Mathematical Principles for Scientific Computing and Visualization
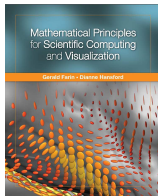
Chapter 1: Introduction

Gerald Farin & Dianne Hansford

©2008

Outline

Role of SCV


```
┌────────┐      ┌───────────┐      ┌───────────┐
│  data  │  ▷   │information │  ▷   │ knowledge │
└────────┘      └───────────┘      └───────────┘
```
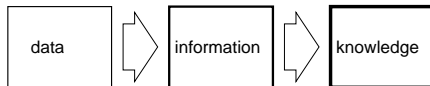
The goal of science is the creation of knowledge

Iterative process of discovery:

- Create/refine hypothesis
- Data acquisition
- Build (better) mathematical model – abstraction
- Run model
- Visualization
- Analyze
- Repeat and improve
  new hypothesis? new data? new model? new visualization?

Key tools: Scientific computing and visualization
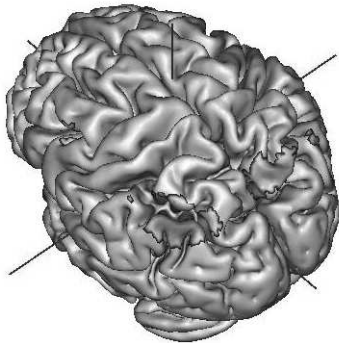
Application Example

Aircraft Development
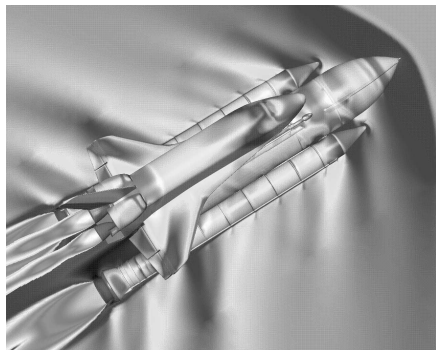
Prototypes expensive to build!

CAD model undergoes extensive computer simulations

1. Numerical solutions of PDEs
2. Simulations
   $\Rightarrow$ large amounts of data
3. Numerical data
   $\Rightarrow$ visualizations
   (e.g., pressure around a wing)

Application Example

MRI Brain Scans

Physical measurements generate data

Complex numerical algorithms
generate information

Interpretation via visualizations
generate knowledge

Visualization Fields

- Scientific Visualization
  - – scientific data and mathematical modeling techniques
  - – spatial/geometric/physical attributes

- Information Visualization
  - – non-spatial, abstract data
  - – human-computer interface/cognitive/perception

- Visual Analytics
  - – analytical reasoning supported by vis
  - – scientific vis + information vis

Try a Google Images search for examples of each!