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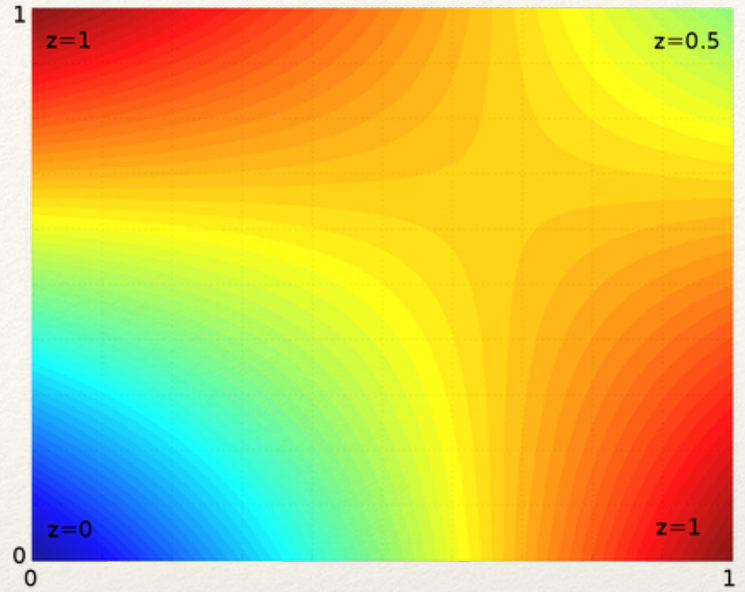


Interpolation

Elements of Graphics
CS324e

Animating a Scene

- 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

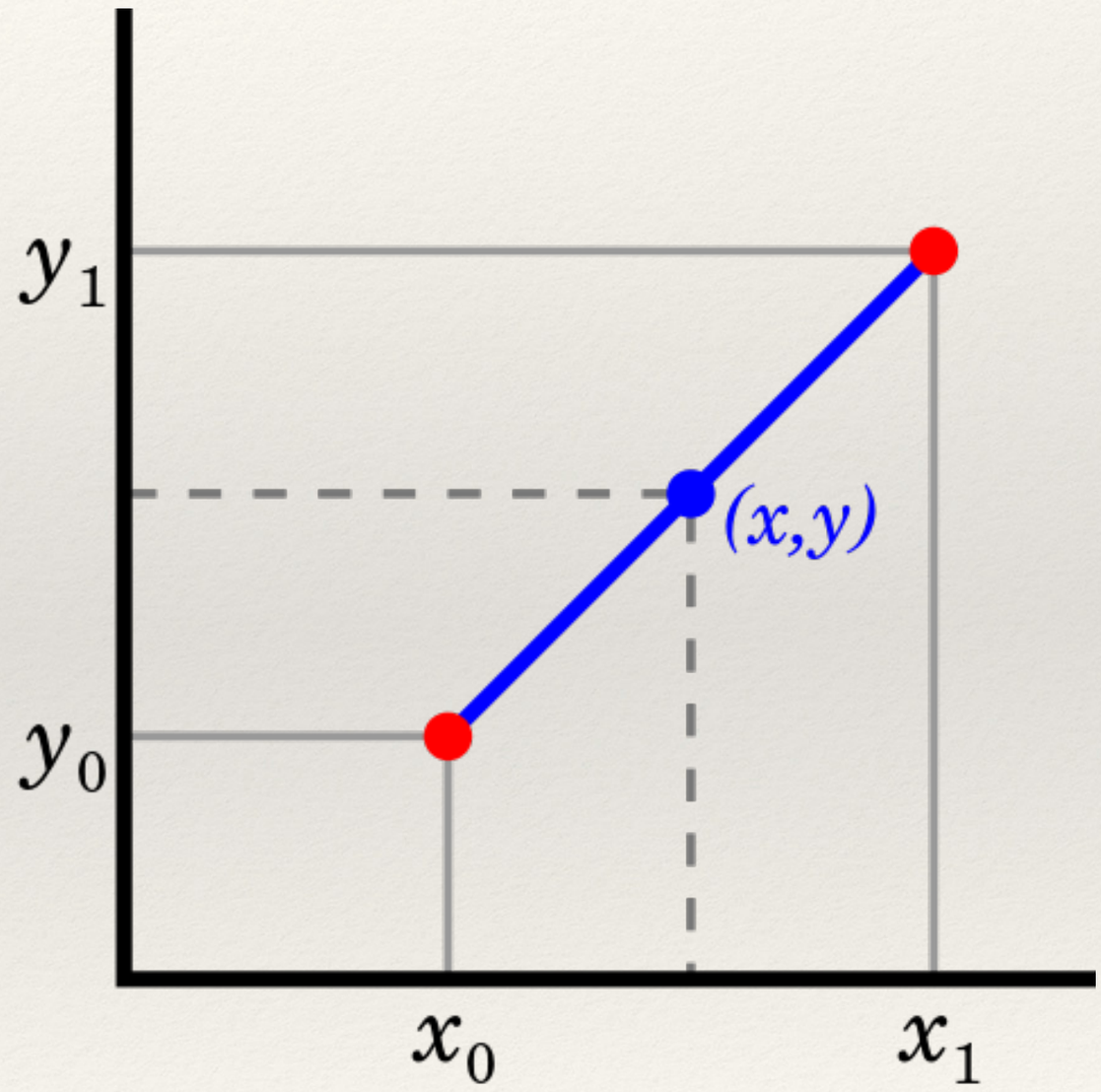
(Chu and Lee, 2009)

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)

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…

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

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

```
void draw() {
  background(210);
  ellipse(x, y, 30, 30);
  if (x < 250) {
    x += dx;
  }
}
```

Question

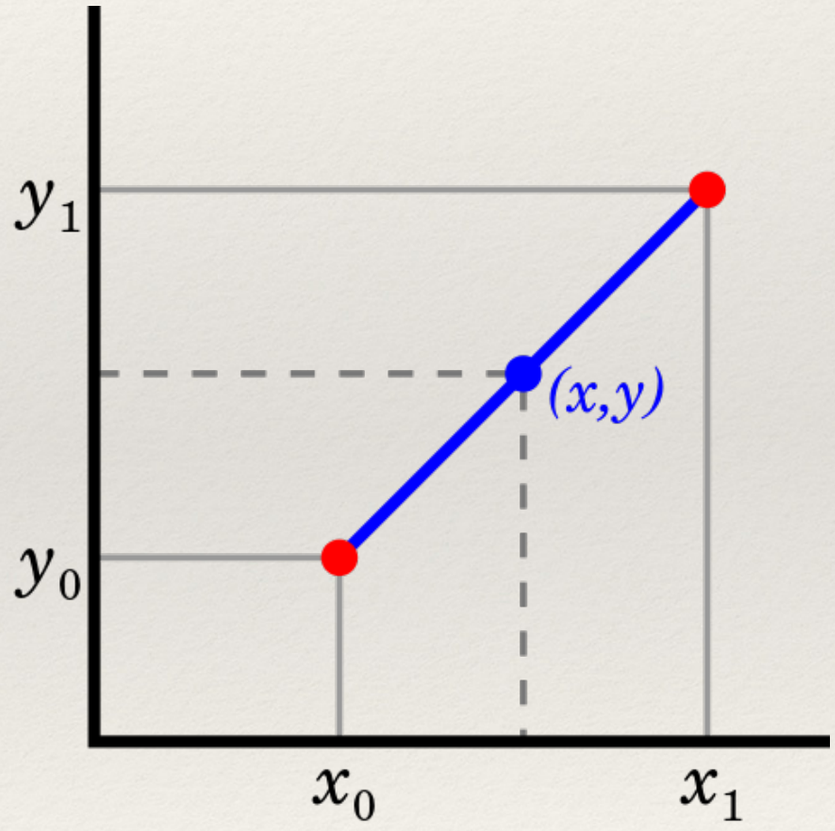
- What if we want to know an object's current (x, y) position at a particular time step?

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
- Note: Does not apply the lerp over time -- you must do that directly!



Instapoll Question: Linear Interpolation

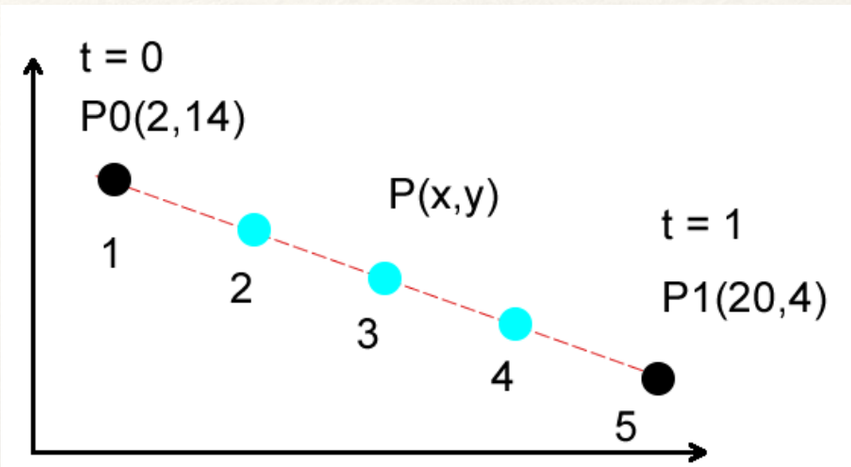
- If a point starts at x0 = 6 and ends at x1 = 25 moving along a line, what is its position on the x-axis at t = 0.4?

Lerp Uses

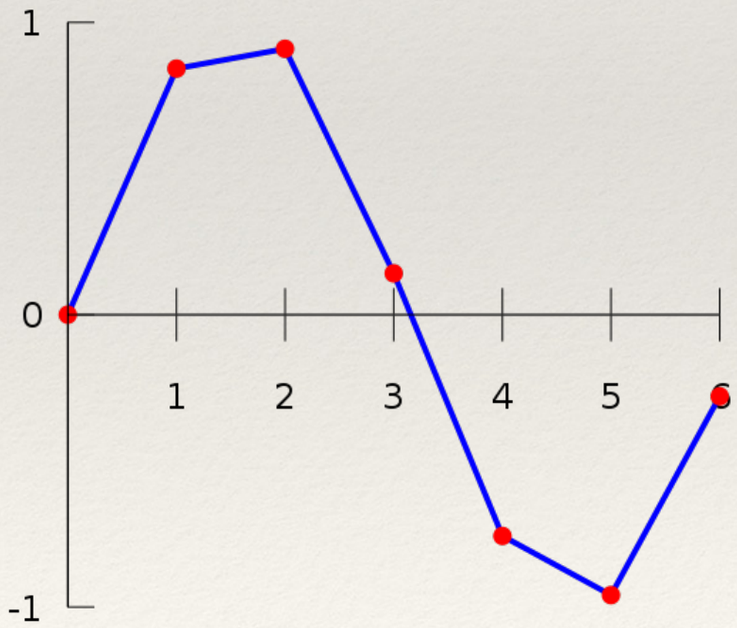
Color and texture

(ShaderForge)

Position over time



Data sets



(Wikipedia)

Cosine Interpolation

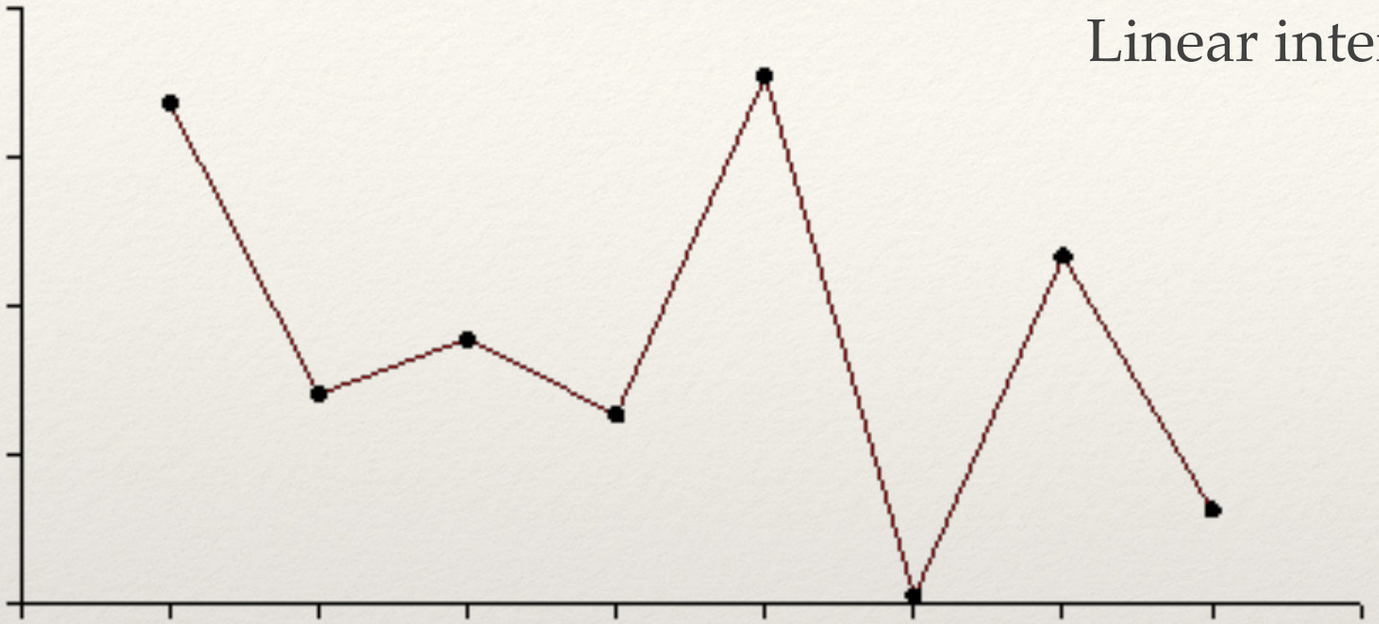
- Linear interpolation can have sharp discontinuities at each point
- Cosine interpolation smooths these transitions without requiring additional points:

$$t2 = (1 - \cos(PI*t))/2$$

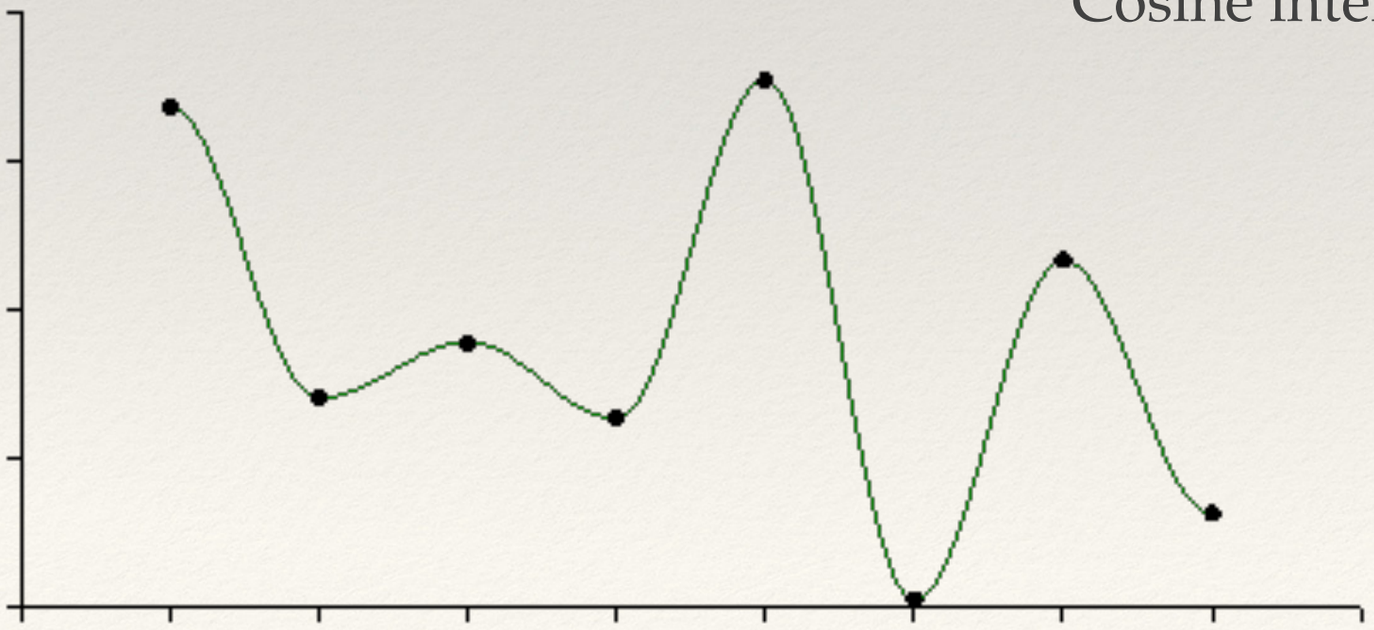
$$v(t) = (1 - t2)v0 + (t2)v1$$

Cosine versus Linear Interpolation

Linear interpolation



Cosine interpolation



(http://paulbourke.net)

Hands-on: Linear Interpolation

- Today's activities:

  1. Experiment with Processing's `lerp()` method using different values for `t` (between 0 and 1)
  2. 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).
  3. Determine the step size based on the length of animation you want for the movement
  4. If time allows, reimplement this method using cosine interpolation