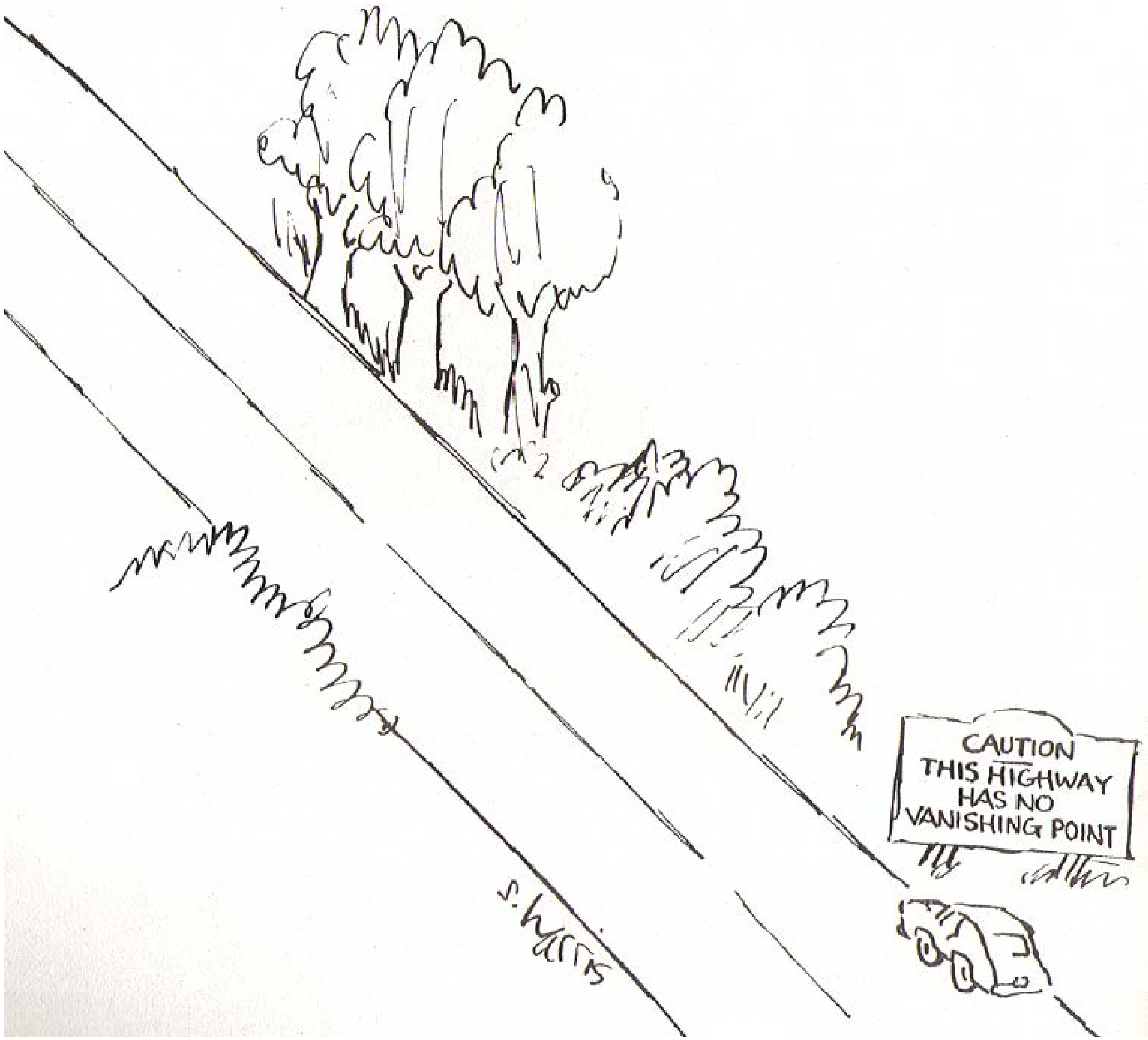
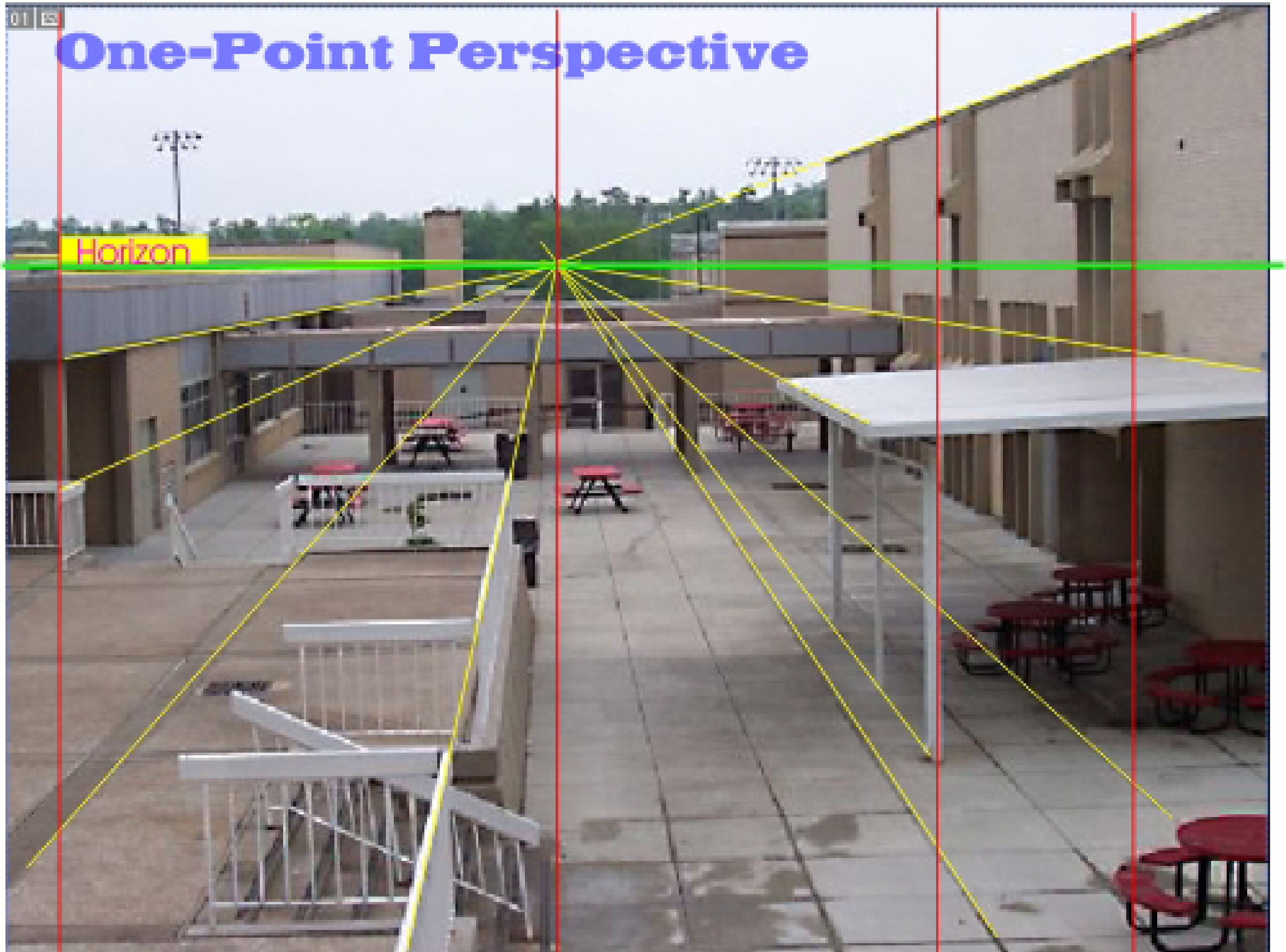
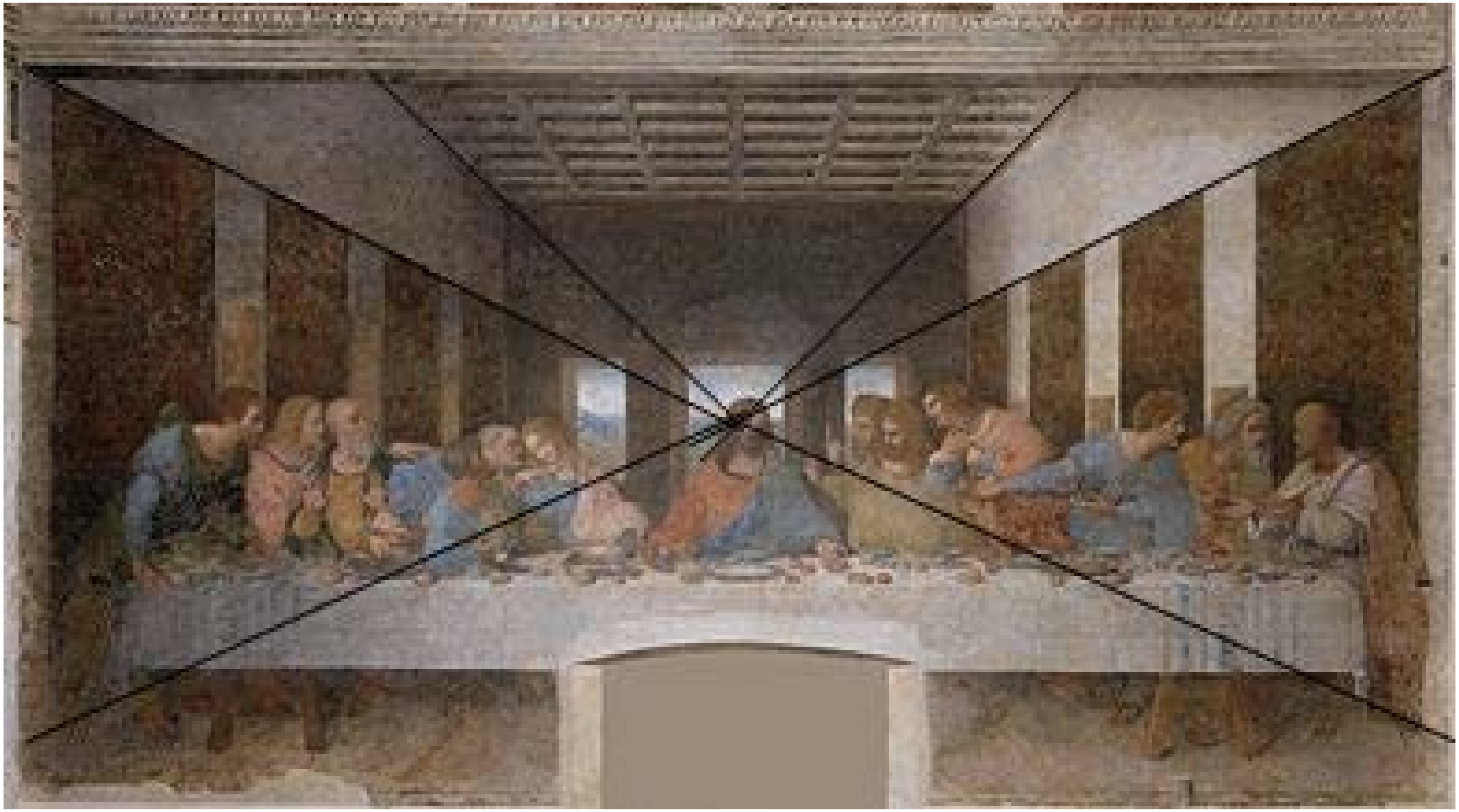
Vanishing point

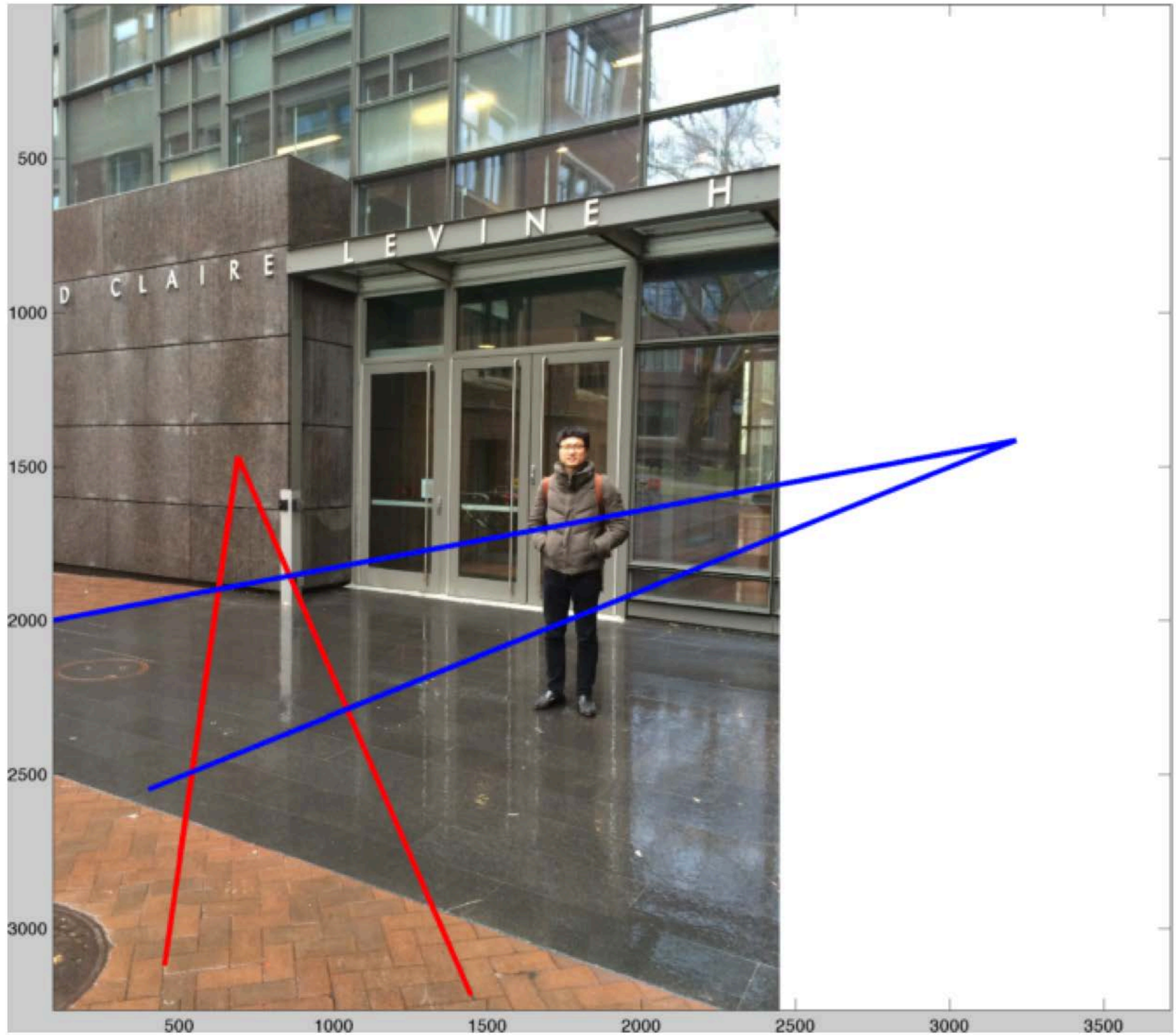


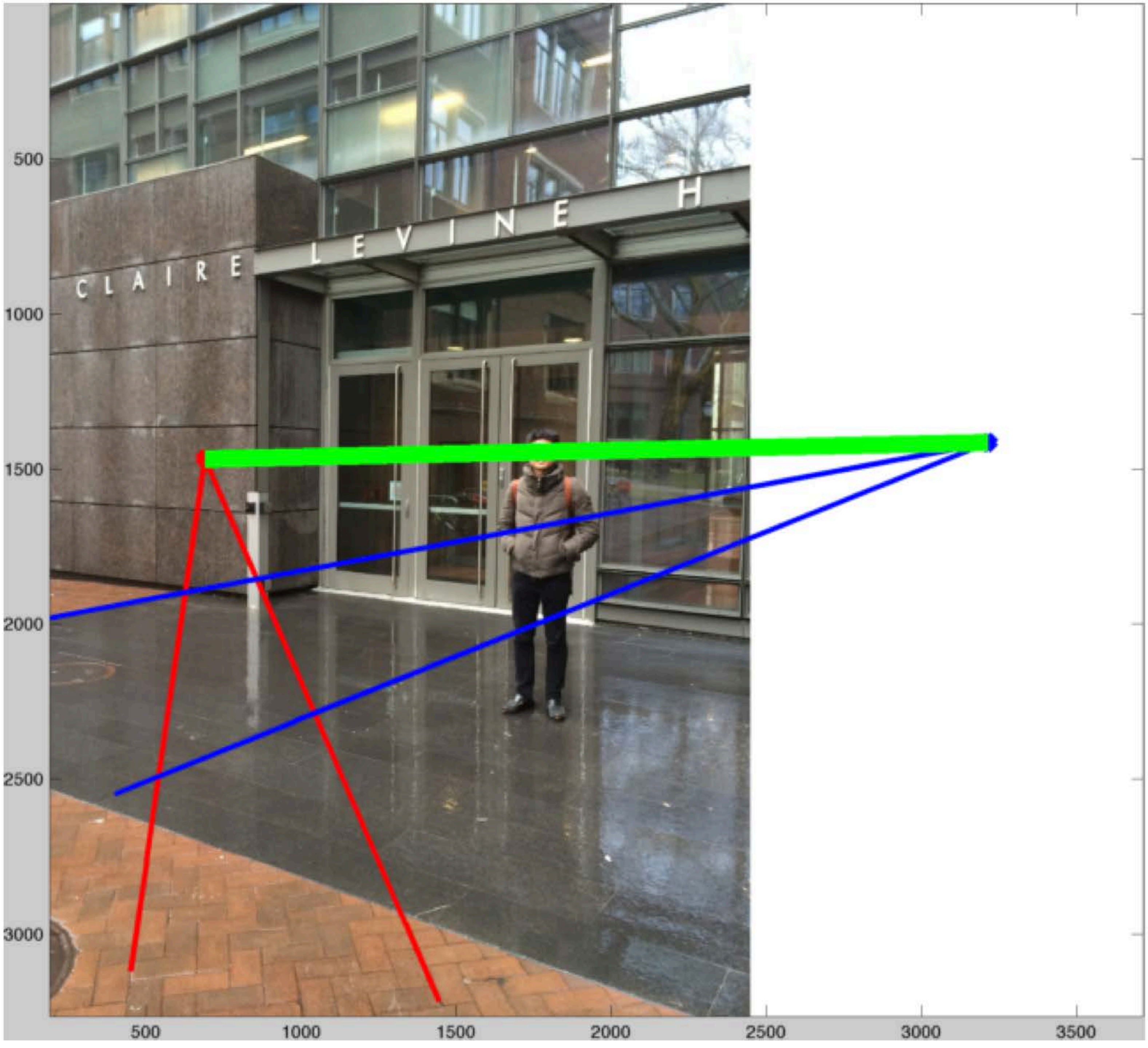
http://www.wetcanvas.com/



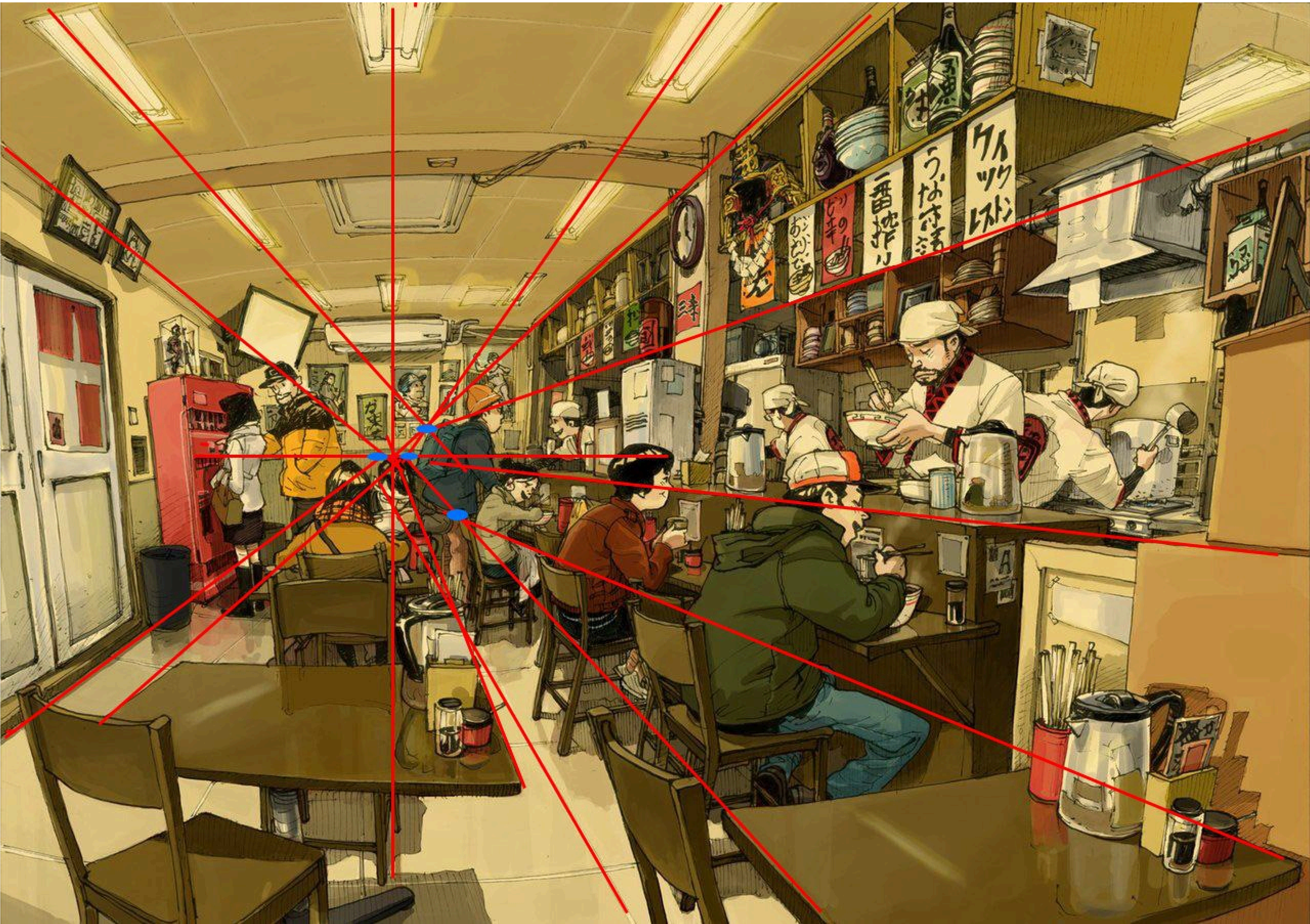
http://pennpaint.blogspot.com/



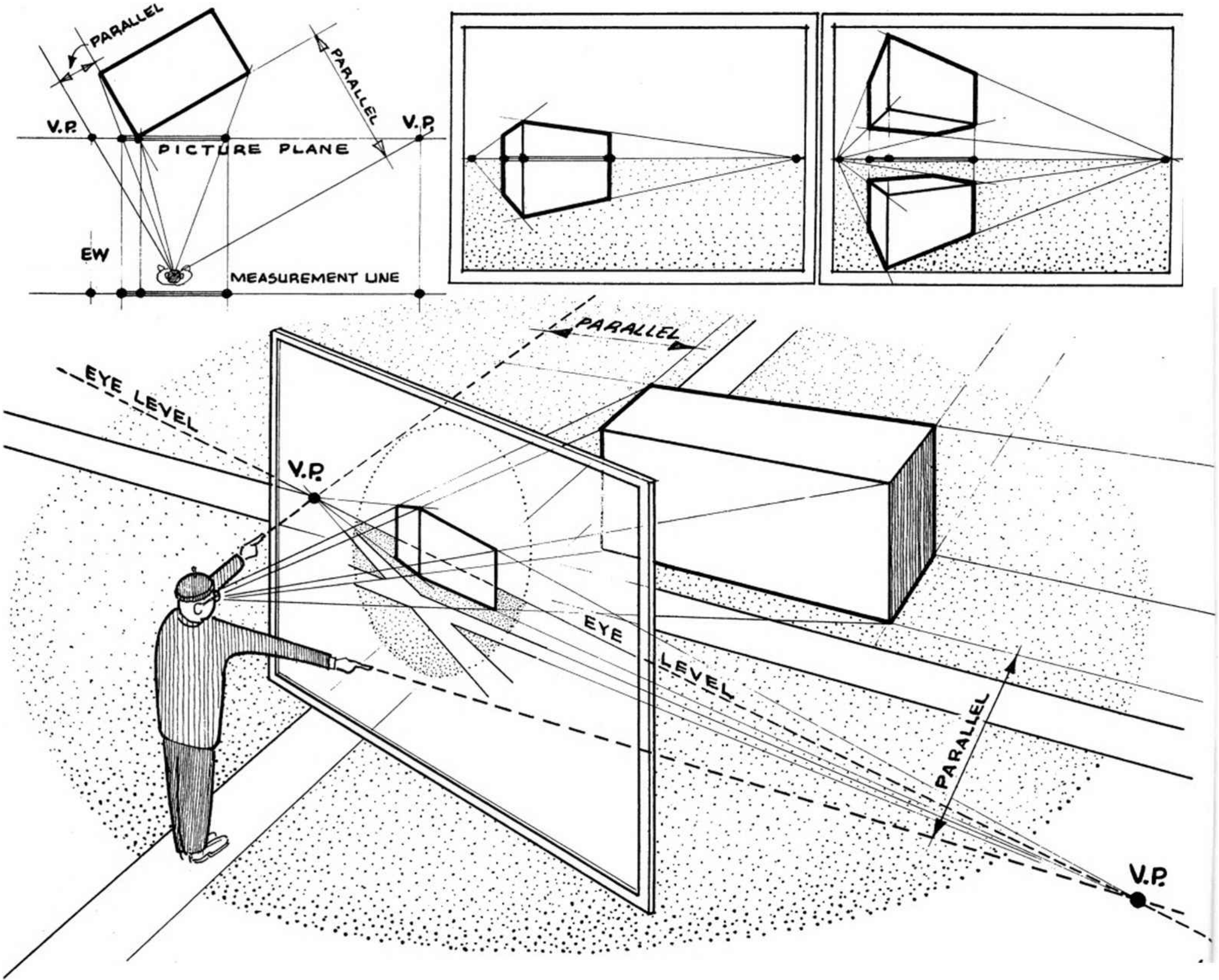

500
1000
1500
2000
2500
3000
500
1000
1500
2000
2500
3000
3500
D CLAIRE
LEVINE H


CLAIRE LEVINE H
500
1000
1500
2000
2500
3000
500
1000
1500
2000
2500
3000
3500

http://dd.salgoodsam.com/

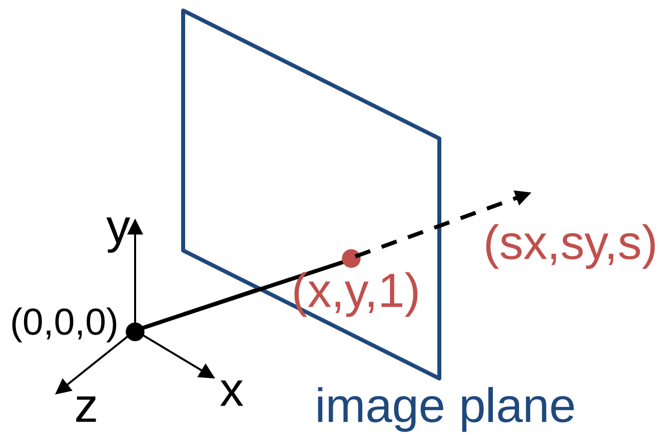


http://www.joshuanava.biz/perspective/in-other-words-the-observer-simply-points-in-the-same-direction-as-the-lines-in-order-to-find-their-vanishing-point.html



The projective plane

- Why do we need homogeneous coordinates?
  – represent points at infinity, homographies, perspective projection, multi-view relationships
- What is the geometric intuition?
  – a point in the image is a *ray* in projective space

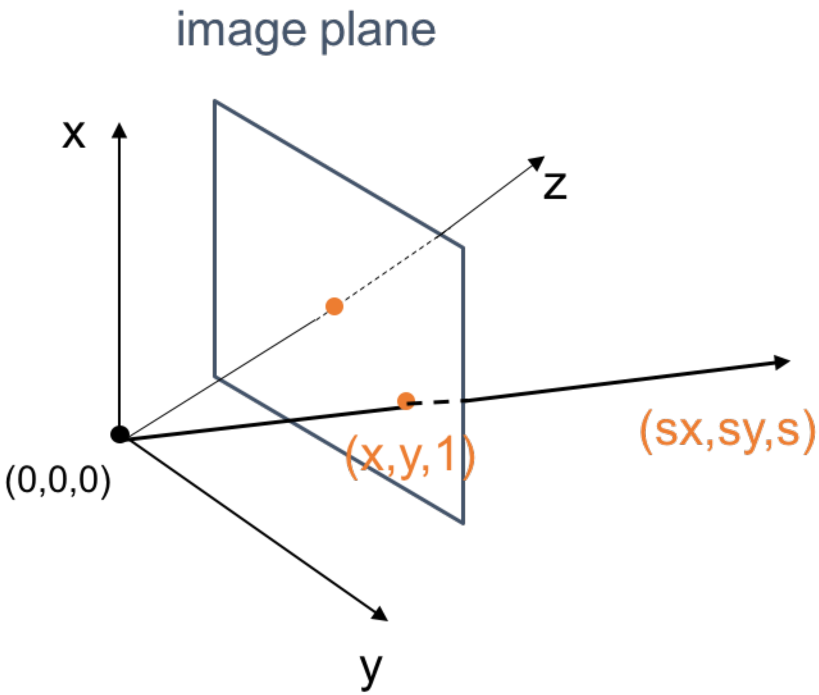


- Each *point* (x,y) on the plane is represented by a *ray* (sx,sy,s)
  – all points on the ray are equivalent: (x, y, 1) ≅ (sx, sy, s)

Point

Homogeneous coordinates

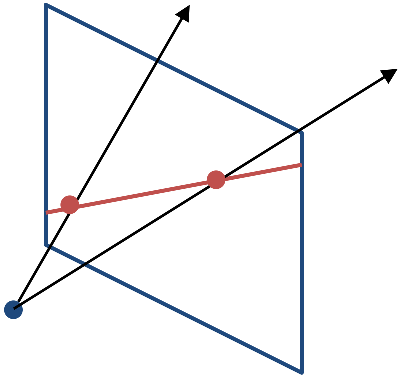
– represent coordinates in 2 dimensions with a 3-vector



$$\begin{bmatrix} x \\ y \end{bmatrix} \xrightarrow{\text{homogeneous coords}} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Projective lines

- What does a line in the image correspond to in projective space?

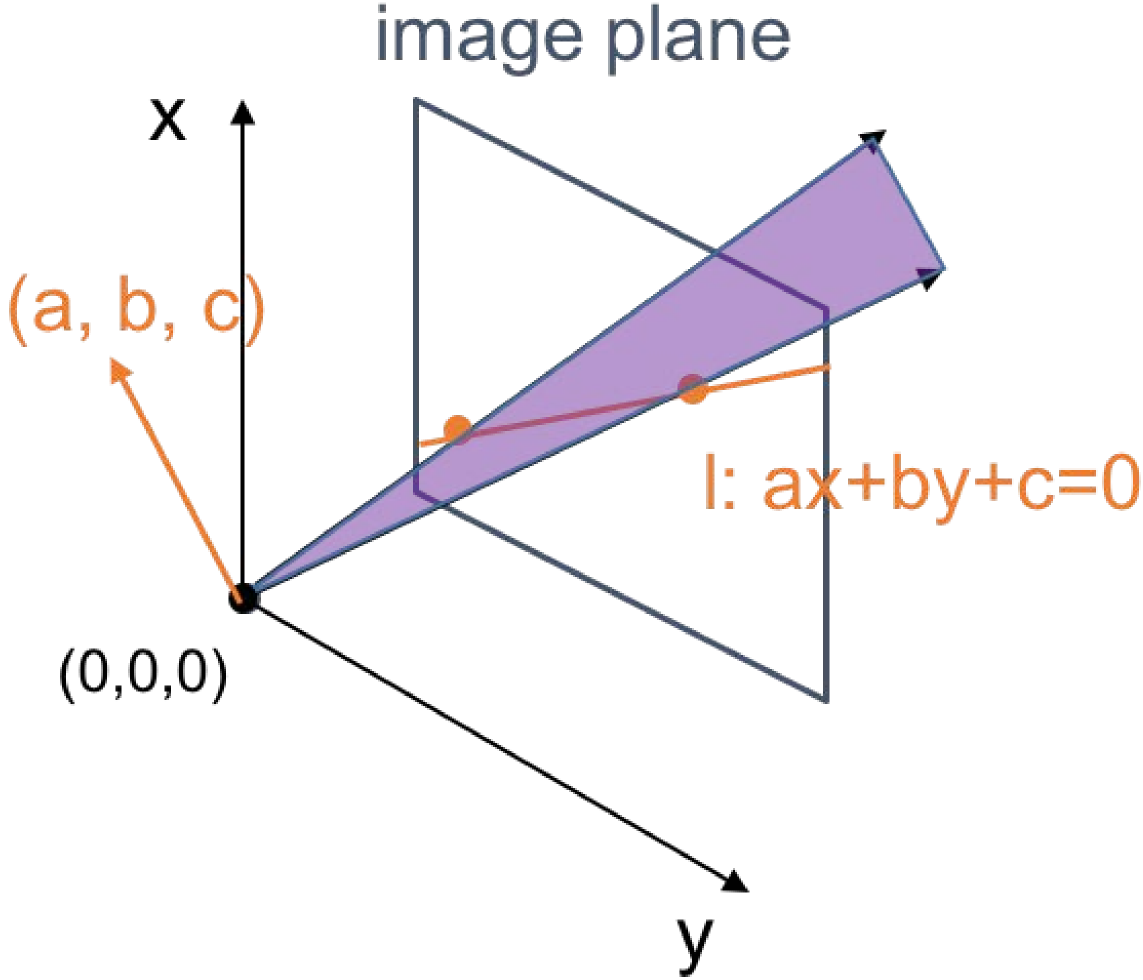


- A line is a *plane* of rays through origin
  - all rays (x,y,z) satisfying: ax + by + cz = 0

$$\text{in vector notation:} \quad 0 = \underbrace{\begin{bmatrix} a & b & c \end{bmatrix}}_{\mathbf{l}} \underbrace{\begin{bmatrix} x \\ y \\ z \end{bmatrix}}_{\mathbf{p}}$$

- A line is also represented as a homogeneous 3-vector **l**

Projective Lines



Line Representation

- a line is $\rho = x\cos\theta + y\sin\theta$

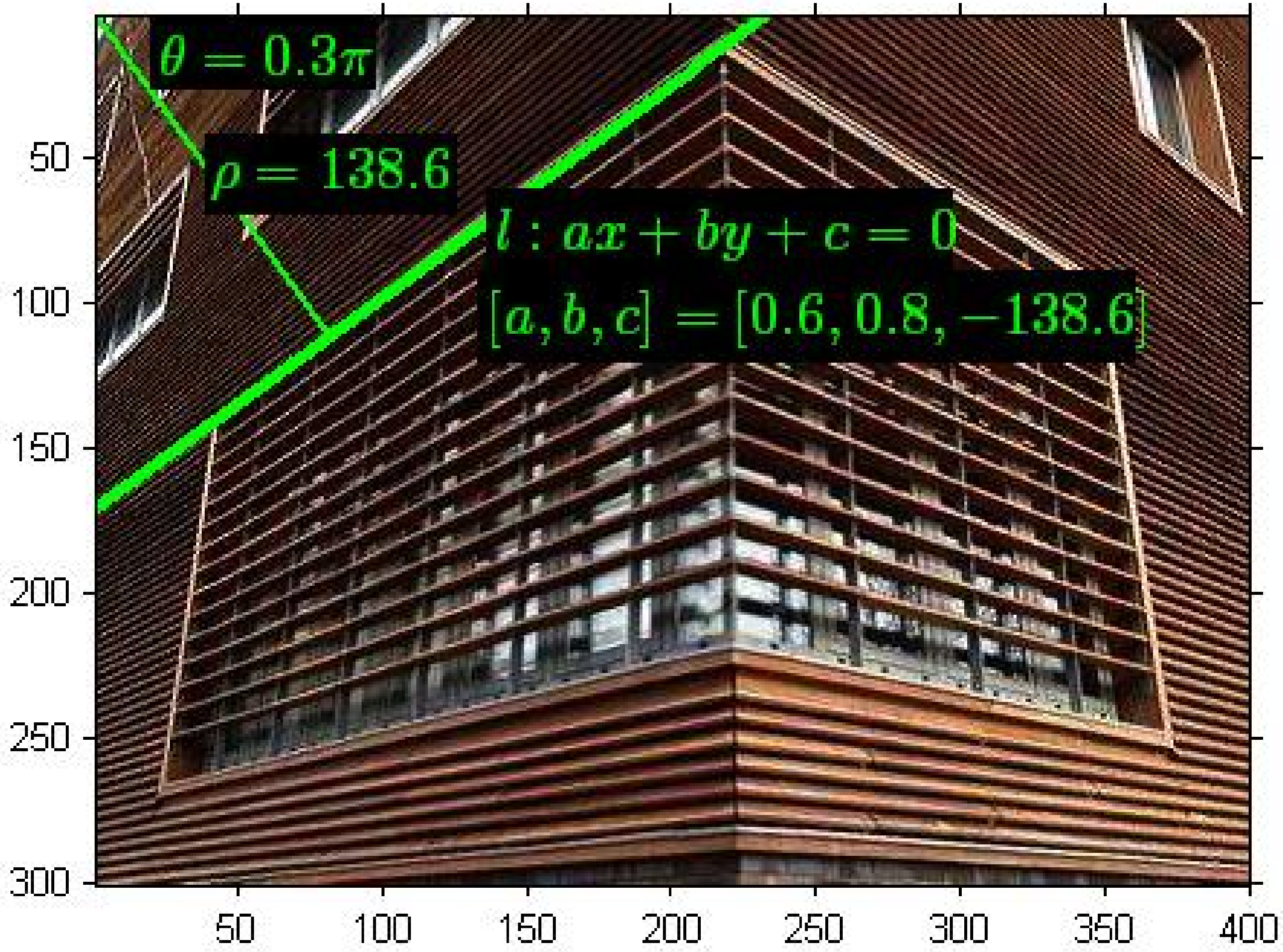
- ρ is the distance from the origin to the line
- θ is the norm direction of the line

- It can also be written as

$$ax + by + c = 0;$$

$$\begin{aligned}
\cos\theta &= \frac{a}{\sqrt{a^2+b^2}} \\
\sin\theta &= \frac{b}{\sqrt{a^2+b^2}} \\
\rho &= -\frac{c}{\sqrt{a^2+b^2}}
\end{aligned}$$

Example of Line



Example of Line (2)