CS324e - Elements of Graphics and Visualization

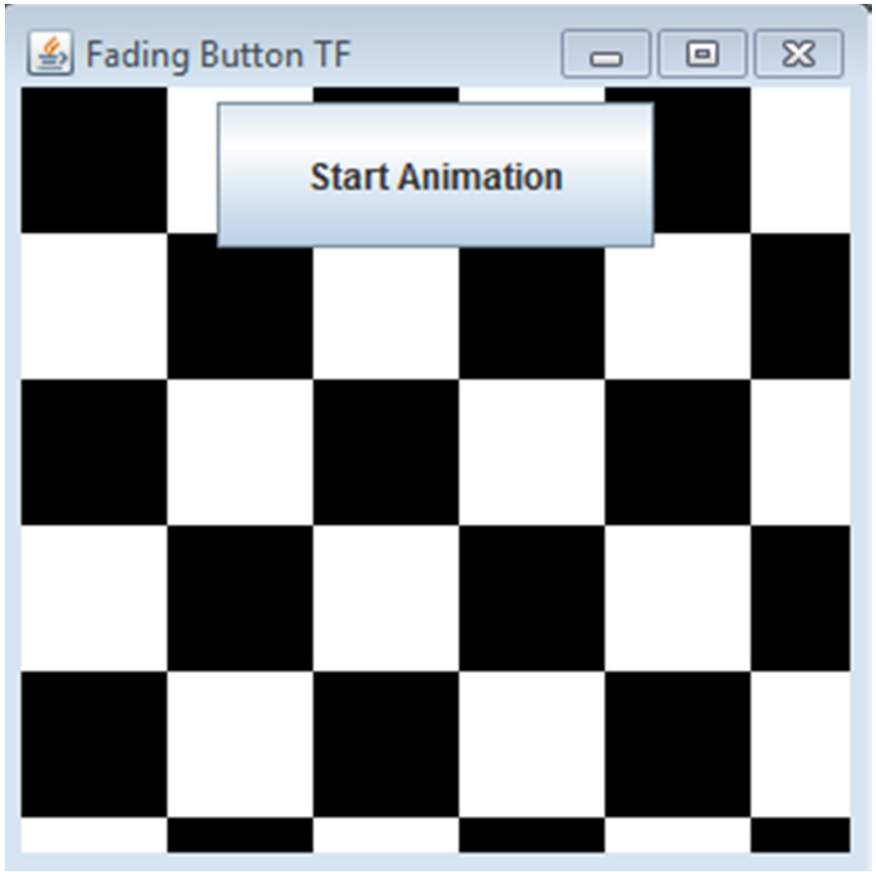
Timing Framework

Animating Swing Based Programs

- From FRC
- goal: provide framework and library to allow animation of components in a GUI
- Set of utility classes that contain the code common to handling timing issues for animation
- more functionality than the javax.swing.timer class

Example - Fading Button

- When button clicked it fades out and then back in
- fading cycle repeats until the button is pressed again



Fading Button Classes

- JFrame to hold panel and button
- checkerboard is a JPanel
- Button is a FadingButtonTF
  - class extends the JButton class
  - implements ActionListener (instead of using an anonymous inner class) and *TimingTarget* interfaces

FRC Timing Framework

- Handle common tasks such as determining what fraction of the animation has been completed
- Provide a simple API (Application Programming Interface)
  - a way of using existing code in a simple way
  - We have been using the Java API

Core Concepts of FRC Timing Framework

- handles timing, but *alteration* left to the programmer
- Animator
  - class that contains most of the timing functionality
- callbacks (listeners)
  - similar to timer callbacks but with more types of callbacks and more information

Core Concepts

- Duration: length of time animation runs, or can be set to indefinite (a clock for a game)
- Repetition: timer can run once and stop or repeat over and over
- Resolution: frame rate or frames per second
  - how often does timer send out notifications
  - default is 20 fps

Core Concepts

- Starting and Ending behaviors:
  - may add delay to start or begin in the middle of a repetition
- Interpolation
  - default is linear interpolation
  - fractions based on elapsed time / total time
  - possible to have other kinds of interpolation
  - start and end slowly (ease in and out)

Example Program

- Class declaration and instance variables

```
public class FadingButtonTF extends JButton
        implements ActionListener, TimingTarget {

    // current opacity of button
    float alpha = 1.0f;
    // for start/stop actions
    Animator animator;
    // each cycle will take 2 seconds
    int animationDuration = 2000;
    BufferedImage buttonImage = null;
```

Example Program

- Constructor with creation of Animator

```
/** Creates a new instance of FadingButtonTF */
public FadingButtonTF(String label) {
    super(label);
    setOpaque(false);
    setPreferredSize(new Dimension(150, 50));
    animator = new Animator(
            animationDuration/2,
            Animator.INFINITE,
            RepeatBehavior.REVERSE,
            this);
    animator.setStartFraction(1.0f);
    animator.setStartDirection(Direction.BACKWARD);
    addActionListener(this);
}
```

Animator Properties

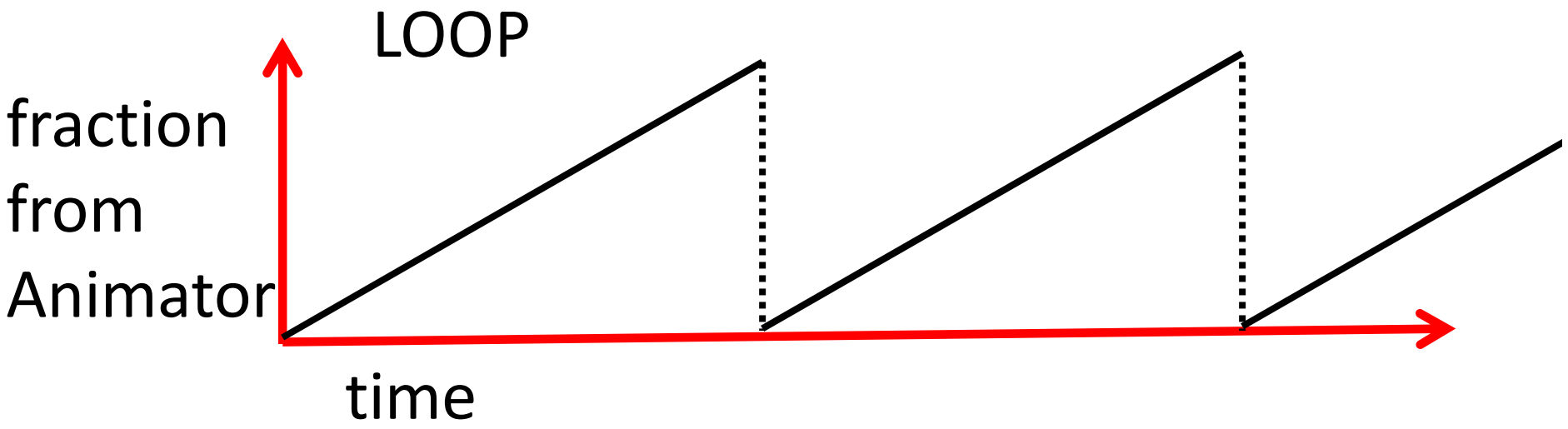
Animator

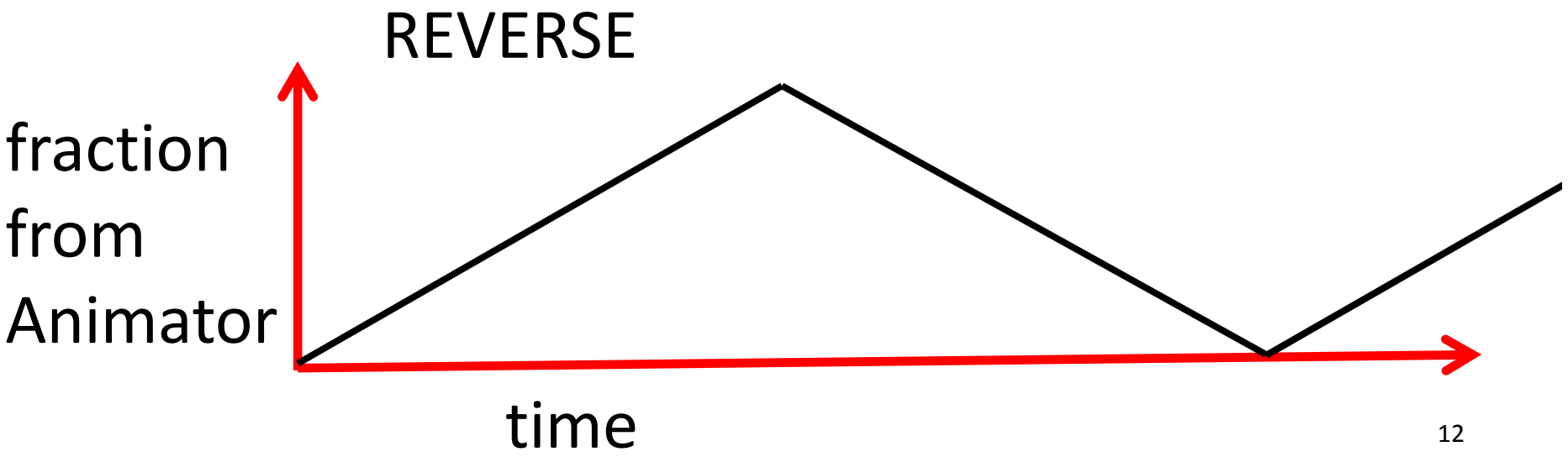
```
public Animator(int duration,
                double repeatCount,
                Animator.RepeatBehavior repeatBehavior,
                TimingTarget target)
```

Constructor that sets the most common properties of a repeating animation.

- duration in milliseconds
  - can set to Animator.INFINITE to run continuously
- repeatCount
  - number of times to run, can also be INFINITE
- repeatBehavior: LOOP or REVERSE
- target: listener for timer notifications

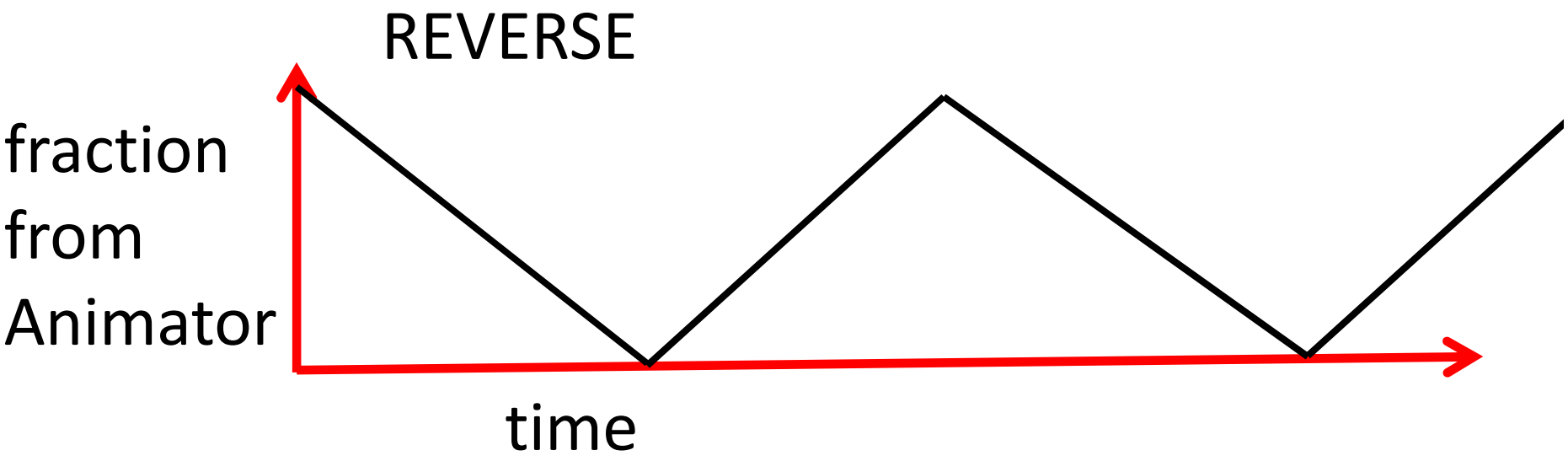
Loop vs. Reverse





Animator Properties

```
animator.setStartFraction(1.0f);
animator.setStartDirection(Direction.BACKWARD);
```



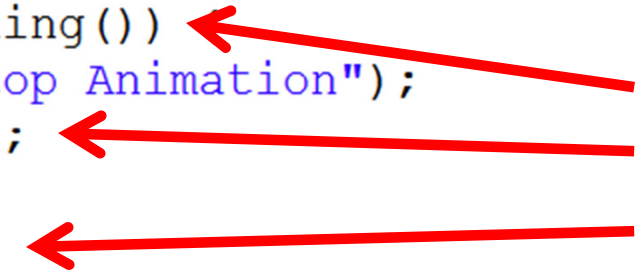
Controlling the Animator

- methods for Animator Object
- void start()
  - callbacks to start and timingEvent methods
- void stop()
  - callback to end method
- void cancel()
  - stops Animator, but no callbacks
- void pause()
- void resume()
- boolean isRunning()

Fading Button Demo

- Respond to button clicks
- recall the FadingButtonTF class implements the ActionListener interface

```
/**
 * This method receives click events,
 * which start and stop the animation
 */
public void actionPerformed(ActionEvent ae) {
    if (!animator.isRunning()) {
        this.setText("Stop Animation");
        animator.start();
    } else {
        animator.stop();
        this.setText("Start Animation");
        // reset alpha to opaque
        alpha = 1.0f;
    }
}
```



Responding to Notifications

- To respond to notifications from the animator create a class that implements the timing

```
public class FadingButtonTF extends JButton
        implements ActionListener, TimingTarget {
```

```
    /**
     * TimingTarget implementation: this method
     * sets the alpha of our button equal to
     * the current elapsed fraction of the animation.
     */
    public void timingEvent(float fraction) {
        alpha = fraction;
        // redisplay our the button
        repaint();
    }
```

Alteration of Button

```
public void paintComponent(Graphics g) {
    // Create an image for the button graphics if necessary
    if (buttonImage == null || buttonImage.getWidth() != getWidth() ||
            buttonImage.getHeight() != getHeight()) {
        buttonImage = getGraphicsConfiguration().
            createCompatibleImage(getWidth(), getHeight());
    }
    Graphics gButton = buttonImage.getGraphics();
    gButton.setClip(g.getClip());

    //  Have the superclass render the button for us
    super.paintComponent(gButton);

    // Make the graphics object sent to this paint() method translucent
    Graphics2D g2  = (Graphics2D)g;
    AlphaComposite newComposite =
        AlphaComposite.getInstance(AlphaComposite.SRC_OVER, alpha);
    g2.setComposite(newComposite);

    // Copy the button's image to the destination graphics
    g2.drawImage(buttonImage, 0, 0, null);
}
```

Non Linear Interpolation

- Animator objects have acceleration and deceleration properties
- by default these are not used
- can set so animation eases in and / or out
- instead of fraction of animation being linear with respect to time elapsed

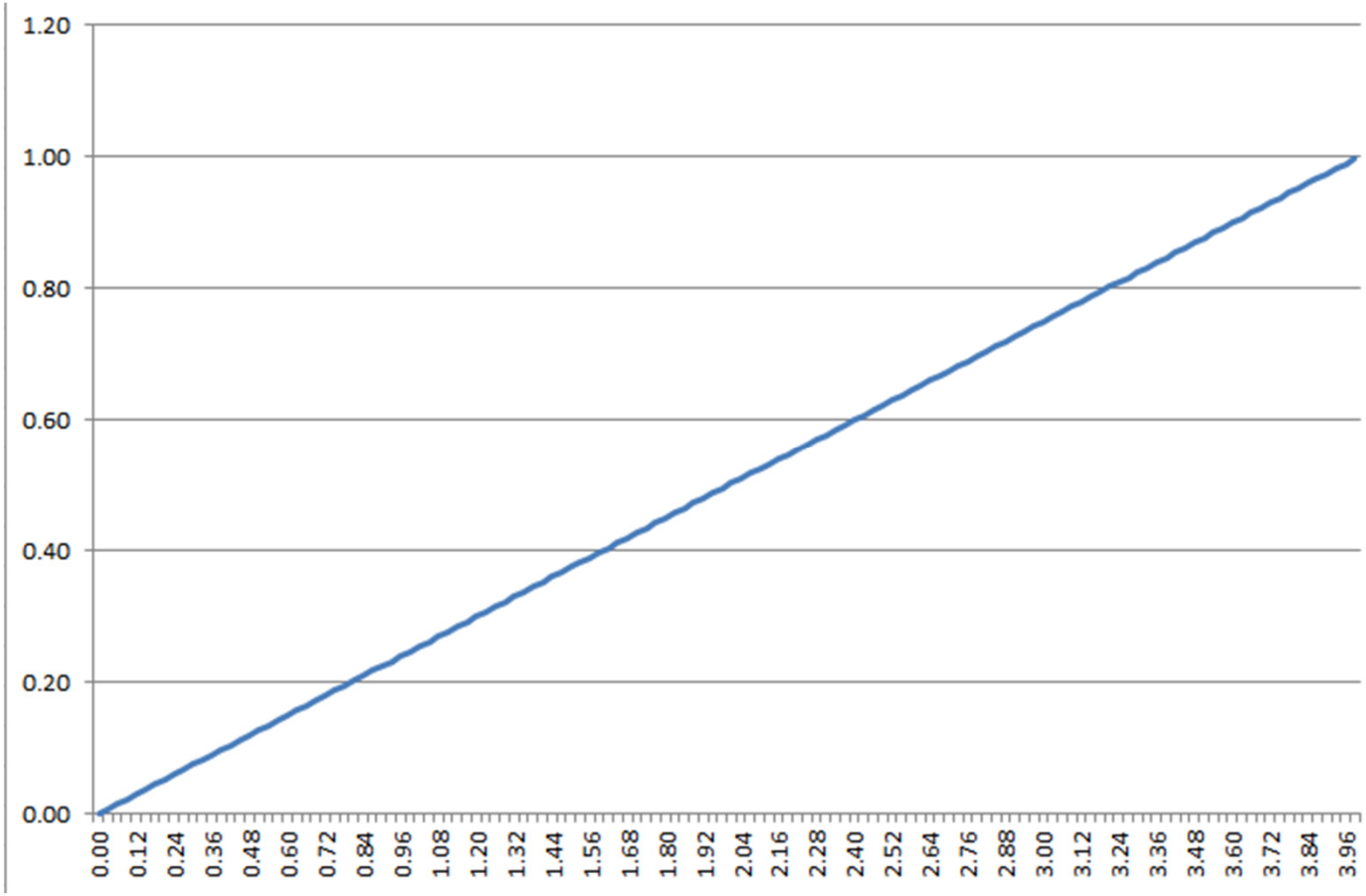
Set Acceleration and Deceleration

- represented as fraction of animation to accelerate to average speed and decelerate to stop
- sum of fractions must be <= 1

```
// sample to show ease in and out
animator.setAcceleration(.2f);
animator.setDeceleration(.4f);
```

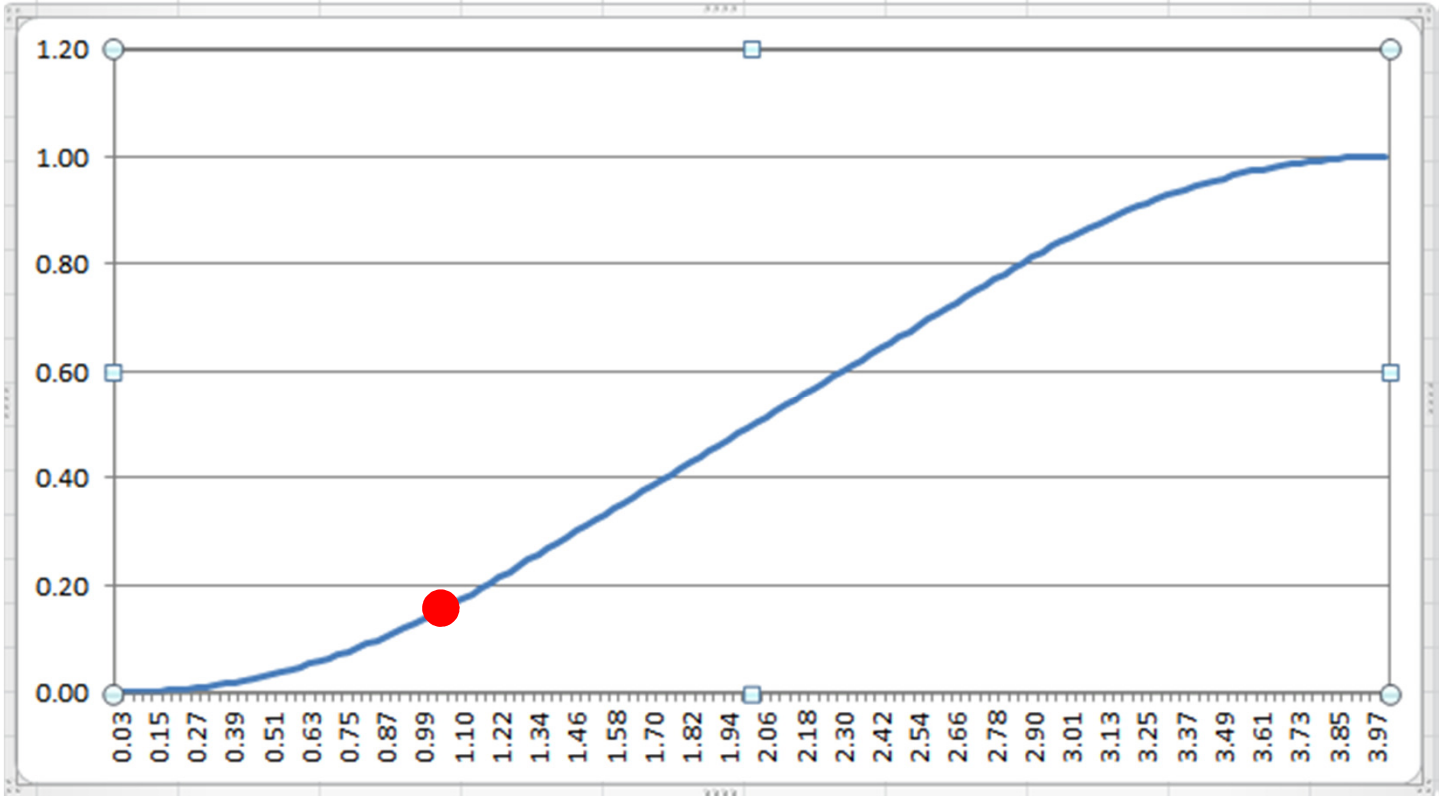
Linear

- Horizontal axis is time
- Vertical axis is fraction



Acceleration and Deceleration

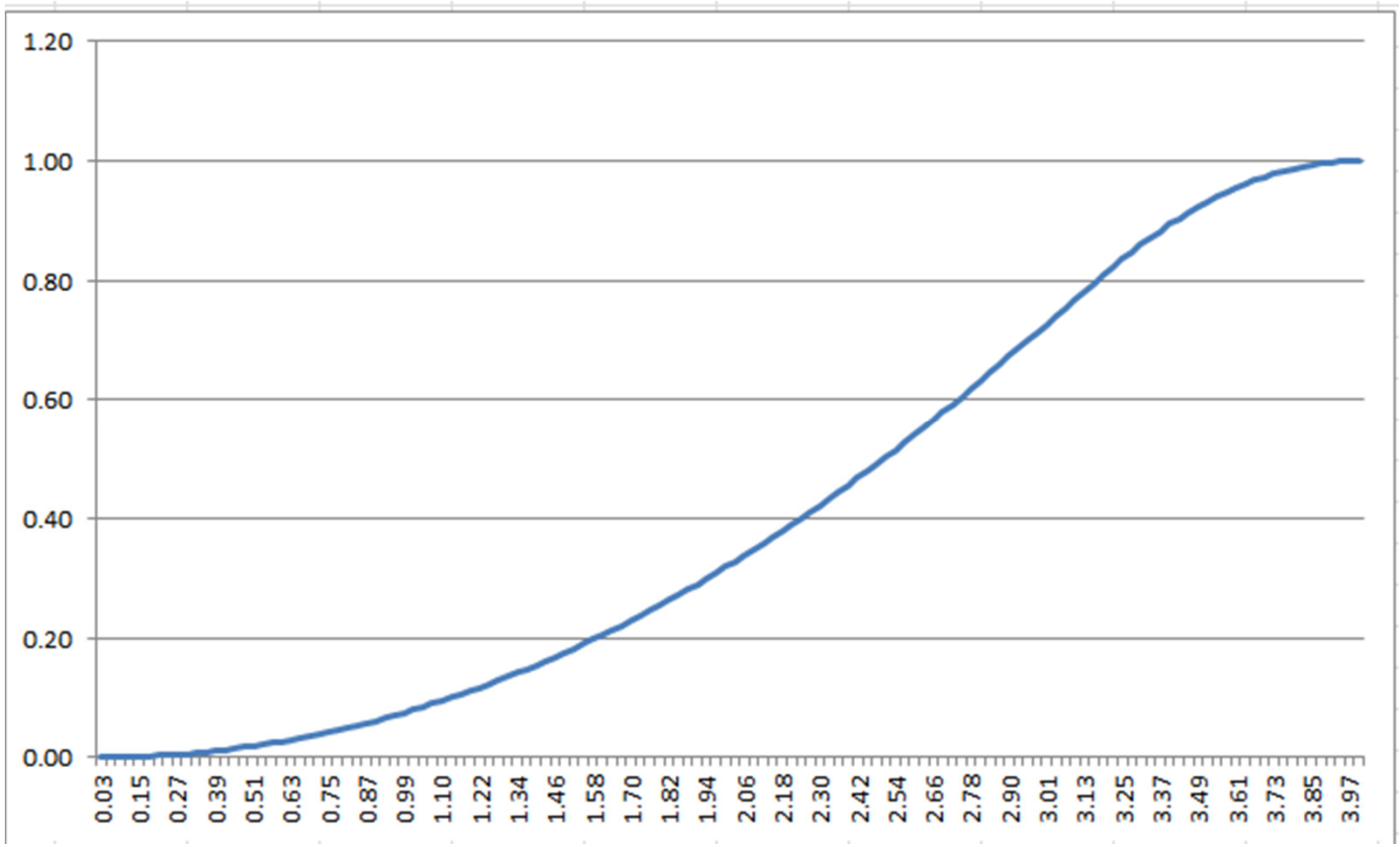
- .3 of duration for acceleration
- .3 of duration for Deceleration



- note, at 1 second (1/4 of time) fraction is still below 0.2

Acceleration and Deceleration

- .7 of duration for acceleration
- .2 of duration for Deceleration



Triggers

- Part of FRC Timing Framework
- Start animation based on a specified event
  - for example:
  - user presses a button
  - user clicks on a door in a game
  - car in a game goes off the track in a game

Triggers

- Respond to
  - GUI events
  - time events
  - custom events created by the programmer
- Use triggers by:
  - create trigger including information about the Animator the trigger will run
  - add listeners to respond to trigger when it goes off

Triggers in Action

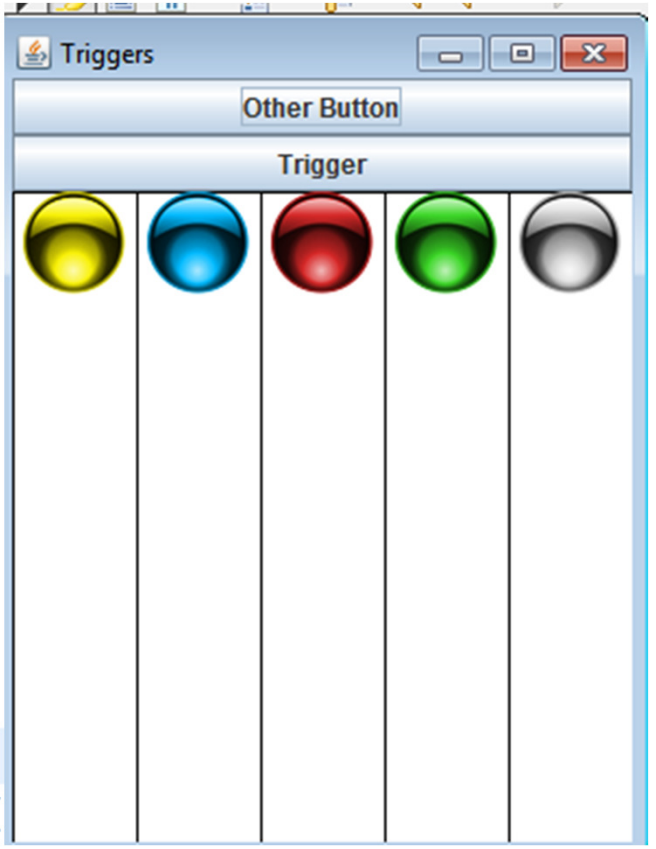
- Firing: when trigger event occurs the Animator objects start
- Disarming: canceling a trigger
- Auto-reverse: trigger has ability to run Animator forwards and then backwards
  - like the button fading in and out

Trigger Classes

- Trigger: base case for more complicated triggers
- TriggerEvent: part of framework to make it easy to add different kinds of Triggers
- ActionTrigger: simplest kind of Trigger
  - responds to java.awt.event.ActionEvent (like button clicks)

Trigger Demo

- Spheres fall and bounce based on various triggers
- The spheres are in their own panels, placed side by side




```
@Override
// SpherePanel paintComponent method
protected void paintComponent(Graphics g) {
    g.setColor(Color.white);
    g.fillRect(0, 0, getWidth(), getHeight());
    g.setColor(Color.BLACK);
    g.drawRect(0, 0, getWidth(), getHeight());
    g.drawImage(sphereImage, sphereX, sphereY, null);
}
```

Trigger Types

- Program demos 5 different kinds of triggers
- Yellow Sphere - ActionTrigger
- when the Trigger button is clicked the yellow ball's animation runs
- restarts if button clicked again before animation complete

```
ActionTrigger.addTrigger(triggerButton, action.getAnimator());
```

- action is the SpherePanel for the Yellow sphere

Animator for SpherePanel

- The FRC timing framework includes a class to automate alteration aspect of animations
  - PropertySetter
- From SpherePanel
- Creates animator

```
bouncer = PropertySetter.createAnimator(2000, this, "sphereY",
        0, (PANEL_HEIGHT - sphereImage.getHeight()), 0);
bouncer.setAcceleration(.5f);
bouncer.setDeceleration(.5f);
```

More on PropertySetter

- Note the PropertySetter.createAnimator method

```
bouncer = PropertySetter.createAnimator(2000,
        this,
        "sphereY",
        0,
        (PANEL_HEIGHT - sphereImage.getHeight()),
        0);
```

- duration, object that has property animated, name of property (must have set… method), values property takes (y coordinate -> top, bottom, top)

Focus Trigger

- Blue Sphere - A FocusTrigger

```
FocusTrigger.addTrigger(triggerButton,
        focus.getAnimator(), FocusTriggerEvent.IN);
```

- When the Trigger Button gains the focus (not pressed) the Blue Sphere bounces
- demo: use tab to change focus between Trigger button and Other Button

MouseTriggers

- Two MouseTriggers in the demo
- Red Sphere - armed trigger

```
MouseTrigger.addTrigger(triggerButton,
        armed.getAnimator(), MouseTriggerEvent.PRESS);
```

- When the mouse is pressed on the button the red sphere bounces
- press and hold button
- change from triggerButton to action panel

MouseTrigger

- Green Sphere - MouseTrigger
- Activated when the mouse enters the Trigger button region
  - does not need to be pressed

```
MouseTrigger.addTrigger(triggerButton,
        over.getAnimator(), MouseTriggerEvent.ENTER);
```

Timing Trigger

- Gray Sphere - TimingTrigger
- When the action trigger (yellow sphere) stops then the timing trigger for the silver sphere starts
- useful for chaining animations

```
TimingTrigger.addTrigger(action.getAnimator(),
        timing.getAnimator(), TimingTriggerEvent.STOP);
```

- Add triggers so when gray sphere stops, red, green, and blue bounce