Scale Transform

Matrix:

Scale (Non-Uniform)

Reflection Matrix

Shear Matrix

Rotate (about the origin (0, 0), CCW by default)

Linear Transforms = Matrices

Homogeneous coordinates(齐次坐标系)

Translation

Translation cannot be represented in matrix form

(So, translation is NOT linear transform!)

But we don’t want translation to be a special case

Is there a unified way to represent all transformations? (and what’s the cost?)

Solution: Homogenous Coordinates

Add a third coordinate (*w-coordinate*)

• 2D point =

• 2D vector =

Matrix representation of translations

Homogenous Coordinates

Valid operation if w-coordinate of result is 1 or 0

• vector + vector = vector

• point – point = vector

• point + vector = point

• point + point = Another point [ In homogeneous coordinates, ]

Affine Transformations (仿射变换)

Affine map = linear map + translation

Using homogenous coordinates:

2D Transformations

Scale

Rotation

Translation

**Inverse Transform**

**is the inverse of transform in both a matrix and geometric sense**

**Composing Transforms**

**Transform Ordering Matters!Matrix multiplication is not commutativeNote that matrices are applied right to left:3D TransformationsUse homogeneous coordinates again:• 3D point = (x, y, z, 1)T• 3D vector = (x, y, z, 0)TIn general, (x, y, z, w) (w != 0) is the 3D point:(x/w, y/w, z/w)**

**3D Transformations**

**Use 4×4 matrices for affine transformations**