# Wissenschaftliches Arbeiten
# 193.052, SS 2020, 2.0h (3 ECTS)

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

Research Division of Computer Graphics
Institute of Visual Computing & Human-Centered Technology
TU Wien, Austria

# Organization

- There is a common first part – **this is the second part**
- New organizer - me
- Switching from pure mail to TUWEL
- Topics are presented and assigned here today
- Organization via TUWEL
  https://tuwel.tuwien.ac.at/course/view.php?id=21553
- General information on LVA site
  https://www.cg.tuwien.ac.at/courses/SeminarAusCG/



# 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 talk in seminar



# Literature List

- Analyze recent papers (select with supervisor)
- Study secondary literature to understand topic
- How to find relevant papers:
  - Digital libraries: IEEE, ACM, …
  - Google Scholar: key words and operators
  - Survey papers, often-referenced papers
- Submit a list of 10+ papers per email to supervisor & me
  → **official registration**



# State-of-the-Art Report (STAR)

- 8 pages per student, preferably in English
- Format in the style of a scientific paper
- Use LaTeX template on course website
- LaTeX tools and guides also on the website
- Submit the draft in PDF format
- Draft has to be complete and min. 8 pages!



# Scientific Review

- You will get a draft 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 according to reviews



# Seminar Talk

- Prepare slides in advance, using template
- Each student talks for approx. 15 minutes in English
- Short discussion after each talk
- Focus is on overview/comparison of methods
- Present so that other students will understand it
- Active discussion is mandatory and is graded
- Submitted slides are presented on seminar PC



# Grading

- Lecture attendance: 5 points
- Review: 20 points
- Seminar slides + talk: 30, discussion 5 points
- Final report: 40 points

- Late submission: 33% off per day, max. 3 days

- 1: 88%, 2: 75%, 3: 63%, 4: 50%



# Important Dates

- 05.04. Submit literature list
- 01.04. 11:00 – 13:00 Lecture Prof. Wimmer
- 21.04. 11:00 – 13:00 Lecture Prof. Gröller
- 13.05. 11:00 – 13:00 Lecture Prof. Purgathofer
- 24.05. Submit review version
- 07.05.2020 Submit reviews
- 21.06.2020 Submit presentation slides
- 22.06.2020 10:00 – 15:00 Presentations
- 28.06.2020 Submit final report



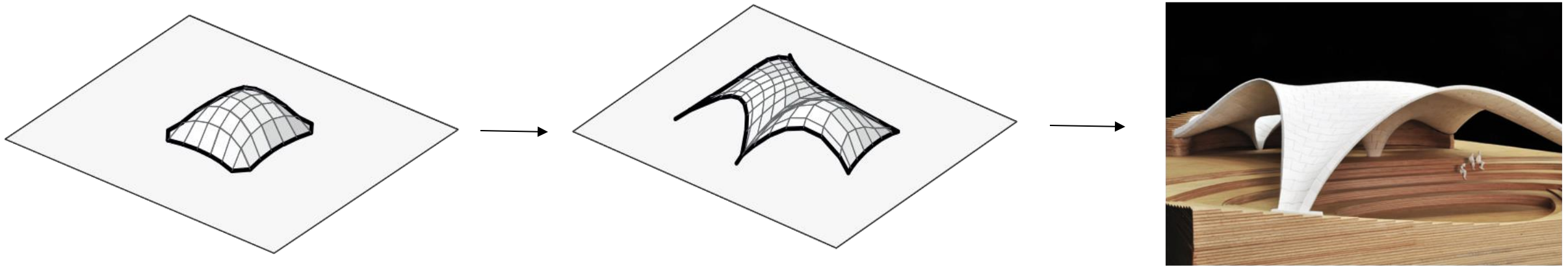
# Topic Presentation

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



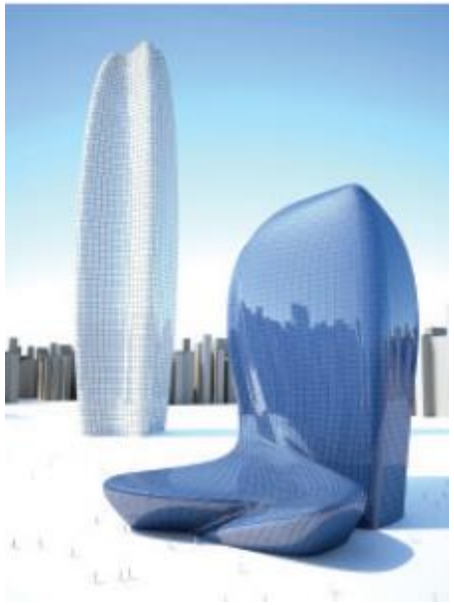
# Form-finding for Shell Structures

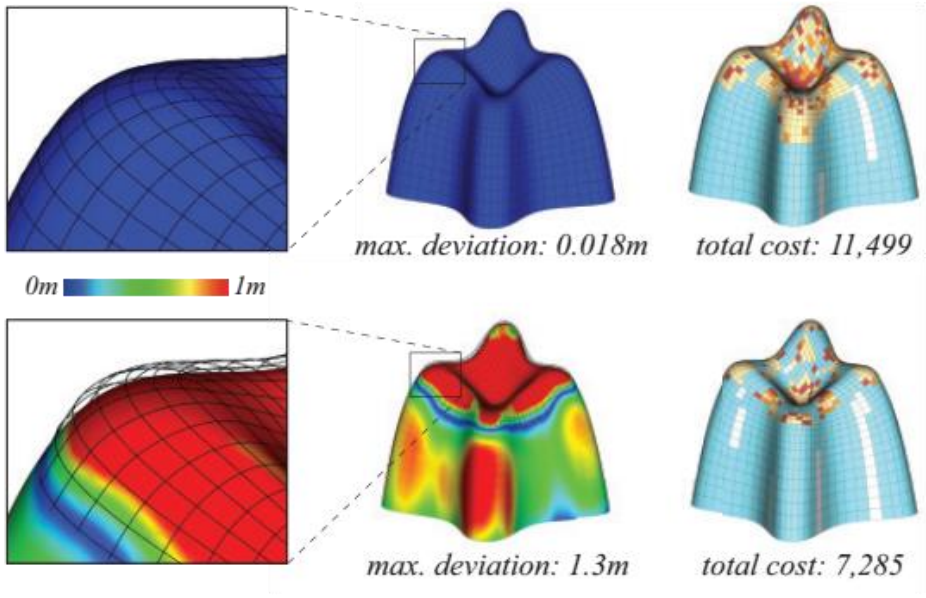
Which forms can be achieved
under given loads?



# Panelization of Surfaces

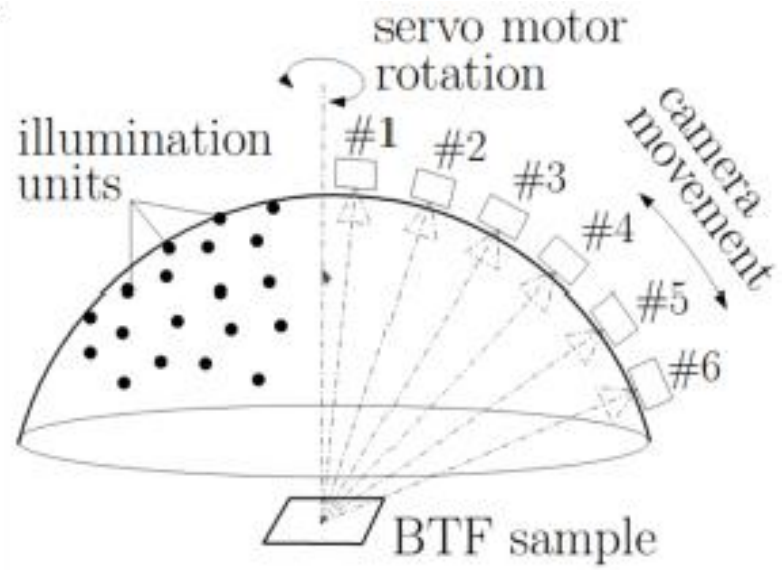
Approximating a surface with patches of target qualities



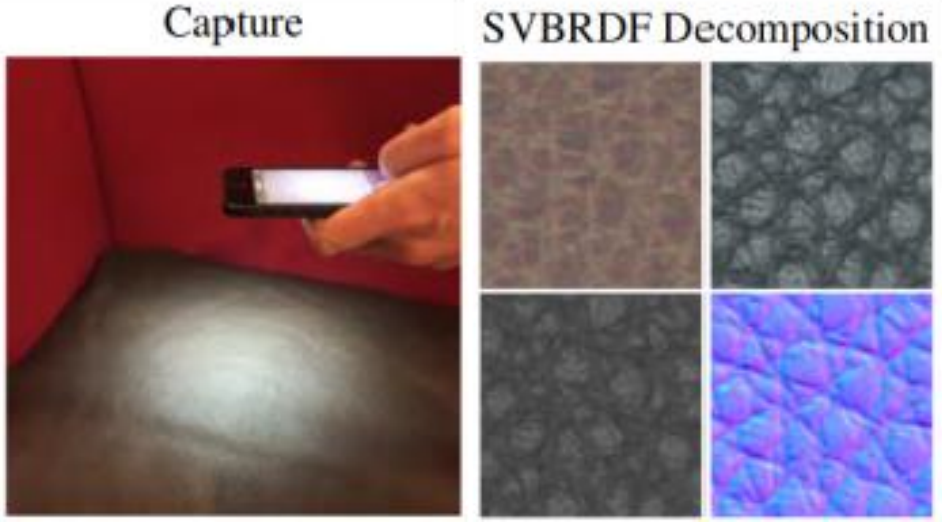


# Material Capture and Reconstruction

- 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




1

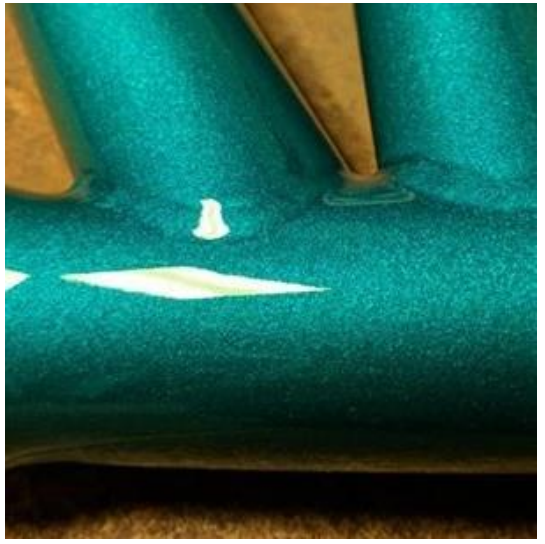



2

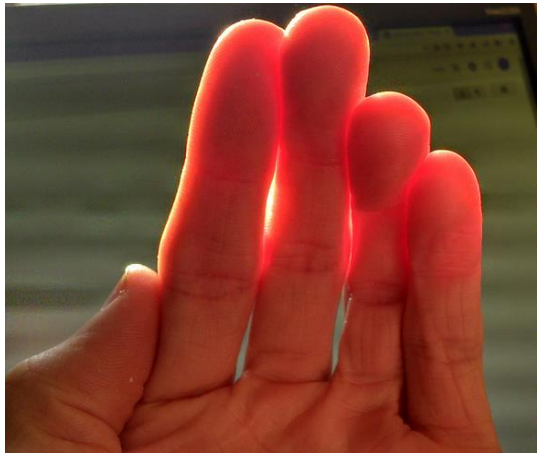
[1] Increasing the Spatial Resolution of BTF Measurementwith Scheimpflug Imaging (Havran et. al)
[2] Two-Shot SVBRDF Capture for Stationary Materials (Aittala et. al)

# Material Models in Physically Based Rendering

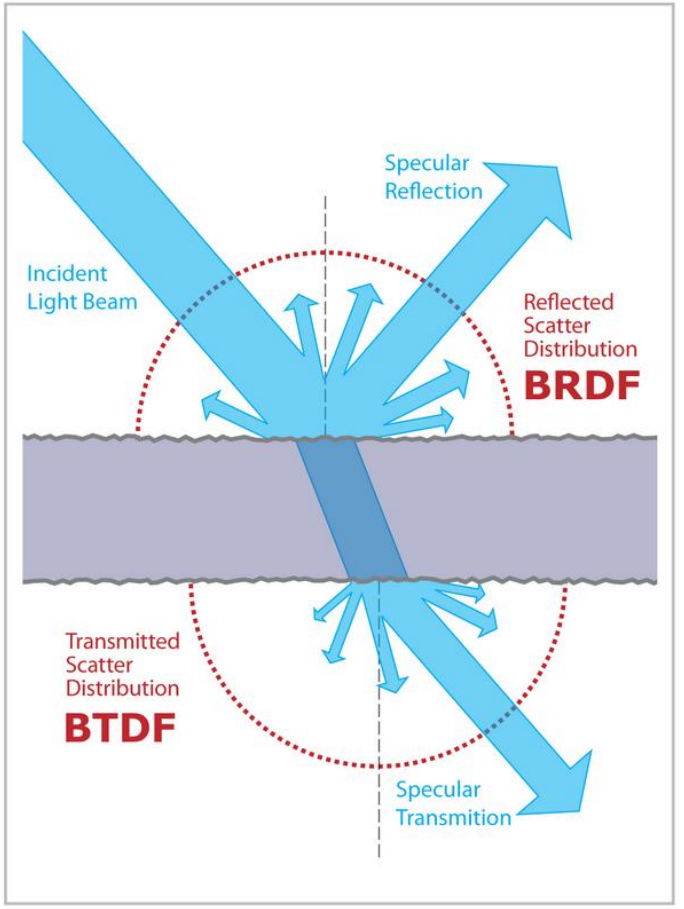
- Physical BSDFs can be complex (metallic paint with coating, SSS, brushed metal)
- Models for rendering simplify, constrains are performance and sampling functions
- Learn about physical background and approaches



2



1

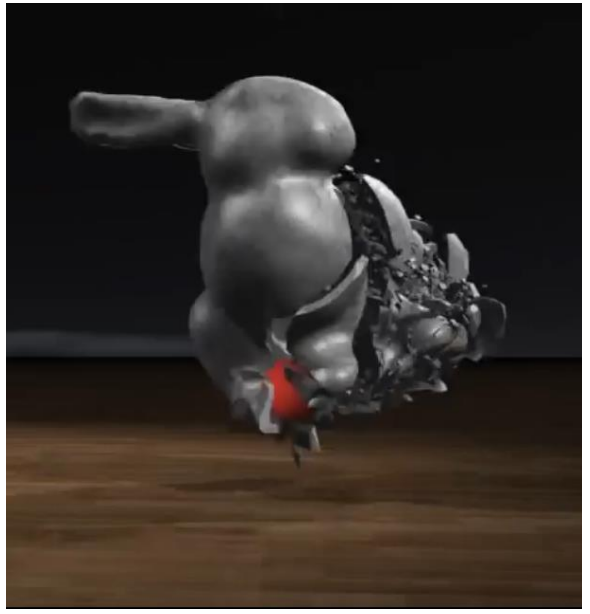



1

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

# Fracturing

- 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)*

# Shape Grammars

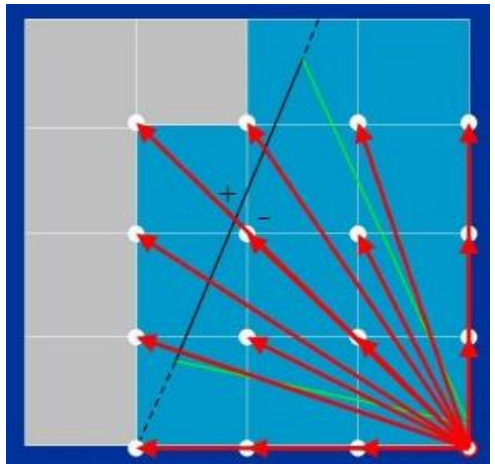
Survey of methods using shape grammars to generate buildings, trees…

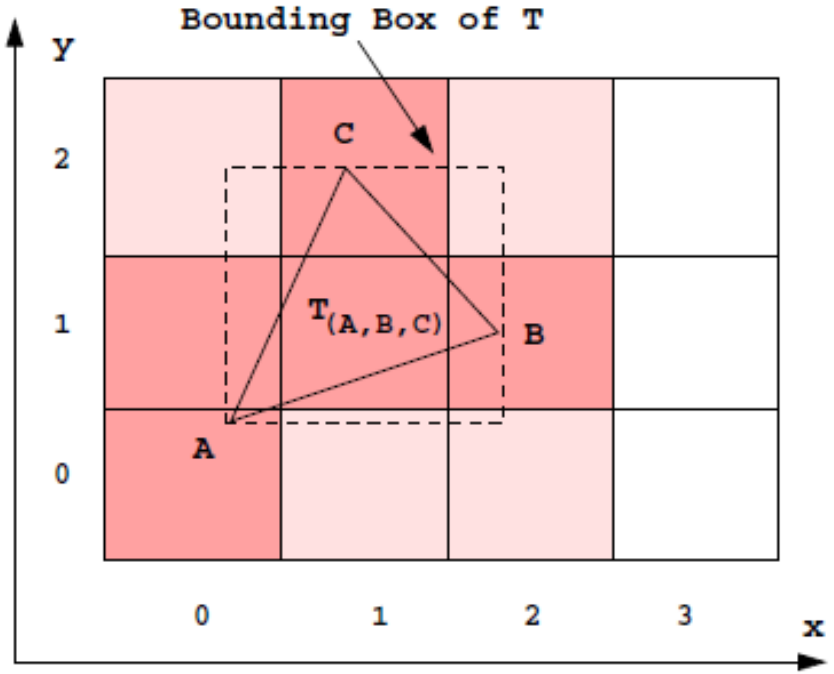
Müller, Pascal, et al. "Procedural modeling of buildings." *Acm Transactions On Graphics (Tog)*. Vol. 25. No. 3. ACM, 2006.

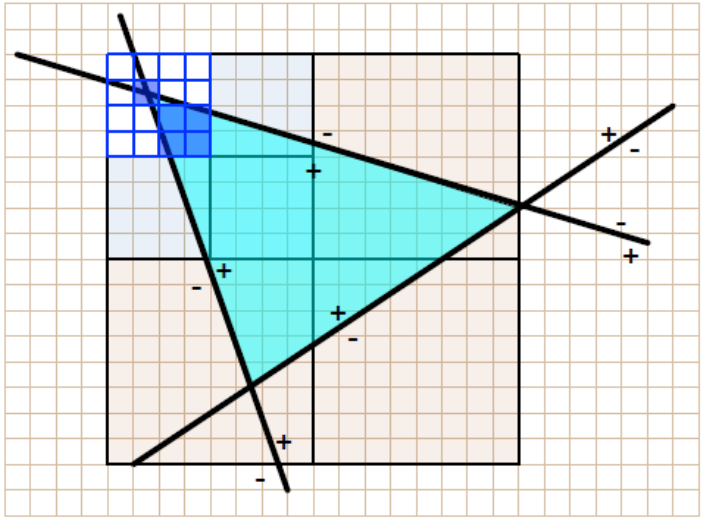

Steinberger, Markus, et al. "On-the-fly generation and rendering of infinite cities on the GPU." *Computer graphics forum*. Vol. 33. No. 2. 2014.

# Hardware Algorithms for Rasterization

- Investigate how GPUs perform rasterization
  - Tile-Based Rasterization
  - Efficient Memory Patterns
- Analyze the logical rasterization pipeline
- Investigate which optimizations/strategies are put in place in vendor-specific implementations of the logical rasterization pipeline.



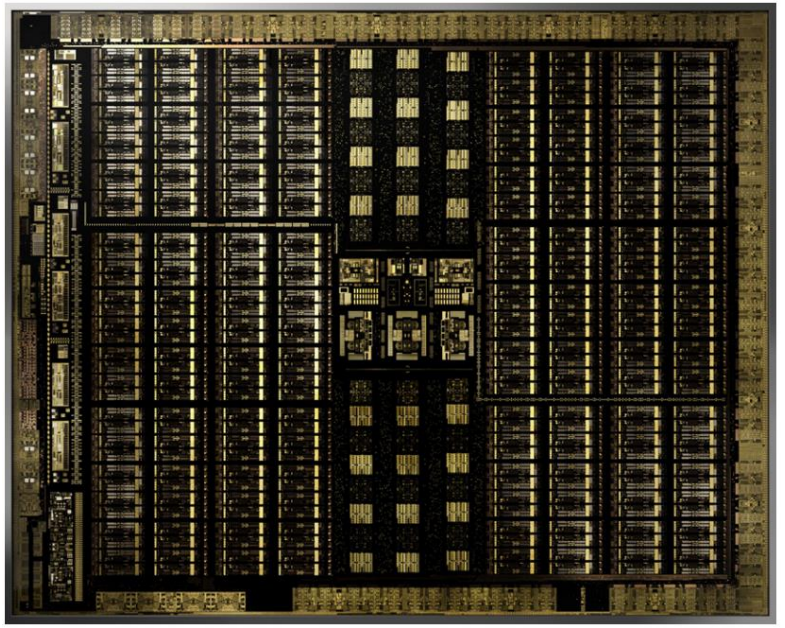


# Hardware Units of GPUs

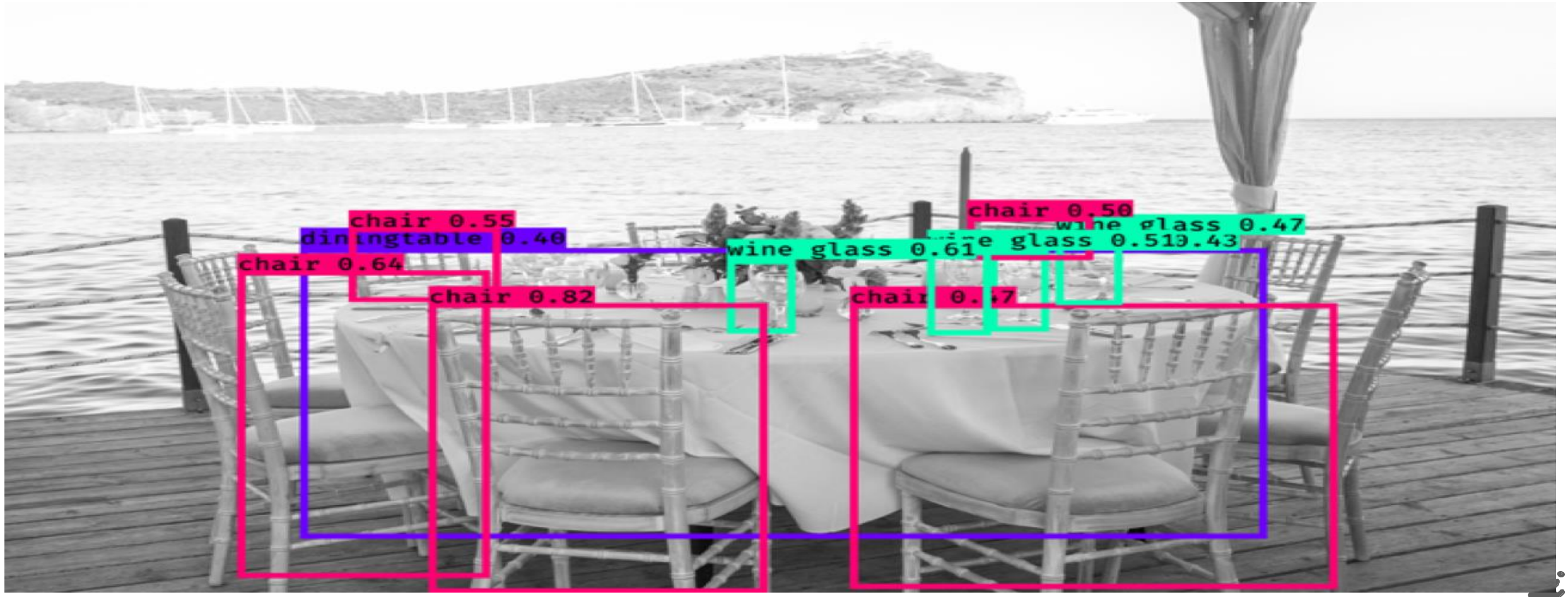
- Investigate the hardware units of GPUs and which operations they accelerate. Also analyze the different levels of memory and cache.
  - Texture Units, Render Output Units, Warp Scheduler, …
  - L1 Cache, L2 Cache, Instruction Cache, Registers, …
  - Other specialized cores/units (e.g. RTX cores, …)
  - Focus on **modern** GPUs
    - Which of these units are implemented in hardware (i.e. hardware-accelerated)
    - Which operations to these units accelerate in hardware in particular?
    - Why is hardware-acceleration required for these operations?

NVIDIA Turing TU102 GPU



# Classify Objects in Point Clouds

- Machine learning algorithms for 3D scanned data
- Detect partial objects and their pose (location+orientation in 3D)

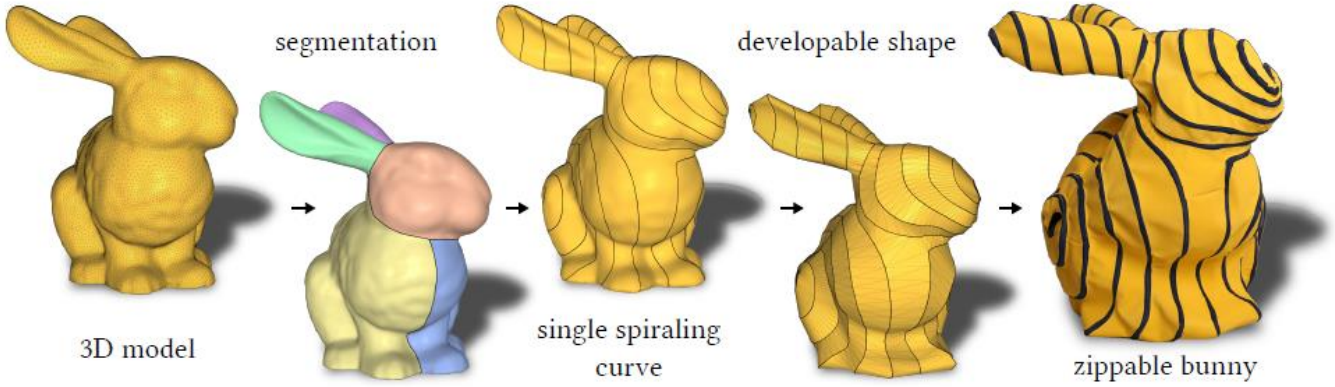


# Learning Objects from Scenes, Unsupervised

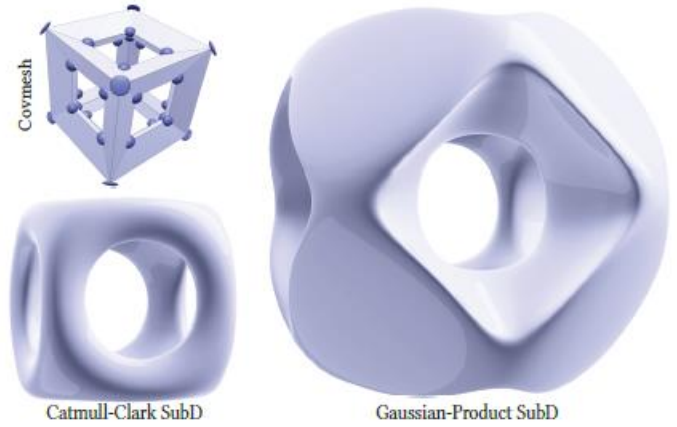
- Machine learning algorithms which can
- automatically classify and detect similar objects
- in a scene, without knowing what they are.
- E.g. in the scene right, detect several instances
- of objects which a human user later can
- label as „chair“, „lamp“, „house front“, „person“

# Surface Modelling

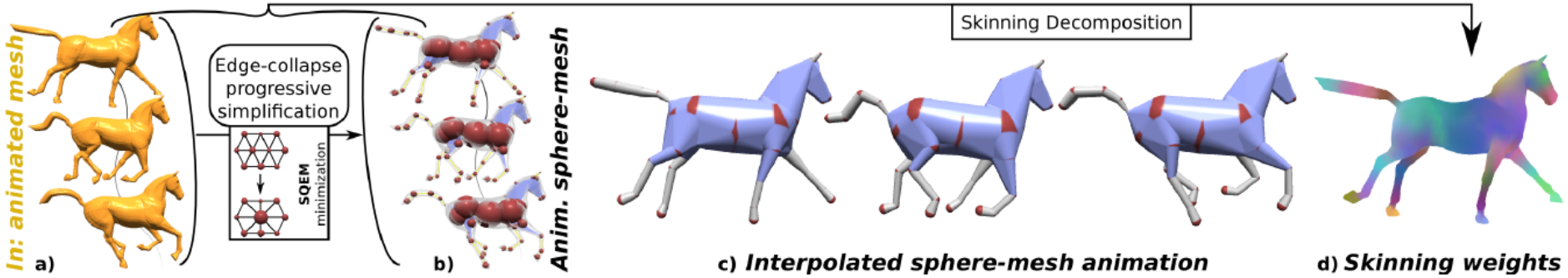
- Beyond classics: polygons, implicit, parametric, CSG




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.

# Deep Learning for Point Clouds Classification & Segmentation

- Point based networks
- Current state of the art and limitations

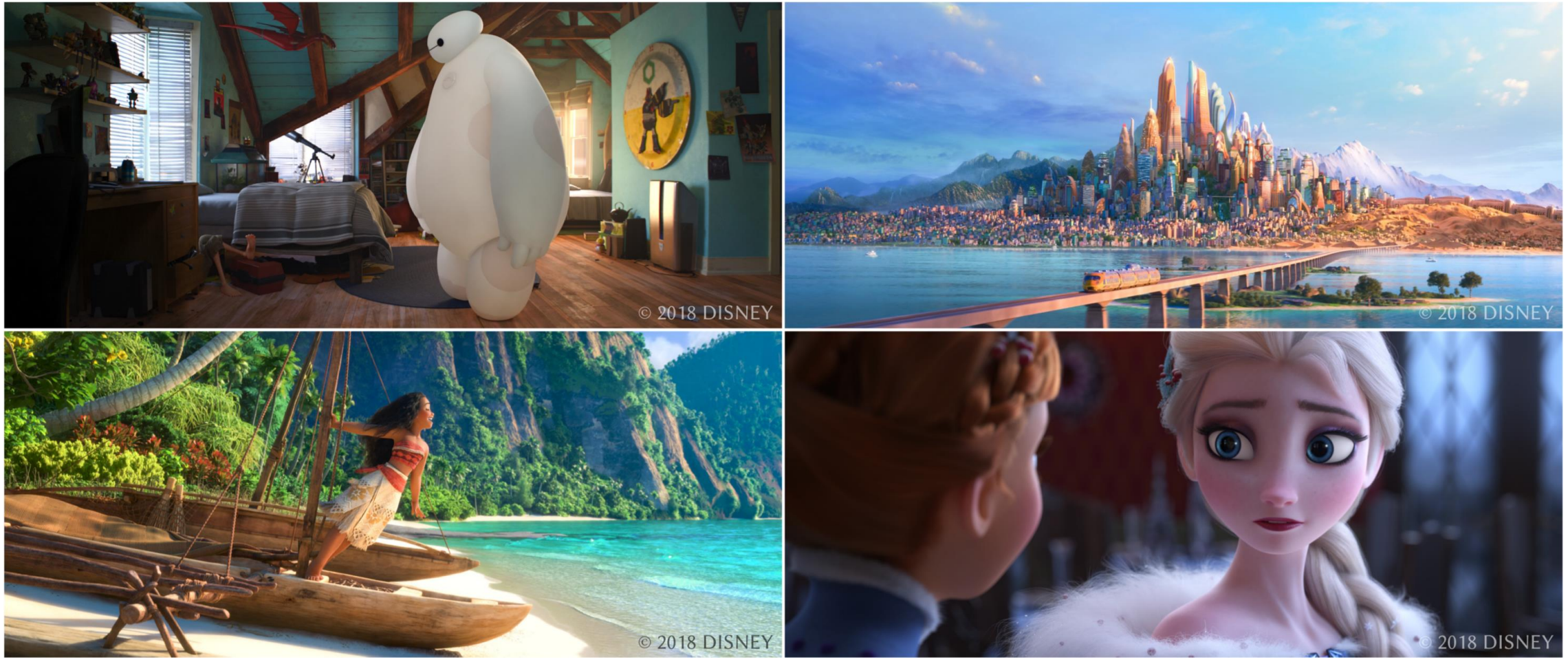

C. R. Qi, H. Su, K. Mo, and L. J. Guibas, "PointNet: Deep learning on point sets for 3D classification and segmentation," in CVPR, 2017.

# The Technology Behind Pixar Films

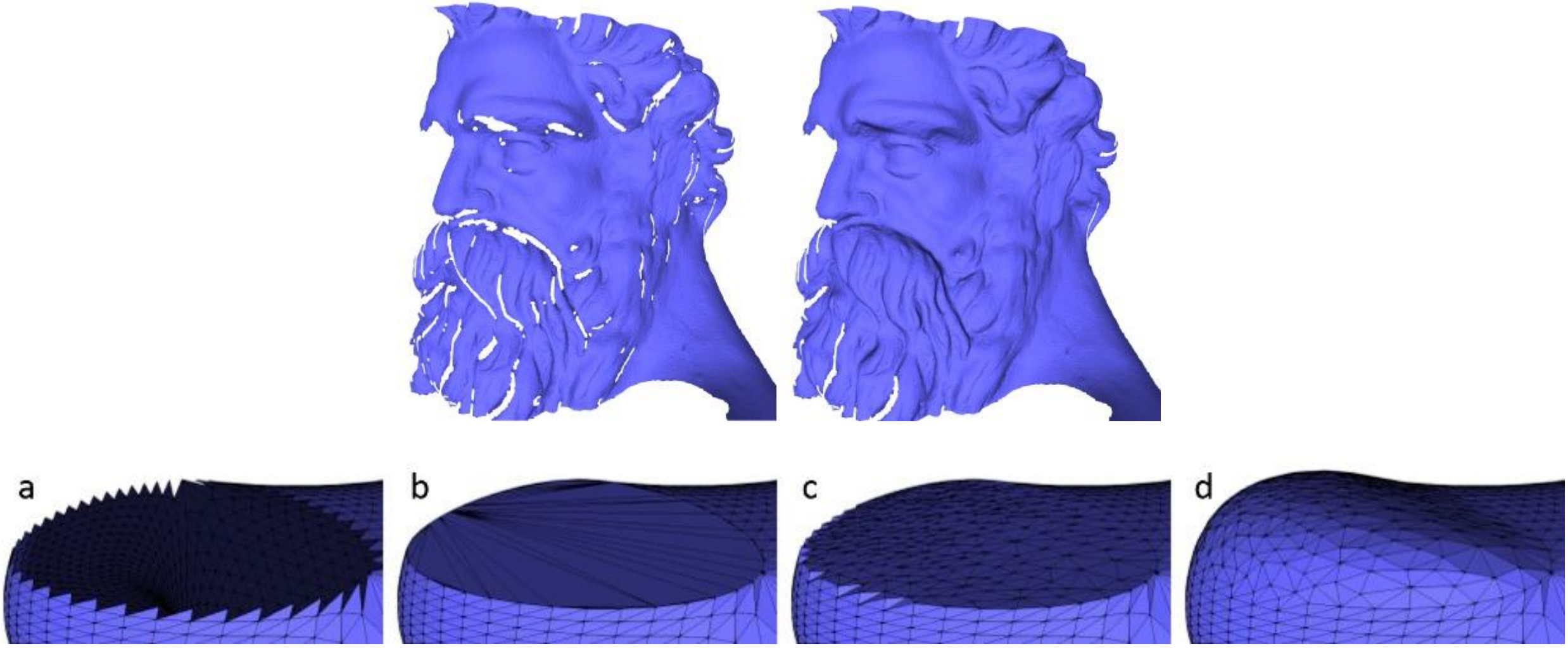
- Provide an overview of the technology behind Pixar films

# The Technology behind Disney Films

- Provide an overview of the technology behind Disney films

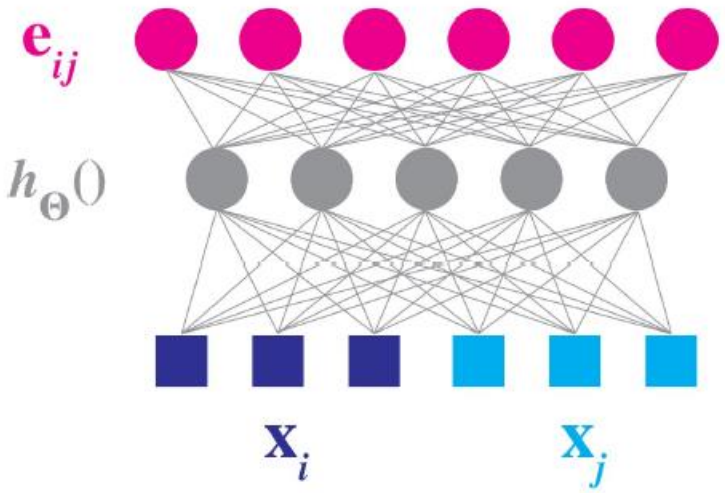


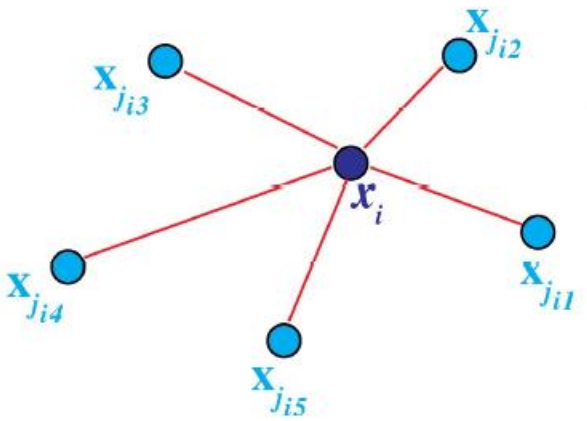
# Hole Filling in Meshes

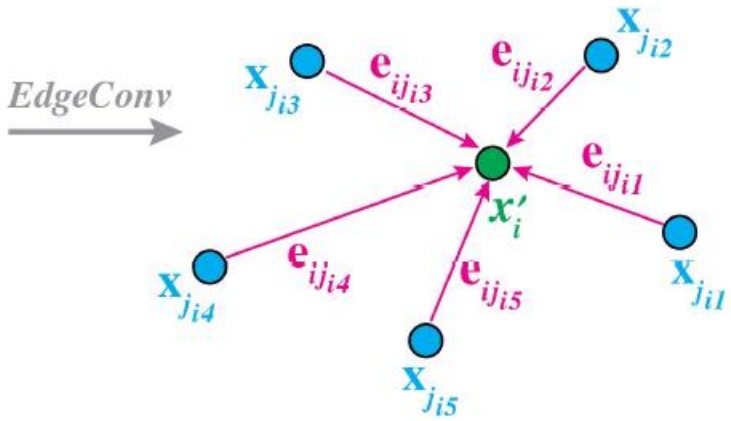


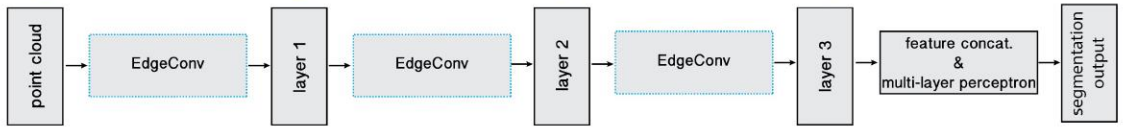

Results of the main steps of the algorithm. From left to right: (a) the hole, (b) the hole after its triangulation, (c) after triangulation and refinement, (d) after triangulation, refinement and fairing.

# Graph-CNNs for CG



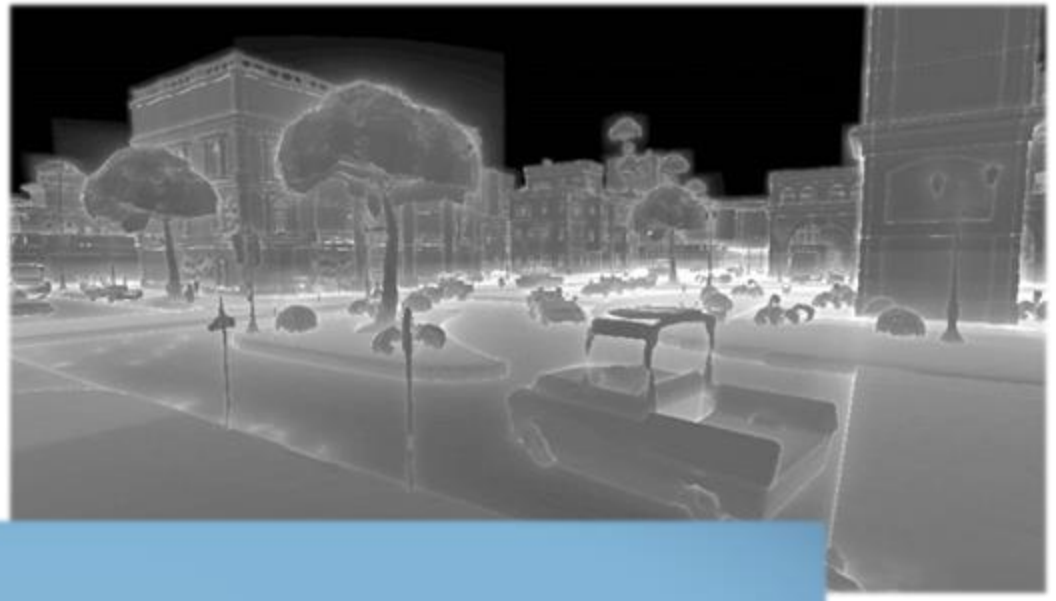




https://arxiv.org/pdf/1801.07829.pdf

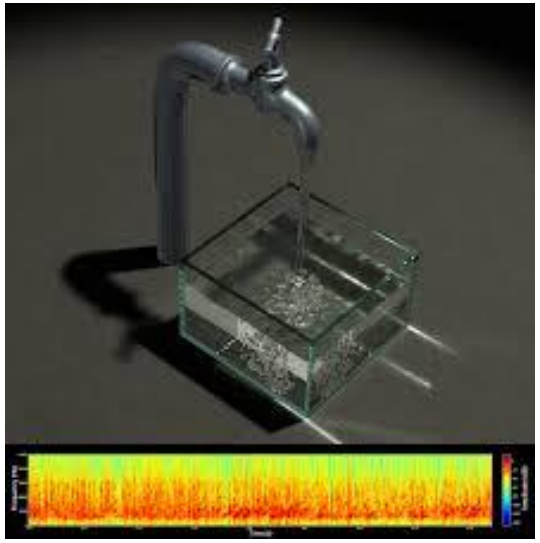
# Signed Distance Field Rendering

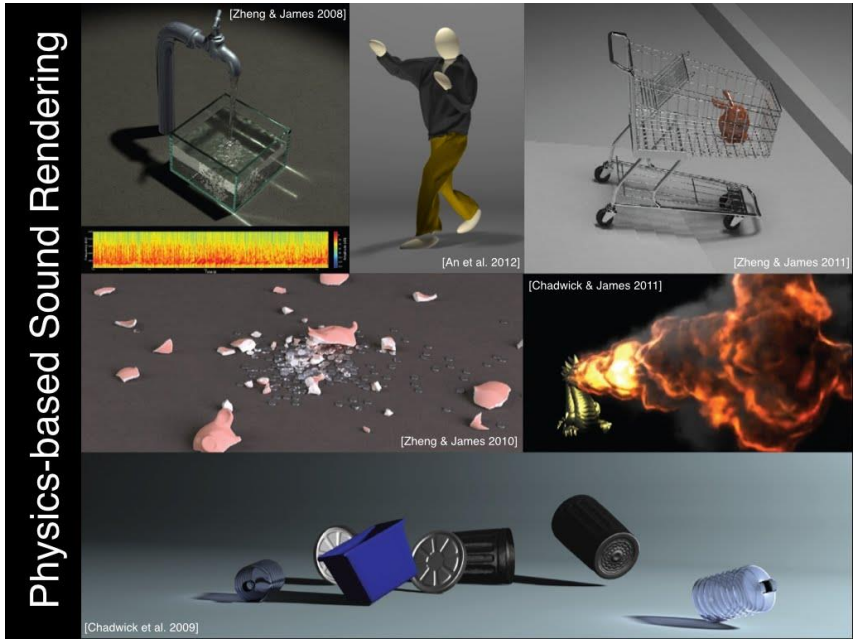
- Conduct a survey on signed distance field rendering.



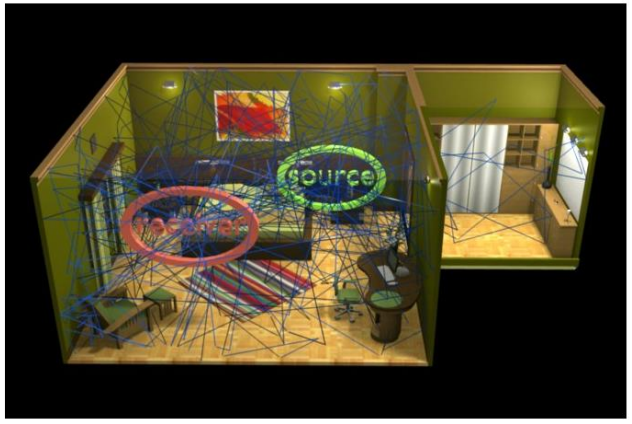
# Sound Rendering

- Conduct a survey on sound rendering techniques.







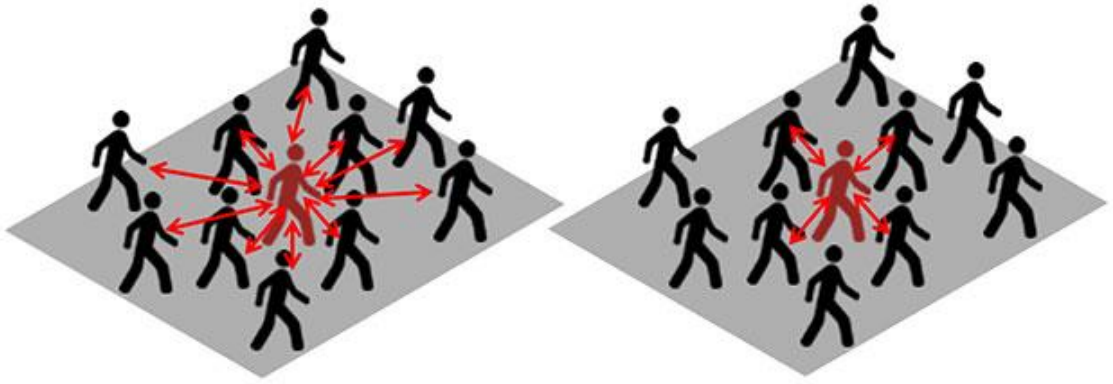



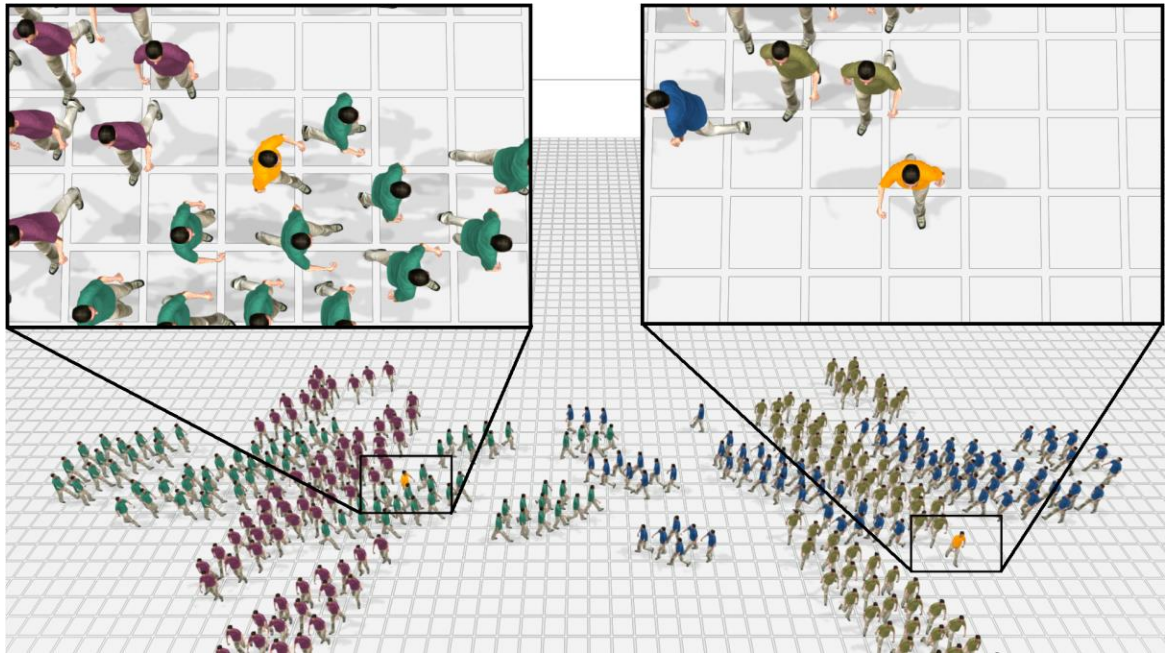
# Atmospheric Rendering

- Atmospheric rendering (light transport, scattering) for real-time
- Based on **participating media** theory
- Many factors can be precomputed
- What about the others? How can you compute them in real-time?

# Crowd Simulation

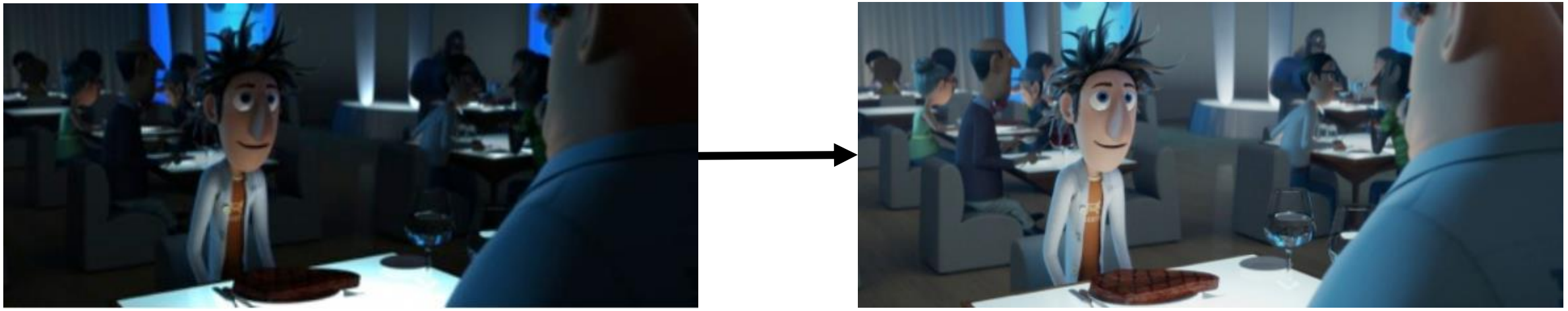
- In order to appear realistic, cities must simulate human crowds
- Many factors and level-of-detail considerations
- How to achieve natural behavior? Interaction? Trends or Patterns?





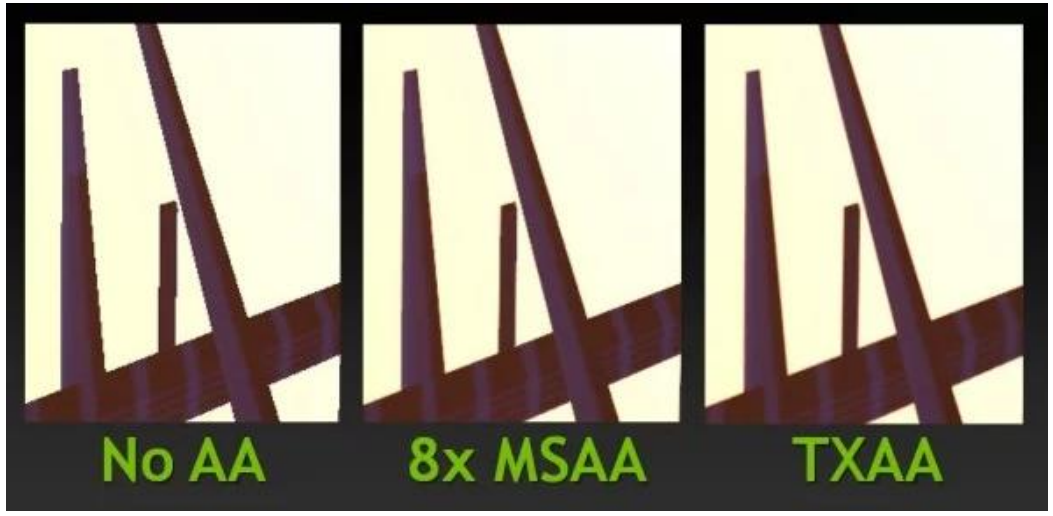
# Automated Color Correction

- Images from both photography and film often require color rebalancing. Modern tools, like photoshop, feature algorithms to automatically balance the color in a photo.
- The student is expected to explain what is color balance and write an overview of both automated traditional methods and deep learning based solutions. Finally, the student should compare them.



# Anti-Aliasing and Multisampling in Real-Time

- Anti-aliasing and multisampling are intrinsically connected, as both are methods to avoid artifacts . To avoid this, graphics engines and even GPUs are shipped with well established methods.
- The student is expected to write an overview of the current state of the art for anti-aliasing and multisampling techniques. He/she should cover both spatial and temporal techniques.




# Topic Assignment

- Non-binding poll to show most-wanted topics
- Short discussion (15 min)
- Set group choice in TUWEL online -> first come, first serve
- Double assignment or groups if more students than topics



# Topic Assignment

1. Form-finding for Shell Structures
2. Panelization of Surfaces
3. Material Capture and Reconstruction
4. Material Models in Physically Based Rendering
5. Fracturing
6. Shape Grammars
7. Classify Objects in Point Clouds
8. Learning Objects from Scenes, Unsupervised
9. Surface Modelling
10. Deep Learning for Point Clouds Classification & Segmentation
11. Hole Filling in Meshes
12. Graph-CNNs for CG
13. Signed Distance Field Rendering
14. Sound Rendering
15. Atmospheric Rendering
16. Crowd Simulation
17. Automated Color Correction
18. Anti-Aliasing and Multisampling in Real-Time
19. The Technology Behind Pixar Films
20. The Technology behind Disney Films
21. Hardware Algorithms for Rasterization
22. Hardware Units of GPUs

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



# Next Steps

- Get in contact with your supervisor ASAP
- Discuss literature list with your supervisor
- Submit the literature list by 20.10.

- Questions?