Building your Game

CMSC425.01 Spring 2019

Find your name/group and sit at that table

Administrivia

- Finish group rosters, correct them on Elms
- Get started with Unity
  - Install Unity
  - Find references
- Project 1
  - Variation on Roll-A-Ball tutorial
- Today – Questions, rather than activities

Game systems this semester

Processing

- Interactive version of Java
- Used to illustrate concepts
- Not a game engine but has rich libraries
- https://processing.org

Unity

- Full game engine
- Used for projects and assignments
- https://unity3d.com

Today's questions

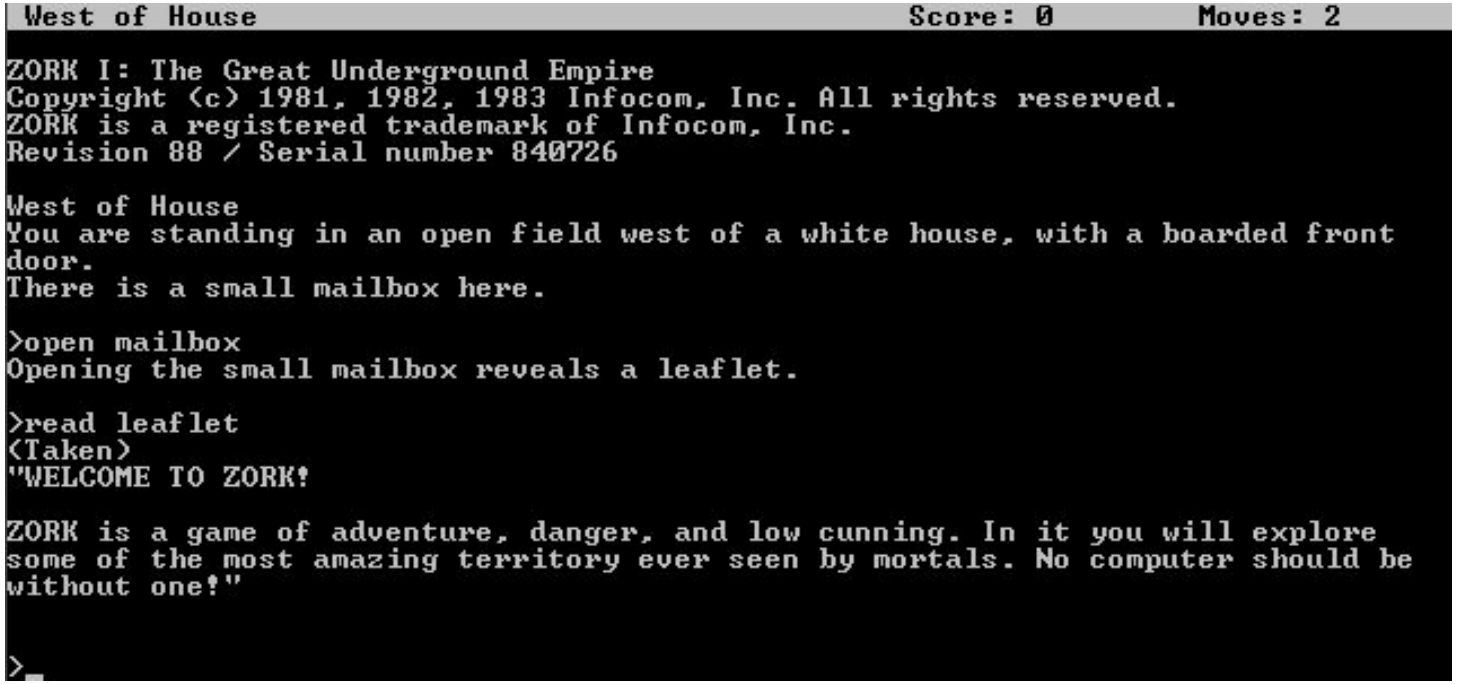
How do you build a
real time, interactive game?

What are the key elements
of a game engine?

Game 1: Zork

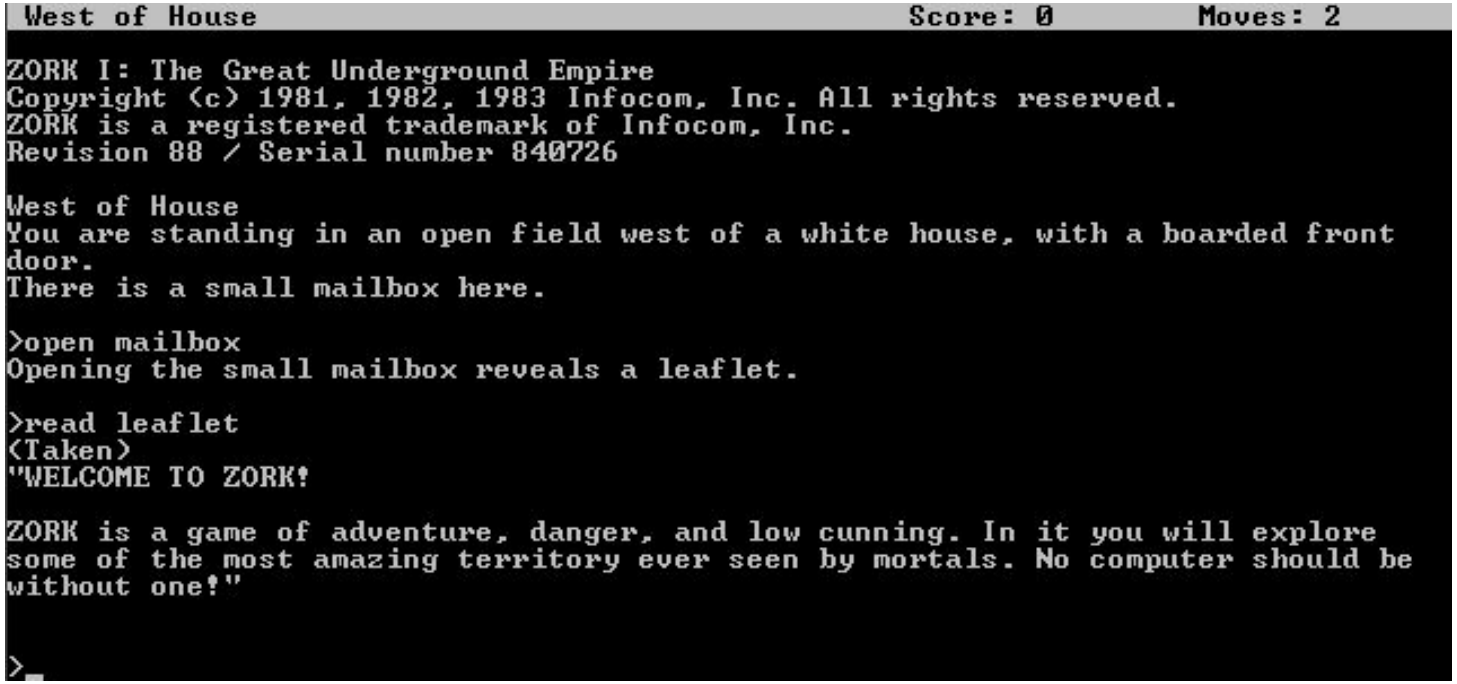
- Early text based game
- Text of places and objects
- Simple command language
- Navigation by text

- **Q:** Can we abstract and write a text game engine?



Game 1: Zork

- Early text based game
- Text of places and objects
- Simple command language
- Navigation by text

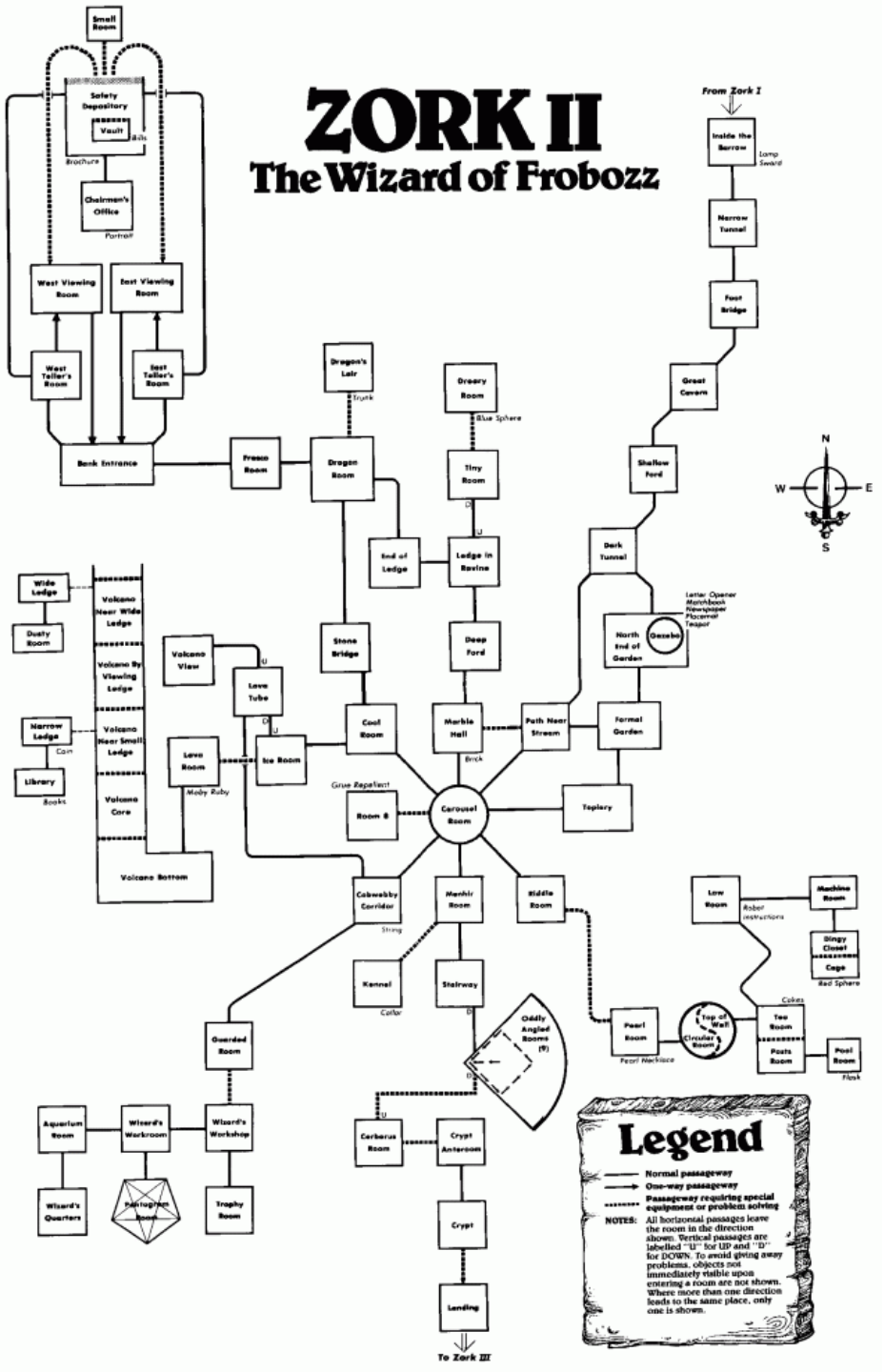


- **Q:** Can we abstract and write text game engine?
- Yes

Need:
Code engine
Command parser
Text file descriptions
Graph of locations
User item bag
Read/parse/do loop

Game 1: Zork

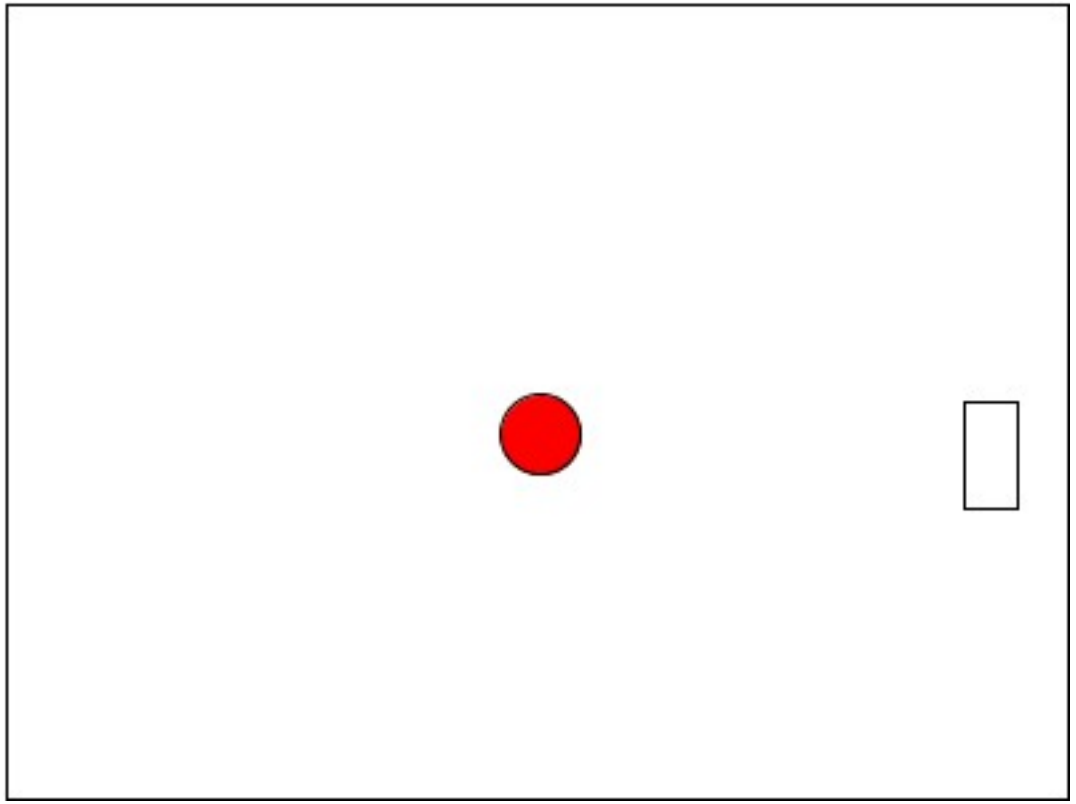
- "Interactive fiction"
- Existing text engines:
  - Adrift, Inform, Quest
- Why care?
- Emphasis on story and language, not glitz
- The skeleton of a game



Game 2: Pong!

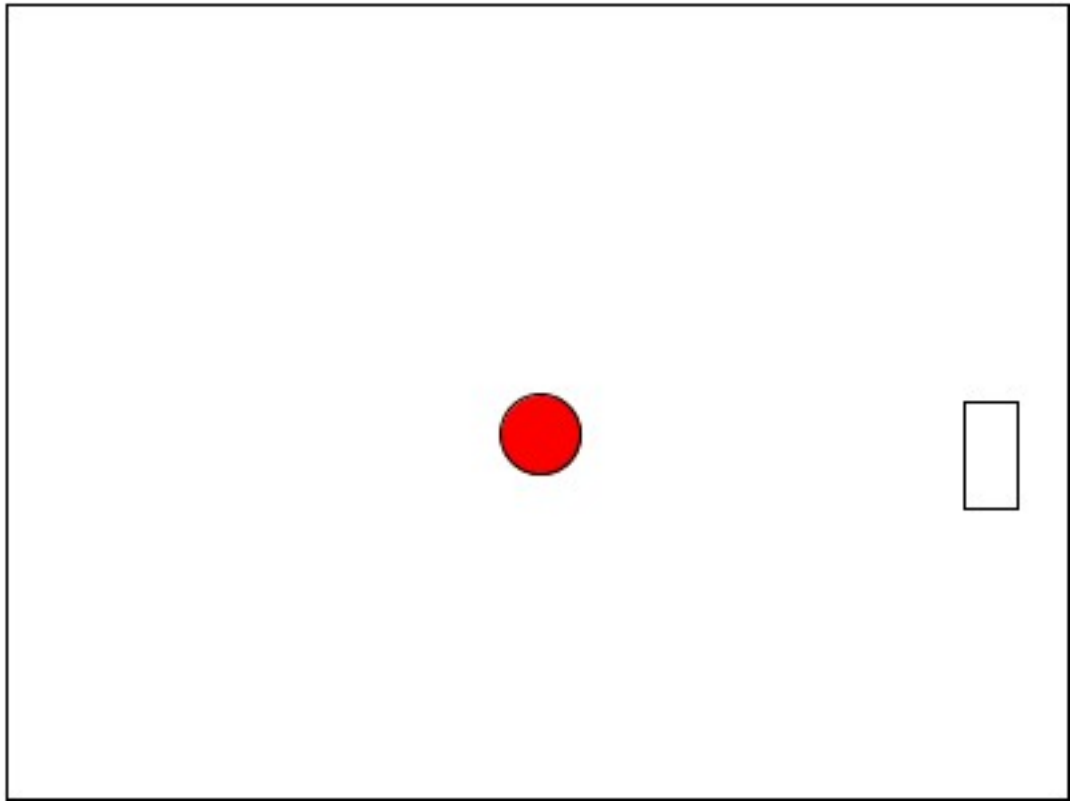
- Flatworm of interactive games
- Simple, but complete interactive game

- Example in Processing



Game 2: Pong!

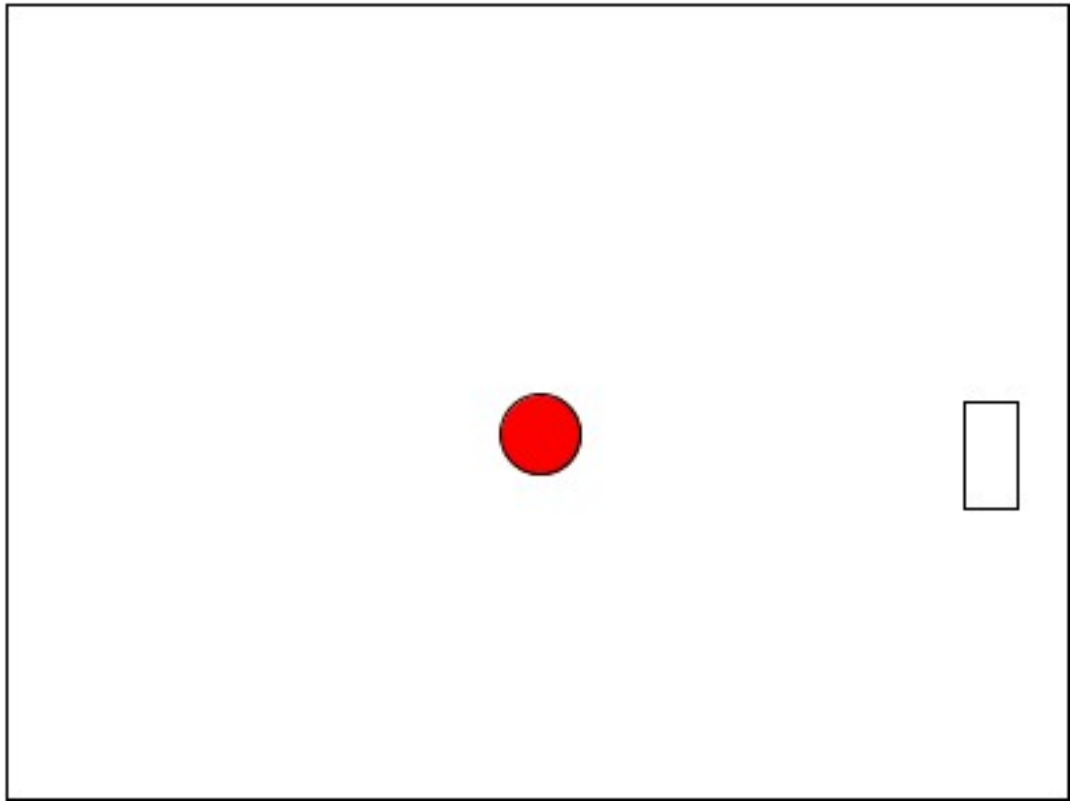
- **Q:** How would you code this?
- What elements needed?



Game 2: Pong!

- Basic game loop

```
Initialize
do
    update ball (physics)
    update paddle (user input)
    if (collide) do something
    draw stuff
until done
Clean up
```



Game 2: Pong!

- Basic game loop

```
Initialize
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    update ball (physics)
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until done
Clean up
```

- **Update ball**
- Very simple physics

```
x += dx;
y += dy;
```

- Can add acceleration

```
dx += ddx;
```

https://processing.org/examples/bouncingball.html

Game 2: Pong!

- Basic game loop

```
Initialize
do
    update ball (physics)
    update paddle (user input)
    if (collide) do something
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until done
Clean up
```

- **Update paddle**
- Poll device – interrogate

```
if (keyPressed && keyCode == DOWN)
     py = constrain(py+2,0,height);
```

Two form of user/system input

- **Poll device**

- Initiate in your code
- Read fixed memory location updated by system

- **Event driven**

- Initiated by system
- Not under your control
- You write **callback** routine to service event (or **event handler**)

```
void mousePressed() {
  save("image.jpg");
}
```

Basic event program in Processing

```
void setup() {
  size(400,400);
}
void draw() {
}
void mousePressed() {
  ellipse(mouseX,mouseY,20,20);
}
void keyPressed() {
  save("pic.jpg");
}
```

- setup – called once on program start
- draw – called every frame (rate adjustable)
- mousePressed – called once when mouse is pressed
- keyPressed – called once when key is pressed

Game 2: Pong!

- Basic game loop

```
Initialize
do
    update ball (physics)
    update paddle (user input)
    if (collide) do something
    draw stuff
until done
Clean up
```

- **if (collide) do something**
- If hit wall or paddle, take action

```
if (pong.hitLeft()) {
  pong.reverseX();
  }
```

Game 2: Pong!

- Basic game loop

```
Initialize
do
    update ball (physics)
    update paddle (user input)
    if (collide) do something
    draw stuff
until done
Clean up
```

- **draw stuff**
- Draw the arena, paddle and ball

```
// draw ball
color c = color(255,0,0); // red(RGB)
fill(c);
ellipse(x,y,radius,radius);
```

Unity game loop

Initialize game

do

  Physics (+collision)

  Input

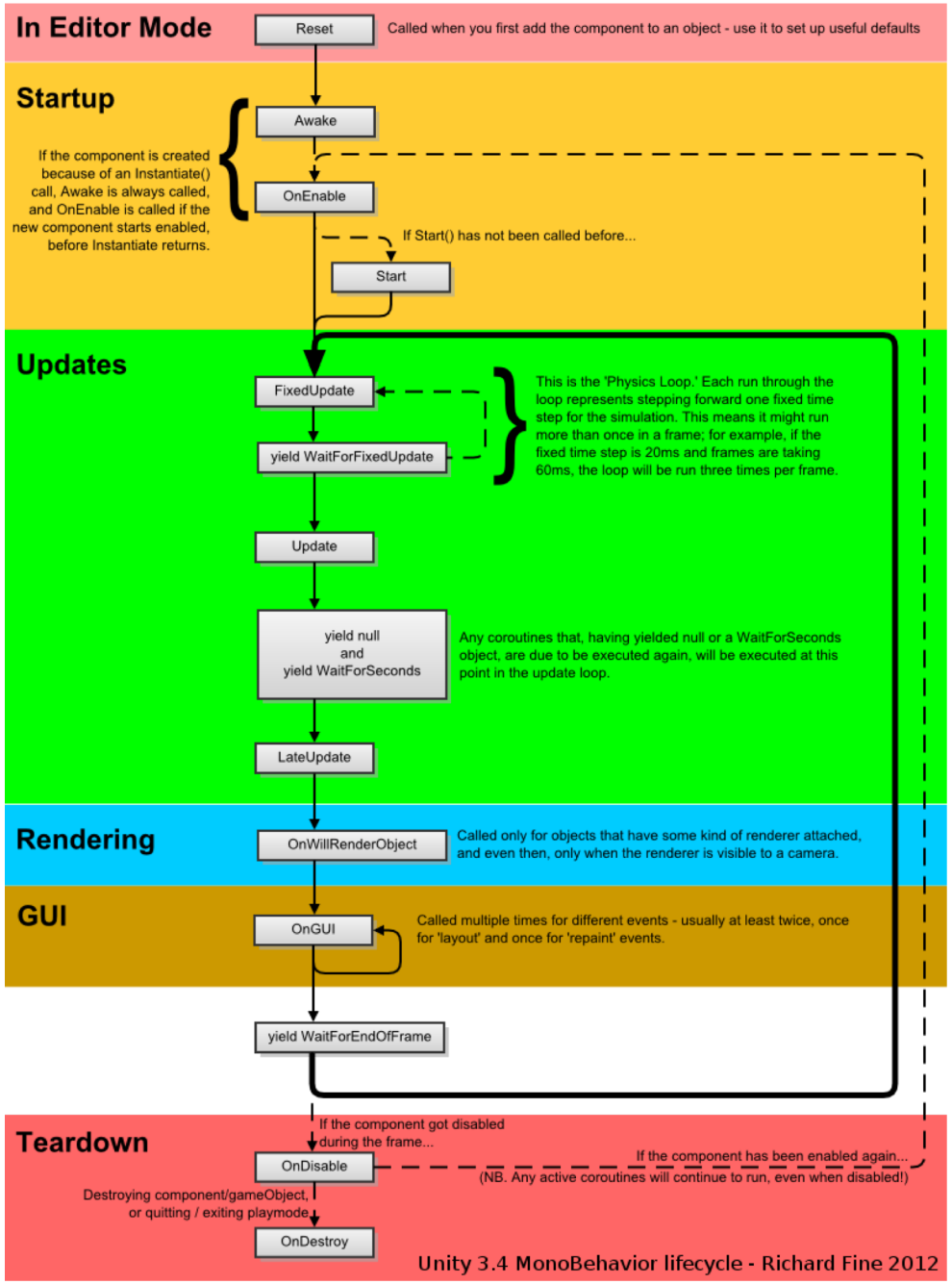
  Game logic(new)

  Rendering

  GUI rendering

loop

Clean up



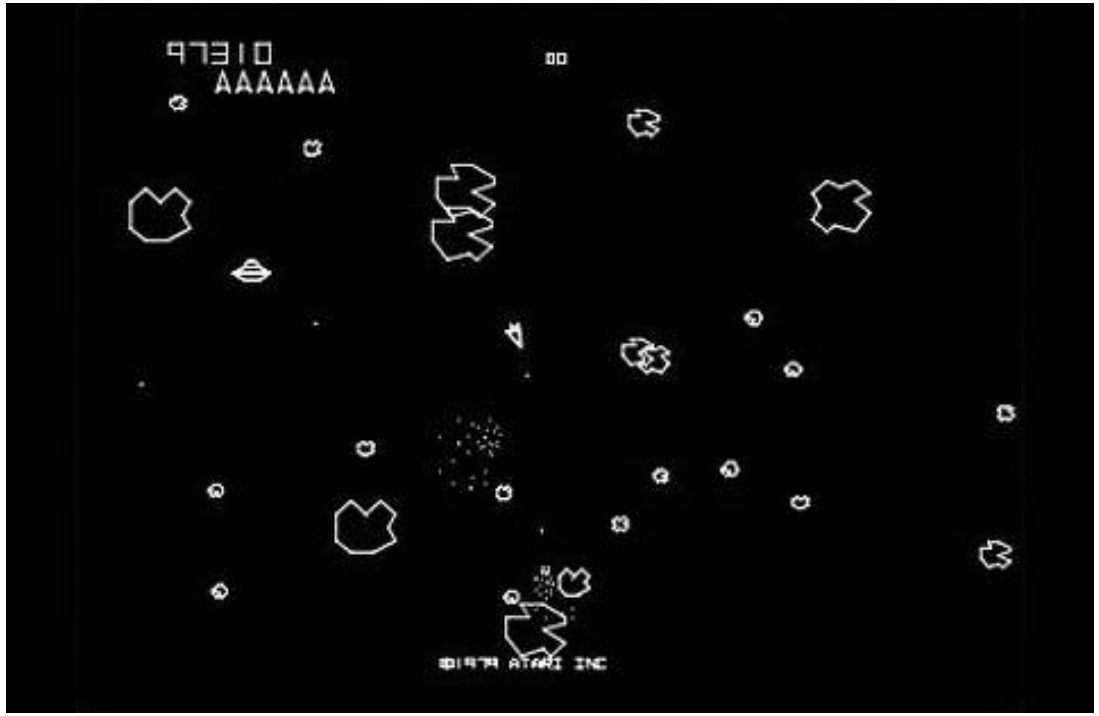
Time!

- Frame time (not constant)
  - Things executed every frame
  - Most important is rendering of scene
- Physics time
  - Steps in physics simulation
  - May run faster than frame time to get physics right (avoid big steps)
- Real time
  - System clock
  - For syncing music, video, other things that need real time

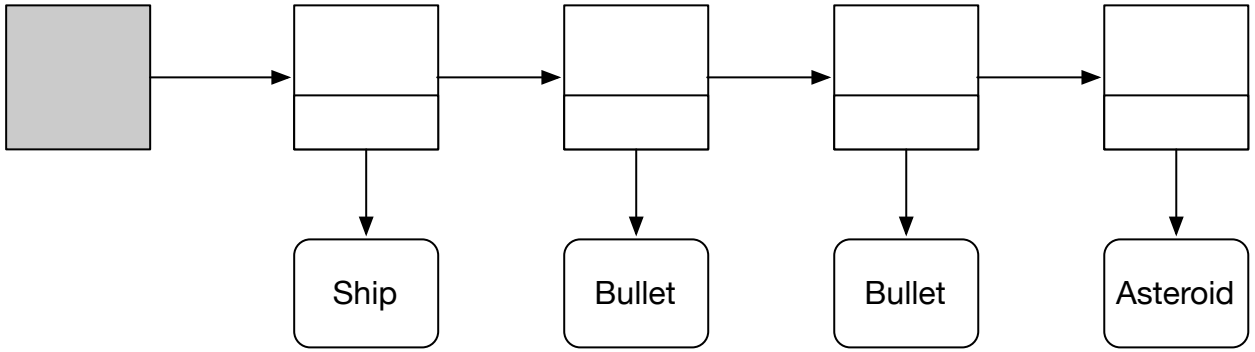
Game 3: Asteroids!

- More objects
  - Ship
  - Bullets
  - Asteroids
  - Enemy ship
  - GUI: Score, remaining ships

- **Q:** How upgrade our Pong game?



Game 3: Asteroids!



- Big change: more objects
  - Ship
  - Bullets
  - Asteroids
  - Enemy ship
  - GUI: Score, remaining ships
- **Q:** How upgrade our Pong game?
  - Object list

- List of game objects
- In loop
  - Update all
  - Interact! (time expensive)
  - Render all

Game 3: Asteroids!

- More objects
  - Ship
  - Bullets
  - Asteroids
  - Enemy ship
  - GUI: Score, remaining ships

- **Q:** How upgrade our Pong game?
  - Object list

Object hierarchy

- **Q:** How design inheritance hierarchy for Asteroid game objects?

Unity – not OOP, but Entity-Component

- More like interfaces in Java

- Bullet
  - Implements Draw (Bullet shape)
  - Implements BallasticMotion
  - Owns Collider component
- Asteroid
  - Implements Draw (Asteroid shape)
  - Implements BallasticMotion
  - Owns Collider component

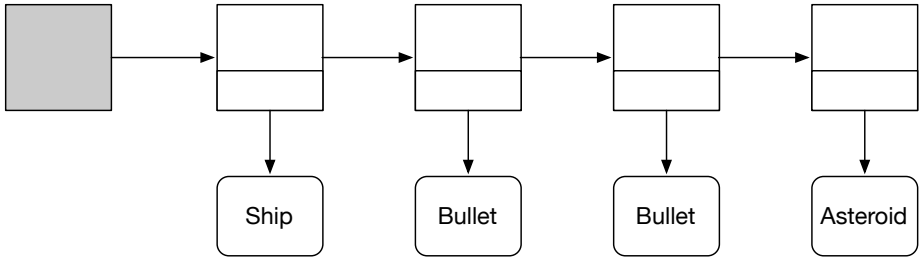
- Ship
  - Implements Draw (Ship shape)
  - Implements UserControlledMotion
  - Owns Collider component
  - Owns Shoot component

- Score
  - Implements Draw (Score shape)
  - No collider component, no motion

Scene graph vs. Object list

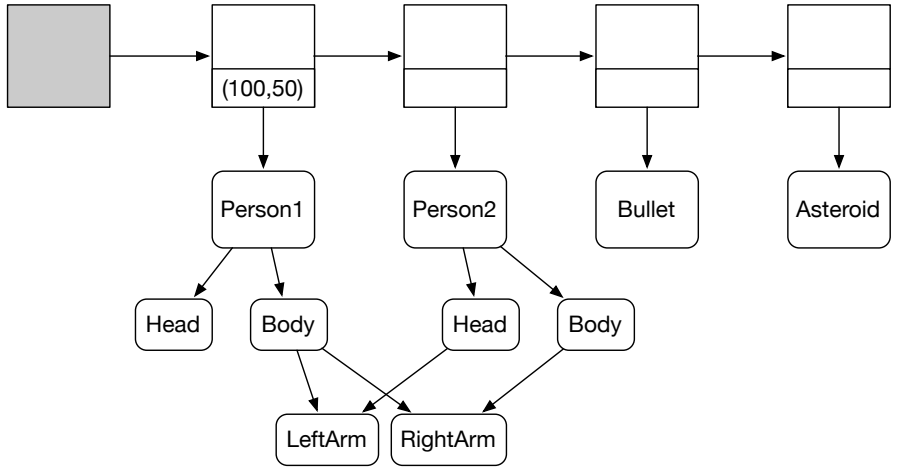
Object list in Asteroids

- All objects are simple, no articulated motion



Scene graph

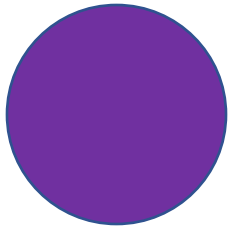
- Directed graph, compound objects
- May share subparts
- Subparts have own displacements



Model View (MV) and rendering

- ***Model* of object stored**
- Circle: (x,y,r,color)
  - Location x,y
  - Radius r

- ***View* of object rendered**

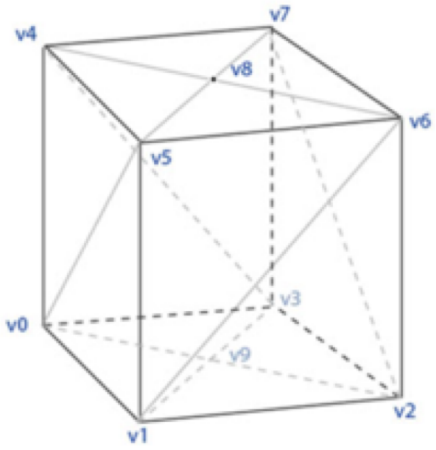


Model View (MV) and rendering

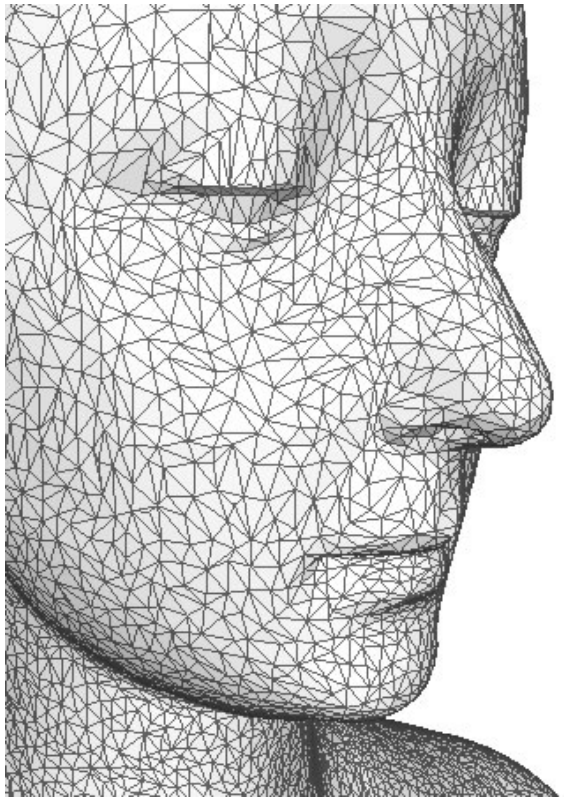
- ***Model* of object stored**
- In 3D
  - Store list of vertices and polygons

Vertex-Vertex Meshes (VV)

	Vertex List	
v0	0,0,0	v1 v5 v4 v3 v9
v1	1,0,0	v2 v6 v5 v0 v9
v2	1,1,0	v3 v7 v6 v1 v9
v3	0,1,0	v2 v6 v7 v4 v9
v4	0,0,1	v5 v0 v3 v7 v8
v5	1,0,1	v6 v1 v0 v4 v8
v6	1,1,1	v7 v2 v1 v5 v8
v7	0,1,1	v4 v3 v2 v6 v8
v8	.5,.5,1	v4 v5 v6 v7
v9	.5,.5,0	v0 v1 v2 v3



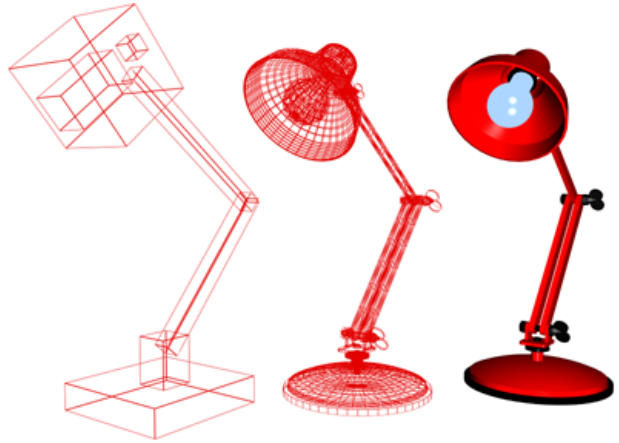
- ***View* of object rendered**
- Render object in 3D (using GPU)



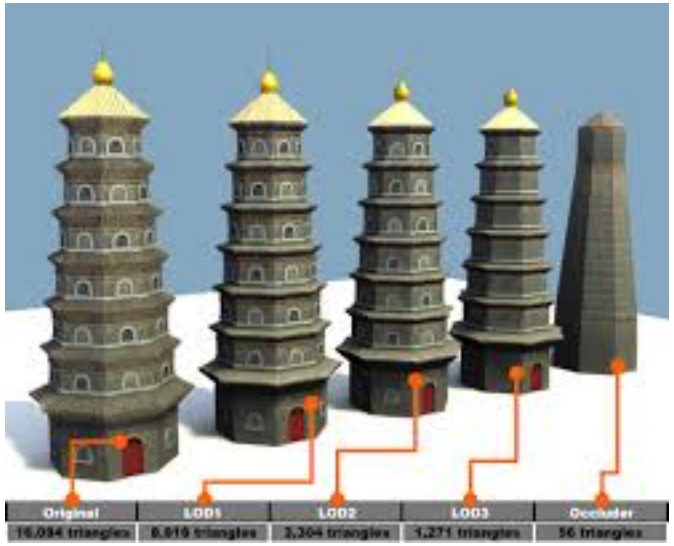
Independence of model and view

- ***Can render 3D model***
- From different viewpoints
  - Eg, split screen simultaneously
  - Change of perspective

- In different ways

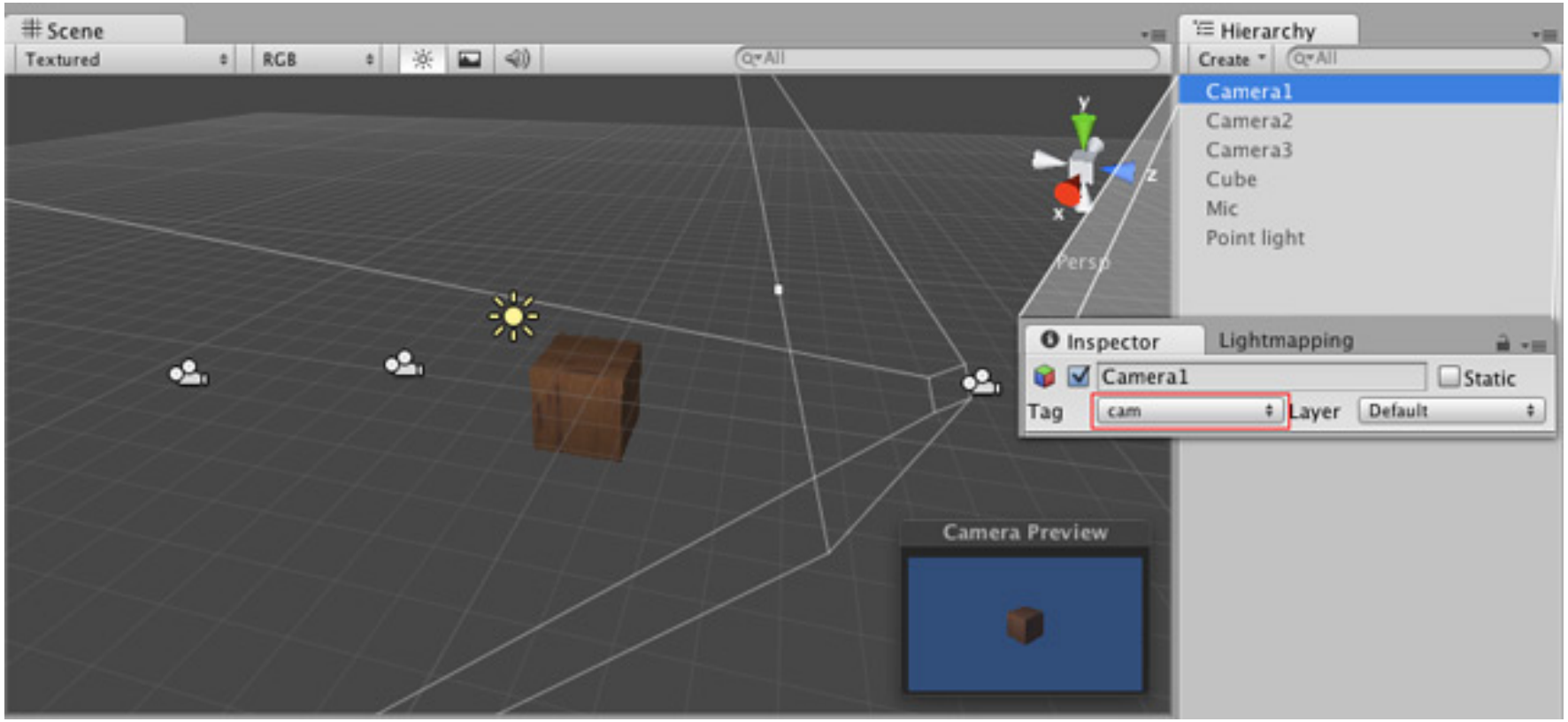


- At different levels of detail
- (far objects, less LOD)



Not all game objects are rendered (visible)

- Cameras/lights can move & behave but aren't rendered in game
- Model, no view except in mock up

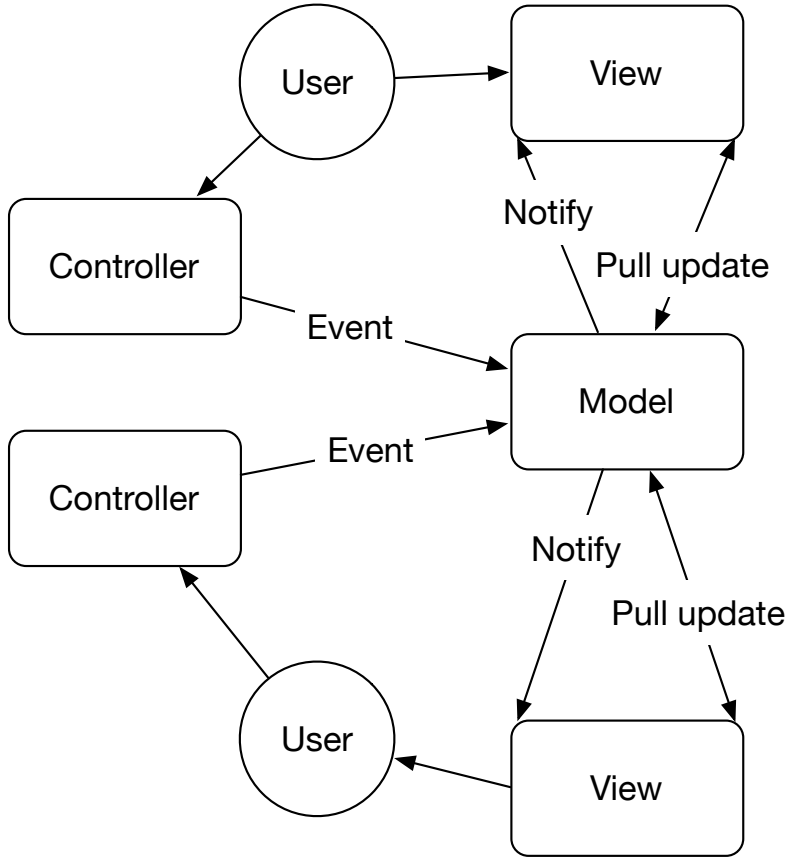


Model View Controller (MVC) program

- Multi-user game

- Shared Model/Database
- Different Views
- Coordinated controllers

- (BTW – this could be Accounting system, any multi-user app)



Rendering!

- Convert 3D polygonal model to 2D image

- Do it well
- Do it cheaply
- Do it fast

- How?

Rendering

- Step 1: Elements of model

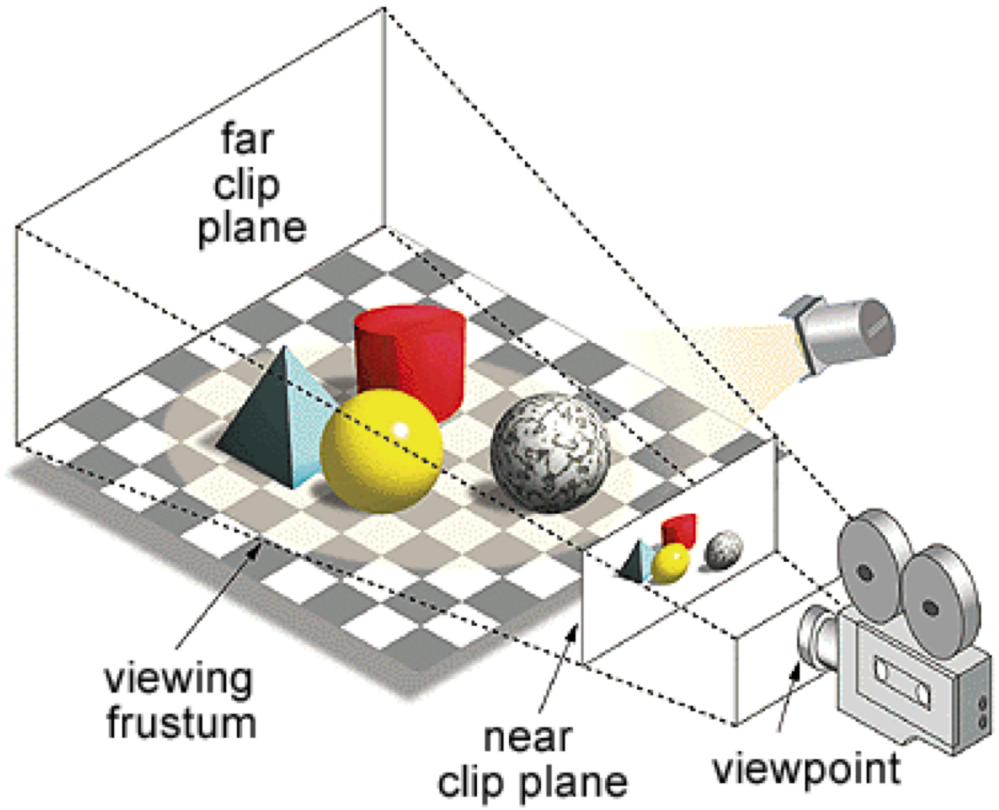
- Geometry: polygonal mesh
  - 3D points
  - Topology (graph structure)
- Appearance: color
  - Texture
  - Procedural shader
- Articulation/motions

Rendering

- Step 2: Scene elements

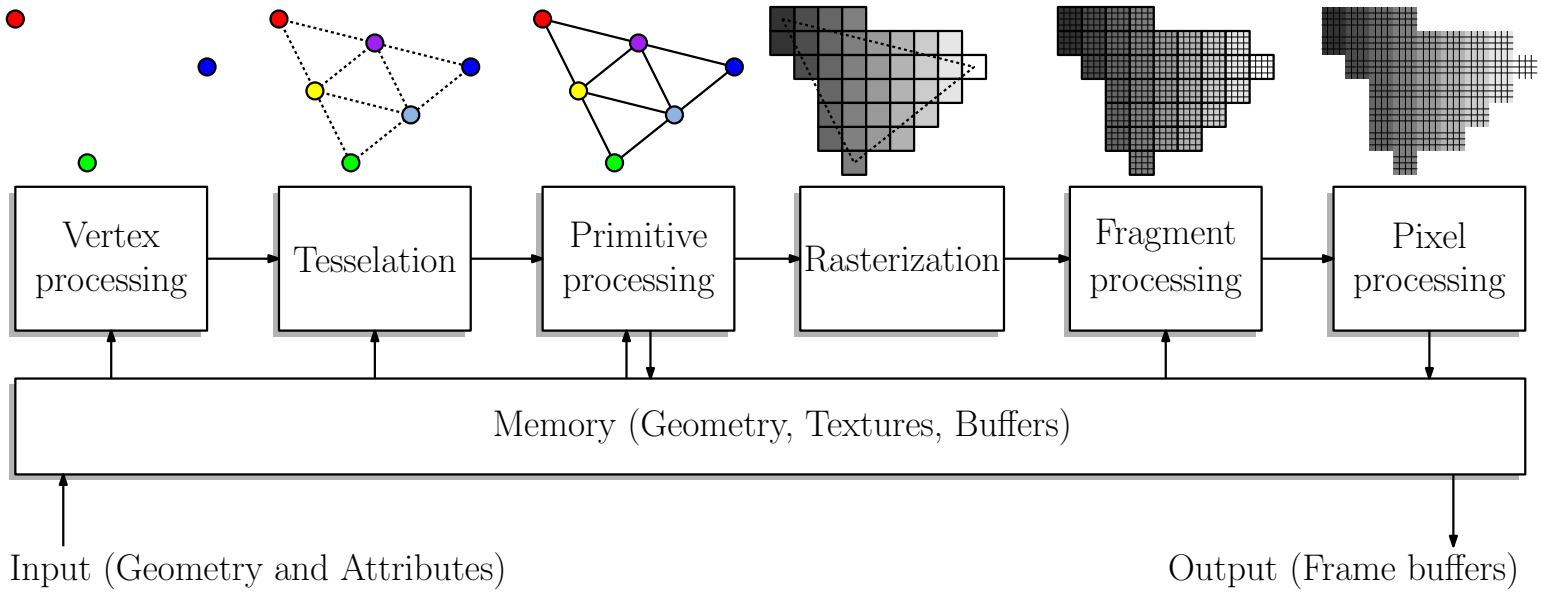
- Figures plus

- Camera
- Lights
- Skybox



Rendering

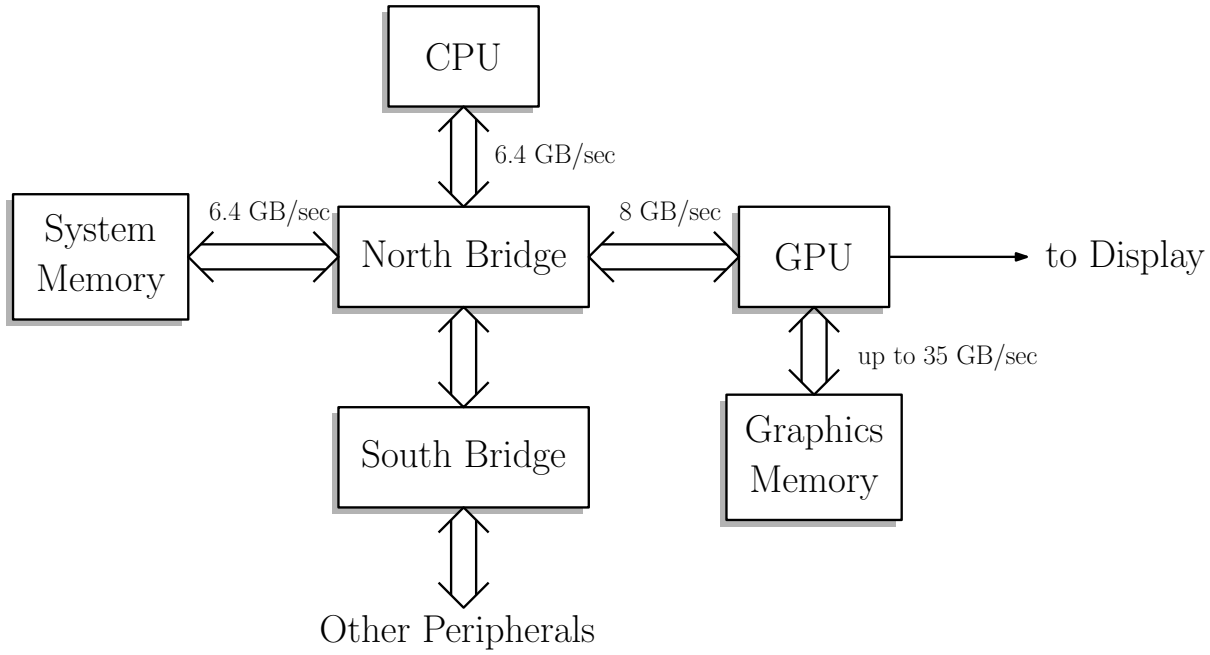
- Step 3: software graphics pipeline
- In 3D compute interaction between lights, model camera (math!)
- In 2D do low level rendering to display triangles with color



Rendering

- Step 4: hardware pipeline

- Push (immense data) to GPU
- Use dedicated bus (north bridge)
- Use GPU memory to pre-load textures, models, send only recent motion data



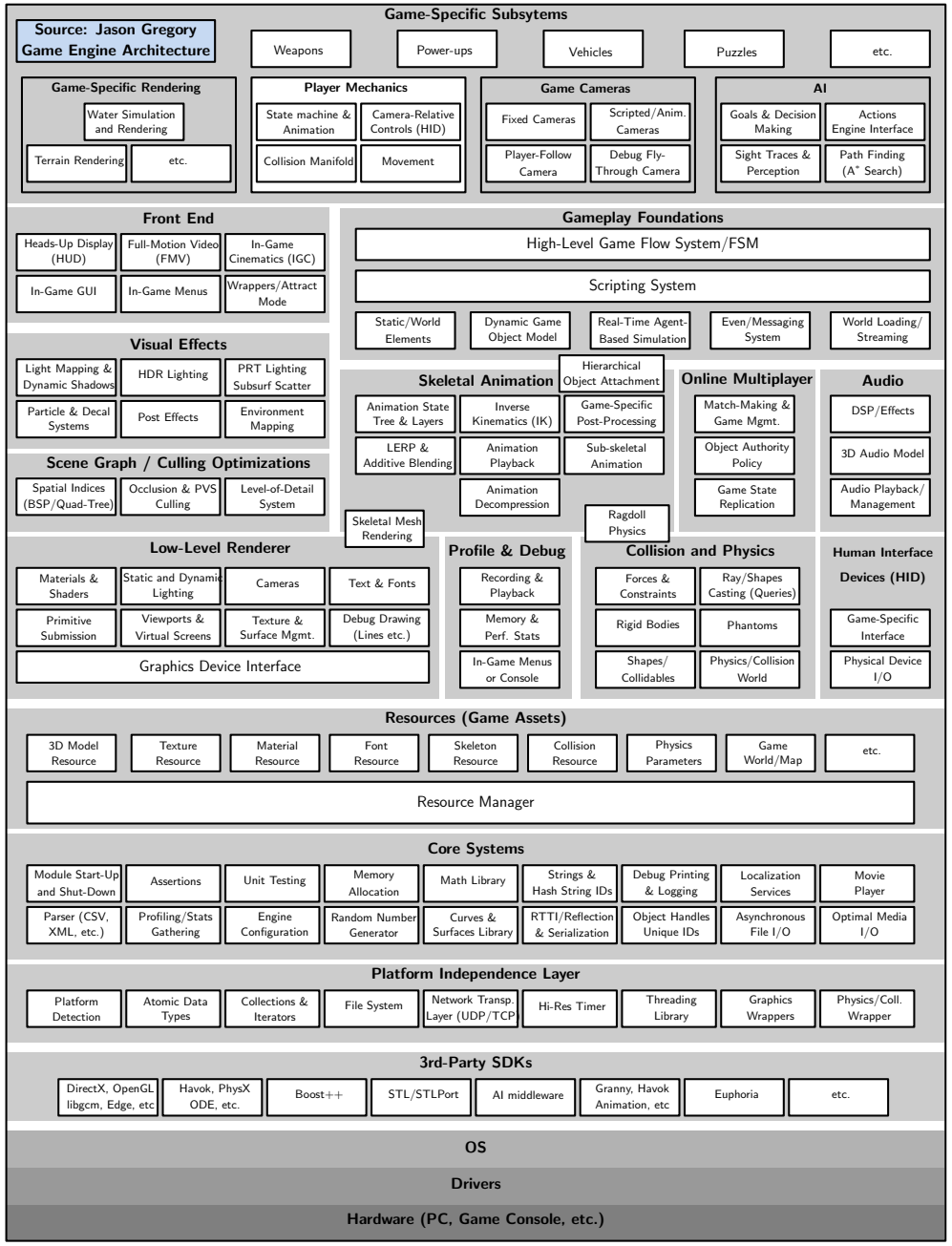
Summary

- After today you should be able:

1) Explain the separation between game engine and game logic, assets
2) Outline and explain a basic game loop and its stages
3) Distinguish polling and events for user (network, game) input
4) Read and explain an event driven real time graphics program
5) Explain the different clocks used in a game
6) Describe an object list, and a scene graph, for game objects
7) Differentiate between OOP and Entity-Component systems
8) Explain the elements of Model-View-Controller systems (MVC)

Putting it all together

- Key elements of typical game engine?
- Lots of parts to full system!
- Don't memorize diagram, but get high level view
  - Gameplay (high level game loop)
  - Model/scene graph+asset management
  - Physics/collision
  - Player/network interface
  - GUI
  - Rendering



Readings

- David Mount's lectures
- This class:
- **"Computer Game and Graphics System Architectures"**
- Next class:
- "**Intro to Unity**"

- Pong code on web site – optional to read or run, but Processing is fun

- Other readings

- Unity manual
- Michael Kissner Gamasutra

Next: Moving on to Unity

- Will refine and explain these ideas through the semester

- You should
  - Install Unity
  - Do Roll-a-Ball tutorial
  - Start working on Project 1

- Ideas from today apply Unity

Activity 2: Create a game! (Ice breaker)

- At each table
- Assembly your game packet (sheet, crayons, cards, dice, pieces)
- Read the instructions
- Design a game in 10 minutes
  - Round robin – take turns making decisions
  - Make rapidly

Activity 4a: Design a computer game

- At each table plan out a game for your team. Answer these questions (quickly!)

- What type of game? (platformer, FPS, RPG, etc. Multi-player?)
- What design choices?
  - Story
  - Environment
  - Characters
  - Gameplay
  - Visual look and feel

Activity 4b: Build a computer game

- At each table plan out a game for your team. Answer these questions (quickly!)

- What platform(s)?
- Any special hardware or peripherals needed?
- What software elements needed?
- Build from scratch or use engine? Which language or engine?
- What assets will you need? How will you make or get them?