Applied and Computational Mathematics

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Numerical Analysis, Mathematical Sciences



What are mathematical sciences?

- Mathematics
- Statistics
- Numerical Analysis and Scientific Computing
- Applied Mathematics
- ▶ ...

Fractal



Fractal in nature

Econfina River State Park, Florida



Fractals at the supermarket

Roman broccoli



Mathematics in engineering

Öresund bridge



Mathematics and safety

Tacoma Narrows Bridge 1940



von Kármán vortices

(cf. Tacoma Narrows)



Fluid-structure interaction - mechanical resonance

Mathematics and uncertainty

Actuarial mathematics



Pensions, life insurance, car insurance, risk assessment and risk management, financial markets

Statistics and probabilistics

Technology and mathematics X-15 rocket plane c. 1965



Mathematics on a stamp

X-15 (2006)



"Computer-generated aerodynamic study of an X-Plane"

Mathematics in sports

Bike racer



"Wind tunnel in the computer"



Aerodynamic design study (pressure and stream lines)

Mathematics in energy systems

Wind turbine park



New visualization methods



Mathematics in pharmaceutics Blood pressure medication



Blood vessel dilation and vessel resistance in artery system

Mathematics in medicine and biochemistry Protein, virus



Mathematics in geophysics

Seismology and geodynamics



Earthquake of 9+ magnitude (rare, 1/300 - 1/500 yrs)

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Math in geophysics

Cascadia subduction zone



Math in geophysics Tsunami simulation (Cascadia, 1700)



Mathematics in traffic planning, Gangnam style Seoul



Max-plus algebra: two operations, + and max

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Mathematics has never been more useful - computers!

- Classical engineering "mechanics"
- Electromagnetics, wireless communication
- Medicine MR and image processing
- Process control
- Software industry
- "Data mining" and Internet search Google
- Statistical analysis
- Risk management
- Optimization

What to learn?

Thinking!

- Algebra vectors, matrices, structures...Ax = b
- Analysis functions, operators, derivatives, integrals
- Complex analysis $e^{i\pi} + 1 = 0$
- Differential equations $u_t = \varepsilon u_{xx} + u_x + f(u)$
- Probabilistics, statistics $f(x) = e^{-(x-\mu)^2/(2\sigma^2)}/(\sigma\sqrt{2\pi})$
- Approximation and scientific computing u(x) = ∑_k⟨φ_k, f⟩φ_k(x)
- Getting the computer to do the "dirty work"
- ▶ ...
- Mathematics, statistics, numerics

Mathematicians need thorough knowledge of applications

John von Neumann 1903 – 1957 *IAS, P*

IAS, Princeton 1952



John von Neumann and the Nobel Laureates



"Just my 37¢..."

Job market CBS News 15 April, 2014:

"When it comes to jobs, mathematicians are No. 1"

CareerCast.com, best jobs, "in relation to how difficult it is to be admitted into studies":

- 1. Mathematician
- 2. Professor
- 3. Statistician
- 4. Actuary
- 5. . . .