Transformations

- Transformations in 3D (rotation, scale, shear) can be expressed as 3x3 matrix multiplications
- Translations cannot
- *Homogeneous coordinates*
  - 3x3 -> 4x4
  - Translation by x,y,z ->

```
1 0 0 x       a       a + x
0 1 0 y   *   b   =   b + y
0 0 1 z       c       c + z
0 0 0 1       1         1      = w
```

  - Division by `w` (*perspective division*) to retrieve inhomogeneous point
- The *Model matrix* defined the result of a number of transformations that are unique for an object

View & Projection Matrix

- Per default: OpenGL's camera is at (0,0,0) looking towards the -z direction
- Everything in *normalized device coordinates* (NDC) in range [-1,1]
- View matrix modifies the location of the OpenGL's camera

- Projection Matrix
  - Projects a 3D scene onto the 2D rendering surface
  - Projection methods
    - Orthographic projection (parallel lines remain parallel)
    - Perspective projection (parallel lines converge)

- Each vertex `v` is modified by model `M`, view `V`, and projection `P` matrices:
  `x = P * V * M * v`