CSE4203: Computer Graphics Chapter – 1 Introduction

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Outline

- What is CG
- CG Areas
- Major Applications
- Graphics API
- Graphics Pipeline

What is CG? (1/1)

- The term computer graphics describes any use of computers to create and manipulate images.
 - Graphics can be 2 or 3 dimensional
 - Images can be completely synthetic or can be produced by manipulating photographs.

CG Areas (1/4)

Modeling:

 deals with the mathematical specification of shape and appearance properties in a way that can be stored on the computer.

CG Areas (2/4)

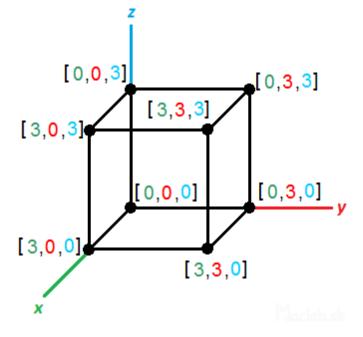
Modeling:

Example –

– an object can be described as 3D coordinates:

[0, 0, 3], [0, 3, 3], [0, 3, 0], [0, 0, 0], [3, 0, 3], [3, 3, 3], [3, 3, 0], [3, 0, 0]

connect the points



CG Areas (3/4)

Rendering:

- a term inherited from art
- deals with the creation of shaded images from 3D computer models.





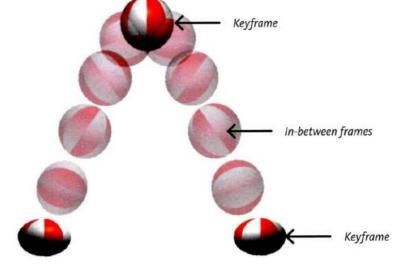
CG Areas (4/4)

Animation:

 creates an illusion of motion through sequences of images.

uses modeling and rendering but adds movement

over time



Major Applications (1/12)

- Video games
- Cartoons
- Visual effects
- Animated films
- CAD/CAM
- Simulation
- Medical imaging
- Information visualization

Major Applications (2/12)



Games (2D)

Source: http://www.cs.cornell.edu/courses/cs4620/2017sp/

Major Applications (3/12)



Games (3D)

Source: http://www.cs.cornell.edu/courses/cs4620/2017sp/

Major Applications (4/12)



Movies (VFX)

Source: http://www.cs.cornell.edu/courses/cs4620/2017sp/

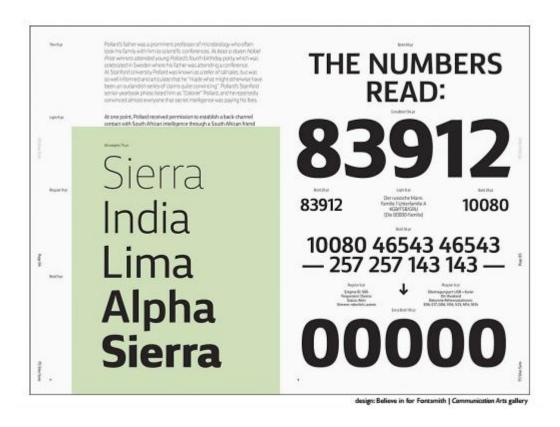
Major Applications (5/12)



Movies (Animated)

Source: http://www.cs.cornell.edu/courses/cs4620/2017sp/

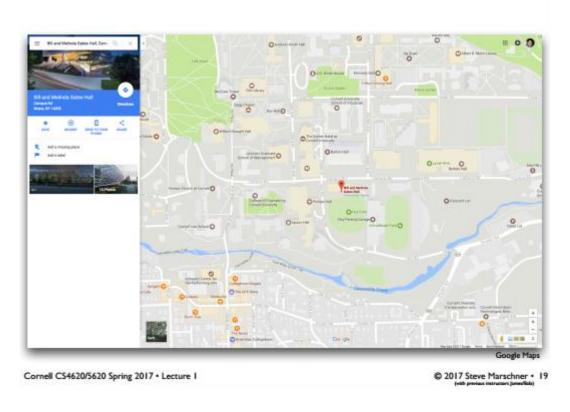
Major Applications (6/12)



Fonts

Source: http://www.cs.cornell.edu/courses/cs4620/2017sp/

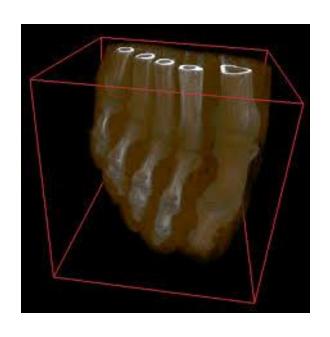
Major Applications (7/12)

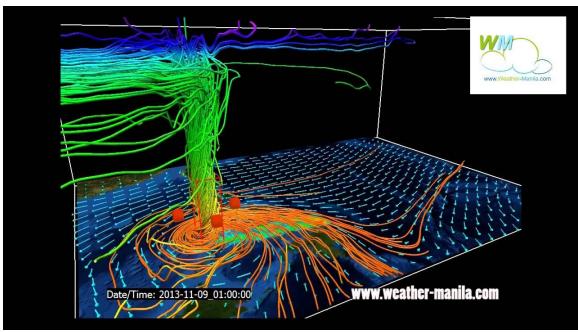


Google Maps

Source: http://www.cs.cornell.edu/courses/cs4620/2017sp/

Major Applications (8/12)

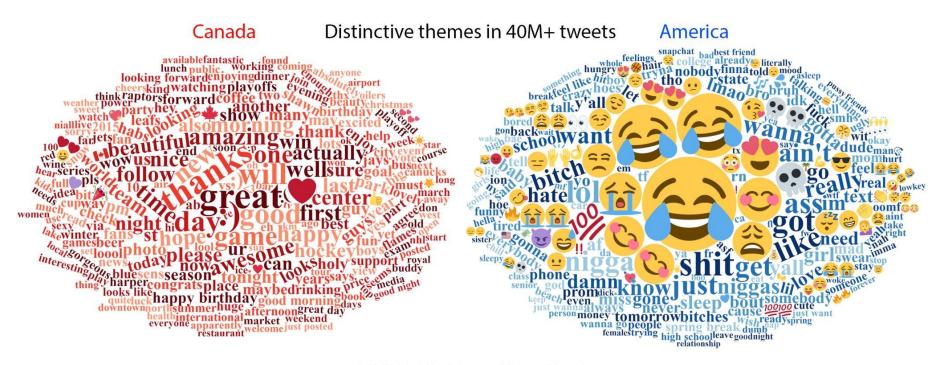




Scientific Visualization

Source: Internet

Major Applications (9/12)



Snefjella, Schmidtke, & Kuperman 2018: goo.gl/bqKtqb

Information Visualization

Major Applications (10/12)



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CAD (3D modeling)

Source: http://www.cs.cornell.edu/courses/cs4620/2017sp/

Major Applications (11/12)



Simulation

Source: Internet

Major Applications (12/12)



Simulation

Source:Internet

Graphics API (1/3)

- An application program interface (API) is a standard collection of functions to perform a set of related operations
- A graphics API is a set of functions that perform basic operations such as –
 - drawing images and 3D surfaces into windows on 2D screen.

Graphics API (2/3)

Every *graphics program* needs to be able to use two related APIs –

- Graphics API for visual output.
 - Ex:
 - i.e. command for drawing lines, circles etc.
- User-interface API to get input from the user.
 - Ex:
 - Window
 - Receiving mouse and keyboard input

Graphics API (3/3)

Two dominant paradigms for APIs –

- 1. Graphics + UI → Particular Language
 - i.e. Java.
- 2. <u>Graphics</u> → Particular Language (e.g. C) + <u>UI</u> → vary from system to system
 - i.e. OpenGL or Direct3D.

Whatever your choice of API, the basic graphics calls will be largely the same.

Graphics Pipeline (1/8)

- Special software/hardware subsystem that maps the 3D vertex locations to 2D screen.
- Modeling

 rendering.
 - Usually optimized for processing 3D triangles.
 - Shade the triangles
 - Realistic
 - Proper back-to-front order.

Graphics Pipeline (2/8)

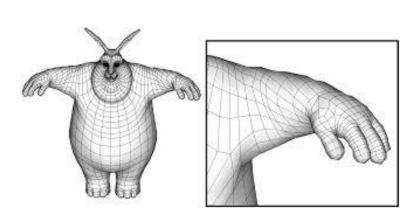
Why triangles?

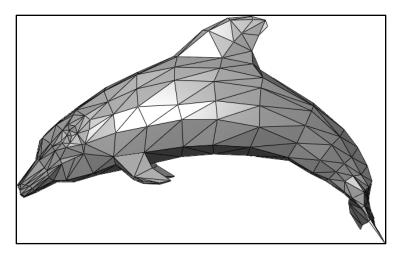
- It is the simplest universal surface element
- it is the convex hull of three points.
 - A line or a point are even simpler, but do not create surfaces.
 - it isn't possible to use only a finite number of them without having cracks.

Graphics Pipeline (3/8)

Mesh:

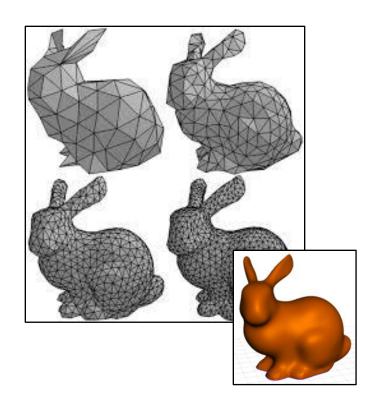
- A polygon mesh is a collection of vertices, edges and faces that defines the shape of a polyhedral object.
- Ex. Quad mesh, Triangle mesh.

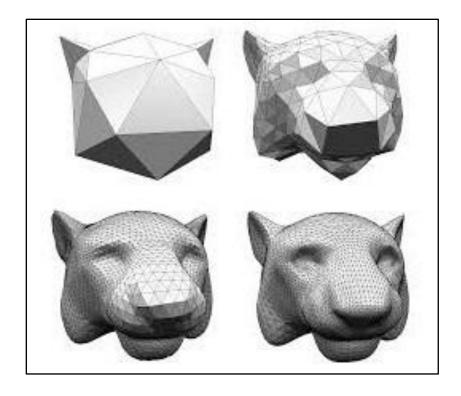




Graphics Pipeline (4/8)

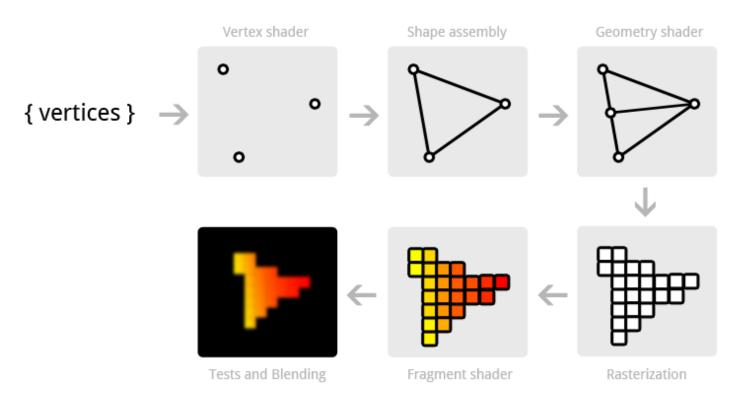
Triangle Mesh (example):





Graphics Pipeline (5/8)

Pipeline (example):



Source: https://open.gl/drawing

Graphics Pipeline (6/8)

- Geometric manipulation can be accomplished in a 4D coordinate space:
 - 3 traditional geometric coordinates (x, y, z) and a 4th homogeneous coordinate for perspective viewing (1).
 - These 4D coordinates are manipulated using 4 × 4 matrices and 4-vectors.
 - The graphics pipeline performs efficiently processing and composing such matrices and vectors.

Graphics Pipeline (7/8)

- Rendering speed ↔ number of triangles.
- Need to minimize the number of triangles.
 - Ex: if the model is viewed in the distance, fewer triangles needed
 - Level of Detail (LoD).

Graphics Pipeline (8/8)

• Example of *LoD*:

Additional Reading

• 1.7: Designing and Coding Graphics Programs

Thank You