HOCHSCHULE FURTWANGEN UNIVERSITY | HFU

Folien zur Vorlesung am 8.04.2025

3D Computer Vision

PERSPEKTIVEN UND ANWENDUNGEN

Ames Room

Task:
Draw this room as seen from the top and the side.

[3DCV Youtube Playlist (Ames Window + Die Ärzte)]

Forced perspective in film

https://www.youtube.com/watch?v=QWMFpxkGO_s

3D to 2D: perspective projection

Projection:

$$\mathbf{p} = \begin{bmatrix} wx \\ wy \\ w \end{bmatrix} = \begin{bmatrix} * & * & * & * \\ * & * & * & * \\ * & * & * & * \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} = \Pi\mathbf{P}$$

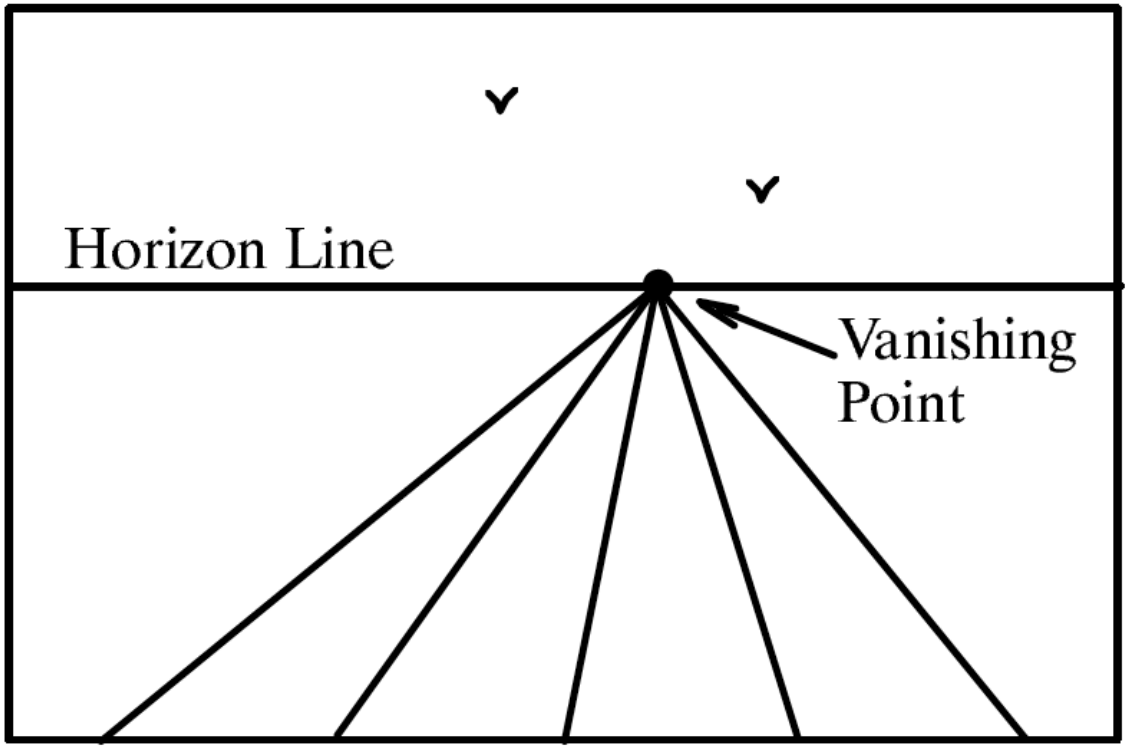
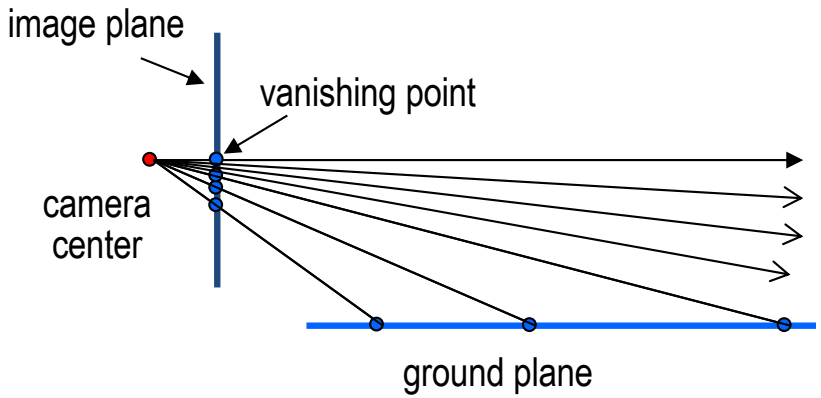
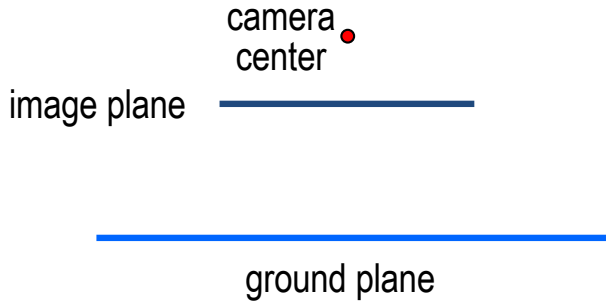


Figure 23.4
A perspective view of a set of parallel lines in the plane. All of the lines converge to a single vanishing point.

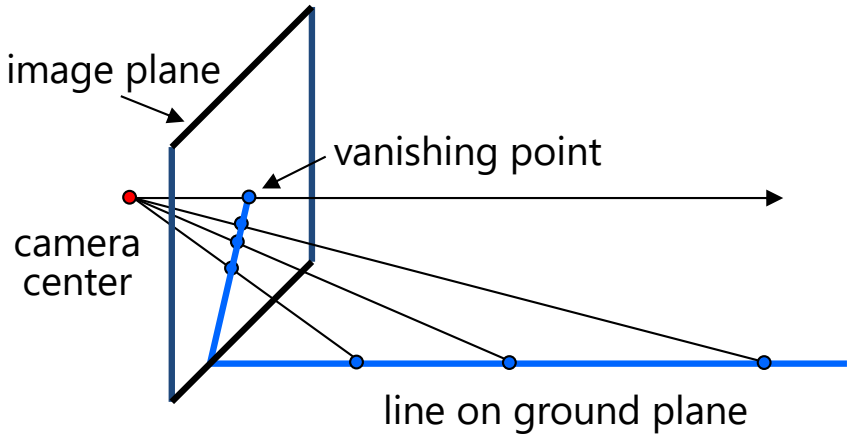
Vanishing points (1D)



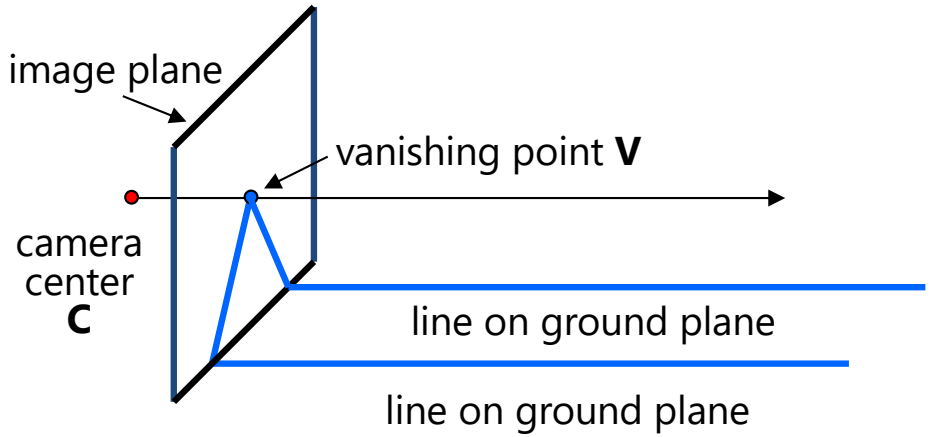
- Vanishing point
  - projection of a point at infinity
  - can often (but not always) project to a finite point in the image



Vanishing points (2D)



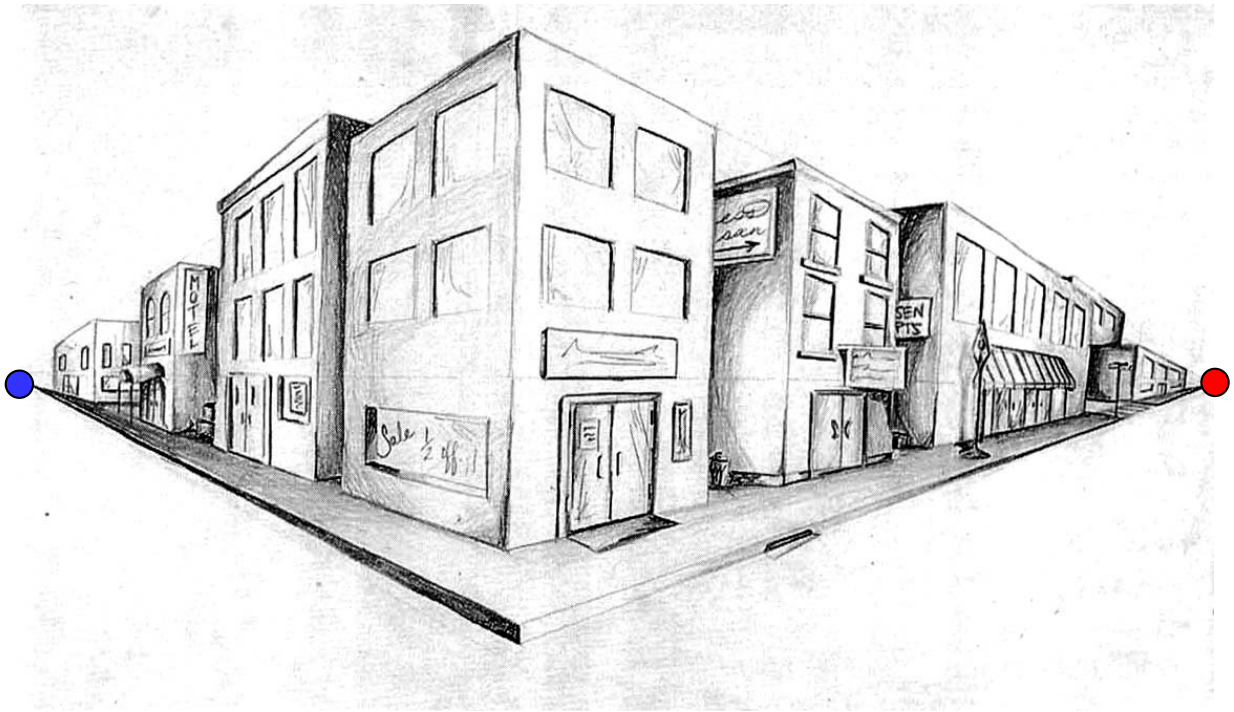
Vanishing points



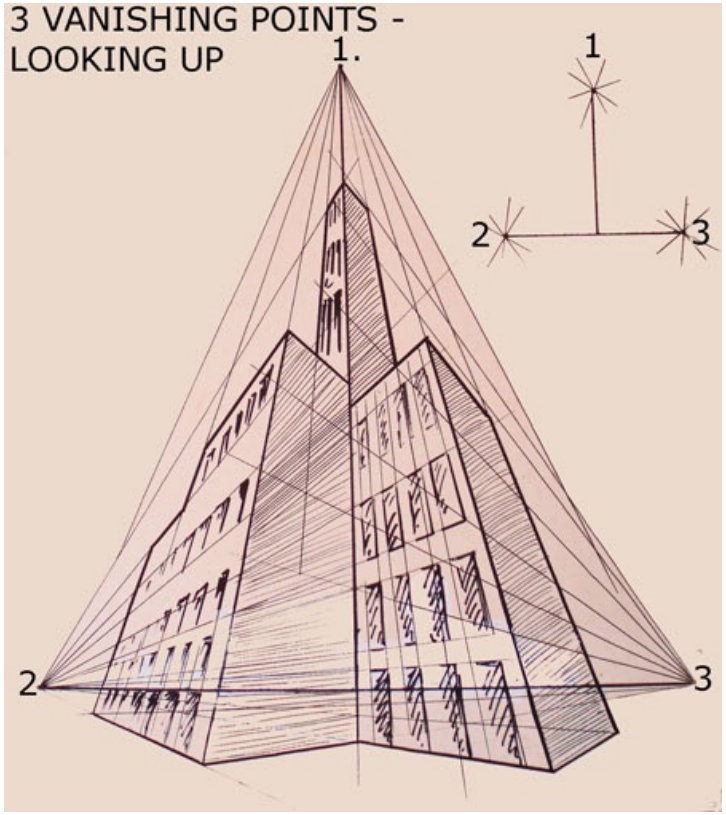
- Properties
  - Any two parallel lines (in 3D) have the same vanishing point **v**
  - The ray from **C** through **v** is parallel to the lines
  - An image may have more than one vanishing point
    - in fact, every image point is a potential vanishing point

One-point perspective

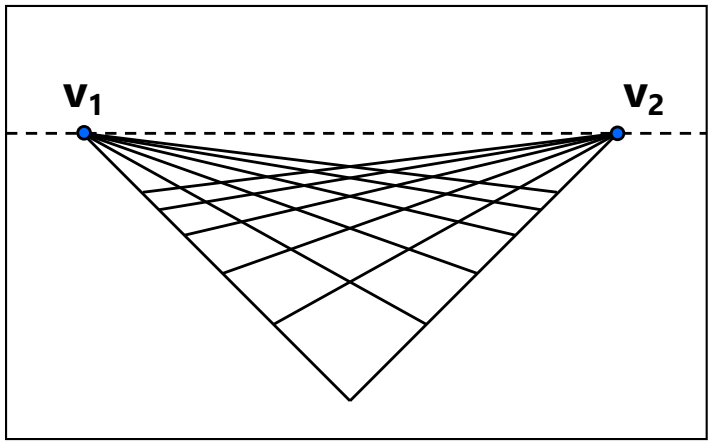
Two-point perspective



Three-point perspective

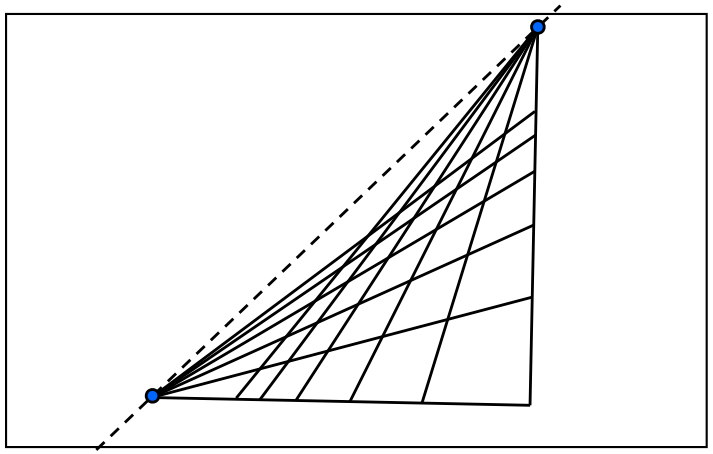


Vanishing lines



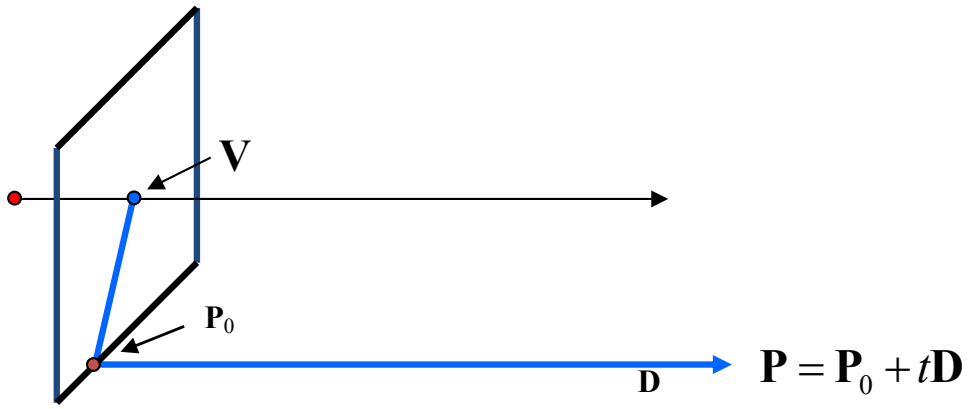
- Multiple Vanishing Points
  - Any set of parallel lines on the plane define a vanishing point
  - The union of all of these vanishing points is the *horizon line*
    - also called *vanishing line*
  - Note that different planes (can) define different vanishing lines

Vanishing lines

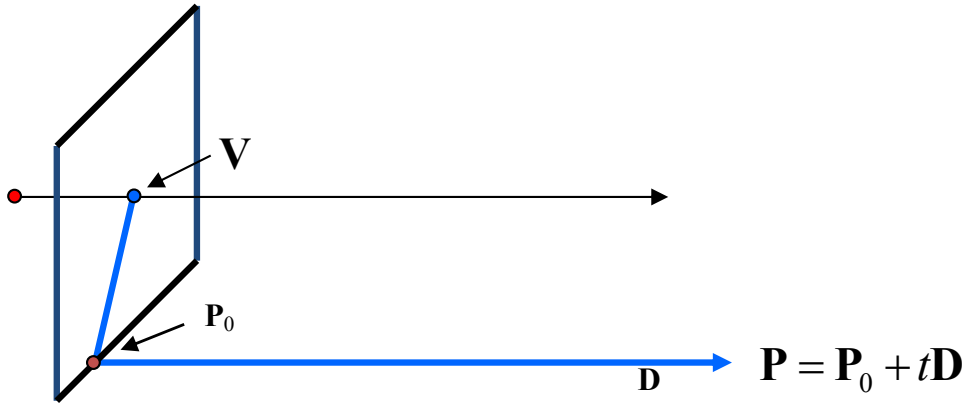


- Multiple Vanishing Points
  - Any set of parallel lines on the plane define a vanishing point
  - The union of all of these vanishing points is the *horizon line*
    - also called *vanishing line*
  - Note that different planes (can) define different vanishing lines

Computing vanishing points



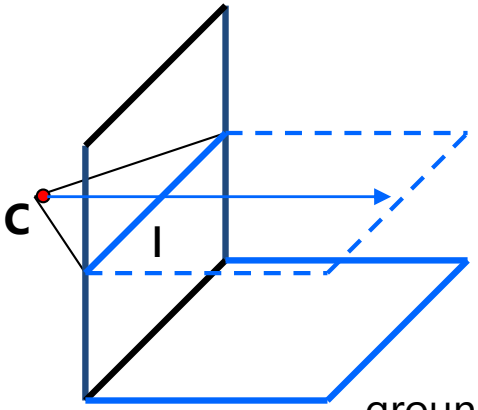
Computing vanishing points

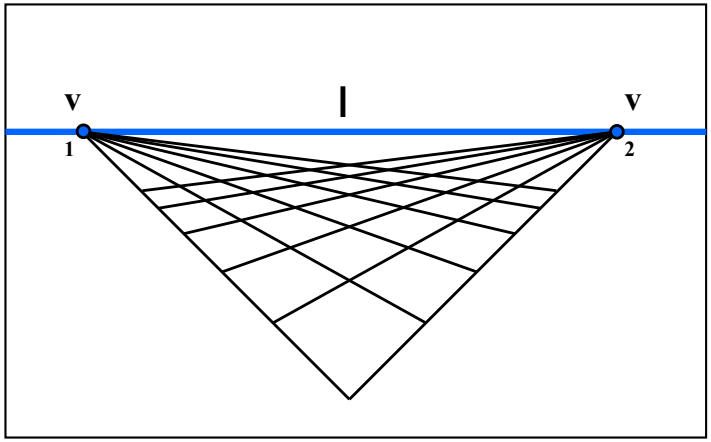


$$\mathbf{P}_t = \begin{bmatrix} P_X + tD_X \\ P_Y + tD_Y \\ P_Z + tD_Z \\ 1 \end{bmatrix} \cong \begin{bmatrix} P_X/t + D_X \\ P_Y/t + D_Y \\ P_Z/t + D_Z \\ 1/t \end{bmatrix}$$

- Properties $\mathbf{v} = \Pi\mathbf{P}_\infty$
  - $\mathbf{P}_\infty$ is a point at *infinity*, **v** is its projection
  - Depends only on line *direction*
  - Parallel lines $\mathbf{P}_0 + t\mathbf{D}$, $\mathbf{P}_1 + t\mathbf{D}$ intersect at $\mathbf{P}_\infty$

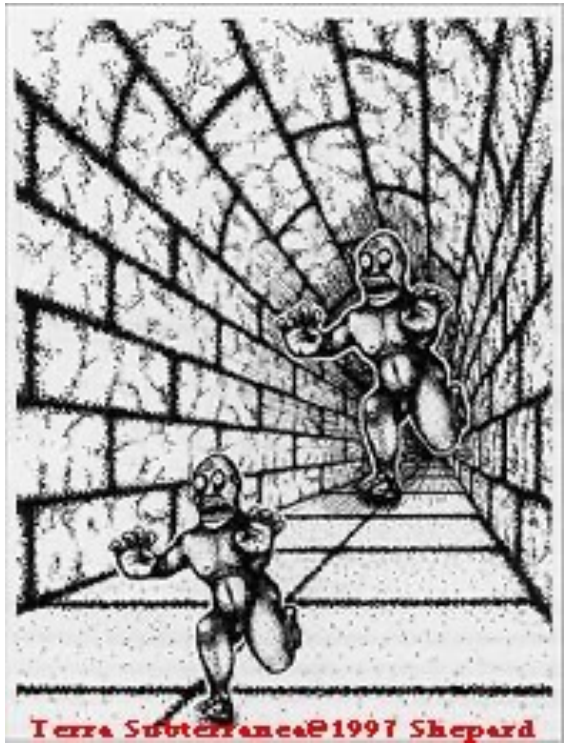
Computing vanishing lines

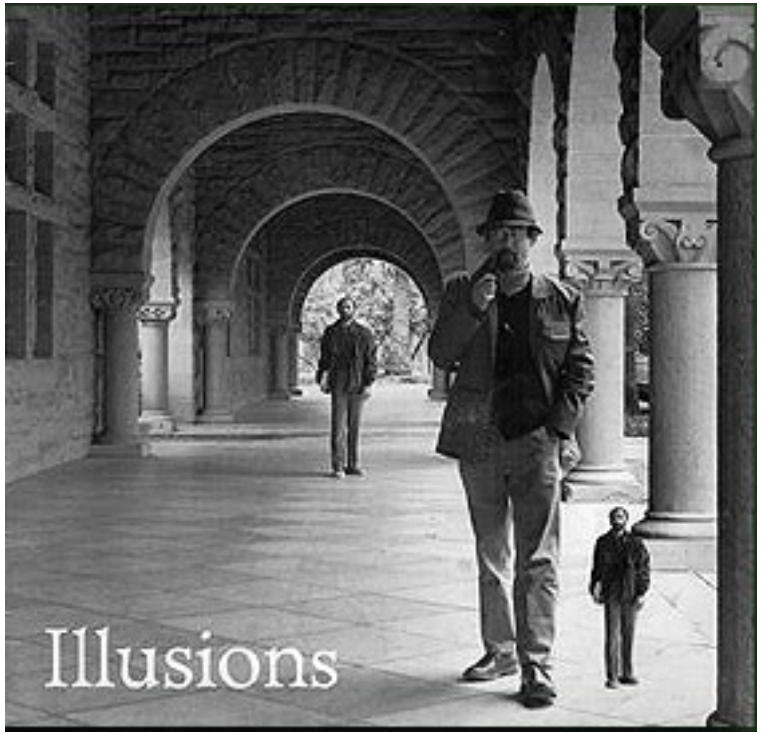




- Properties
  - **l** is intersection of horizontal plane through **C** with image plane
  - Compute **l** from two sets of parallel lines on ground plane
  - All points at same height as **C** project to **l**
    - points higher than C project above l
  - Provides way of comparing height of objects in the scene

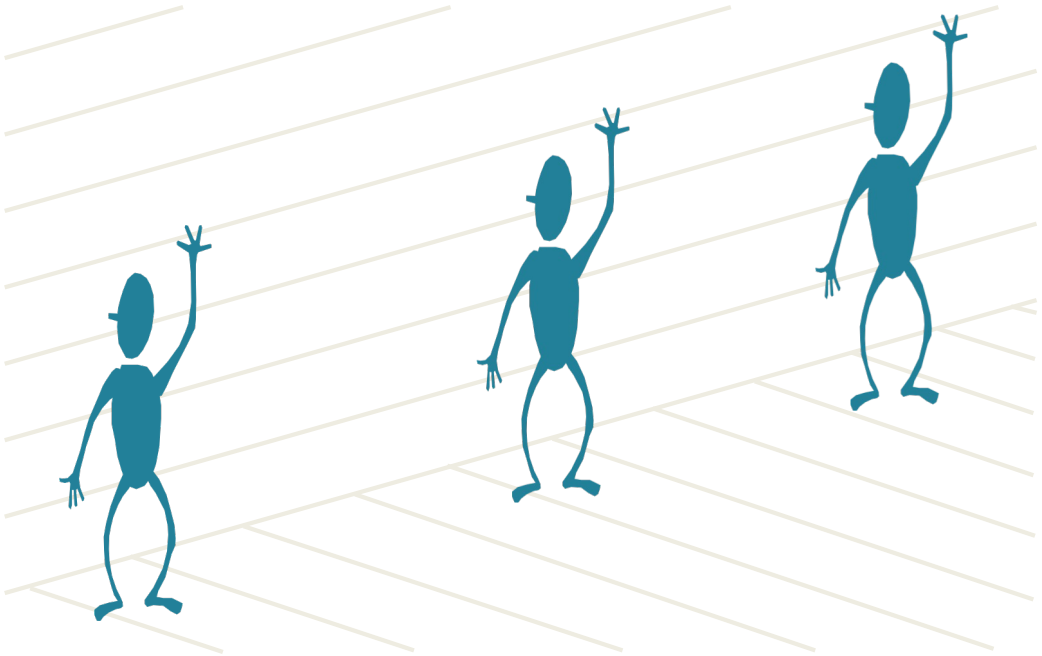
Fun with vanishing points





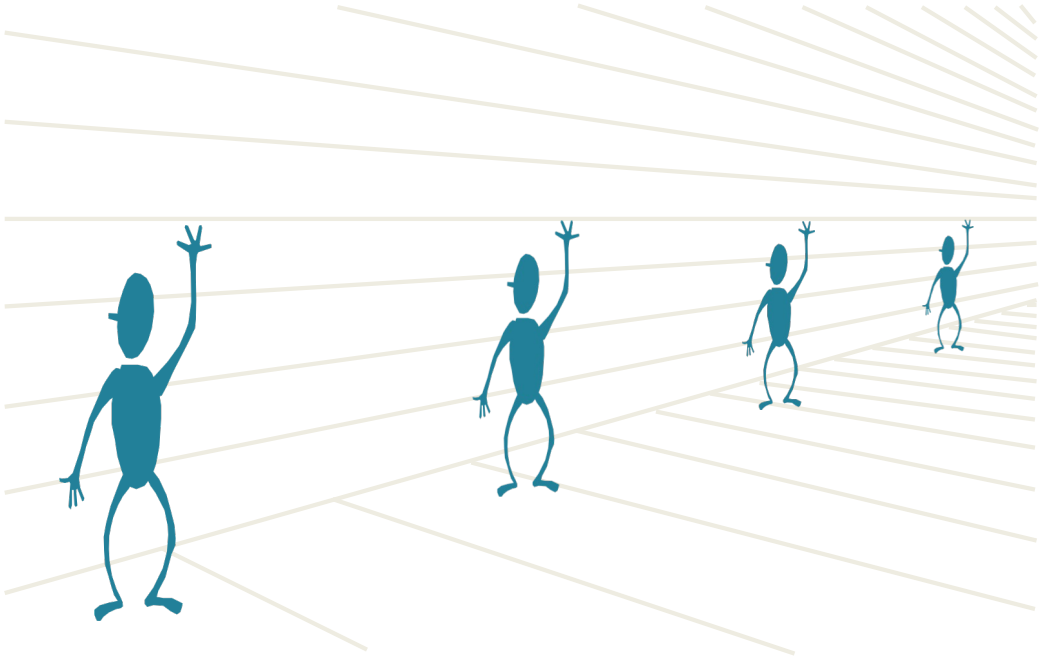
Lots of fun with vanishing points

Perspective cues

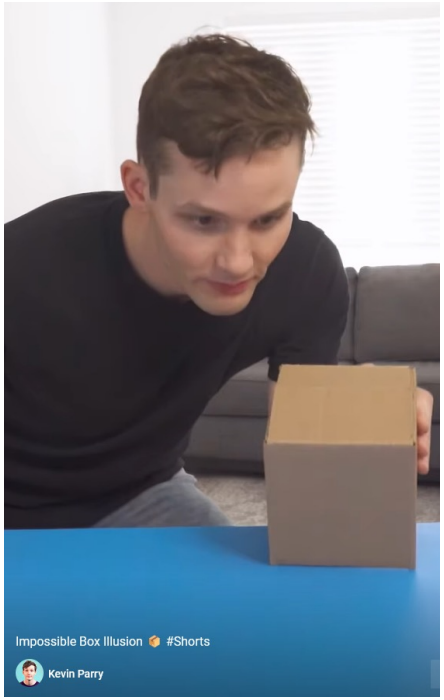


Perspective cues

Perspective cues



More fun with perspectives



https://www.youtube.com/shorts/xq_CmZ3d6pk