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

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TU Wien, Austria

Organization

- Organization via TUWEL
  https://tuwel.tuwien.ac.at/course/view.php?id=30703
- General information on LVA site
  ~~https://www.cg.tuwien.ac.at/courses/SeminarAusCG/~~
  https://www.cg.tuwien.ac.at/courses/SeminarAusCG/SE/2020W
  - Dates on this site count
  - Please mail me if you find conflicting information
- Topics are presented and assigned 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

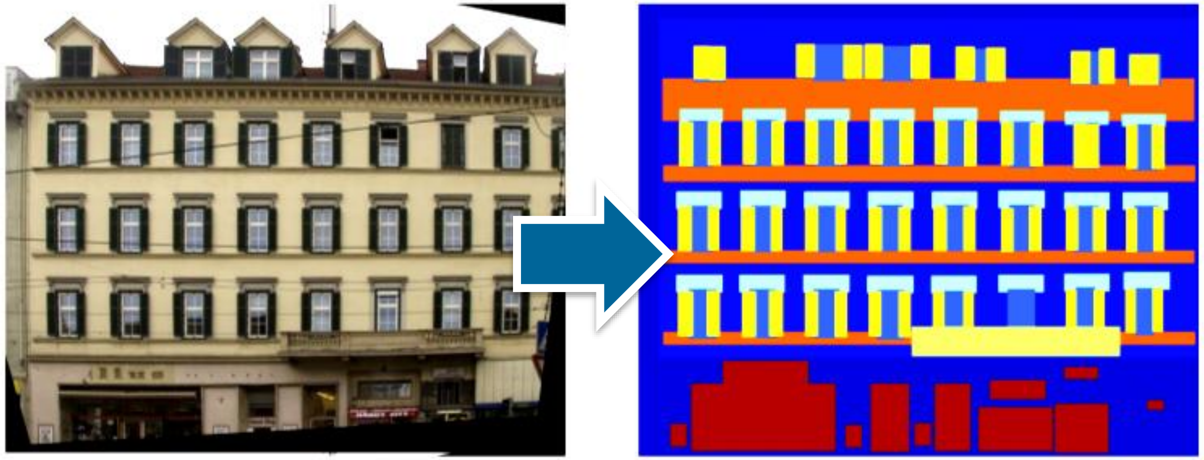
Topic Presentation

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

Detailed 3D City Models

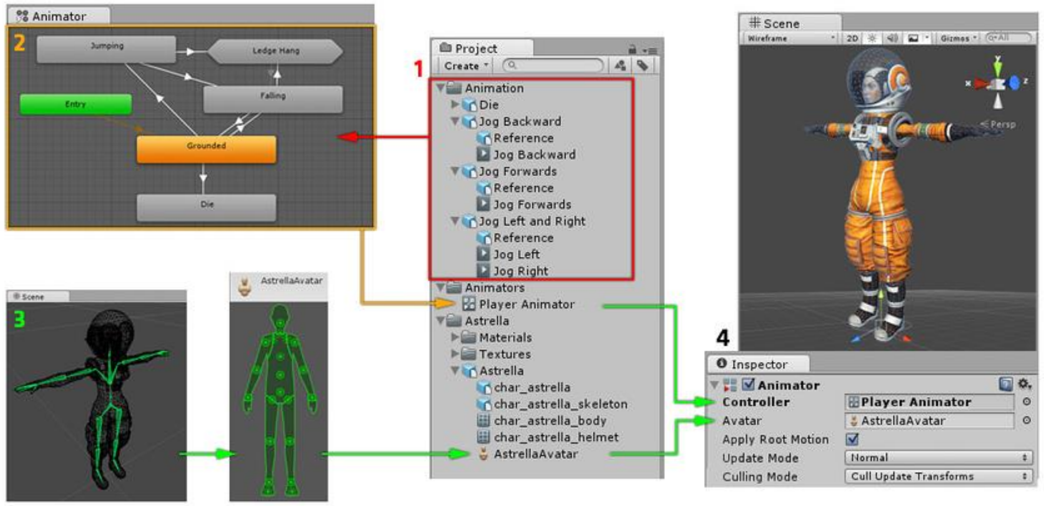
- Visualizing cities based on available data
  - How is the geometry obtained?
  - How does texturing work?
  - Commonly used solutions (CityGML, etc.)?
  - What are their strengths and weaknesses?

- Special focus: using machine learning to augment data with additional information from available images
  - How many floors?
  - How many windows/doors?
  - Where are they?
  - Color, style?

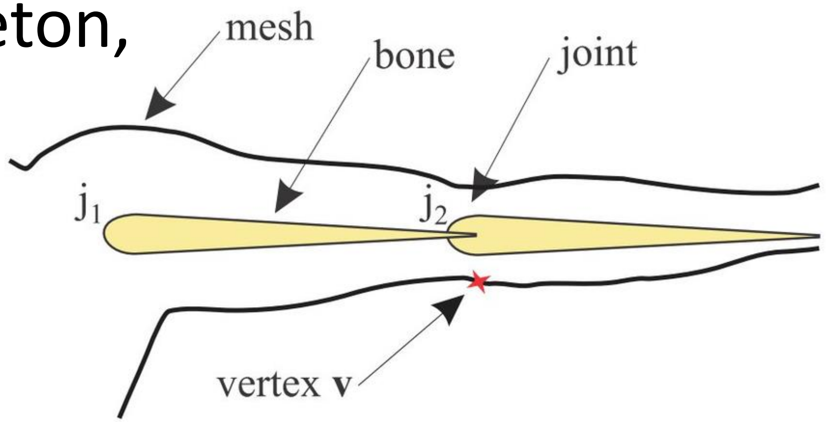


Modern Character Animation Systems

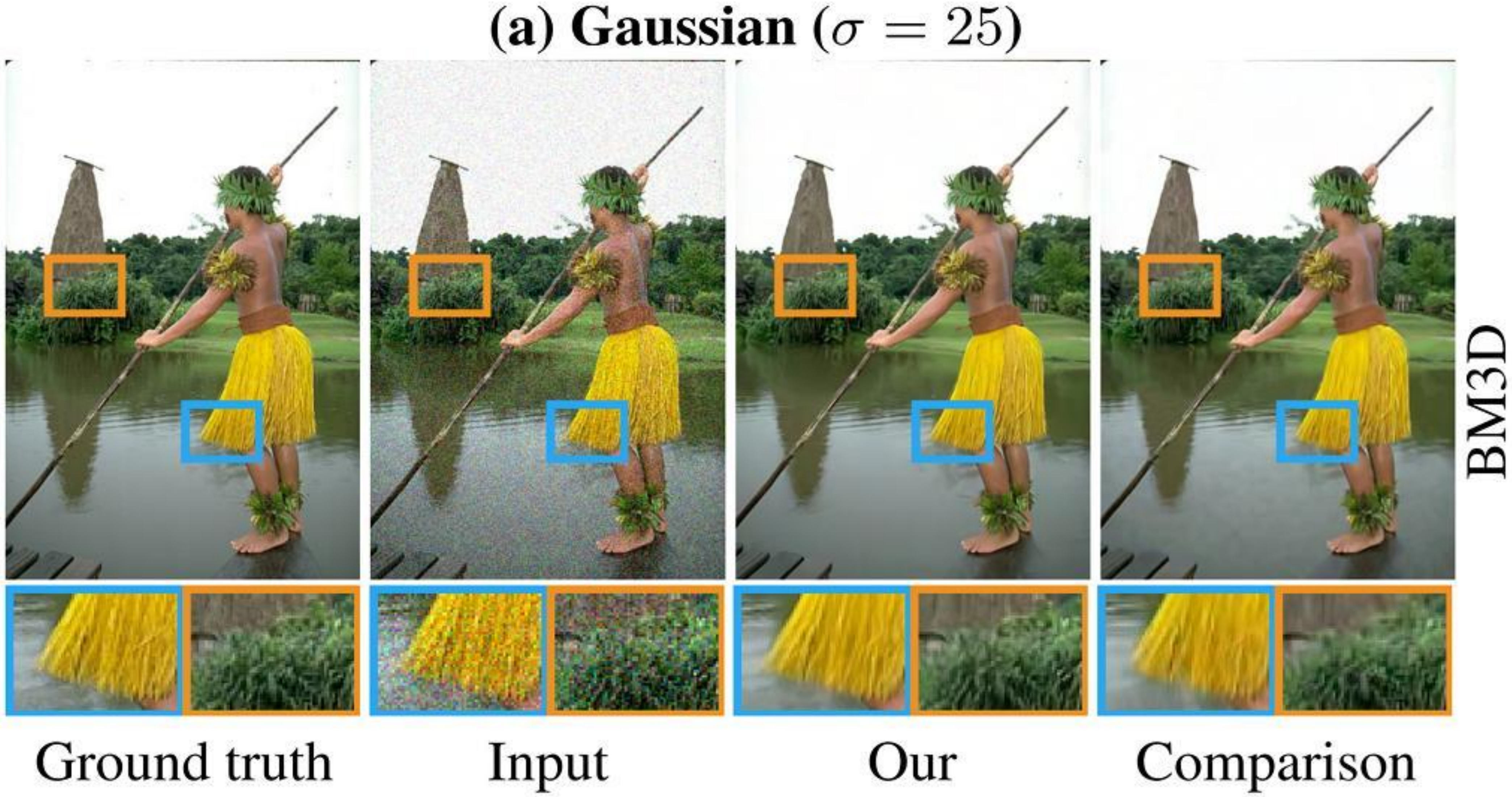
- A modern animation system must be able to consider multiple methods at runtime:
  - Key-framed animations
  - Inverse kinematics
  - Animation blending
  - Animation masks and partial updates



- Special focus: If we animate a character with a skeleton, mesh vertices should move with close-by bones
  - Linear Blend Skinning
  - Spherical Blend Skinning
  - Dual Quaternion Skinning
  - How do these work and which one works best?



Deep Learning Based Noise Reduction in Rendering



LEHTINEN, Jaakko, et al. Noise2noise: Learning image restoration without clean data.

Convolutional Deep Learning Networks for 3d Data

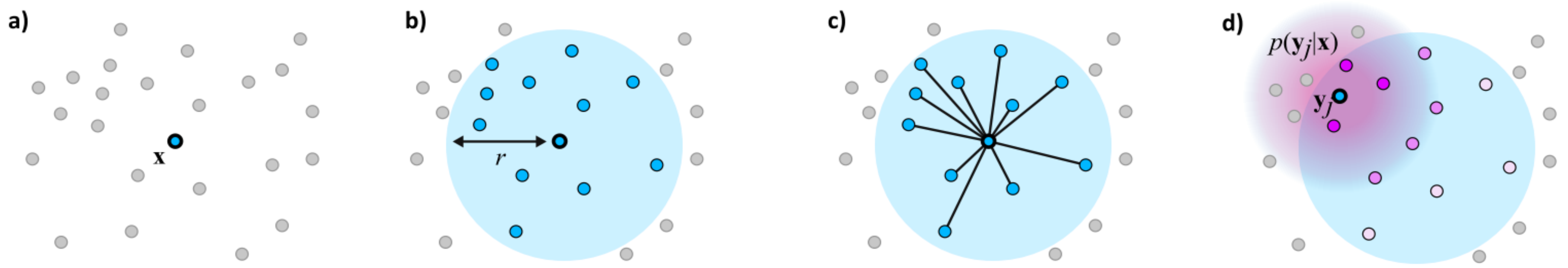


Fig. 4. Steps of our MC convolution. For a given point $\mathbf{x}$ **(a)** the neighbors within the receptive field r are retrieved **(b)** to be used as Monte Carlo integration samples **(c)**. For each neighboring point $\mathbf{y}_j$, its probability density function, $p(\mathbf{y}_j|\mathbf{x})$, is computed using *Kernel Density Estimation* [Parzen 1962; Rosenblatt 1956] **(d)**. Based on the bandwidth used (pink disk), the neighboring points have different effects on the computation of $p(\mathbf{y}_j|\mathbf{x})$ (pink gradient).

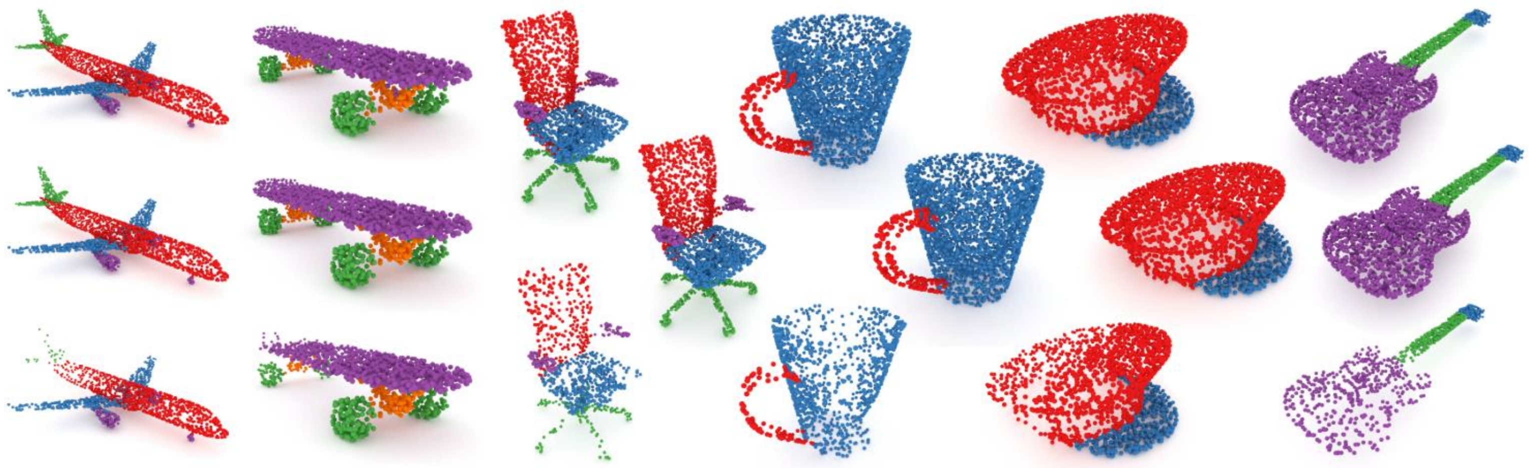
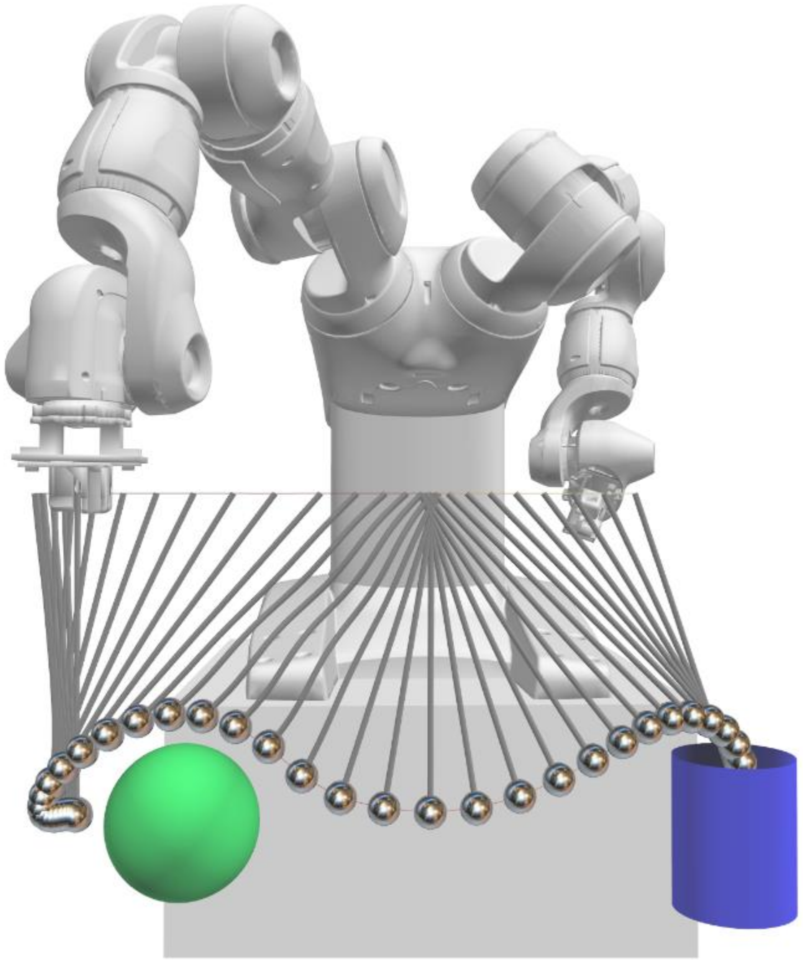


Fig. 9. Comparison of our segmentation result for uniform **(second row)** and non-uniform samplings **(third row)** to the ground truth **(first row)**. Non-uniform sampling use the Gradient (first and second columns), Lambert (third and fourth columns), and Split (fifth and sixth columns) protocols.

HERMOSILLA, Pedro, et al. Monte carlo convolution for learning on non-uniformly sampled point clouds

Differentiable Simulation

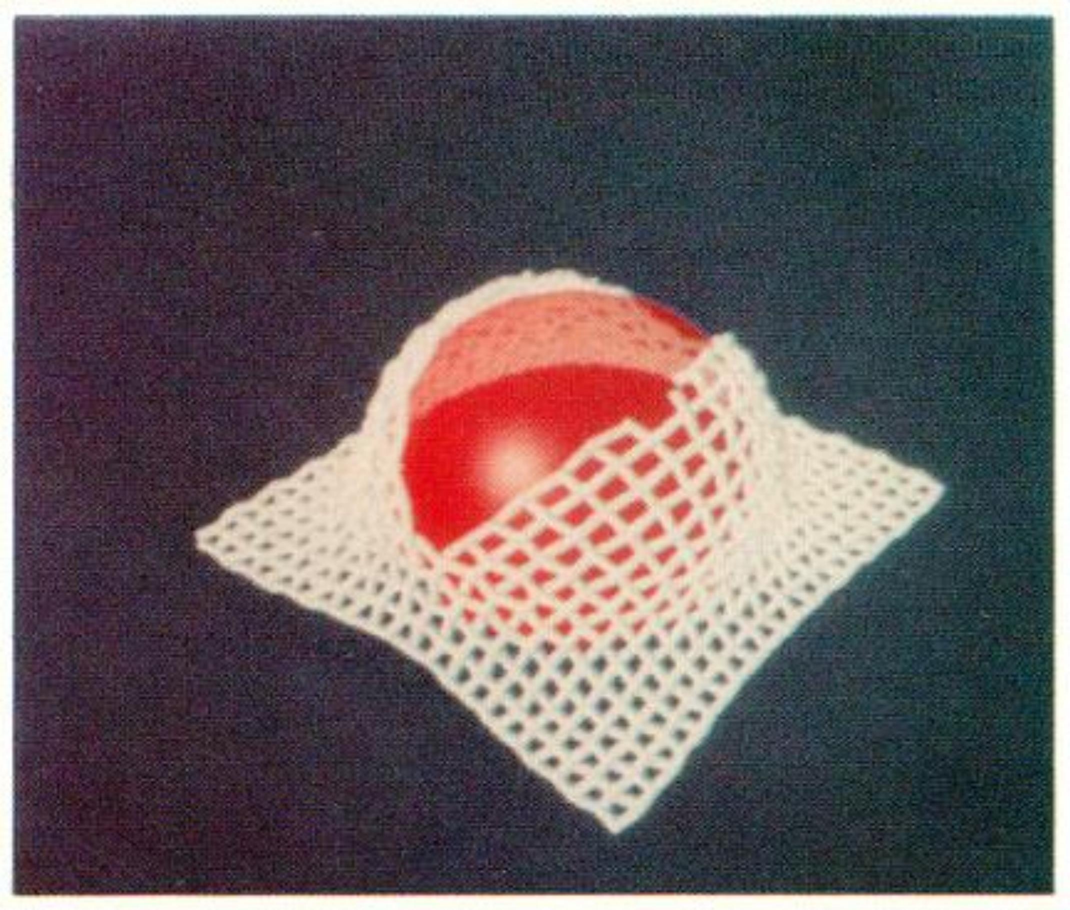
$$\frac{d\,\Phi(\mathbf{x}(\mathbf{q}))}{d\,\mathbf{q}}$$



Liang et al., Differentiable Cloth Simulation for Inverse Problems. Advances in Neural Information Processing Systems 32 (2019)

Zimmermann et al., PuppetMaster: Robotic Animation of Marionettes. ACM Trans. Graph. 38, 4 (2019)

Fracture simulation

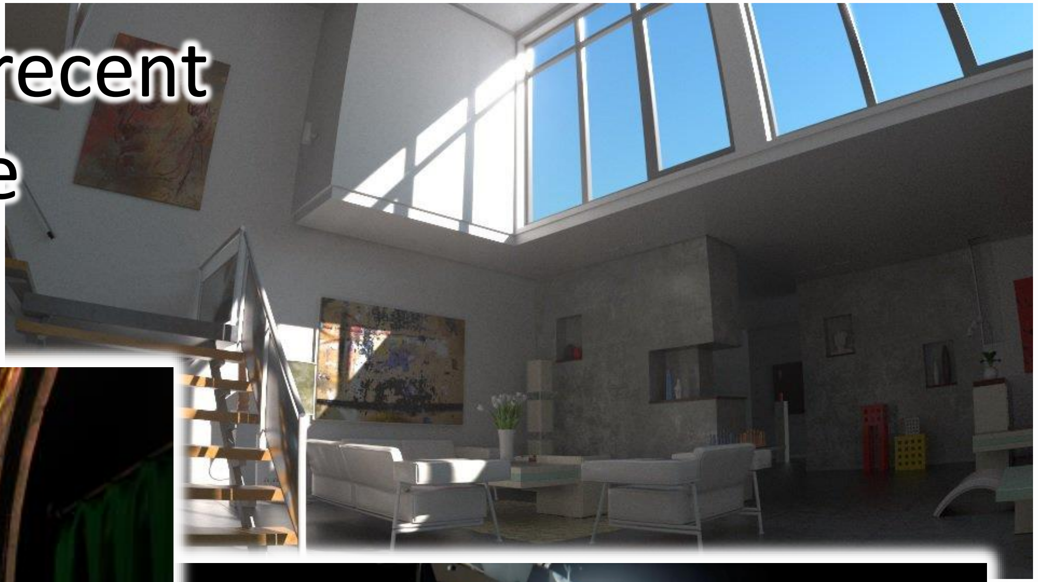


Terzopoulos and Fleischer, Modeling inelastic deformation: viscolelasticity, plasticity, fracture. Proceedings of the 15th Annual Conference on Computer Graphics and Interactive Techniques (1988)

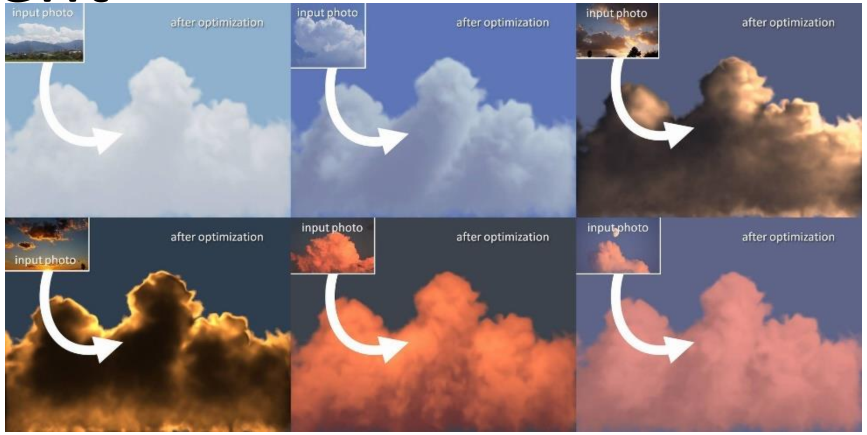
Wolper et al., CD-MPM: Continuum Damage Material Point Methods for Dynamic Fracture Animation. ACM Trans. Graph. 38, 4 (2019)

Global Illumination in Real Time

Conduct a survey of recent advances in real-time global illumination



- Conduct a survey on recent advances in inverse rendering.



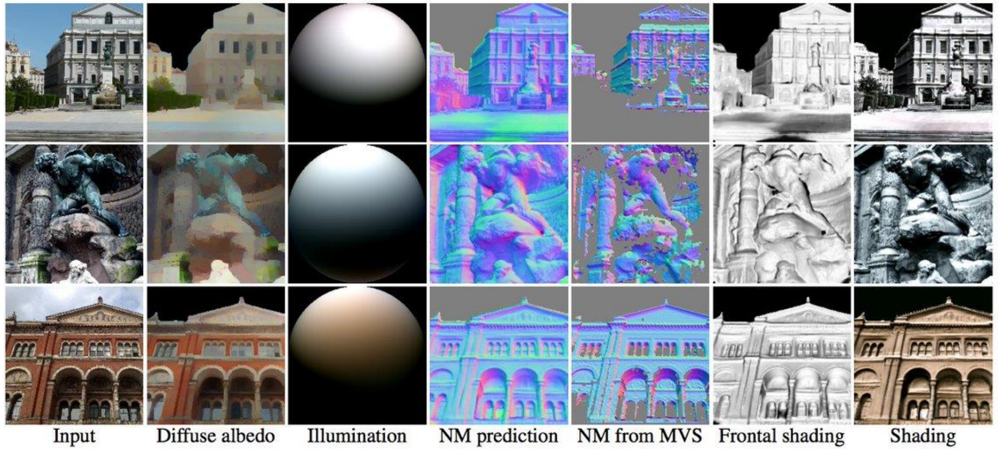
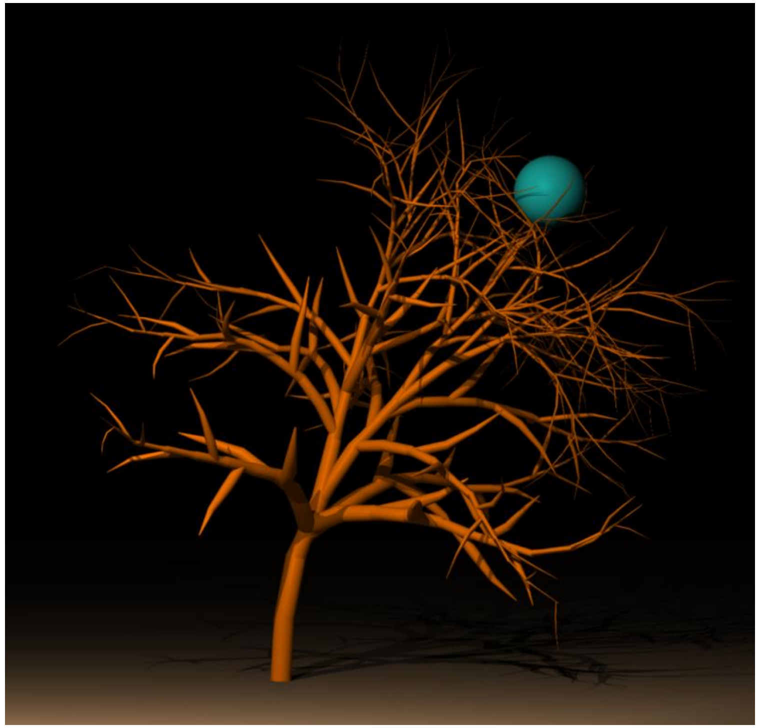
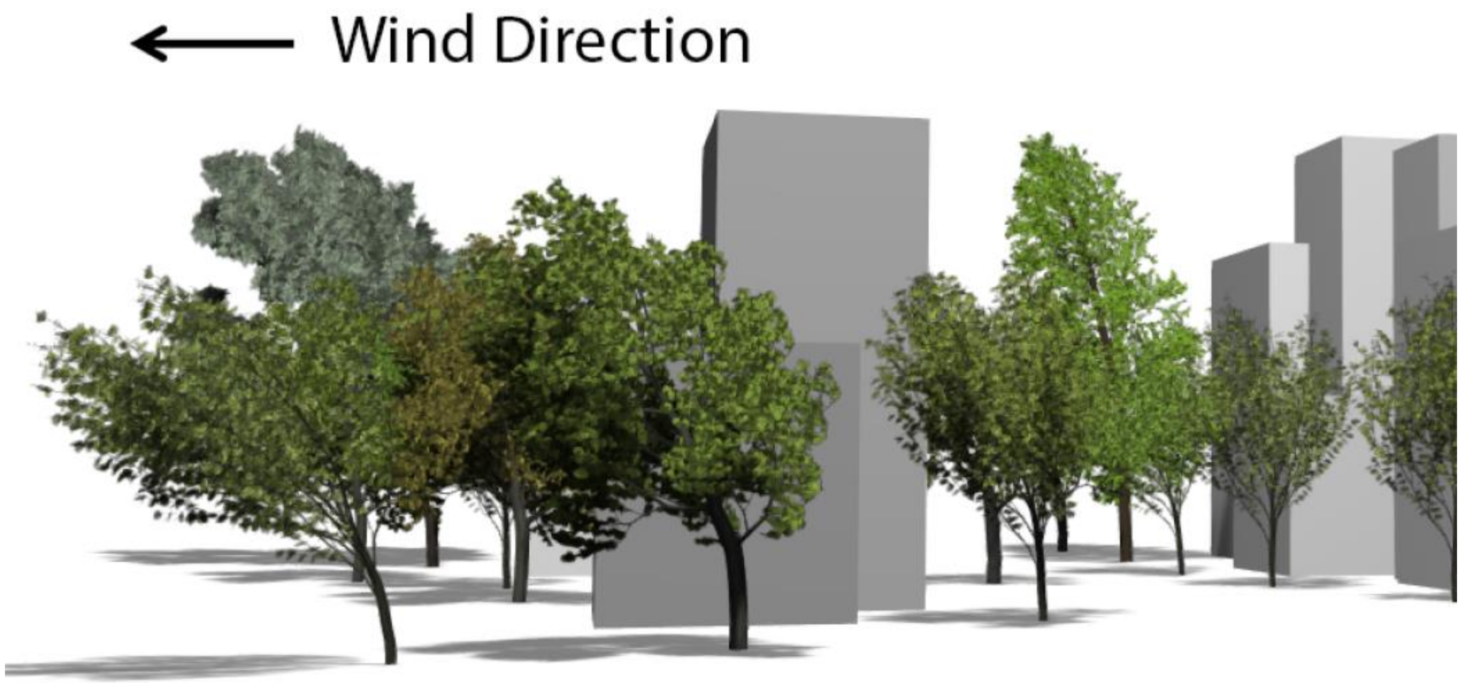


Figure 1: From a single image (col. 1), we estimate albedo and normal maps and illumination (col. 2-4); comparison multi-view stereo result from several hundred images (col. 5); re-rendering of our shape with frontal/estimated lighting (col. 6-7).

Tree Animation

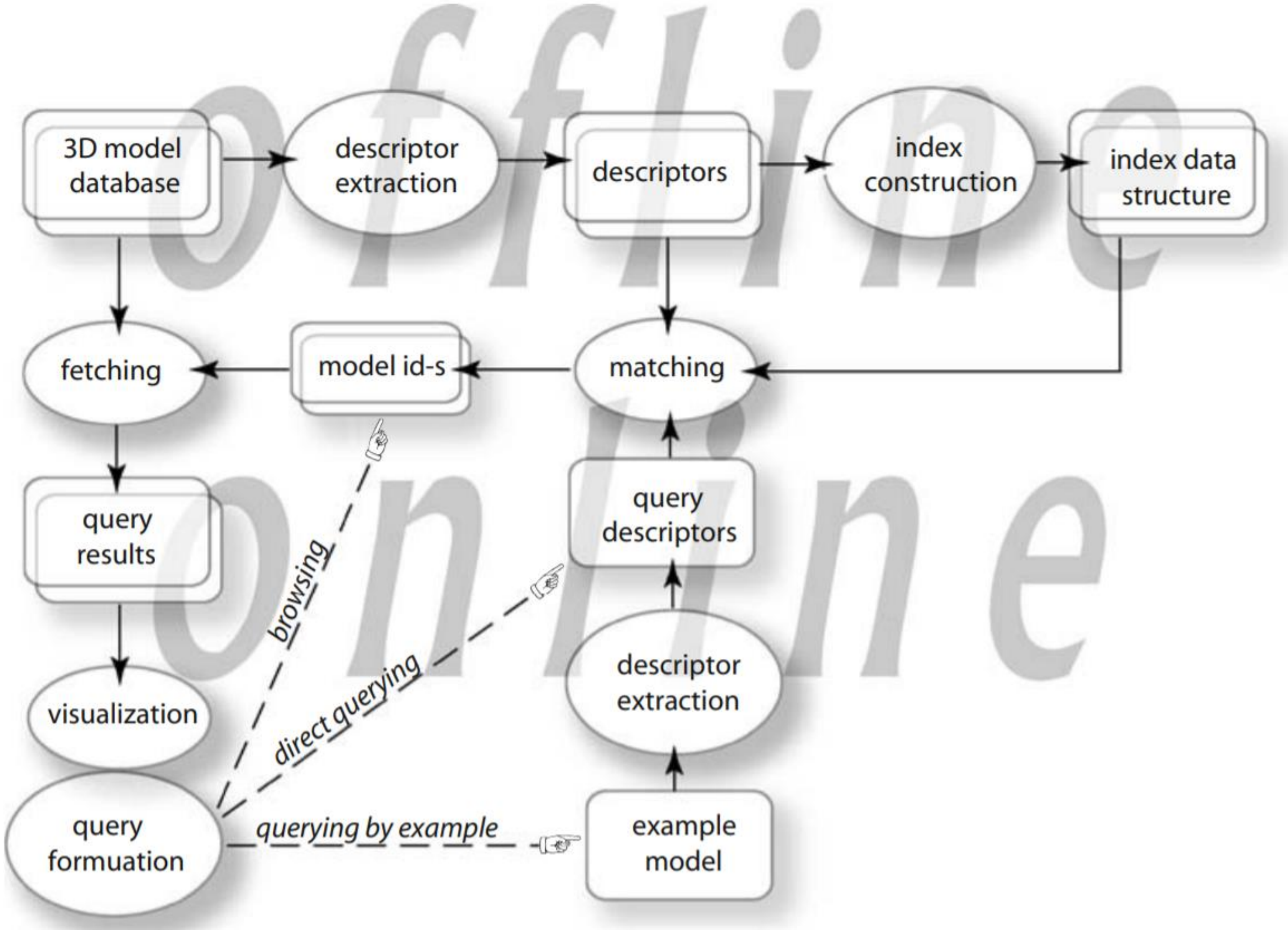


Quigley, Ed, et al. "Real-time interactive tree animation." *IEEE transactions on visualization and computer graphics* 24.5 (2017): 1717-1727.



Pirk, Sören, et al. "Windy trees: computing stress response for developmental tree models." *ACM Transactions on Graphics (TOG)* 33.6 (2014): 1-11.

Shape Retrieval



Tangelder JW, Veltkamp RC. A survey of content based 3D shape retrieval methods. Multimedia tools and applications. 2008 Sep;39(3):441-71.

Bronstein, Alexander M., et al. "Shape google: Geometric words and expressions for invariant shape retrieval." *ACM Transactions on Graphics (TOG)* 30.1 (2011): 1-20.

Eitz, Mathias, et al. "Sketch-based shape retrieval." *ACM Trans. Graph.* 31.4 (2012): 31-1.

The Technology Behind Pixar Films

- Provide an overview of the technology behind Pixar films





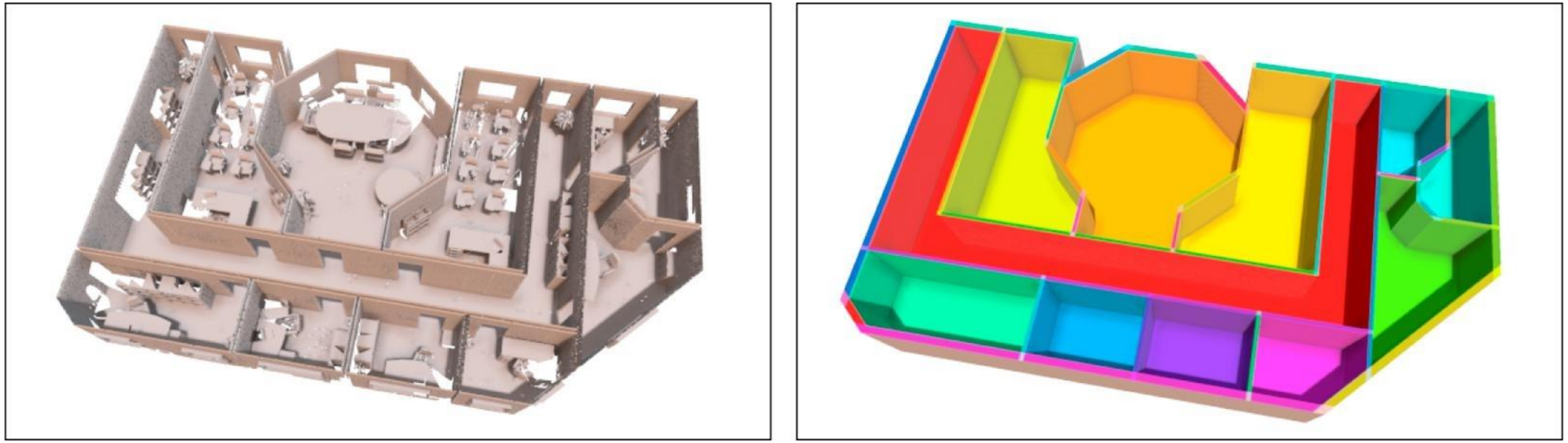


The Technology behind Disney Films

- Provide an overview of the technology behind Disney films

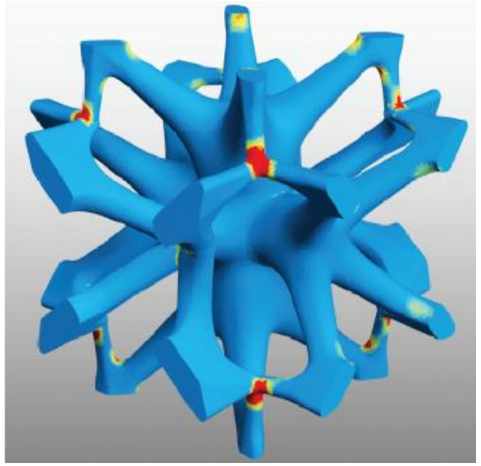
3D Reconstruction of Buildings

- Subset of 3D reconstruction from point clouds
- Obtain a polygonal model with sharp features



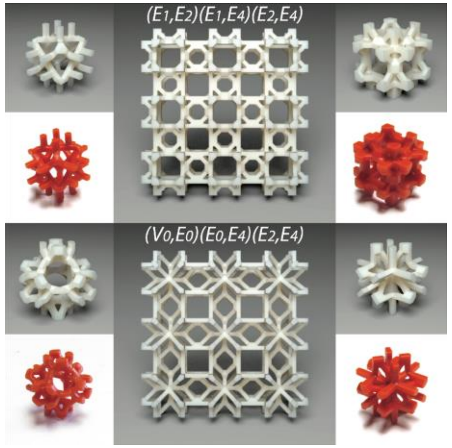
Sebastian Ochmann, Richard Vock, Reinhard Klein,
“Automatic reconstruction of fully volumetric 3D building models from oriented point clouds”,
ISPRS Journal of Photogrammetry and Remote Sensing, 2019,

Generating mesoscale structures with target elastic properties



Panetta *et al.*, 2017

Martínez *et al.*, 2016



Panetta *et al.*, 2015

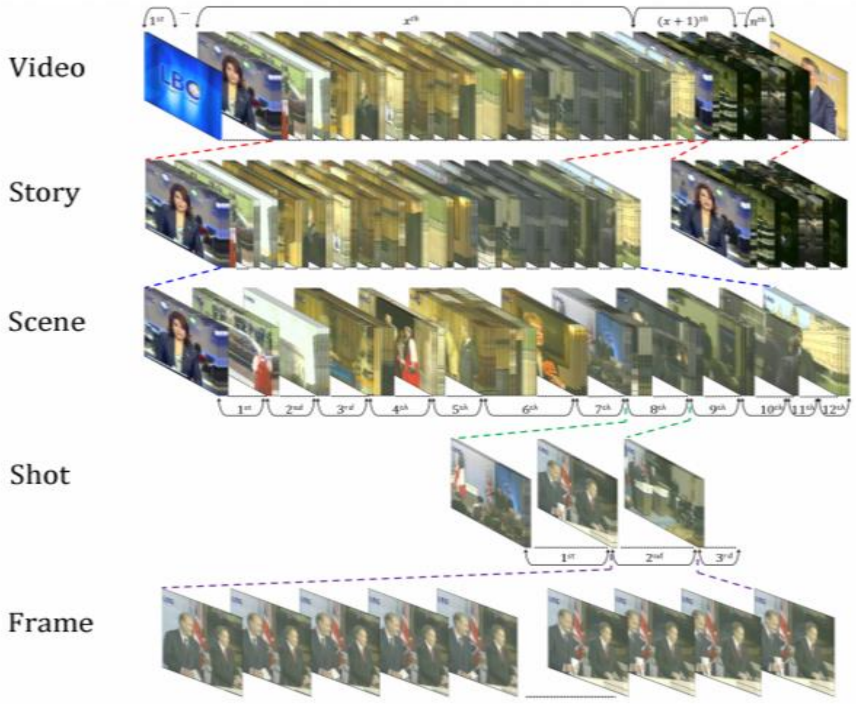
Video and Image Quality Metrics

Processing and compression of video or image files can result in a degradation of the original visual quality. The student will search for existing methods that, given a ground truth file and potentially degraded file, measure the amount of degradation on at a given pixel/point in time.

Suggested citation: *Zhang X, Lin W, Xue P. Just-noticeable difference estimation with pixels in images. Journal of Visual Communication and Image Representation. 2008 Jan 1;19(1):30-41.*

Automated Film Metadata Generation

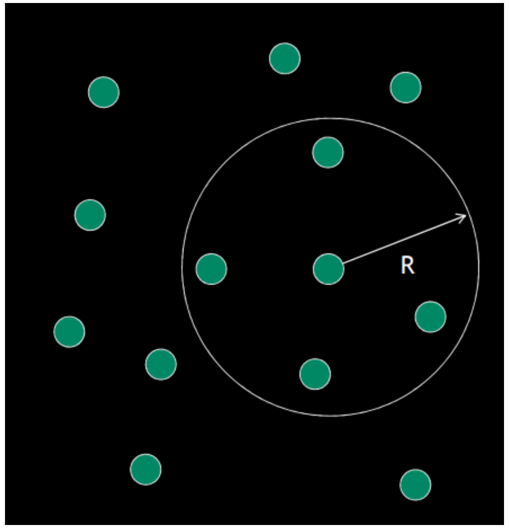
A lot of information about a video, such as multiple shots or camera movement is immediately obvious to humans. For computers however, it is not explicitly stated in the pixel data. The student will search for existing methods that process the video data and attempt to predict new abstract information about it.



Suggested citation: *Abdulhussain SH, Ramli AR, Saripan MI, Mahmmod BM, Al-Haddad SA, Jassim WA. Methods and challenges in shot boundary detection: a review. Entropy. 2018 Apr;20(4):214.*

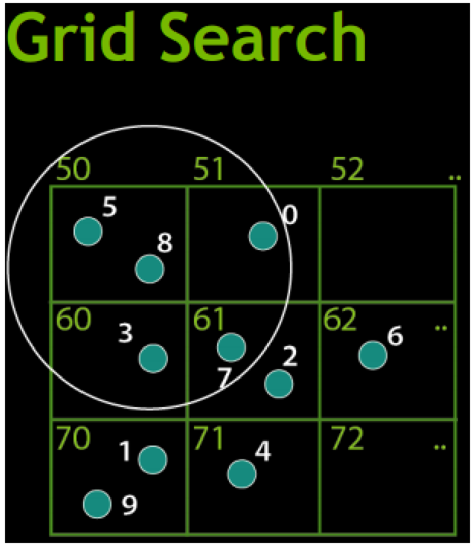
GPU-Based Neighborhood Search

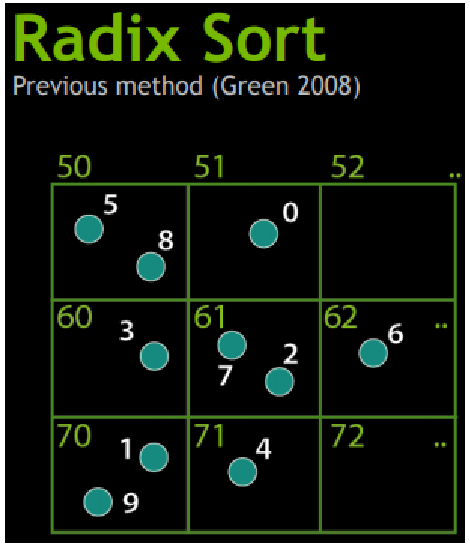
- This is all about **GPU**-algorithms!
- Given a large amount of particles, e.g. N >> 100k, how to efficiently find the neighbors **of each particle**?
- Research different approaches
- Start with the „oldie but goldie" by Simon Green: Particle Simulation using CUDA
- Describe how Counting Sort works (by Rama C. Hoetzlein)
- Anything more advanced?

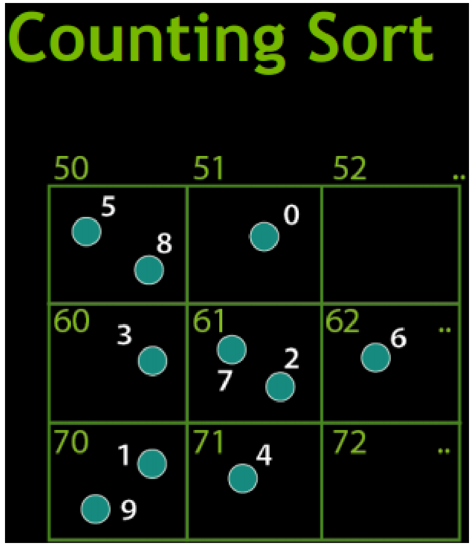


Here's your objective:

Find all neighboring particles in a fixed radius R!





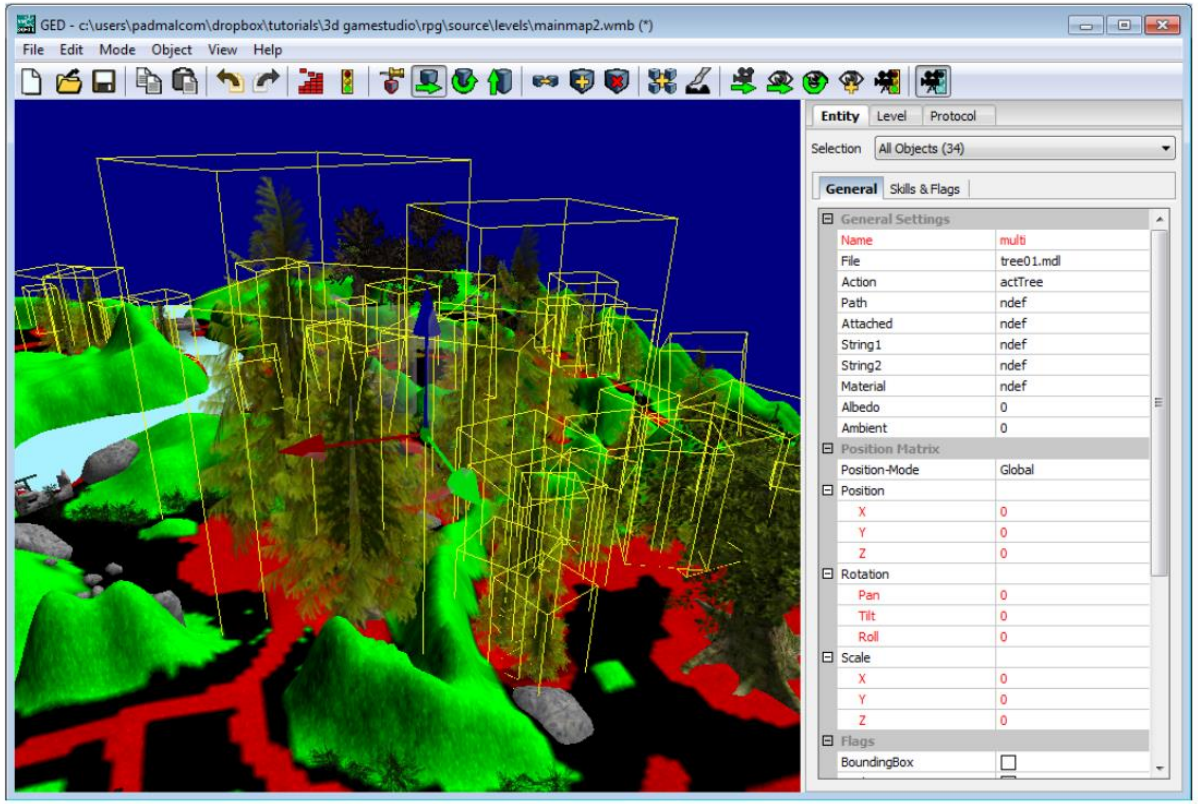


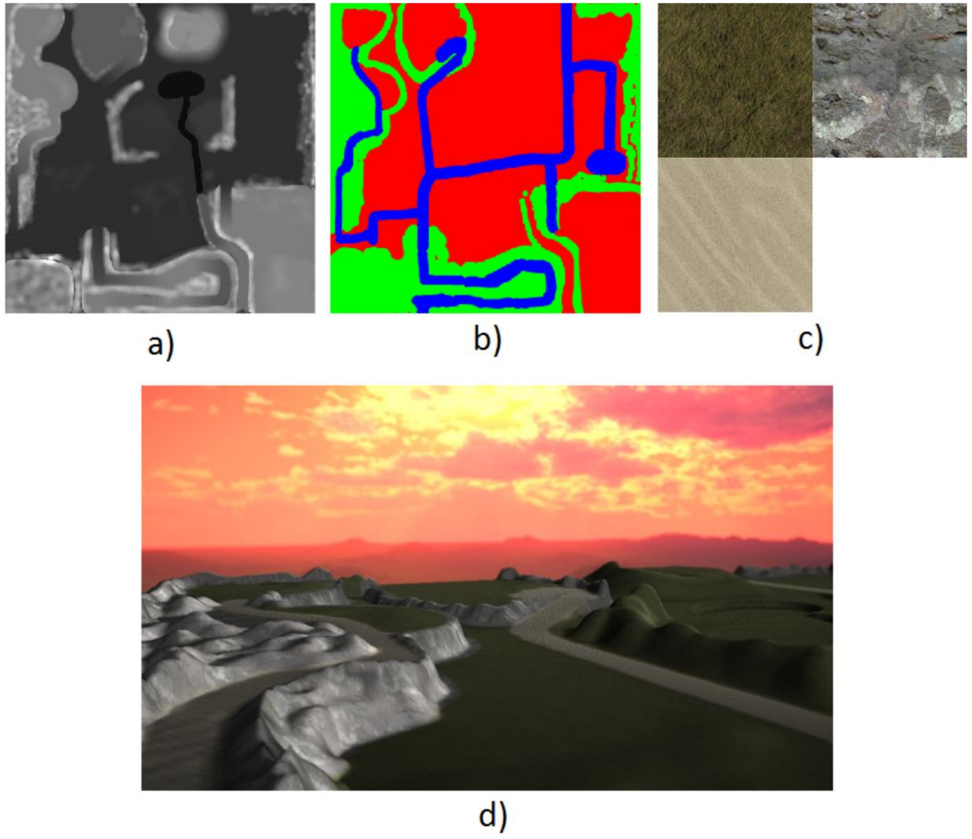
RTX-Accelerated Algorithms

- This is all about algorithms, which are either severely **RTX-accelerated** or **only possible with RTX-acc.** at real-time frame rates (60Hz).
  „RTX“ here means: GPU-accelerated Real-Time Ray Tracing using new hardware-features such as the RT-cores introduced with NVIDIA Turing.
- Two examples of suitable publications on the right →
- None of your references can be older than 2018 ¯_(ツ)_/¯
  NVIDIA Turing was introduced in 2018.
- Find great RTX algorithms!

Adaptive Temporal Anti-Aliasing
by Marrs et al.

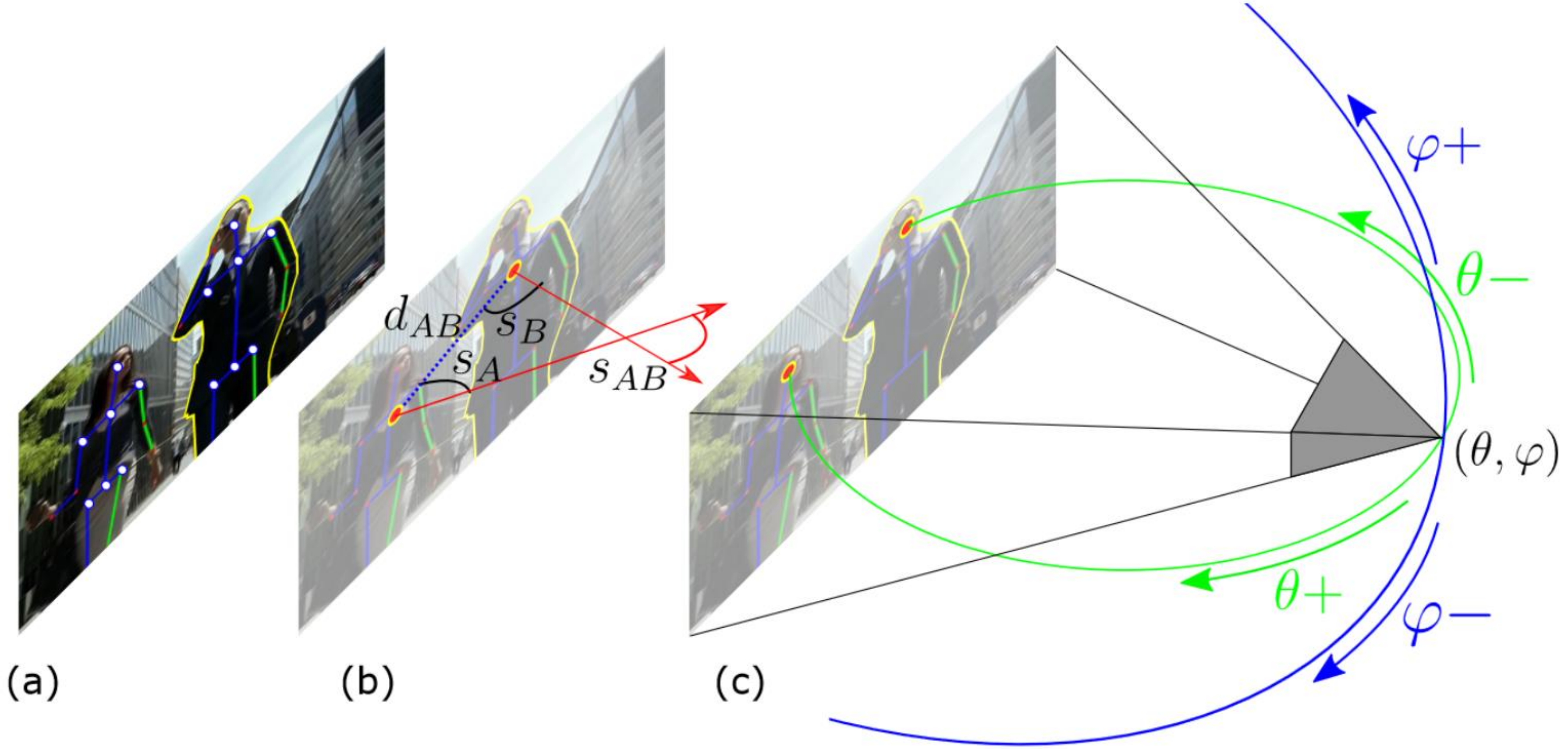
Ray-Guided Volumetric Water Caustics in Single Scattering Media with DXR
by Holger Gruen





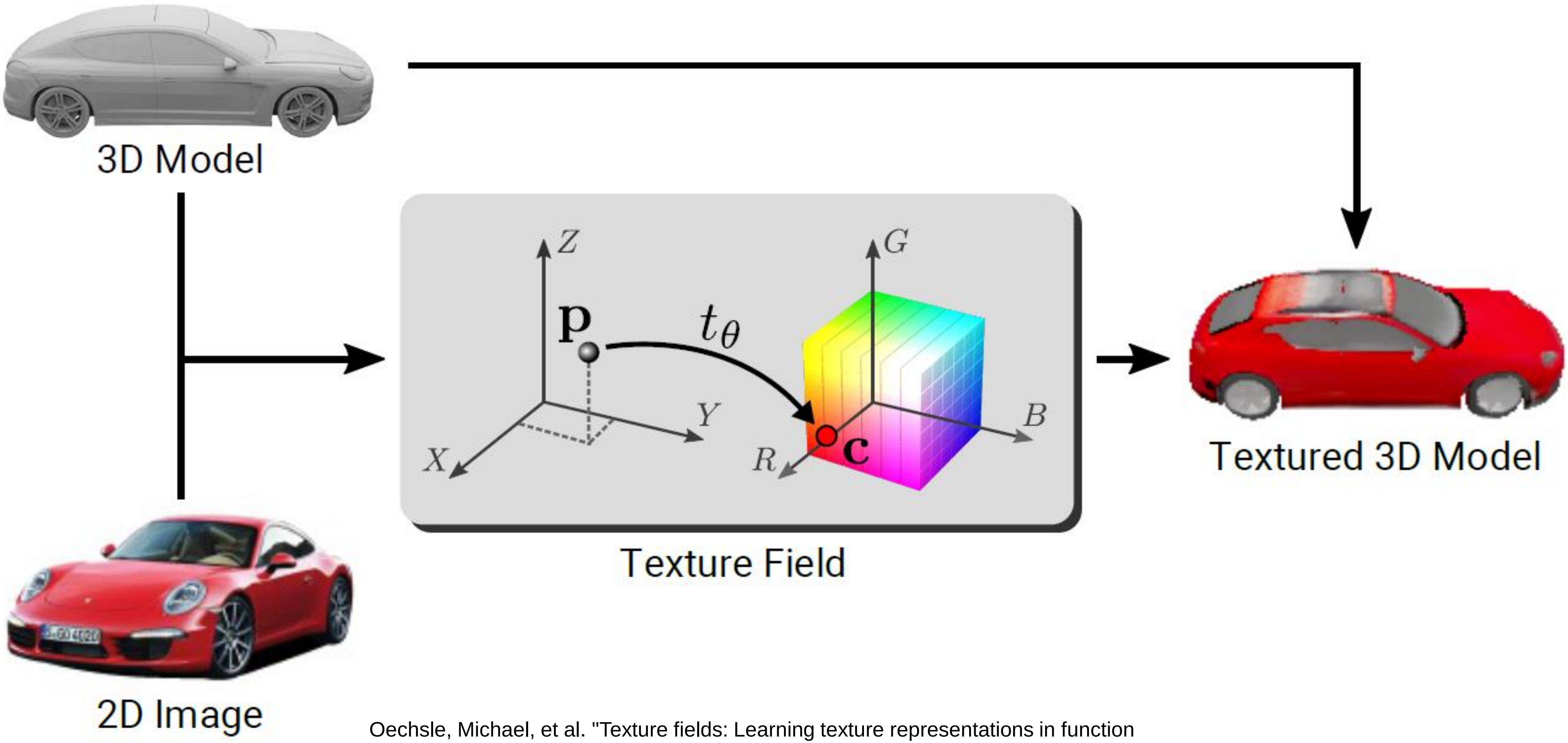
Freiknecht J, Effelsberg W. A Survey on the Procedural Generation of Virtual Worlds. Multimodal Technologies and Interaction. 2017; 1(4):27.

3D Pose Reconstruction



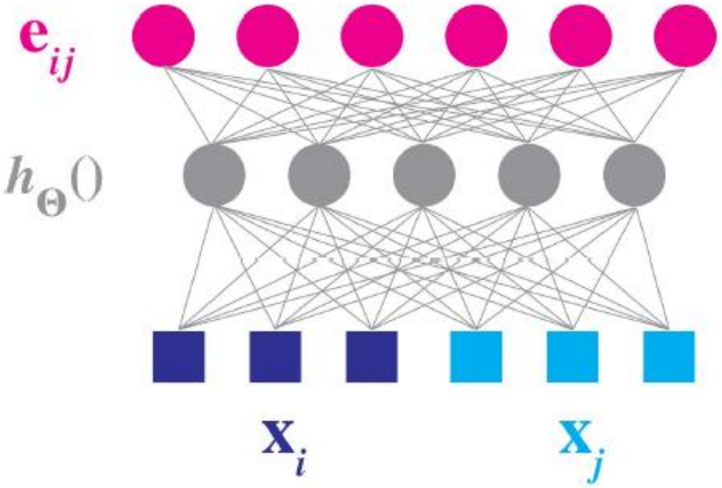
Hongda Jiang, Bin Wang, Xi Wang, Marc Christie, and Baoquan Chen. 2020. Example-driven virtual cinematography by learning camera behaviors. ACM Trans. Graph. 39, 4, Article 45 (July 2020), 14 pages.

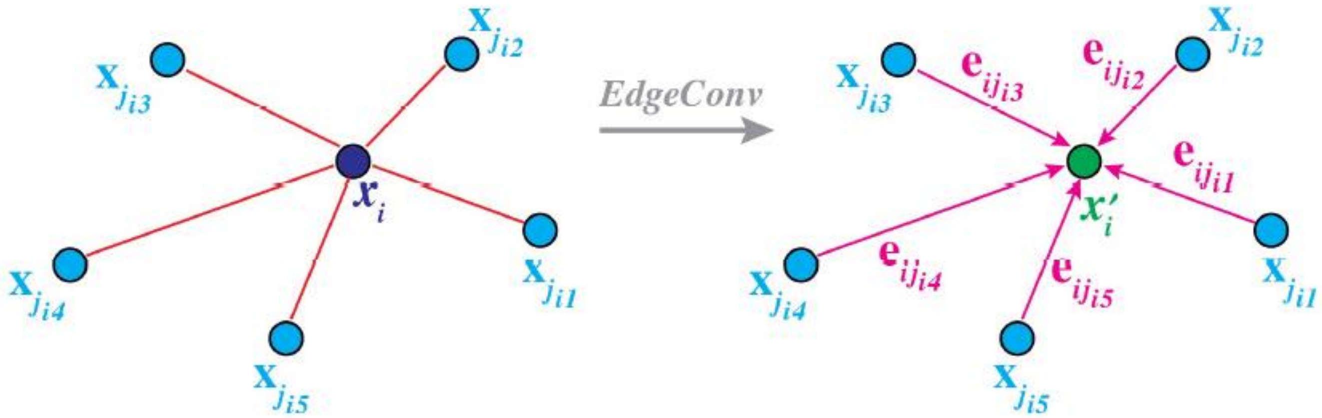
Colored Reconstruction

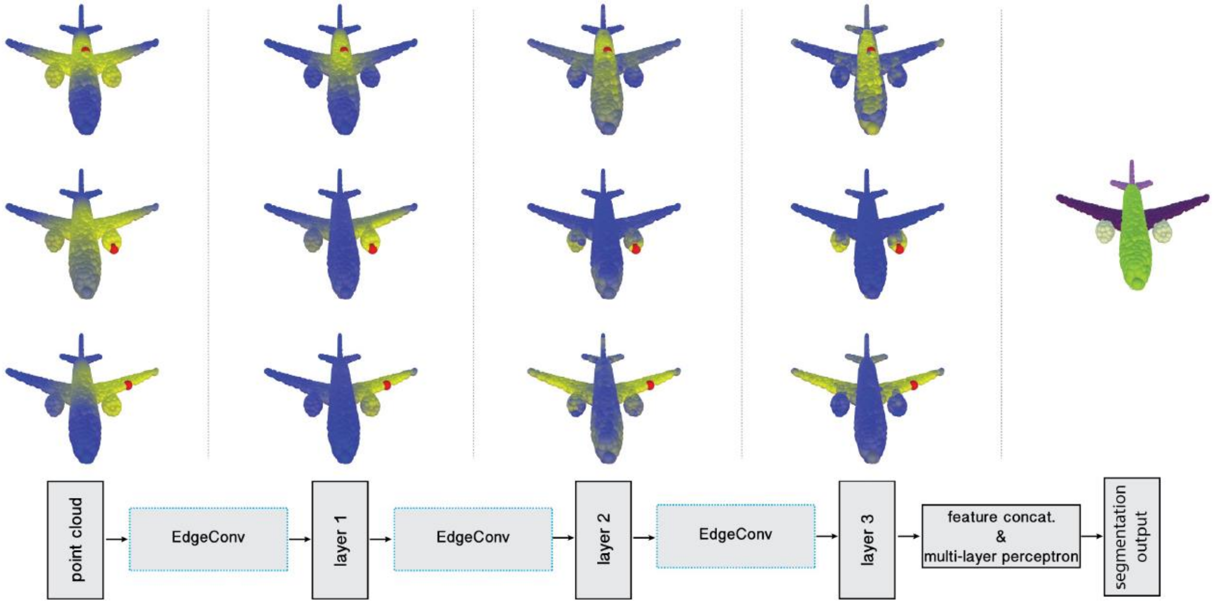


Oechsle, Michael, et al. "Texture fields: Learning texture representations in function space." *Proceedings of the IEEE International Conference on Computer Vision*. 2019.

Graph-CNN







Wang, Yue, et al. "Dynamic graph cnn for learning on point clouds." *Acm Transactions On Graphics (tog)* 38.5 (2019): 1-12.

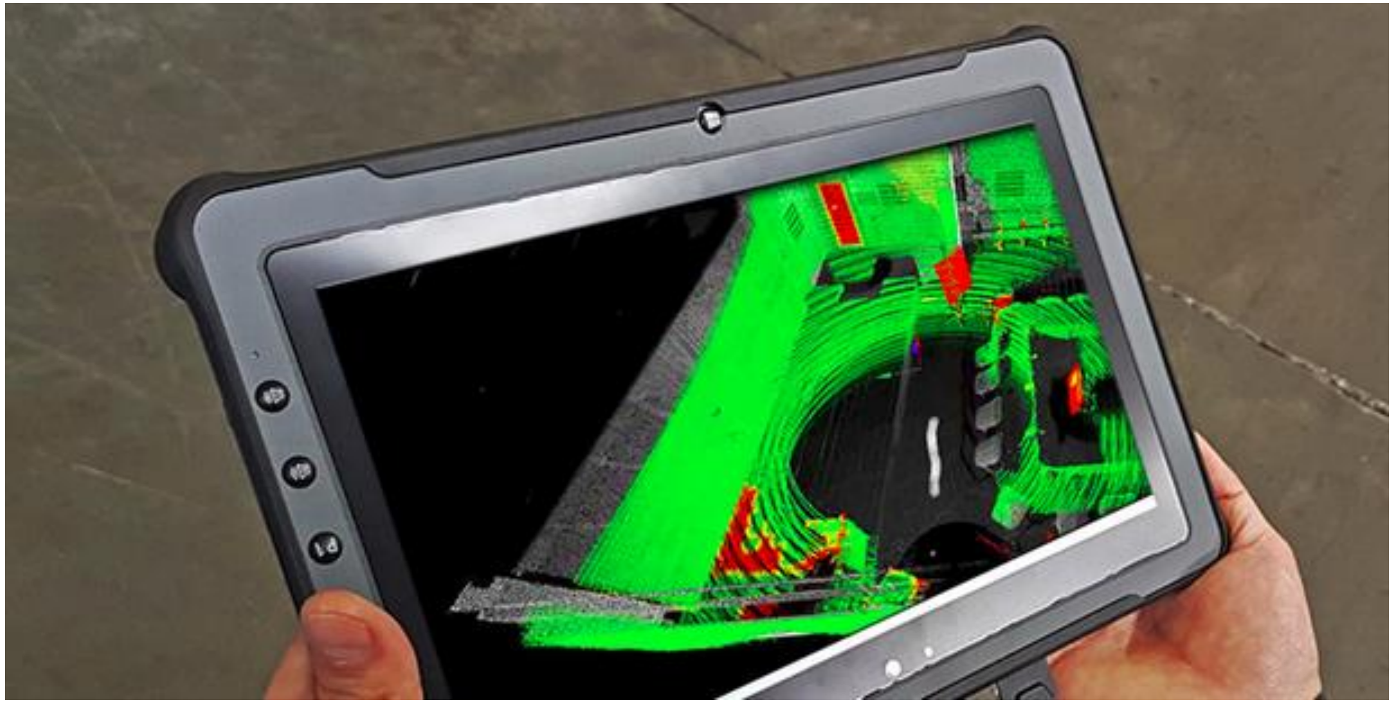
Classify Objects in Point Clouds

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

Real-time Change Detection

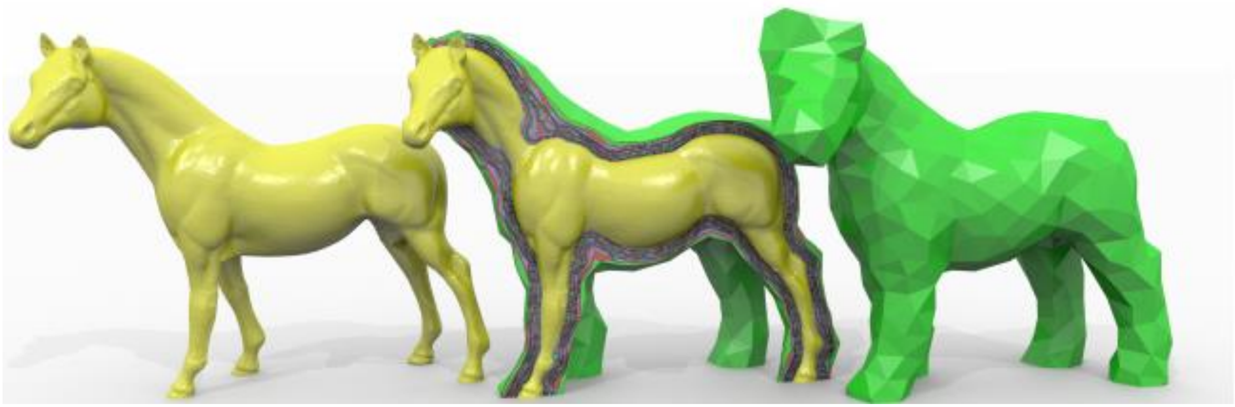
- Mobile App shows AR changes to scanned 3D model in real-time

- Requirements:
- 3D Occupancy Maps
- Sensor noise tolerance
- Clustering segments
- Real-time performance

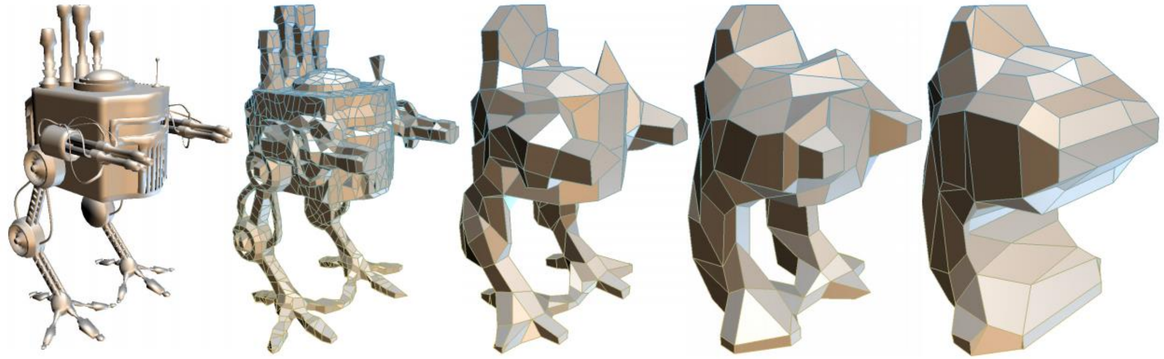


Multi Scale Bounding Cages

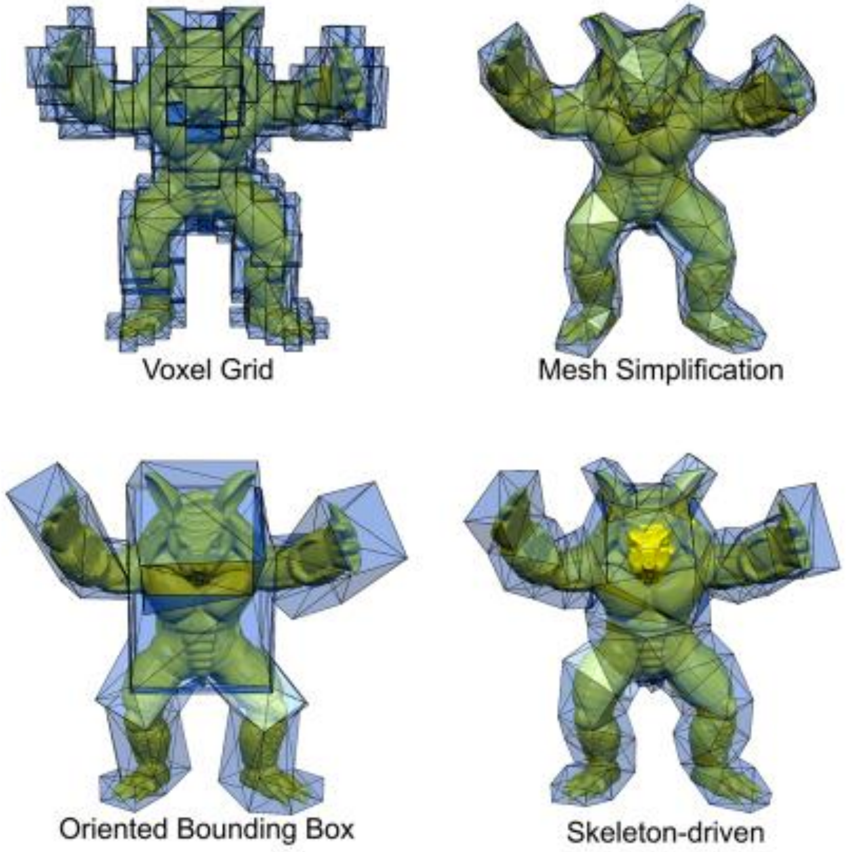
- Review different approaches



Sacht et al. "Nested Cages." *ACM Trans. (TOG)*. ACM, 2015.



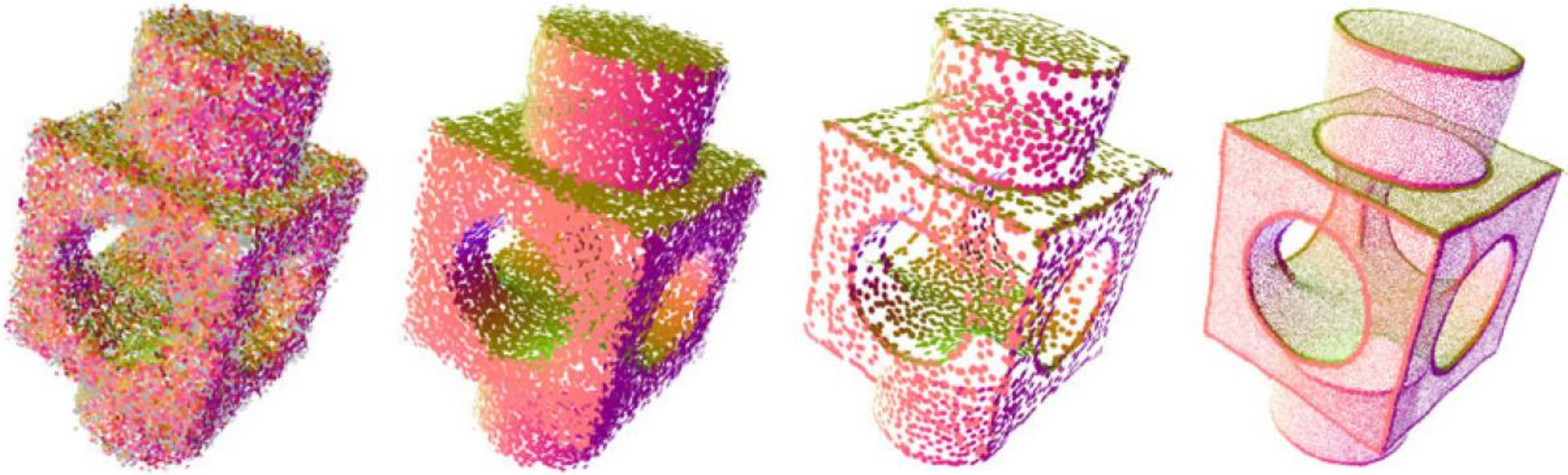
Calderon et al. "Bounding Proxies for Shape Approximation." *ACM Transactions on Graphics (TOG)*. ACM, 2017.



Le and Deng. "Interactive Cage Generation for Mesh Deformation."
ACM SIGRAPH SI3D. 2017.

Resampling Noisy Point Sets

- Challenges: noise, missing data, sharp features
- Review recent approaches



(a) Noisy input (b) Bilateral smoothing (c) GPF (d) Upsampling

Lu et al. "GMM-Inspired Feature-Preserving Point Set Filtering." *IEEE Trans. on Visualization and and Computer Graphics*. 2018.

WebGPU / WebGL

- Research publications implemented in WebGL / WebGPU

- Research publications implemented in WebVR / WebXR

Topic Assignment

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

Topic Assignment

1. Deep Learning Based Noise Reduction in Rendering
2. Convolutional Deep Learning Networks for 3d Data
3. Detailed 3D City Models
4. Modern Character Animation Systems
5. Differentiable Simulation
6. Fracture simulation
7. Global Illumination in Real Time
8. Inverse Rendering
9. Tree Animation
10. Shape Retrieval
11. The Technology Behind Pixar Films
12. The Technology behind Disney Films
13. 3D Reconstruction of Buildings
14. Computational Metamaterials
15. Video and Image Quality Metrics
16. Automated Film Metadata Generation
17. GPU-Based Neighborhood Search
18. RTX-Accelerated Algorithms
19. Procedural Generation of Cities and Landscapes
20. 3D Pose Reconstruction
21. Colored Reconstruction
22. Graph-CNN
23. Classify Objects in Point Clouds
24. Real-time Change Detection
25. Multi Scale Bounding Cages
26. Resampling Noisy Point Sets
27. WebGL / WebGPU
28. WebVR / WebXR

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

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.

- Questions?