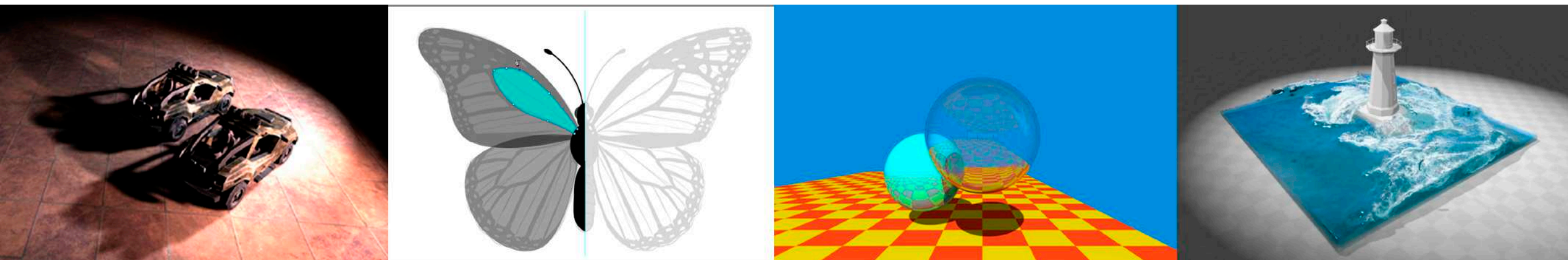


Introduction to Computer Graphics

GAMES101, Lingqi Yan, UC Santa Barbara

Lecture 1: Overview of Computer Graphics



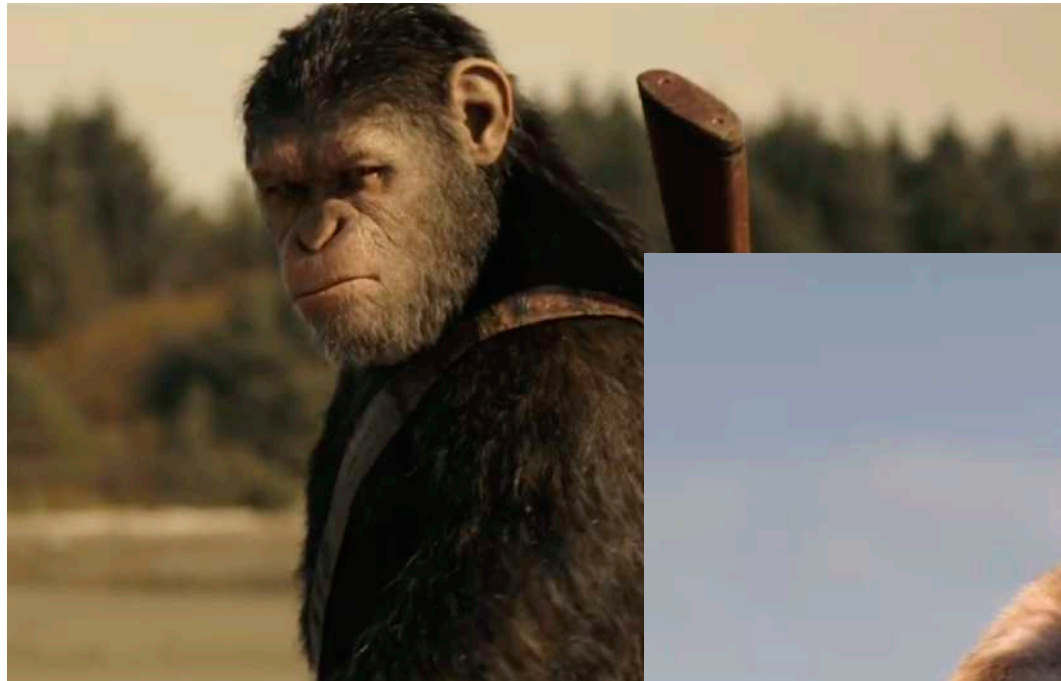
Welcome!

Instructor

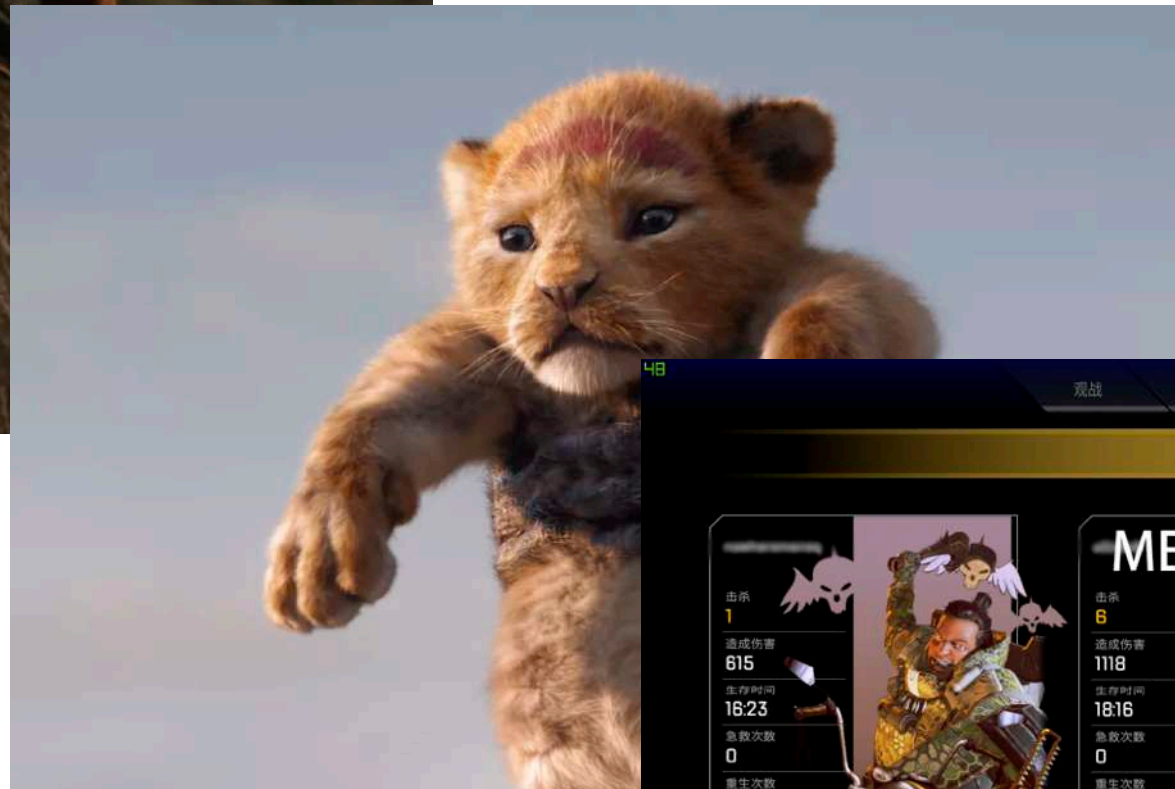
- Lingqi Yan (闫令琪)
 - 2018 - now: Assistant Professor @ UCSB
 - 2013 - 2018: Ph.D @ UC Berkeley
 - 2009 - 2013: B.E. @ Tsinghua University
 - Website: www.cs.ucsb.edu/~lingqi/
 - Research: Rendering in Computer Graphics
 - Hobbies: research, video games, piano, traveling, NBA, etc.



Instructor's Achievements



2018: Oscar Nominee
for Best Visual Effects



2019: research 2017
widely adopted in
Lion King HD



**2019: six APEX Champions in one evening
(collaborated with Adobe)**

Course Staff

- Teaching Assistants
 - 刘光哲 (清华, lgz17@mails.tsinghua.edu.cn)
 - 史雨宸 (中科大, syc0412@mail.ustc.edu.cn)
 - 邓俊辰 (哈工大, 1050106988@qq.com)
- More will be recruited soon after this lecture (based on need)

Today's Topics

- What is Computer Graphics?
- Why study Computer Graphics?
- Course Topics
- Course Logistics
- Linear Algebra Review

What is Computer Graphics?

com•put•er graph•ics /kəm'pyʊdər 'ɡrafiks/ n.

The use of computers to synthesize and manipulate visual information.

Today's Topics

- What is Computer Graphics?
- Why study Computer Graphics?
 - Applications
 - Fundamental Intellectual Challenges
 - Technical Challenges
- Course Topics
- Course Logistics

Video Games



Sekiro: Shadows Die twice (2019 Game of the Year)

Video Games



Borderlands 3 (2019)

Movies



The Matrix (1999)

Movies



Avatar (2009)

Animations



Zootopia (2016)

Animations



Frozen 2 (2019)

Design



CG



Photo

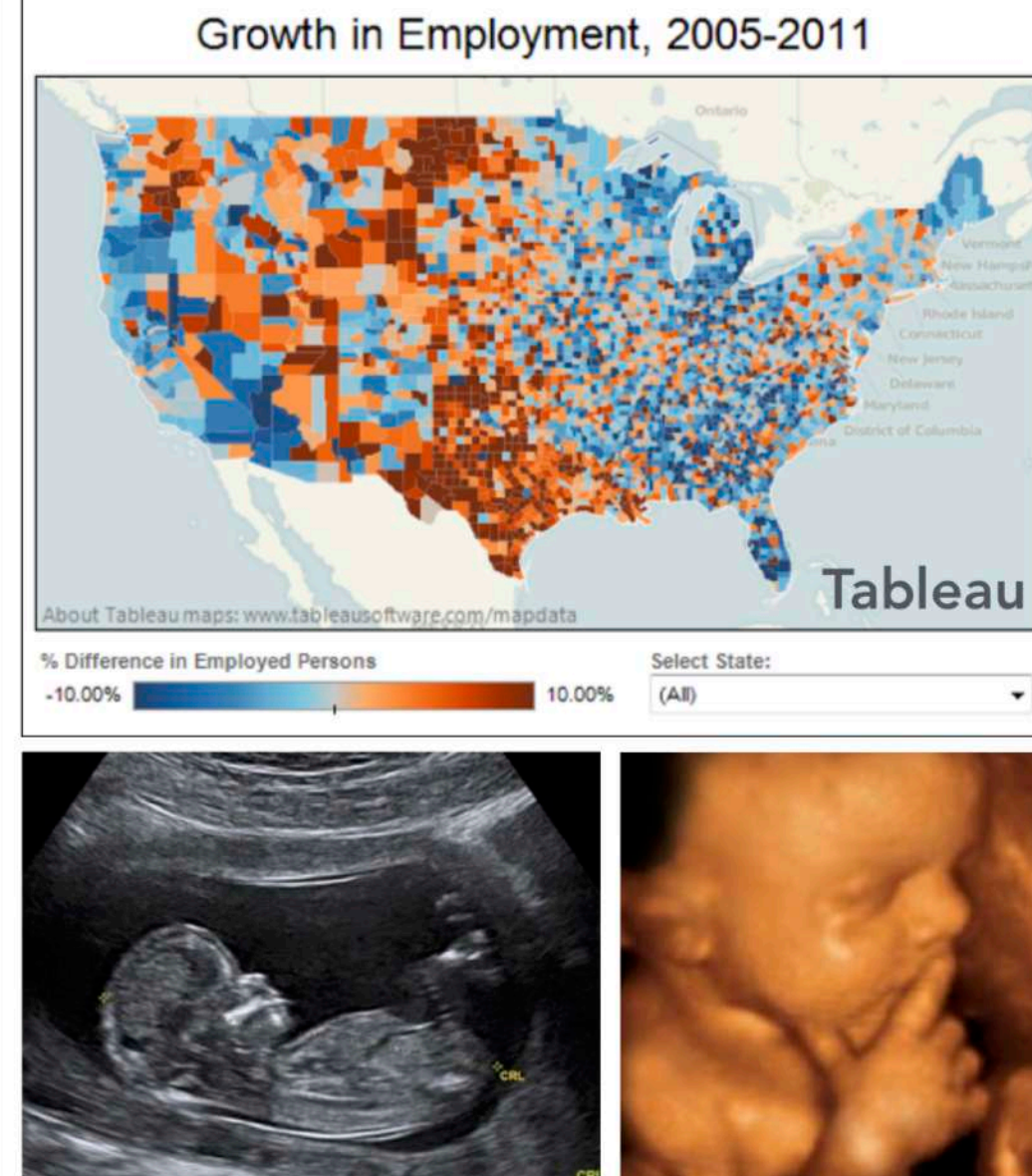
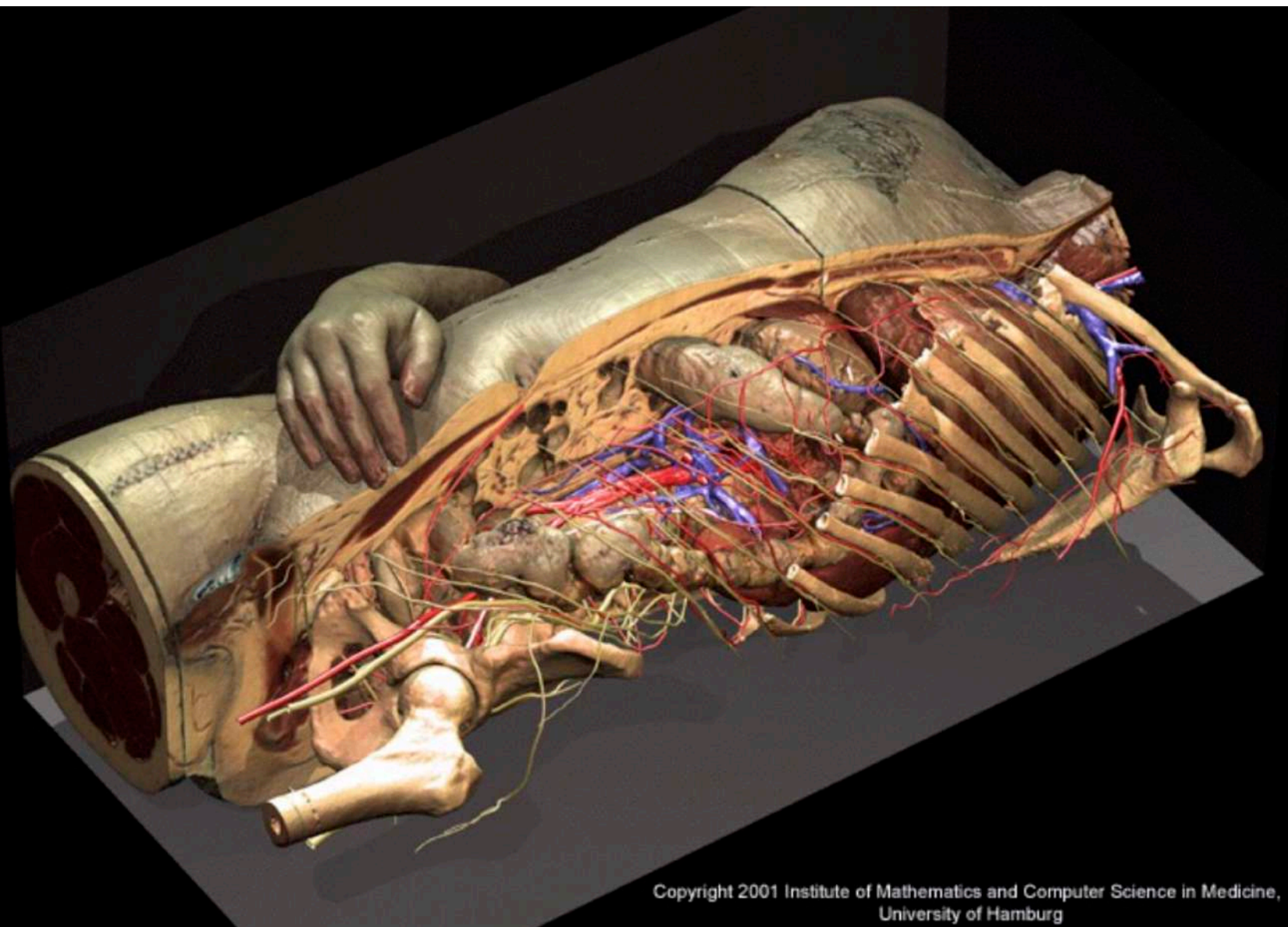
Autodesk Gallery

Design



Ikea - 75% of catalog is **rendered** imagery

Visualization

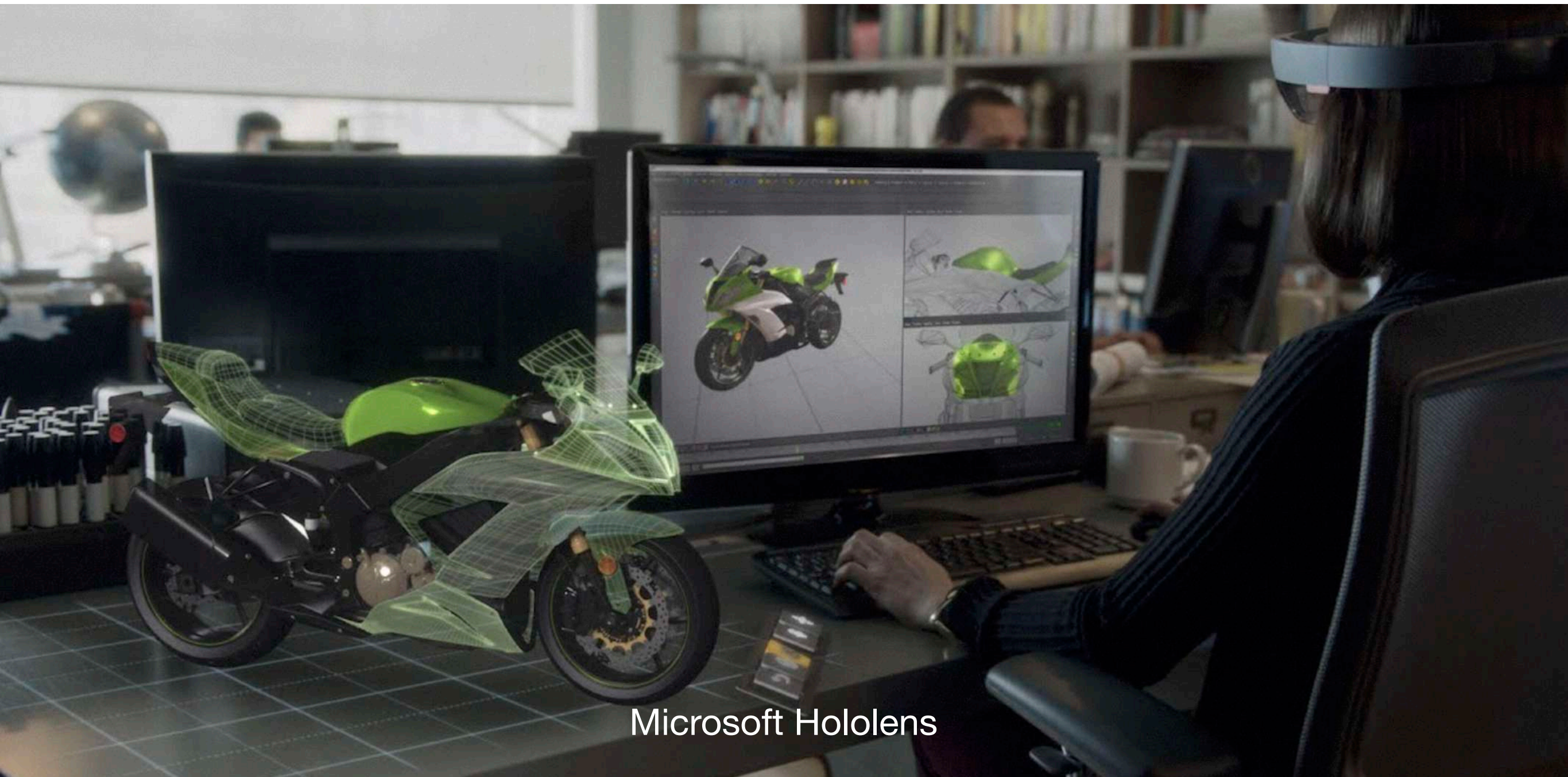


Science, engineering, medicine, journalism, etc.

Virtual Reality



Augmented Reality



Microsoft HoloLens

Digital Illustration



Simulation



The Dust Bowl phenomena



Black hole from Interstellar

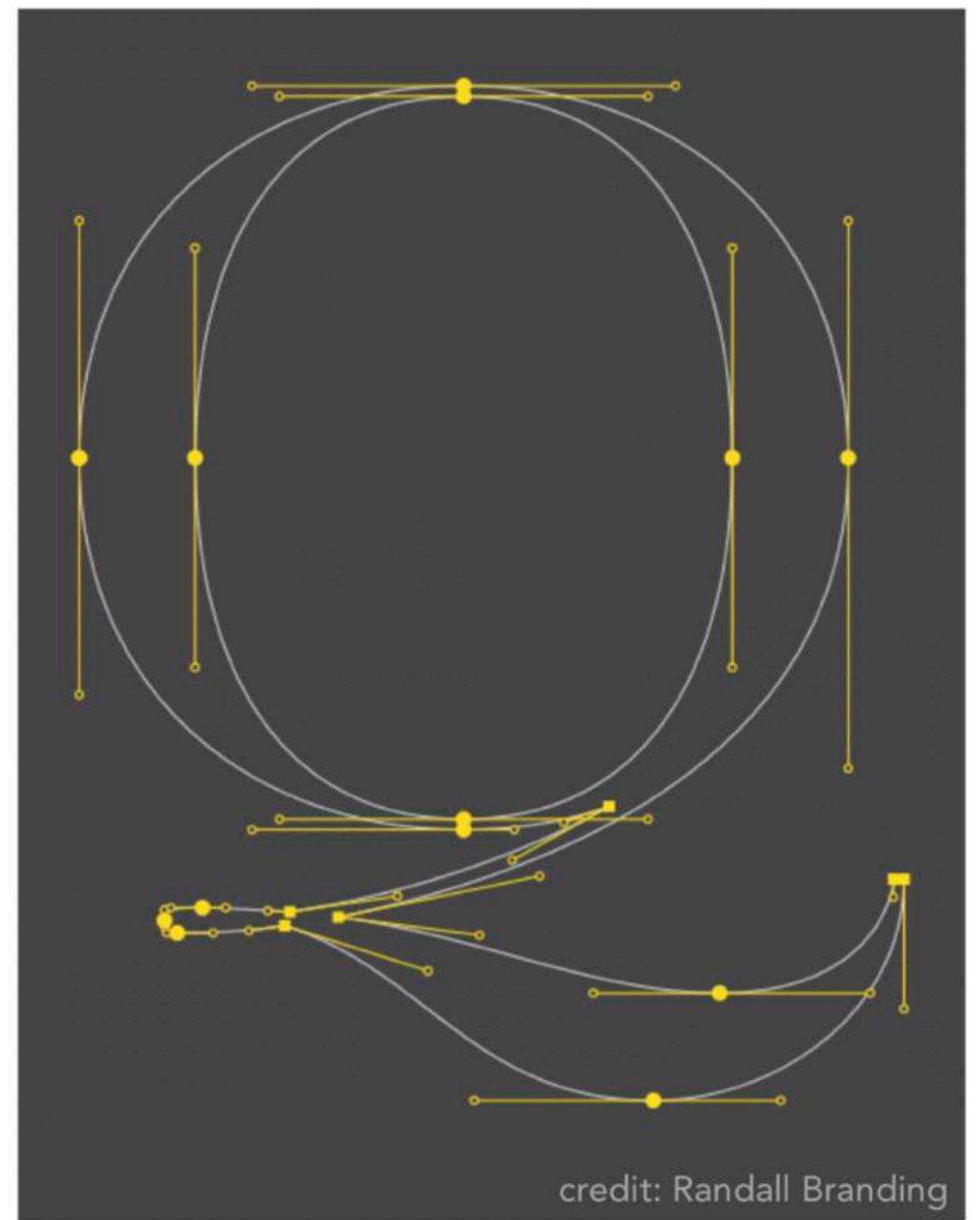
Graphical User Interfaces



Typography

The Quick Brown
Fox Jumps Over
The Lazy Dog

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz 01234567890



The font Baskerville

Why Study Computer Graphics?

- Fundamental Intellectual Challenges
 - Creates and interacts with realistic virtual world
 - Requires understanding of all aspects of physical world
 - New computing methods, displays, technologies

Why Study Computer Graphics?

- Technical Challenges
 - Math of (perspective) projections, curves, surfaces
 - Physics of lighting and shading
 - Representing / operating shapes in 3D
 - Animation / simulation
 - ~~3D graphics software programming and hardware~~

Why Study Computer Graphics?

- Forget about the previous reasons

**Computer Graphics
is
AWESOME!**

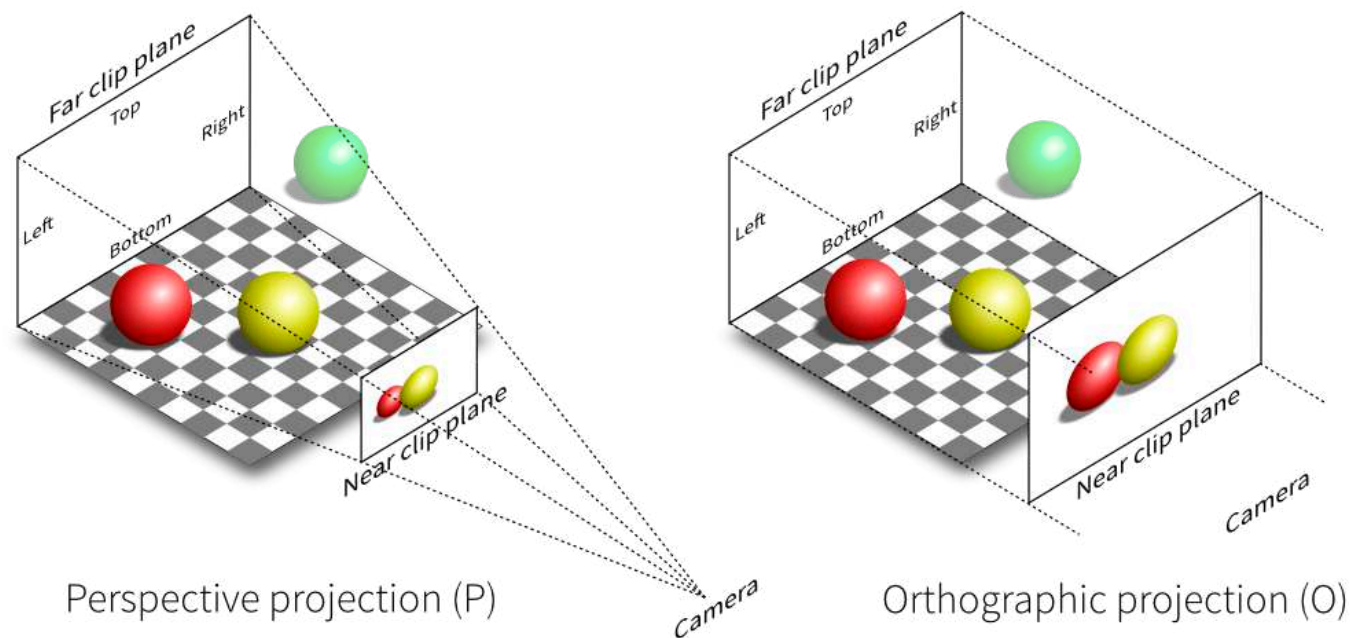
Questions?

Today's Topics

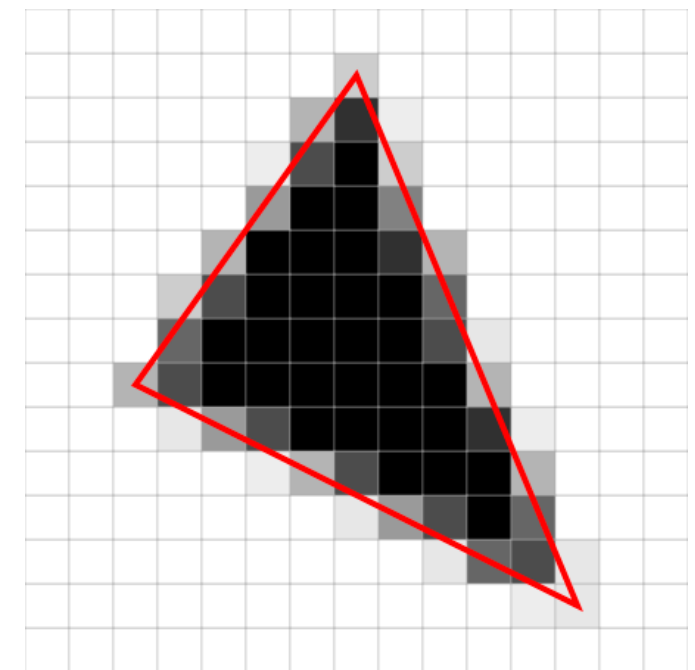
- What is Computer Graphics?
- Why study Computer Graphics?
- Course Topics (mainly 4 parts)
 - Rasterization
 - Curves and Meshes
 - Ray Tracing
 - Animation / Simulation
- Course Logistics

Rasterization

- Project **geometry primitives** (3D triangles / polygons) onto the screen
- Break projected primitives into **fragments** (pixels)
- Gold standard in Video Games (Real-time Applications)



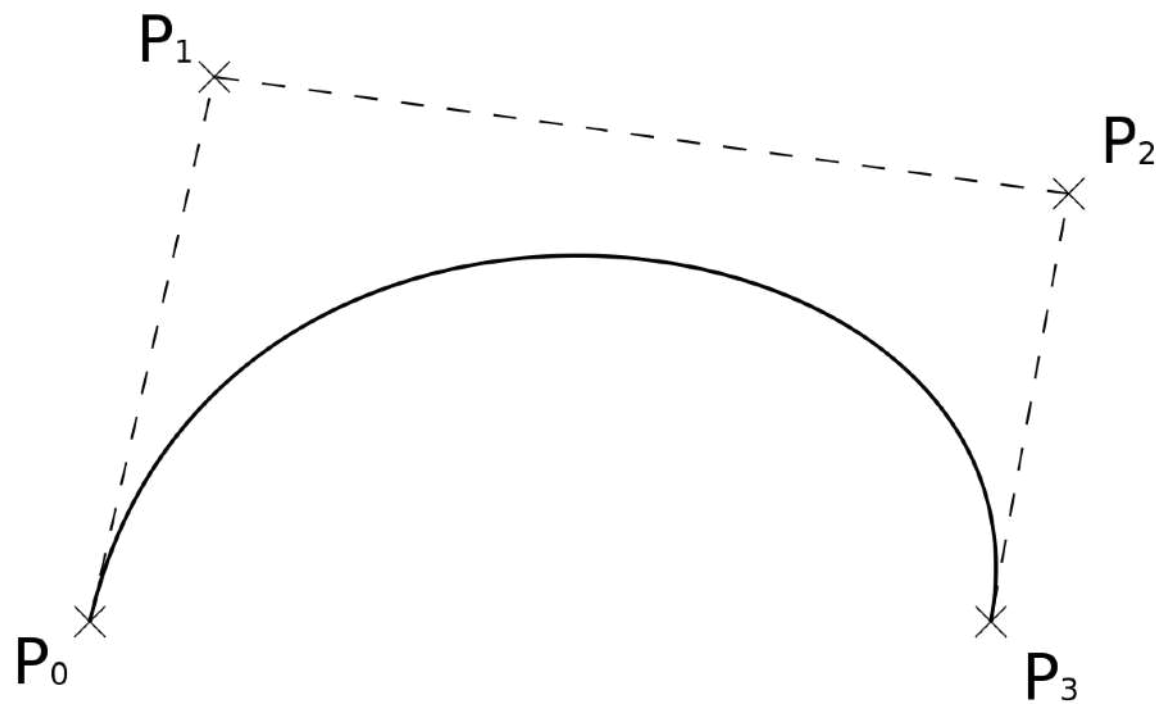
<http://vispy.org/modern-gl.html>



https://commons.wikimedia.org/wiki/File:Rasterisation-triangle_example.svg

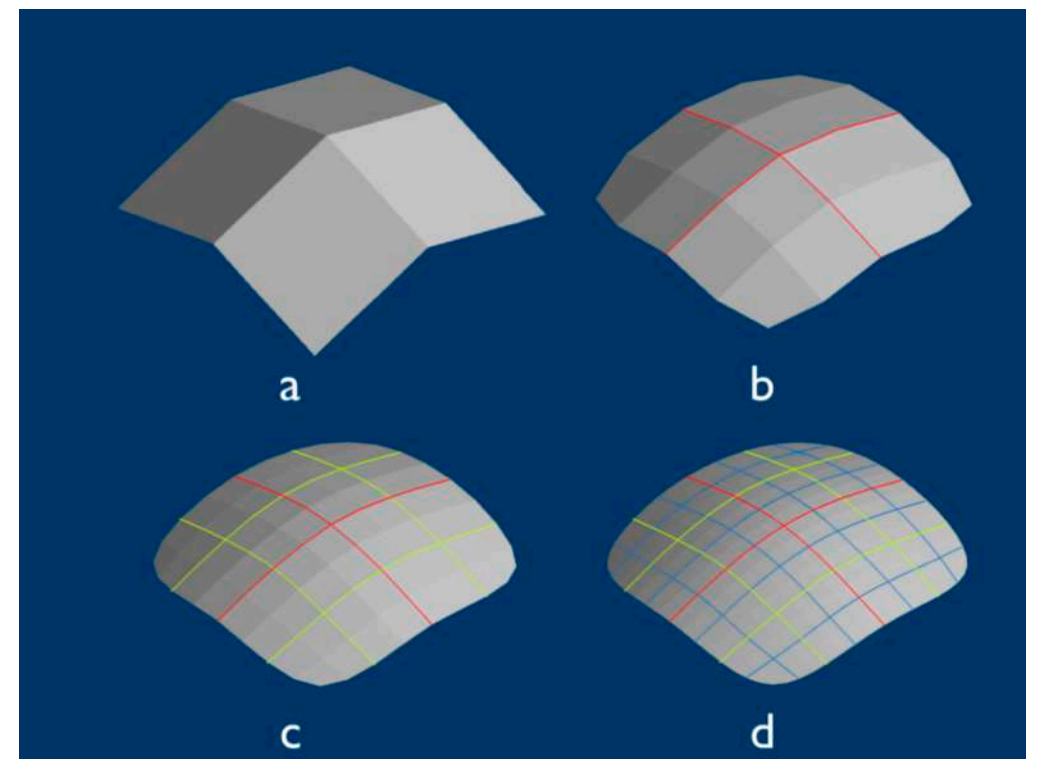
Curves and Meshes

- How to represent geometry in Computer Graphics



Bezier Curve

https://en.wikipedia.org/wiki/Bezier_curve

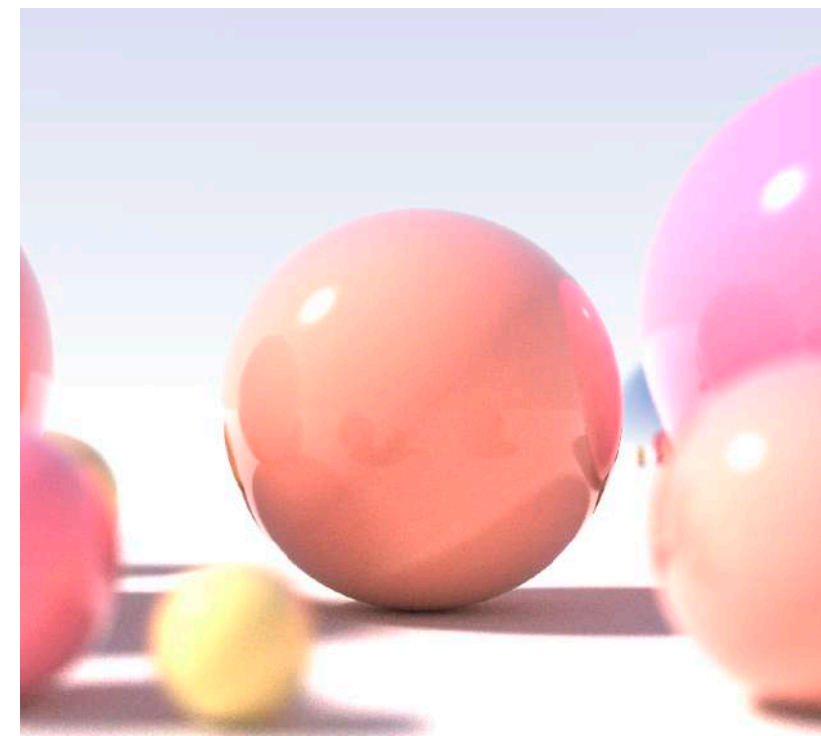
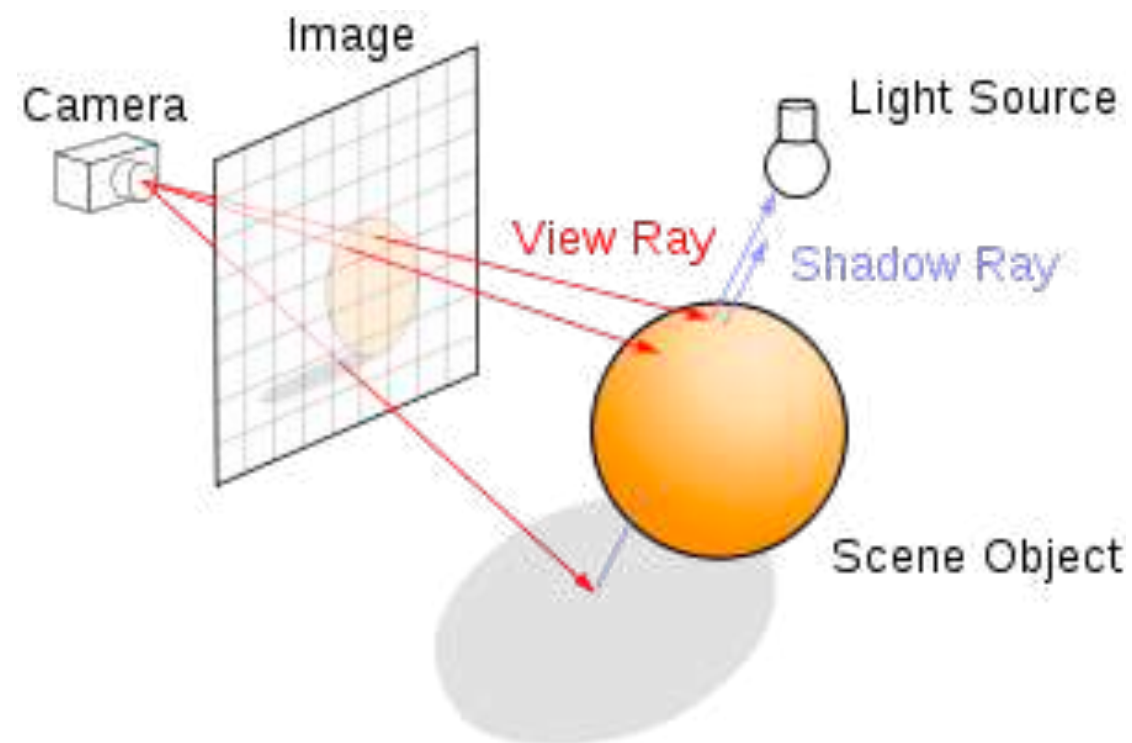


Catmull-Clark subdivision

https://commons.wikimedia.org/wiki/File:Catmull-Clark_subdivision_of_4_planes.png

Ray Tracing

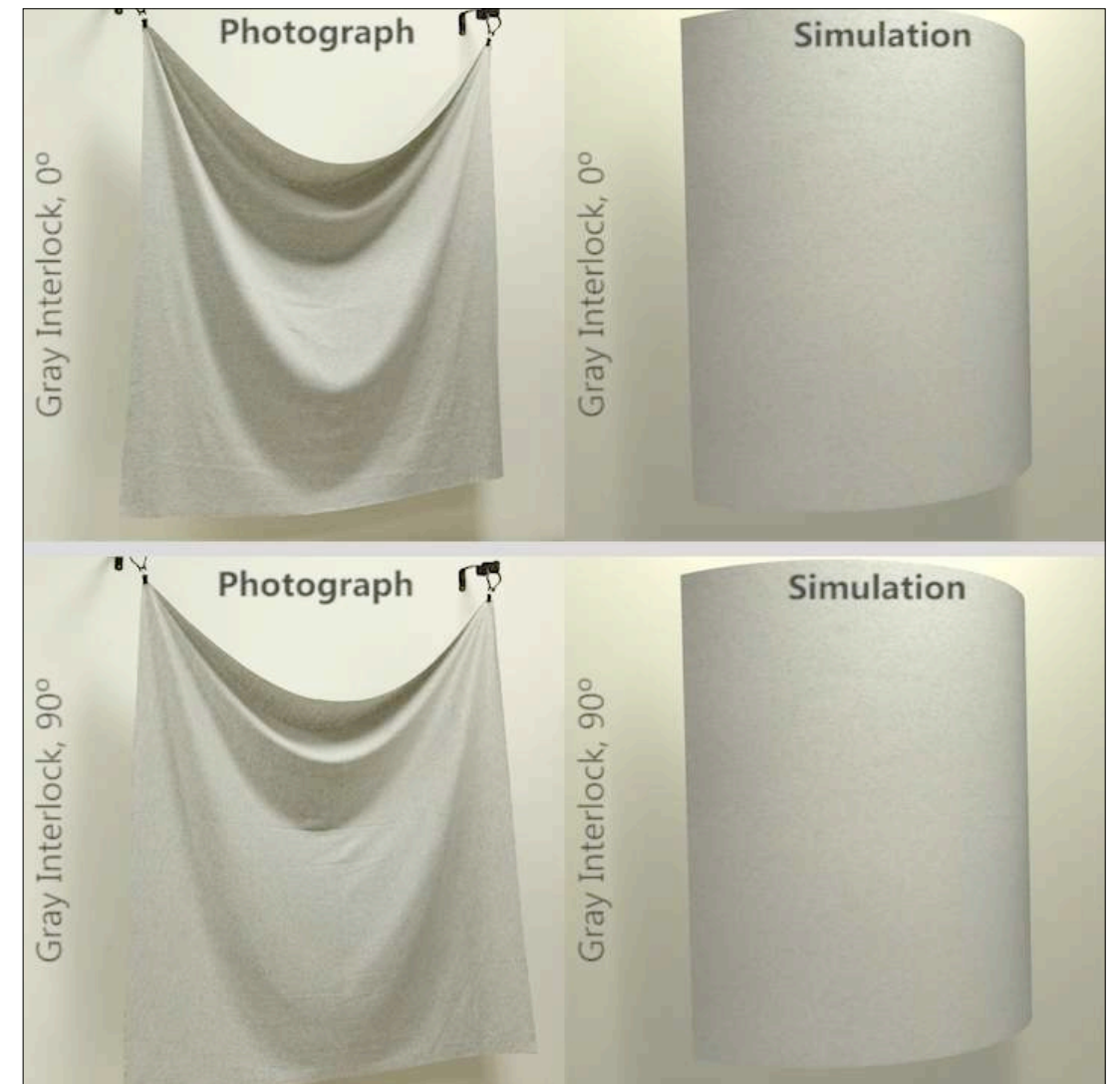
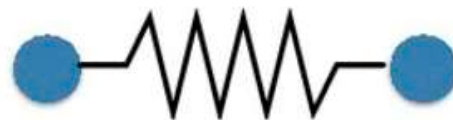
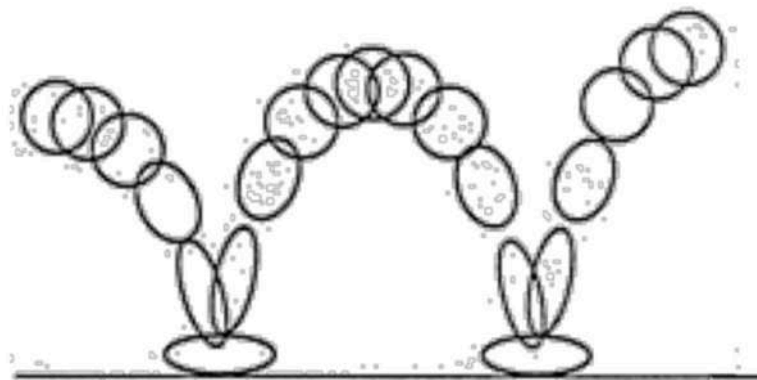
- Shoot rays from the camera through each pixel
 - Calculate **intersection** and **shading**
 - **Continue to bounce** the rays till they hit light sources
- Gold standard in Animations / Movies (Offline Applications)



[https://en.wikipedia.org/wiki/Ray_tracing_\(graphics\)](https://en.wikipedia.org/wiki/Ray_tracing_(graphics))

Animation / Simulation

- Key frame Animation
- Mass-spring System



GAMES101 is **NOT** about

- Using OpenGL / DirectX / Vulkan
- The syntax of Shaders
- We learn Graphics,
not Graphics APIs!
- After this course,
you'll be able to learn these
by yourself (**I promise**)

Name

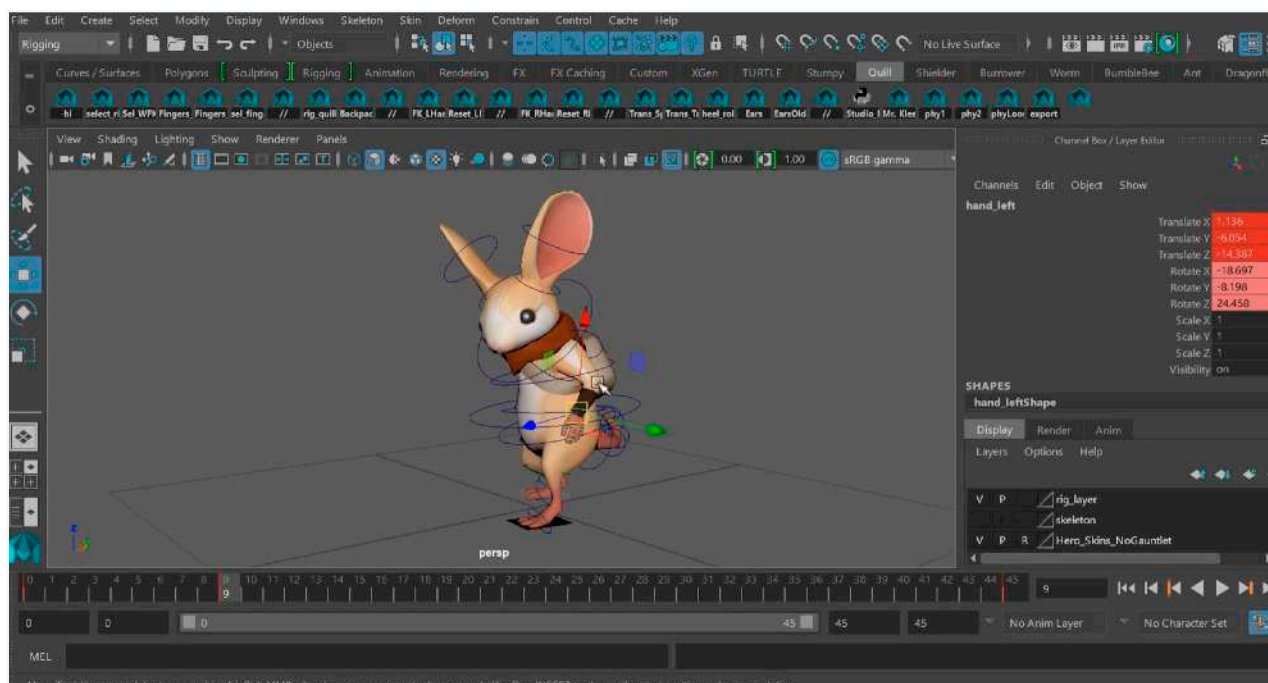
`gluPerspective` — set up a perspective projection matrix

C Specification

```
void gluPerspective( GLdouble fovy,  
                    GLdouble aspect,  
                    GLdouble zNear,  
                    GLdouble zFar);
```

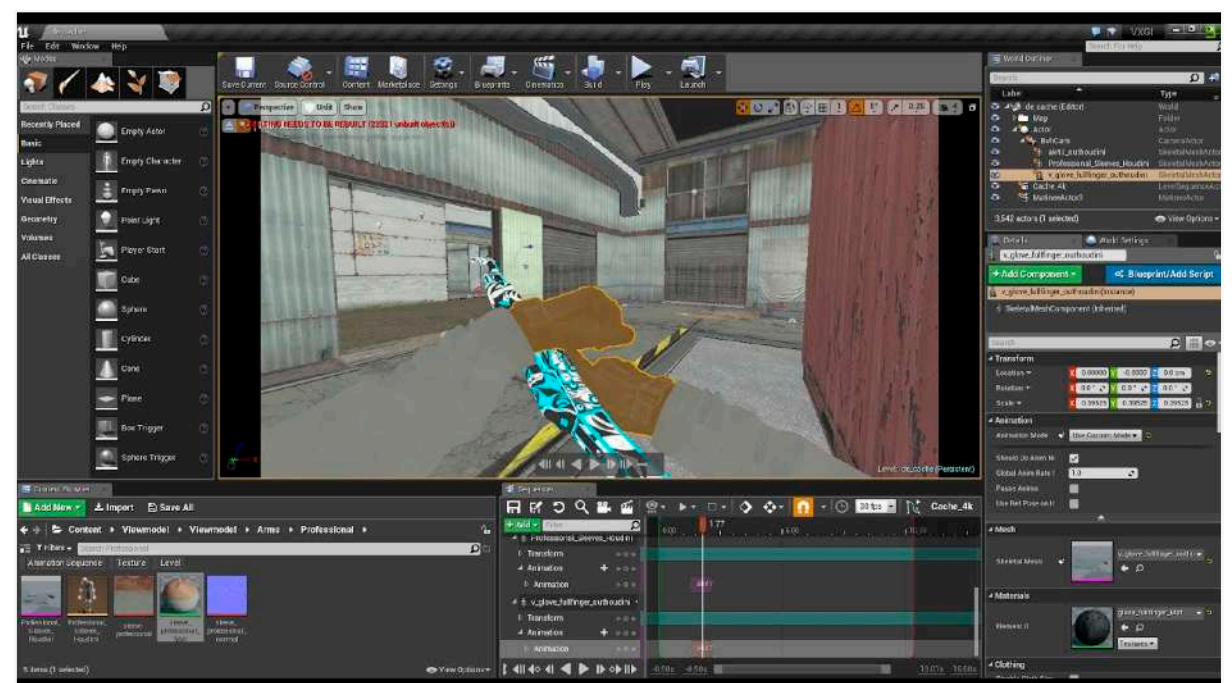

GAMES101 is **NOT** about

- 3D modeling using Maya / 3DS MAX / Blender, or VR / game development using Unity / Unreal Engine (where can I learn them?)



Modeling character animation in Maya

[<http://tutorials.cgreCORD.net/2017/08/17-minute-animation-process-in-autodesk.html>]



CSGO PoV Cam set up in Unreal Engine

[<https://www.youtube.com/watch?v=3TQ18SmQSw0>]

GAMES101 is **NOT** about

- Computer Vision / Deep Learning topics, e.g. XYZ-GAN
(where can I learn them?)



Semantic Segmentation

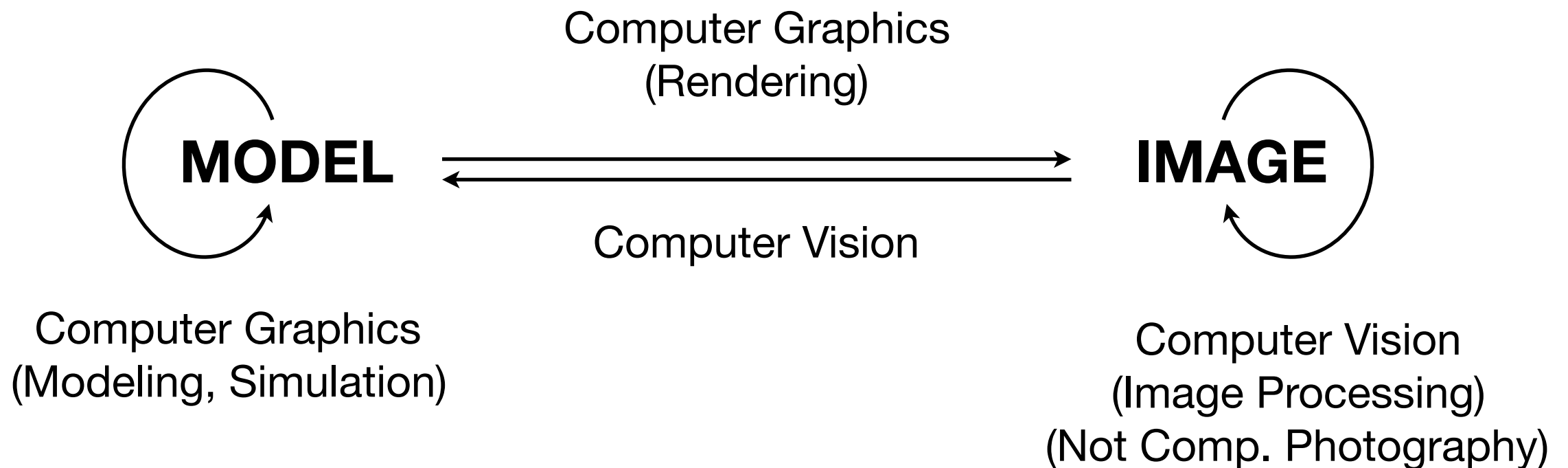
<https://modeldepot.io/oandrienko/icnet-for-fast-segmentation>



GAN 2.0: NVIDIA's
face generator (both are fake)

Differences?

- Personal Understanding



- No clear boundaries
- And I can't define Computer Graphics

Questions?

Today's Topics

- What is Computer Graphics?
- Why study Computer Graphics?
- Course Topics
- Course Logistics

General Information

- Modern Course

- Comprehensive but
without hardware programming!
- Pace / contents subject to change



- Course Website

- <http://www.cs.ucsb.edu/~lingqi/teaching/games101.html>
- Has all the needed information
- Syllabus, slides, reading materials, etc.

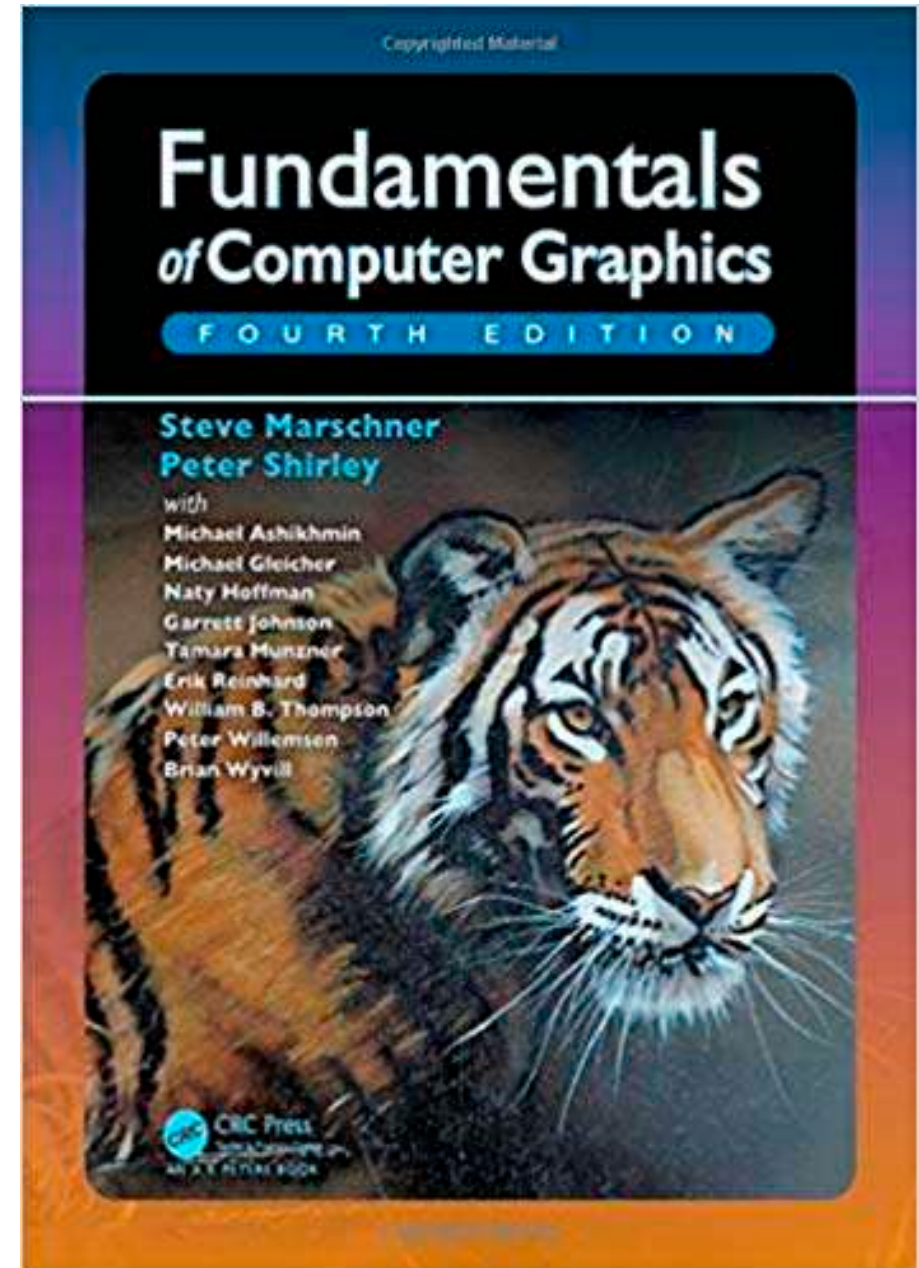
Course Website

- Course slides and (pre)-reading materials

Week	Date	Topics
1	Jan 7	Overview of Computer Graphics [PDF]
	Jan 9	Vectors and Linear Algebra Reading: Chapter 2 (Miscellaneous Math) and Chapter 5 (Linear Algebra)

References

- No Required Textbooks
 - Reading materials (if any) will be available online before lectures
 - Lecture slides will be available after class
- Most recommended reference
 - Steve Marschner and Peter Shirley, "Fundamentals of Computer Graphics", 3rd or later edition.



Q & A

- Sign up on our BBS for discussion
(<http://games-cn.org/forums/forum/games-online-course-forum/>)

The screenshot shows the GAMES forum interface. The main header is '计算机图形学与混合现实研讨会' (GAMES: Graphics And Mixed Environment Seminar). Below it, a navigation bar includes links like '首页', '活动通知', '往期报告PPT&视频', '在线课程', 'GAMES线下会议', '招聘信息', '讨论区', and '其他信息'. The main content area displays a forum thread titled '现代计算机图形学入门讨论区主楼(置顶)'. The thread summary states: 'This forum has 3 topics (+1 hidden), 1 reply, and was last updated 1 day, 12 hours ago by Chen, Linghao.' Below this, a table lists the topics:

Topic	Voices	Posts	Last Post
现代计算机图形学入门讨论区主楼(置顶) Started by: Chen, Linghao	2	2	3 days, 20 hours ago 风儿
现代计算机图形学入门作业提交方式 Started by: Chen, Linghao	1	1	1 day, 12 hours ago Chen, Linghao
Frequently Asked Questions(Keep Updating) Started by: Chen, Linghao	1	1	3 days, 11 hours ago Chen, Linghao

On the right side, there is a 'FOLLOW:' section, a 'NEXT STORY' section with a link to 'GAMES在线课程 (现代计算机图形学入门) 讨论区', and a search bar. At the bottom right, there is an '活动通知' (Activity Notice) for 'GAMES Webinar 2020 - 127 期' by Tuanfeng Y. Wang.

Assignments

- Assignments

- Mostly programming tasks with provided code skeletons and virtual machine image
- Weekly (usually no more than 20 lines of code per week)
- Language: C++

- Submission

- Submit your project by 11:59PM on/before the due dates (strictly enforced)
- Feedback will be provided in a week

Assignments

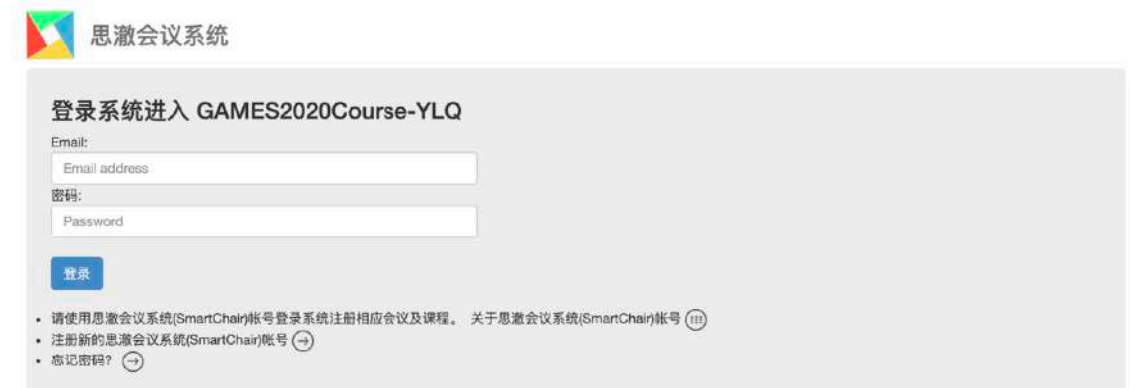
- Assignment Submission Website

(<http://www.smartchair.org/GAMES2020Course-YLQ/>)

- No Exams

- Course Project / Final Project

- Starting midway of this course
- References will be provided, but you decide the topic
- Best work will be posted online for showing off



思澈会议系统

登录系统进入 GAMES2020Course-YLQ

Email:

Email address

密码:

Password

登录

• 请使用思澈会议系统(SmartChair)帐号登录系统注册相应会议及课程。关于思澈会议系统(SmartChair)帐号 (??)

• 注册新的思澈会议系统(SmartChair)帐号 (→)

• 忘记密码? (→)

GAMES2020在线课程：计算机图形学（闫令琪）

<http://games-cn.org/intro-graphics>

在线 2020年 2月9日 ~ 5月30日

本课程将全面而系统地介绍现代计算机图形学的四大组成部分：(1) 光栅化成像，(2) 几何表示，(3) 光的传播理论，以及(4) 动画与模拟。每个方面都会从基础原理出发讲解到实际应用，并介绍前沿的理论研究。通过本课程，你可以学习到计算机图形学背后的数学和物理知识，并锻炼实际的编程能力。

原名意义，作为入门，本课程会尽可能的覆盖图形学的方方面面，把每一部分的基本概念都尽可能说清楚，让大家对计算机图形学有一个完整的、自上而下的全局把握。全局的理解很重要，学完本课程后，你会了解到图形学不等于 OpenGL，不等于光线追踪，而是一套生成整个虚拟世界的方法。从本课程的标题，大家还可以看到“现代”二字，也就是说，这门课所要给大家介绍的都是现代化的知识，也都是现代图形学工业界需要的图形学基础。

本课程与其它图形学教程还有一个重要的区别，那就是本课程不会讲授 OpenGL，甚至不会提及这个概念。本课程所讲授的内容是图形学背后的原理，而不是如何使用一个特定的图形学API。在学习完这门课的时候，你一定有能力自己使用OpenGL编写实时渲染的程序。另外，本课程并不涉及计算机视觉、图像视频处理、深度学习，也不会介绍游戏引擎与三维建模软件的使用。

Use An IDE!

- IDE: Integrated Development Environment
- Helps you parse a entire project
 - And gives hints on syntax / usages of member functions, etc.
- Recommended IDEs
 - Visual Studio (Windows only) / Visual Studio Code (cross platform)
 - Qt Creator (personal)
- Not Recommended IDEs (for C++ programming)
 - CLion, Eclipse
 - Sublime Text, Vi / Vim, Emacs (not even IDEs)

Academic integrity

- Work alone for regular assignments
 - no copy-pasting from any other sources
- Do not publish your code (on Github, etc.) for assignments using our skeleton code
- Do not post your solution online
 - Discussion / explanation is welcomed

Questions?

Thank you!