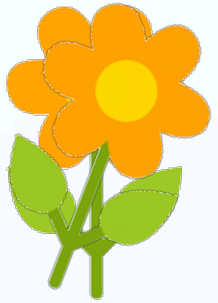
CSC 240 Computer Graphics
Video 7A: Animation

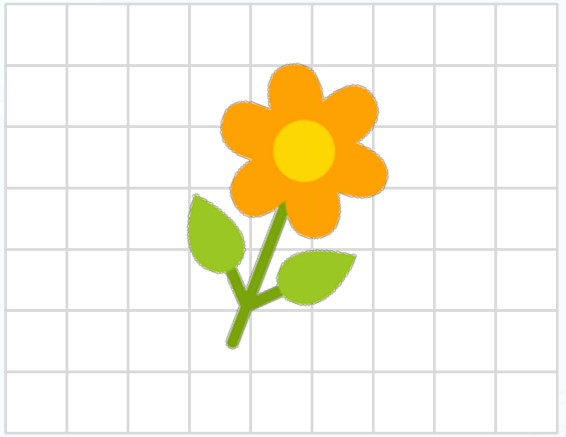
Nick Howe
Smith College

Modeling with Transforms

Typical work flow:

1. Design your object
2. Apply transform (scale, rotate, translate) & draw in scene





Note that in code, the applications must be applied in the opposite order (translate first, rotate second, scale third)

$T = I$	$P' = I \cdot P$	Initial state
$T = I \cdot T$	$P' = I \cdot T \cdot P$	Apply translate
$T = I \cdot T \cdot R$	$P' = I \cdot T \cdot R \cdot P$	Apply rotate
$T = I \cdot T \cdot R \cdot S$	$P' = I \cdot T \cdot R \cdot S \cdot P$	Apply scale

Undo transforms when done if you have more objects to draw!

Animations

The human eye has a bias towards perceiving motion

- **Persistence of vision**
  - Briefly presented stimulus remains perceptible for up to 1/16 second
  - If similar stimulus is presented within this time, will seem continuous
  - Animation possible by displaying sequence of slightly varying images

Single Object Animation

We can use transforms to do animation.

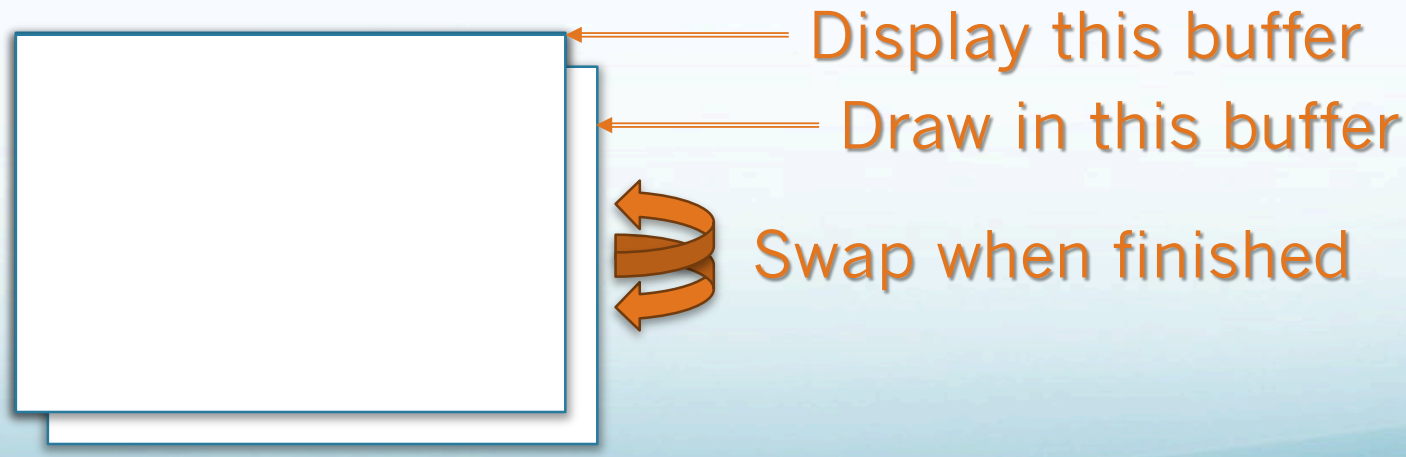
- Initialization: Define object appearance, initial model transform
- Infinite loop:
  1. Erase screen / draw background
  2. Draw object using current transform
  3. Update transform for next iteration

  Note: update can be either cumulative (applying new transform on top of existing) or replacing (creating entire transform from scratch on each update)

https://www.deviantart.com/flutterluv/art/A-Cow-Jumped-Over-The-Moon-

Buffering

- For animation, need to draw and redraw graphics
- Complex renderings take time to produce
- Don’t want user to see drawing process
- Solution: **double buffering**



Animation Over Time

Sometimes we want to animate one motion, followed by another, etc.

- Use a counter to keep track

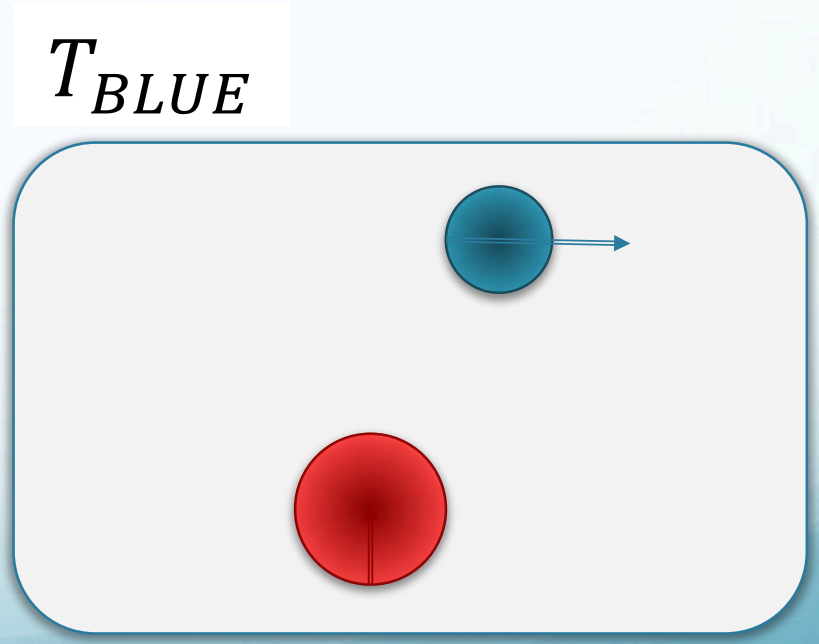
```
if (c < 100) {
    // move right
    graphics.translate(10,0);
} else if (c < 200) {
    // move down
    graphics.translate(0,10);
} else  {
    // move up & left
    graphics.translate(-10,-10);
}
c++;
if (c>300) {
    // reset
    c = 0;
}
```

Animation with Multiple Objects

Multiple independent motions can be achieved via transform swapping

- Each moving object has its own independent transformation matrix
  Prep to draw: either reverse previous transform, or wholesale replacement

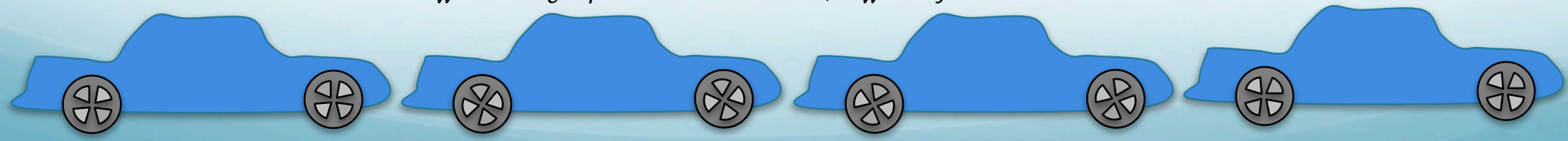
- Animation loop:
  1. Erase screen / draw background
  2. Loop over objects
     A. Install transform for the current object
     B. Draw object using current transform
     C. Update transform for next iteration of this object
     D. (Save/remove transform for the current object)



Hierarchical Modeling

- Complex objects can be built up of subparts
- Overall object has one modeling transform
  - Subparts apply their own transform on top of the parent's
    - If they have subparts, they can apply yet another, etc.
  - After adding each subpart, revert to the parent transform
- When animating, a change to the transform of the overall object modifies all the subparts as well

Car transformation is T_c. Wheel transformation is $T_c T_w R_w$
Wheels rotate, but always have same position relative to car.
R_w and T_c update with time; T_w stays the same.



https://www.canstockphoto.com/kicking-mannequin-4280471.html

Questions

PAUSE NOW & ANSWER

A hierarchical model is used for a steam locomotive, with the boiler as the root and the hierarchy shown

1. What is the full transformation applied to driver wheel #1?

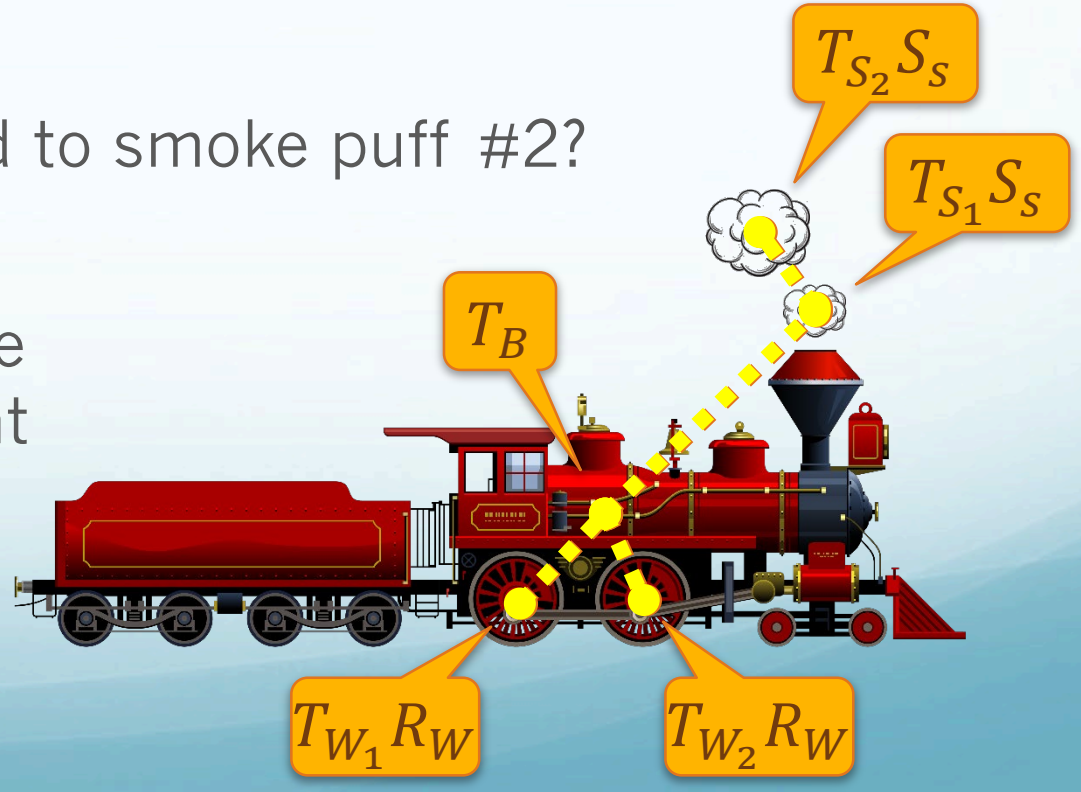
$$T_B T_{W_1} R_W$$

2. What is the full transformation applied to smoke puff #2?

$$T_B T_{S_1} S_s T_{S_2} S_s$$

3. Why can the smoke puffs use the same scale transformation but need different translations?

They grow by the same amount, but the movements are different.



Review

After watching this video, you should be able to...

- Outline the steps for creating a simple animation
- Customize animations with different motions over time
- Create animations involving multiple independent objects
- Understand how object part hierarchies can be used to compose transformations to get relative motion in complex multipart objects

Music: https://www.bensound.com