CS580:
Graduate-Level Computer Graphics
- Focus on rendering

Sung-Eui Yoon
(윤성의)

Course URL:
http://sglab.kaist.ac.kr/~sungeui/GCG

KAIST

About the Instructor

- 2015~: Tenured
- 2012~: IEEE Senior member
- 2011~2012: conf. and program co-chairs of ACM symp. on Interactive 3D Graphics and Games (I3D)
- Joined KAIST at 2007

- Main research focus
  - Handling of massive geometric data for various computer graphics and geometric problems

KAIST

About the Instructor

- **Contact info**
  - **Email: sungeui@gmail.com**
  - **Office: 3432 at CS building**
  - **Homepage: http://sglab.kaist.ac.kr/~sungeui**

Class Information

- **Class time**
  - **1:00pm ~ 2:15pm on TTh**
- **Office hours**
  - **Right after class**

KAIST

TAs

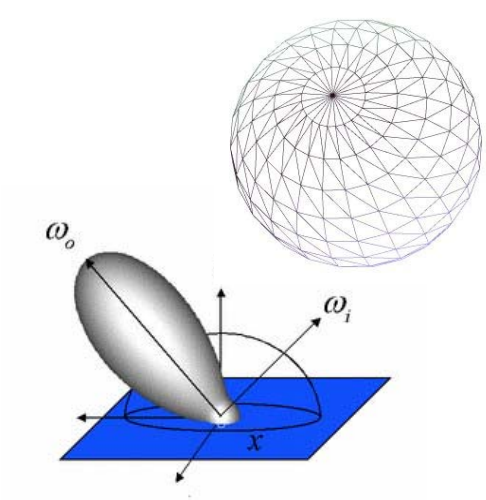
- **DongHyuk Kim (김동혁)**
  - **bishopak@gmail.com**
  - **E3-1, Room 3440**
  - **Office hour: right after the class on Tue.**

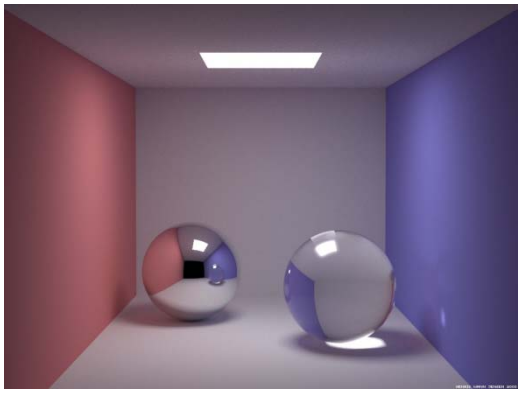
- **ByungYoon Choi (최병윤)**
  - **byungyoonc@gmail.com**
  - **E3-1, Room 3443**
  - **Office hour: right after the class on Thur.**

KAIST

Overview

- **We will discuss various parts of computer graphics**





Modelling **Simulation & Rendering** **Image**

Computer vision inverts the process
Image processing deals with images

KAIST

Application of Computer Graphics

- Games
- Movies and film special effects
- Product design and analysis
- Medical applications
- Scientific visualization

Games

2D game

3D shooting game

KAIST

Game Industry at Korea

- **One of biggest IT sectors in Korea**

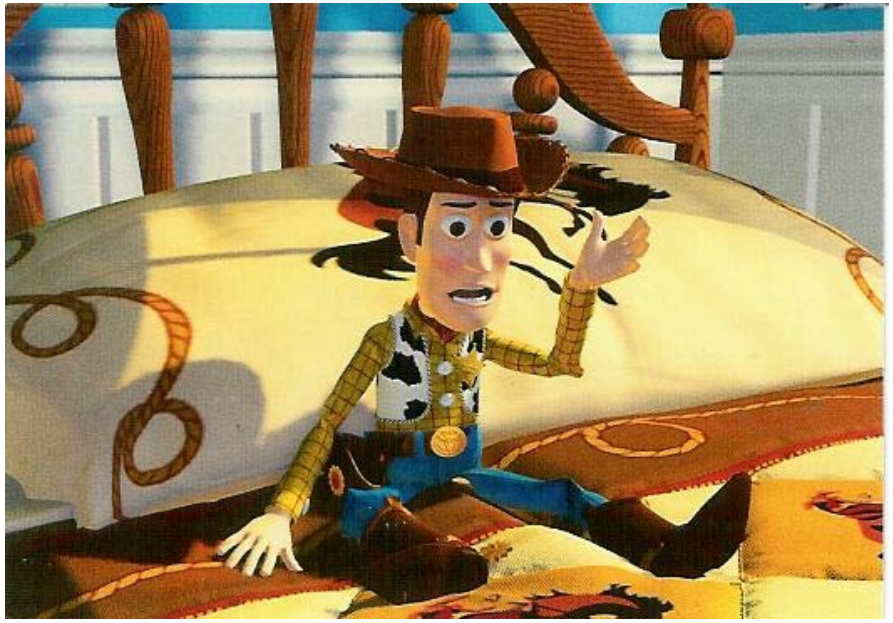
창원에 엔씨소프트 프로야구단 생긴다(종합)

KBO 이사회 개최

(서울=연합뉴스) 이상학 기자 =11일 오전 서울 강남구 도곡동 야구회관에서 열린 KBO 이사회에서 유영구 총재가 회의를 주재하고 있다. 8개 구단 사장단이 참석한 가운데 열린 이날 이사회에서는 9구단 승인 여부 등을 논의한다.2011.1.11 leesh@yna.co.kr

KAIST

Movies and Film Special Effects



Toy story

Matrix

KAIST

3D Movies

Avatar

KAIST

3D TV

Samsung 3D TV

KAIST

Head-Mounted Display (HMD) for VR

KAIST

HoloLens for Augmented Reality (AR)

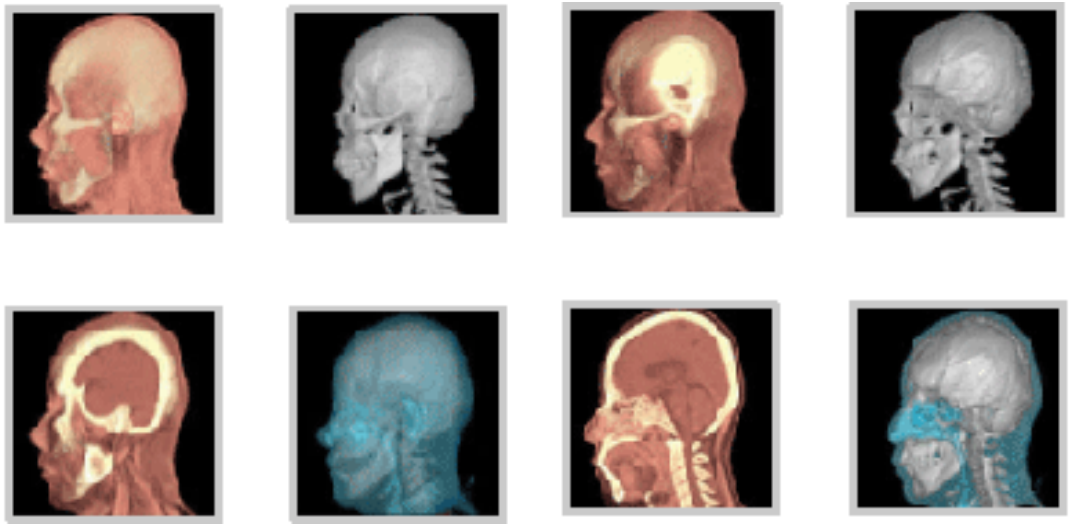
MS

Product Design and Analysis

- **Computer-aided design (CAD)**

Medical Applications

- **Visualizing data of CT, MRI, etc**

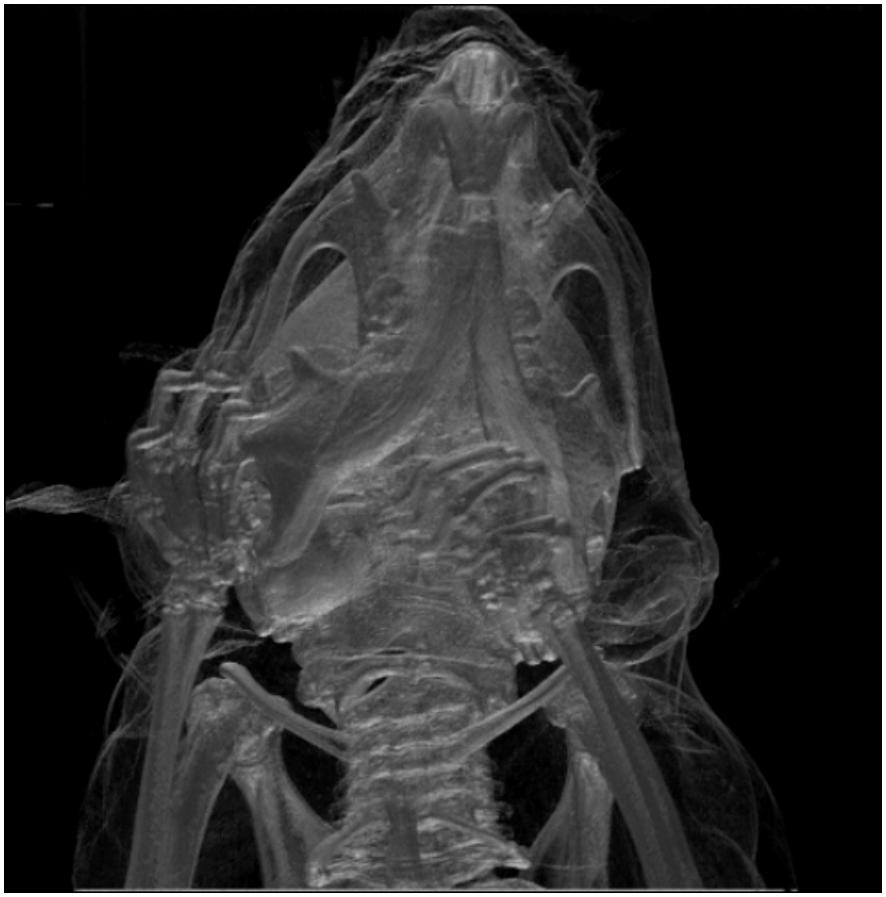


Rapidia homepage

KAIST

Medical Applications

- **Visualizing data of CT, MRI, etc**



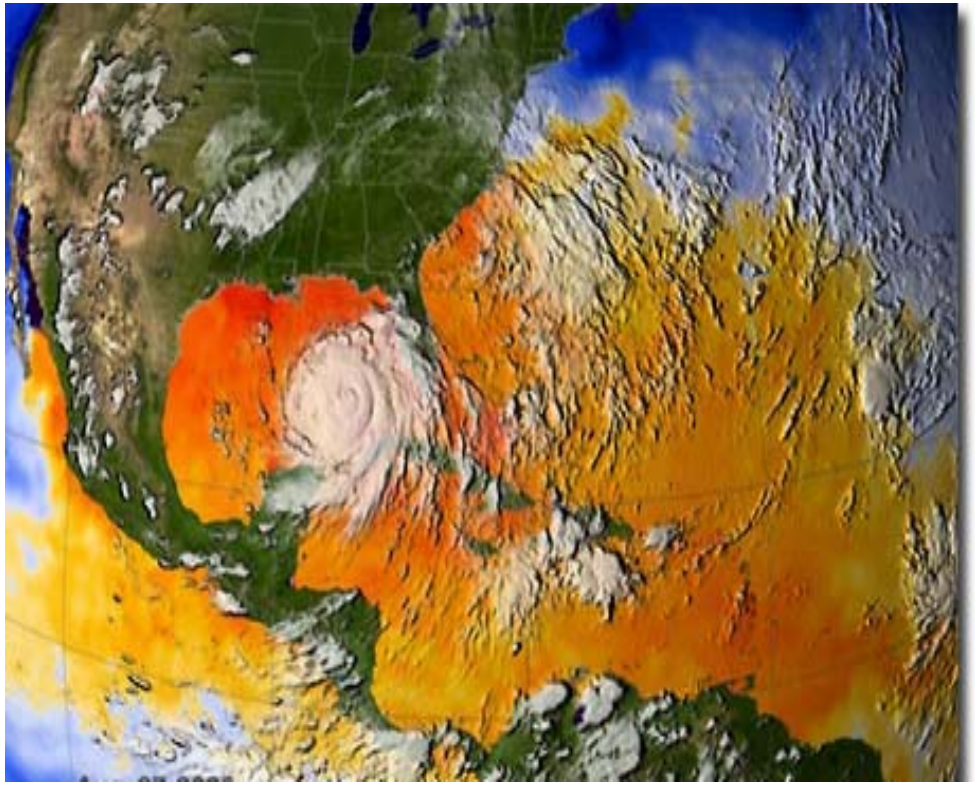
Wikipedia

Mouse skull (CT)

KAIST

Scientific Applications

- **Weather visualization**



LLNL

KAIST

About the Course

- **We will focus on the following things:**
  - **Study basic concepts of physically-based rendering**
  - **Discuss various basic concepts of computer graphics**
  - **Implement a recent technique, and discuss its pros and cons**

KAIST

Photo-Realistic Rendering

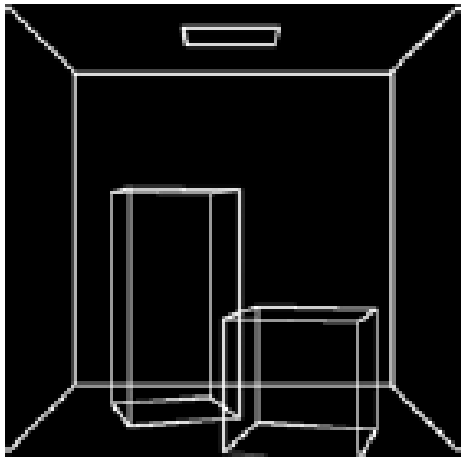
- **Achieved by simulating light and material interactions**

from Prof. Bala's slide

- **Rendering equation**
  - **Mathematical formulation of light and material interactions**

Global Illumination (GI)

- **GI algorithms solve the rendering equation**
  - **Generate 2D image from 3D scene**

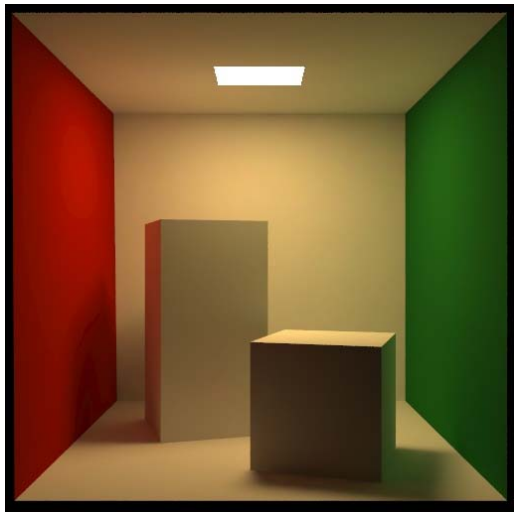


from Prof. Bala's slide

+

Emission (light sources)
Geometry (objects)
BRDF (materials)

⇨ **GI Algorithm** ⇨



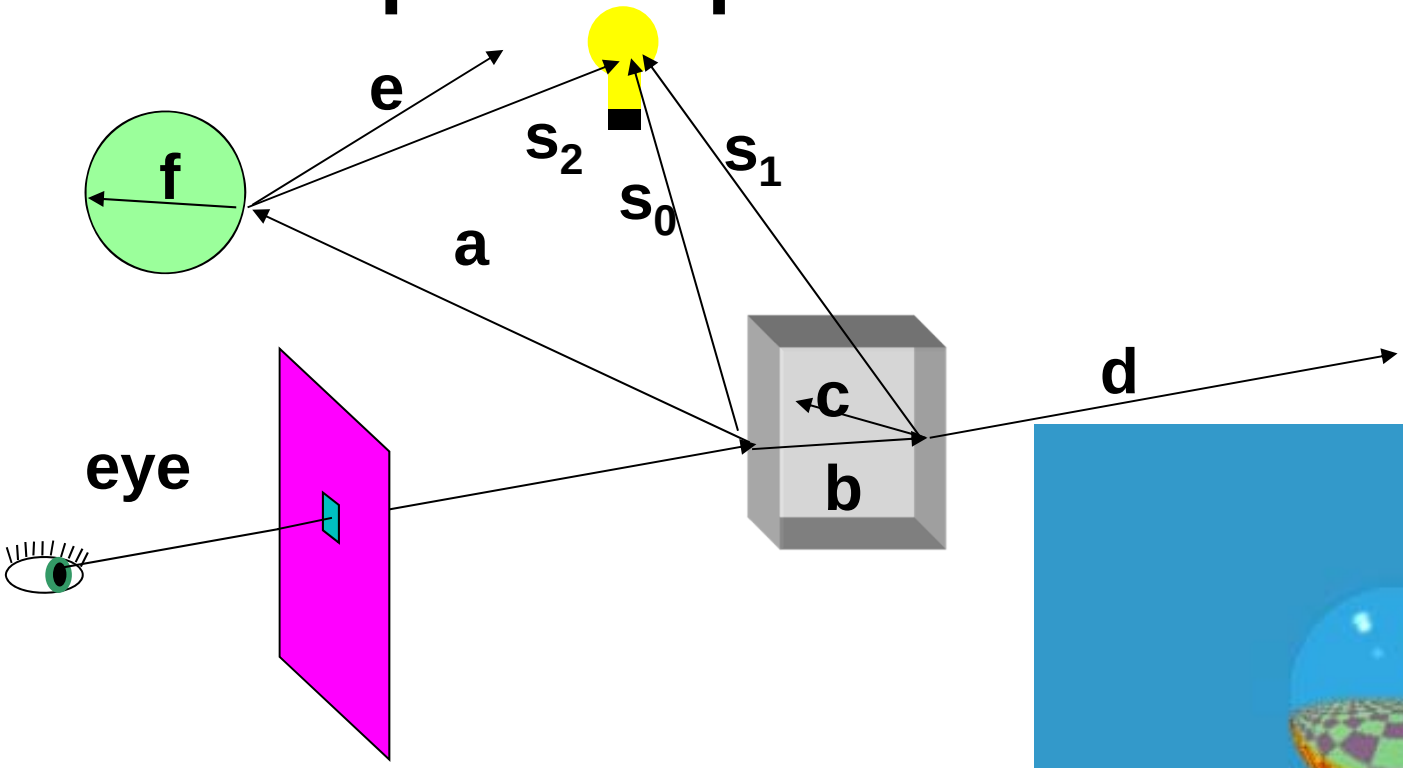
KAIST

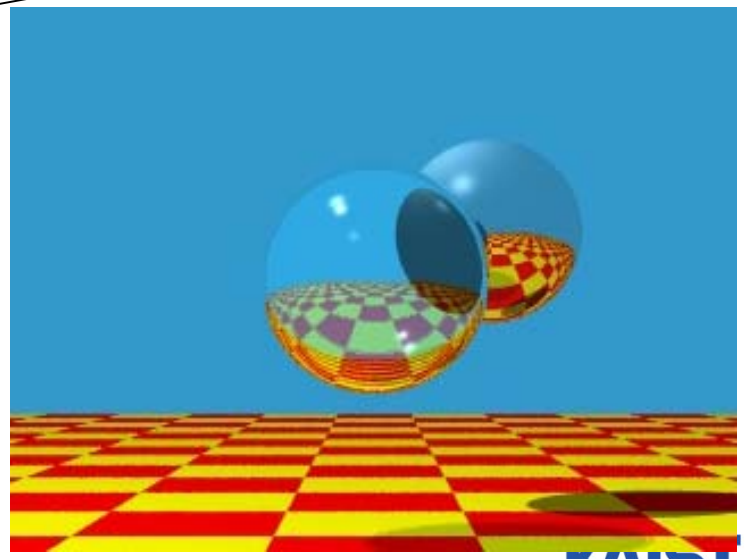
Classic Methods of GI

- Ray tracing
  - Introdued by Whitted in 1980
- Radiosity
  - Introduced in 1984
- Monte Carlo rendering

Ray Tracing

- Assume perfect specular or diffuse material





Radiosity

- **Assume diffuse inter-reflections**

KAIST

Advanced Global Illumination

- **Extend to handle more realistic materials than just perfect specular / diffuse**
  - **Classic ray tracing and classic radiosity are basic building blocks**

from photon map paper

from Pixar movie

KAIST

Scalable GI

- How can we handle complexity?
  - Many objects
  - Many triangles
  - Many lights
  - Complex BRDFs
  - Dynamic scenes, etc.
- Can we achieve interactive GI on commodity hardware?

Some of Topic Lists

- Ray tracing
- Rendering pipeline
- Path tracing
- BRDF
- Rendering equations
- Monte Carlo method
- Shading
- Textures
- Shadow
- Lighting and shading
- Radiosity
- GPU acceleration
- Reyes architecture
- Tessellation and subdivision
- Sampling and reconstruction
- Realistic rendering

Prerequisites

- **Basic programming skill**
- **Basic understanding on data structures (e.g., stack) and linear algebra (e.g., matrix multiplication)**

- **If you are not sure, please consult the instructor at the end of the course**

Resource

- **No textbook**
- **My own ongoing write-up**

Lecture on
Advanced Techniques for Rendering

Sung-eui Yoon
KAIST

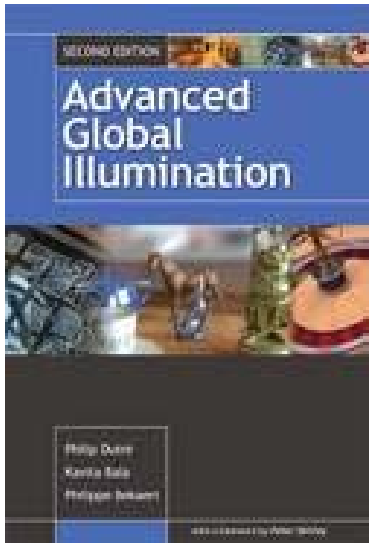
January 25, 2016

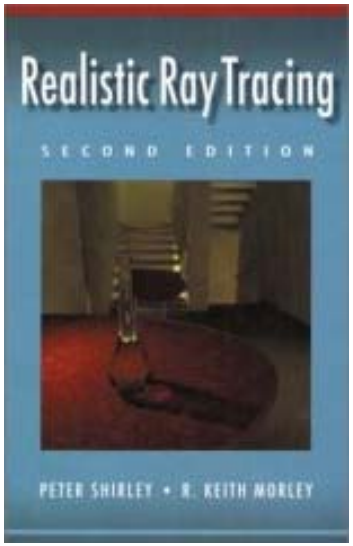
Contents

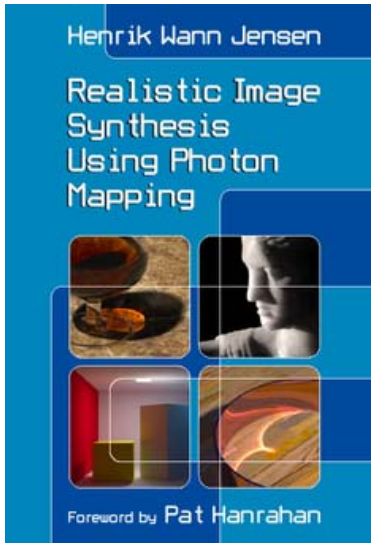
KAIST

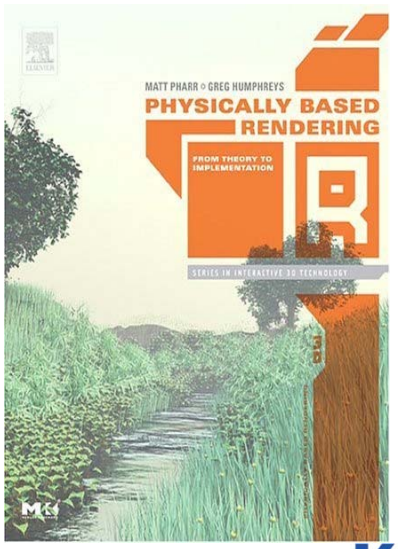
Resource

- **Reference**
  - **Physically based renderig, Matt Pharr et al.**
  - **Advanced Global Illumination, Philip Dutre et al. 2nd edition**
  - **Realistic Image Synthesis Using Photon Mapping, Henrik Jensen**
  - **Realistic Ray Tracing, 2nd edition, Peter Shirley et al.**









KAIST

Other Reference

- Technical papers
  - Graphics-related conference (SIGGRAPH, etc)
  - http://kesen.huang.googlepages.com/
- SIGGRAPH course notes and video encore

- Course homepages
- Google or Google scholar

Course Overview

- **Half lectures and another half for student presentations**
  - **Mid-term & final-term exams with a few quiz**
  - **Two programming assignments**
  - **A few paper presentation**
  - **Team project (Major activity)**

What you will do

- **Paper presentation and final team project**
  - **Make a team of two or three members**
  - **Choose a topic for the team, and each team member presents a paper related to it**
  - **All the team members implement techniques of a paper**
    - **Role of each team member should be clear**
  - **Present what the team did for the team project**

Course Awards

- **Best speaker and best project**
  - **Provide small gifts**

Grading

- Quiz, assignments, and exams: 60%
- Class presentations: 20%
- Final project: 20%

- Late policy
  - No score for late submissions
  - Submit your work before the deadline!
- Instructor and students will evaluate presentations and projects
  - Instructor: 50% weights
  - Students: 50% weights

Class Attendance Rule

- **Late two times → count as one absence**
- **Every two absences →lower your grade (e.g., A- → B+)**
- **To check attendance, I'll call your names or take pictures**
- **If you are in situations where you should be late, notify earlier**

Honor Code

- **Collaboration encouraged, but *assignments must be your own work***
- **Cite any other's work if you use their code**

Official Language in Class

- **English**
  - **I'll give lectures in English**
  - **I may explain again in Korean if materials are unclear to you**
  - **You are also recommended to use English, but not required**

KAIST

Schedule

- Please refer the course homepage:
  - http://sglab.kaist.ac.kr/~sungeui/GCG/

Homework for Each Class

- **Go over the next lecture slides before the class**
  - **Just 10 min ~ 20 min for this should be okay**

Homework

- **Watch 2 SIGGRAPH Videos**
  - **Write their summaries and submit at the beginning of every Tue. class**

- **Example of a summary**
  - **Just one paragraph for each summary**

Title: XXX XXXX XXXX
Summary: this video is about accelerating the performance of ray tracing. To achieve its goal, they design a new technique for reordering rays, since by doing so, they can improve the ray coherence and thus improve the overall performance.

About You

- Name
- Your (non hanmail.net) email address

- What is your major?
- Previous graphics experience

- Any questions

Next Time

- **Rasterization based classic rendering pipeline**