

Introduction to Computer Graphics

0. Overview

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Before we start (about language)

- ▶ This is **not** an **EMI** (English as a Medium of Instruction) course.
- ▶ The **lectures** will be in Mandarin Chinese.
- ▶ The **slides**, **homework assignments**, and **exam papers** are in English.
 - ▶ Students are welcome to ask questions, write reports and answer sheets in **Chinese** or **English**.
- ▶ If you are interested in Computer Graphics but not familiar with Chinese, you are welcome to enroll in the **graduate-level Computer Graphics** course (**EMI**) that I will teach in the **next semester**.

About the course

- ▶ Course title: Introduction to Computer Graphics
- ▶ Lectures:
 - ▶ EC115, 10:10~12:00(Tues.) + asynchronous video
- ▶ Pre-requisites:
 - ▶ Computer programming skills in C/C++.
 - ▶ Data structures, such as arrays, trees, and linked lists.
 - ▶ Essential concepts about matrix computation.
- ▶ Teacher:
 - ▶ I-Chen Lin (林奕成)
 - ▶ Email: ichenlin@cs.nycu.edu.tw
 - ▶ Office: EC 704 (工程三館)
 - ▶ Tel ext: 56684

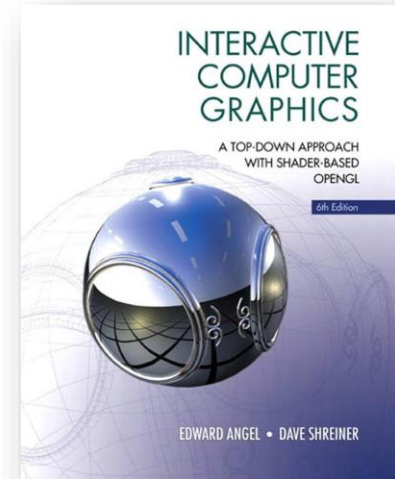
About the course (cont.)

- ▶ TAs:
 - ▶ 張綺恩、廖柏任、王嘉羽等。
 - ▶ Office: EC229b
 - ▶ Phone ext.: 56676
- ▶ Course web page: E3, NYCU
 - ▶ <https://e3p.nycu.edu.tw/course/view.php?id=9314>
- ▶ Participating in a Higher Education Certificate Program.
 - ▶ Students may be required to voluntarily provide some feedbacks for comparison of course design.

About the course (cont.)

▶ Text book:

- ▶ Edward Angel, Dave Shreiner, *Interactive Computer Graphics: A Top-Down Approach with Shader-Based OpenGL*, 6th Edition., Pearson, 2012 (or later versions).



▶ References:

- ▶ Donald D. Hearn, M. Pauline Baker, Warren Carithers, *Computer Graphics with OpenGL* (4th Edition), Pearson, 2010.
- ▶ J. D. Foley, A. van Dam, S. K. Feiner, J. F. Hughes, R. L. Phillips. *Introduction to Computer Graphics*, Addison-Wesley, 1993.
- ▶ Joey de Vries, *Learn OpenGL: Learn modern OpenGL graphics programming in a step-by-step fashion*, Kendall & Welling, 2020.

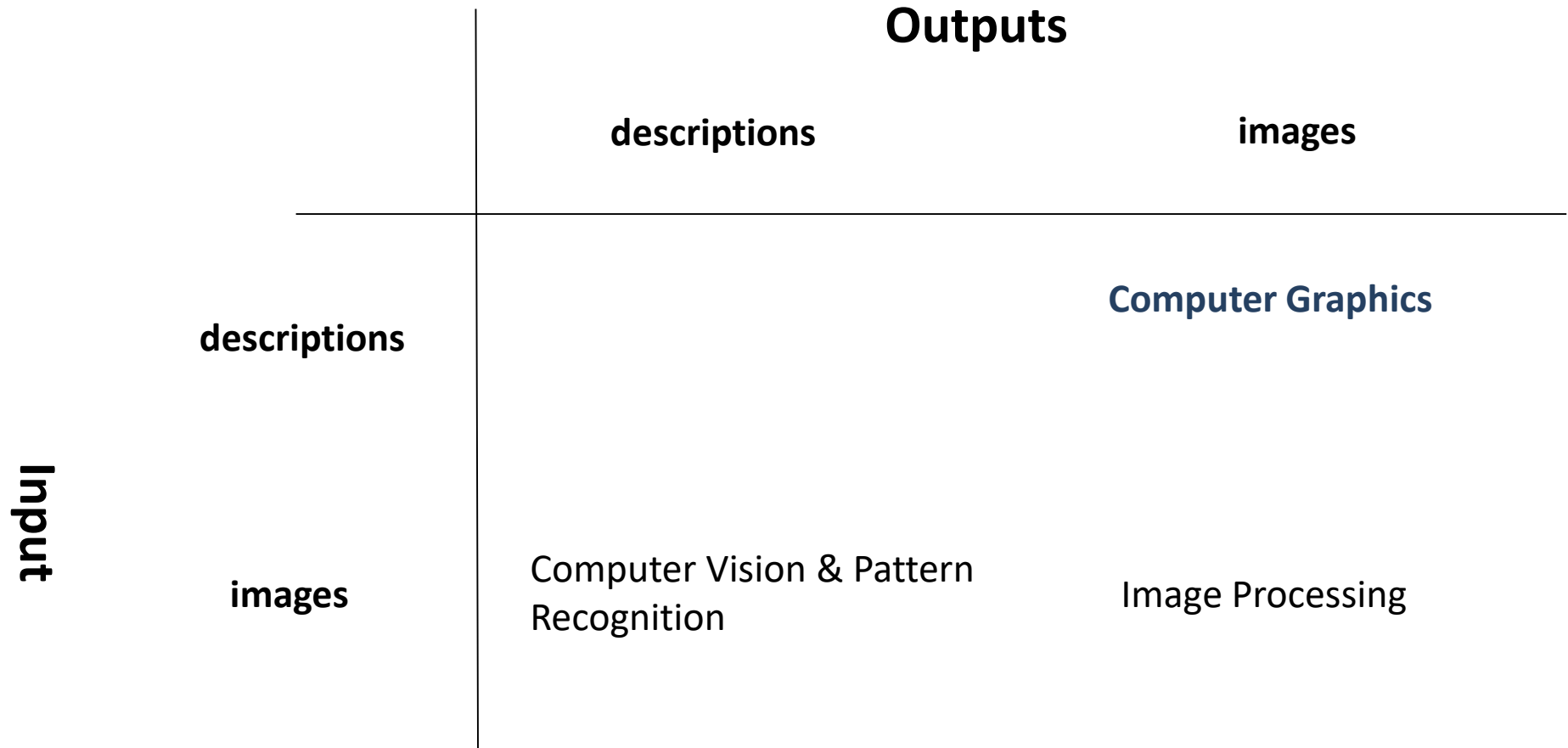
What's CG?

- ▶ Computer Graphics.
 - ▶ Mainly focuses on 3D graphics.
 - ▶ Displays a realistic virtual environment by computers.
 - ▶ Or synthesizes virtual objects in the real world.

What's CG? (cont.)

- ▶ Or demonstrates a virtual world with specific styles.
(e.g. non-photorealistic rendering)
- ▶ CG tech. is the foundation of modern 3D animation, special effects and games.

Graphics and related fields



Nevertheless, the boundaries between these fields, especially CG and CV, are getting indistinct.

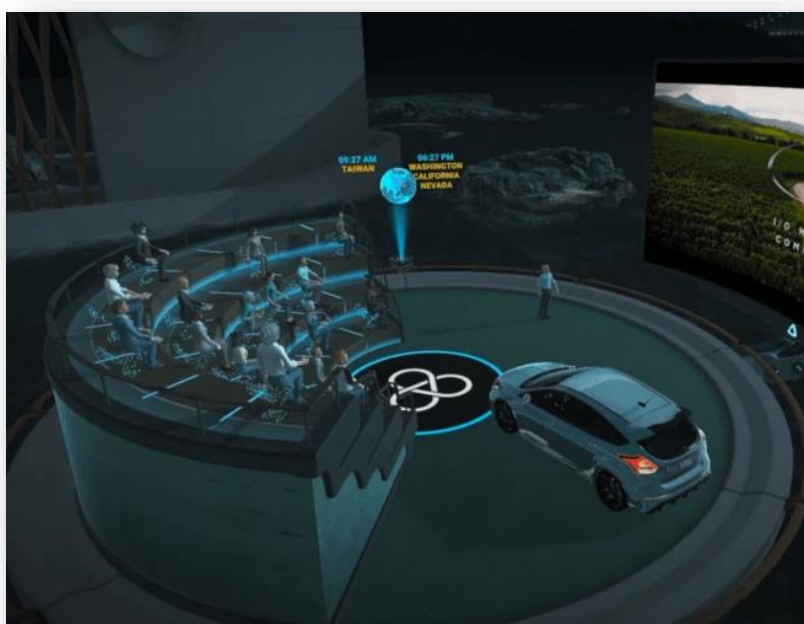
Applications

- ▶ Movies
- ▶ Games
- ▶ Virtual characters



Applications (cont.)

► Virtual reality (VR)



VIVE Sync, VIVE Studio



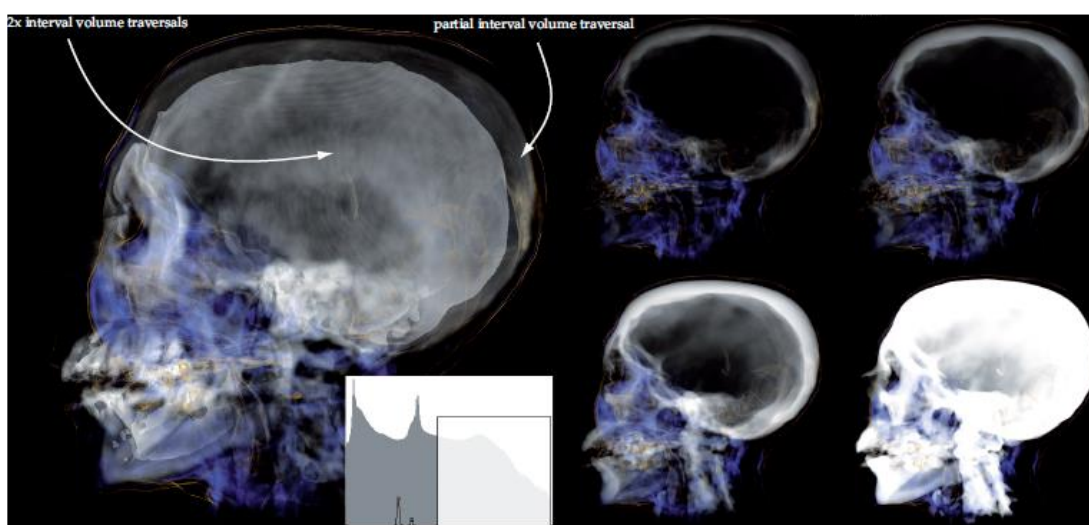
Virtuix Omni



Fig. from:
en.wikipedia.org/wiki/Flight_simulator

Applications (cont.)

- ▶ Medical diagnosis.
- ▶ Virtual Surgery.



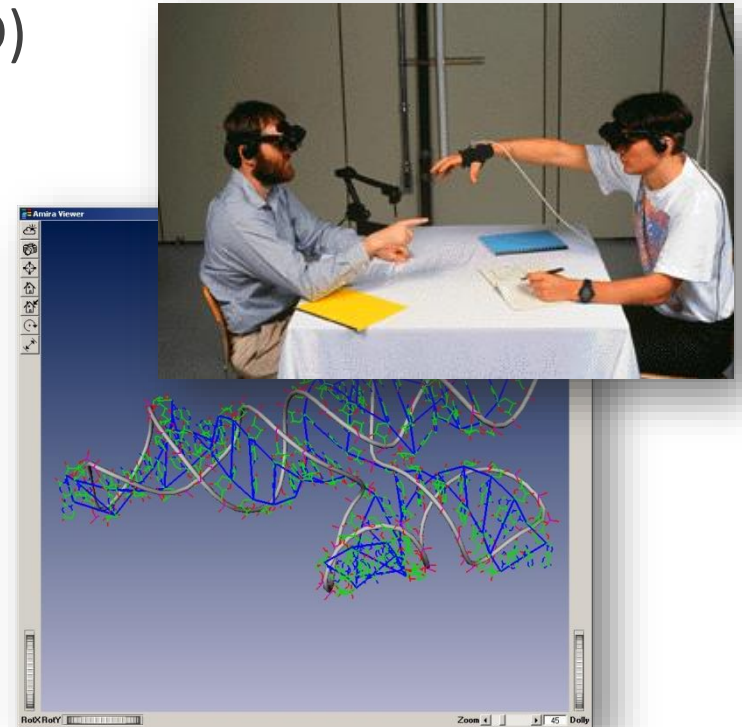
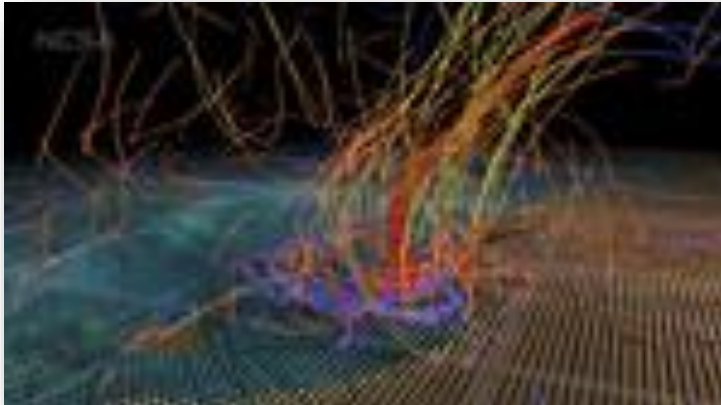
Direct Interval Volume Visualization, IEEE Vis'10



The Karlsruhe Endoscopic Surgery Trainer

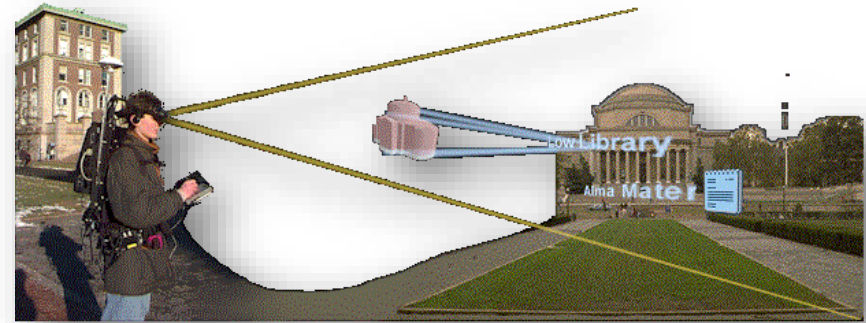
Applications (cont.)

- ▶ Computer aided design (CAD)
 - ▶ Collaborating on cyberspace.
 - ▶ Ex. Cabin design (Boem Inc.)
- ▶ Visualization tools
 - ▶ Meteorology



Applications (cont.)

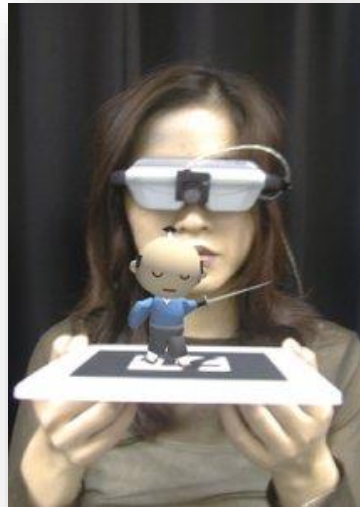
- ▶ Augmented reality (AR)
- ▶ Advanced human computer interfaces



AR, U. Columbia



AR on iPhone,
Fig. from en.wikipedia.org/wiki/Augmented_reality



AR Toolkit



Microsoft HoloLens

Nowadays: Graphics + Learning



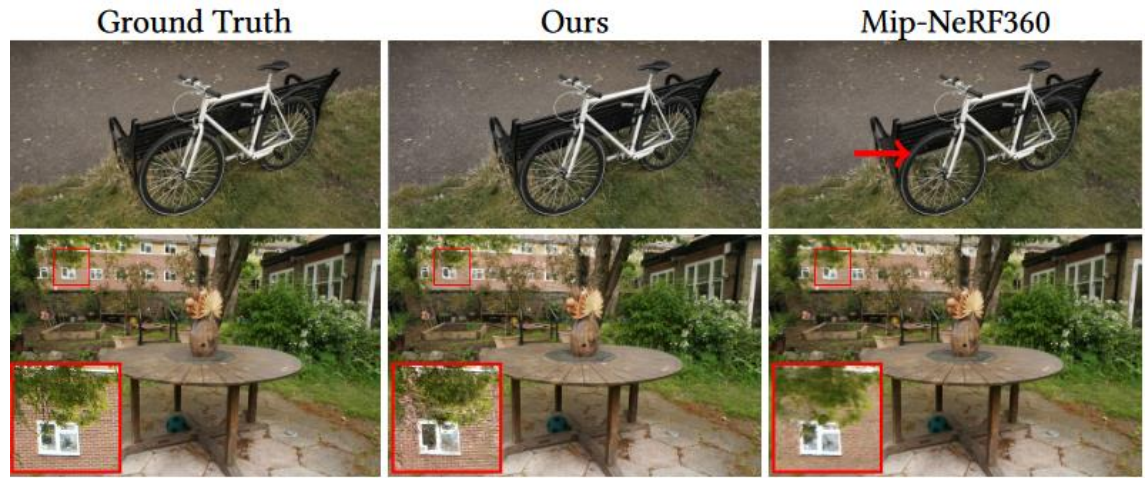
a lion reading the newspaper*

Poole et al., DreamFusion: Text-to-3D
using 2D Diffusion, Google Research



Siddiqui et al., MeshGPT, CVPR'24

Note: This course may **not**
cover the topics about
Graphics + Learning.



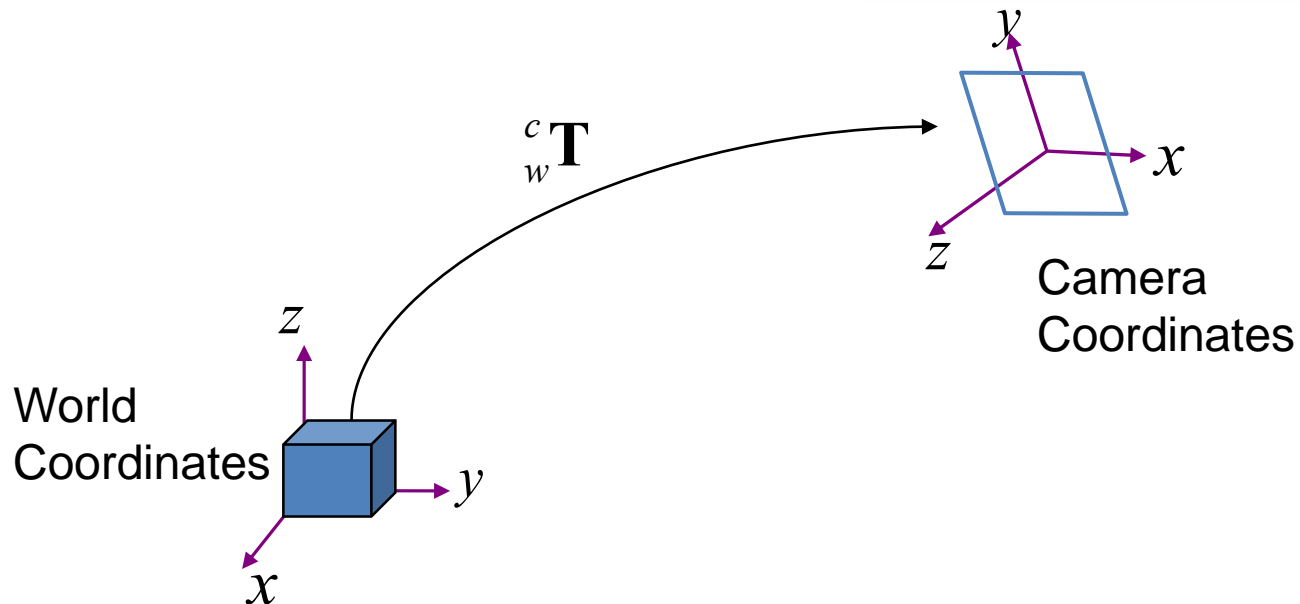
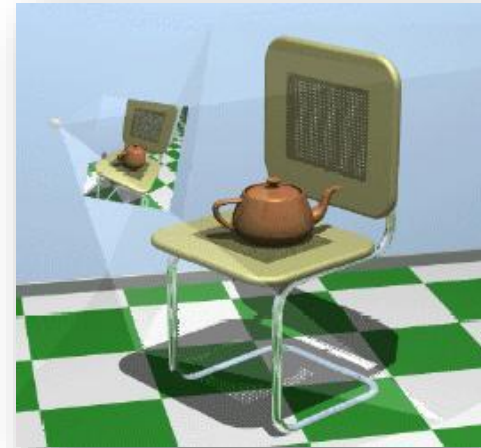
Kerbl et al., 3D Gaussian Splatting, SIGGRAPH'23

Intended learning outcomes of this course

- ▶ On completion of this ICG course, a student will be able to:
 - ▶ Describes the fundamental concept of a computer graphics system.
 - ▶ Explain how an image is synthesized by a graphics system.
 - ▶ Apply graphics algorithms for image and animation synthesis through graphics programming language GLSL.
 - ▶ Compare classic graphics algorithms and assess their advantages and limitations.

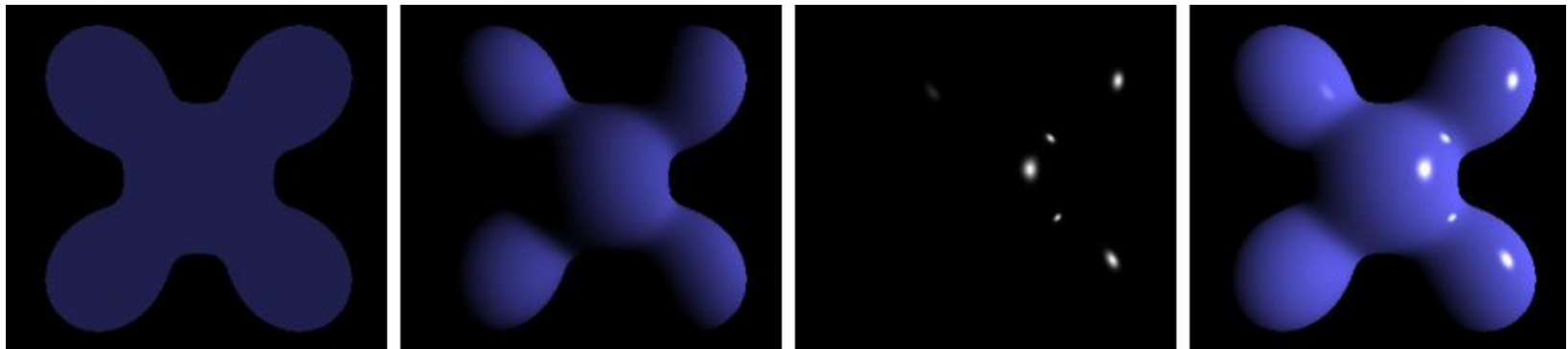
Syllabus

- ▶ Introduction
- ▶ Graphics primitives
- ▶ Geometric transformations
- ▶ Viewing in 3D



Syllabus (cont.)

► Illumination and surface rendering



Ambient

+

Diffuse

+

Specular

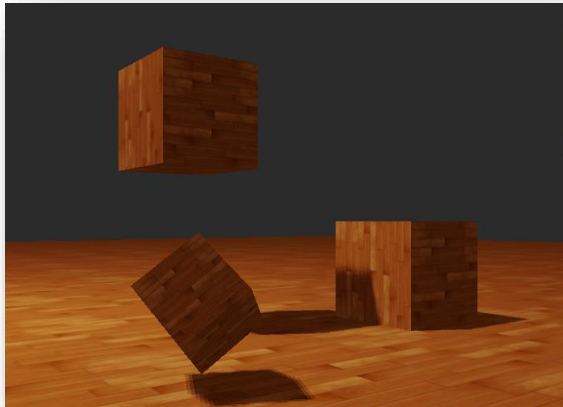
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Phong reflection

► Visible-surface detection

Syllabus (cont.)

- ▶ Texture mapping
- ▶ Programming with Graphics processing unit (GPU)
- ▶ Global illumination



Samples from <http://leanopengl.com>



http://www.ozone3d.net/tutorials/bump_mapping.php



the Chartres Cathedral
www.graphics.cornell.edu

Syllabus (cont.)

- ▶ Curves and surfaces (optional)
- ▶ Advanced topics or research in CG (optional)
- ▶ (Note: advanced graphics-related courses in NYCU)
 - ▶ Computer graphics (graduate-level)
 - ▶ Computer animation and visual effects
 - ▶ Image manipulation techniques and visual effects
 - ▶ Interactive shape manipulation
 - ▶ Real-time rendering
 - ▶ 3D game programming
 - ▶

About the course (cont.)

- ▶ Grading: (provisional)
 - ▶ Assignments (3 programs)
 - ▶ OpenGL/GLSL viewer: transformation + viewing.
 - ▶ GLSL viewer: transformation + texture.
 - ▶ Shading with GLSL.
 - ▶ Project: Animation with GLSL
 - ▶ 1 ~ 2 (or 3) members
(Last year: a 20~30-second animation using GLSL with three kinds of shaders).
 - ▶ Exams
 - ▶ Midterm (25% \pm 15%)
 - ▶ Final (20% \pm 15%)
 - ▶ Note: The numbers of exams and assignments and their percentages may vary)
- ▶ Class participation (1 ~ 10% or bonus)

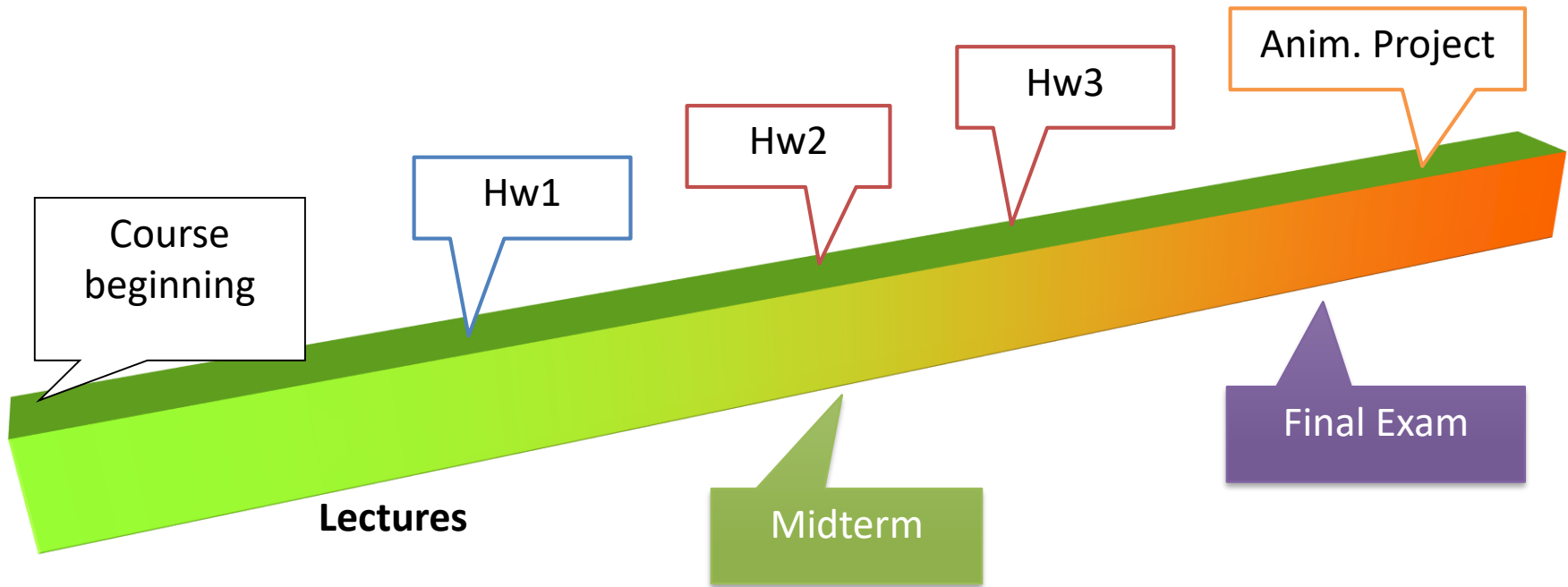
Note:

HW sample codes on Windows will be provided.

SDK settings for MacOS will be introduced.

(Note: Apple may cease supporting OpenGL)

Schedule



What can I obtain in this course?

- ▶ Fundamentals of computer graphics techniques.
- ▶ Programming ability for 3D graphics.
- ▶ Preliminary concepts about graphics-related topics, e.g. 3D games, animation, VFX movies.

What can I obtain in this course?

- ▶ 2D image special effects?

Somewhat

- ▶ Digital art styles ?

- ▶ Usage of editing tools ?

- ▶ Photoshop, 3DMax, Maya, etc.

- ▶ Making a blockbuster movie/game?

Ambitious! Let's draw a triangle first !

Conclusion

- ▶ The role of graphics people in CS
 - ▶ Improving faithfulness or visual effects.
 - ▶ Speed-up of CG generation.
 - ▶ Exploring the use of graphics.
 - ▶ (through computer techniques)

CG gives “wizards” the “wands” and “spells” !