Animation design patterns

Design Pattern : re-usable software design that solves a common problem

API: Application Programmer Interface

Game Loop Pattern

→ Implements an interactive application

```
while (!timeToQuit)
    processInput()
    updateApp()
    display()
```

implements one frame
framerate depends on
Speed of each loop
iteration

→ Typically, the application "customizes" what happens in the game loop

how?

Patterns for responding to game loop events

Listener pattern: an obj is stored & its methods are called when "something" happens. (aka Observer / Subscriber)

ex. Swing components in JAVA

Callback fn: a ptr to a fn (or method) is stored & then invoked when "something"

ex. Javascript, GLFW

CS317

Facade pattern: an interface to hide the details of the game loop & only provide high-level "hook"

ex. agl/window.cpp atkui/framework.cpp

framework.cpp

To build our own demos, override atkui::Framework

→ override setup() to do custom initialization

→ override scene() to update + draw objects each frame

note: any data that is part of the application should be a member of your framework subclass

Event-based architecture

Game loop pattern is an example

Events: initialization, draw, mouse clicks, key input, ...

Organize application in terms of events

for us: just need to design

what do we need to do for initialization?

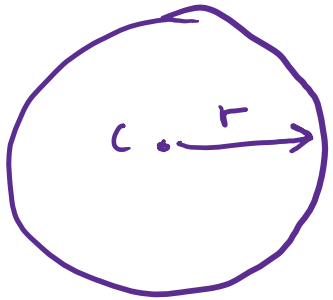
" " each frame?

" " in response to mouse & key events?

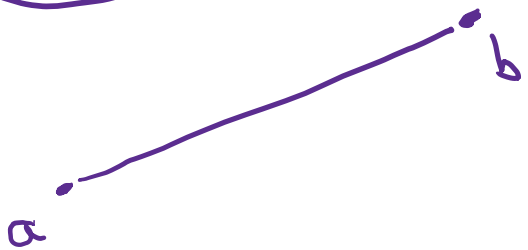
Drawing

→ all drawing should be done in scene()

Primitives: sphere
- → center c
- → radius r



line
- → 2 endpoints



Colors

RGB triplets, where each component varies from 0 to 1

red green blue

EX red (1,0,0)
green (0,1,0)
blue (0,0,1)

black (0,0,0)
white (1,1,1)

We sometimes use a 4th component, alpha, which controls transparency ← RGBA

0 : invisible
1 : opague

note: blend must be enabled for transparency to work

Points + Directions

Vector is a n-tuple of real numbers ($n = 2, 3, 4$)

ex. 3D point $p = (0, 2.3, 7)^T$ ← all vectors/pts are column vectors!

RGB color $c = (\frac{1}{2}, 1, \frac{1}{10})^T$

Important to distinguish between points & directions! ← vector is a direction vector

defn: point: specific location in space
ex. address, a pin in a map

direction vector: has no location in space
ex. north, east, left, up

Points and directions are interpreted differently

ex. A pt + direction = pt

ex. A pt - pt = direction

ex. A direction + direction = direction

we use glm::vec3 to implement both

Coordinate System (aka Coordinate Frame)

Meaning of a pt or vector depends on the coordinate system.

Defined by

right-handed system

→ origin $(0,0,0)$

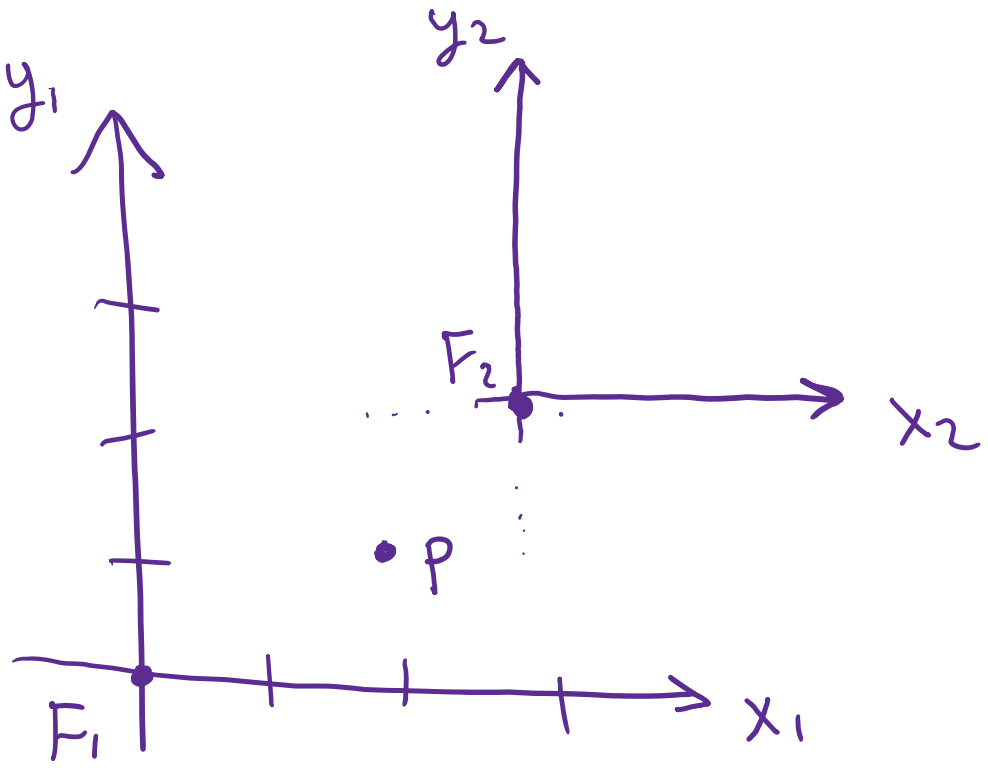
→ axes : directions corresponding to each component

$\hat{i}$ $(1,0,0)$ x - coordinate

$\hat{j}$ $(0,1,0)$ y - coordinate

$\hat{k}$ $(0,0,1)$ z - coordinate

Example



F_2 is located at $(3,2)^T$ w.r.t to F_1

What is the coordinate of p

w.r.t F_1 ? $(2,1)^T$

w.r.t F_2 ? $(-1,-1)$

Positions, velocity, time

Velocity is an n-tuple where each component is a rate of change

ex. $vel = (-1, 3, 4)^T$ → move -1 units/s along X
3 units/s along Y
4 unit/s along Z

ex. Suppose we start at position $(0, 1, -4)^T$ and we move by vel. Where is the point after 2 s?

$$p = \begin{pmatrix} 0 \\ 1 \\ -4 \end{pmatrix} + \begin{pmatrix} -1 \\ 3 \\ 4 \end{pmatrix} * 2 = \begin{pmatrix} 0 - 2 \\ 1 + 6 \\ -4 + 8 \end{pmatrix} = \begin{pmatrix} -2 \\ 7 \\ 4 \end{pmatrix}$$

$$= p_0 + vt$$

note: speed is the magnitude of velocity

$$\|v\| = \sqrt{(-1)^2 + 3^2 + 4^2}$$

Let's use velocity to implement a smoothly moving particle

Alg:

```
setup()
    currentPos = vec3(0, 1, -4)
    vel = vec3(-1, 3, 4)

scene()
    currentPos = currentPos + vel * dt();
    drawSphere(currentPos) 100.0);
```

dt(): time since the last time code was run

dt(): part of the framework

```
data { vec3 currentPos;
       vec3 vel;
```

note: framework also gives us elapsedTime()