Computer Graphics Seminar

MTAT.03.305

Spring 2018

Raimond Tunnel

Contact Information

- Raimond Tunnel – jee7@ut.ee

Organizational Information

- 16 seminars:
  - 3 introductory lectures

  - 7 student presentations
  - 4? special events

  - 1 project demos
  - 1 thesis defense practice

We hope that...

- 16 seminars

  Attendance: ~24h = 0.85 credits

- 1 seminar

  Preparation: 16h = 0.6 credits

  Conducting: 1.5h = 0.05 credits

- Project

  Everything: 40h = 1.5 credits

... but it may happen that ...

- 16 seminars

  Attendance: ~24h = 0.85 credits

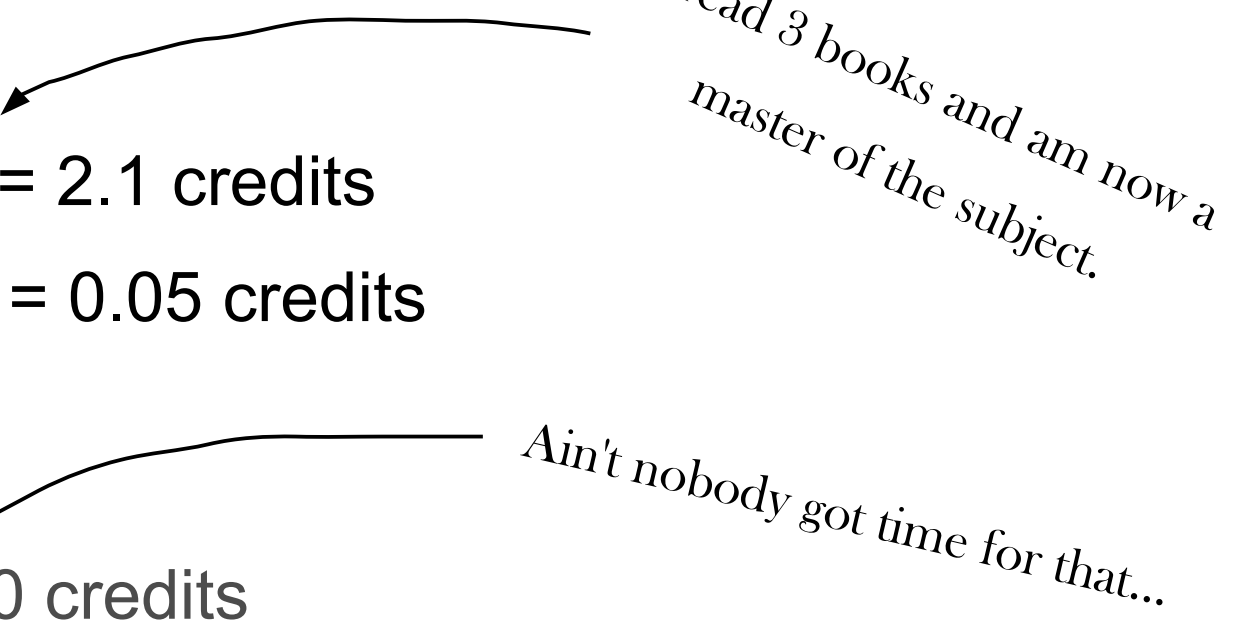
- 1 seminar

  Preparation: 56h = 2.1 credits

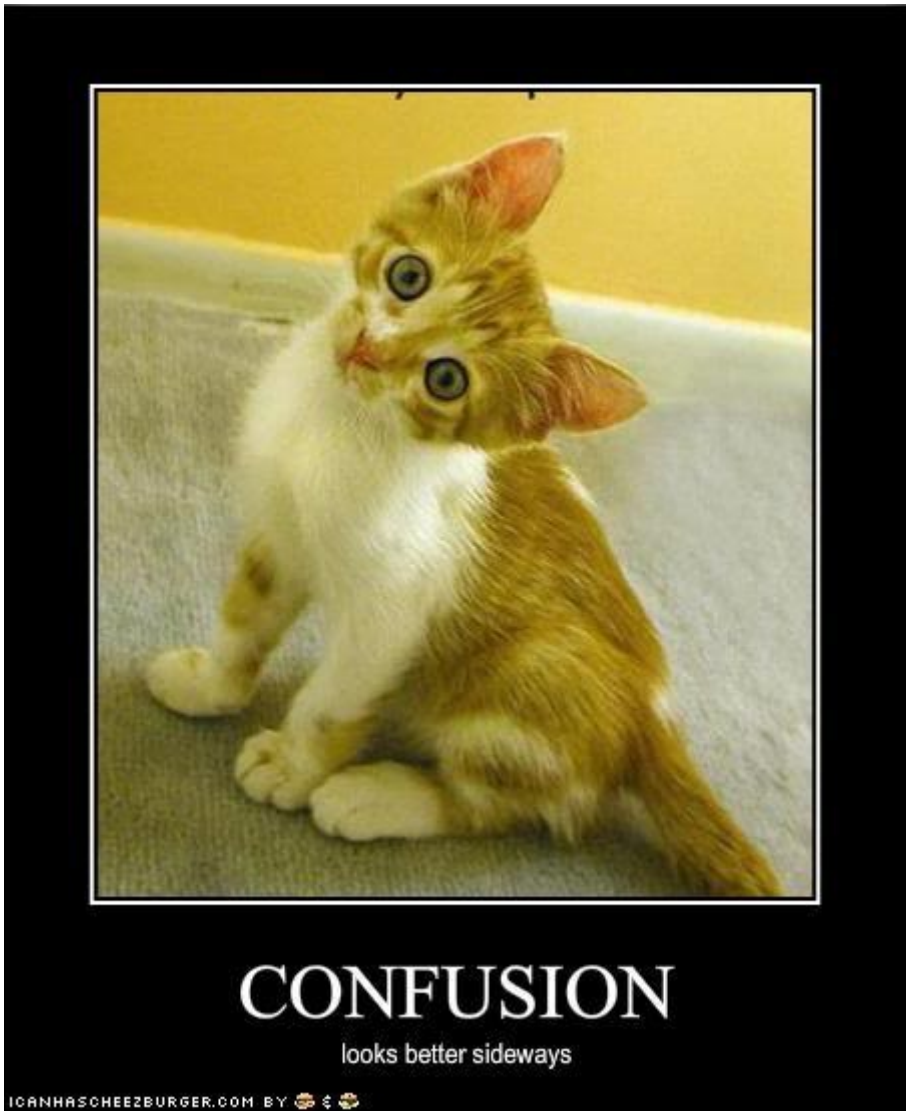
  Conducting: 1.5h = 0.05 credits

- Project

  Everything: 0h = 0 credits



What am I even doing here?



What do I see?

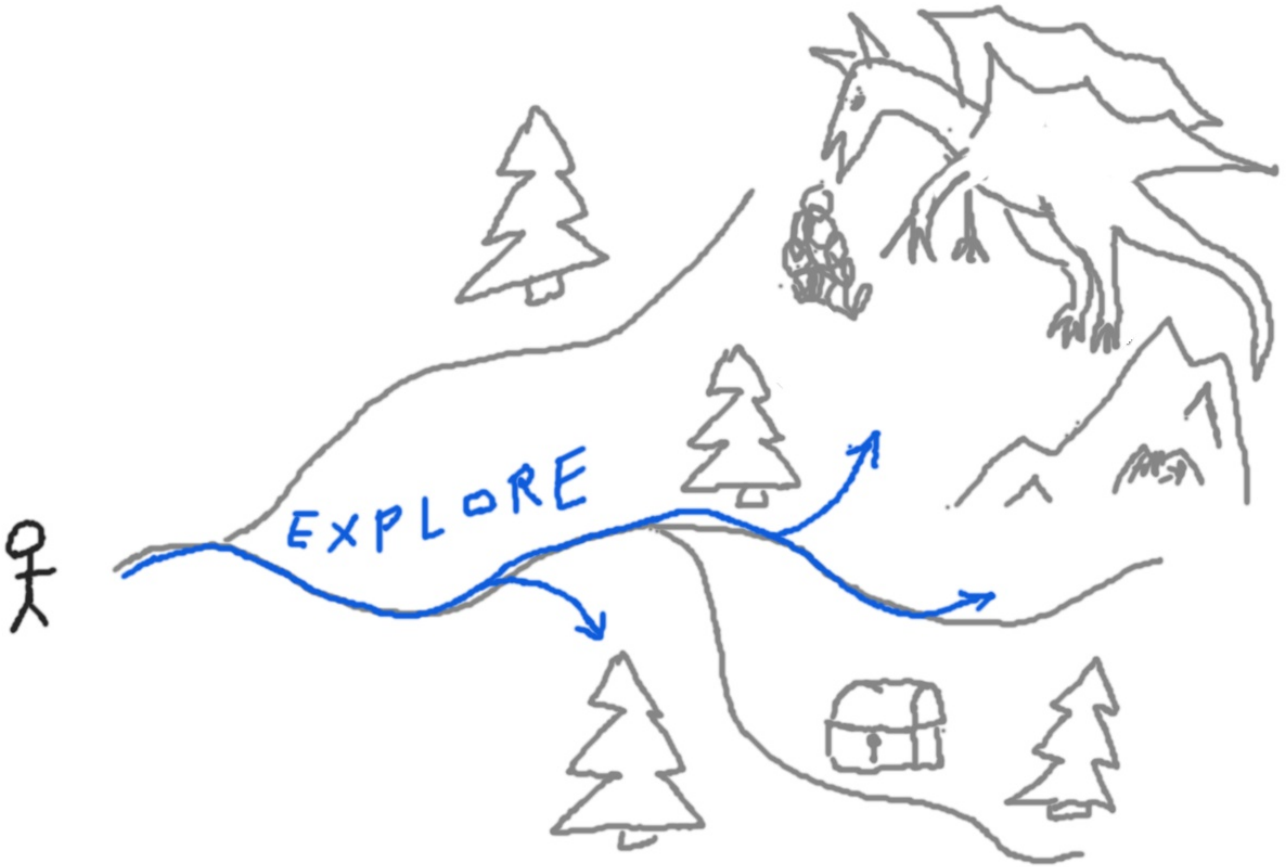
What about this one?

Or this one?

This one should be easy...

The Seminar

- Explore an interesting CG topic

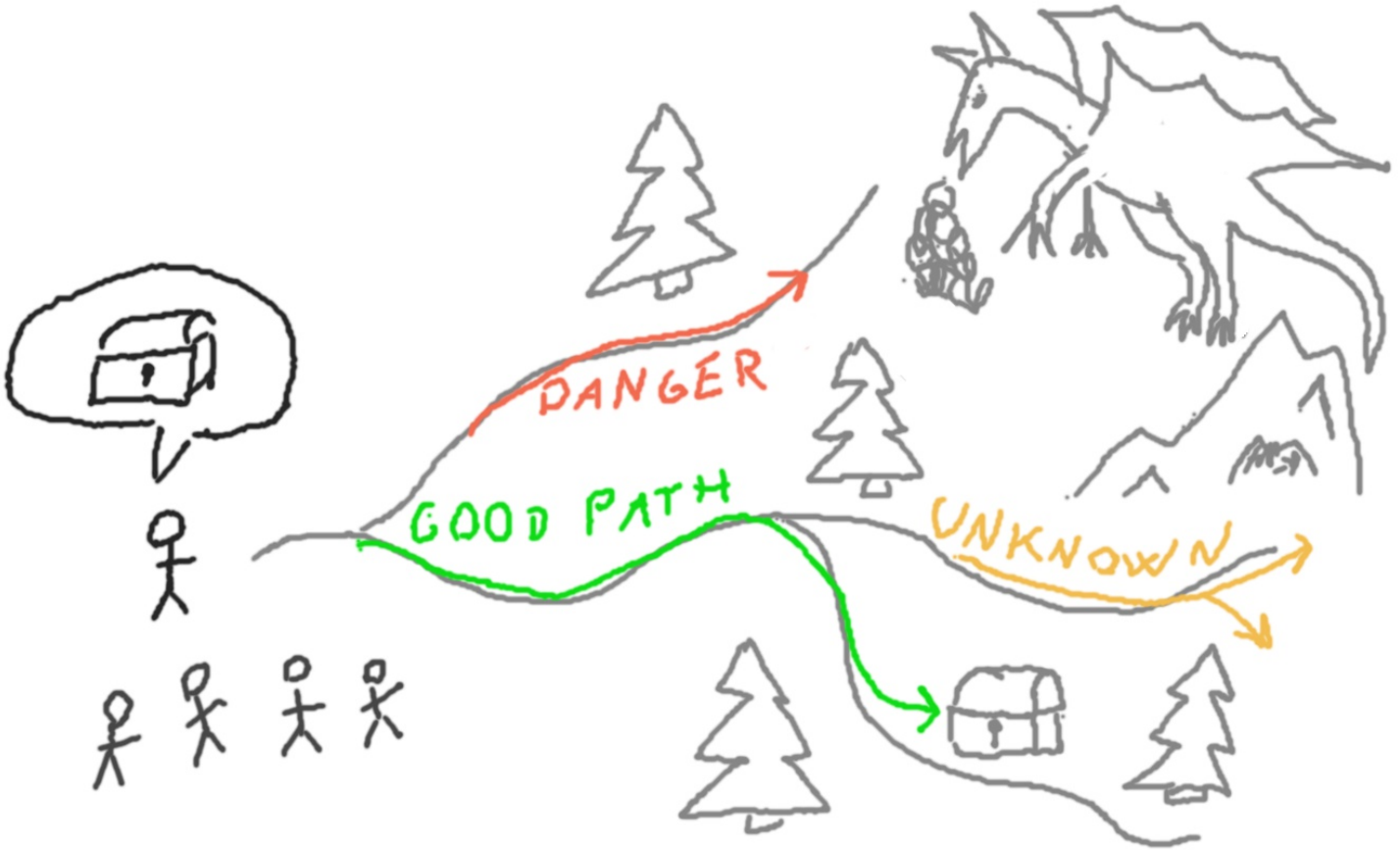


The Seminar

- Tackle a difficult subject together

The Seminar

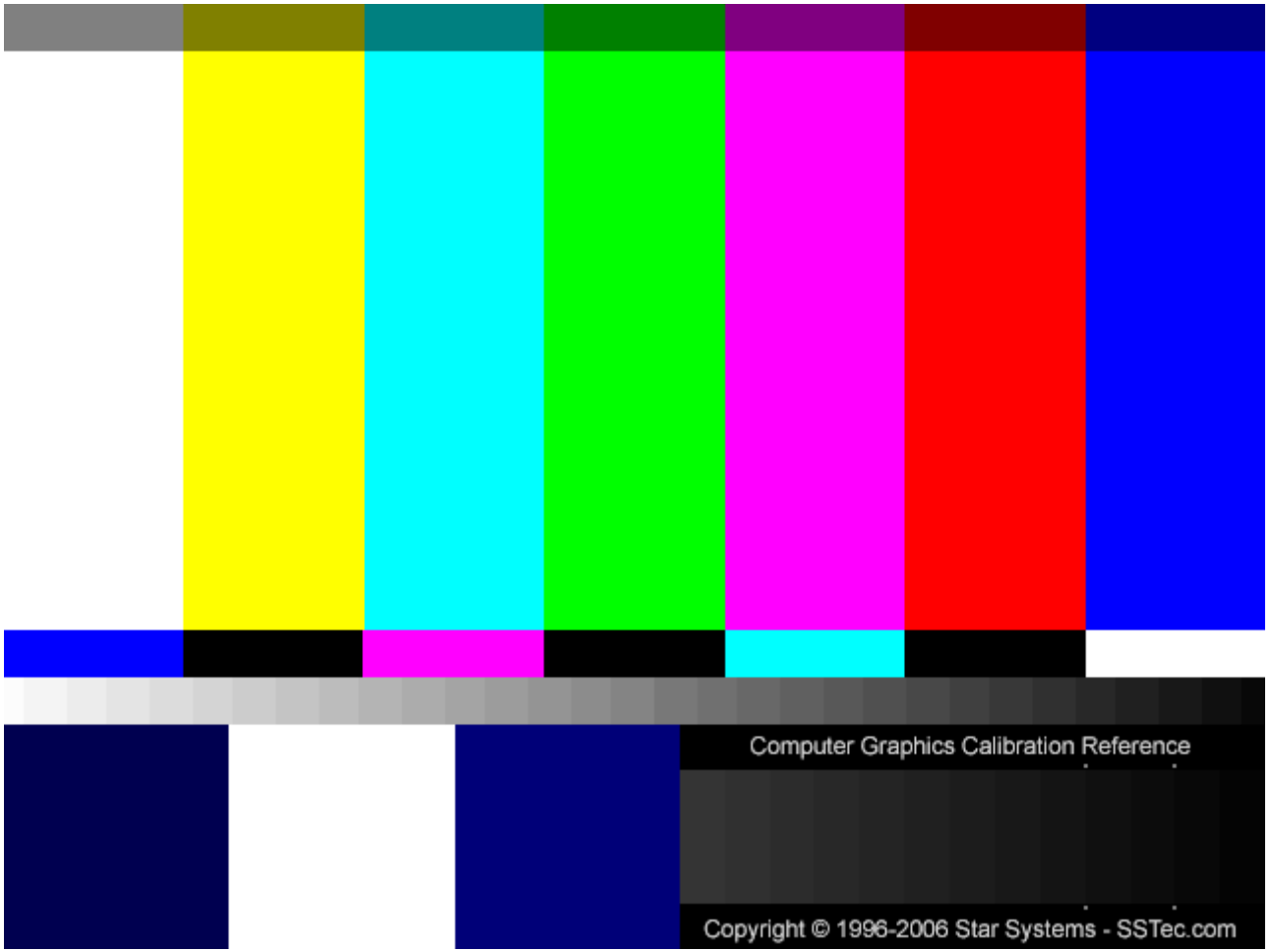
- Tell (teach) others about your discoveries



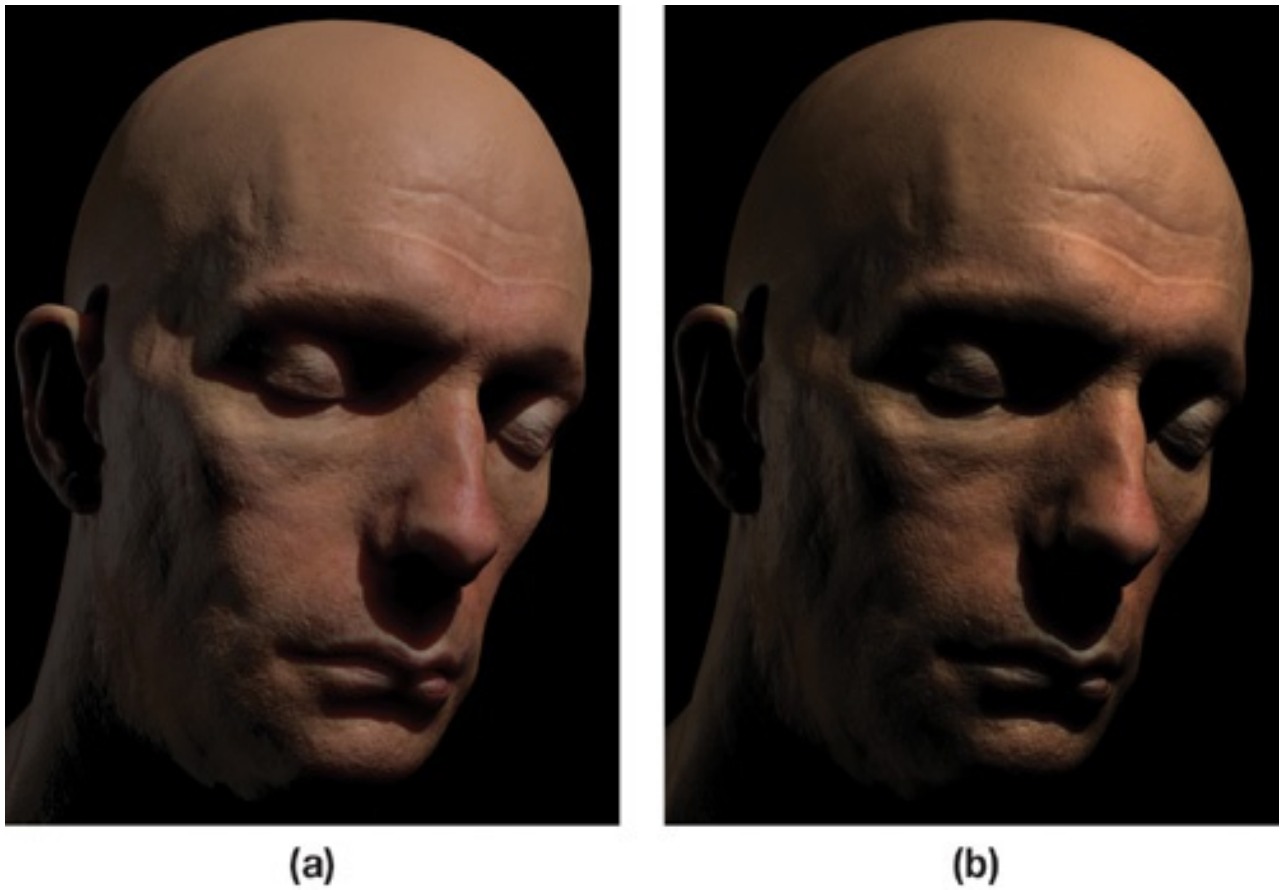
Some ideas

What is this?

Sidetrack: Gamma correction



Sidetrack: Gamma correction



GPU Gems 3: http://http.developer.nvidia.com/GPUGems3/gpugems3_ch24.html

Some ideas

What is this?

Sidetrack: Bloom effect

Need for Speed: Most Wanted

Elephant's Dream

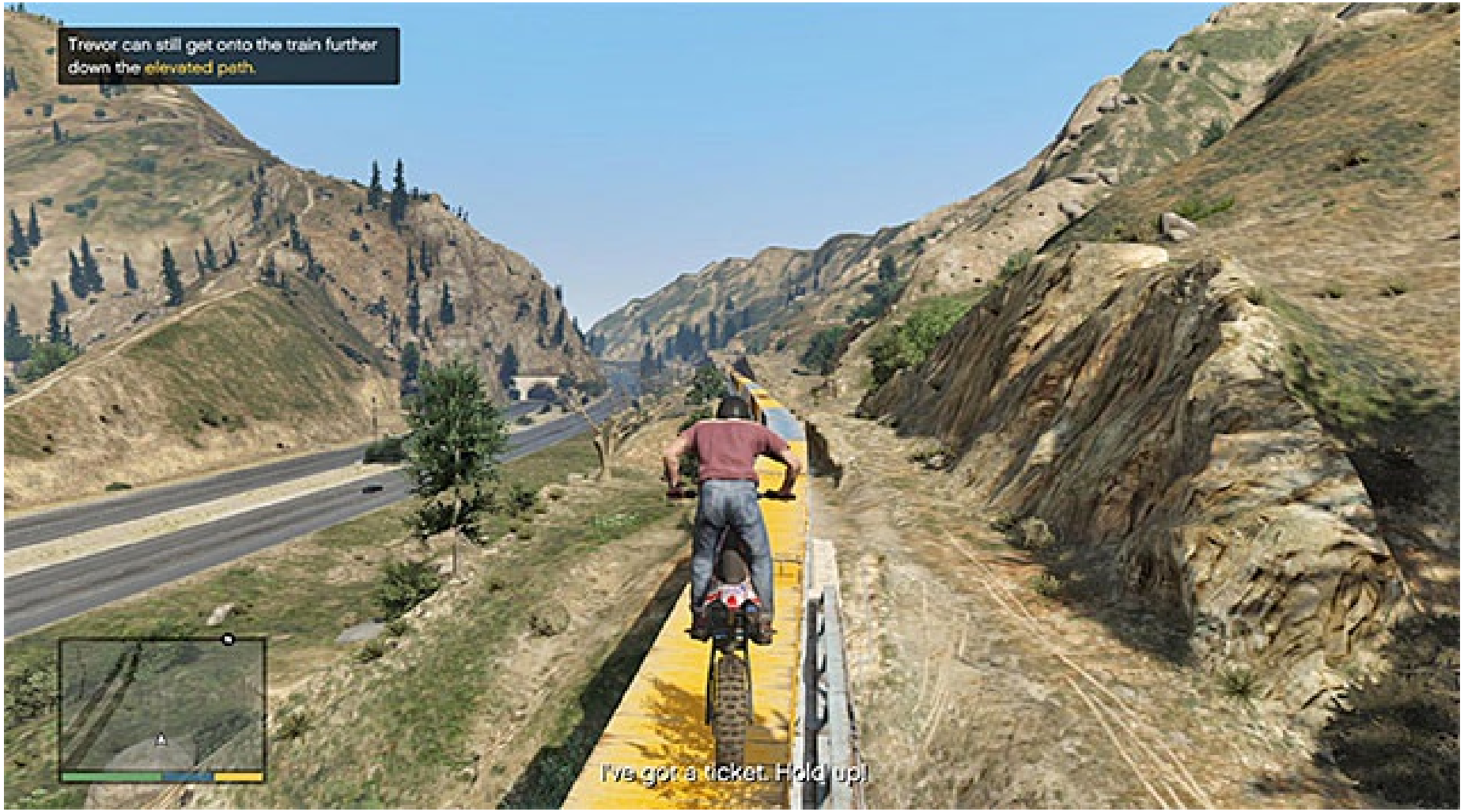
Hitman: Absolution

Warframe: https://www.youtube.com/watch?v=gYHxhlvEyHk

Sidetrack: Bloom effect

Elder Scrolls 3: Oblivion

Back to the main track



How do I choose a topic?

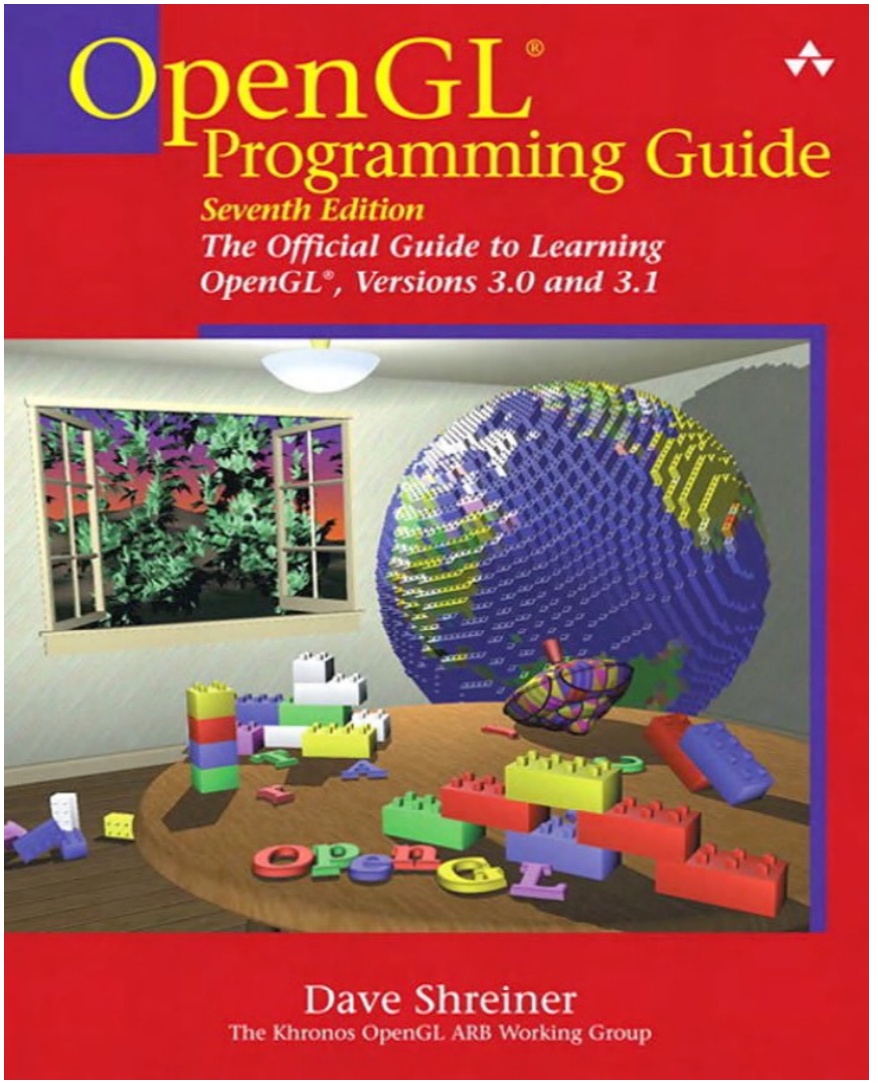
- There just were two ideas:
  - Visal effects (like the Bloom effect)
  - Gamma correction
- Read something:
  - OpenGL's Red Book
  - GPU Gems, GPU Pro
  - Other literature
- Continue on a previous theme / thesis
  - My example: Procedural tree generation?

How do I choose a topic?

- Continue on some already discovered theme

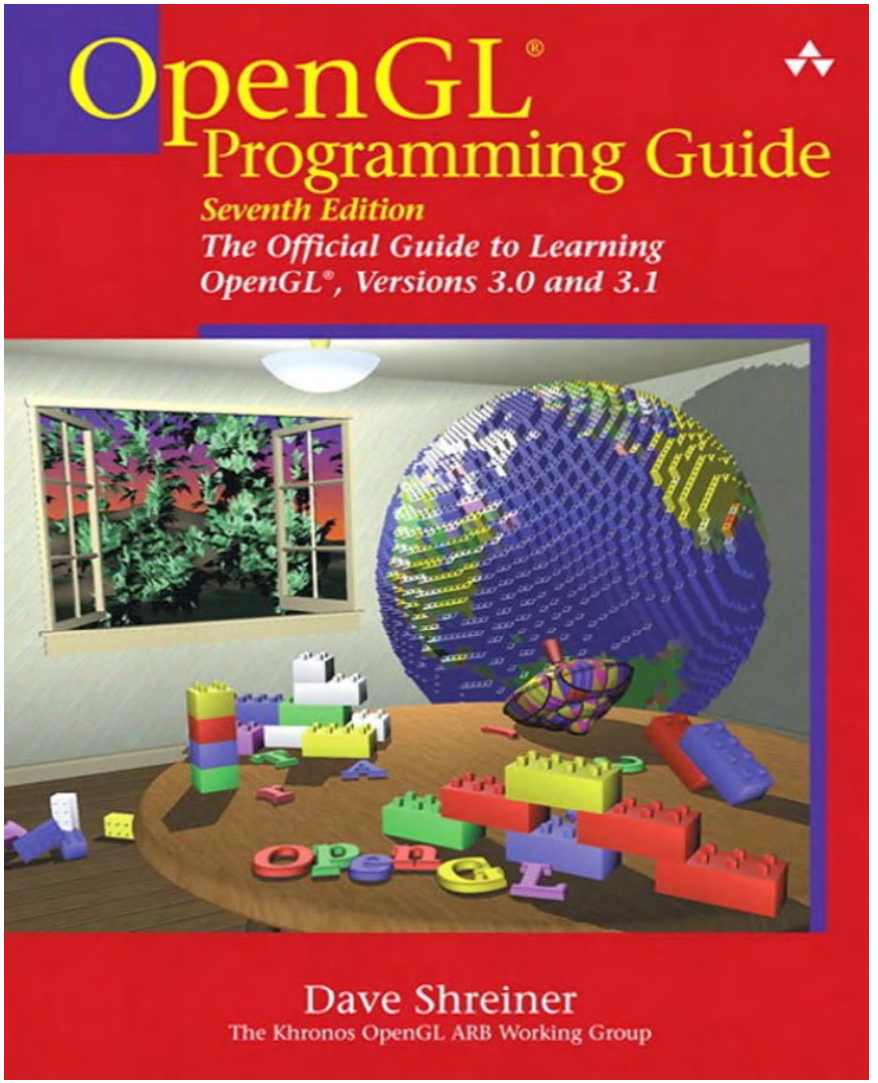
How to choose a topic?

- OpenGL ver 3.0 & 3.1
- Practical
- Basic topics:
  - Viewing
  - Color
  - Lighting
  - Blending
  - Textures
  - Buffers



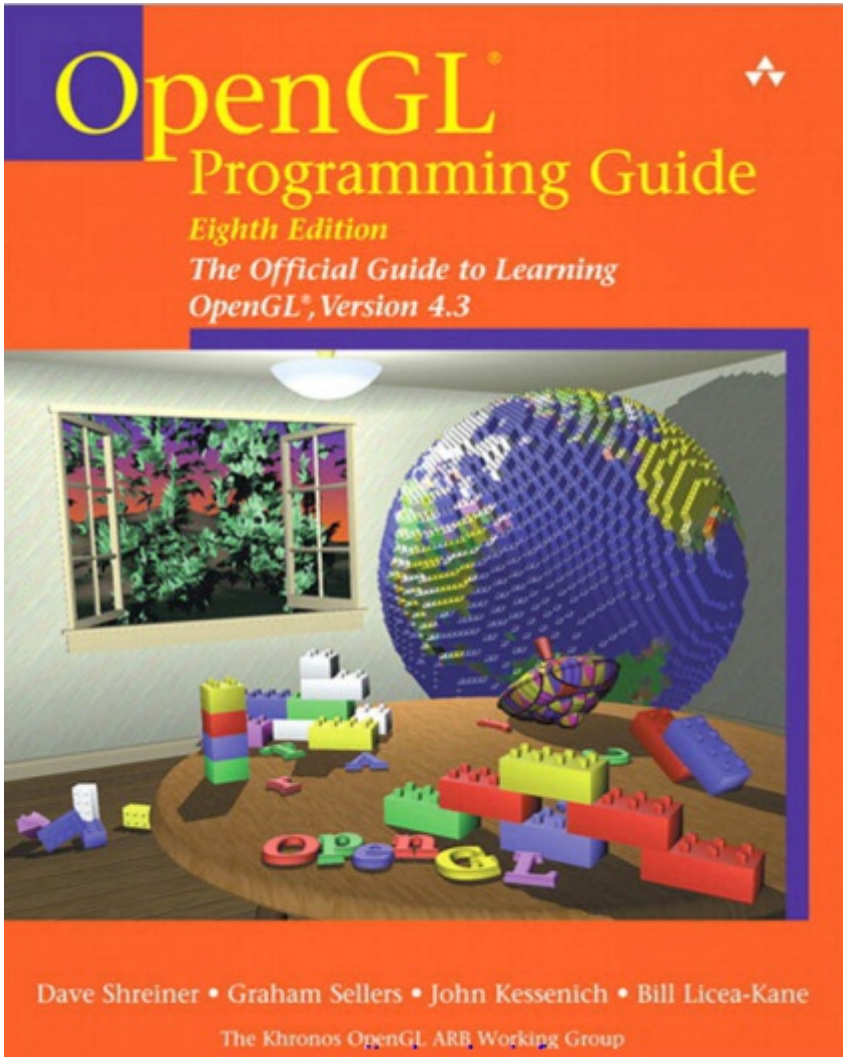
How to choose a topic?

- Advanced topics:
  - Display lists (perf.)
  - Tessellation
  - Quadrics
  - Evaluators (curves & surfaces)
  - NURBS



How to choose a topic?

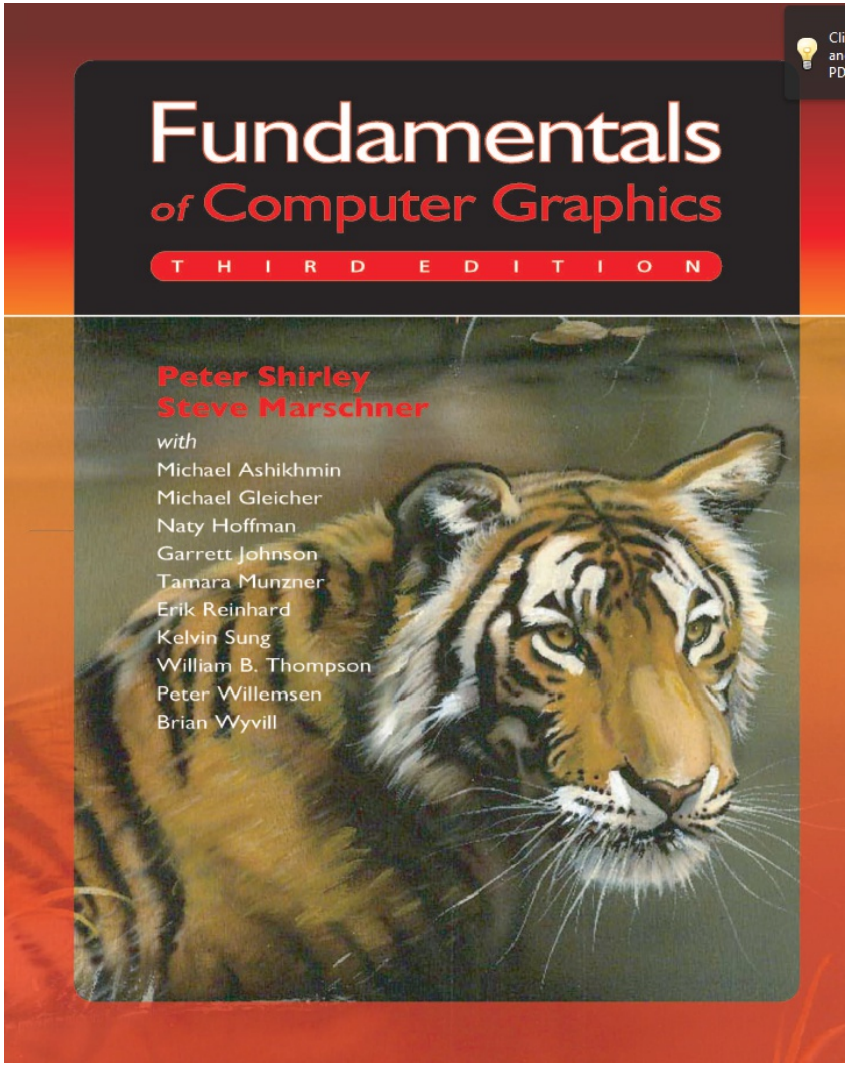
- OpenGL ver 4.3
  - Lots of new techniques and topics.
  - For example:
    - Tessellation shaders
    - Geometry shaders (access to all vertices)
    - Procedural texturing



http://www.ics.uci.edu/~gopi/CS211B/opengl_programming_guide_8th_edition.pdf

How do I choose a topic?

- Covers all topics already mentioned and more
- Math heavy, but most of it you should be at home with



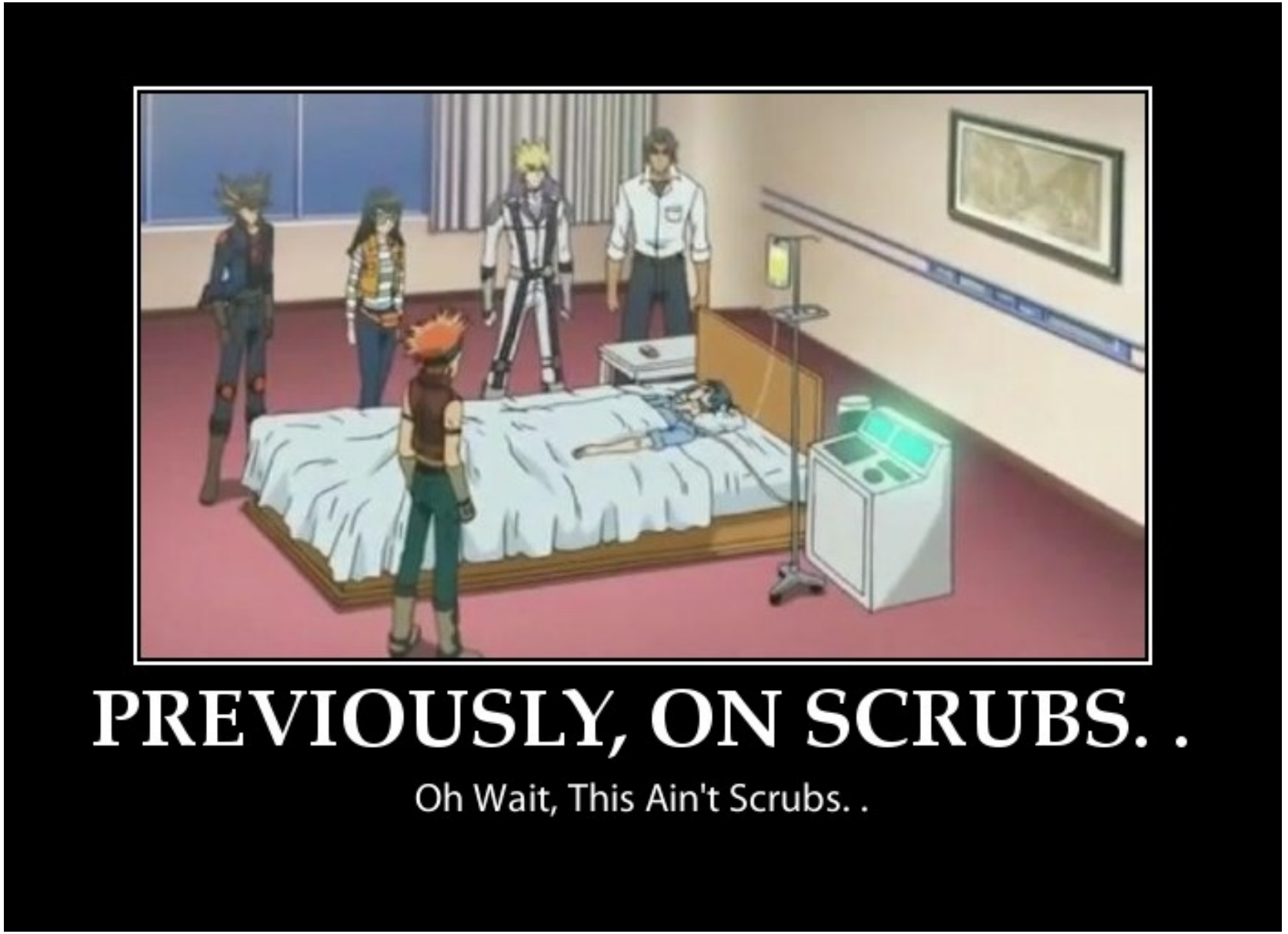
How do I choose a topic?

- Advanced CG algorithms and techniques.

Extra conditions!

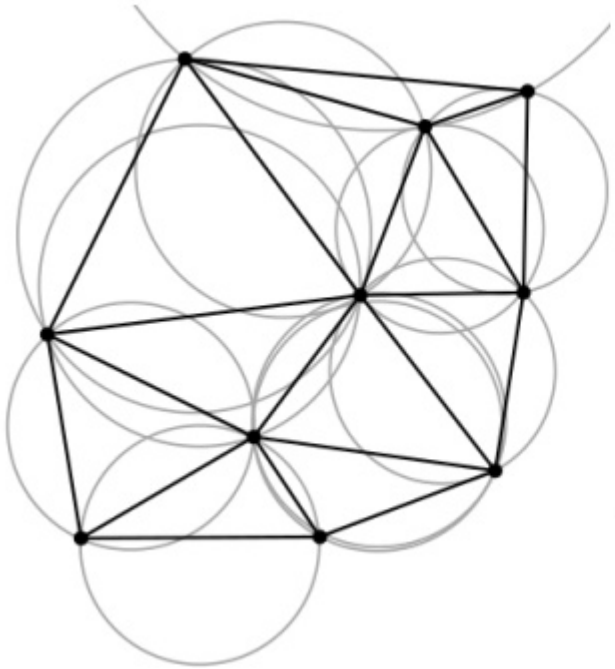
First time participant BSc, MSc	**Returning participant MSc, PhD**
No additional requirements – you can choose any CG-related topic. 	Your topic should be related to several scientific articles / a book. ACM SIGGRAPH (Special Interest Group on GRAPHics and Interactive Techniques): http://www.siggraph.org/

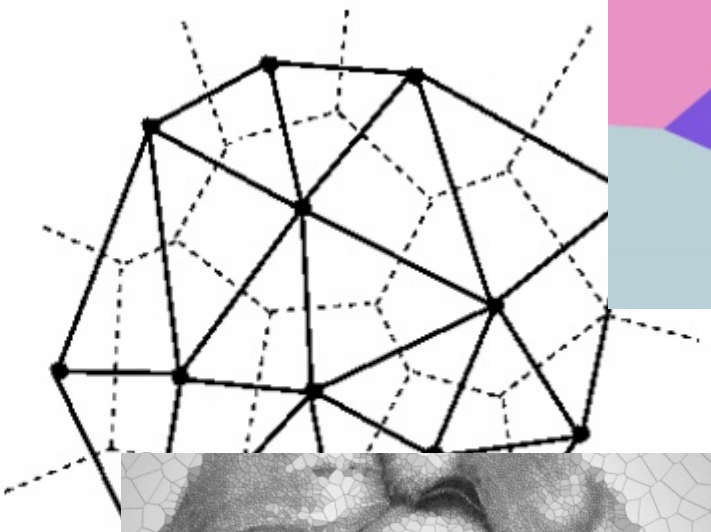
Previously...

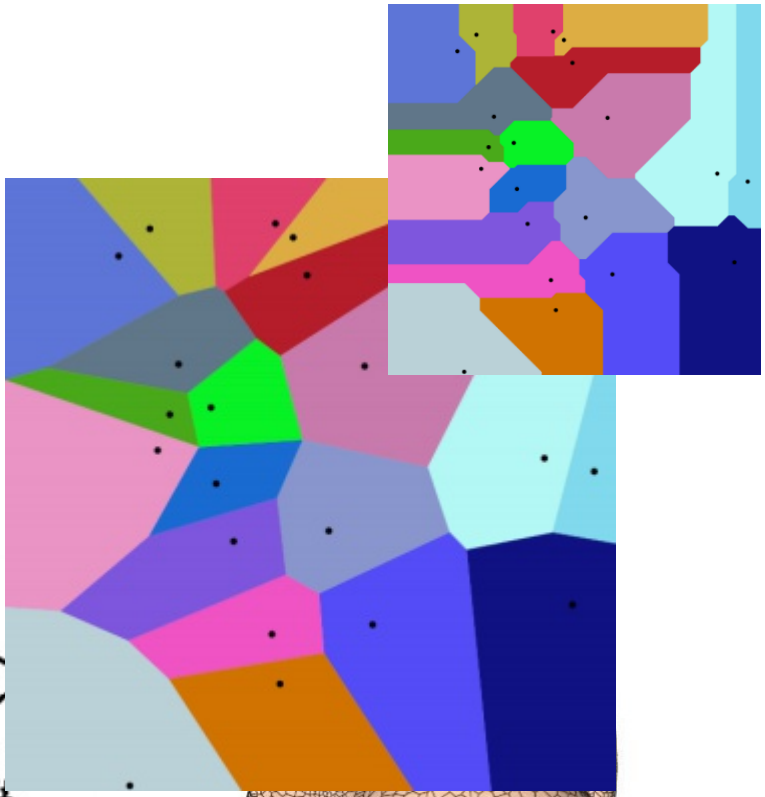


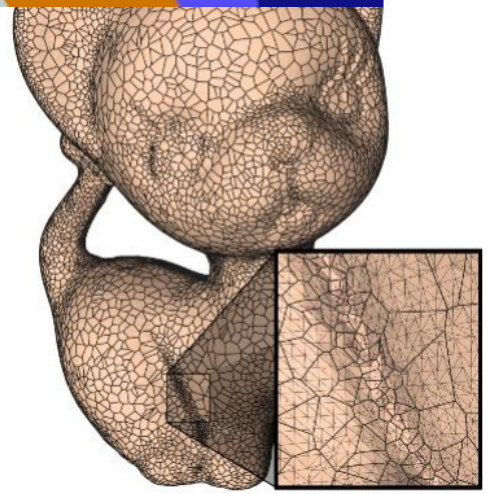
Voronoi Diagrams

- Delauney triangulation
- Bowyer-Watson algorithm



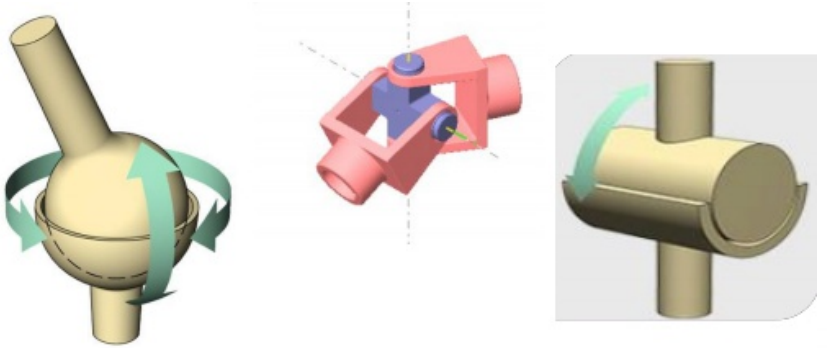


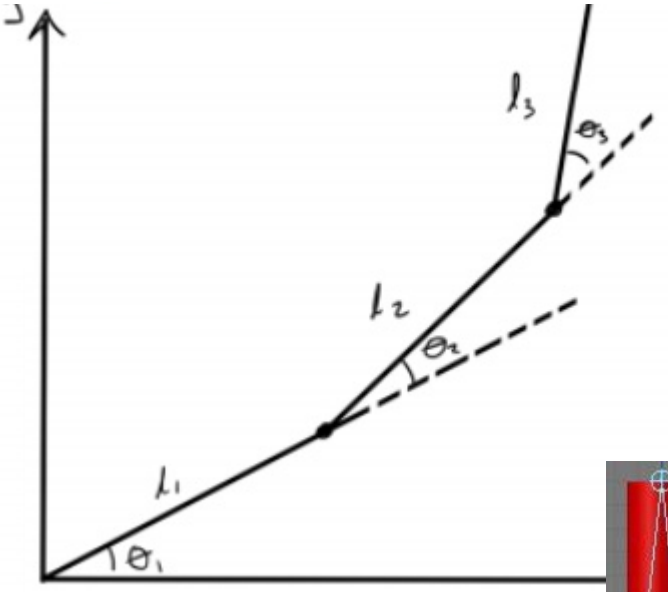


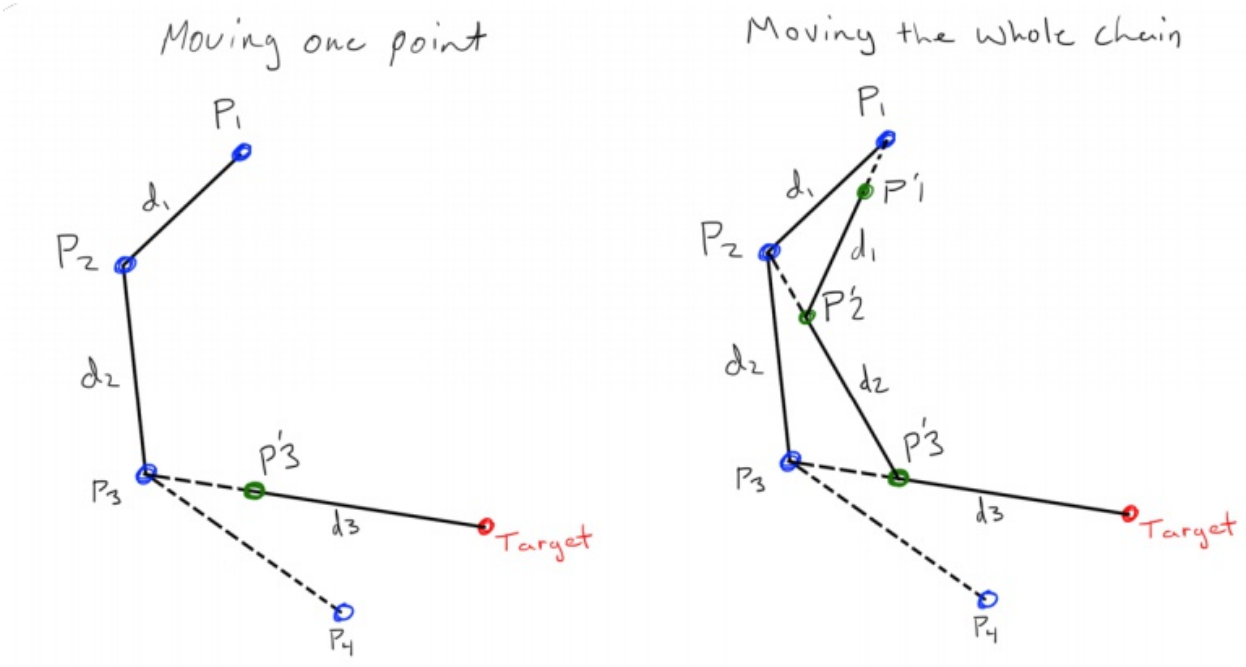


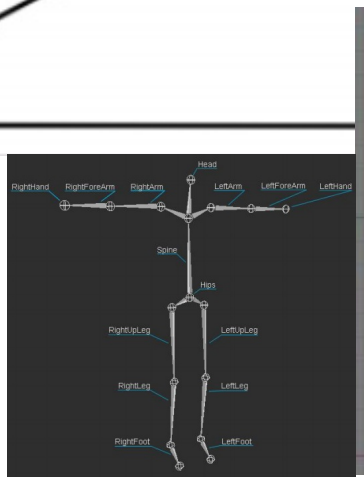
Skeletal Animation & Unity Anima 2D

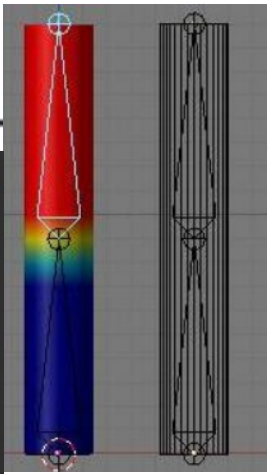
- Bones & joints
- The humanoid skeleton
- Forward kinematics
- Inverse kinematics





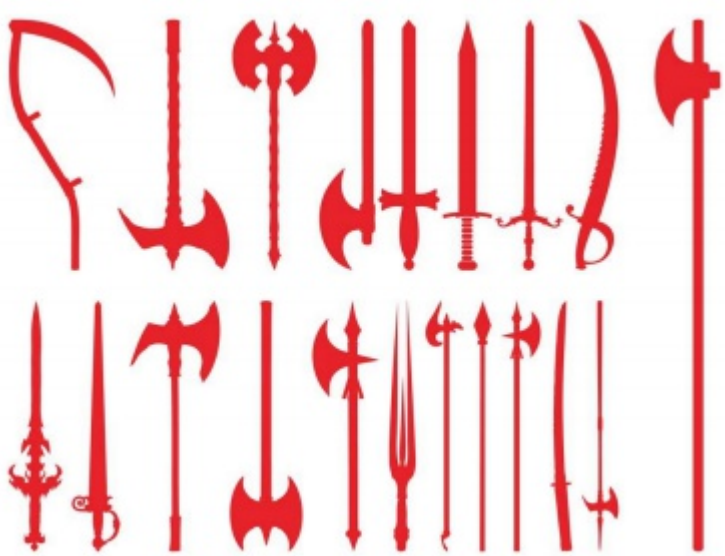


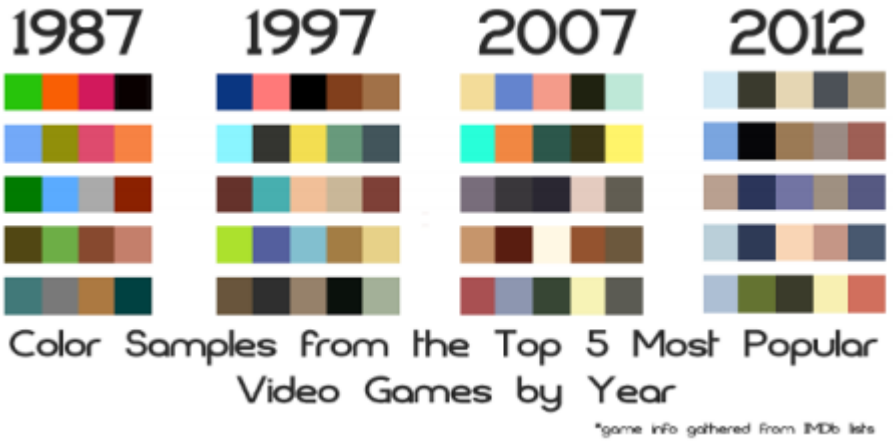




Polished Game Development

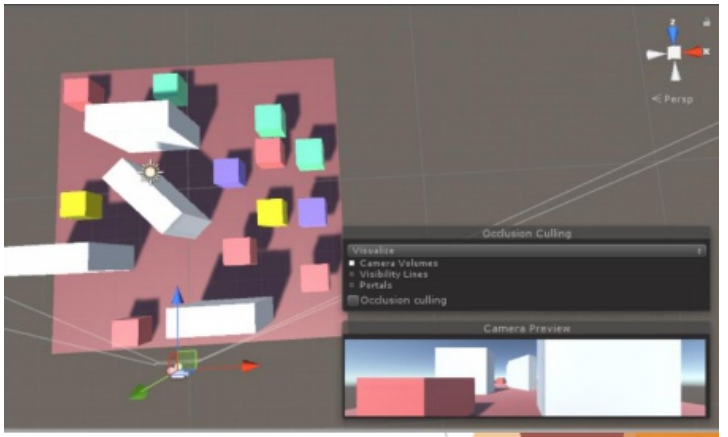
- Design considerations
- UX and teaching players
- Colors
- Trends
- Silhouettes

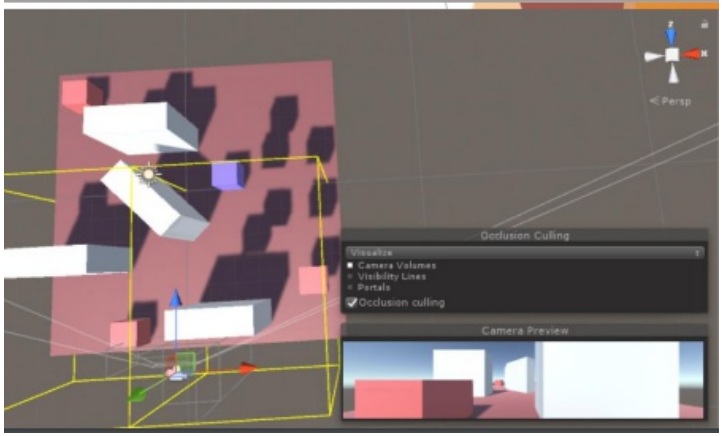


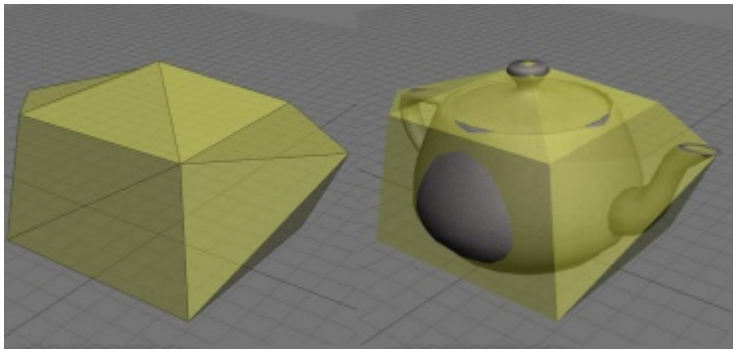


Polished Game Development

- LODs
- Texture atlas
- Optimizations
- Lighting
- Occlusion culling
- Shadows

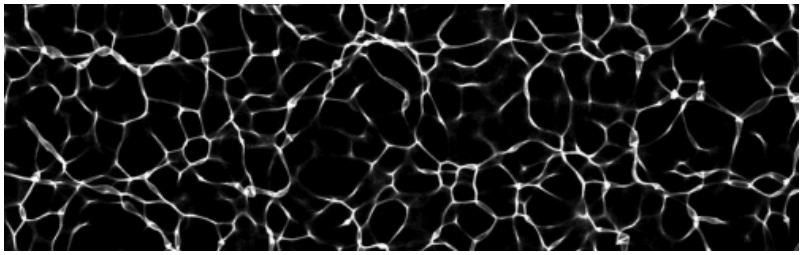


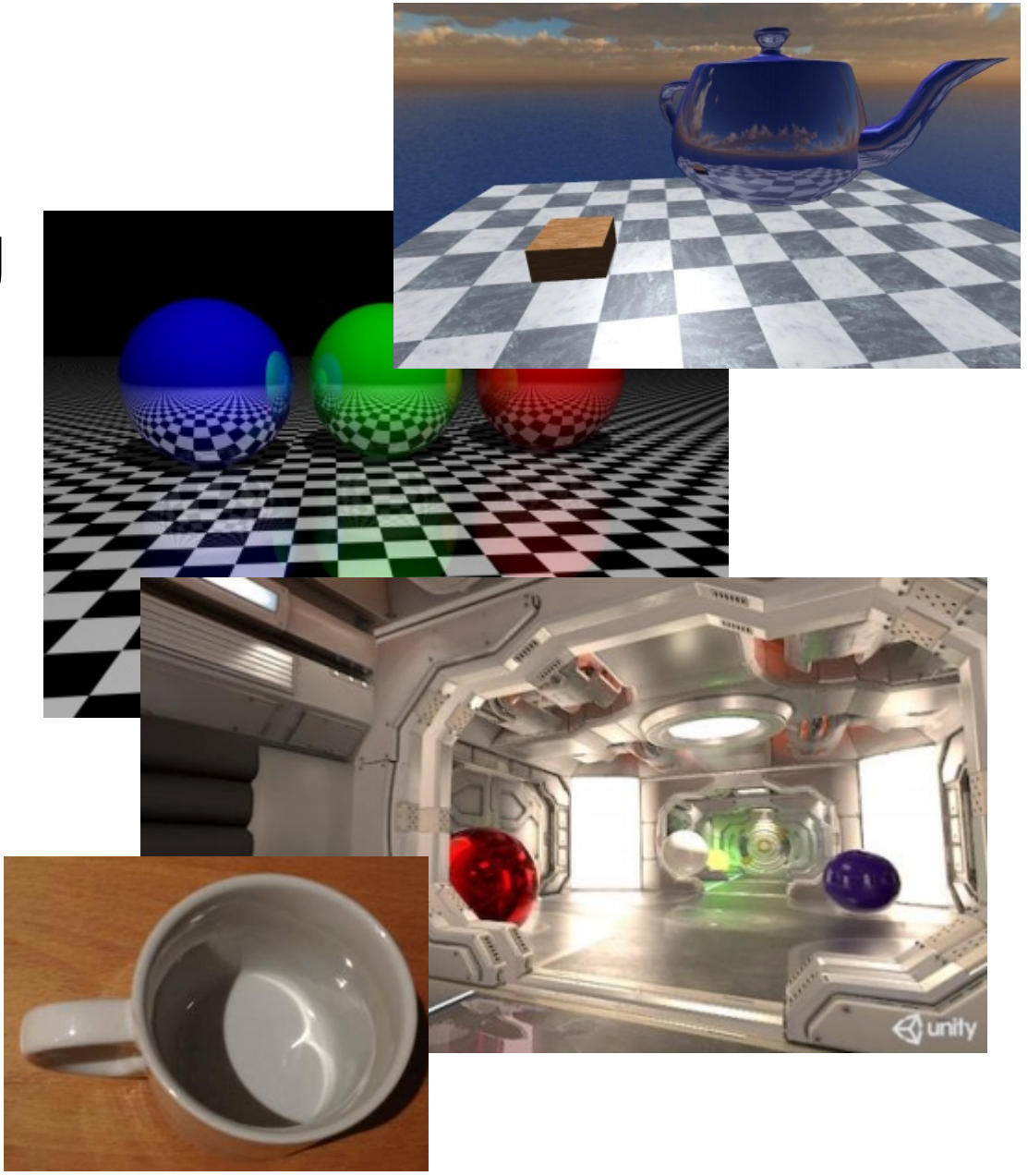




Reflections & Caustics

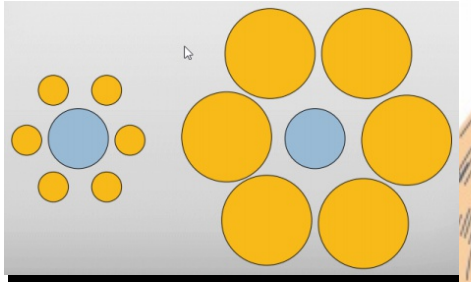
- Ray & path tracing
- Environment mapping
- Planar reflections
- Caustics
- Photon Mapping
- Caustics texture
- Unity & Unreal

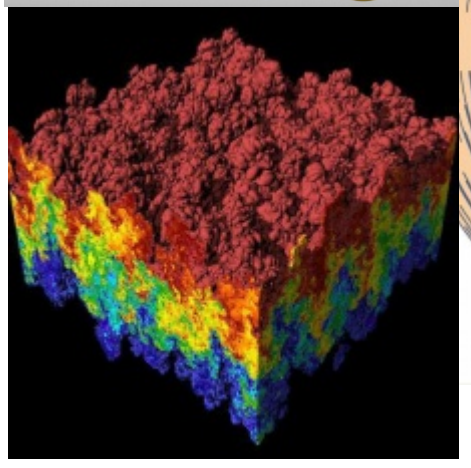


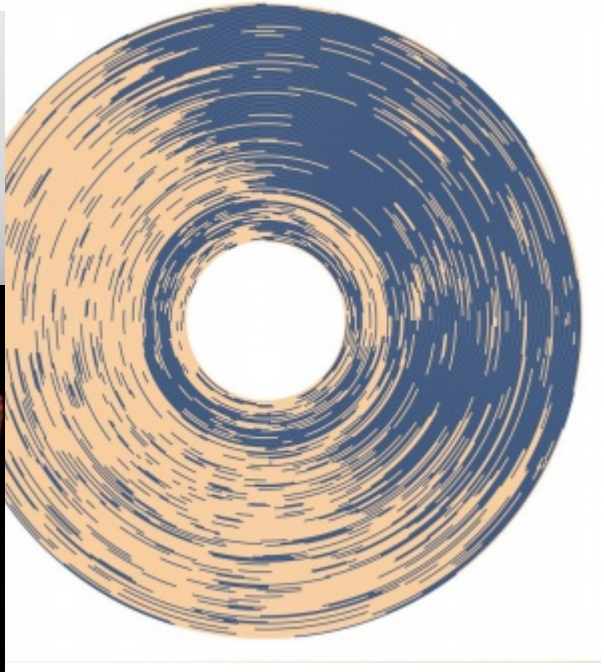


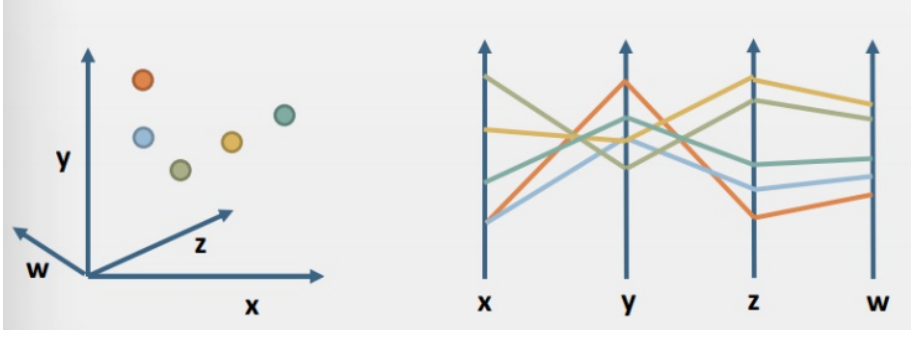
Data Visualization

- Types of visualization
  - Mathematical
  - Scientific
  - Information
  - Domain
- Perception
- Types of data
- Parallel coordinates





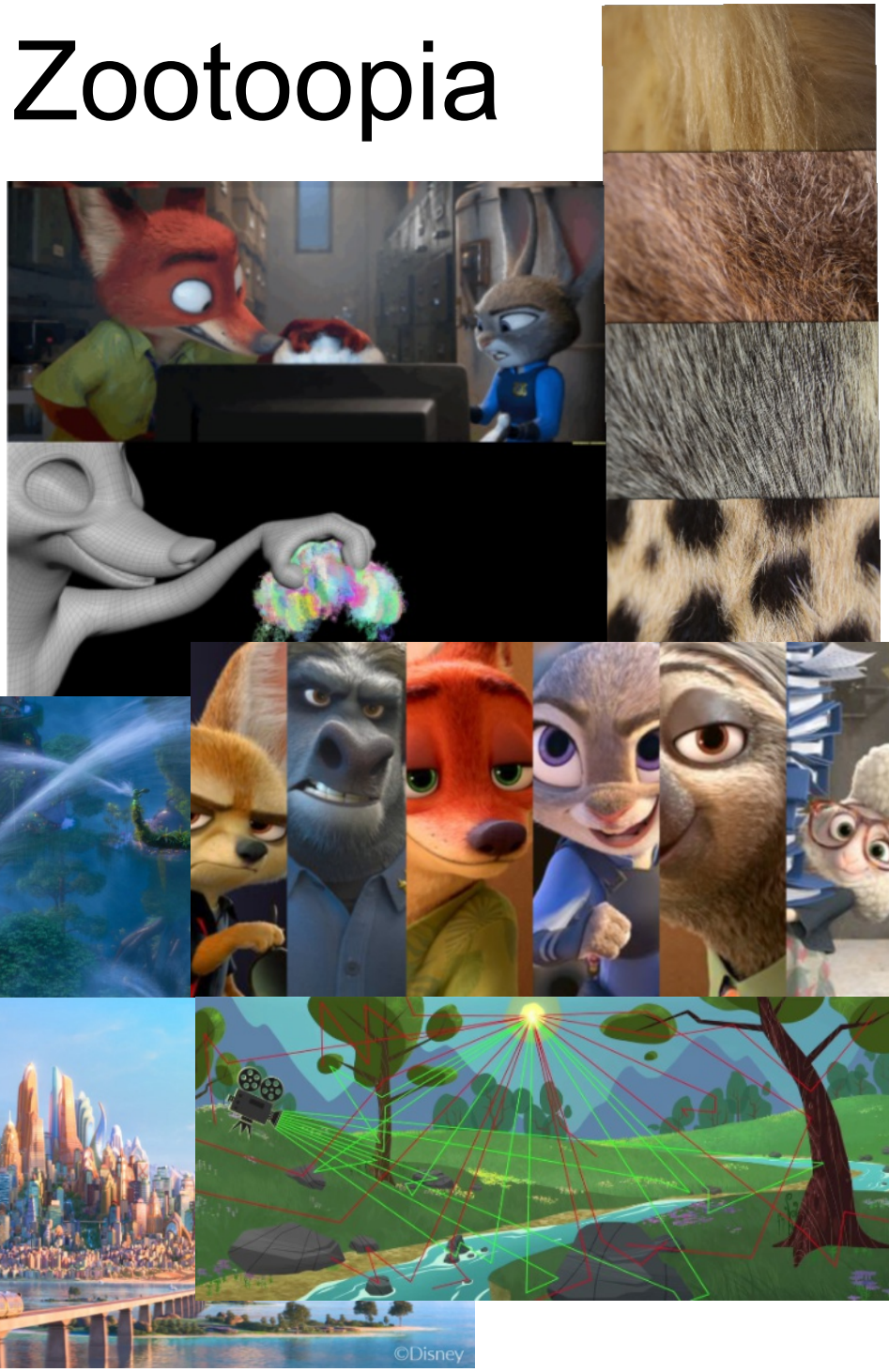




	Discrete (no between values)	Continuous (values between)
Ordered (values are comparable)	**Ordinal,** e.g. size: S,M,L,XL,… **Quantitative,** e.g. counts: 1,2,3,…	**Fields,** e.g. altitude, temperature
Unordered (values not comparable)	**Nominal,** e.g. shape: ☐○△ **Categories,** e.g. nationality	**Cyclic values,** e.g. directions, hues

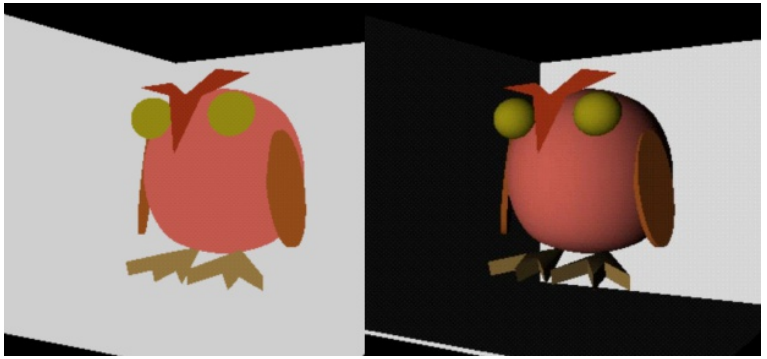
Case Study: Zootoopia

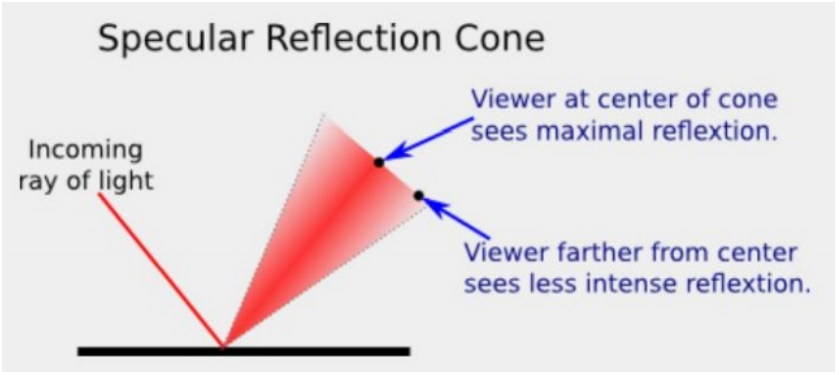
- Scenes
- Fur
  - Mouse – 480k hairs
  - Giraffe – 9 mln hairs
- Water
- Design
- Vegetation
- Issues
- Solutions

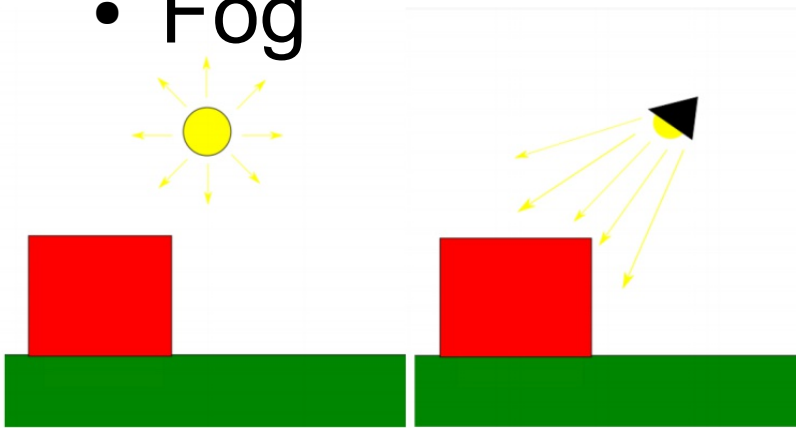


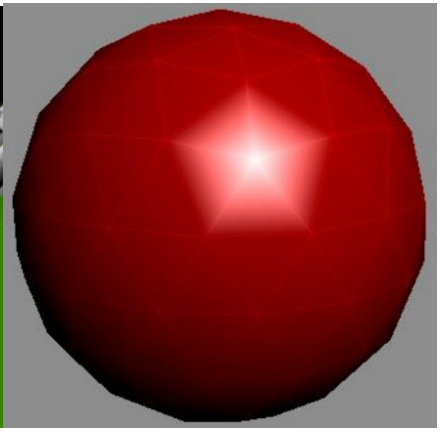
Lighting Models

- Types of light
  - Point, directional, spot
- Ambient light
- Specular reflection
- Shading
  - Flat, Gouraud, fragment
- Fog

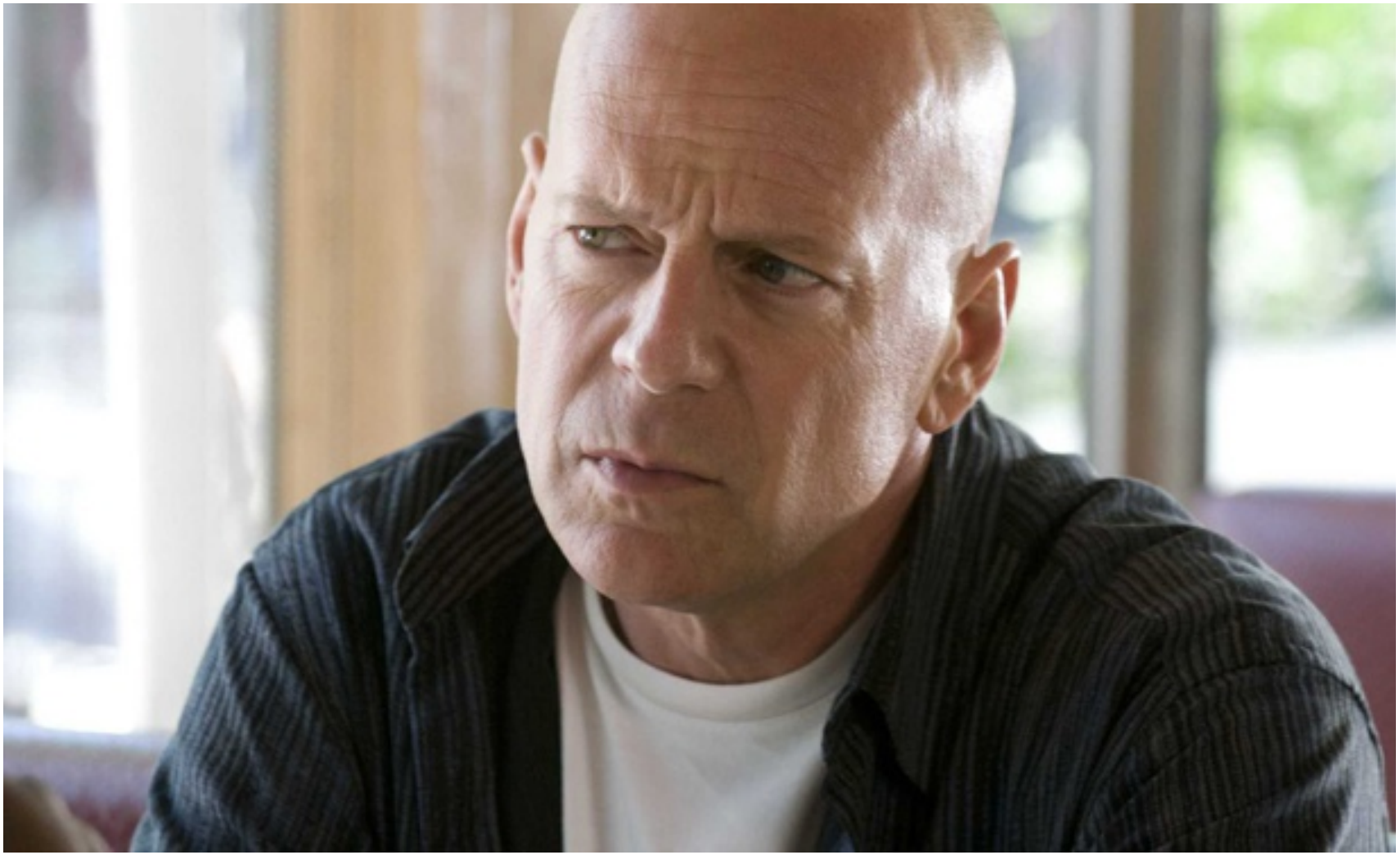








Still confused?



You can...

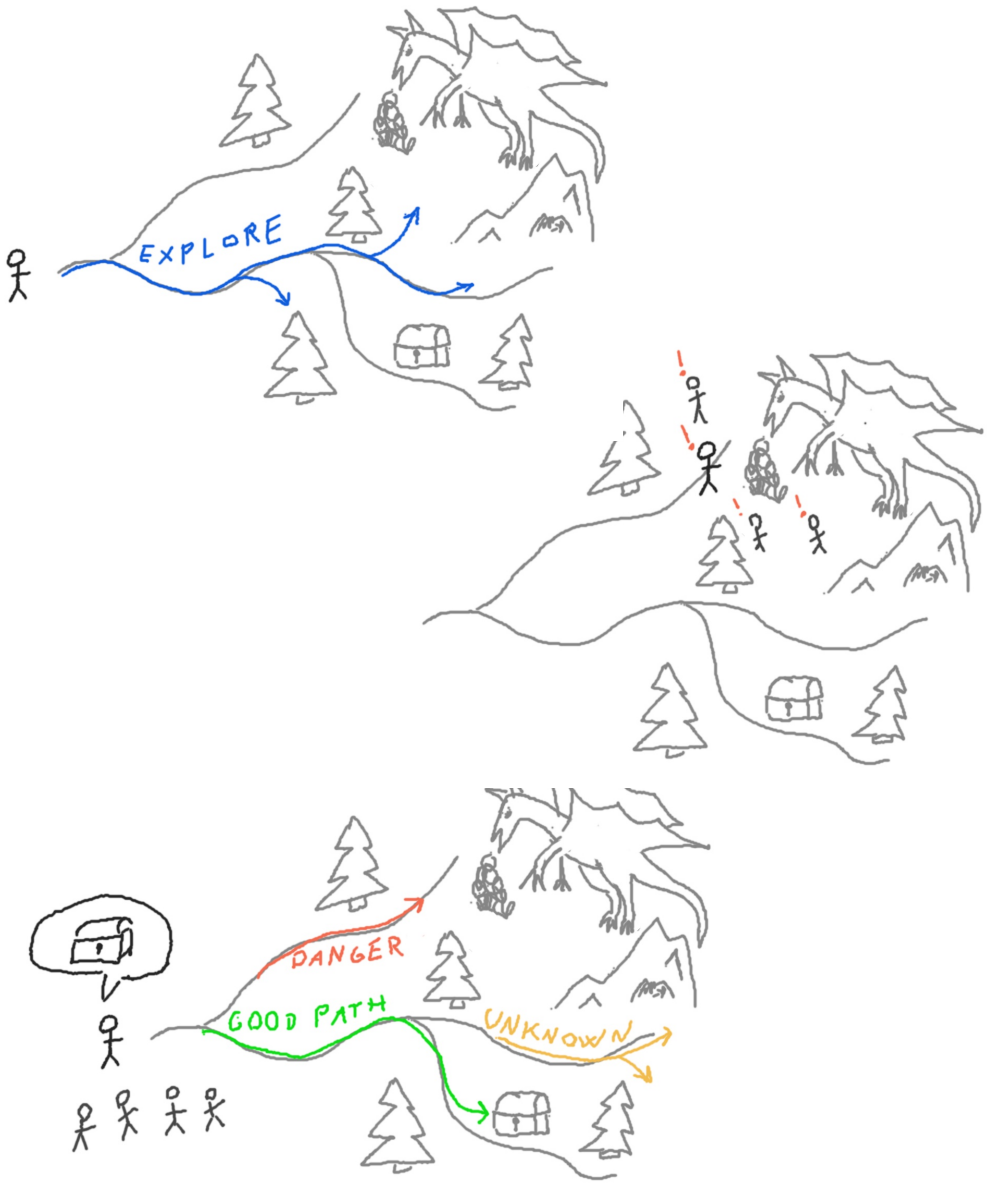
- ... pick any topic from previous year
- ... pick some other CG related topic

World is a vast and mysterious place!

Mandelbulber, http://krzysztofmarczak.deviantart.com/art/3D-Mandelbrot-1-263702708

When you have a topic...

- Look for materials
- Investigate, research
- Find examples
- Try it out yourself
- Present your findings
- Engage others
  - Discussion
  - Interactive demo
  - Workshop



Creating a Presentation

Creating a Presentation

Ensure you understand what you put on the slide!

$$L_o = L_e + \int_{\Omega} L_i \cdot f_r \cdot \cos\theta \cdot d\omega$$

Creating a Presentation

Ensure you understand what you put on the slide!

Use big fonts, use your slide space optimally.

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Creating a Presentation

Ensure you understand what you put on the slide!

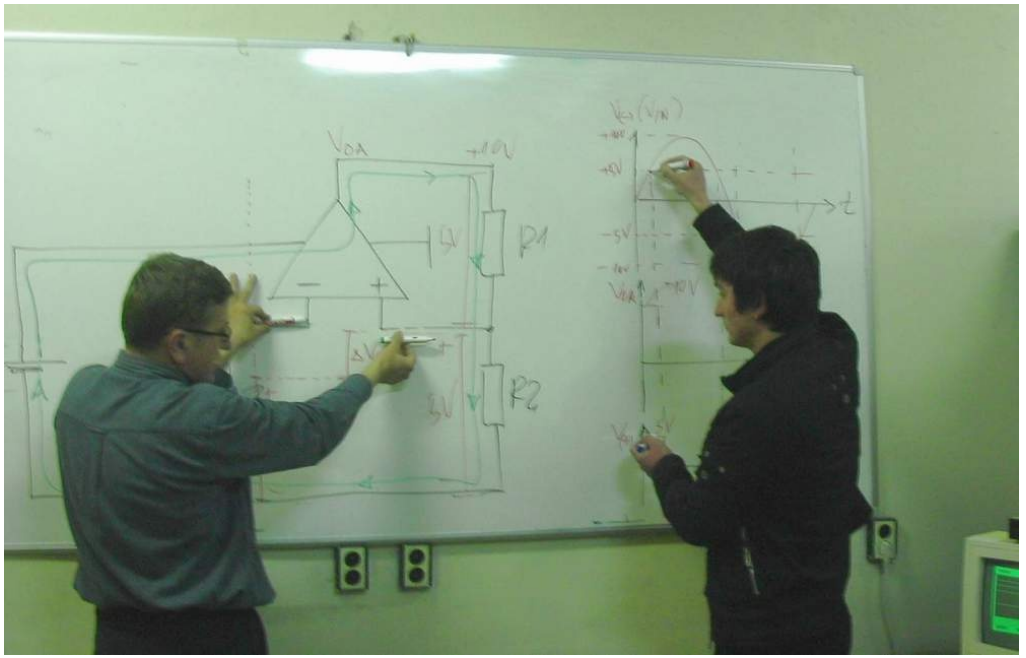
Use big fonts, use your slide space optimally.

Try to make the drawings, diagrams etc yourself.

paint.net

draw.io

GeoGebra
Dynamic Mathematics for Everyone



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Try to make the drawings, diagrams etc yourself.

Put drawings, diagrams etc on the slides!

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Put drawings, diagrams etc on the slides!

Try to implement what you share.

Creating a Presentation

Ensure you understand what

Use big fonts, use your slide

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Try to implement what you sh

The quality should be on par with a thesis level.

Creating a Presentation

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Put drawings, diagrams etc on the slides!

Try to implement what you share.

The quality should be on par with a

You are the master of your topic!

Creating a Presentation

- Ensure you understand what you put on the slide!
- Use big fonts, use your slide space optimally.
- Try to make the drawings, diagrams etc yourself.
- Put drawings, diagrams etc on the slides!
- Try to implement what you share.
- The quality should be on par with a thesis level.
- You are the master of your topic!

Want to do projects?

- **Computer Graphics Project** (MTAT.03.316)
  - 3 credits course
  - Consists entirely of a project
  - Work on your own idea throughout the semester
  - Roughly 6h per every 2 weeks
  - https://courses.cs.ut.ee/2016/cg-project/fall

I didn't understand >70% of what you said...

- Don't worry about it!
- Pick a topic that suits your knowledge base
- Your topic may very well be:
  - Rasterization of triangles
  - Comparison of lighting models
  - How to do simple shadows?
  - Raytracing explained
  - etc

I don't even know where to start!

- There will be 2 introductory lectures about the basics.
- Check out the topics from Computer Graphics:

  https://courses.cs.ut.ee/2016/cg/fall

  https://courses.cs.ut.ee/2017/cg/fall

- Check out the topics from the previous seminar:

  https://courses.cs.ut.ee/2017/cg-sem/fall/Main/Seminars

  https://courses.cs.ut.ee/2017/cg-sem/spring/Main/Seminars

- Find some online tutorial and try it out.

Questions?

List of some arbitrary topics

1. **Color blending** – What happens when there are transparent objects in your scene?
2. **Lighting models** – What are the common models? Where and when are they used?
3. **Texturing** – How can one sample from a texture? What kinds of artefacts may appear?
4. **Curves** – Why are they important in CG? What about curved surfaces?
5. **Global illumination** – Pick one or compare different methods: Radiosity, path tracing, photon mapping.
6. **Realtime realistic rendering** – Provide an overview of the common methods or pick some effect (light, wetness, fog, fur / hair) and find out how it's rendered realistically in real time.
7. **Non-photorealistic rendering** – Where is it used and how is it achieved? Realtime vs prerendered?
8. **Tessellation** – How can this be done in OpenGL 4?
9. **Post-processing effects** – What effects are there? When and how are they used?
10. **Procedural generation** – Where and how is it used? How to apply procedural textures to procedurally generated meshes?

List of some other topics

11. **Physically-Based Shading** – What is it? Why is it important to understand physical properties of materials for shading? What games / game engines use it?
12. **Rendering in VR** – What extra considerations are in VR? How do different technologies overcome them?
13. **Vulkan** – What can be done with it? Why is it useful? How to Vulkan?
14. **Subsurface scattering** – What is it? How it is implemented? What does it solve?
15. **Reflections and caustics** – What are the modern techniques, which do those?
16. **GLSL vs HLSL** – What are the differences? How are both used?
17. **Use case study** – Find out in detail how graphics are done in one game or movie.
18. **Motion capture** – What are the difficulties today? Best budget setup for it?
19. **Modern GPU architecture** – How are GPU-s built today? What are they optimized for?
20. **Graphics on consoles / smartphones** – What limitations are there in consoles or embedded systems vs the PC? How to overcome them compared to the PC approach?