

# Applied and Computational Mathematics

**Gustaf Söderlind**

*Numerical Analysis, Mathematical Sciences*

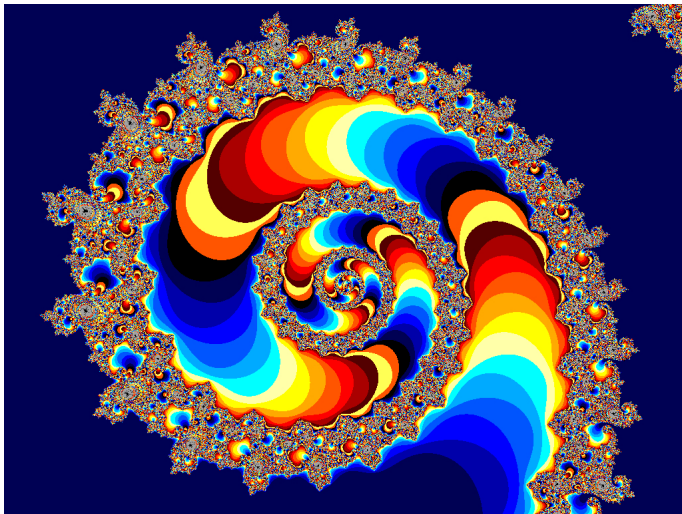


**LUND**  
UNIVERSITY

# What are mathematical sciences?

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

# Fractal



## Fractal in nature

*Econfina River State Park, Florida*



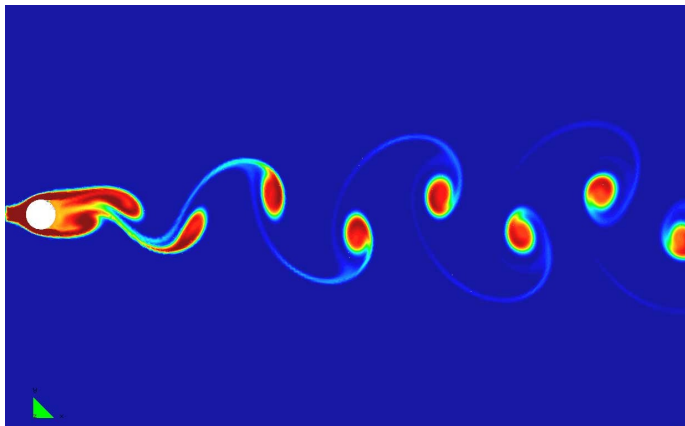






## von Kármán vortices

(cf. Tacoma Narrows)



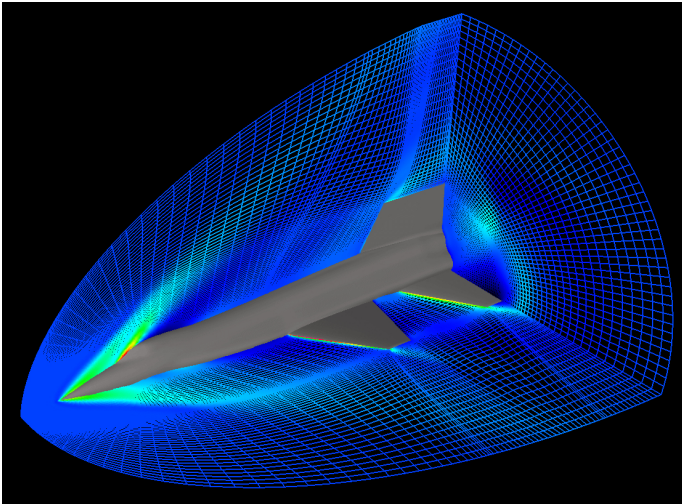
Fluid-structure interaction – mechanical resonance





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

Statistics and probabilistics

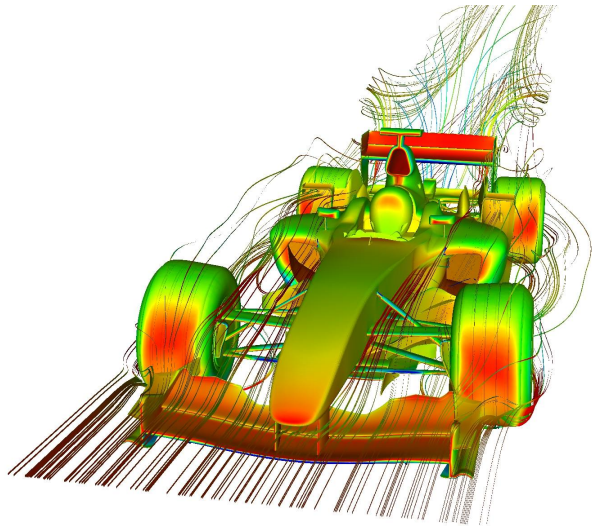




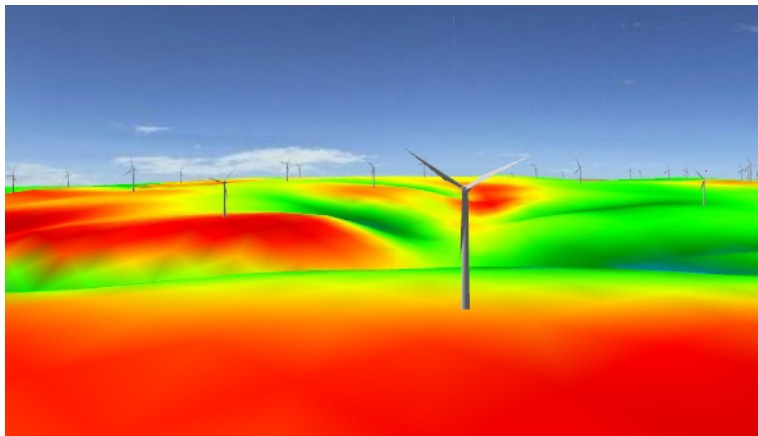
“Computer-generated aerodynamic study of an X-Plane”



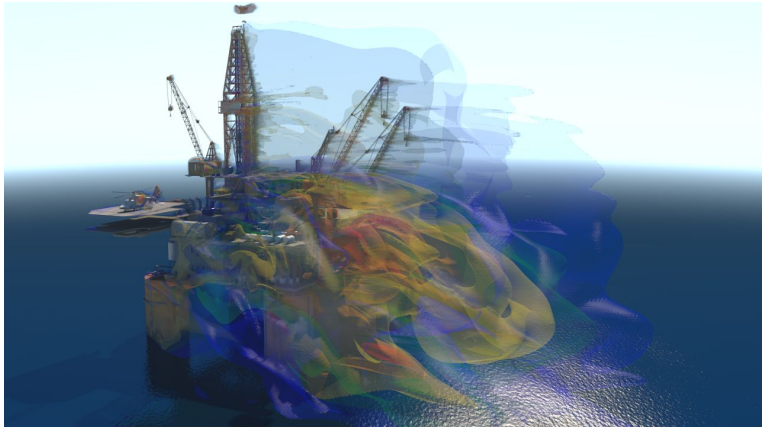
"Wind tunnel in the computer"



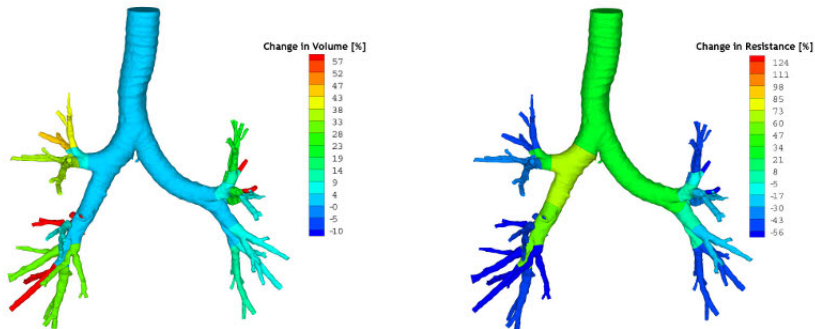
Aerodynamic design study (pressure and stream lines)



# New visualization methods



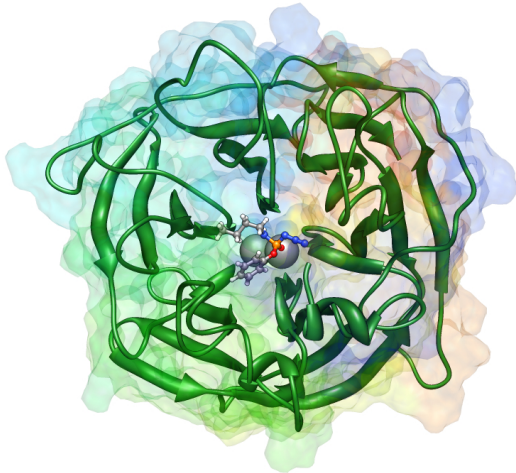
# Mathematics in pharmaceuticals *Blood pressure medication*

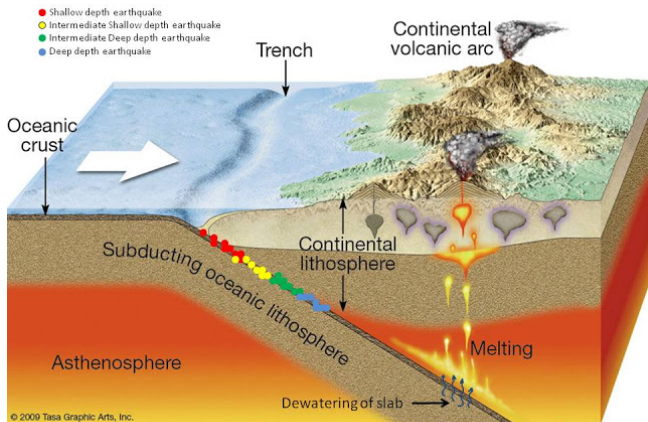


Blood vessel dilation and vessel resistance in artery system



# Mathematics in medicine and biochemistry *Protein, virus*

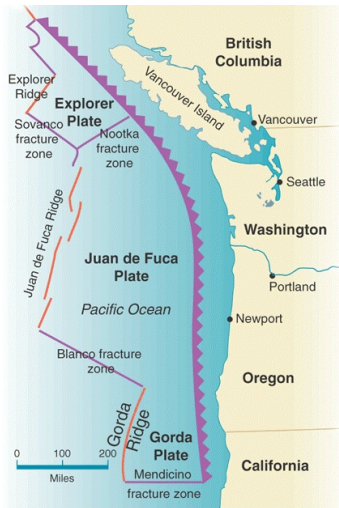


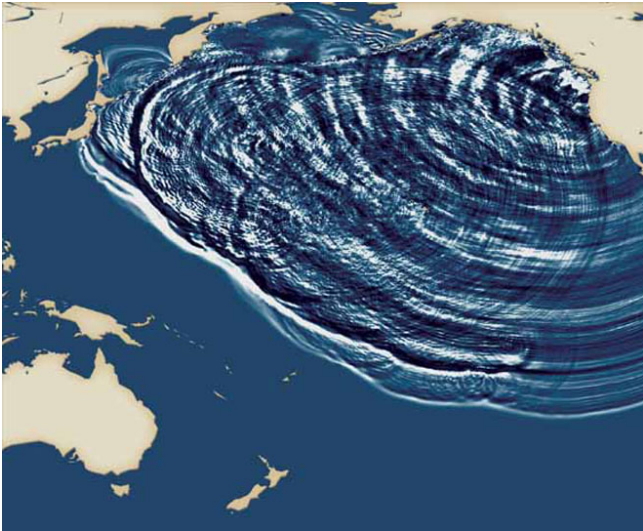


Earthquake of 9+ magnitude (rare, 1/300 – 1/500 yrs)

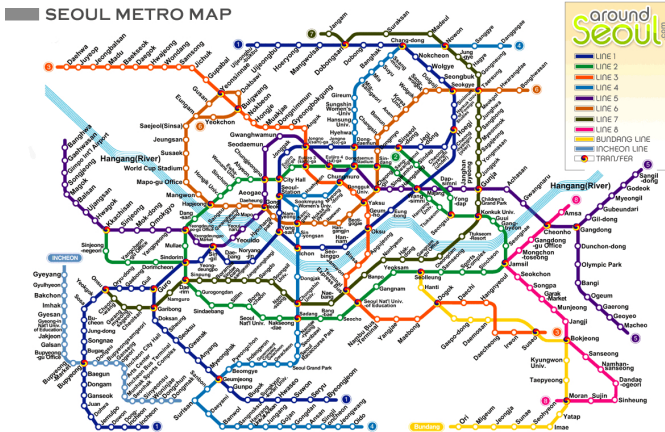
# Math in geophysics

## *Cascadia subduction zone*





# Mathematics in traffic planning, Gangnam style *Seoul*



Max-plus algebra: two operations,  $+$  and  $\max$

## Mathematics has never been more useful – computers!

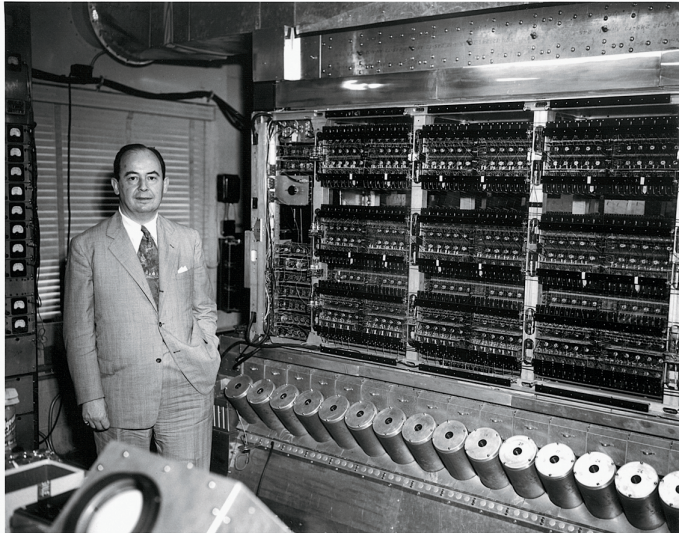
- ▶ Classical engineering – “mechanics”
- ▶ Electromagnetics, wireless communication
- ▶ Medicine – MR and image processing
- ▶ Process control
- ▶ Software industry
- ▶ “Data mining” and Internet search – Google
- ▶ Statistical analysis
- ▶ Risk management
- ▶ Optimization

- ▶ 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  
 $u(x) = \sum_k \langle \varphi_k, f \rangle \varphi_k(x)$
- ▶ Getting the computer to do the “dirty work”
- ▶ ...
- ▶ **Mathematics, statistics, numerics**

Mathematicians need thorough knowledge of **applications**

John von Neumann 1903 – 1957

*IAS, Princeton 1952*





# John von Neumann and the Nobel Laureates

2005



*“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. ...