The Pumpkin Problem

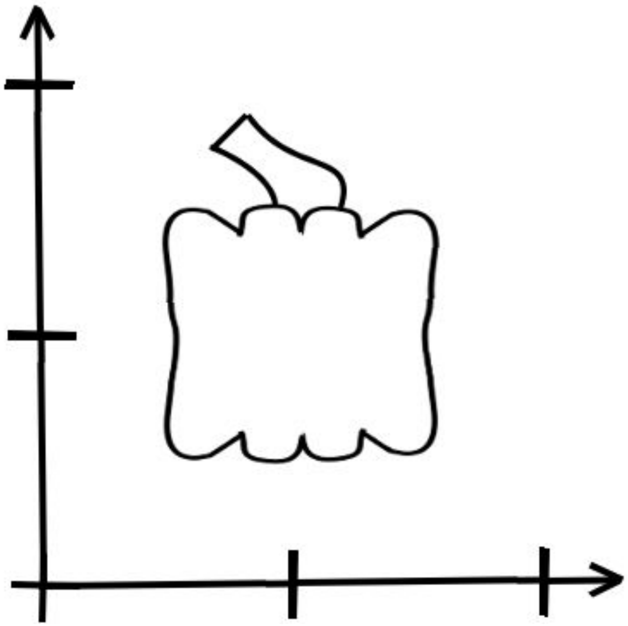
Transformations practice problem

Three Ways To Do Every Transformation Problem:

- 1. Intuition using moving bases (or axes)
  - Reading typical code forwards
  - Reading written product left-to right ending at p
  - Products formed via post-multiplication
- 2. Intuition using a moving point cloud (or shape)
  - Reading typical code backwards
  - Reading written product right-to-left starting at p
  - Products formed via pre-multiplication
- 3. Writing the product out, doing matrix multiplication by hand, and not relying on intuition at all

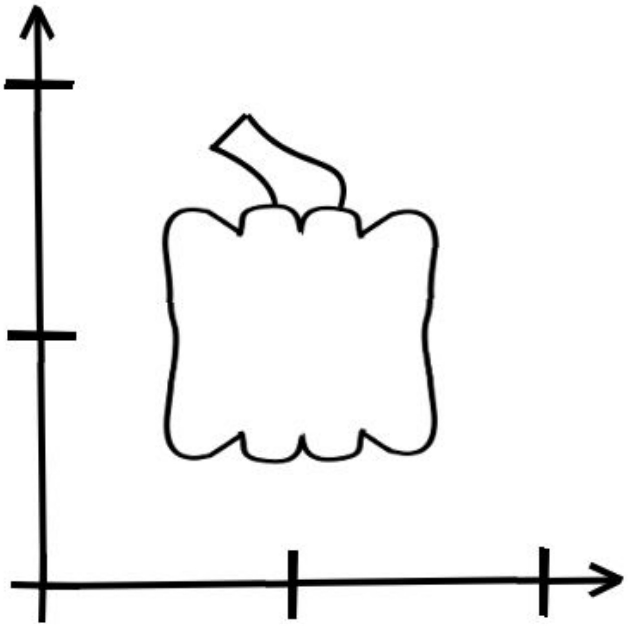
Drawing example: Pumpkin

Given this pumpkin at (1,1),



Drawing example: Pumpkin

Given this pumpkin at (1,1), do the following:



model *= trans(x+2,y+2);

model *= rot_z(90);

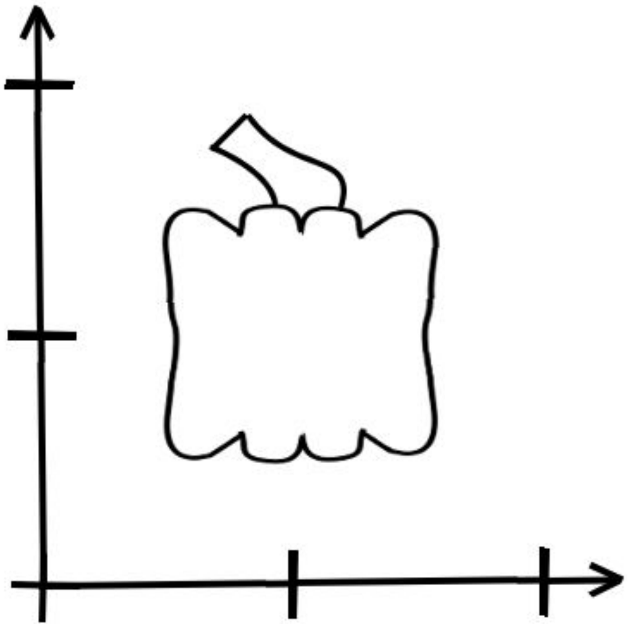
model *= $scale_x$(-1);

model *= trans(x-1,y-1);

Drawing example: Pumpkin

Given this pumpkin at (1,1), do the following:

trans(2,2) * rot_z(90) * $scale_x$(-1) * trans(-1,-1)

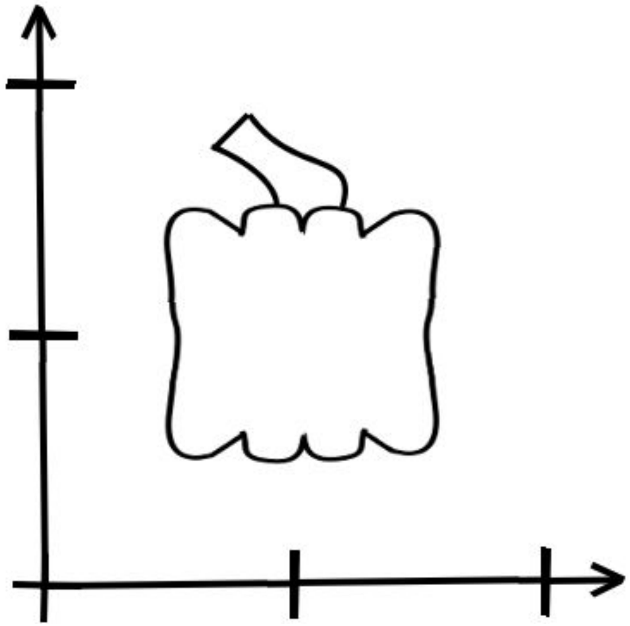


Drawing example: Pumpkin

Manually writing the product of matrices

$\text{trans}(2,2) * \text{rot}_z(90) * \text{scale}_x(-1) * \text{trans}(-1,-1)$

= what actual matrices?

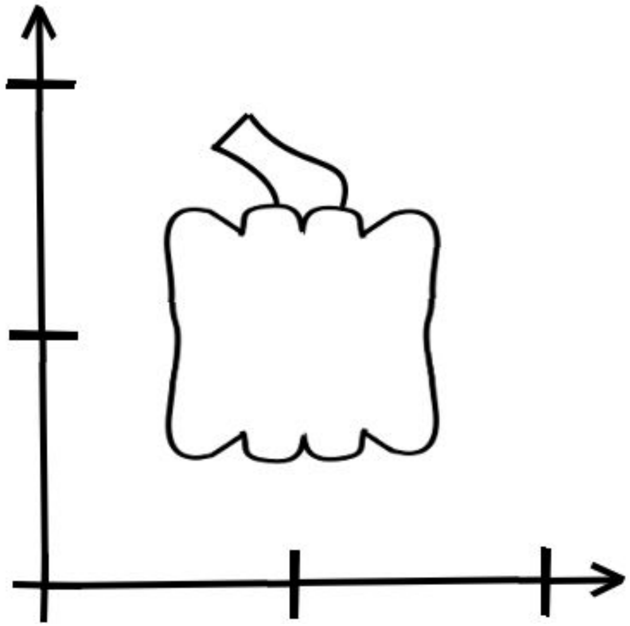


Drawing example: Pumpkin

- Manually writing the product of matrices

trans(2,2) * rot_z(90) * $scale_x$(-1) * trans(-1,-1) = ?

- Multiply out the product with the "drawing below" trick
- Apply the final product to some points (0,0), (0,2), (2,0)

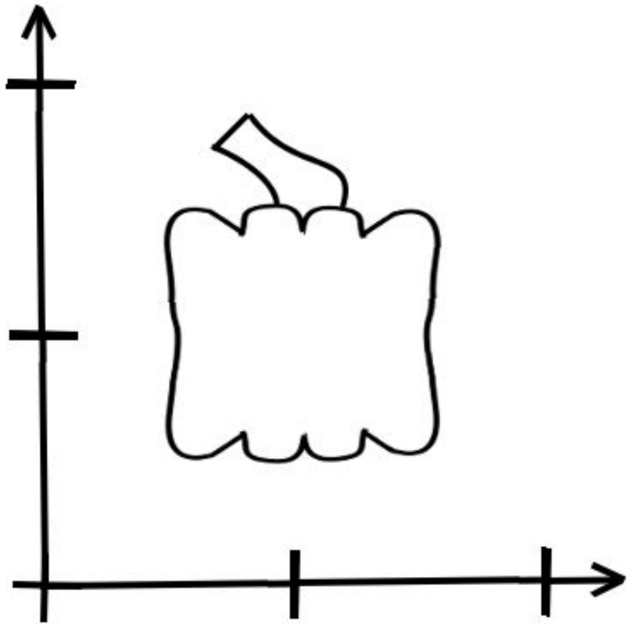


Drawing example: Pumpkin

- Actually draw out where the pumpkin moves at each step of

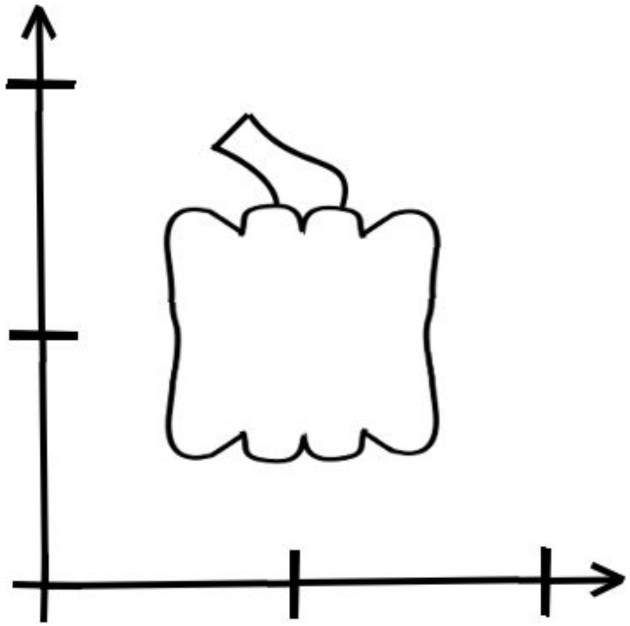
$\text{trans}(2,2) * \text{rot}_z(90) * \text{scale}_x(-1) * \text{trans}(-1,-1)$

- We're treating it like an image -> Start at point and move Right-to-Left
- Show that where it landed is consistent with where the product displaced the 3 points to



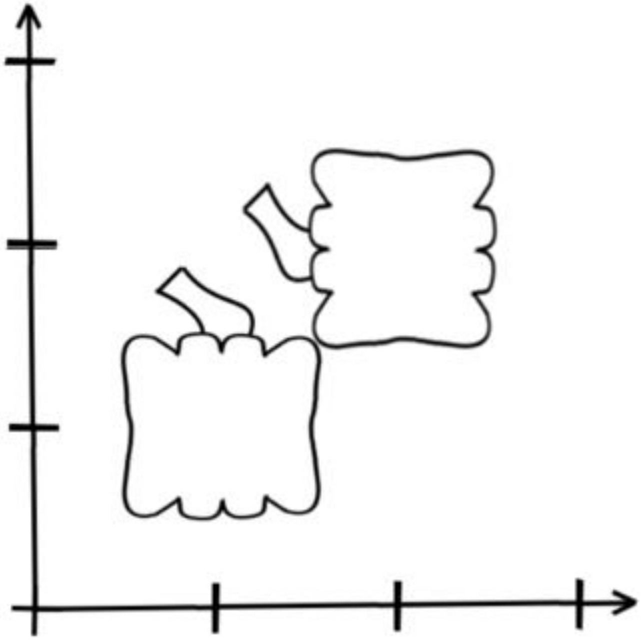
Drawing example: Pumpkin

- Actually draw out where a basis would move at each step (go left-right, maintain a basis as your temporary instead of a point)
- Wherever the origin winds up, draw the original image there using those axes

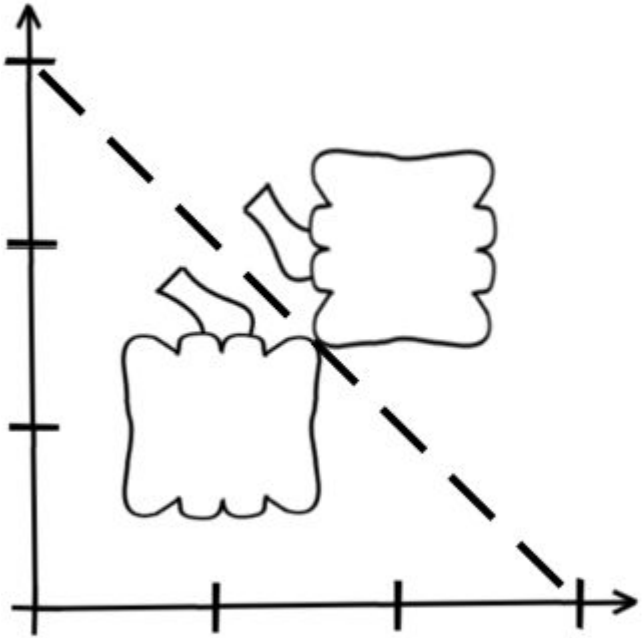


Drawing example: Pumpkin

- Why do we prefer left to right when building programs?
- Because of our temporary "partial matrices" when making the various products
  - Each sets us up for the next piece of a hierarchical model



Checking our Answer



Checking our Answer

- Easily summarized as a reflection around a line from (3,0) to (0,3)
- The sequence of transforms to do that reflection is different:
  - trans(0,3) * rot_z(-45) * $scale_y$(-1) * rot_z(45)* trans(0,-3)
  - What's the code for this?
- Numerically multiplying it out, it was the same matrix, surprise!!!