Sprite Graphics

CS 4730 – Computer Game Design

Slide material courtesy Walker White (Cornell)

First, a history lesson…

- We start with the CRT (cathode ray tube)
  - Made up of pixels (picture elements)
  - A 300x200 screen would have 200 scan lines of 300 pixels each
  - Each line would get drawn, starting from the top and working it's way down
  - This is one reason graphics coordinates start with the upper left

History

- After drawing all the scan lines (aka one frame), the ray gun had to line back up at the top
- This delay is called VBLANK
  - It's what makes a PAL TV different than an NTSC, etc.
- Early game systems didn't have enough memory to store one screen's worth of pixels at one time!

Synctastic

- If a game (old or modern) updates the frame buffer when the scan lines are in the middle of being drawn, tearing occurs
- One option is to lock the update() method to VBLANK (not the best option)
- Another is to have more than one buffer and swap the two during VBLANK
- This swapping is called VSYNC
- Good frame rates lock to VSYNC

Pretty, Pretty Pictures

- "Though still rooted in the work of the first two games, X improves on the visuals even more and features impressive graphical effects."
- "And despite all of their saccharin-sweet cuteness, the graphics are magnificent. X's dream of producing an interactive cartoon has been fully realized -- the animation is lavish, the textures rich, and even the most superfluous touches have been completely executed."

Pretty, Pretty Pictures

- Castlevania 3 (NES)
- Super Mario 64 (N64)

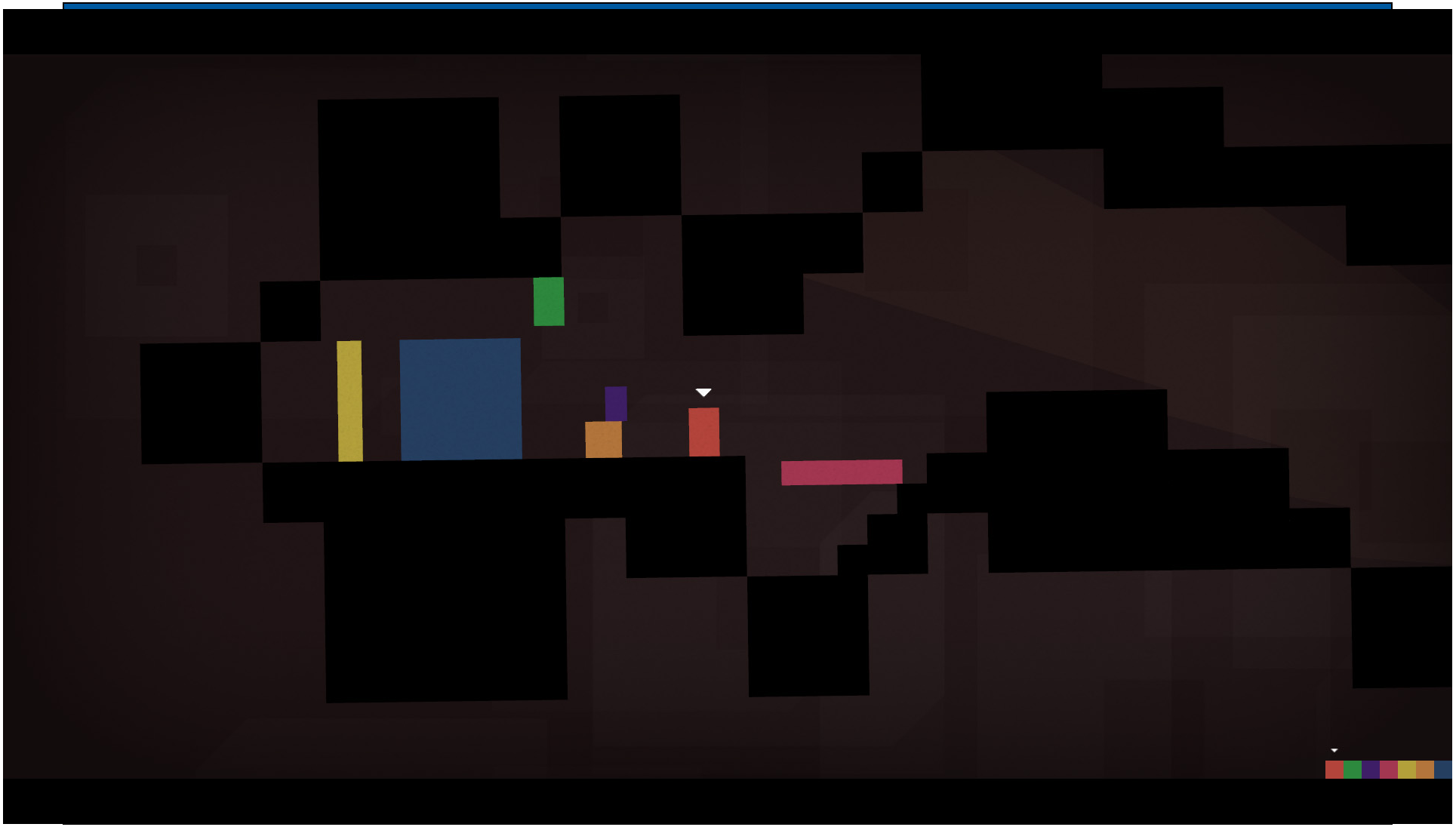
- So… it's all relative, huh?

Graphics vs. Visual Design

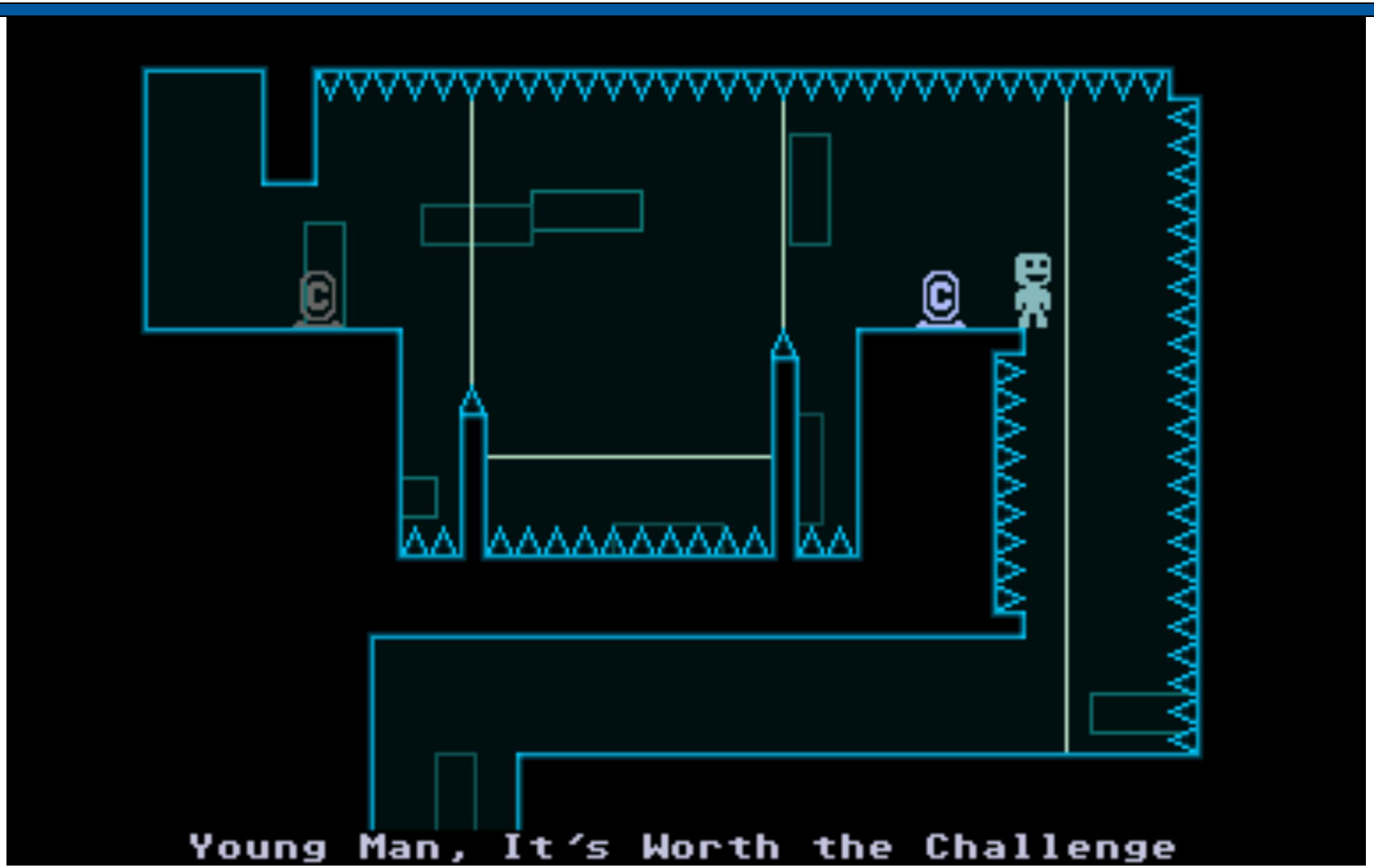
- Sometimes (most times) you don't have to have AMAZING graphics
- You need to have the RIGHT graphics
- Tetris wouldn't be "better" with sweet bump mapping
- Just because we're using 2D, that doesn't mean you're being held back

Graphics vs. Visual Design

Graphics vs. Visual Design



Graphics vs. Visual Design



Graphics vs. Visual Design

The SpriteBatch

- The SpriteBatch is exactly what it sounds like:
  - A way to draw a bunch of Sprites all at once (aka "in a batch")
  - SpriteBatch composites Sprites on top of each other, like cels of animation
- With each frame, we need to clear the screen, stack the sprites, then draw them all to the screen (and update the system that we have drawn)

The SpriteBatch

```
Texture2D background = Content.Load<Texture2D>("stars");
Texture2D shuttle = Content.Load<Texture2D>("shuttle");
Texture2D earth = Content.Load<Texture2D>("earth");

protected override void Draw(GameTime gameTime)
{
    graphics.GraphicsDevice.Clear(Color.CornflowerBlue);
    spriteBatch.Begin();
    spriteBatch.Draw(background, new Rectangle(0, 0, 800, 480),
Color.White);
    spriteBatch.Draw(earth, new Vector2(400, 240), Color.White);
    spriteBatch.Draw(shuttle, new Vector2(450, 240), Color.White);
    spriteBatch.End();
    base.Draw(gameTime);
}
```

The SpriteBatch

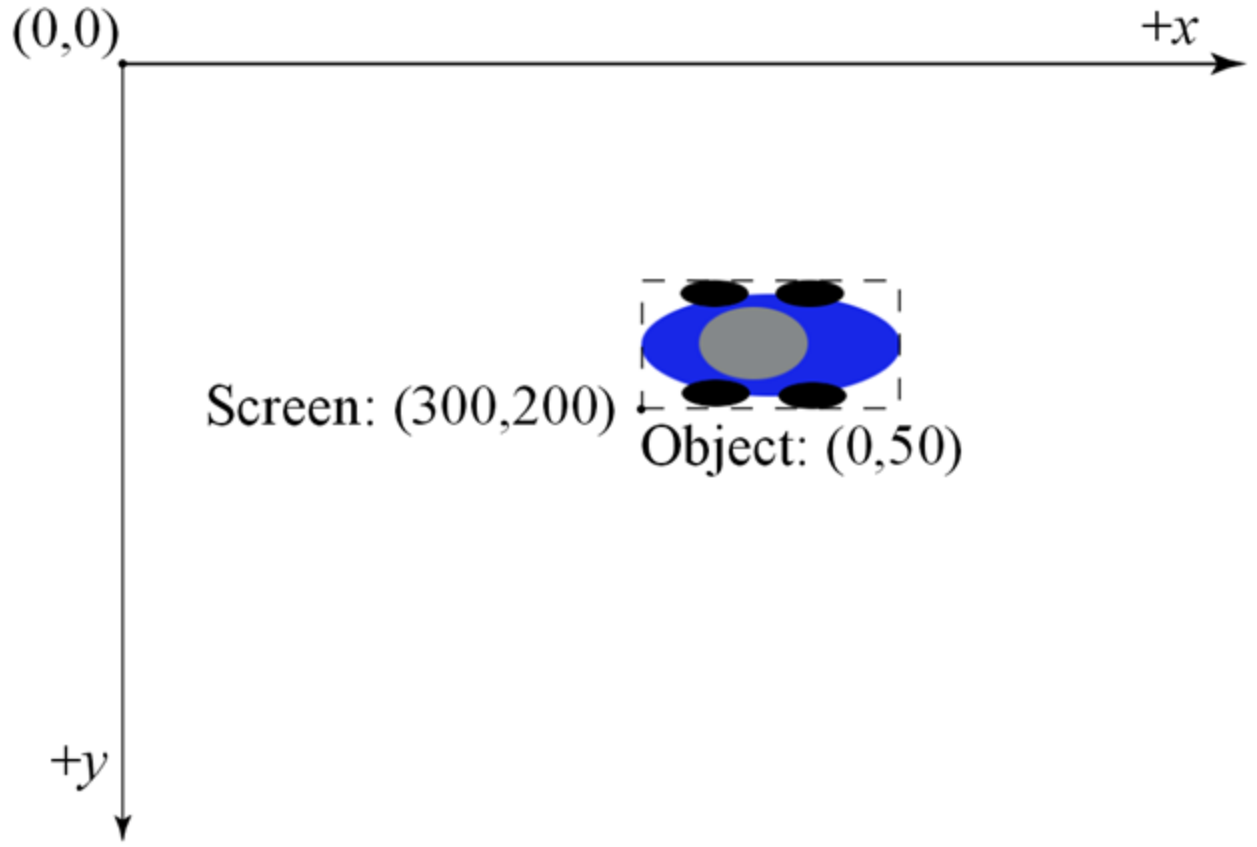
- What this gives us is the library methods we need to know whether we HAVE to draw each pixel
- If two images overlap, which color do you make the pixel? This is handled for us!

Sprite Coordinates

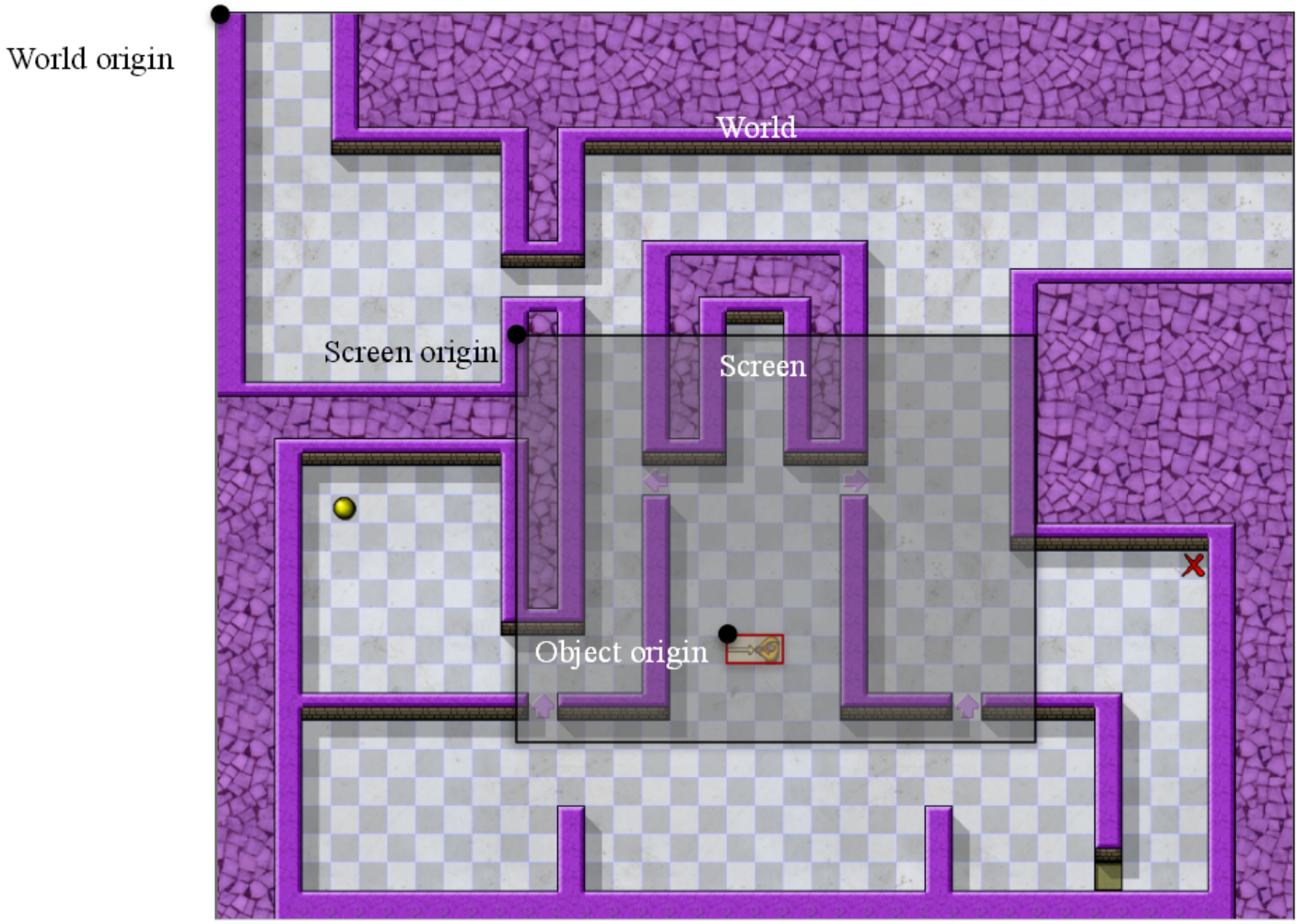
- Sprites are an abstraction of all graphical content
- Three kinds of coordinates: world, screen, and object
- We can manipulate sprites using linear algebra
  - Some examples include translation, scaling, and rotation

Object coordinates

- Position of a pixel within an object



Screen and world coordinates



Drawing Back to Front

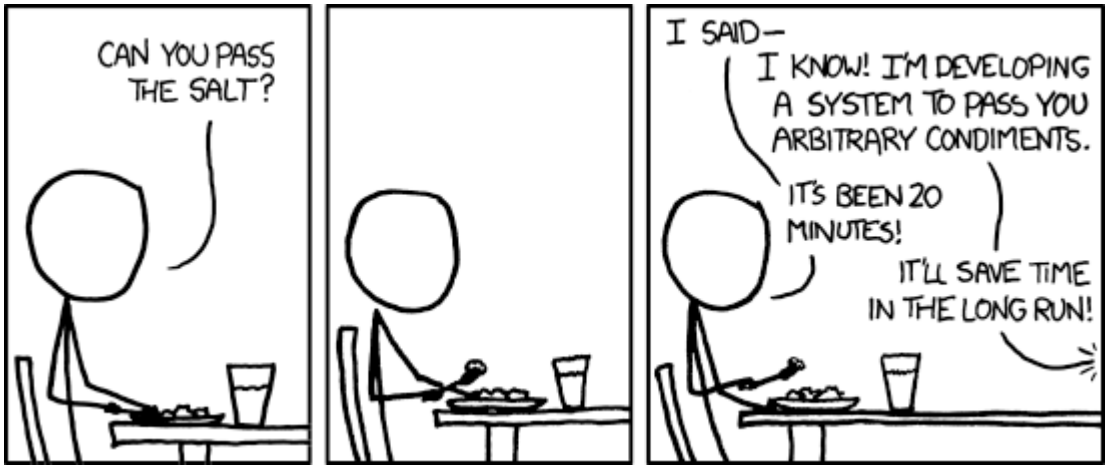
- End() is easy – you call it when you're finished drawing things!
- Draw() is a touch more complex, but still simple. Three arguments:
  - The image to draw
  - The position at which to draw
  - A color to tint it (use Color.White most of the time)

e.g.

```
mySpriteBatch.Draw(background, Vector2.Zero, Color.White);
```

Back to front (continued)

- The Begin() method is the most complex
- You can pass it a variety of parameters that control how everything is drawn
- Or you can just pass it nothing (easiest and therefore most recommended choice)



2D Transformations

- A function *T :*
  - Moves one set of points to another set of points
  - Transforms one coordinate system to another
  - The new coordinate system is the distortion
- The Idea: Draw then "distort" it
  - Examples: Stretching, rotating, reflecting
  - Allows us to get multiple images for free! (i.e. character facing both directions)

The Drawing Transform

- The simplest transformation is a direct mapping
  - Assume pixel *(a,b)* of the image is blue
  - Then screen pixel *T(a,b)* is blue
- By default, the object space = screen space
  - The color at one point in the image = the color of the screen's point
  - The draw is the actual transformation

Translation Transformation

- $T(v) = v + u$
  - Here, we shift an object in the direction of u
  - Distance shifted is the magnitude of u
- This is what is used to place objects on the screen
- By default, object origin is screen origin
- This transformation places the object origin at u

Composing Transformations

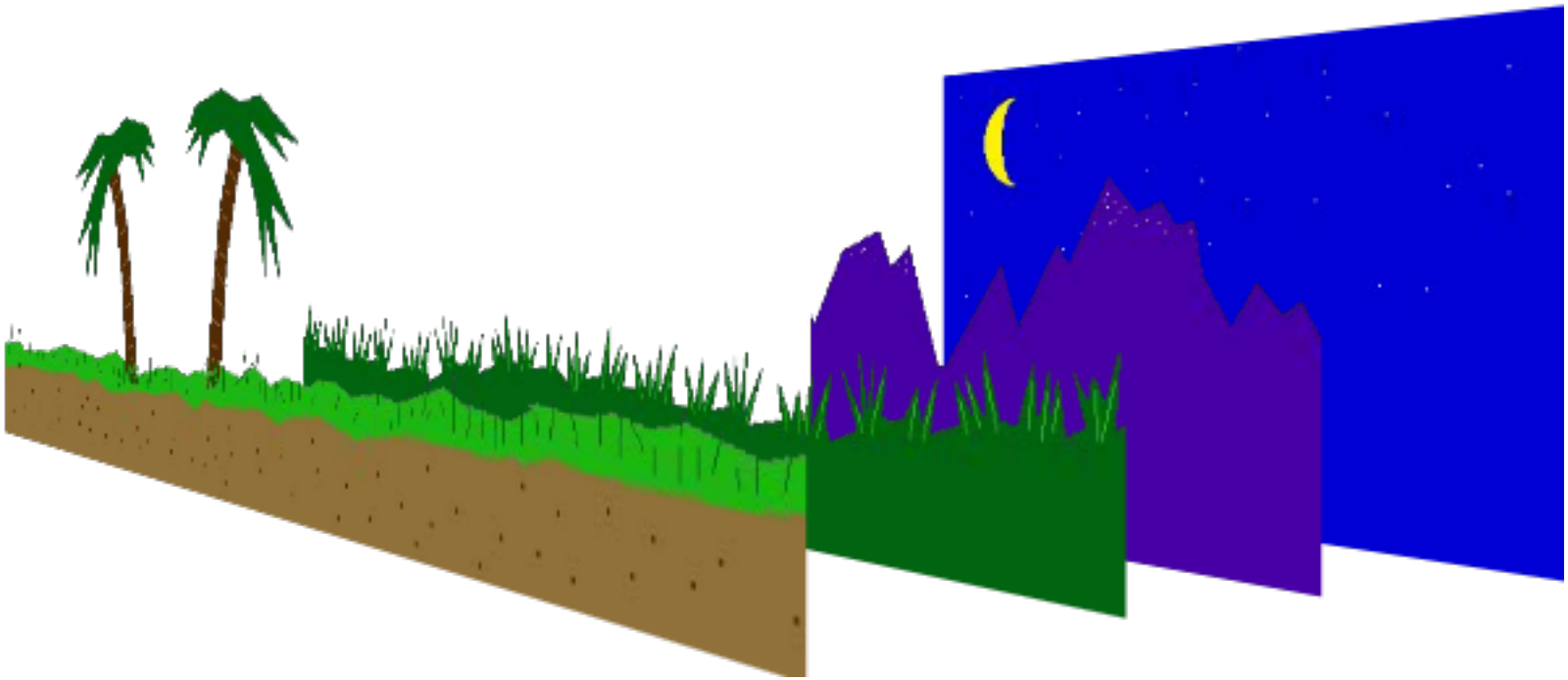
- Assume we have two transformations, *T* and *S*
  - Assume pixel *(a,b)* is blue in the image
  - Transform *T* makes *T(a,b)* blue
  - Transform ST makes *S(T(a,b))* blue
- Consider what you want the image to do, then break it down into a set of transformations

Scrolling

- Place object in the World at p = *(x,y)*
  - i.e. *T(v) = v+p*
- Suppose the screen origin is at q = *(x', y')*
  - Then the object on the screen is at point p-q
  - *S(v) = v-q* transforms World coords to Screen
  - *ST(v)* transforms Object to the Screen
- Thus to scroll:
  - To move the object, change *T,* but not *S*
  - To scroll the screen, change *S*, but not *T*

Parallax Scrolling

- Multiple layers of background, scrolling at different speeds to give the illusion of depth



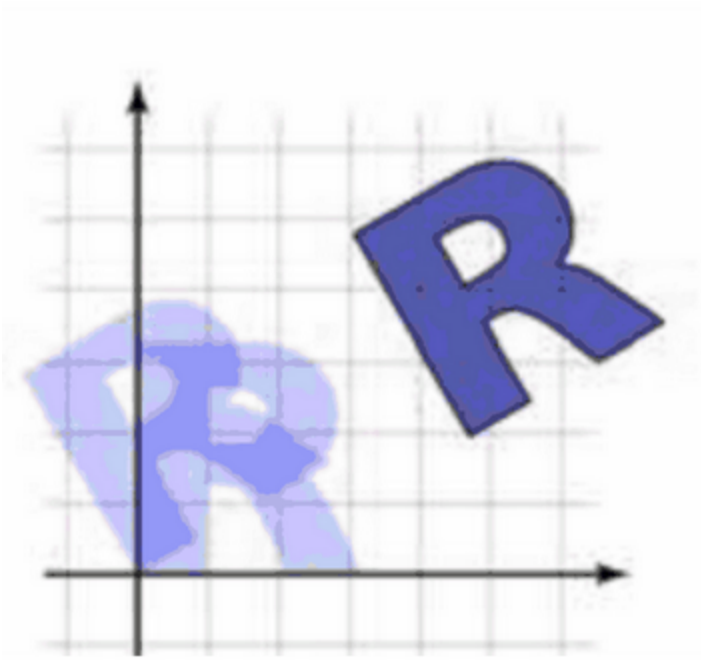
Scrolling

- What about objects not on screen?
  - If you try to draw them, that's fine
  - The graphics card will just ignore them
- But what does that do to your game loop?
  - Keeping up with all those objects…
  - Updating all those locations…

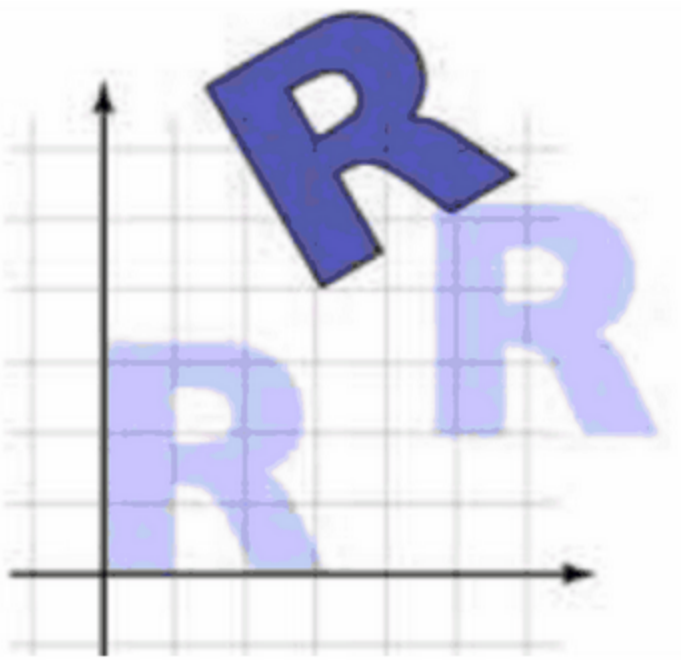
Beware Some Transforms!

- Scaling can be tough
- If you up-scale an image, you are increasing the number of pixels, but not the amount of information
- This leads to “jaggies” or blocky images
- Scaling down is okay (usually)

Beware Transform Order!



Rotate then Translate



Translate then Rotate

Animation

- Not quite as simple as you might hope…
- Roll your own AnimatedSprite class
  - Here you would load the sprite sheet and keep up with which frame is up next
- Try a third-party tool like TexturePacker

Sprite Sheets

What makes a game 3D?

- For the most part, the game is still rendered in 2D for a flat monitor screen…
- So how is it 3D?

What makes a game 3D?

- Two main aspects:
  - Assets are rendered on all sides
  - User has some extra control of the camera to move in all three directions

The Camera

- When we refer to the camera in a game, we are referring to the angle and perspective of the player
- Represented as it's own coordinate system
- Moving the camera is another coordinate transformation!

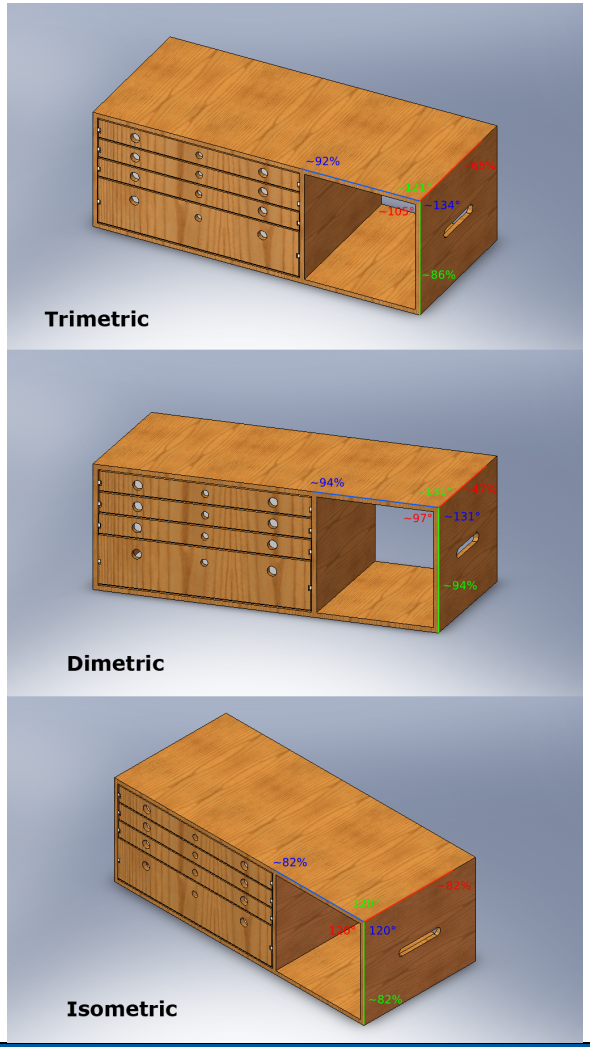
Some Types of Cameras

- Orthographic
  - perpendicular to the plane of the game
  - Z-axis? Top-down perspective.
  - Y-axis? Side scroller.
- Handy for artists!
  - Art is done as tiles and easy to manage
- Forces 2D gameplay only

Some Types of Cameras

- Axonometric
  - "off axis" view
  - Allows for some 3D gameplay
  - Isometric is most common form
    - All axes are equal
  - Can have other forms by shortening/lengthening some axes for artistic reasons

Some Types of Cameras



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