Seminar in Computer Graphics
186.175, WS 2020, 2.0h (3 ECTS)

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https://www.cg.tuwien.ac.at/staff/PhilippErler.html

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Institute of Visual Computing & Human-Centered Technology

TU Wien, Austria

Organization

- Organization via TUWEL
  https://tuwel.tuwien.ac.at/course/view.php?TODO
- General information on LVA site
  https://www.cg.tuwien.ac.at/courses/SeminarAusCG/
  - Dates on this site count
  - Please mail me if you find conflicting information
- Topics are presented and assigned here today

Goals

- Practice selecting, reading and understanding
  - Search and select papers relevant to your topic
  - Summarize them as a state-of-the-art report
  - Prepare a talk about your topic in the seminar

- This permits in-depth familiarization with the topic

Tasks

- Submit a literature list
  - Chosen with supervisor
- Attend 3 lectures
- Meetings with supervisor
  - paper selection
  - discussion of papers
  - preparing talk slides
- Alternative: evaluate and compare algorithms
- Final presentation in seminar

Literature List

- Analyze recent papers (select with supervisor)
- Study secondary literature to understand topic
- How to find relevant papers:
  - Google Scholar: key words and operators
  - Digital libraries: IEEE, ACM, …
  - Survey papers, often-referenced papers
  - Skim the papers at least
- Submit a list of 10+ papers in TUWEL
  e.g. 8 technical papers + 2 survey papers or text books
  → **official registration**

State-of-the-Art Report (STAR)

- LaTeX template
  - Information on course website
  - Overleaf reference project available to copy
- Submit the paper in PDF format in TUWEL
- First submission must be complete!
  - Min. 8 pages, preferably in English
  - All papers mentioned and complete structure
  - This version will be reviewed but not graded
- Start early! Plan at 4 weeks for reading and writing.

Scientific Review

- You will get the first submission of another student to review
- Typical conference review form (Eurographics)
- This helps author to improve the manuscript
- Guides on review writing on course website
- You will receive 2 reviews (student, supervisor)
- Improve final report (camera-ready submission) according to reviews
- Plagiates -> Fail!
  [Institute Guidelines]

Seminar Presentations

- Duration:
  - will be decided later depending on number of students
  - approx. 15 minutes presentation + approx. 5 minutes discussion
- Presentation (preferably in English)
  - Prepare slides in advance, using template
  - Focus is on overview/comparison of methods
  - Present only the most important papers in depth
  - Present so that other students will understand it
  - ~~Submitted slides are presented on seminar PC~~ via Zoom
- Active discussion is mandatory and graded

Dates

- Rough overview, see LVA page for details
- 2 weeks for meeting supervisor and literature list
- 7 weeks for report
  - 3 lectures of 2h during this time
  - Start early!
- 2 weeks for reviews
- 2 weeks for presentation preparation and final paper

Grading

- Grades: 1: >88%, 2: 75%, 3: 63%, 4: 50%, 5: <50%
- Every submission must be 4 or better, otherwise 5 overall
- Late submission:
  - 1% off the task points per started hour
    -> fail course after 50h
  - You will delay the next task for everyone!

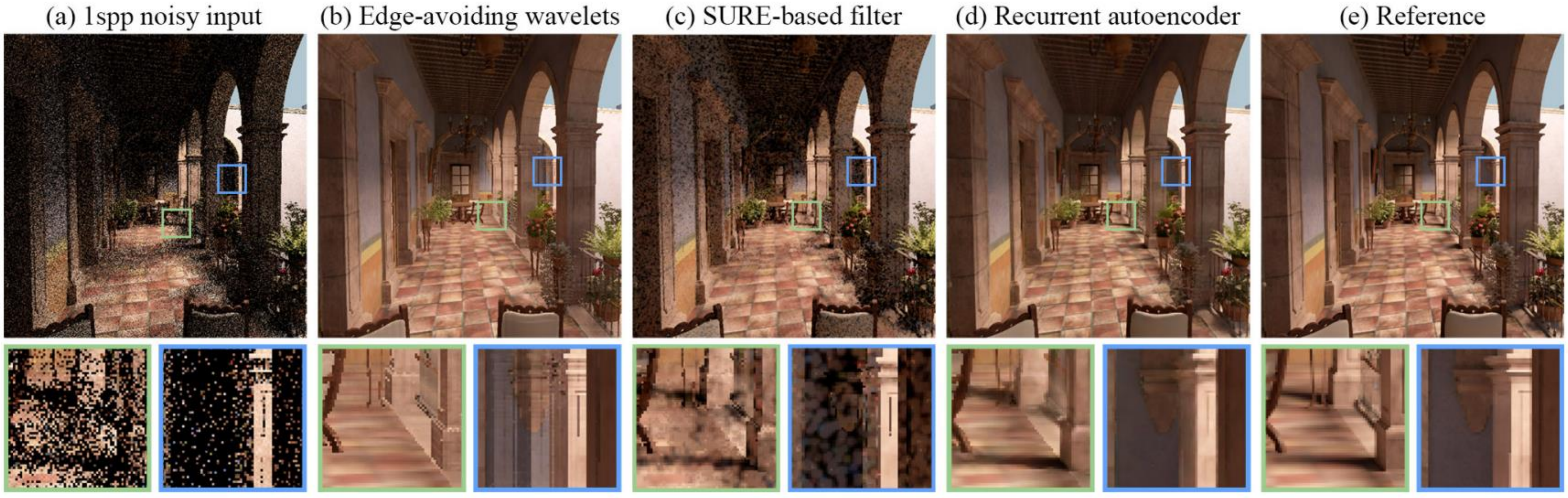
Task	**Points**
Lecture attendance	5
Review	20
Presentation	30
Participation in discussion	5
Final report	40
Sum	100

Topic Presentation

- Now, topics will be presented
- Topic assignment:
  - Non-binding poll to show most-wanted topics
  - Short discussion (in Zoom break-out rooms)
  - Set group choice in TUWEL online -> first come, first serve
  - Double assignment or groups if more students than topics

(Stable) Image Reconstruction with Neural Networks

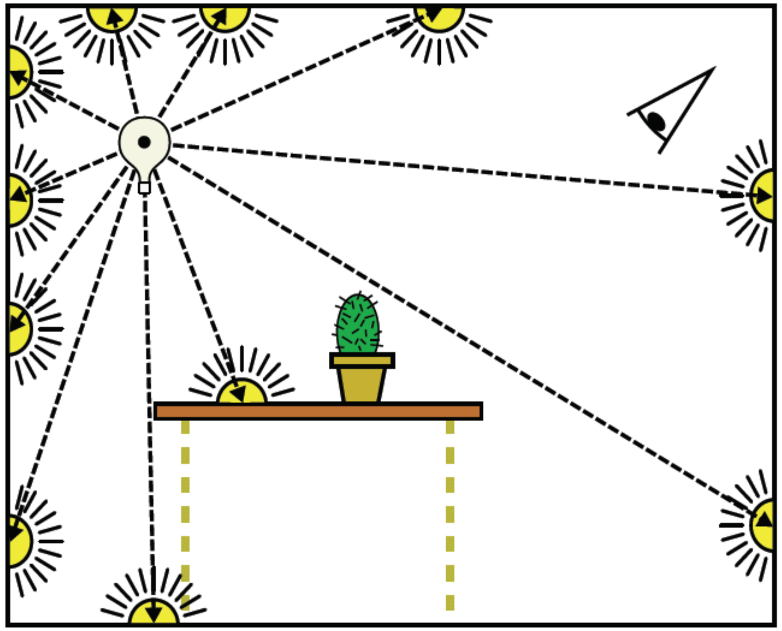
- Use NN to fill in missing information, correct rendering artefacts
- “Easy” for single image, stability issues in animated sequences
- Recurrent/post-processed architectures improve temporal stability



Chaitanya et al. "Interactive Reconstruction of Monte Carlo Image Sequences using a Recurrent Denoising Autoencoder." ACM Transactions on Graphics 36(4), Proceedings of SIGGRAPH 2017

Many Light Rendering

- Direct illumination is easy, indirect is hard
- Idea: distribute **many** *virtual point lights* throughout the scene
- Indirect lighting problem becomes direct!



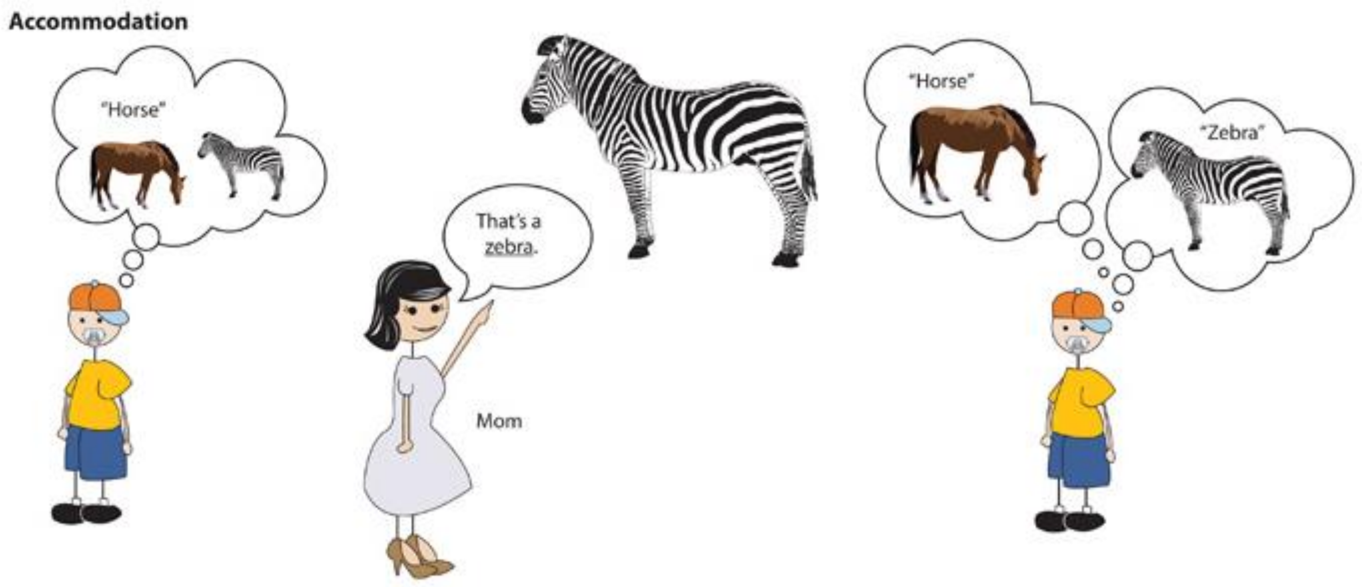
Dachsbacher et al. "Scalable Realistic Rendering with Many-Light Methods." Eurographics State of the Art Reports 2013

Infant-like Learning

CNN classify images well, but only into before-known classes

Infants start from scratch and differentiate classes progressively

→ How to subdivide already learned classes, with human-in-the-loop

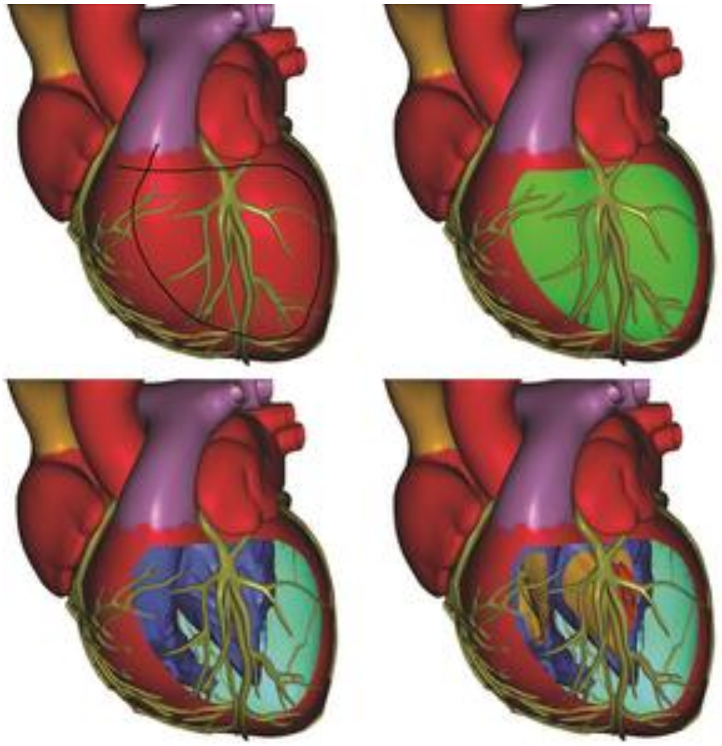


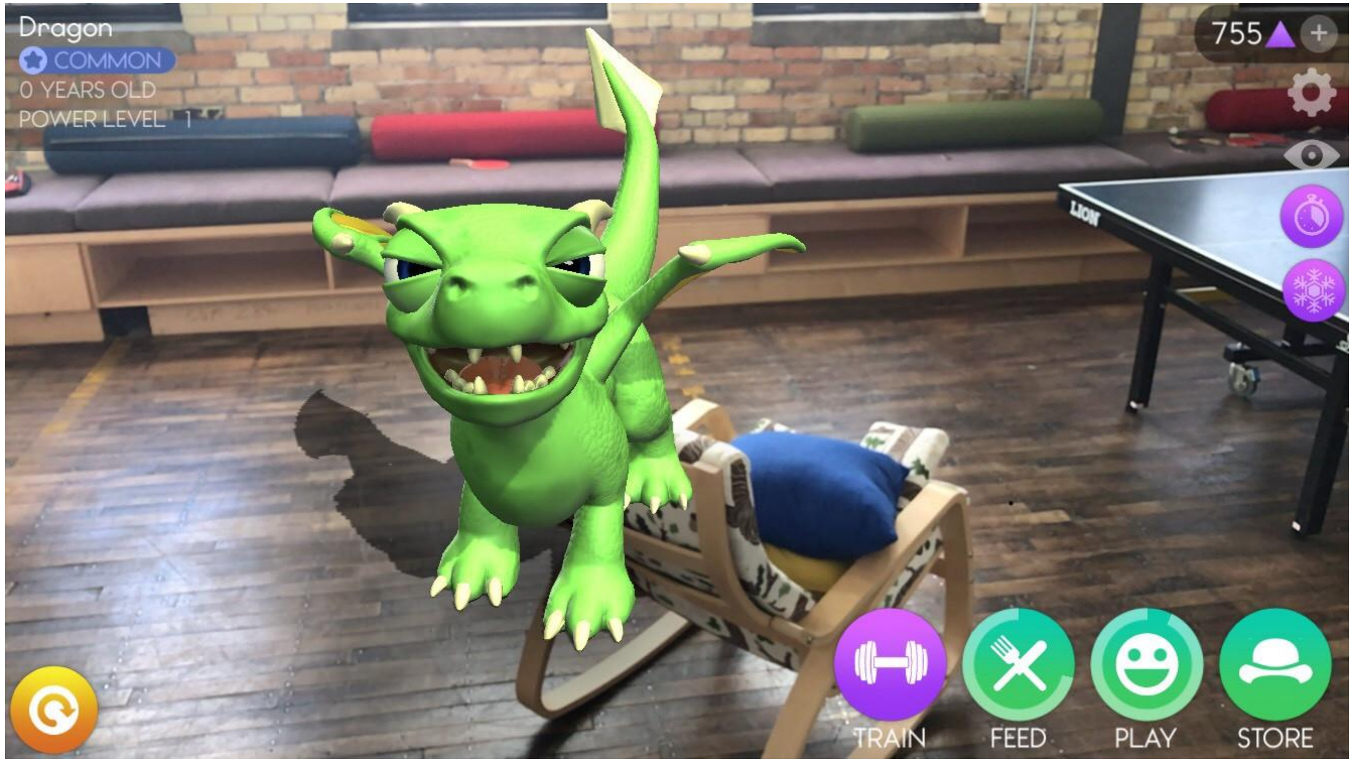
Charles Stangor, Introduction to Psychology - 1st Canadian Edition, https://opentextbc.ca/introductiontopsychology/

Fun with Occlusions

Applications using occlusion relations in a scene for a specific view

e.g. paint, edit surfaces; discover and expose (AR) objects in scene





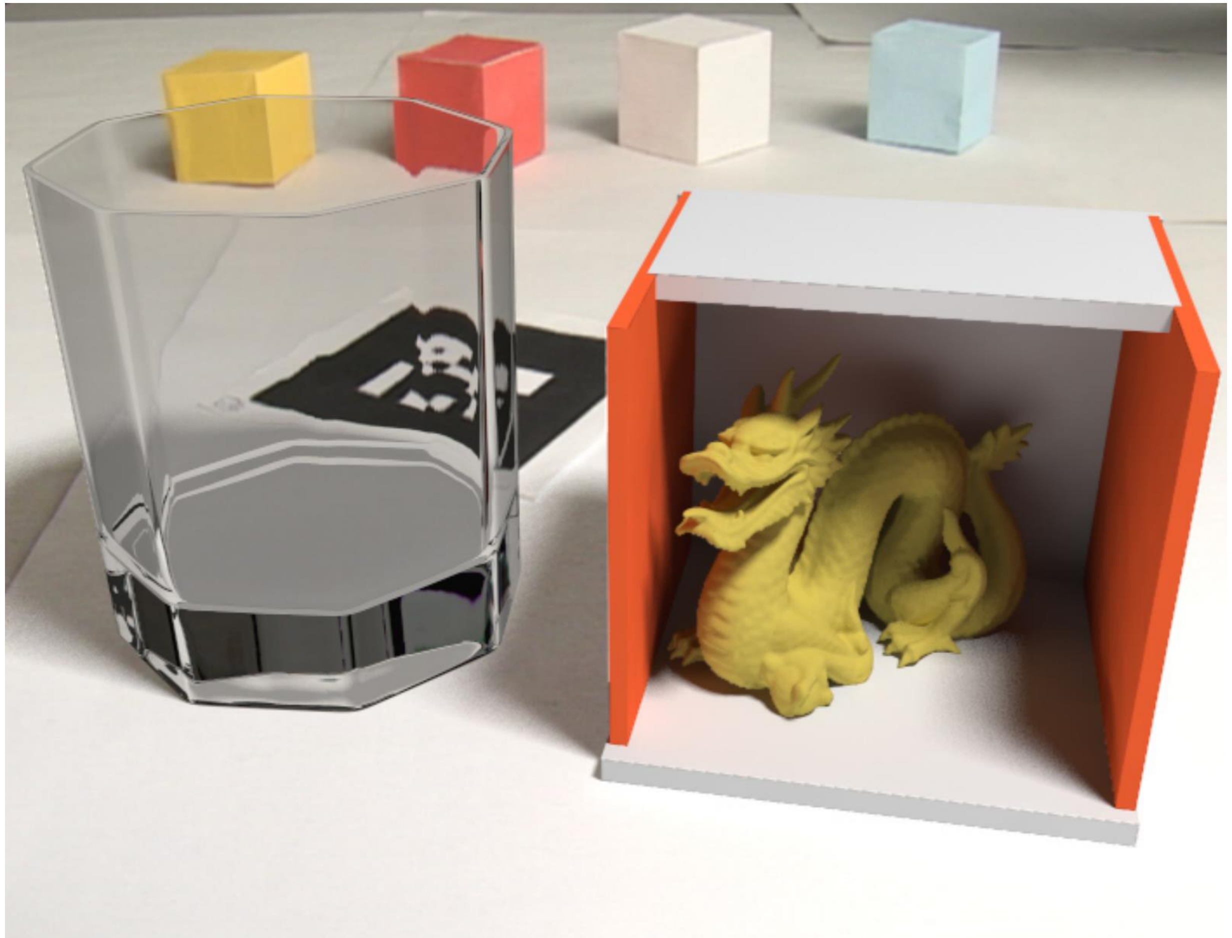
Radwan et al. “Cut and Paint: Occlusion-Aware Subset Selection for Surface Processing”, GI 2017

https://hackernoon.com/why-is-occlusion-in-augmented-reality-so-hard-7bc8041607f9

- Provide an overview of techniques that leverage machine learning for rendering.

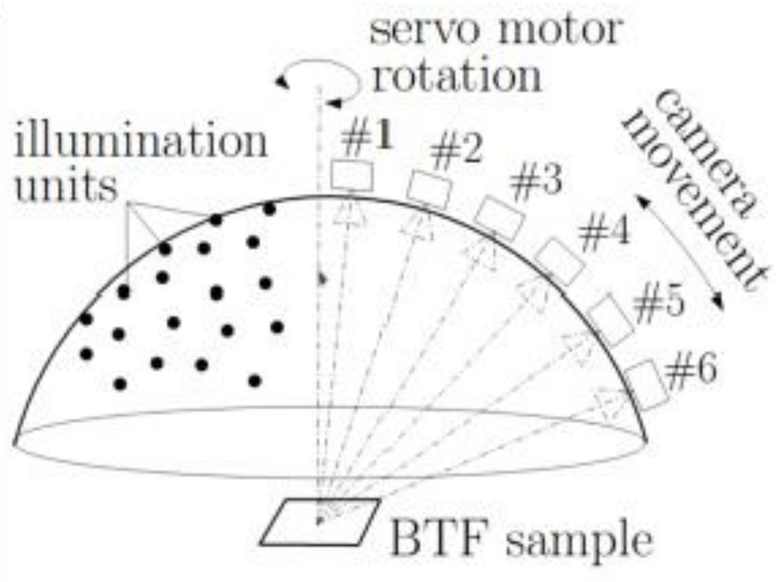
Global Illumination in VR and AR

- Provide an overview of global illumination rendering techniques for virtual and augmented reality.



Material Capture and Reconstruction

- Precise methods for capturing the ground truth of physical material reflectance
- Reconstruction of material model parameters from photos, e.g. find diffuse, specular, normal maps etc. from photos or point cloud data



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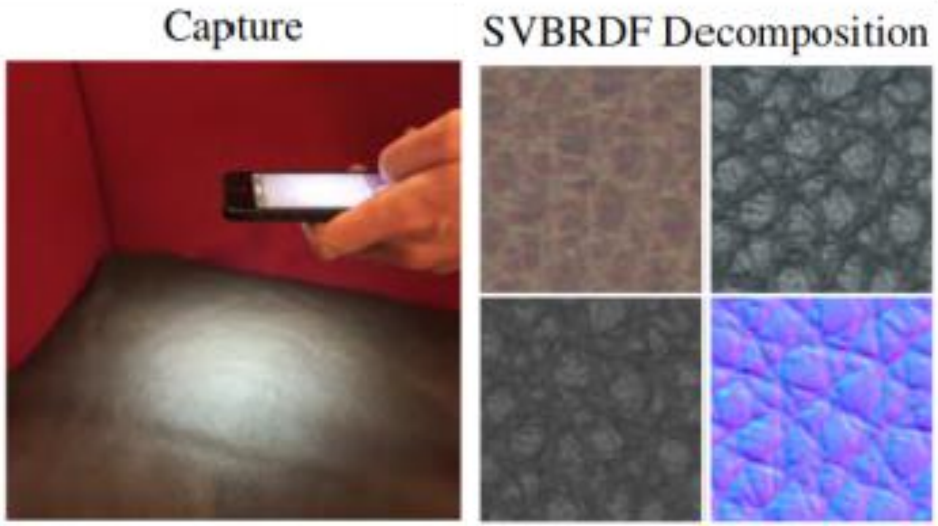

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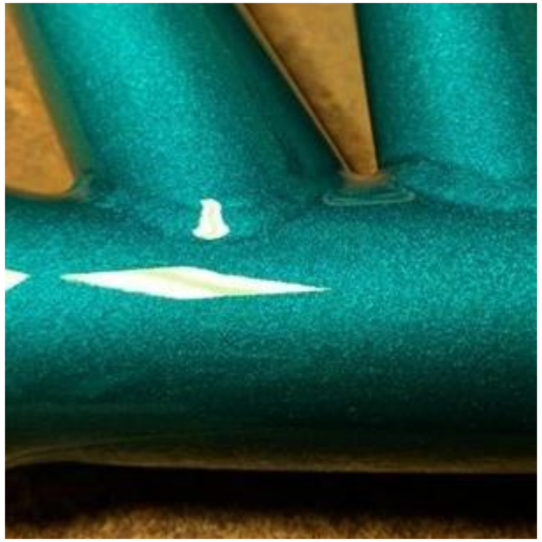
[1] Increasing the Spatial Resolution of BTF Measurementwith Scheimpflug Imaging (Havran et. al)
[2] Two-Shot SVBRDF Capture for Stationary Materials (Aittala et. al)

Material Models in Physically Based Rendering

- Physical BSDFs can be complex (metallic paint with coating, SSS, brushed metal)
- Models for rendering simplify, constrains are performance and sampling functions
- Learn about physical background and approaches



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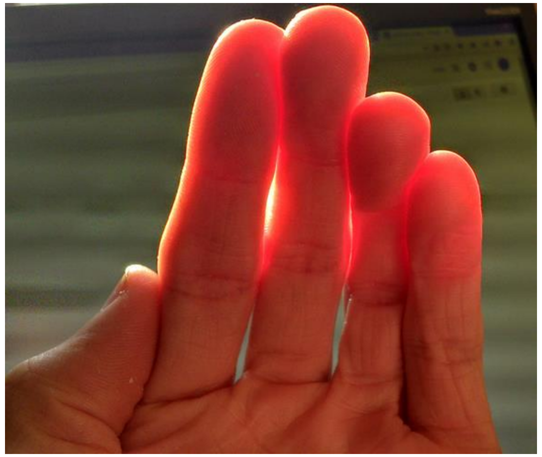

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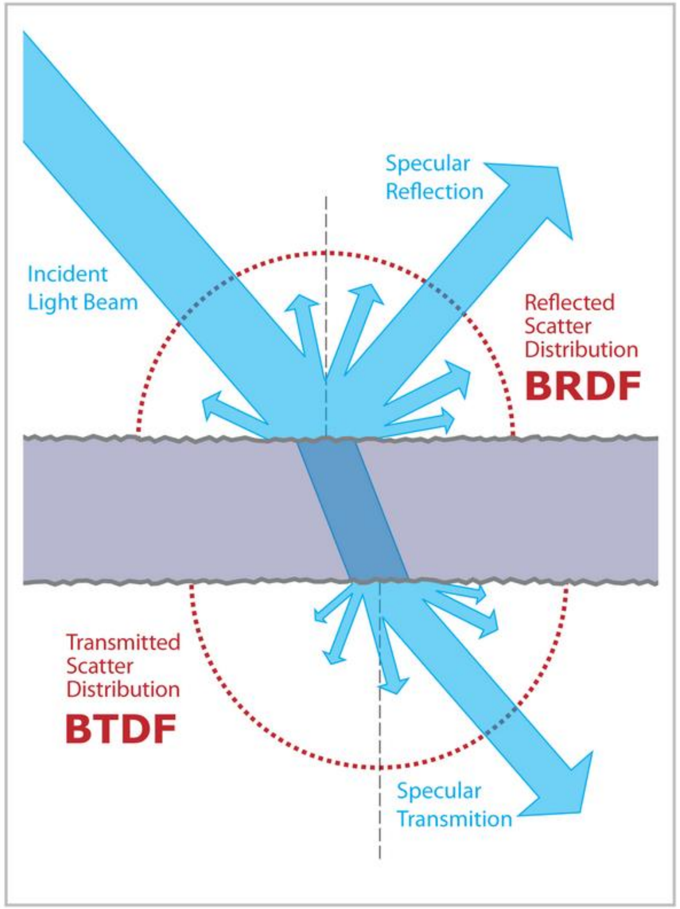

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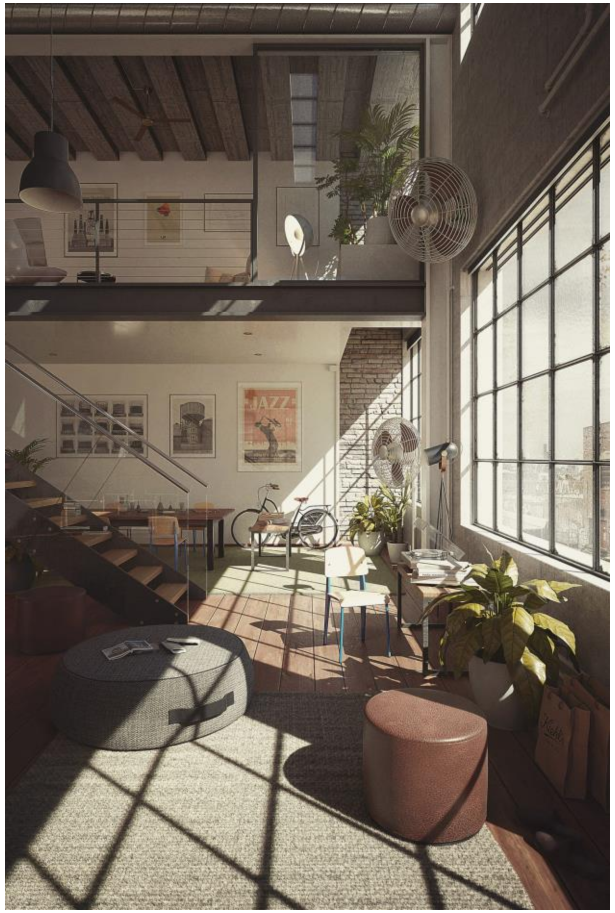
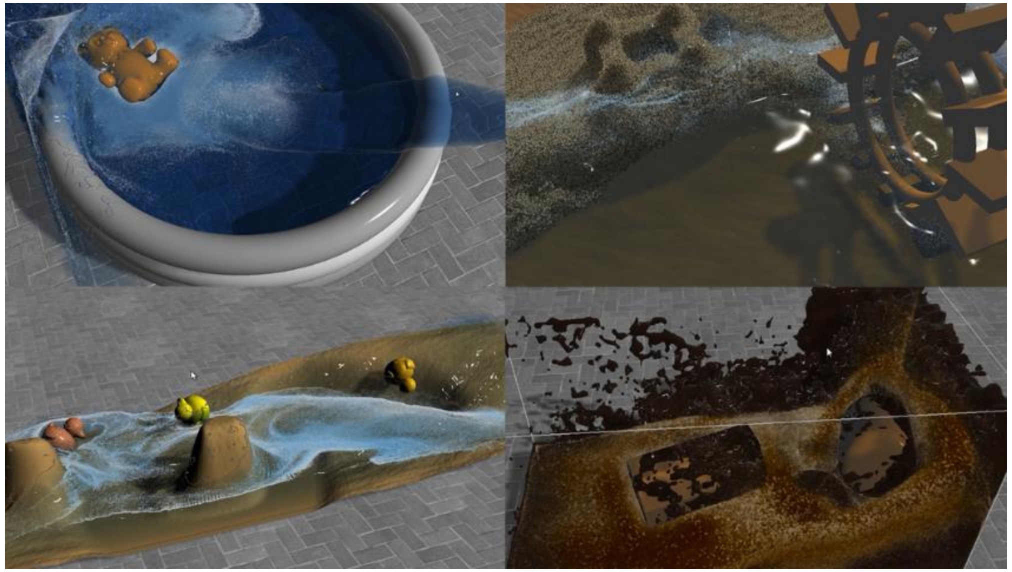
[1] wikipedia.org
[2] www.thepowdercoatstore.com

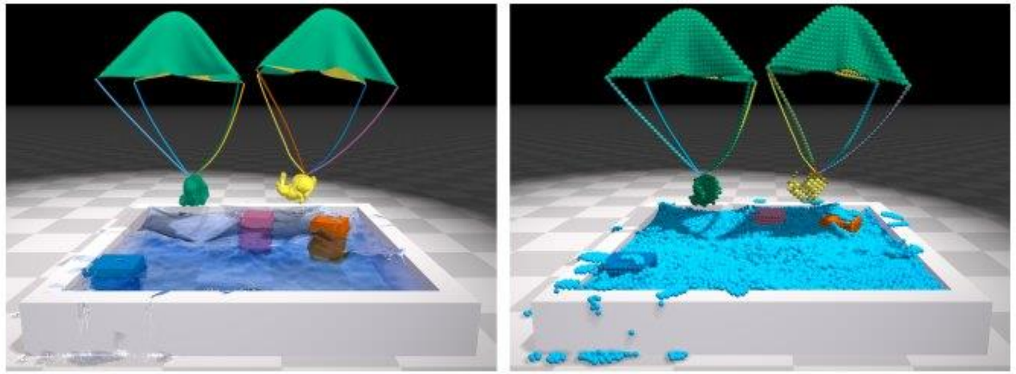
- Conduct a survey of the state-of-the-art in Physically Based Rendering



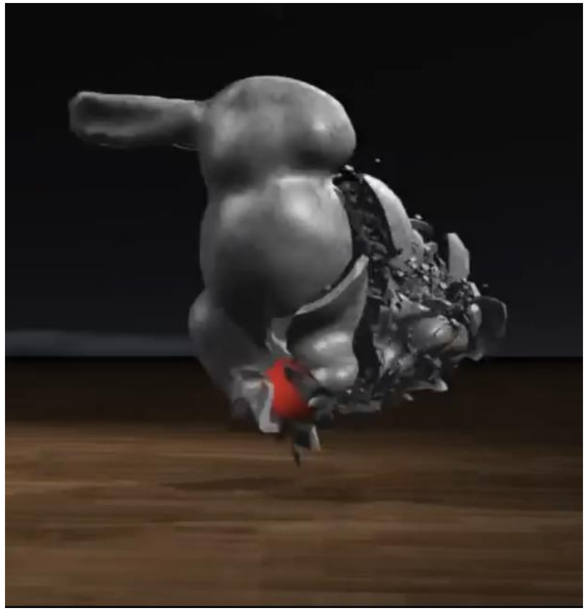
Real-time Physics Simulation

- Conduct a survey of the state-of-the-art in Real-time Physics Simulation





- Destruction of objects
- Static methods
  - Fast
  - Careful preparation
  - Implausible
- Dynamic methods
  - More realistic
  - Simplifies model preparation
  - Compute-intensive



M. Müller et al., Real Time Dynamic Fracture with Volumetric Approximate Convex Decompositions, *ACM Transactions on Graphics (SIGGRAPH 2013)*

Survey of methods using shape grammars to generate buildings, trees…

Müller, Pascal, et al. "Procedural modeling of buildings." *Acm Transactions On Graphics (Tog)*. Vol. 25. No. 3. ACM, 2006.

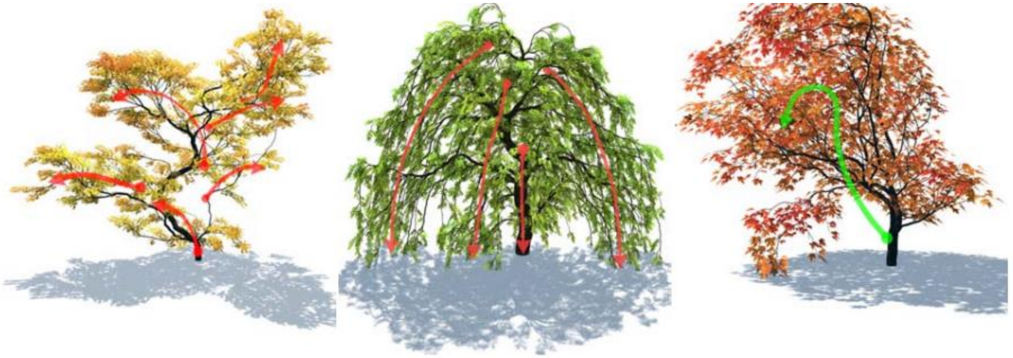
Steinberger, Markus, et al. "On-the-fly generation and rendering of infinite cities on the GPU." *Computer graphics forum*. Vol. 33. No. 2. 2014.

Automated 3D Generation

- Trees, interiors, urban space
- Procedural design vs optimization

Kan and Kaufmann. "Automatic Furniture Arrangement Using Greedy Cost Minimization."IEEE VR, 2018.

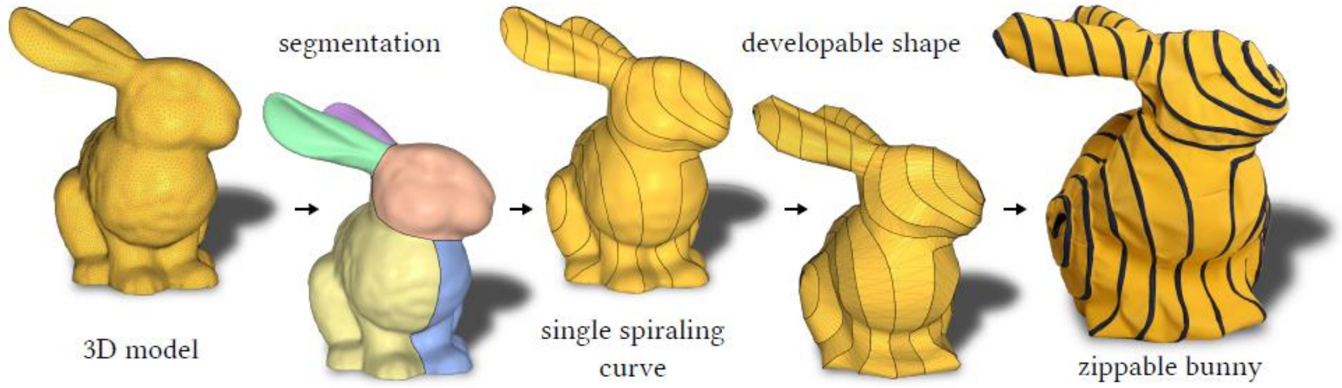
Vanegas et al. "Inverse Design of Urban Procedural Models." *ACM Transactions on Graphics (TOG)*. Vol. 31. No. 6. ACM, 2012.



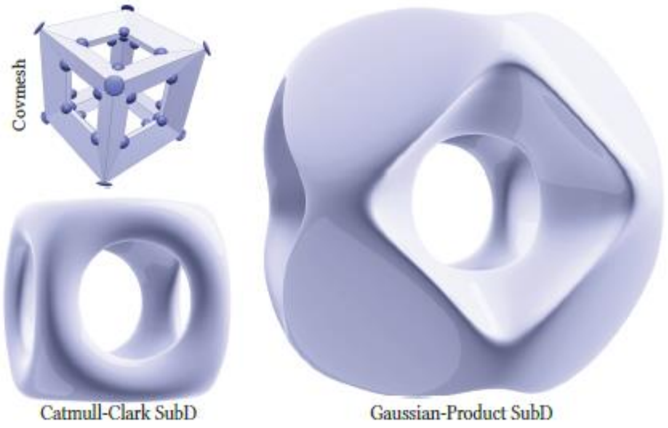
Longay et al. "TreeSketch: Interactive Procedural Modeling of Trees on a Tablet." Eurographics Workshop on Sketch-Based Interfaces and Modeling, 2012.

Surface Modelling

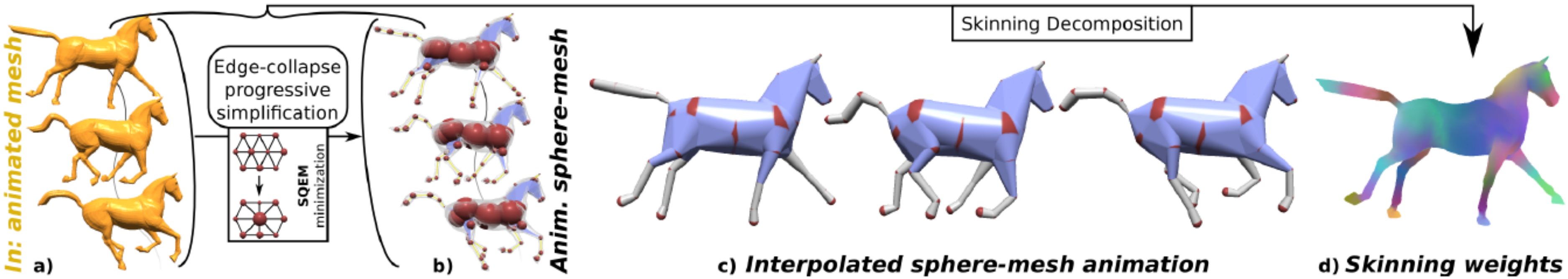
- Beyond classics: polygons, implicit, parametric, CSG



Schüller et al. "Shape Representation by Zippables." *ACM Transactions on Graphics (TOG)*. Vol. 37. No. 4. ACM, 2018.



Preiner et al. "Gaussian-Product Subdivision Surfaces." *ACM Transactions on Graphics (TOG)*. Vol. 38. No. 4. ACM, 2019.

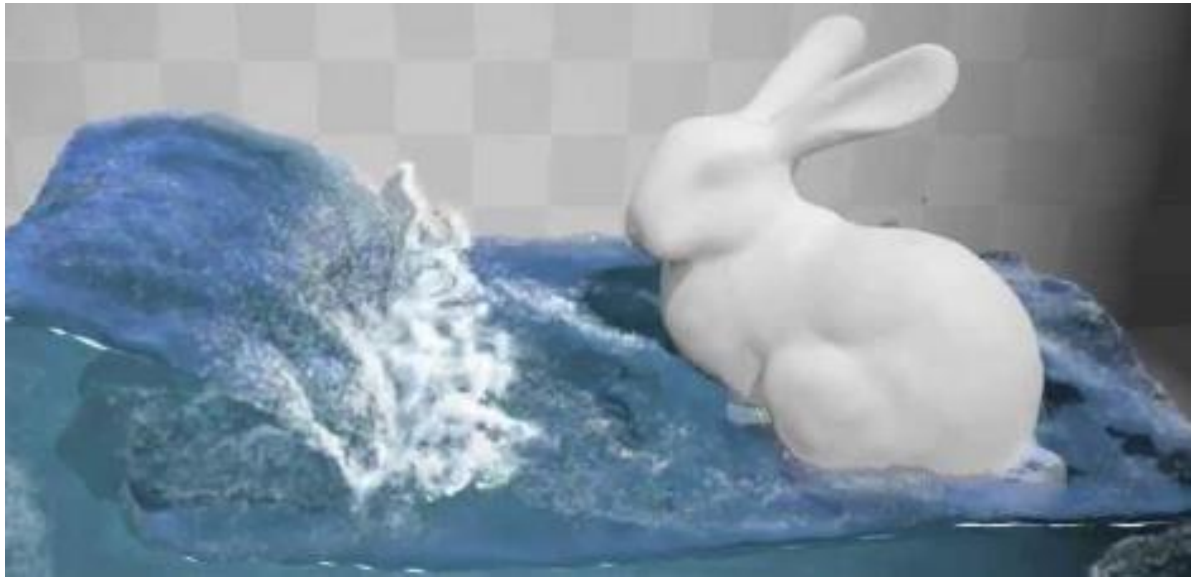


Thiery et al. "Animated Mesh Approximation With Sphere-Meshes." *ACM Transactions on Graphics (TOG)*. Vol. 35. No. 3. ACM, 2016.

Real-Time Water Simulation

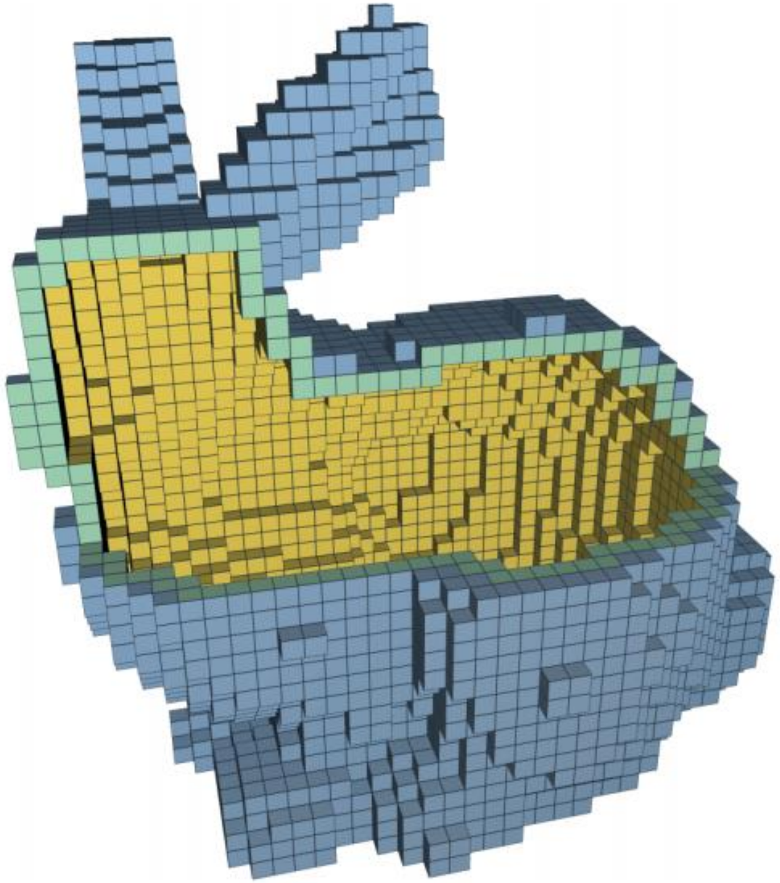
How to **simulate water in real-time** (simulation, not rendering)

- How to represent water (grid, particles, …?)
- How to achieve real-time frame rates?
- Which fluid properties to use in a simulator?
  - Viscosity
  - Pressure
  - etc.?
  - How to avoid too high viscosity (=> honey) or gas-like behavior, but get believable water.



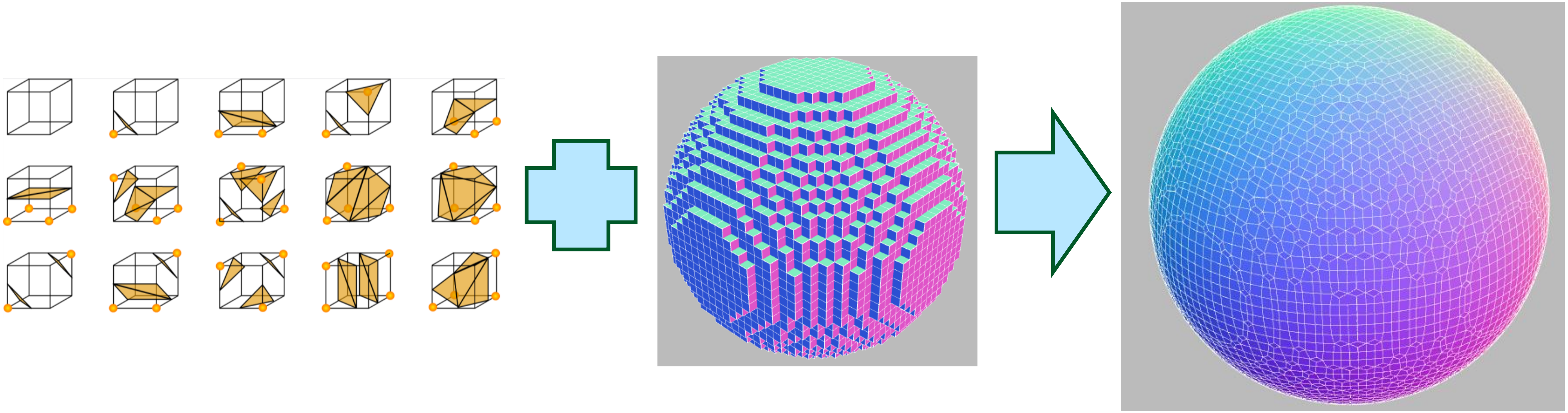
GPU Voxelization Algorithms

- Voxelized representation of a 3D scene
- GPU algorithms (not offline algorithms)
- Different voxelization approaches
- Applications of voxelized 3D scenes



Meshing of Implicit Surfaces

- Convert volume data into a mesh
- E.g. Marching Cubes

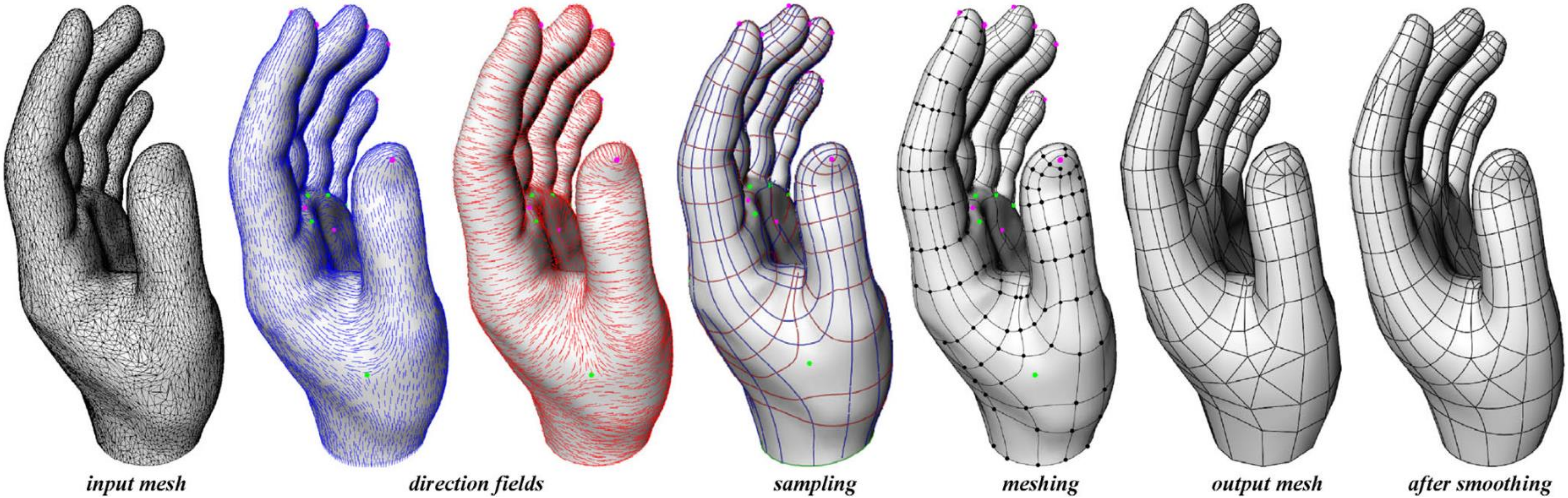


https://commons.wikimedia.org/wiki/File:MarchingCubes.svg

https://0fps.net/2012/07/12/smooth-voxel-terrain-part-2/

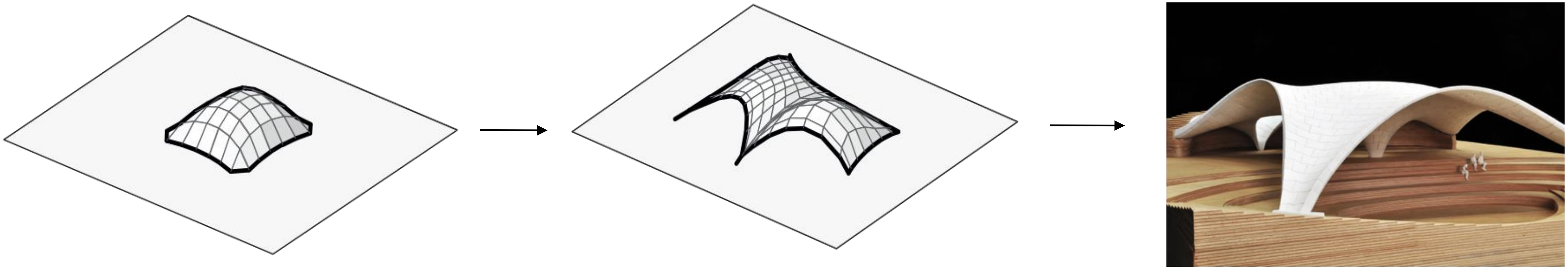
Quad Remeshing

- Align vector field to e.g. curvature
- **Trace field lines** to convert triangles to quads (or quad-dominant)

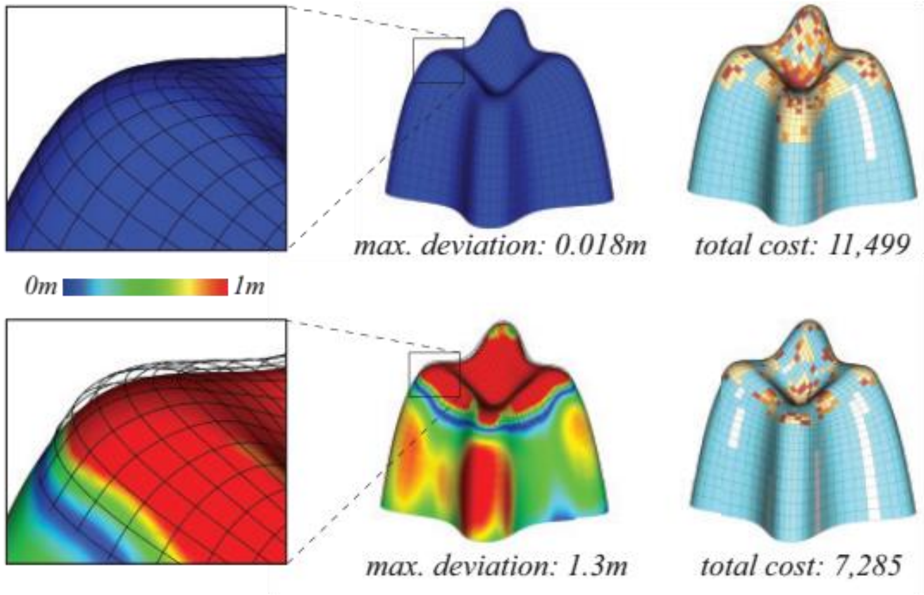


Alliez, Pierre, et al. "Anisotropic polygonal remeshing." *ACM Transactions on Graphics (TOG)*. Vol. 22. No. 3. ACM, 2003.

Which forms can be achieved
under given loads?

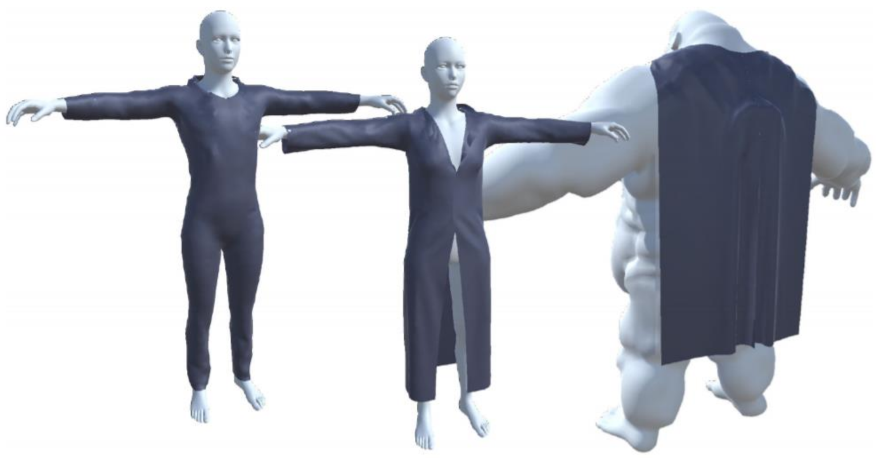


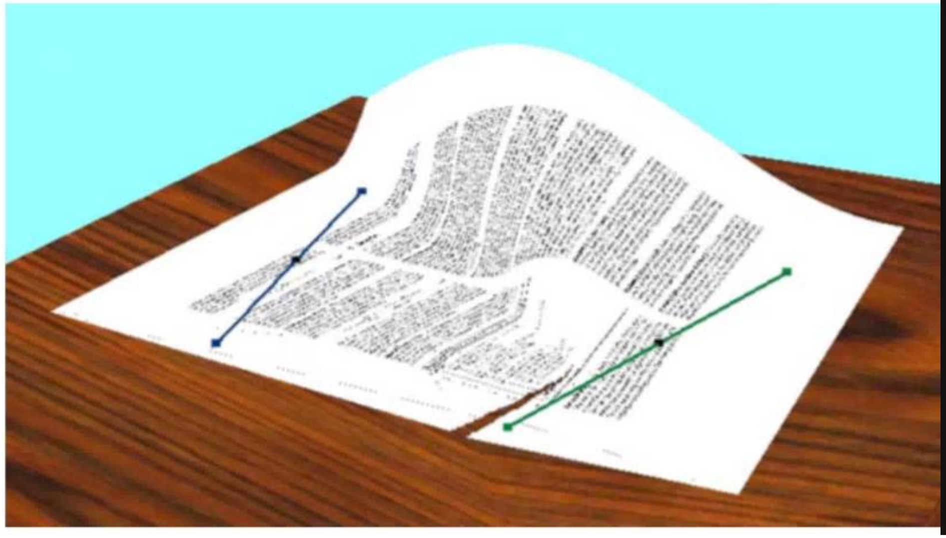
Approximating a surface with patches
of target qualities



Interactive Simulation of Deformable or Tearable Materials

- Solving the animation of this type of materials is non-trivial, with the added constraint of interactive rates requiring a compromise between fidelity and computational cost.
- Generally, approaches can be divided into physically based and data driven models. Models can also be generalists (for no specific purpose) or optimized to specific problems (examples: paper, clothing, skin)





Deep Learning for Non-Photorealistic Imagery

- Deep learning, especially convolutional networks, have shown promise in helping computers to classify, understand, modify and generate art.
- Existing work generally focus on: metadata extraction, style transfer and generational adversarial networks.

generated characters

Topic Assignment

- Non-binding poll to show most-wanted topics
- Short discussion (in Zoom break-out rooms)
- Set group choice in TUWEL online -> first come, first serve
- Double assignment or groups if more students than topics

Topic Assignment

1. (Stable) Image Reconstruction with Neural Networks
2. Many Light Rendering
3. Infant-like Learning
4. Fun with Occlusions
5. Applications of Machine Learning for Rendering
6. Global Illumination in VR and AR
7. Material Capture and Reconstruction
8. Material Models in Physically Based Rendering
9. Physically Based Rendering
10. Real-time Physics Simulation
11. Fracturing
12. Shape Grammars
13. Automated 3D Generation
14. Surface Modelling
15. Real-Time Water Simulation
16. GPU Voxelization Algorithms
17. PE: Meshing of Implicit Surfaces
18. PE: Quad Remeshing
19. Form-finding for Shell Structures
20. Panelization of Surfaces
21. Interactive Simulation of Deformable or Tearable Materials
22. Deep Learning for Non-Photorealistic Imagery

- Non-binding poll to show most-wanted topics
- Short discussion
- Set group choice in TUWEL online -> first come, first serve
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Next Steps

- Contact your supervisor ASAP
- Find mail addresses here: https://www.cg.tuwien.ac.at/staff/
- Discuss literature list with your supervisor
- Submit the literature list in TUWEL by 20.10.
- Remarks about Covid-19:
  - Do you prefer a final presentation online or in-person?

- Questions?