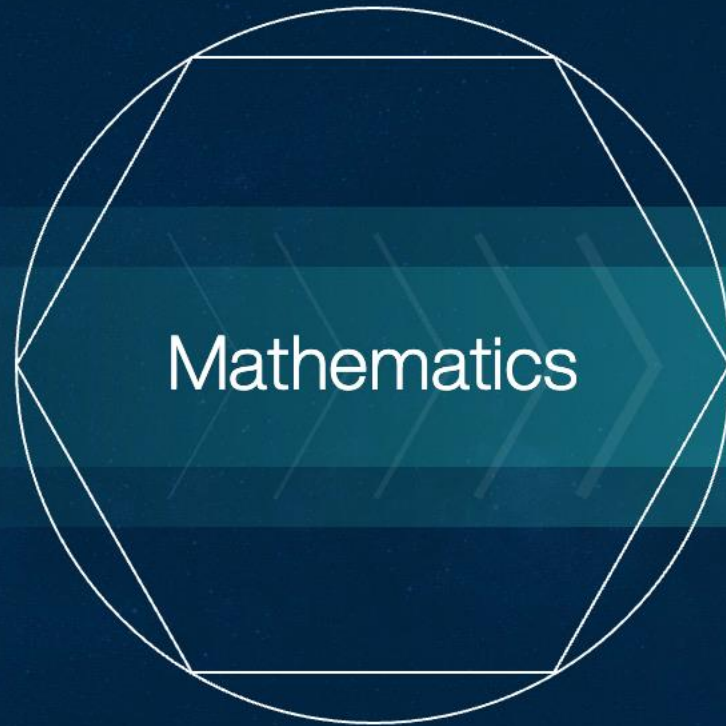
Math models and analysis can assist in comprehending and limiting foreign social media influence campaigns by identifying key influencers and detecting coordinated behaviors.

Math improves

Geospatial Awareness

Math models can help uncover and interpret anomalies by identifying irregularities in geographical data and enabling the detection of spatial patterns.

Humans



Mathematics

Prosperity

Security

Health of Human

Health of Planet



Math

**Health of
Human**

Medical Imaging

Patient Care

Pharmaceutical
Research

Genomics &
Bioinformatics

Math changes

Medical Imaging

Precise & Advanced Image Reconstruction

Math algorithms help create high-resolution and accurate images.

Diagnostics Accuracy

Math models analyze complex data for precise diagnosis.

Imaging Efficiency

Math-driven innovations reduce scan times and improve patient experiences.

Math advances Patient Care

Proactive & Personal Treatment

Math-driven analytics forecast patient outcomes and drive treatment.

Resource Optimization

Math models streamline healthcare operations.

Risk Stratification

Math algorithms enable optimized care for high-risk individuals.

Math revolutionizes

Pharmaceutical Research

Drug Discovery

Computational math accelerates prediction of interactions between drugs and genomes.

Optimized & Targeted Therapies

Math models identify potential drug targets and precise dosages.

Cost-Efficient Screening

Compute models streamline virtual screening, reducing research time and costs.

Predictive Analytics

Predictive math models guide decisions in drug development pipelines.

Math changes

Genomics & Bioinformatics

Genomic Sequencing

Vaccine Design

Personalized Medicine

Math enables

Genomic Sequencing

Mathematical models & combinatoric algorithms analyze vast genomic data and interactions within biological systems to unravel genetic codes.

Math contributes to Vaccine Design

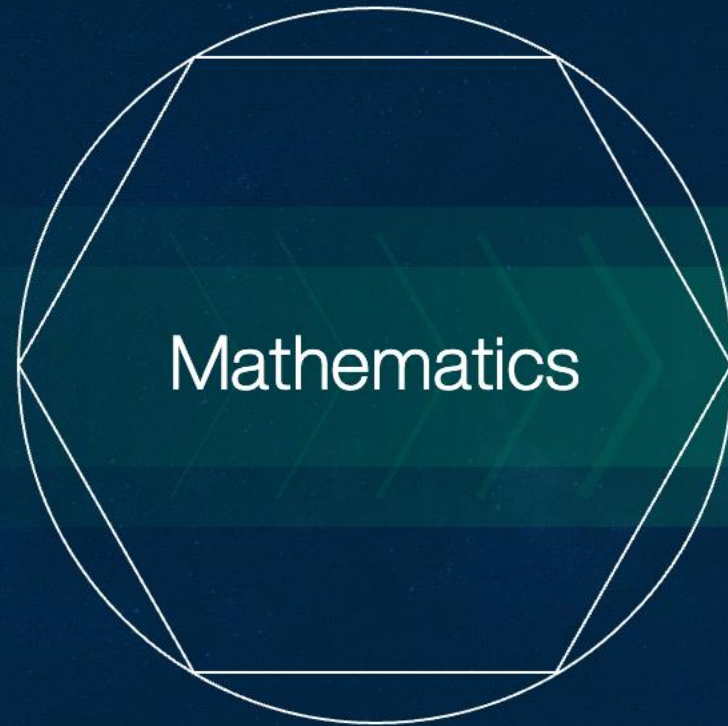
Math algorithms help design and improve vaccines, enhancing their effectiveness and safety.

Math supports

Personalized Medicine

Mathematical approaches interpret genetic variations,
guiding tailored treatment strategies for individual patients.

Humans

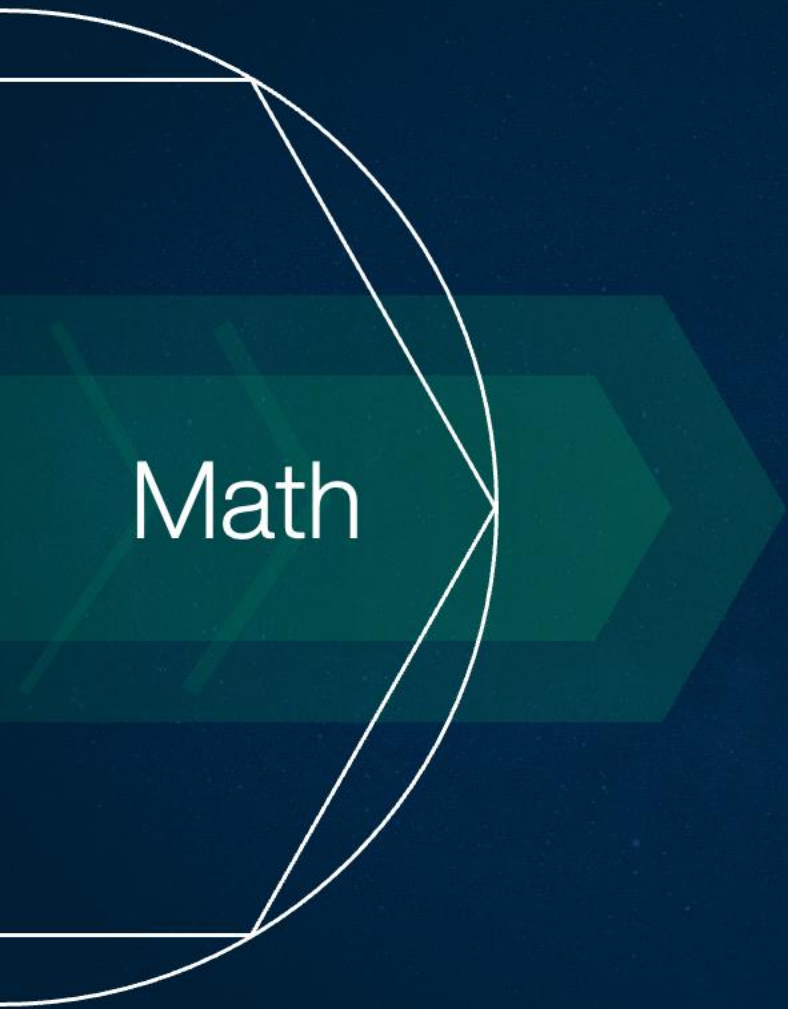


Prosperity

Security

Health of Human

Health of Planet



Health of Planet

Energy
Optimization

Crisis
Resilience

Resource
Allocation

Math empowers

Energy Optimization

Grid Efficiency & Management

Network models for efficiency, reliability, and control.

Power Plant Efficiency

Simulations & digital twins to enhance design and operation.

Carbon Emission Reduction

Math driven analysis for effective strategies.

Math facilitates

Crisis Resilience

Crisis Prediction

Predictive Modeling for early warnings and strategic decision-making.

Emergency Response & Aid

Algorithms and simulations for effective response plans and coordination.

Infrastructure Resilience

Analysis and simulations for strengthening design.

Math changes

Resource Allocation

**Healthcare
Management**

**Water Resource
Control**

**Food Security
& Planning**

**Supply Chain
Logistics**

Math models optimize

Healthcare Management

Healthcare resource distribution and improving
access to medical services.

Math models guide

Water Resource Control

Addressing scarcity and promoting responsible use of water resources globally.

Math optimizes Food Security & Planning

Strategies to optimize safety, production, distribution, and accessibility.

Math governs

Supply Chain Logistics

Ensuring a rapid and efficient flow of essential goods.

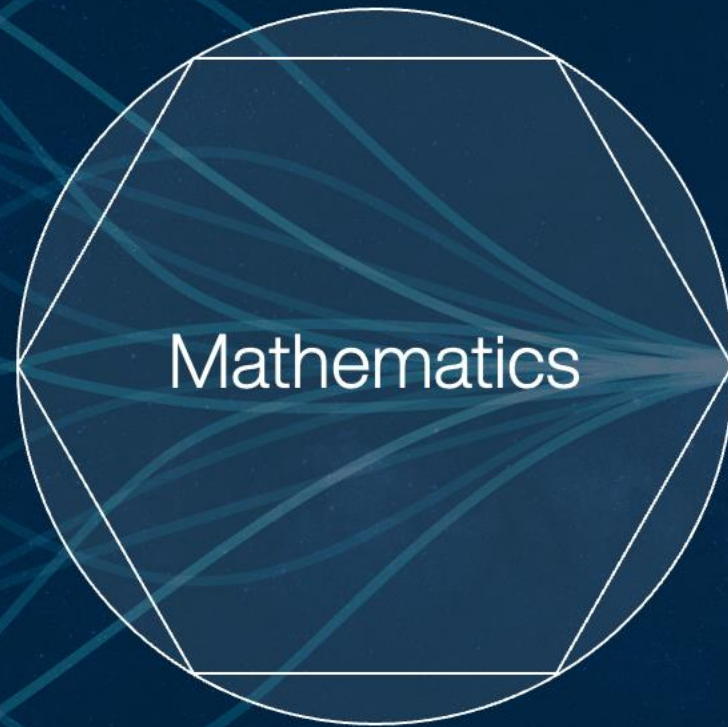
Math Changes Everything

Math is a
human
endeavor...



...across
prosperity,
security, people
and planet.

A path to our future success



A path to our future success

**Natural resources
and abilities?**

Certainly, but they only
go so far

A path to our future success

**Natural resources
and abilities?**

Certainly, but they only
go so far

**Passion for
Innovation?**

Absolutely, but the fire
must be fed

A path to our future success

**Natural resources
and abilities?**

Certainly, but they only
go so far

**Supportive
Ecosystem?**

Necessary, but not
sufficient

**Passion for
Innovation?**

Absolutely, but the fire
must be fed

A path to our future success

Strategic Investment in Mathematics Research

Q&A

Seeking input and dialogue on
the critical role of mathematics