



Interactive Graphics

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Plan for today

- Syllabus
- Logistics
- Computer graphics

Syllabus (Core)

- Introduction, Color, Graphics pipeline
- WebGL, 3D modeling, Transformation
- Rasterization, Clipping
- Lighting and shading
- Texture mapping
- Advanced Techniques, Global Illumination

Syllabus (Optional)

- Graphics hardware, intro to GPGPU
- Animation introduction, particle systems, rigid bodies simulation
- Topics in animation and modeling
- Research topics

Contents

- **you will**
 - understand image synthesis principles
 - learn math to make images
 - implement key algorithms
 - write cool apps
 - learn graphics Javascript APIs (WebGL)
- **you will not**
 - implement large systems

Website, email, office hours

- Website:

<https://piazza.com/uniroma1.it/fall2014/1044398/home>

- Email: marco.schaerf@uniroma1.it

- Office hours:
after each lesson or by appointment in
room B220

Recommended Books

- Fabio Ganovelli, Massimiliano Corsini, Sumanta Pattanaik, Marco Di Benedetto, [Introduction to Computer Graphics: A Practical Learning Approach](#) CRC Press (also available in [e-book format](#))
- Angel and Shreiner, Interactive Computer Graphics (6th ed.) - optional
- Alan Watt, 3D Computer Graphics (3rd ed.) - optional
- Wright et al., OpenGL SuperBible (5th ed.) – optional
- T. Akenine-Moller et al., Real-Time Rendering (3rd ed.) - optional

Grading

- Two ways to pass the exam
 1. Homeworks + Project
 2. Project + Oral exam
- Homeworks
 - Three small individual projects
 - They **must** be delivered in two weeks
 - During the discussion:
 - » Questions about the theory behind the homeworks
 - » Questions about the code you wrote

Projects

- Delivered when you have it ready (no fixed deadline)
- Individually or in small groups (up to 4)
- You choose the topic, I must approve it before starting to work in the project
- Guidelines available before the end of the course

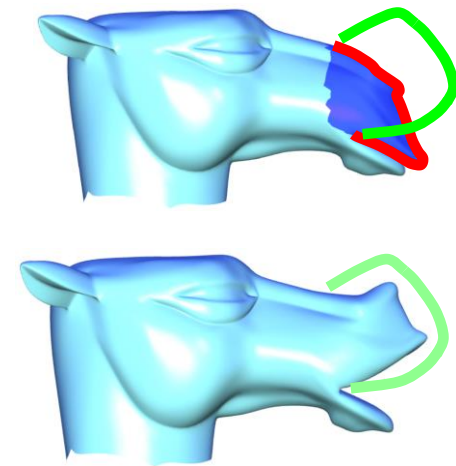
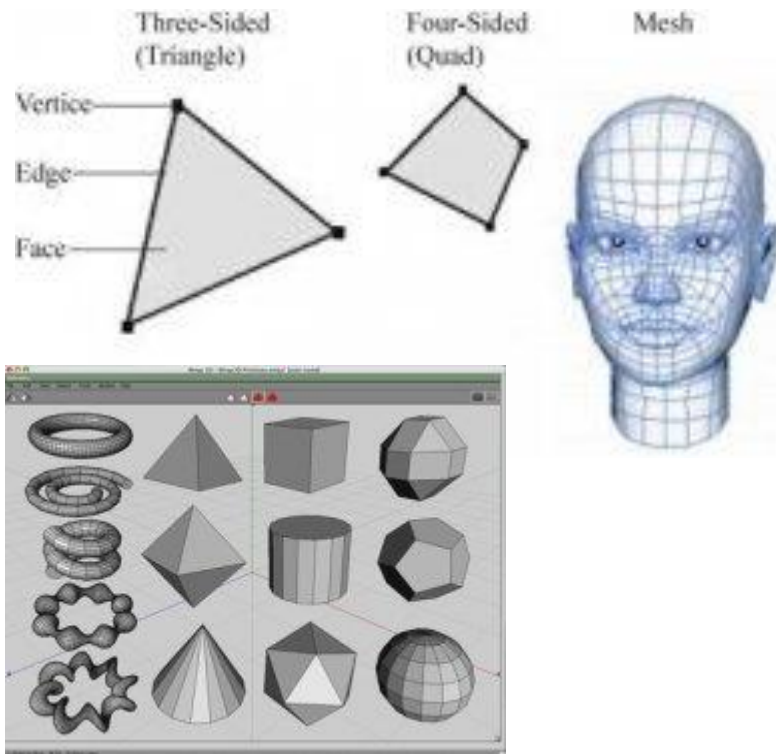
COMPUTER GRAPHICS

Visual representation of digital data

- **Modeling:** definition of a shape
- **Animation:** how the shape moves
- **Rendering:** interaction with the light

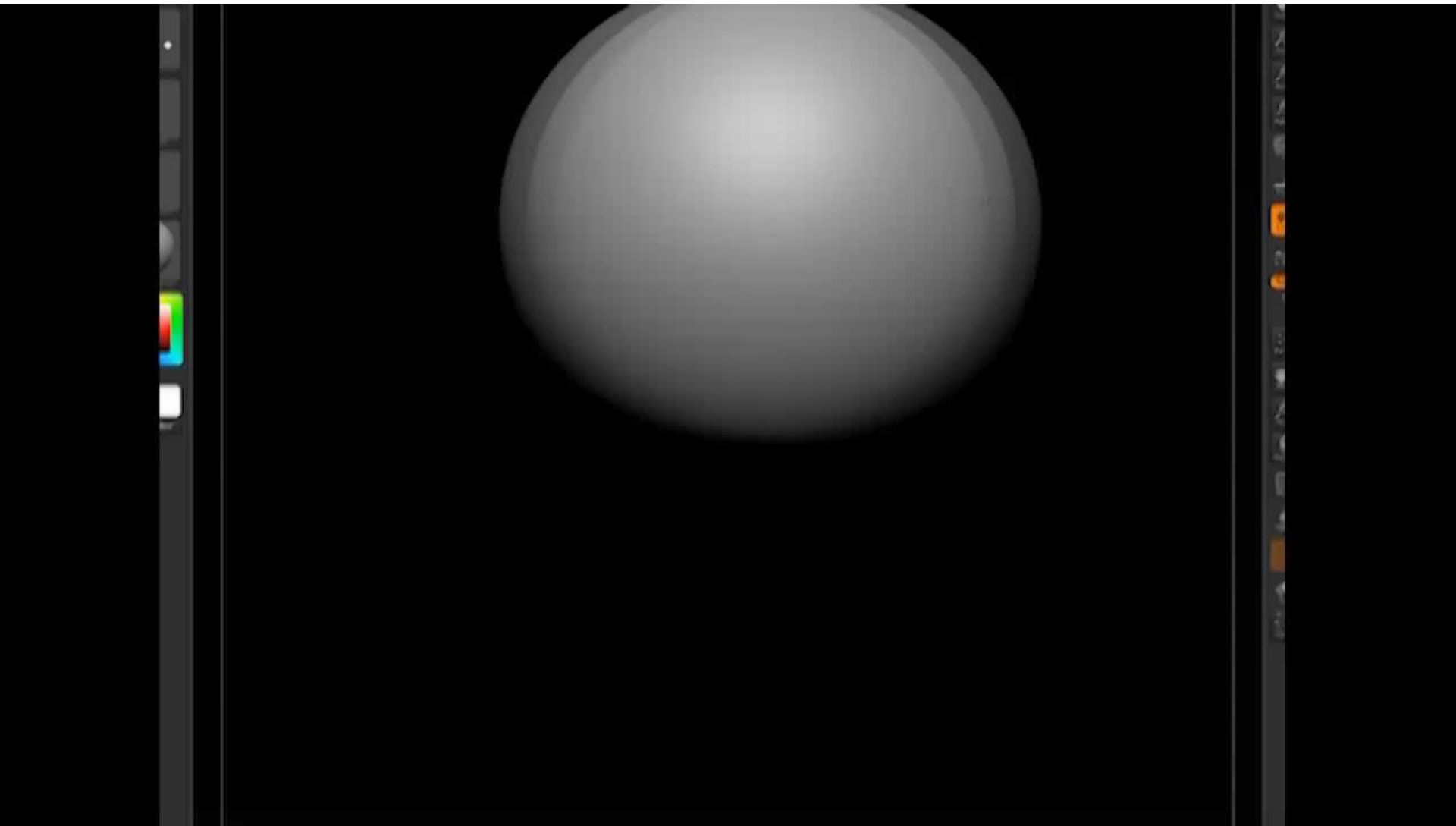
3D Modeling

- How to synthesize digital shapes?



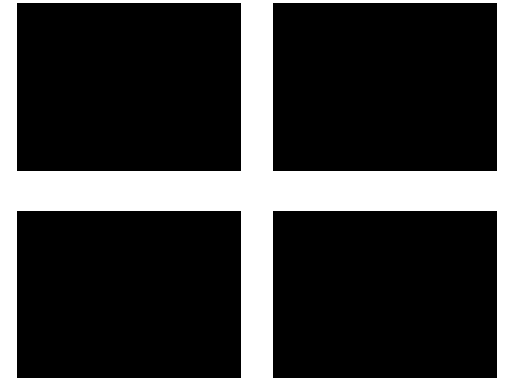
[Nealenv et al. 2005]

Example: digital sculpting

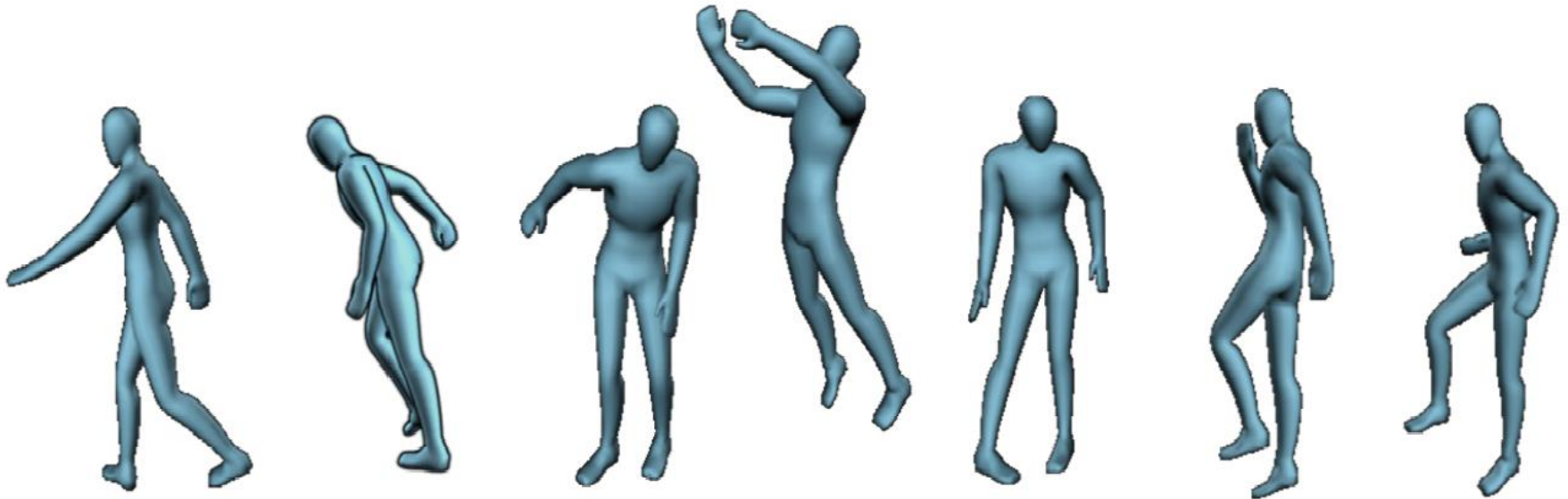


Animation

- How to synthesize motion?



[Essa et al. 2005]



Physics-based animation

Realistic animation as a simulation

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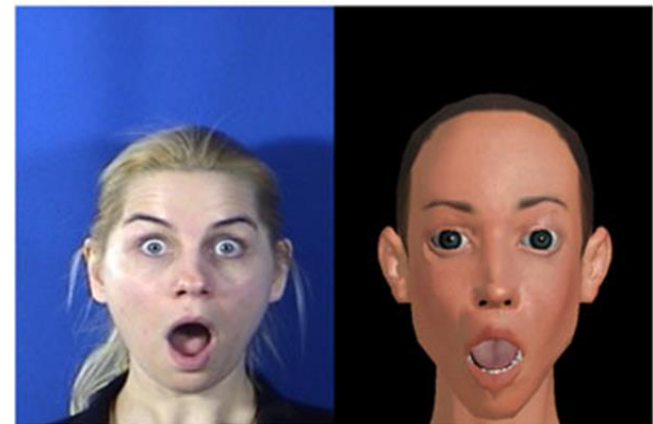
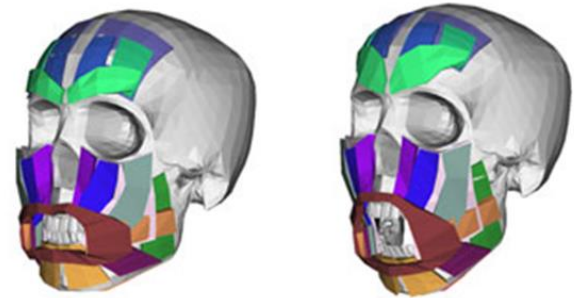
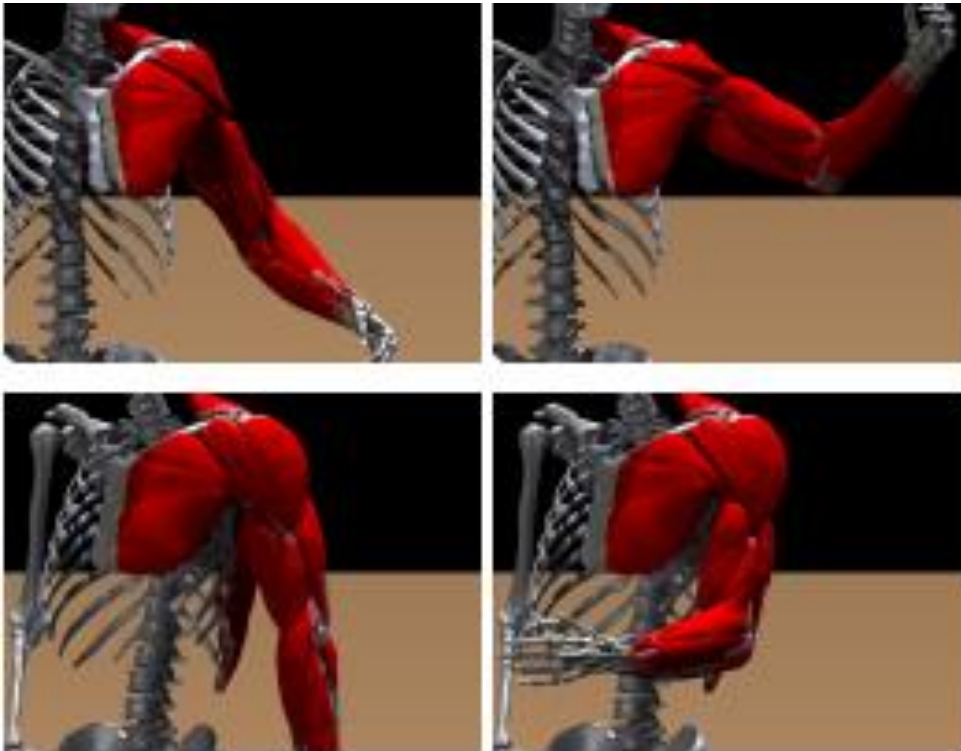
Numerically solve the underlying
differential equations of motions

Application – Cloth simulation



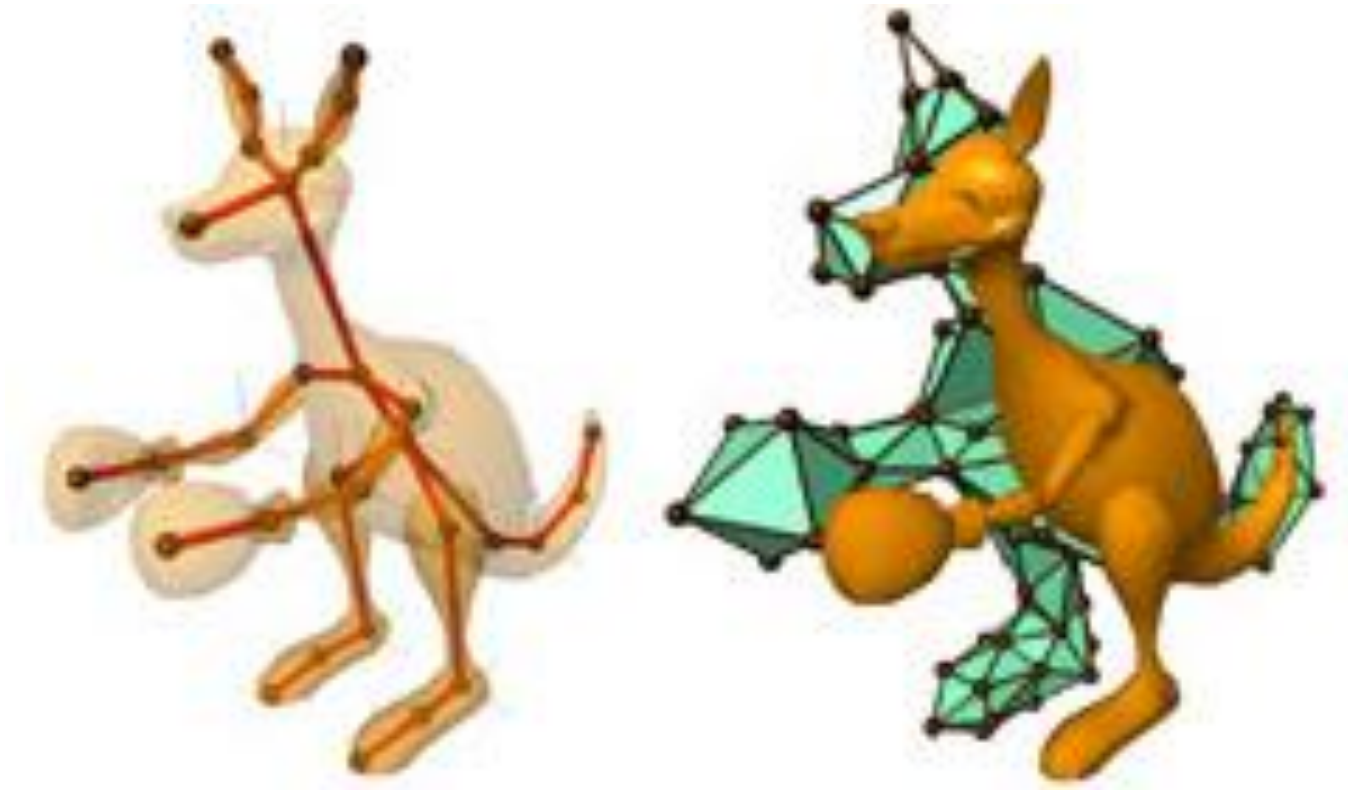
Application

Muscles and face

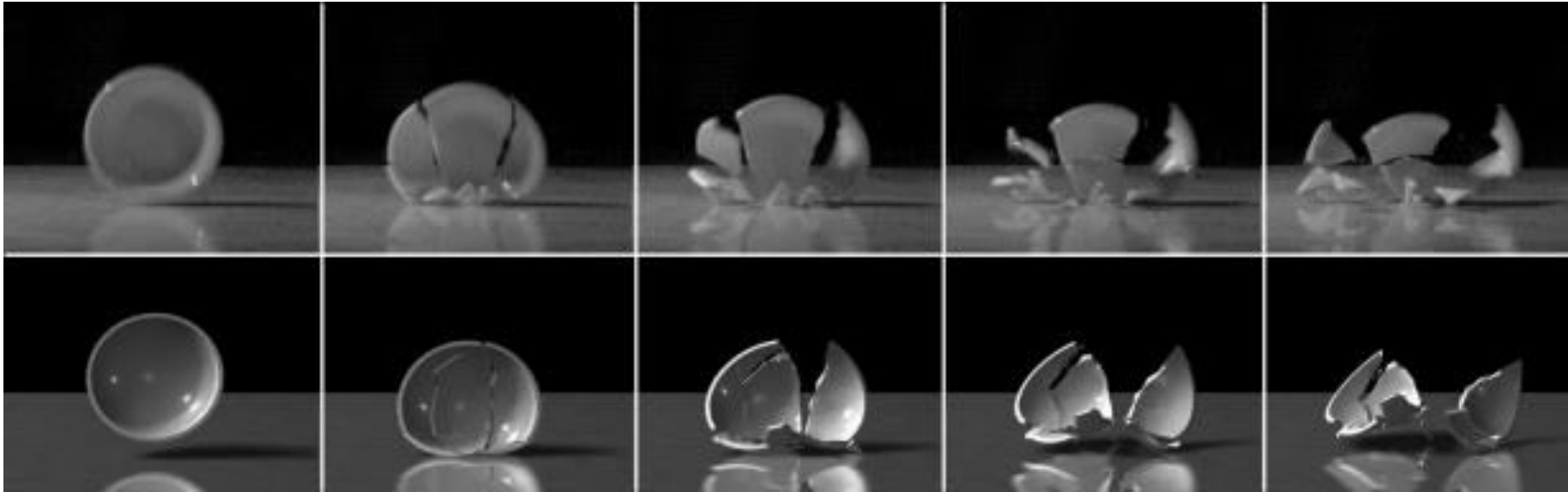


Application

Flesh deformation



Application - Fracture



[O'Brien and Hodgins. 1999]

Application - Entertainment



Movies



Games

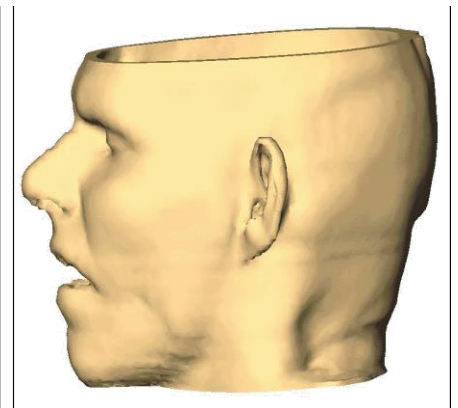
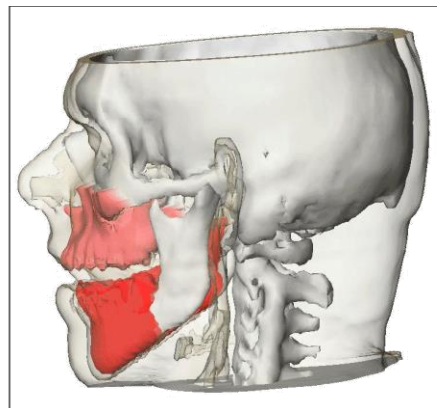
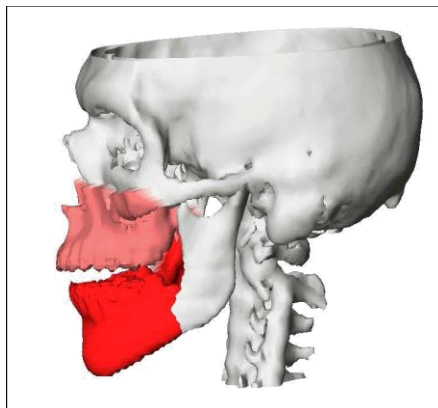
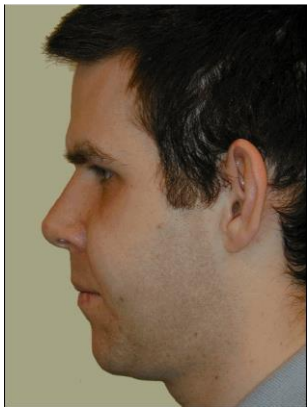
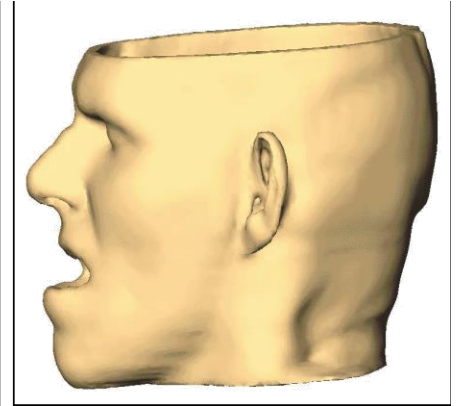
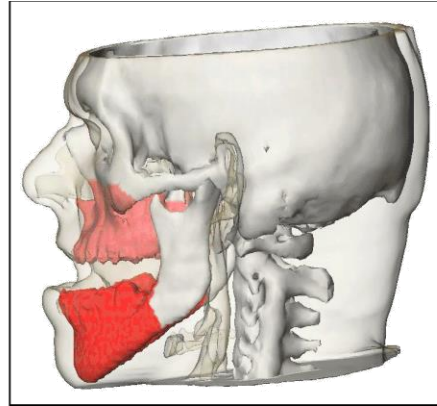
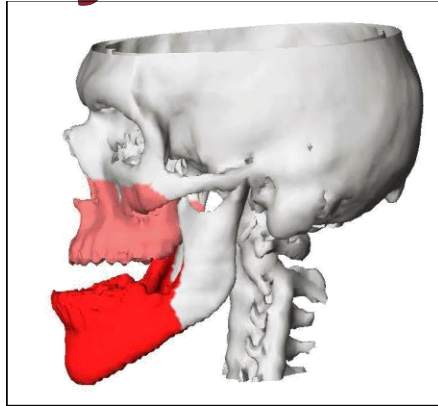
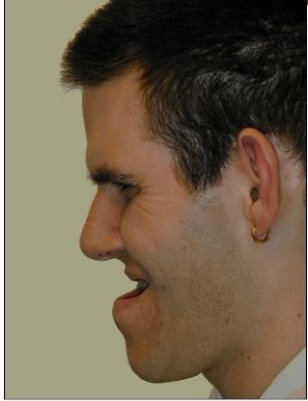
Applications - virtual avatars

Cultural heritage: [lifepplus: virtual pompeii]



Social networks

Applications - Computer-aided Surgery

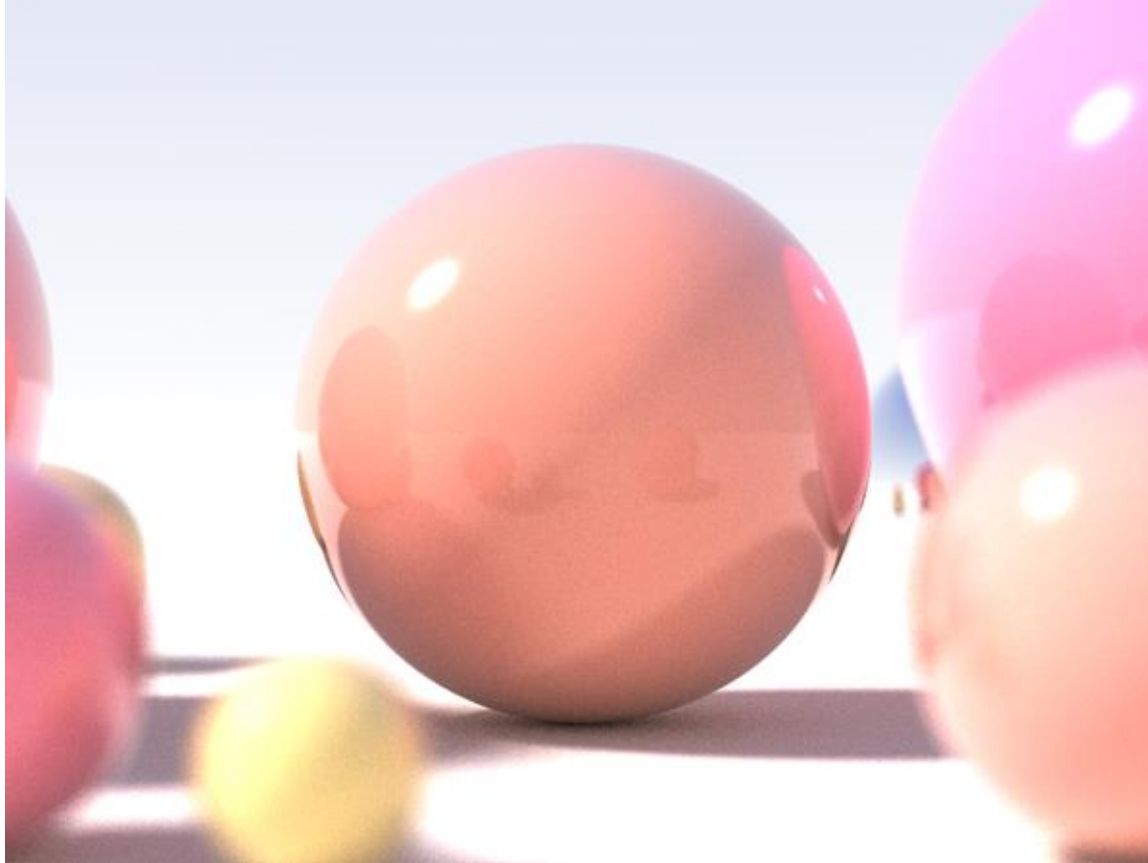


Features of the Simulation

- **Accuracy**
numerical results from the virtual simulation are nearly equal to the real expected ones
- **Efficiency**
computation time scaled to time requirements
 - hard real-time, 60 frame per second (fps) \Leftrightarrow 16.67 ms

Rendering

- Lighting simulation
- Material simulation
- Visibility estimation



Offline ray tracing of a sphere

Shallow depth of field, area light sources and diffuse inter-reflections



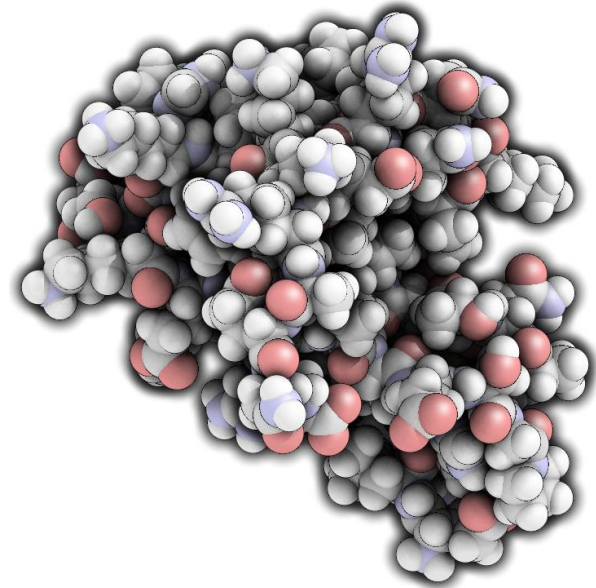
Ray tracing can achieve a very high degree of visual realism.



Interactive rendering [Crysis 2 - Crytek]



[Praun et al. 2001]



[Tarini et al. 2005]

Non-photorealistic Rendering

Scientific Visualization, Cartoon rendering, ...

Interaction with the user

- 2D/3D user interfaces
- haptics
- augmented reality

A robust method for real-time
thread simulation

Visual representation of digital data

- Entertainment
- Social life
- Education
- Art and creative expression
- Design and architecture
- Training and simulation
- Medicine
- Augmented reality

applications

- entertainment
 - movies
 - games



[NBA Live 07 – © EA Games]



applications

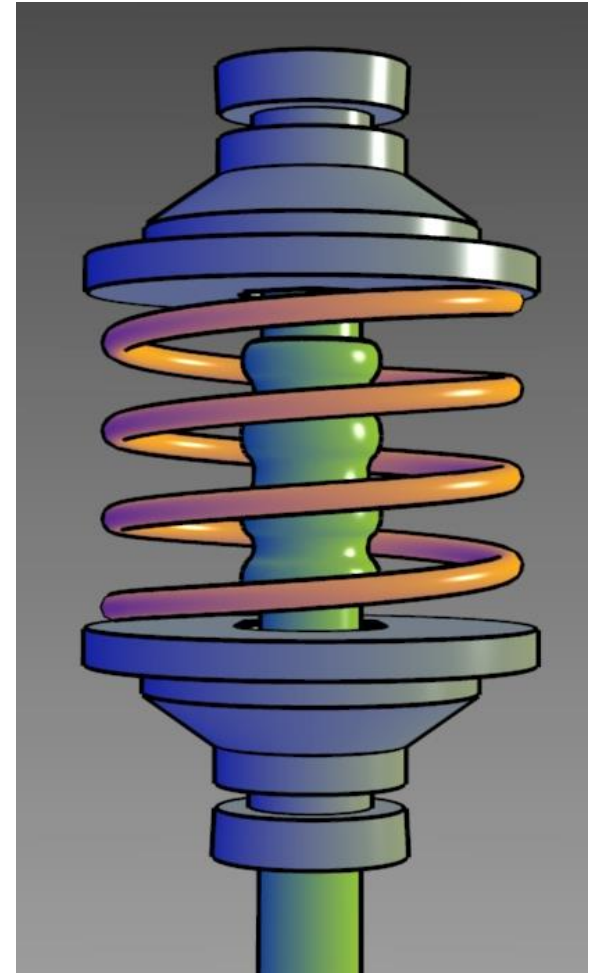
- entertainment
 - movies
 - games



[*Lord of the Rings II* – © EA Games]

applications

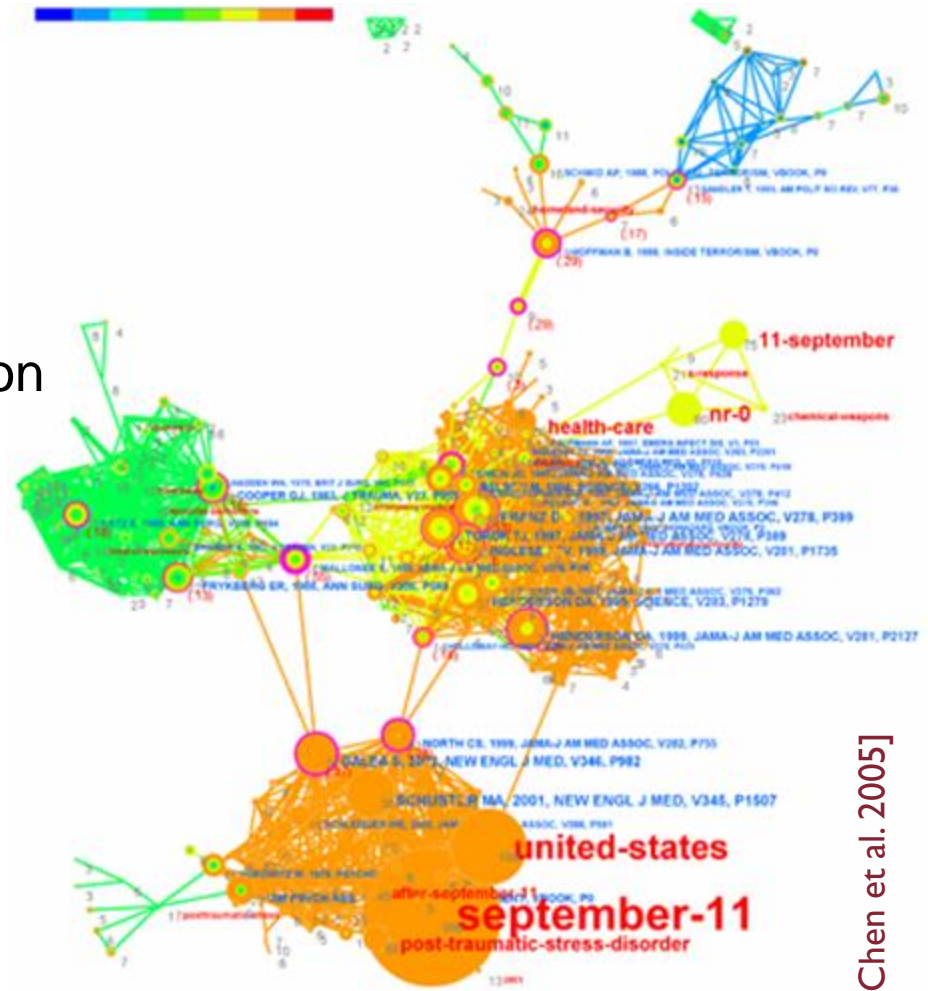
- entertainment
- science and engineering
 - computer-aided design
 - scientific/medical visualization



[Gooch et al. 1998]

applications

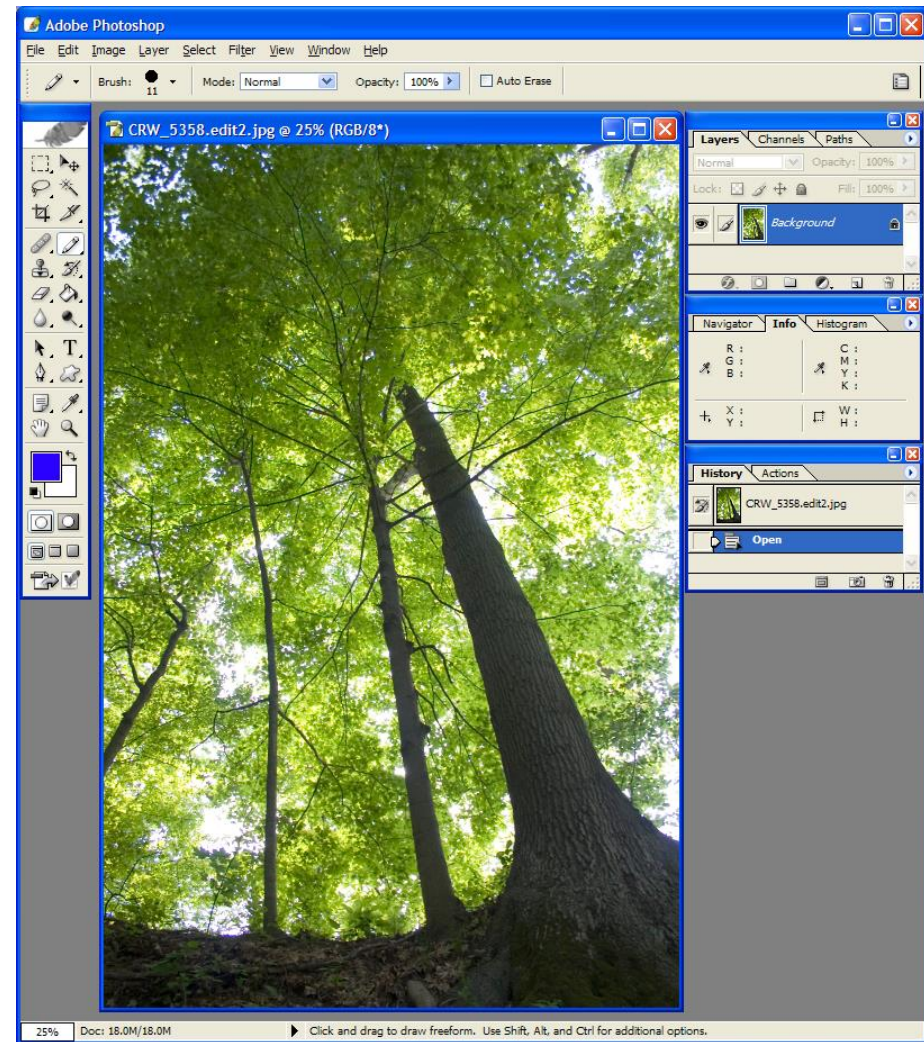
- entertainment
- science and engineering
- visualization
 - information visualization



[Chen et al. 2005]

applications

- entertainment
- science and engineering
- visualization
- graphic arts
 - digital photography
 - graphic design



applications

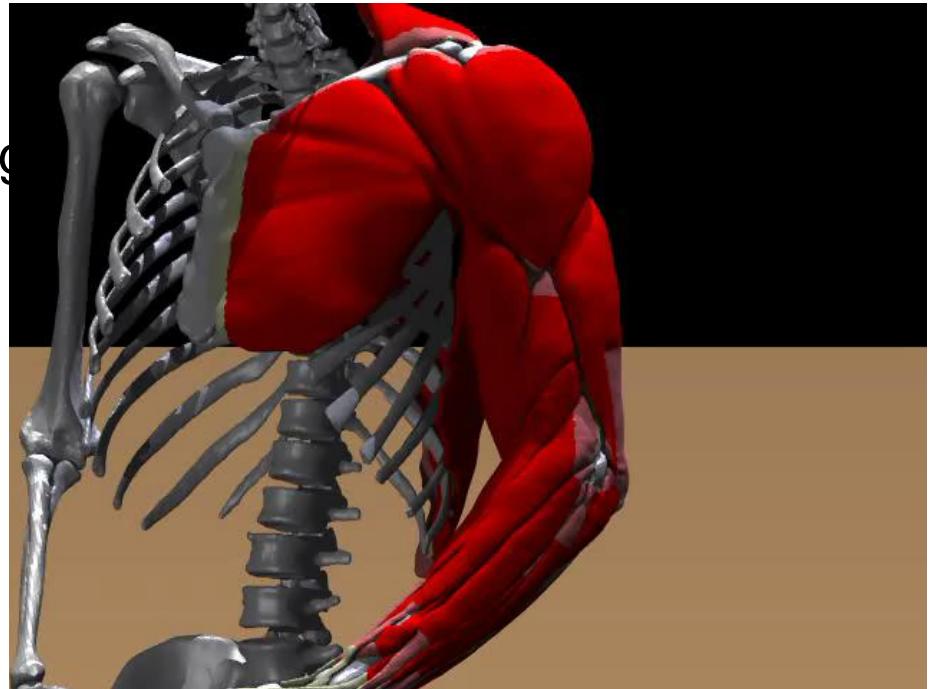
- entertainment
- science and engineering
- visualization
- graphic arts
- fine arts



[*Wooden Mirror – Daniel Rozin*]

applications

- entertainment
- science and engineering
- visualization
- graphic arts
- fine arts
- medicine



Animations of muscles constructed from the NIH visible human data set
Teran, Sifakis and Lau

applications

- entertainment
- science and engineering
- visualization
- graphic arts
- fine arts
- medicine
- augmented reality

