Student Presentation
So far we’ve focused on how to construct static images
One way to animate a scene would be to define a sequence of static images that form the final animation
This is a very involved, very laborious process
How can we simplify this process?
 Tweening

- In-betweening
- Used in both traditional and digital animation
- Define distinct “keyframes” then automatically interpolate between them

(Chu and Lee, 2009)
Linear Interpolation

- Changes over time give the appearance of an animation
- Given a starting and ending target, we can change by a fixed value at each time step
- The value is (theoretically) the same from frame to frame
- This way, change happens at a linear rate
Translation over Time

- Consider a point at starting position \((x_0, y_0)\)
- Its target position is \((x_1, y_1)\)
- At each time step, its position \((x, y)\) will be on the blue line

(Wikipedia)
Question

❖ How can we animate a moving object in Processing?
Moving Objects in Processing

- A simple way to change values over time is via the `draw()` function
- `draw()` is called at a (supposedly) fixed frame rate
- This frame rate determines the size of our time step
  - 60 fps = 16ms time step
  - 30 fps = 33ms time step
- Unexpected behavior can happen when the frame rate fluctuates though…
void draw() {
  background(210);
  ellipse(x, y, 30, 30);
  if (x < 250) {
    x += dx;
  }
}

float x = 0.0;
float y = 250.0;
float dx = 5.0;

void setup () {
  size(500, 500);
}
Question

- How can we know an object’s current \((x, y)\) position based on time step?
Lerp Operation

- Processing has `lerp()` function
- Lerp is a contraction of “linear interpolation”
- Lerps determine the position between any two values, \( v0 \) and \( v1 \), based on parameter \( t \):
  \[
  v(t) = v0(1 - t) + v1(t)
  \]
- Parameter \( t \) can be any value between 0 and 1
Lerp Uses

Color and texture
(Color and texture image)

Position over time
(Position over time diagram)

Data sets
(Data sets graph)

(ShaderForge)

(Wikipedia)
Question!

- If a point starts at $x_0 = 6$ and ends at $x_1 = 25$ moving along a line, what is its position on the x-axis at $t = 0.4$?
Multivariate Interpolation

- Bilinear interpolation performs three linear interpolations to interpolate over two dimensions:

- Over how many dimensions does trilinear interpolation operate?
Cosine Interpolation

- Linear interpolation can have sharp discontinuities at each point
- Cosine interpolation smooths these transitions without requiring additional points:

\[ t_2 = \frac{(1 - \cos(\pi t))}{2} \]

\[ v(t) = (1 - t_2)v_0 + (t_2)v_1 \]
Cosine versus Linear Interpolation

Linear interpolation

Cosine interpolation

(http://paulbourke.net)
Hands-on: Using Linear Interpolation

❖ Today’s activities:

1. Experiment with Processing’s `lerp()` method using different values for \( t \) (between 0 and 1)

2. Experiment with the general linear interpolation formula to recreate those results using the previous values for \( t \)

3. Create a method `move`, which takes a start position, an end position, and a step size. This method, called by `draw()`, will update the shape’s position at the given rate (step size)

4. If time allows, reimplement this method using cosine interpolation