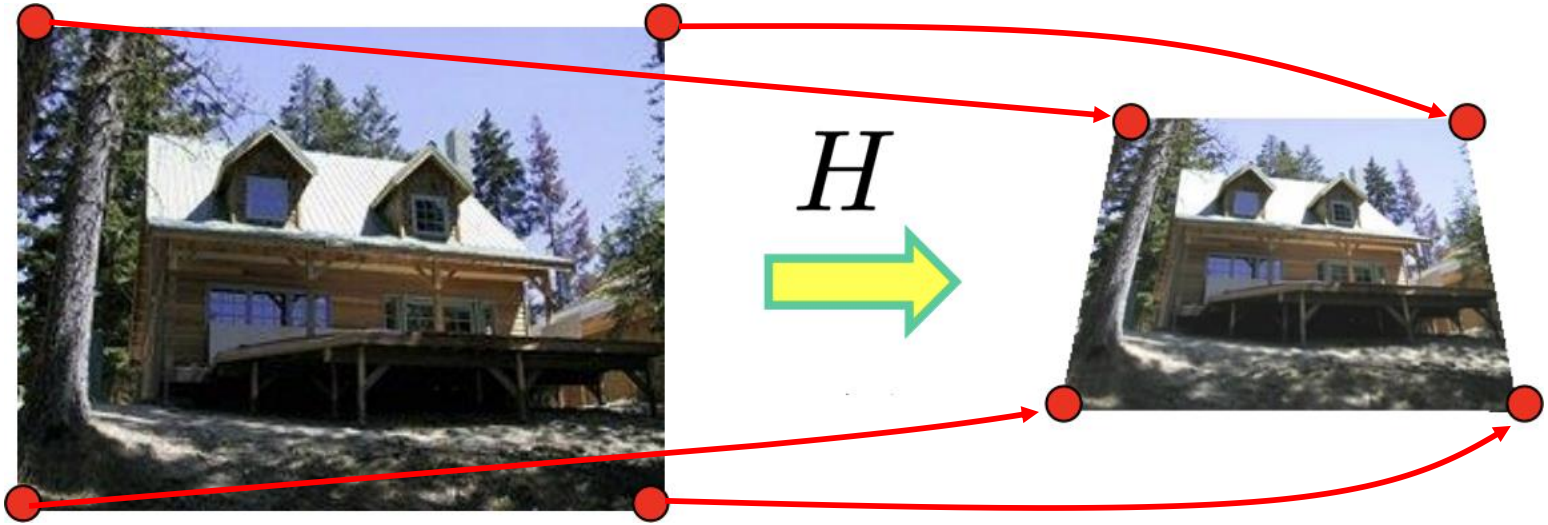
CS 180 Discussion #5

Homography for stitching...



Konpat

Welcome!!

Logistics

- Justin is in Korea this week

Welcome!!

Logistics

- Justin is in Korea this week

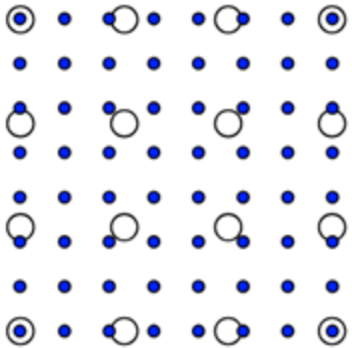
Discussion today

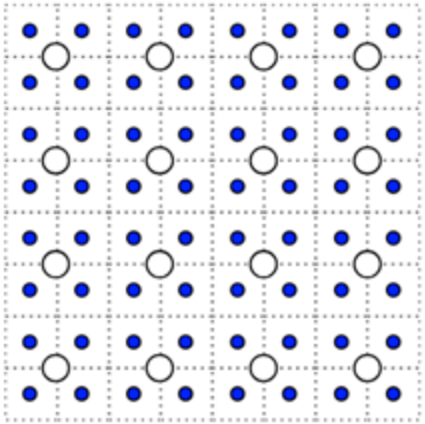
- Two conventions of coordinates
- Homography
- Both are **super** useful for Proj3 😉

The two conventions of coordinates 🤦

This time →

Looks weird.
Simpler to implement.





← **Last time**

Looks nice.
Hard to implement.

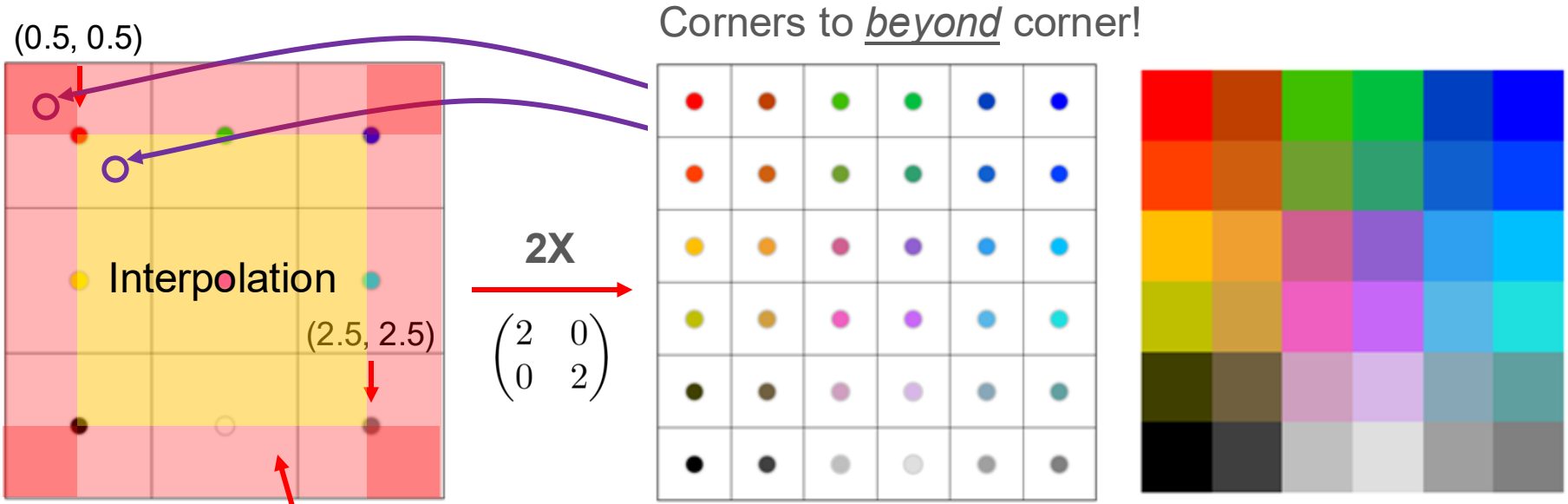
Both are correct in their own ways.
Learn both!

First way: pixels as “dots in the middle”

3 x 3

Align corners = False

First way: pixels as “dots in the middle”



Extrapolation

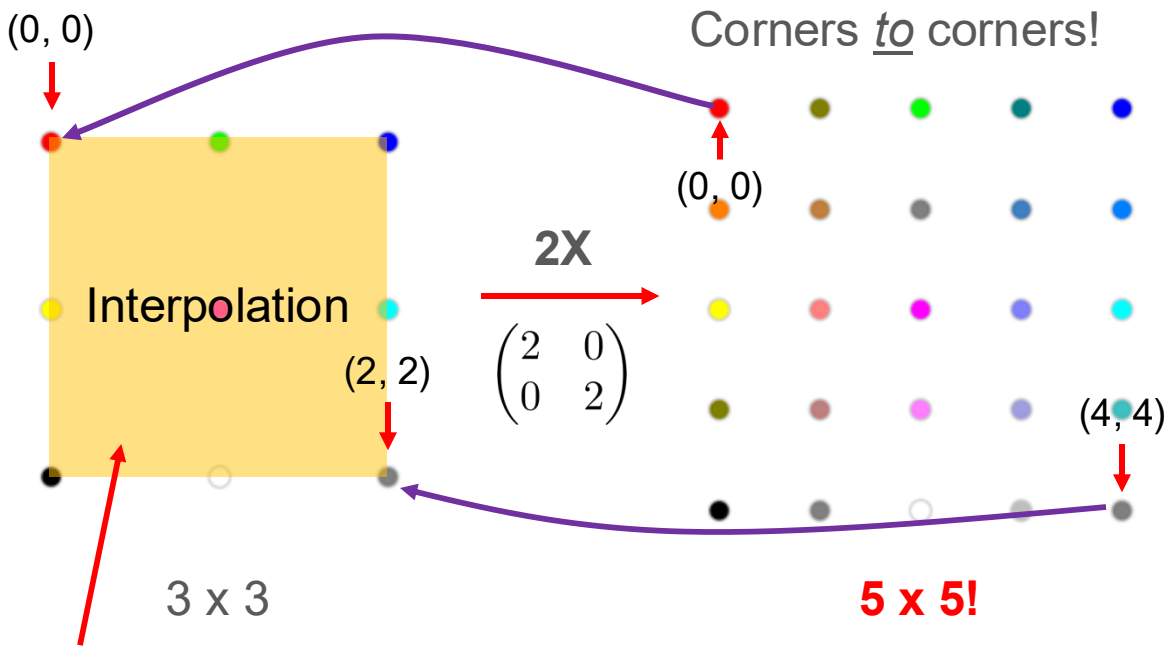
Don’t have 4 corners (bilinear).
Assume same pixel values outside

Complex:

Handle corner cases, 0.5 offset

Align corners = True

Second way: pixels as "rays"

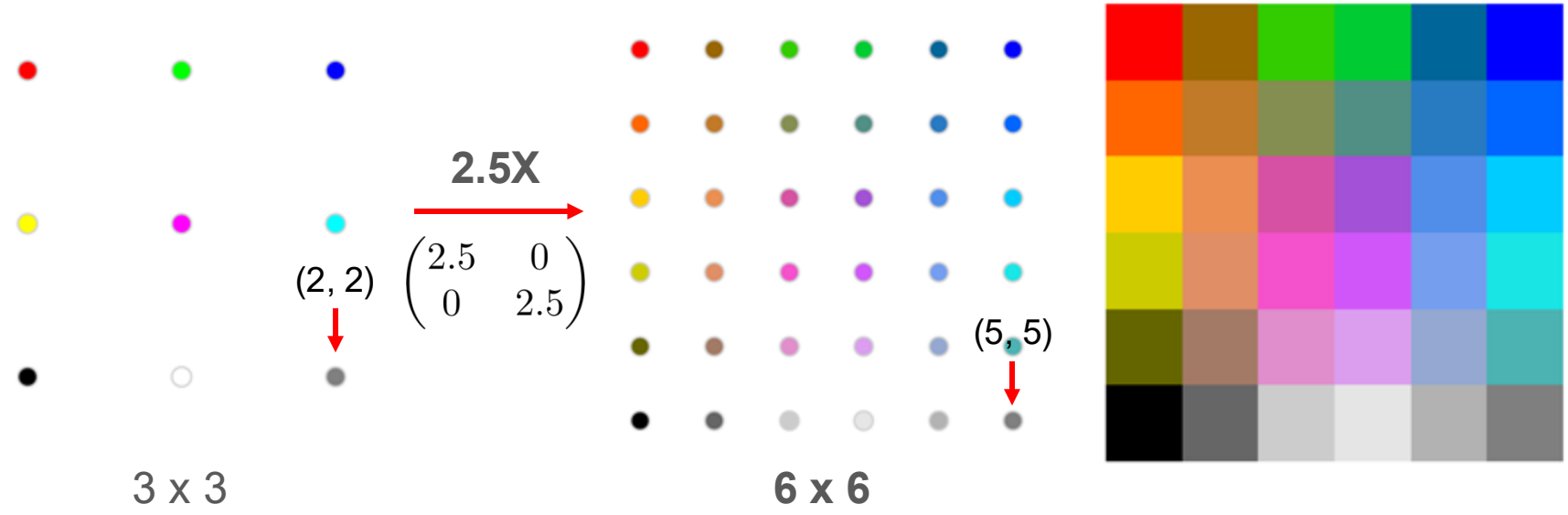


Sample more rays in "middle"
Only interpolation, always have 4 corners.

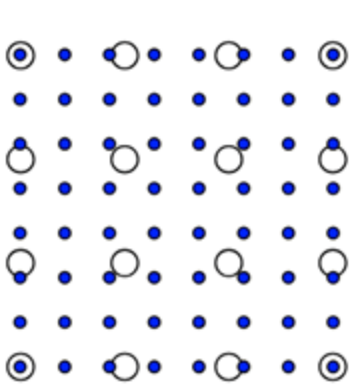
Simple:
No edge cases, and start at (0, 0)

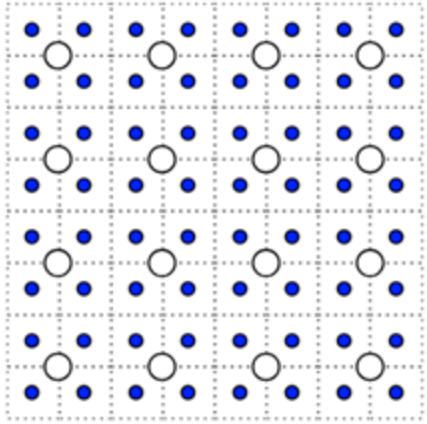
Align corners = True

How to 2x output? need to scale by 2.5x



Side by side...



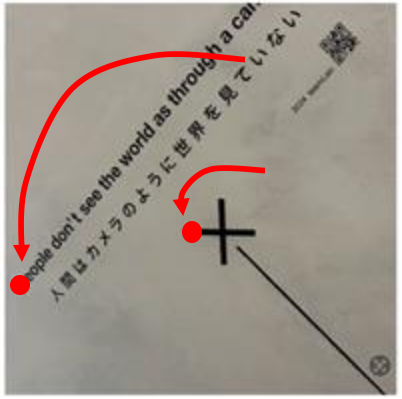


Align corners = True

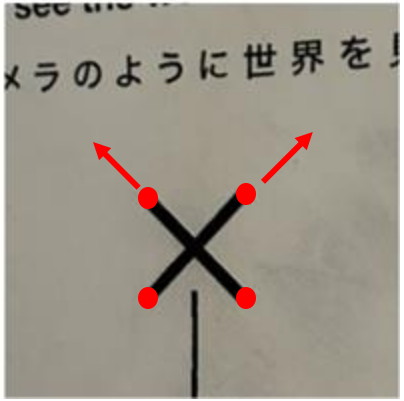
Align corners = False

Homography / Projective transformation

Previous Transformations



Rotation



Zoom

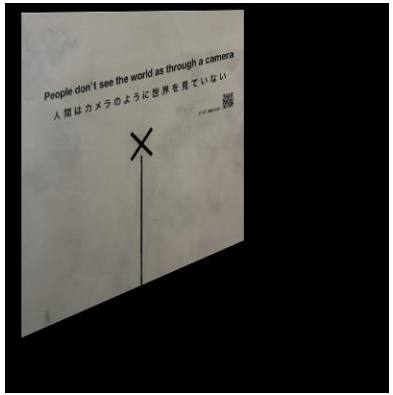
$$\begin{pmatrix} a & b & c \\ d & e & f \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix}$$

Homogeneous coord.

Scale / Rotation /
Shear / Translation

What do all these transformations have in common?
(Linear / Preserve parallel lines.)

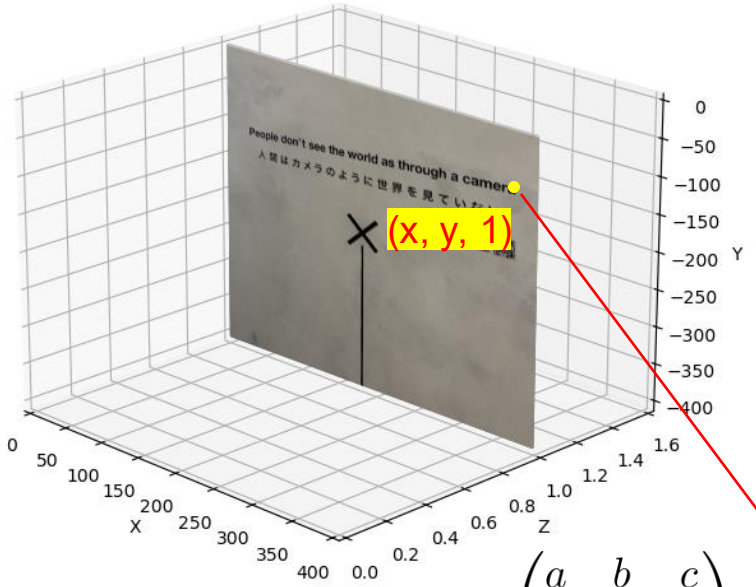
Homography

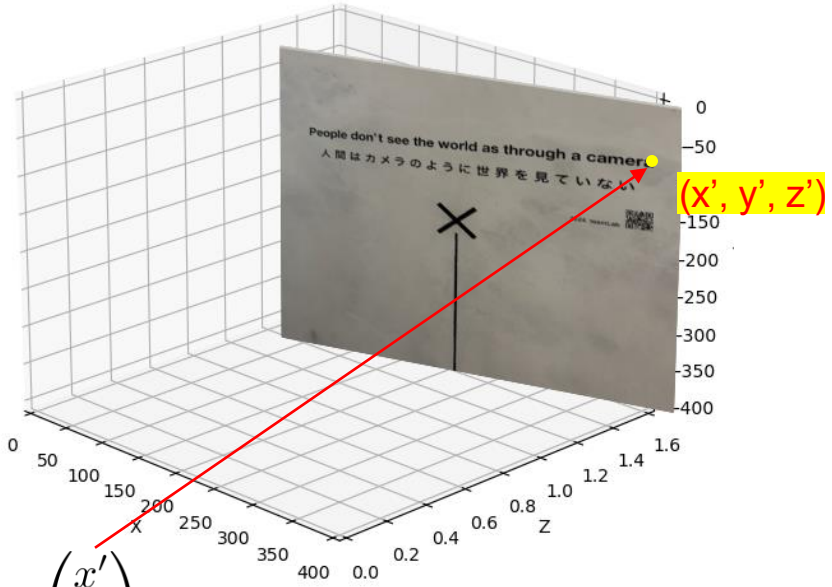


$$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \lambda \begin{pmatrix} u \\ v \\ 1 \end{pmatrix}$$

It's quite deep actually…

Lifting points to 3D





$$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} x' \\ y' \\ z' \end{pmatrix}$$

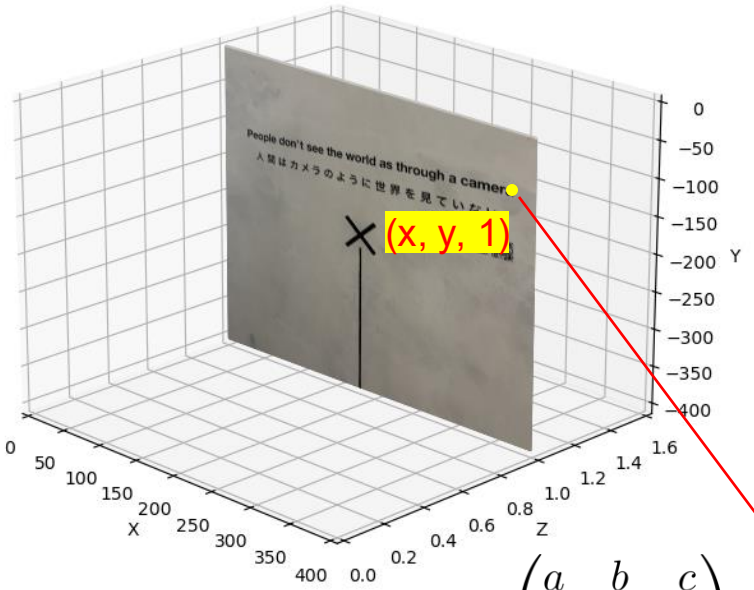
3D coord!

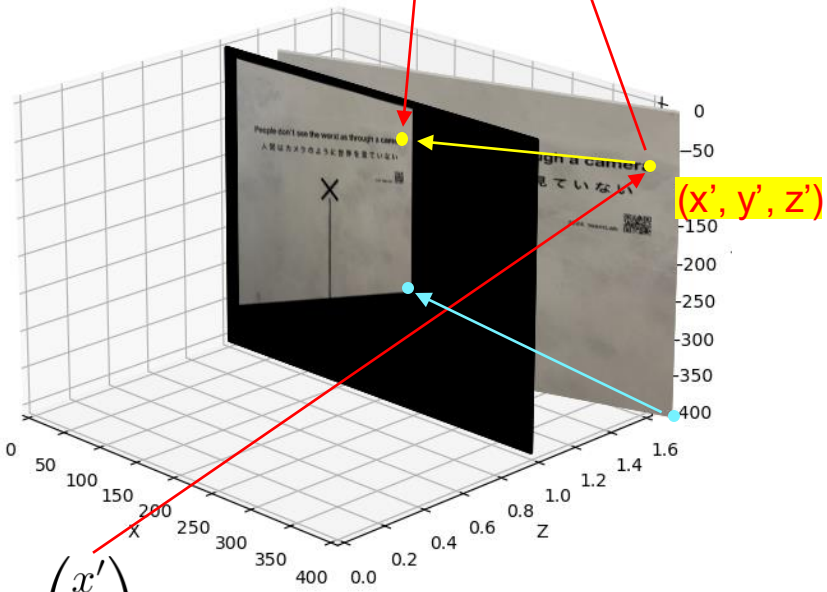
How to “lift” each point

Perspective projected to z = 1 plane

Project onto a plane

$$\lambda \begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} x' \\ y' \\ z' \end{pmatrix}$$





$$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} x' \\ y' \\ z' \end{pmatrix}$$

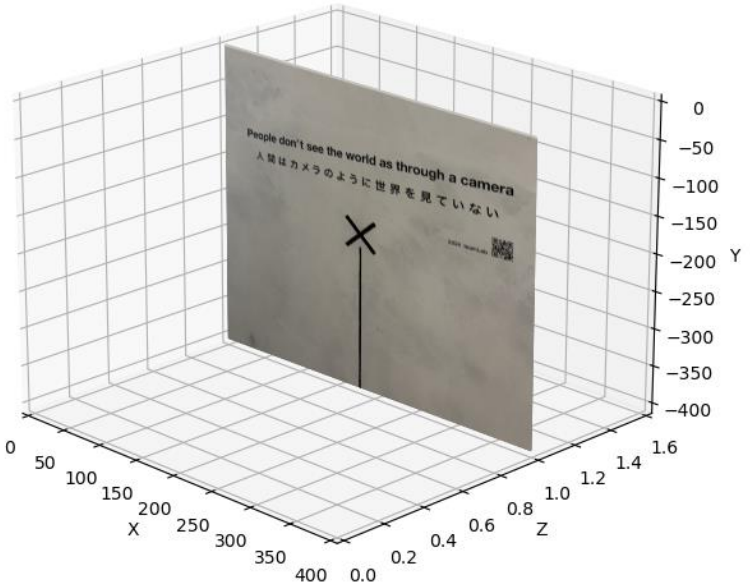
3D coord!

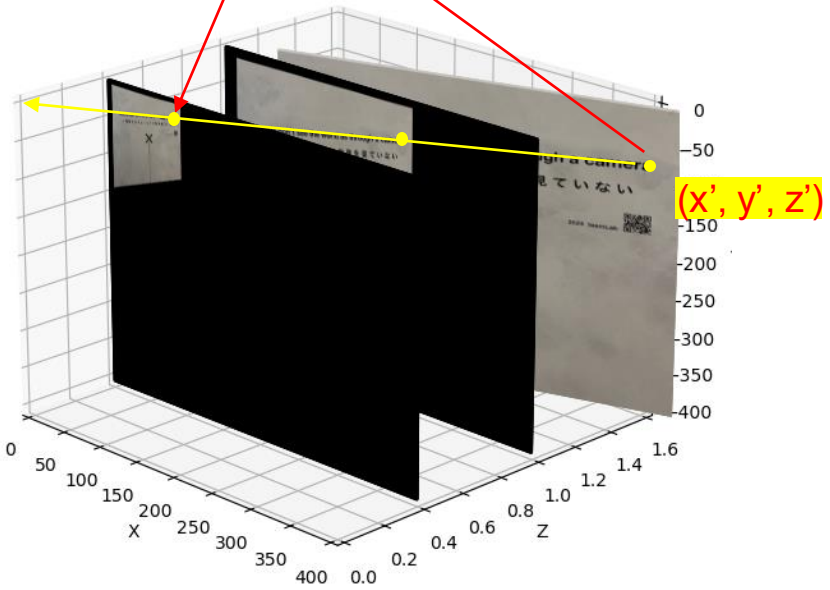
How to “lift” each point

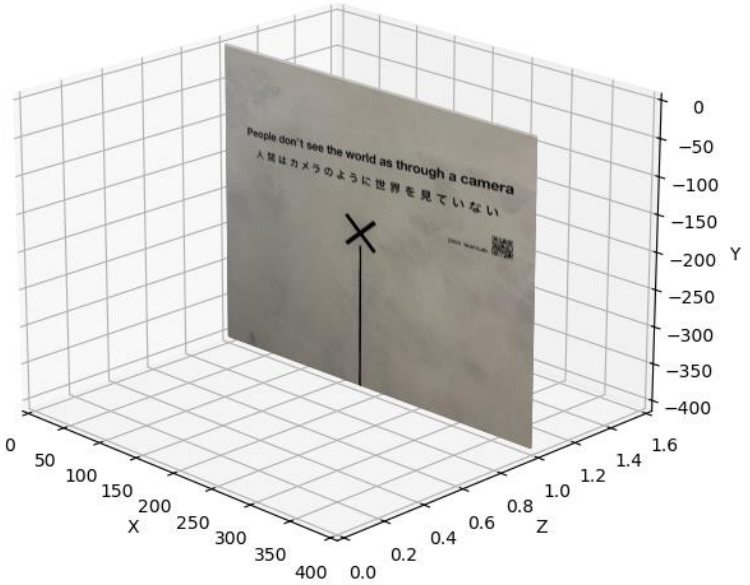
Another plane...

Perspective projected to z = 0.4 plane

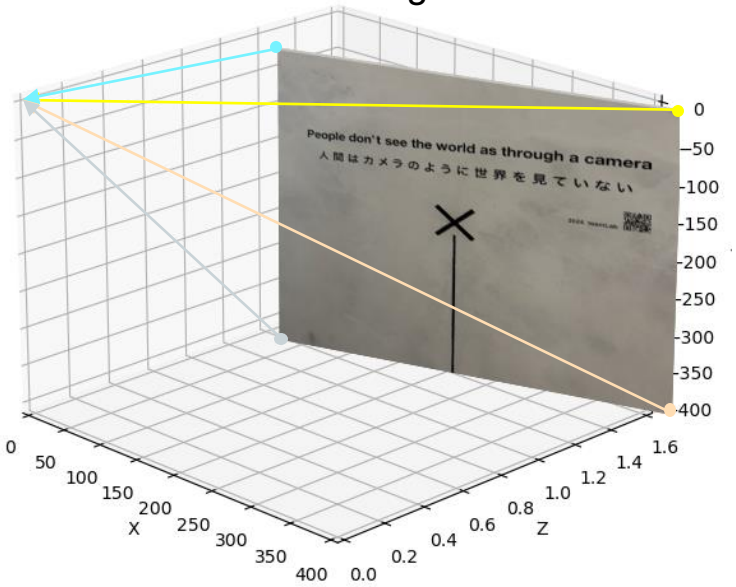
$$\lambda' \begin{pmatrix} u' \\ v' \\ 0.4 \end{pmatrix} = \begin{pmatrix} x' \\ y' \\ z' \end{pmatrix}$$

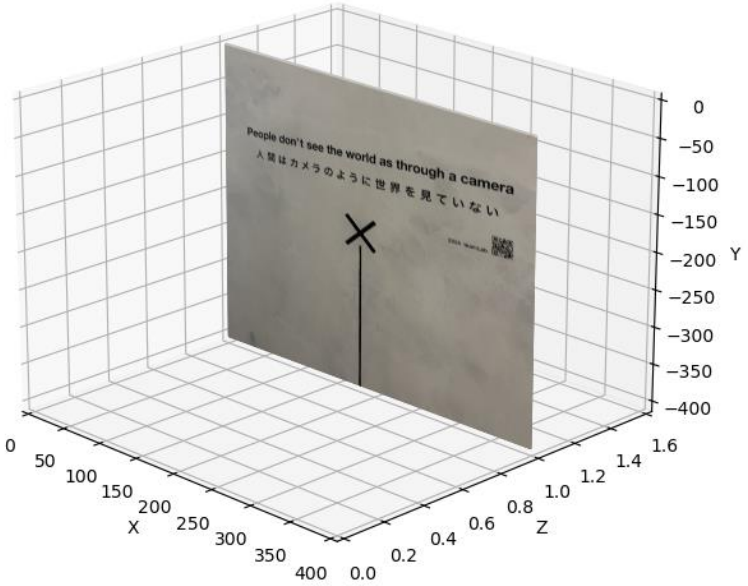


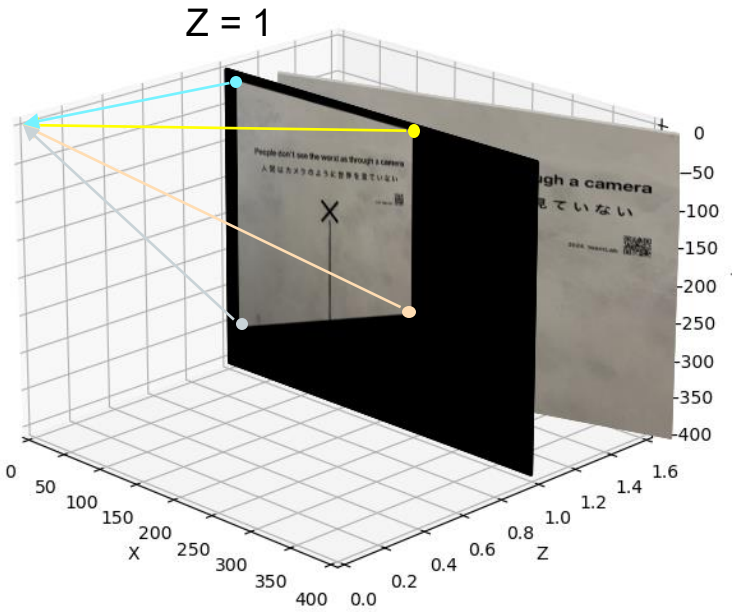


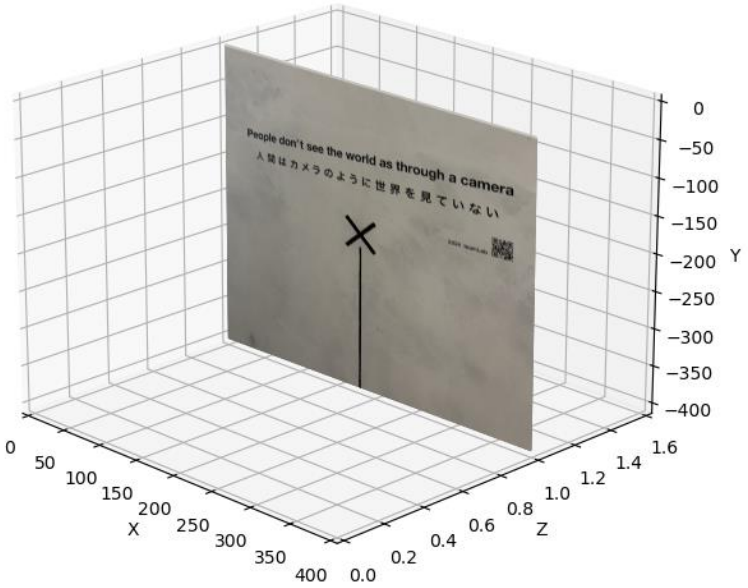


Transformed image

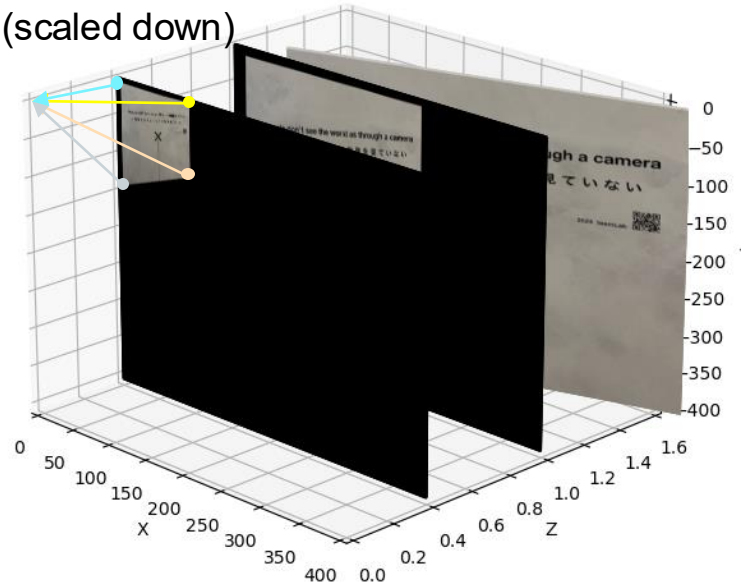



People don't see the world as through a camera
人間はカメラのように世界を見ていない
0
−50
−100
−150
−200
−250
−300
−350
−400
Y
0
50
100
150
200
250
300
350
400
X
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Z

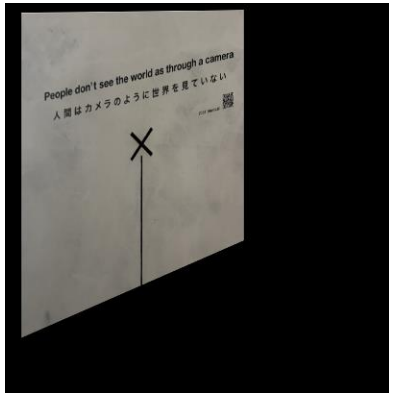

Z = 1
0
−50
−100
−150
−200
−250
−300
−350
−400
0
50
100
150
200
250
300
350
400
X
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Z



Z = 0.4
(scaled down)



Homography in a nutshell

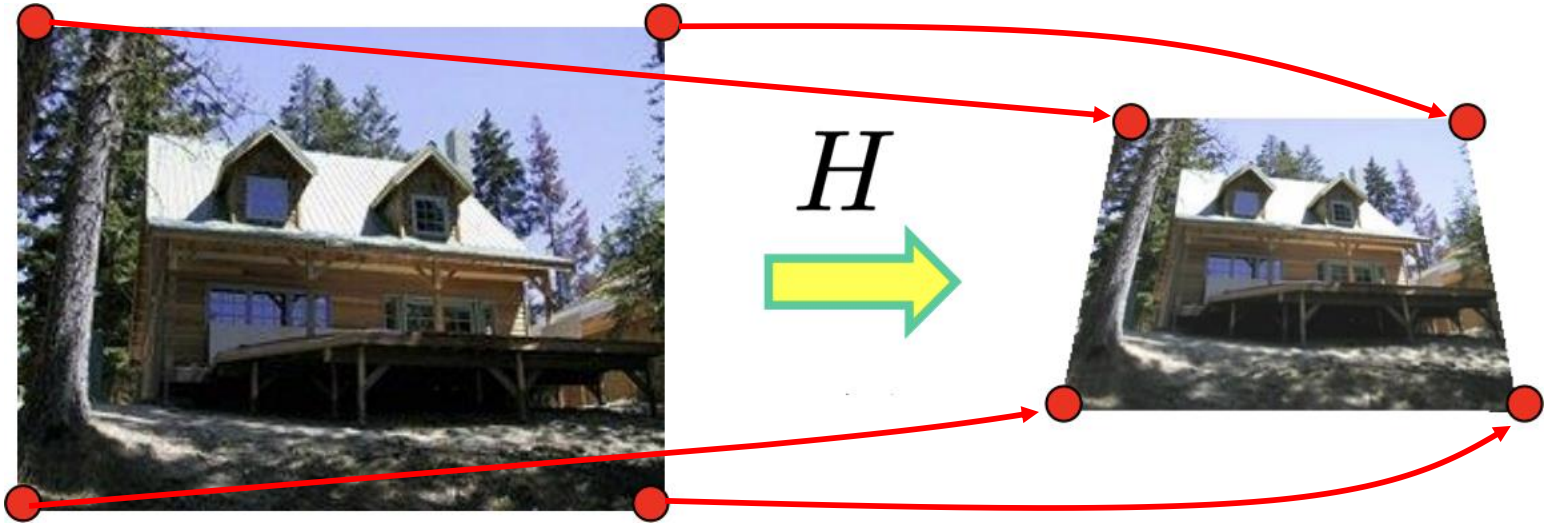


$$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \lambda \begin{pmatrix} u \\ v \\ 1 \end{pmatrix}$$

How to “lift” each point

Project on z = 1 plane

Getting your homography



$$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{pmatrix} = ?$$

Let's work on the worksheets