

Introduction

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Computer Graphics (1)
lecture no. 1



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Course rules – lectures, practical sessions, final exam

- Practical sessions vs. final exam: 50% vs. 50%
- Practical sessions (exercises)
 - min. 25 pts, max. 50 pts
 - (you will learn the remaining rules from Dr. Makovník during the first practical session)
- Final exam
 - min. 25 pts, max. 50 pts
 - 25 pts: written part – practical problems
 - 25 pts: oral part – theory
- Course grading
 - A: 100-91 • D: 70-61
 - B: 90-81 • E: 60-51
 - C: 80-71 • Fx: ≤ 50



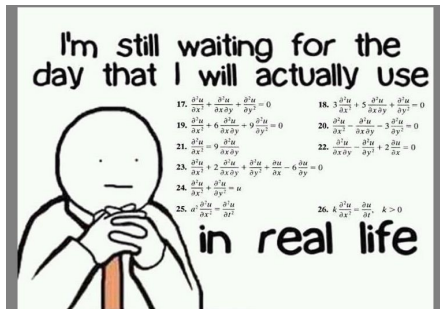
References

- Ružický E., Ferko A.: Počítačová grafika a spracovanie obrazu (SK), Bratislava: Sapientia, 1995
- Žára J., Beneš B., Felkel P.: Moderní počítačová grafika, Computer Press (SK), 1998
- Watt A.: 3D computer graphics (3rd edition), Addison Wesley, 1999
- Schneider P., Eberly D.: Geometric Tools for Computer Graphics, Morgan Kaufmann, 2003
- Hearn D., Baker M, Carithers, W.: Computer Graphics with Open GL (4th Edition), Pearson, 2010
- Sederberg T.: Computer Aided Geometric Design, Brigham Young University, 2012
- Angel E., Shreiner D.: Interactive Computer Graphics: A Top-Down Approach with WebGL (8th Edition), Pearson, 2020



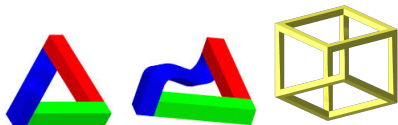
Lecture overview

1. Affine transformations in 2D and 3D
 - translation, rotation, scaling, shearing, reflection, ...
2. Quaternions
3. Object modelling and representation
 - data structures, polygon meshes, fractals, splines, surfaces ...
 - parametric, implicit and explicit representations, CSG ...
4. Visibility determination algorithms
5. Parallel and perspective projection
6. Intersection computation
7. Clipping algorithms
8. Rasterization algorithms
9. Anti-aliasing
10. Graphics pipeline

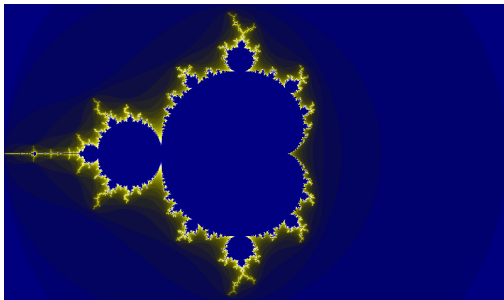


Computer graphics and mathematics

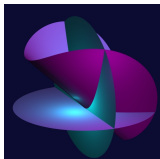
- Image generation
- Modelling objects and scenes
- Visualization
 - solving various problems (e.g. differential equations)
 - complex objects and structures
 - algorithms and procedures
 - paradoxes
- Resolving visual paradoxes (optical illusions, anamorphoses), Penrose triangle and impossible cube



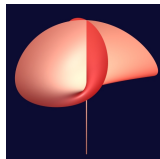
Mandelbrot set



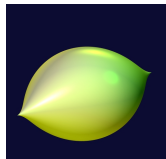
$$yz(x^2+y)=yz^2$$



$$x^2=y^2z$$

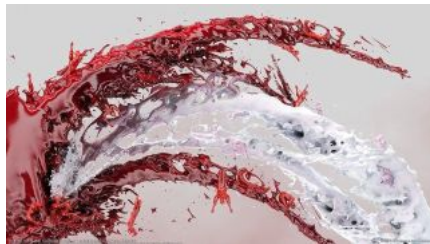


$$x^2+z^2=y^3(1-y)^3$$



Computer graphics vs. physics and computer games

- Modelling physical phenomena
 - water, sand, fog, rain, snow...
- Visualization of physical processes
 - water flow, illumination of objects ...
 - rendering $\leadsto$ Computer Graphics (2)
- Simulations
 - plant growth, fire propagation, ...
 - floods, avalanches, ...
- Procedural modelling of objects

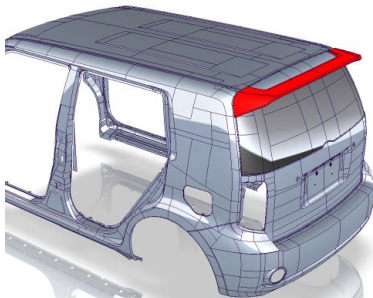
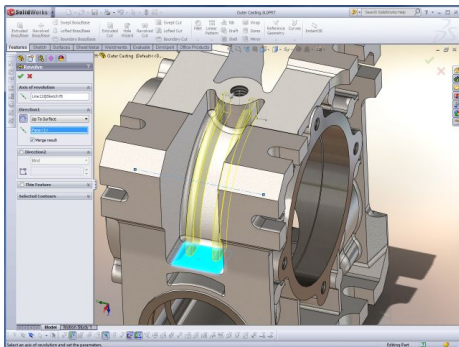


www.youtube.com/watch?v=O0kyDKu8K-k



Computer graphics vs. CA(G)D

- CA(G)D – Computer-Aided (Geometric) Design

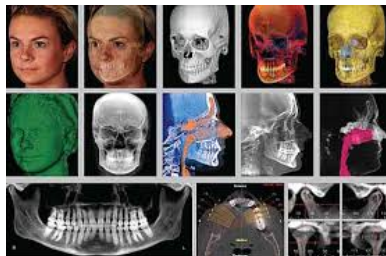
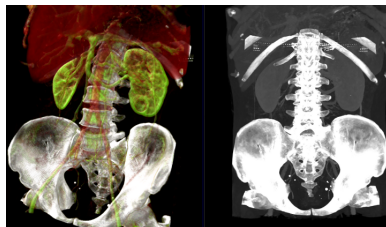
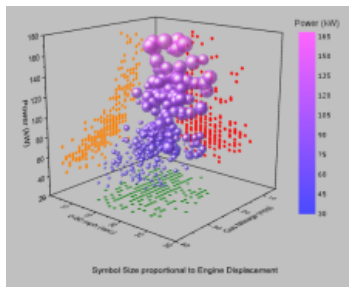


$$\mathcal{N}(u, v) = \frac{\sum_{i=0}^m \sum_{j=0}^n N_i^p(u) N_j^q(v) w_{ij} V_{ij}}{\sum_{i=0}^m \sum_{j=0}^n N_i^p(u) N_j^q(v) w_{ij}}$$



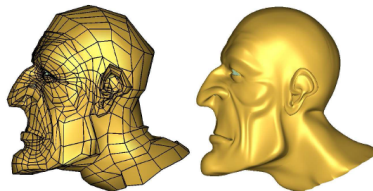
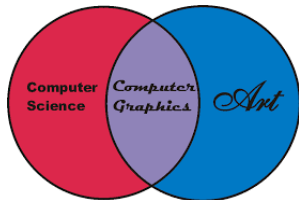
Computer graphics vs. medicine and scientific visualization

- CT (Computed Tomography), MRI (Magnetic Resonance Imaging), etc.
- Data and visualization of scientific data
- Data and their recognition $\rightsquigarrow$ computer vision



Computer graphics vs. art and entertainment

- Digital photography and sculpture
- Photo enhancement
- Graphic design and advertising
- Animations, movies, games ...



www.youtube.com/watch?v=kweN7VLx-JE



Computer graphics vs. (insert your area of interest here ☺)

Relevant Disciplines

- **Analytic Geometry**
- **Art and Graphic Design**
- **Cognitive Science**
- **Computer Engineering**
- **Engineering Design**
- **Education**
- **Film**
- **Human Factors**
- **Linear Algebra**
- **Numerical Analysis**

