Computer Graphics

- Introduction -

Philipp Slusallek

Pascal Grittmann

Overview

- **Today**
  - Administrative stuff
  - History of Computer Graphics (CG)

General Information

- **Core Lecture (Stammvorlesung)**
  - Applied Computer Science (Praktische Informatik)
  - Lectures in English

- **Time and Location (in presence)**
  - Mon   10-12h c.t. (E1.3, HS03)
  - (Thu   8:30h-10h s.t. (E1.3, HS03))

- **ECTS:**
  - 9 credit points

- **Web-Page**
  - http://graphics.cg.uni-saarland.de/courses/
  - Schedule, slides as PDF, etc.
  - Literature, assignments, other information

- **Sign up for the course on our Web and in LSF!!!**
  - [Do not forget to sign-out in time before the exams, if you need to]

People

- **Lecturers**
  - Philipp Slusallek, slusallek@cg.uni-saarland.de
  - Pascal Grittmann, grittmann@cg.uni-saarland.de

- **Teaching Assistant**
  - Philippe Weier, philippe.weier@dfki.de

- **Tutors (see web page for contact details)**
  - Lukas Auer
  - Ben Samuel Dierks
  - Leonard Butz
  - Arsenii Dremin
  - Philipp Ziegler

Tutorials

- **Available slots are**
  - **Wednesday 10:00 – 12:00**
  - **Wednesday 16:00 – 18:00**
  - **Thursday 14:00 – 16:00**
  - **Friday 14:00 – 16:00**
  - **Friday 16:00 – 18:00**
- **Mandatory poll in Teams to assign your group a slot**
  - **(Optional but encouraged) Indicate your partner (groups of 2 max)**
  - **Hard deadline: 21.10. 23:59**

Partially-Inverted Classroom Format

- **For the first part of the lecture (until the winter break)**

  - **Overview lecture on every 2nd Monday**

  - **Summarizes all key parts, provides reading materials for details**

- **QA session on every other Monday**

  - **In the lecture hall**

  - **Starts with a mini-test, then you can ask anything**

- **No lecture on Thursdays (until January)**

Regular Mini-Tests

- **Exam prerequisite, mandatory, but not graded**

- **When?**

  - **At the beginning of each QA session**

- **What?**

  - **One or two exam-like exercises based on the topics from the current block**

- **Solutions are discussed right afterwards in the QA session**

Weekly Assignments

- **Weekly assignment sheets**
  - Theoretical & programming assignments
  - You will incrementally build your own ray tracing system
  - This will be the basis for the → **Rendering Competition**

- **Grading**
  - Results of the exercises will contribute to the final grade
  - Bonus points (towards the exam) are possible

- **Handing in assignments**
  - Theoretical: At beginning of lecture
  - Code: See exercise sheet (usually by email to tutor)

  Push tagged commit to GitLab, submit tag on Teams

- **Tutorials**
  - Discuss lectures and any issues you might have with TAs

- **Groups of max. 2 students allowed**
  - Each one must be able to present and explain his/her results!
  - Please state who did what!!!

Grading

- **Weekly Assignments**
  - Counts ~~30%~~ **35%** towards final grade (with ~~+20%~~ bonus points) — *exact amount TBD*
- **Rendering Competition (exam prereq.)**
  - Counts ~~10%~~ **15%** towards final grade
  - Grading: Artistic quality (jury)
  - Groups of max. 2 students (but higher requirements then)
- **Exams**
  - ~~Mid-term (exam prereq.), counts 20% towards final grade~~
  - Final exam counts ~~40%~~ **50%** towards final grade
  - Minimum: 50% to pass (in each of the above)
- **Cheating**
  - 0% of assignment grade on first attempt
  - Possibility to fail the entire course if repeated
- **Chance for Repeated Exam**
  - ~~Oral exam (if possible)~~ at the end of the semester break

Rendering Competition

- **Task**
  - Create a realistic image of a virtual environment
  - Incorporate additional technical features into your ray tracer
  - Bonus points count towards exam
  - Creative design of a realistic and/or aesthetic 3D scene
  - Modeling and shading

- **Hand-out in course**
  - You can work on it parallel to the course
  - Deadline will be announced (see Web page)

- **Results:**
  - One rendered image
  - Web page with technical detail info

Rendering Competition

Rendering Competition

Text Books

- **Suggested Readings:**
  - Peter Shirley: **Fundamentals in CG**, 4. Ed, AK Peters, 2016
    5th edition now out
  - Matt Pharr, Wenzel Jakob, Greg Humphreys: **Physically Based Rendering : From Theory to Implementation**, Morgan Kaufmann Series, 3. Ed., 2016, now freely available: http://www.pbr-book.org/
  - John Hughes, et al.: **Computer Graphics – Principles and Practice**, Addison-Wesley, 3. Ed, 2013
  - Eric Haines and Tomas Akenine-Möller: **Ray-Tracing Gems**, http://www.realtimerendering.com/raytracinggems
  - Thomas Akenine-Möller, Eric Haines, et al., **Real-Time Rendering**, AK Peters, 4th Ed., 2018

- **Older**
  - A. Glassner: **An Introduction to Ray-Tracing**, Academic Press, ´89
  - D. Ebert: **Texturing & Modeling – A procedural approach**, MK, ´03

Course Syllabus (Tentative)

- **Overview of Ray Tracing**
- **Geometry Intersections**
- **Spatial Index / Acceleration Structures**
- **Vector Algebra Review**
- **Geometric Transformations**
- **Light Transport / Rendering Equation**
- **Material Models**
- **Shading**
- **Texturing**
- **Spectral Analysis / Sampling Theory**
- **Anti-Aliasing**
- **Distribution Ray Tracing**
- **Human Vision**
- **Color**

- **Splines**
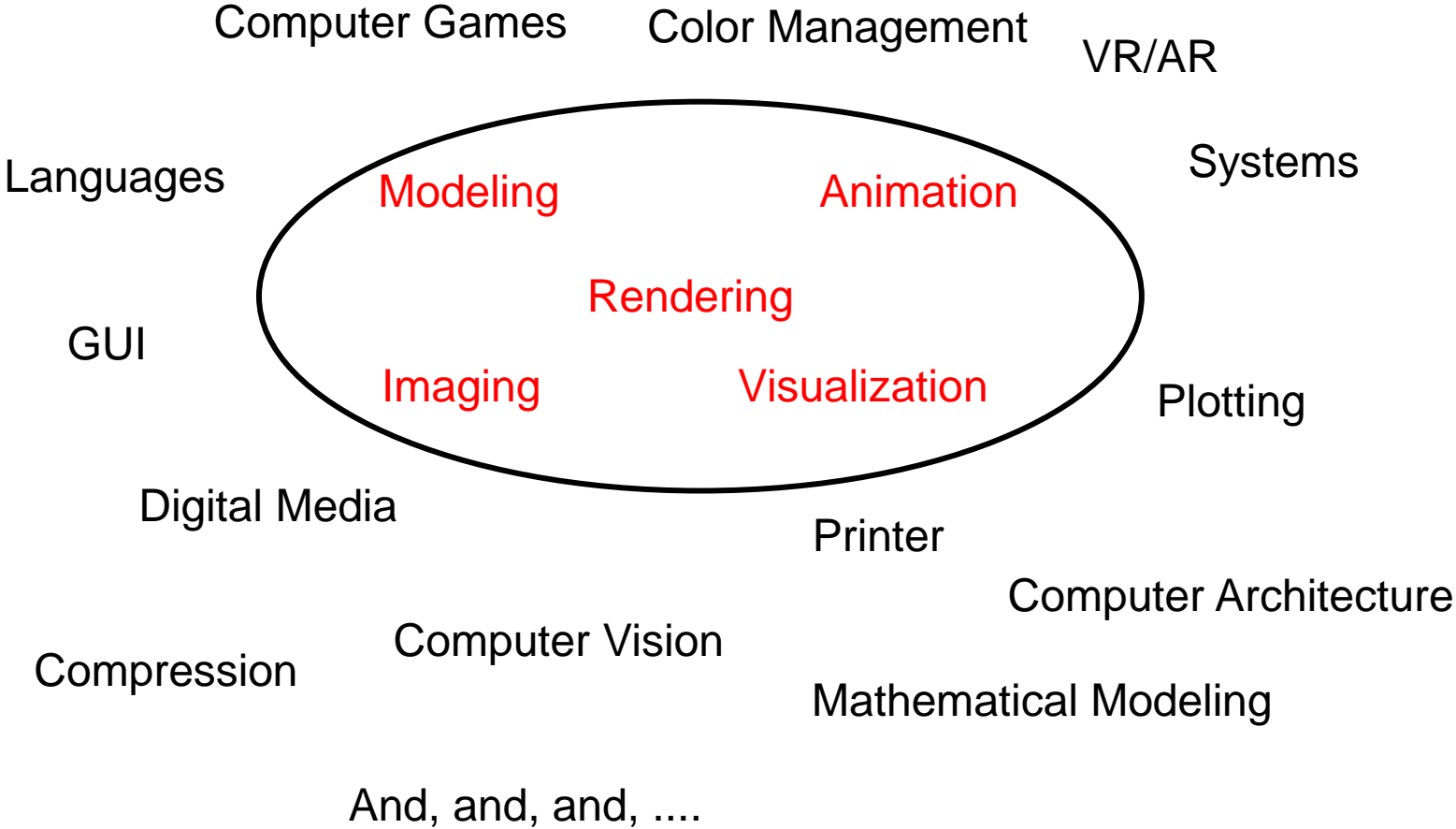- **Clipping**
- **Rasterization**
- **OpenGL & Shading Language**
- **Volumes**

What is Computer Graphics ?

Engineering

Photography

Psychology

CAD/CAM/CAE

Rendering

Perception

Graphics &
"Visual Computing"

Simulation & Animation

Inverse Rendering

Physics

Geometric
Modeling

Computer Vision

Mathematics

What is Computer Graphics?

Computer Games   Color Management   VR/AR

Languages   **Modeling**   **Animation**   Systems

Rendering

GUI   **Imaging**   **Visualization**   Plotting

Digital Media   Printer

Computer Architecture

Compression   Computer Vision

Mathematical Modeling

And, and, and, ...

Applications

- Entertainment Industry: Special effects for motion pictures

[© Weta Digital]

[© Rhythm & Hues]

[© Industrial Light & Magic]

[© Sony Pictures Imageworks]

Applications

- Entertainment Industry: Animated films

[© Disney / Pixar]

[© PDI DreamWorks]

[© Blue Sky Studios]

[© Sony Pictures Imageworks]
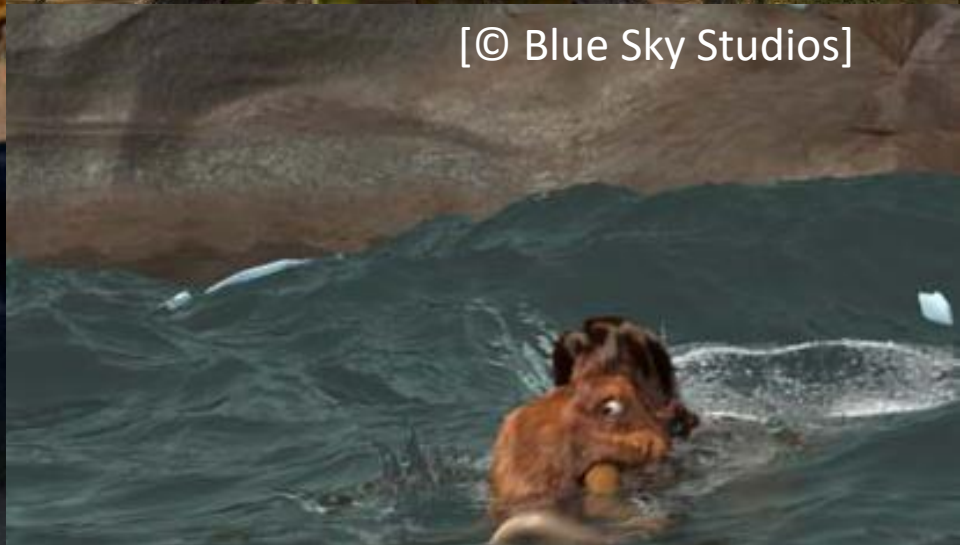
Applications

- Entertainment Industry: Video games

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[© Valve]

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[© Blizzard Entertainment]
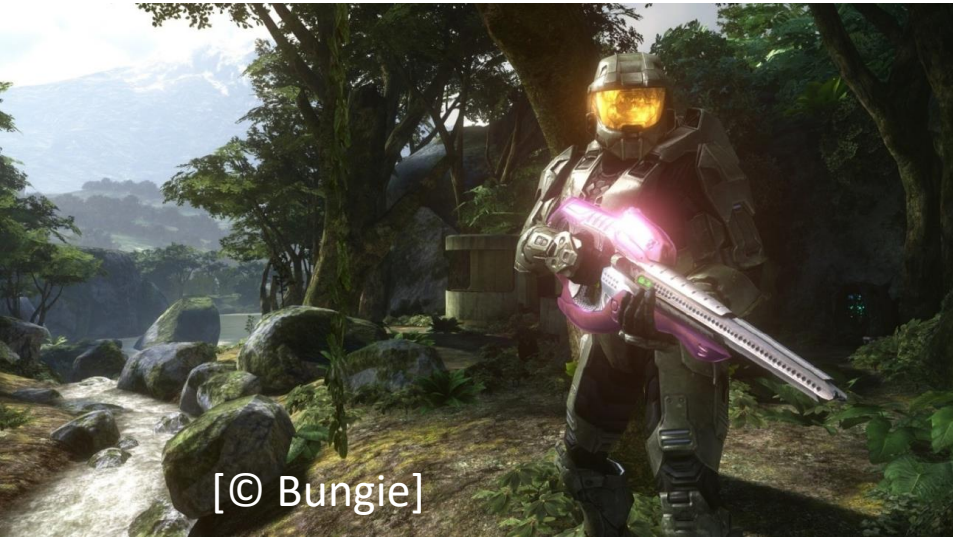
Applications

- Simulation & Augmented Reality

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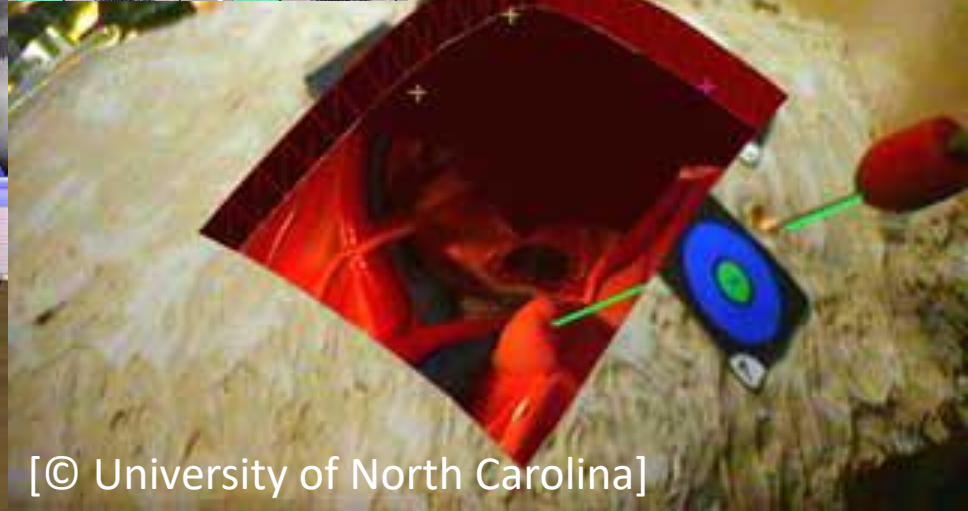
Applications

- Industrial Design & Engineering: Automotive / Aerospace

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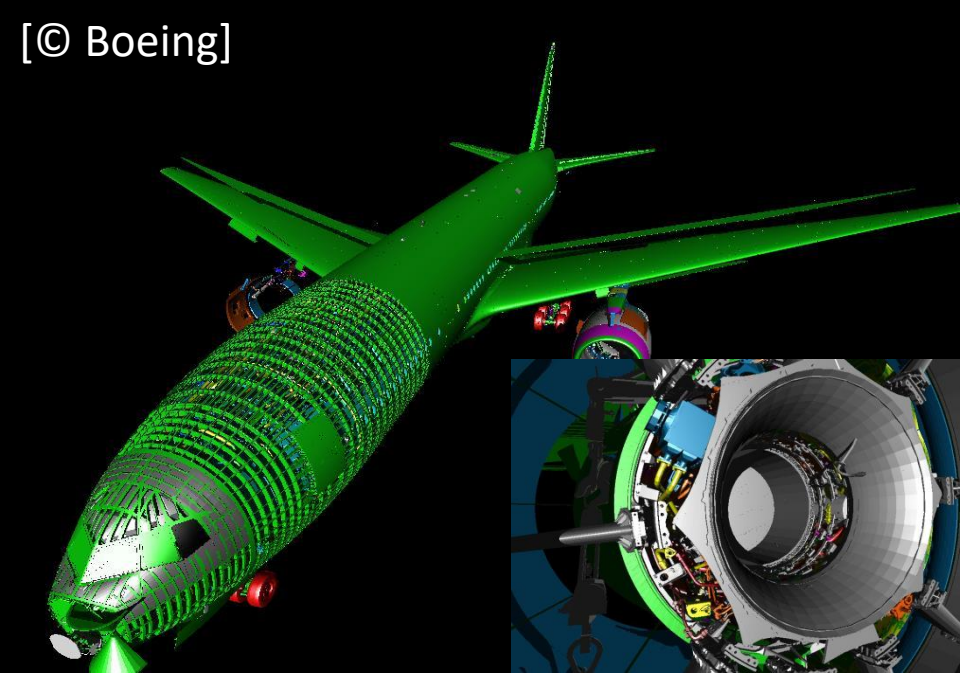
Applications

- Architectural / Interior Design
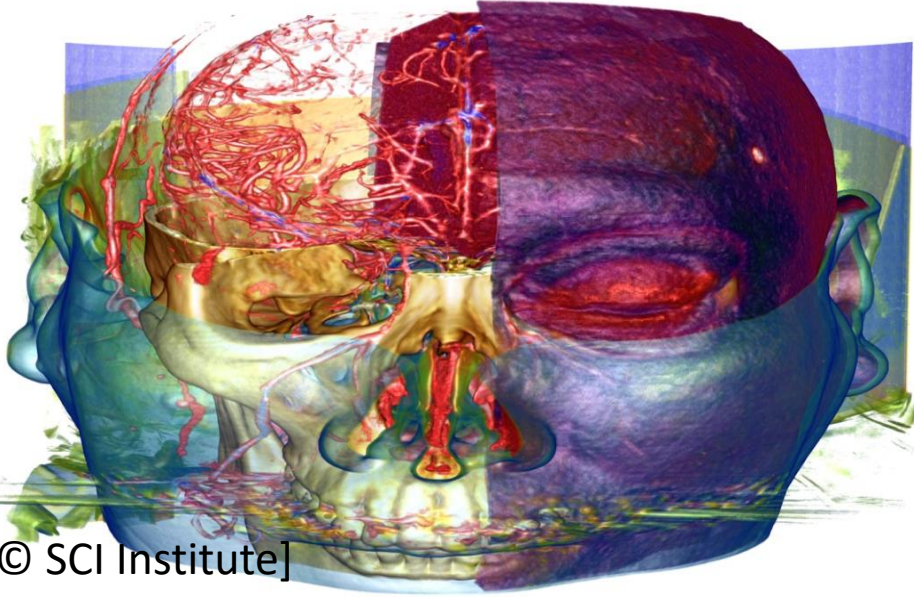- Landscape / Urban Planning
- Archeological Reconstruction
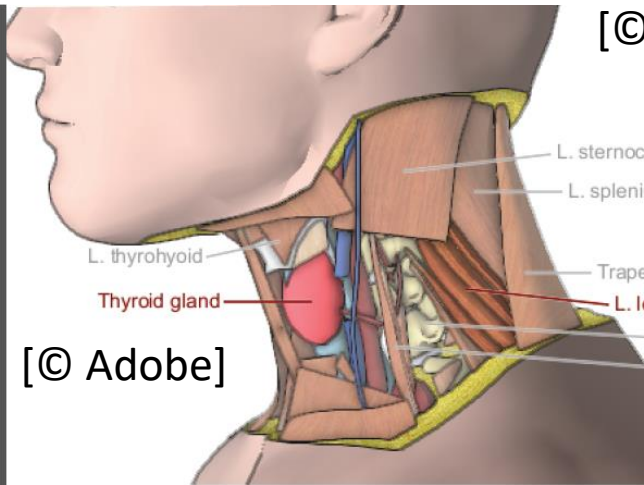
[© Saarland University]
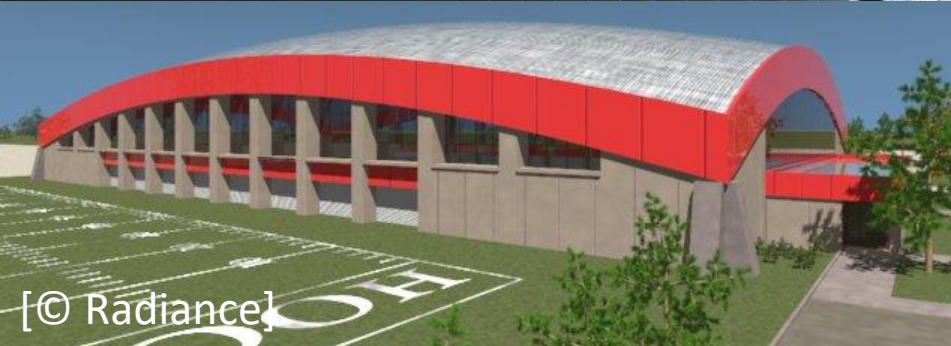
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[© Radiance]

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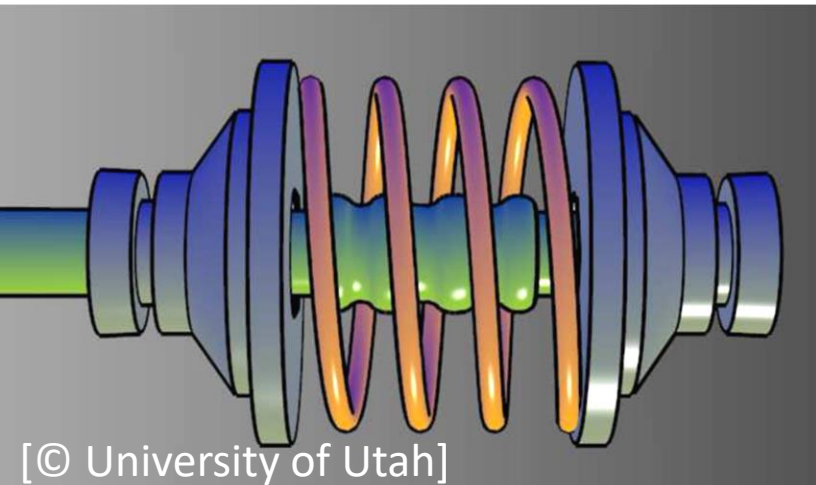# Applications

- Scientific/Information Visualization

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[© Oak Ridge National Laboratory]
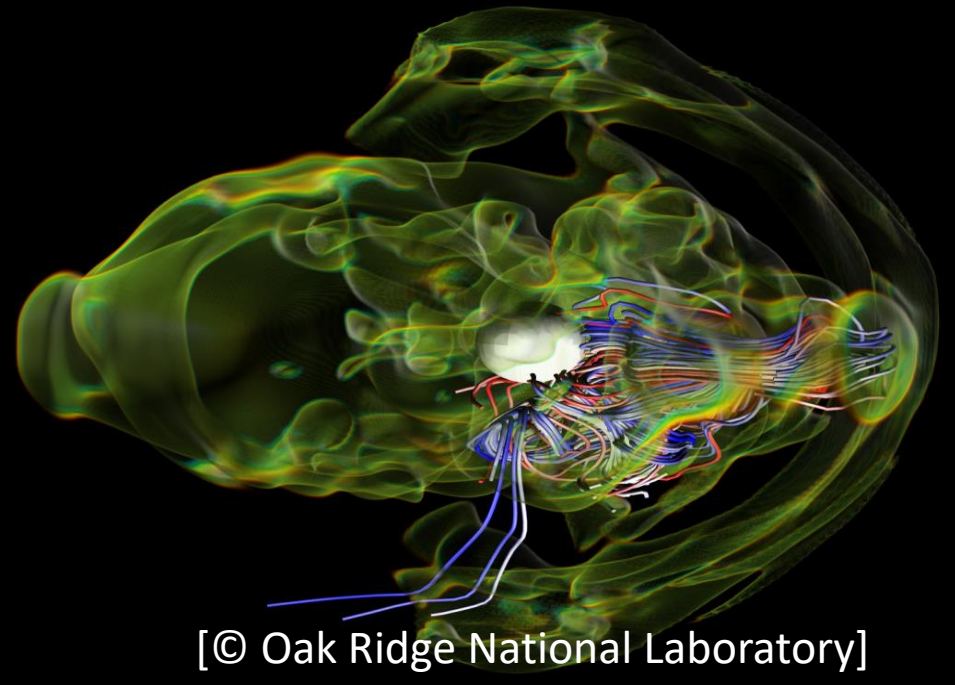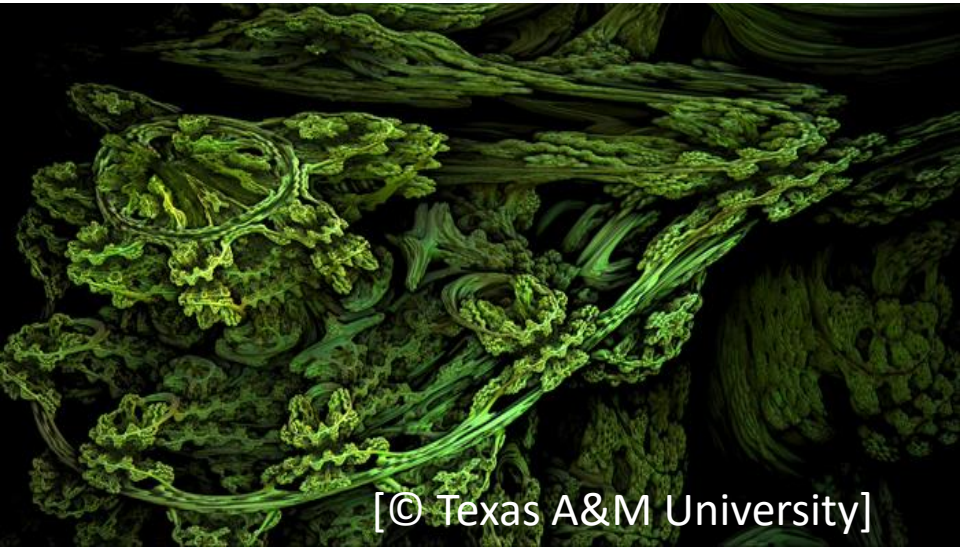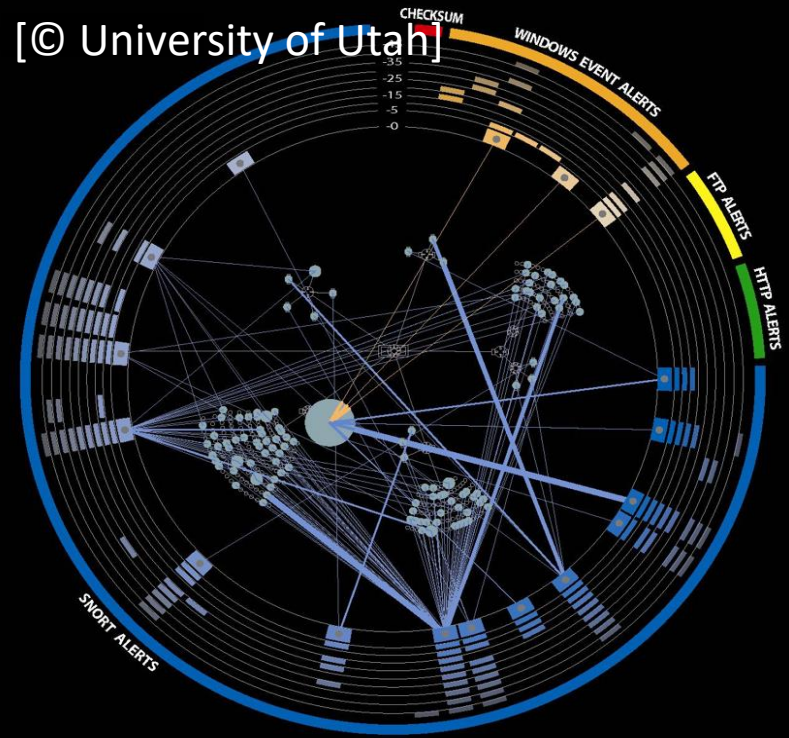
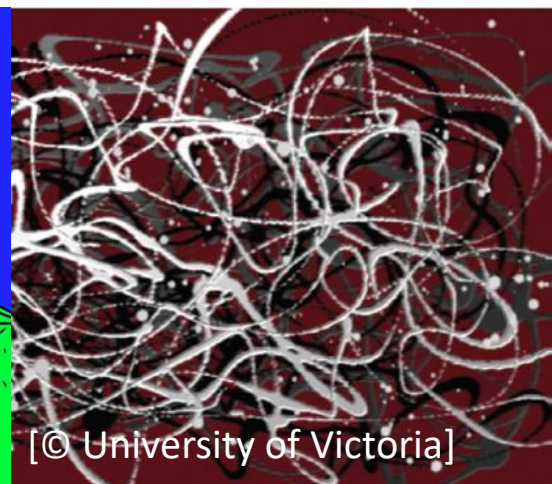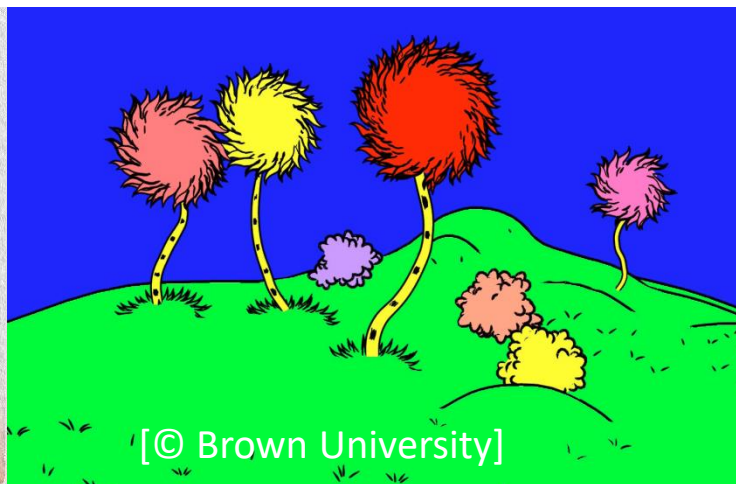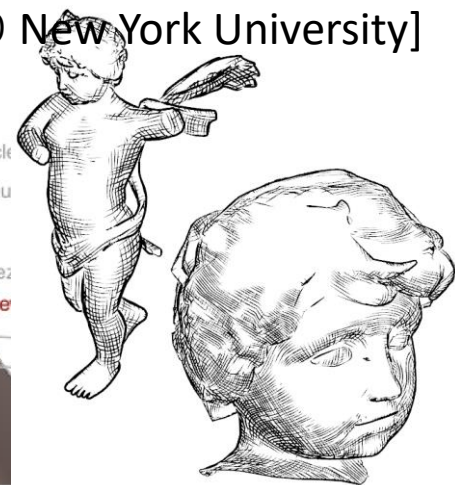# Applications

- Non-photorealistic rendering: art/stylized/pen&ink illustration
- Painterly/Toon Shading, Computational Aesthetics

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**Physically-Based Image Synthesis
with Real-Time Ray Tracing**

RT-HW in EVERY GPU now

Technical Oscar
Feb 2021

Key product offered now by all major GPU/HW vendors:
e.g. Intel (Embree), Nvidia (OptiX), AMD (Radeon Rays) , …

Wrap-Up

- **Computer Graphics**
  - Rendering, Modeling, Visualization, Animation, Imaging, …

- **Young, dynamic area**
  - "Everything is possible" mentality
  - Progress driven by research & technology
  - Flexible transfer between research and industry

- **Big industry !**
  - Intel, Nvidia, AMD, Imagination, ARM, …
  - Automotive, aerospace, engineering, …
  - Entertainment: games, film, TV, animations, ...

- **Innovation areas**
  - Digital Reality, Visualization, Industrie-4.0, Big Data, Smart Cities, …

- **Interdisciplinary field**
  - Relations to mathematics, physics, engineering, psychology, art, entertainment, …