Lesson 3

Seeing in linear perspective

What we’ll ignore

What we'll ignore

- Binocular vision: instead, we are cyclops (one-eyed).
- Focus: model will not explain sharp vs. blurry images.
- Round Earth: instead, Earth is flat, modeled as the **ground plane**.*

* Good approximation for observers drawing pictures or taking photos near Earth's surface.

Terms about 3D space

- (Infinite straight) **line**:
- **Line segment**:

Terms about 3D space

- (Infinite straight) **line**:
- **Line segment**:
- **Parallel lines**: two lines pointing in the same direction

Terms about 3D space

- (Infinite straight) **line**:
- **Line segment**:
- **Parallel lines**: two lines pointing in the same direction

Like this: 

parallel lines lying on the same plane

Terms about 3D space

- (Infinite straight) **line**:
- **Line segment**:
- **Parallel lines**: two lines pointing in the same direction

Like this:

parallel lines lying on the same plane

Not like this:

line on top

line on bottom

lines lying on different planes

Terms about 3D space

- (Infinite straight) **line**:
- **Line segment**:
- **Parallel lines**: two lines pointing in the same direction

Like this:

parallel lines lying on the same plane

Not like this:

line on top

line on bottom

lines lying on different planes

- **Plane**: flat surface

Terms about 3D space

- (Infinite straight) **line**:
- **Line segment**:
- **Parallel lines**: two lines pointing in the same direction

Like this:

parallel lines lying on the same plane

Not like this:

line on top

line on bottom

lines lying on different planes

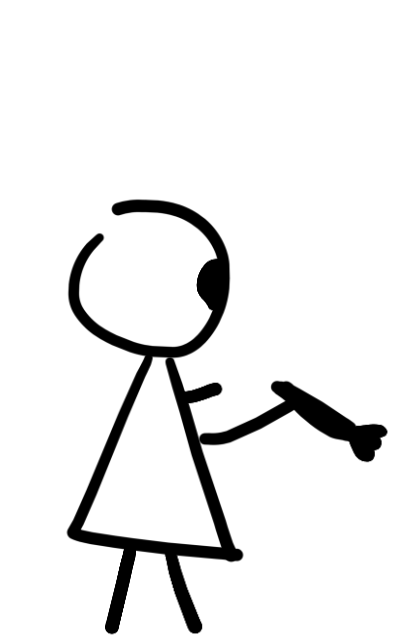
- **Plane**: flat surface
- **Parallel planes**: two planes that don't intersect.

The setup (the artist)

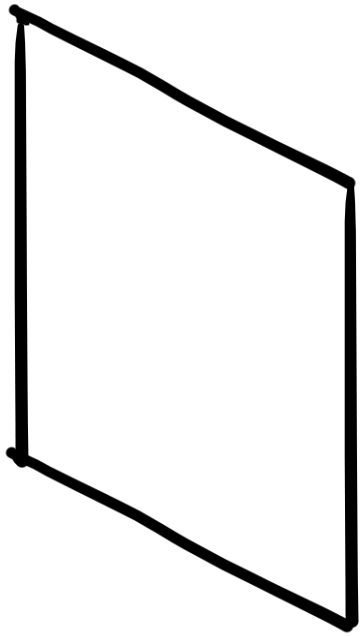
The **observer** or **artist** draws a scene from the **real world** to the **picture plane**.

The setup (the artist)

The **observer** or **artist** draws a scene from the **real world** to the **picture plane**.



observer/artist

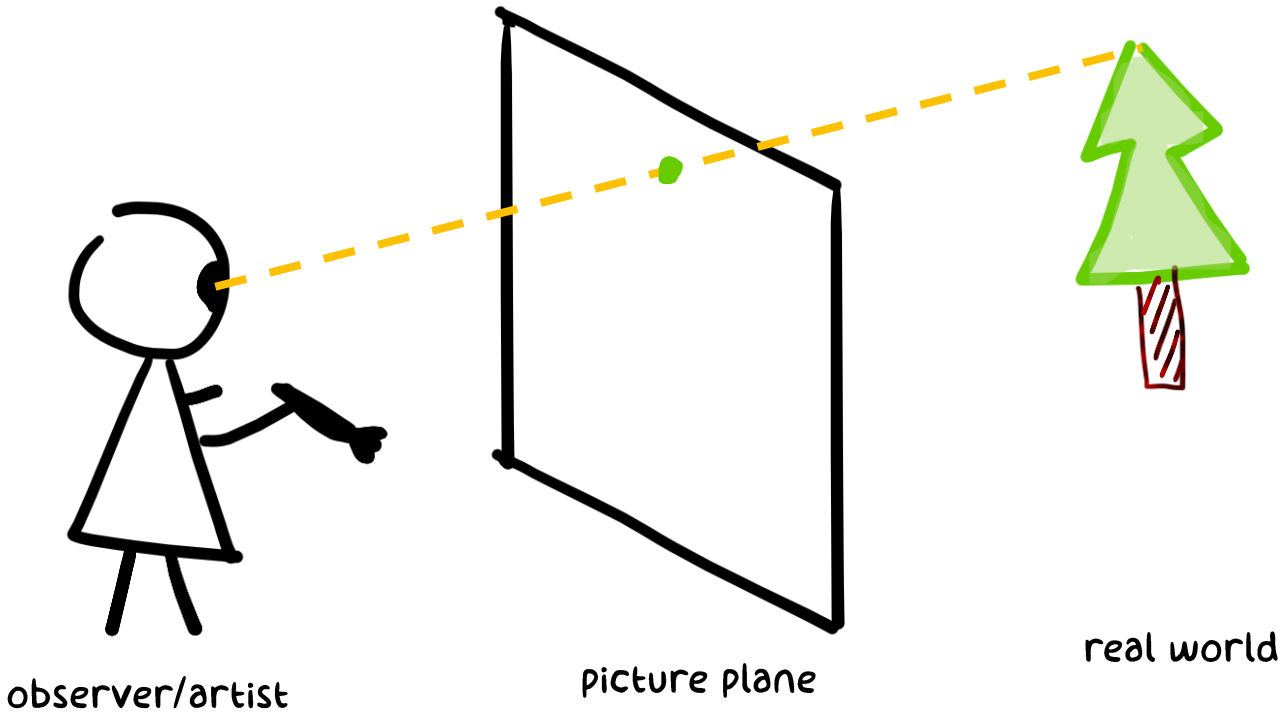


picture plane

real world

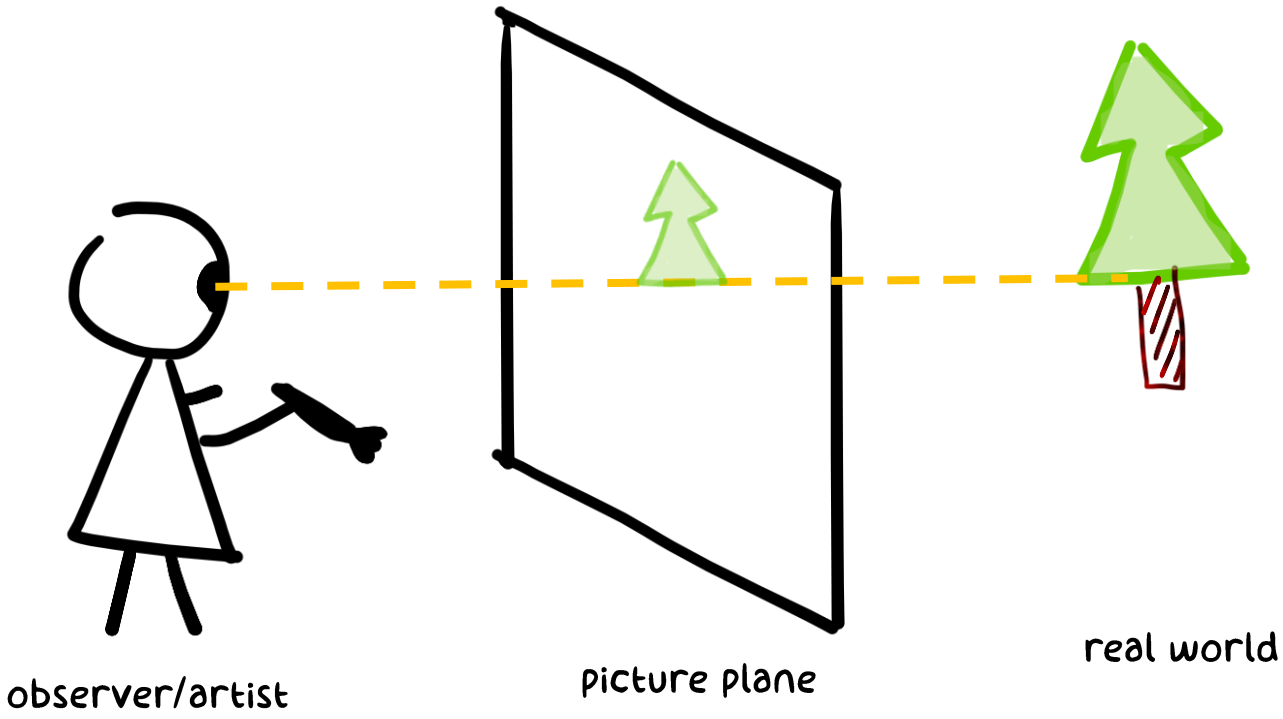
The setup (the artist)

The **observer** or **artist** draws a scene from the **real world** to the **picture plane**.



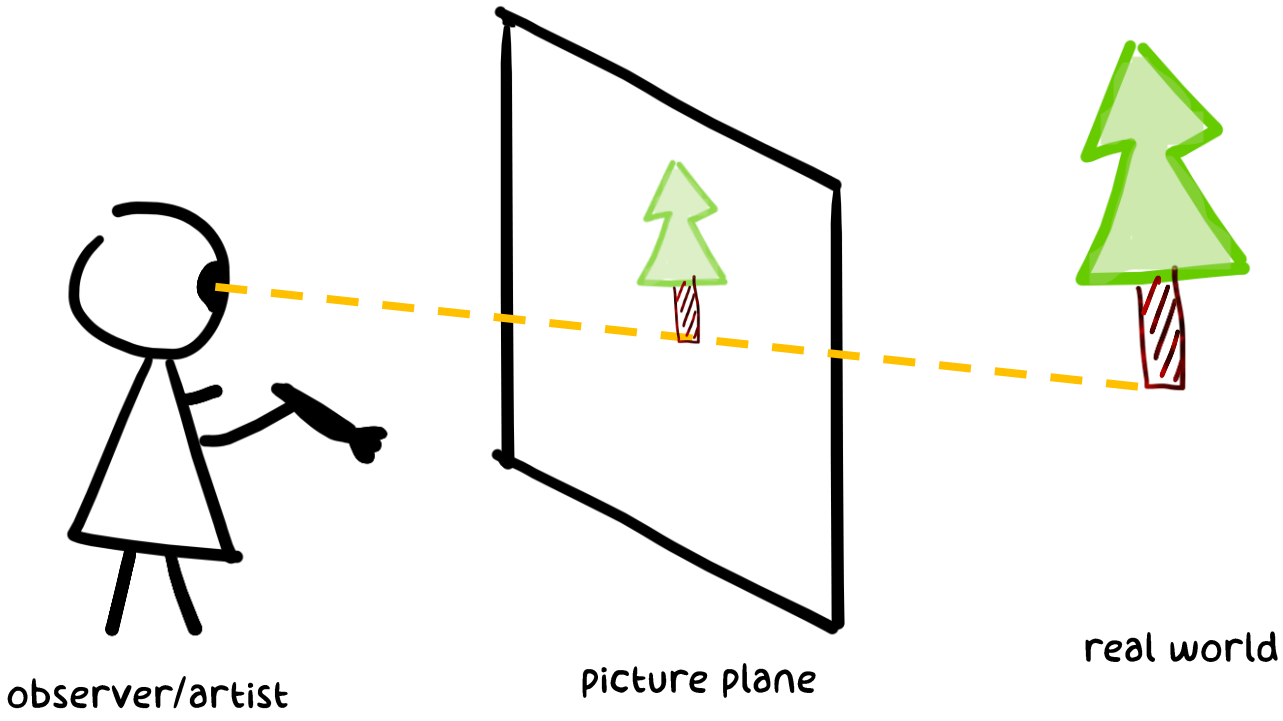
The setup (the artist)

The **observer** or **artist** draws a scene from the **real world** to the **picture plane**.



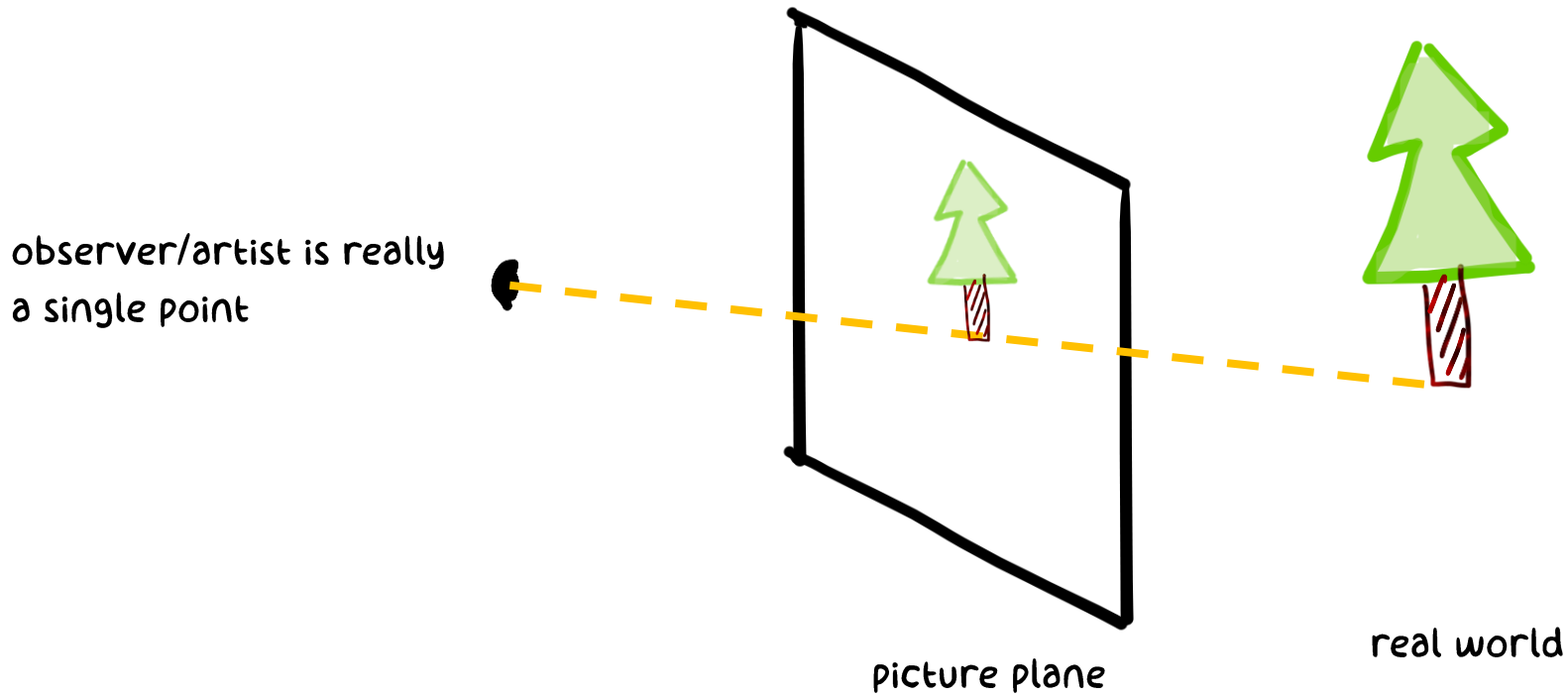
The setup (the artist)

The **observer** or **artist** draws a scene from the **real world** to the **picture plane**.



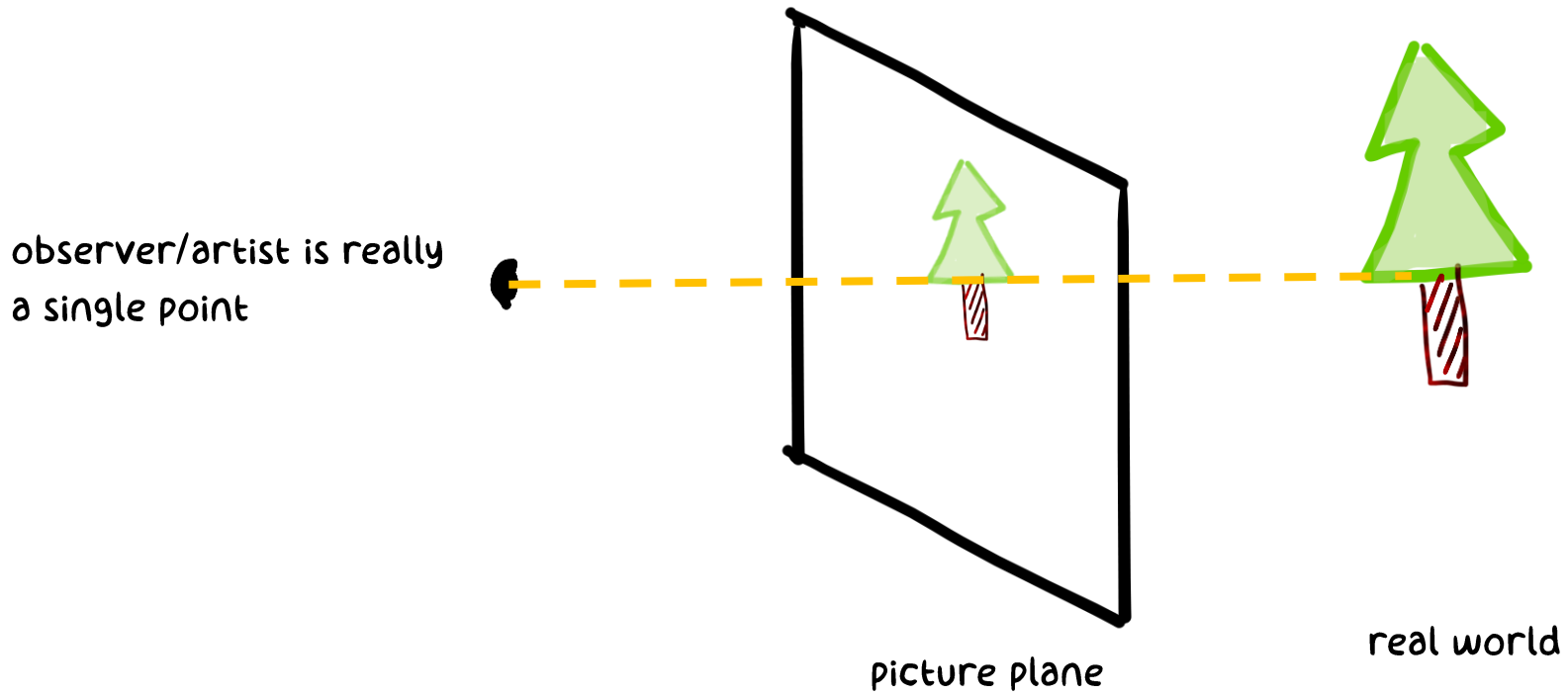
The setup (the artist)

The **observer** or **artist** draws a scene from the **real world** to the **picture plane**.



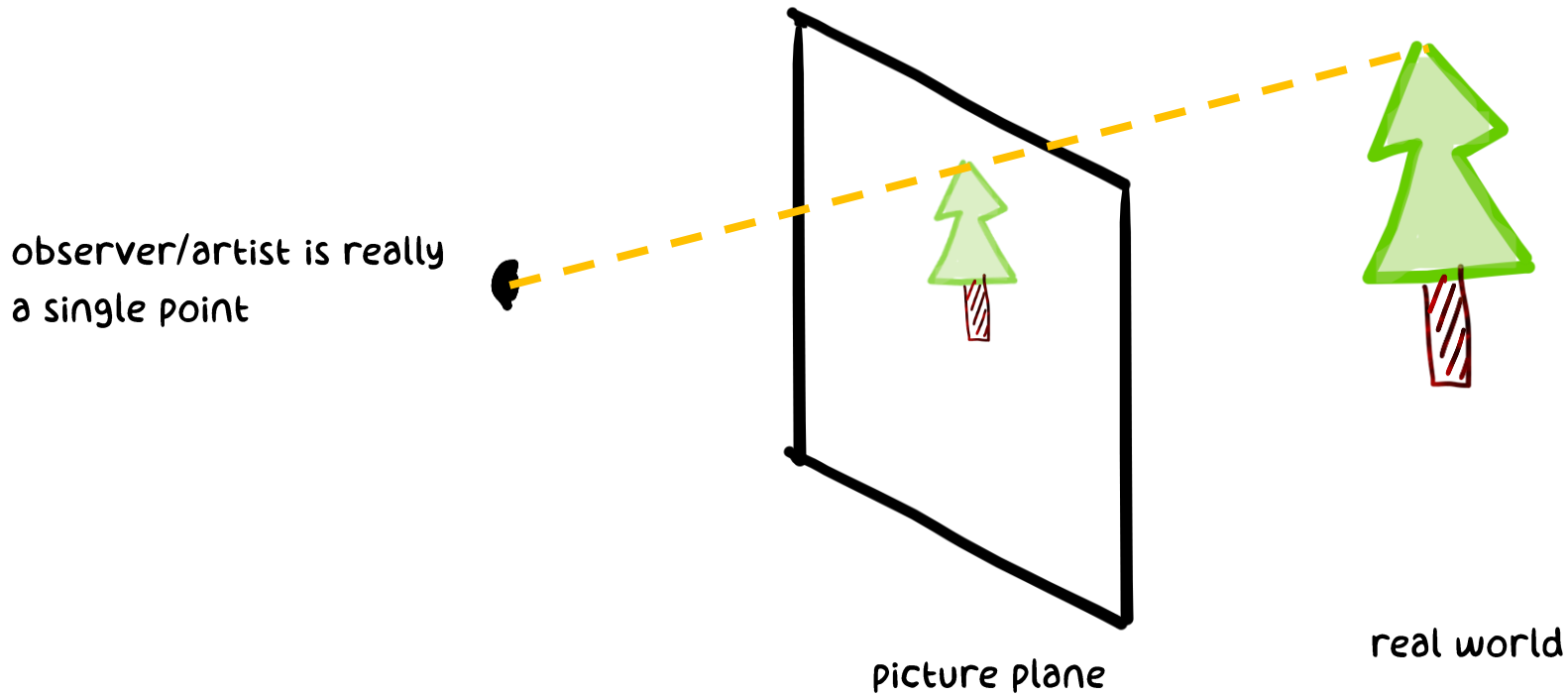
The setup (the artist)

The **observer** or **artist** draws a scene from the **real world** to the **picture plane**.



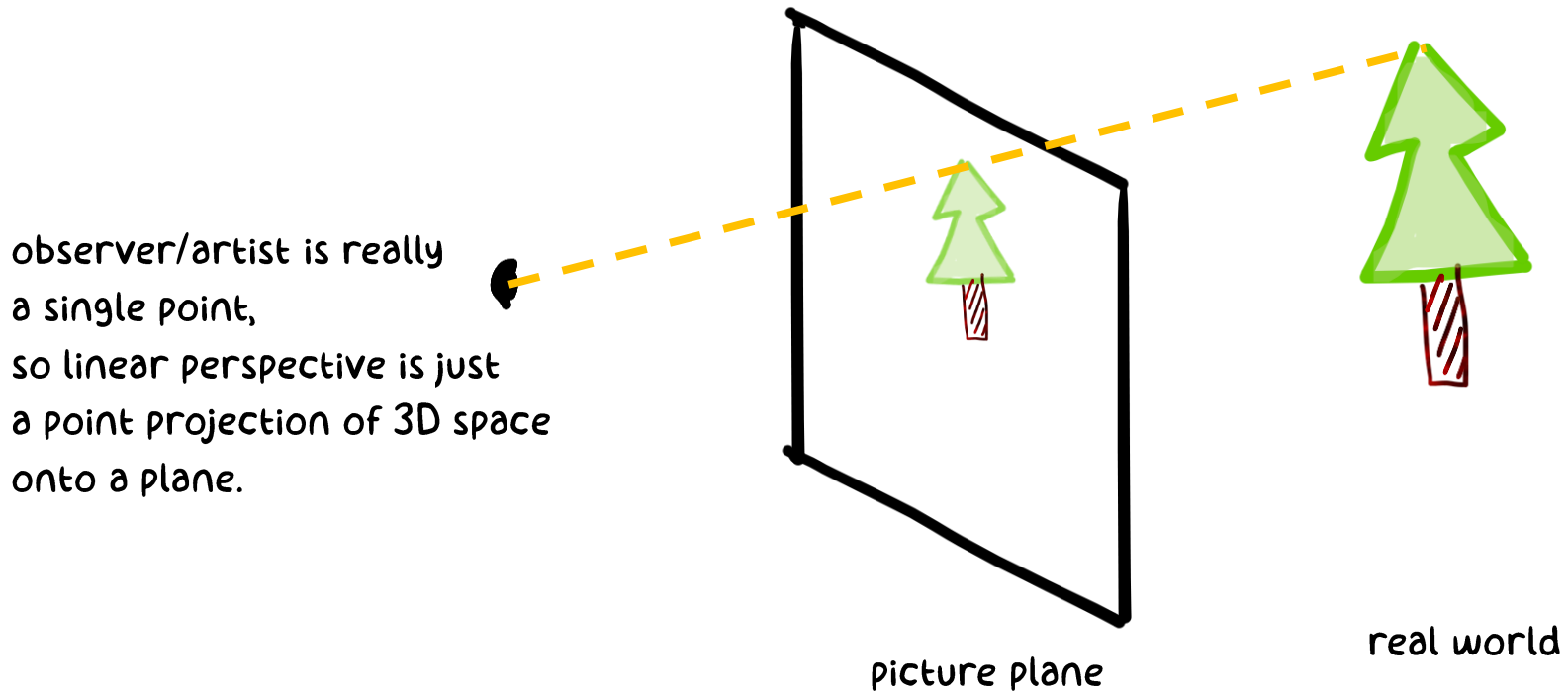
The setup (the artist)

The **observer** or **artist** draws a scene from the **real world** to the **picture plane**.



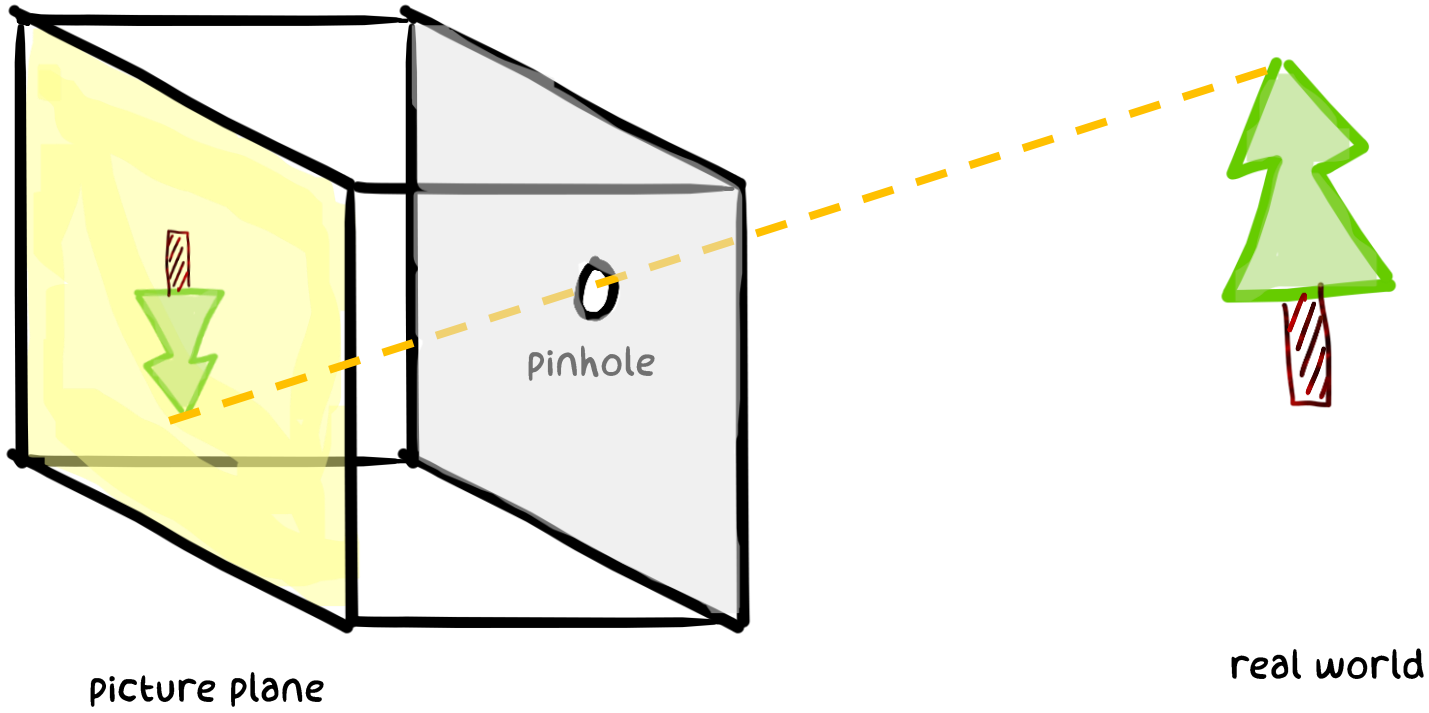
The setup (the artist)

The **observer** or **artist** draws a scene from the **real world** to the **picture plane**.



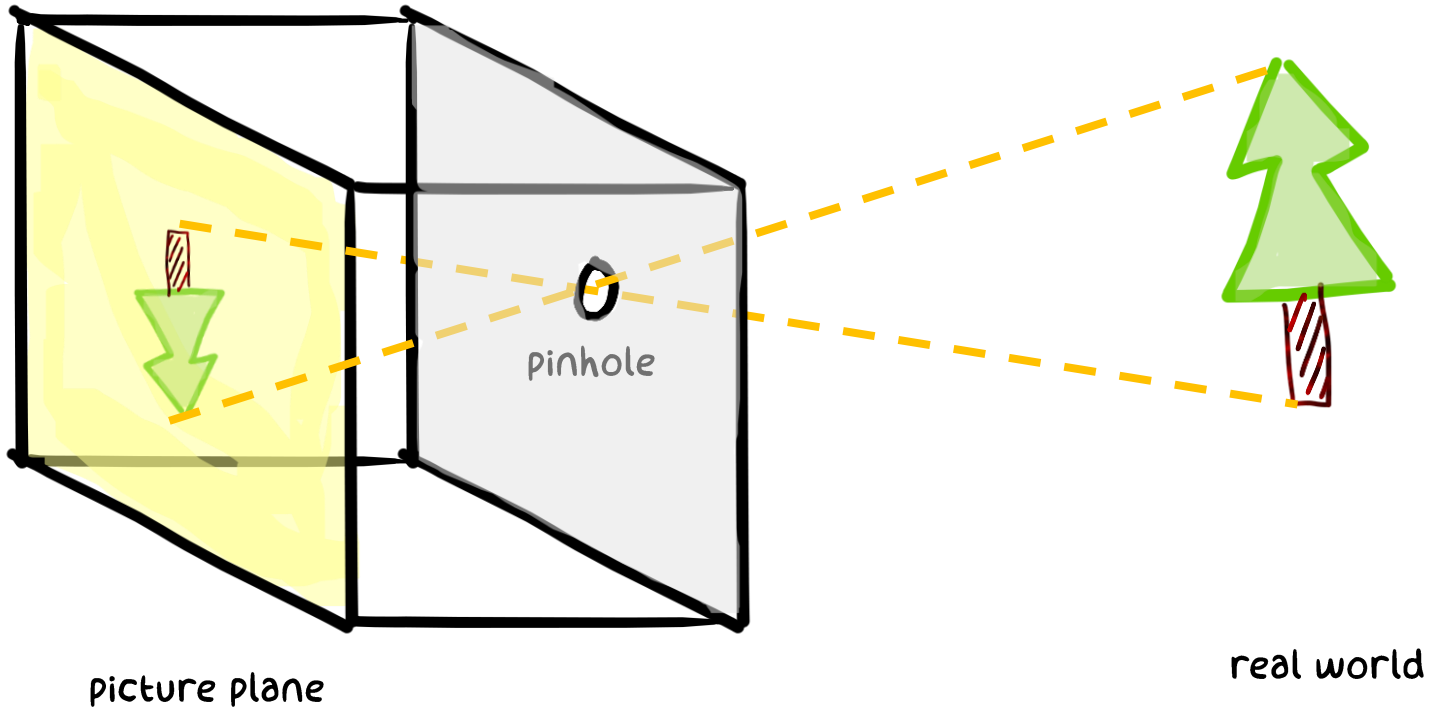
The setup (the camera)

Light enters a pinhole and hits the sensor panel in the back.

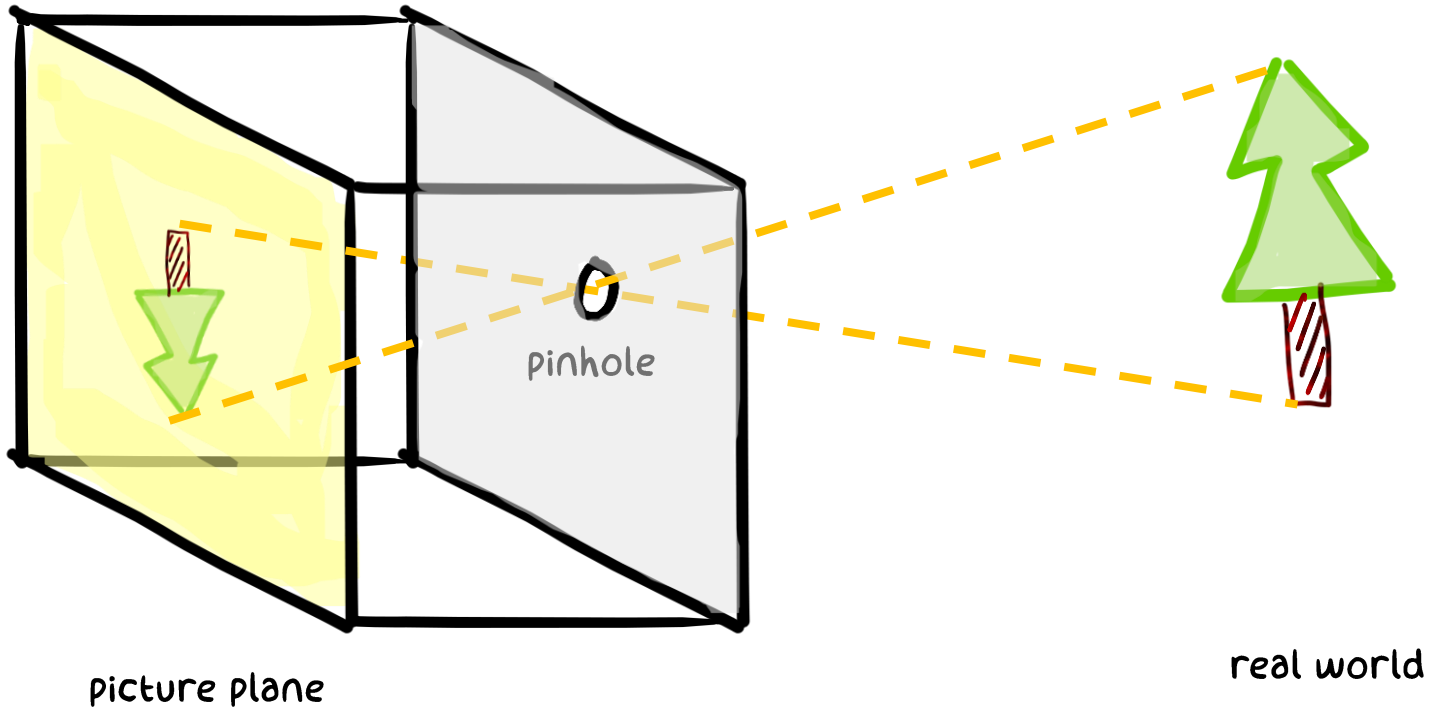


The setup (the camera)

Light enters a pinhole and hits the sensor panel in the back.

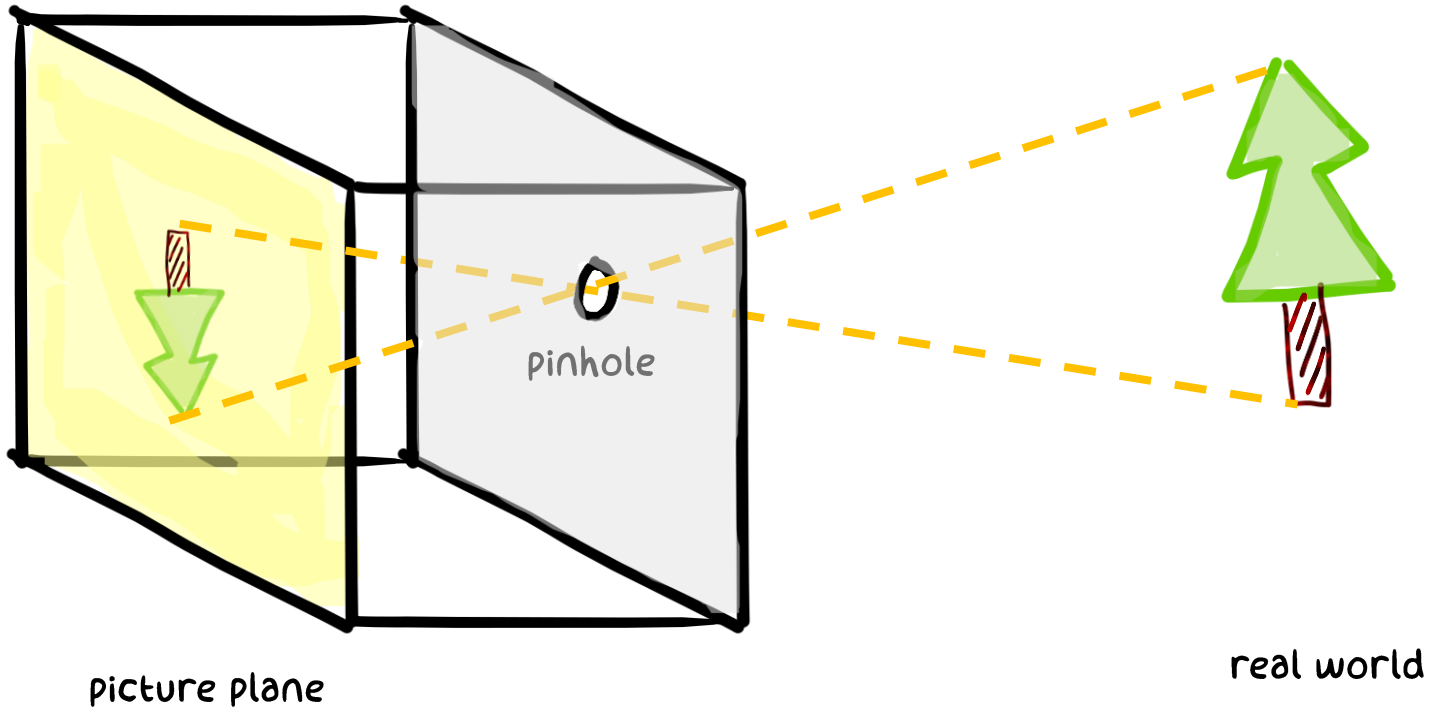


Both setups give the same result



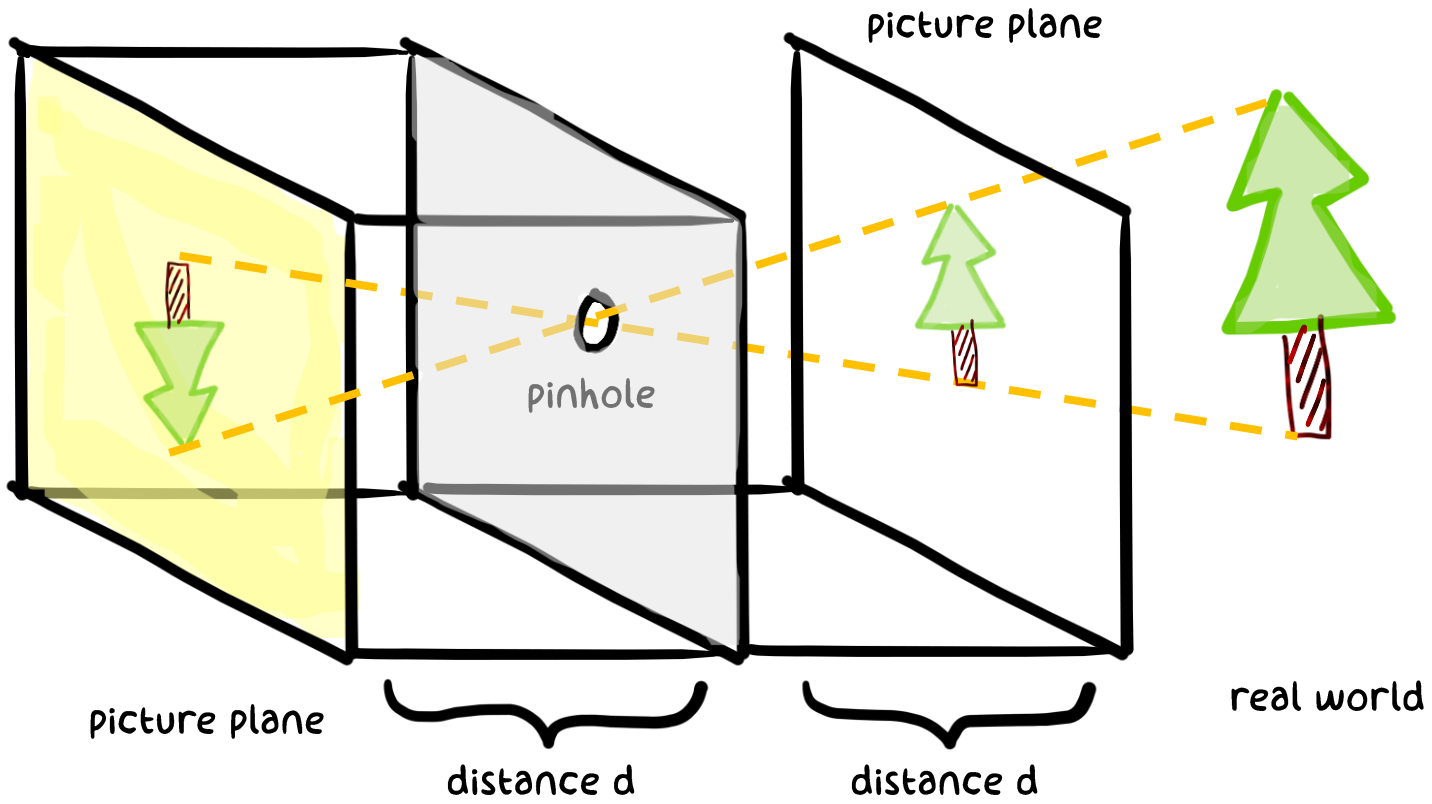
Both setups give the same result

Since we can replace real-world scene by picture plane:



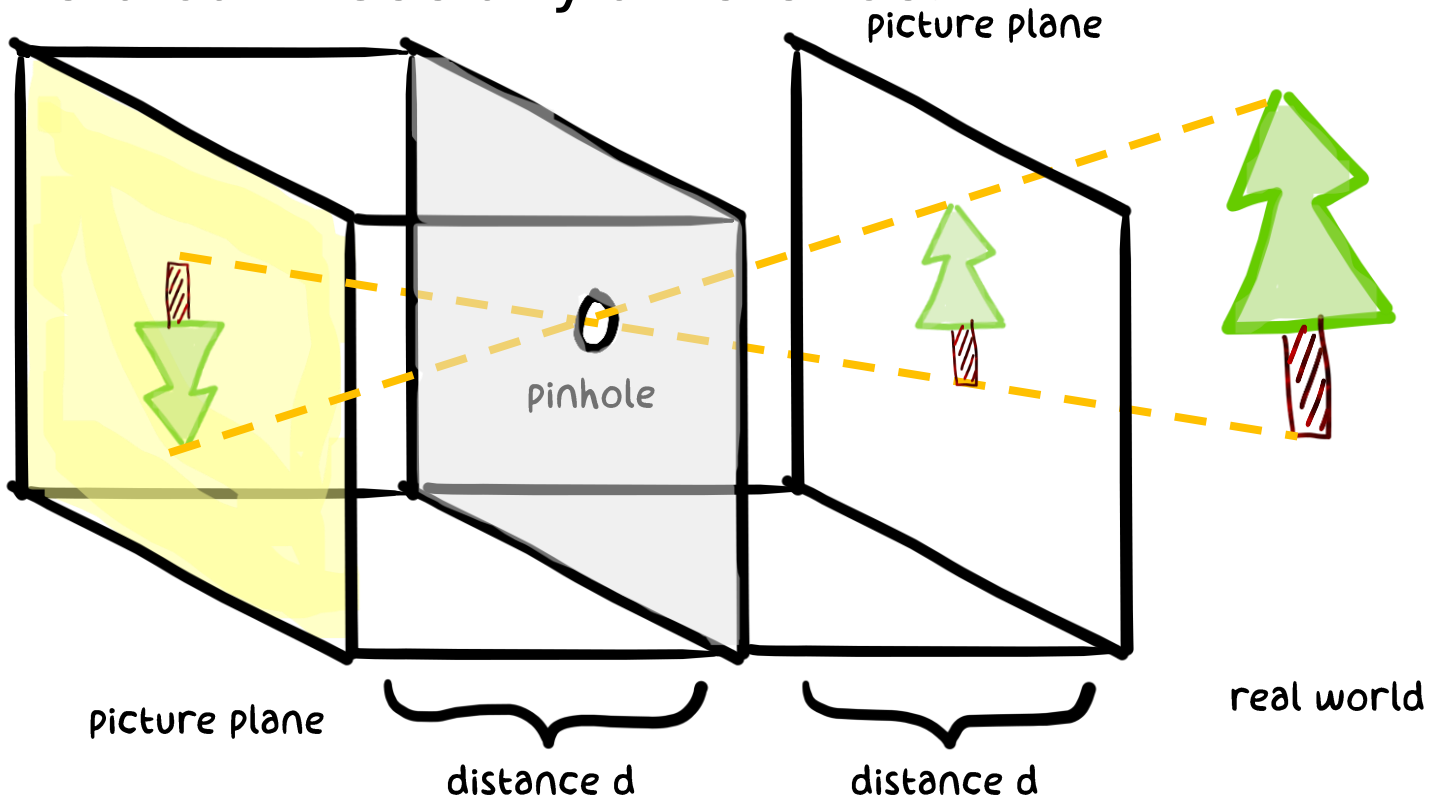
Both setups give the same result

Since we can replace real-world scene by picture plane:

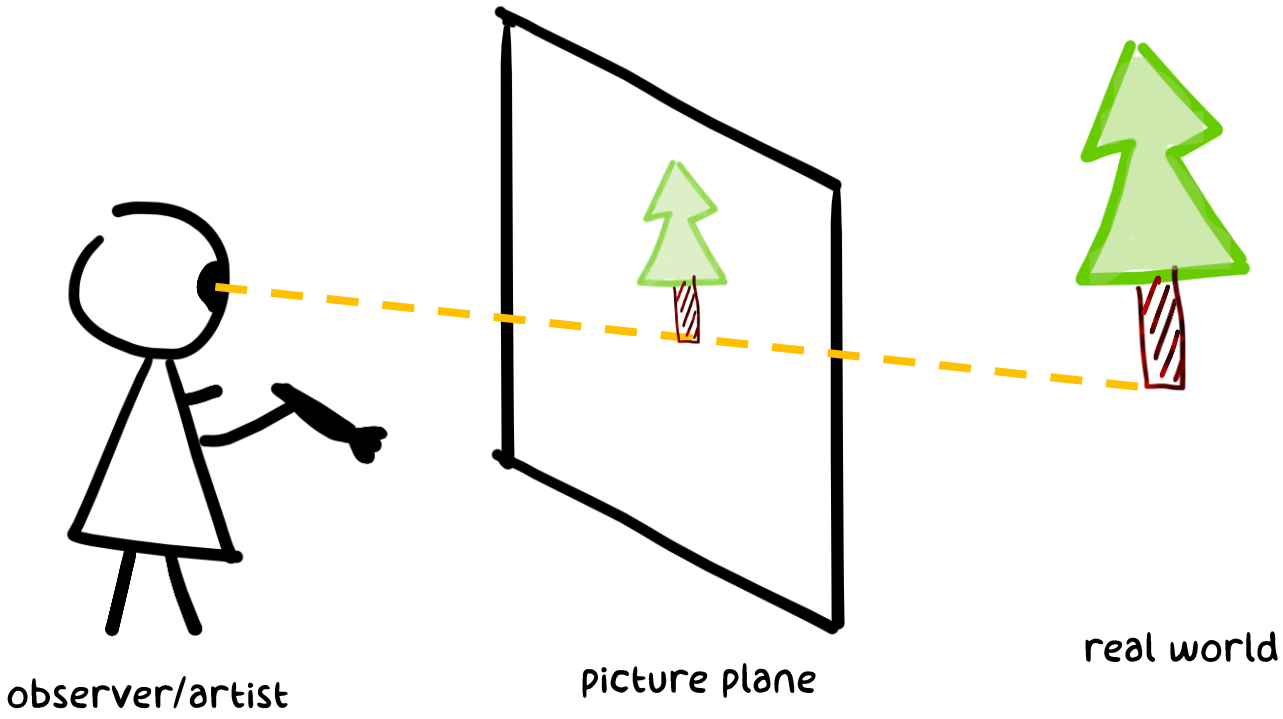


Both setups give the same result

Since we can replace real-world scene by picture plane, and the camera can’t see any difference.

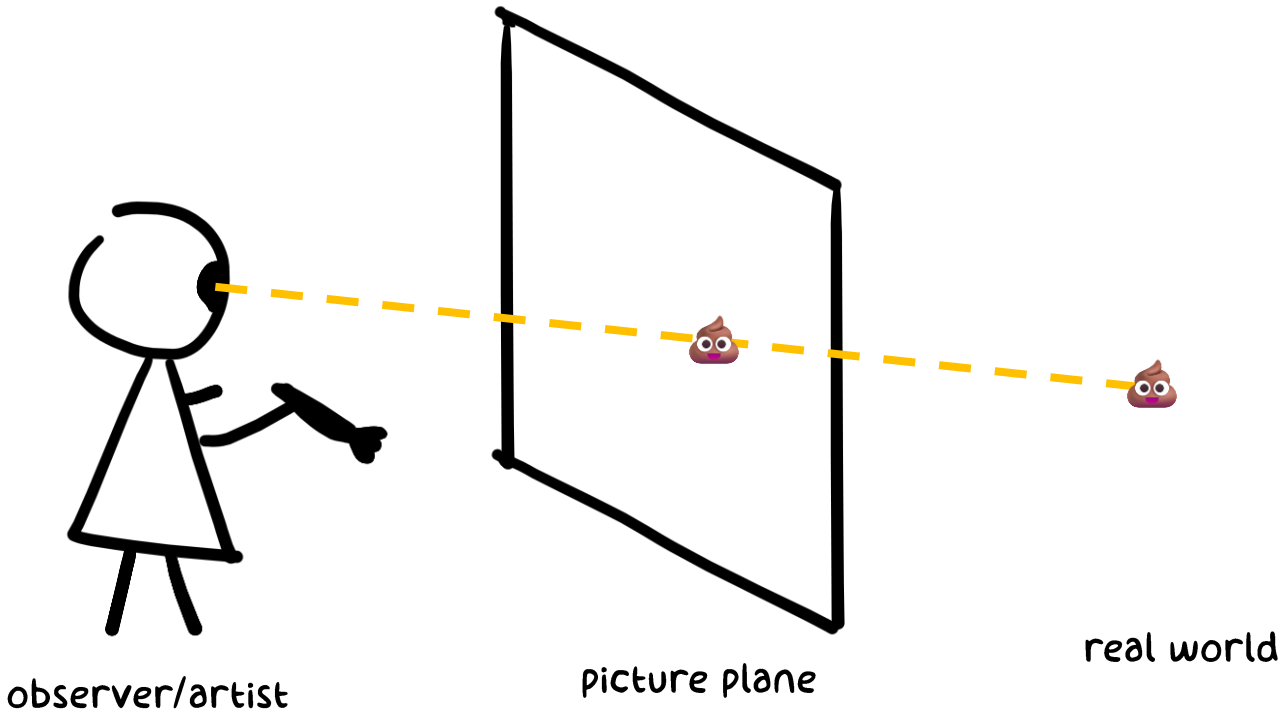


So let’s just stick with the artist’s setup


observer/artist
picture plane
real world

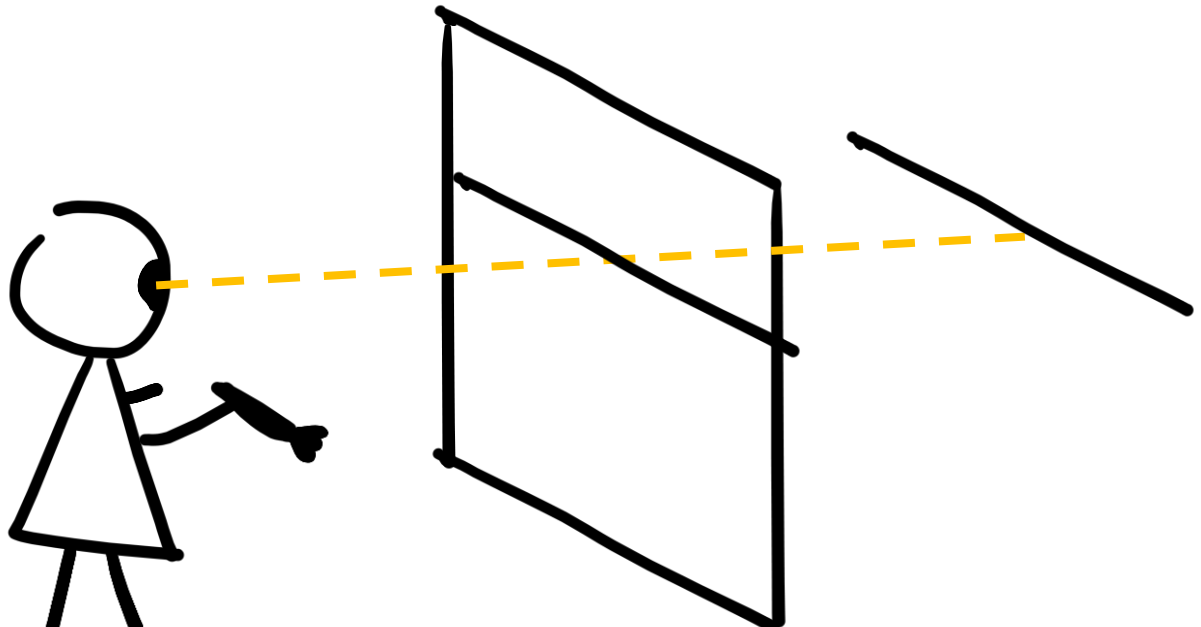
Dictionary

Real world	Picture plane
Point	Point



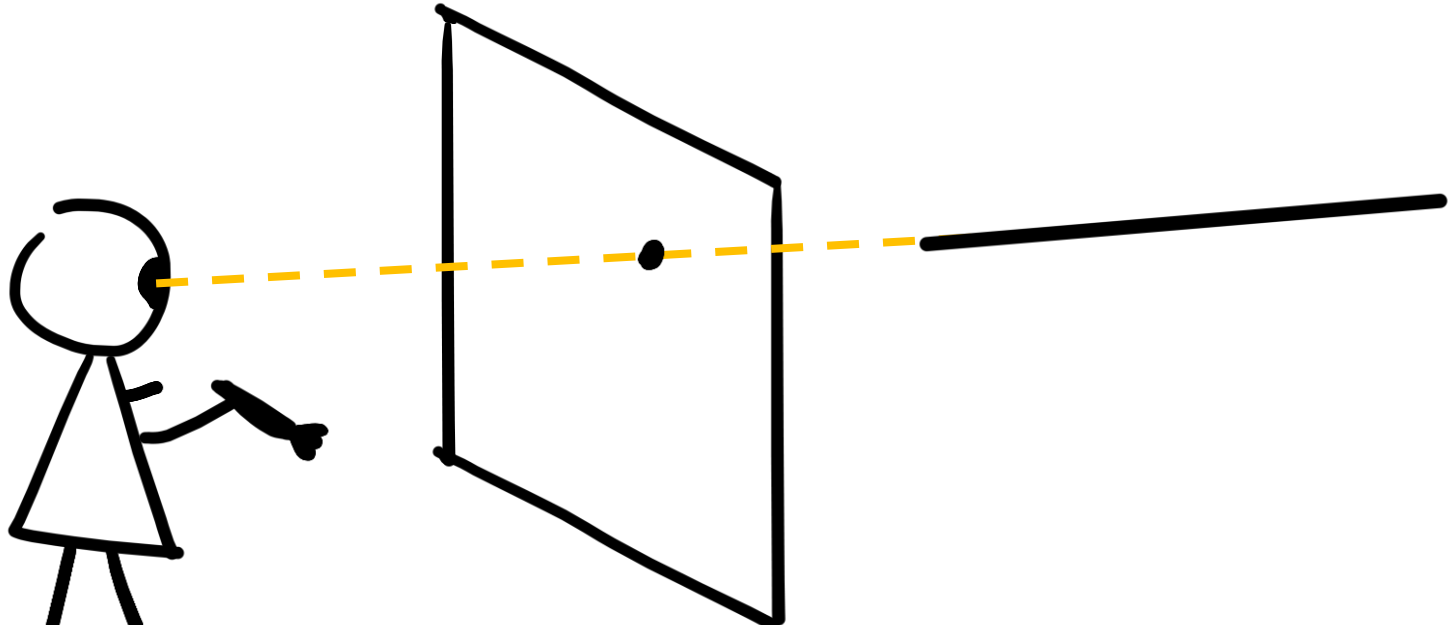
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line



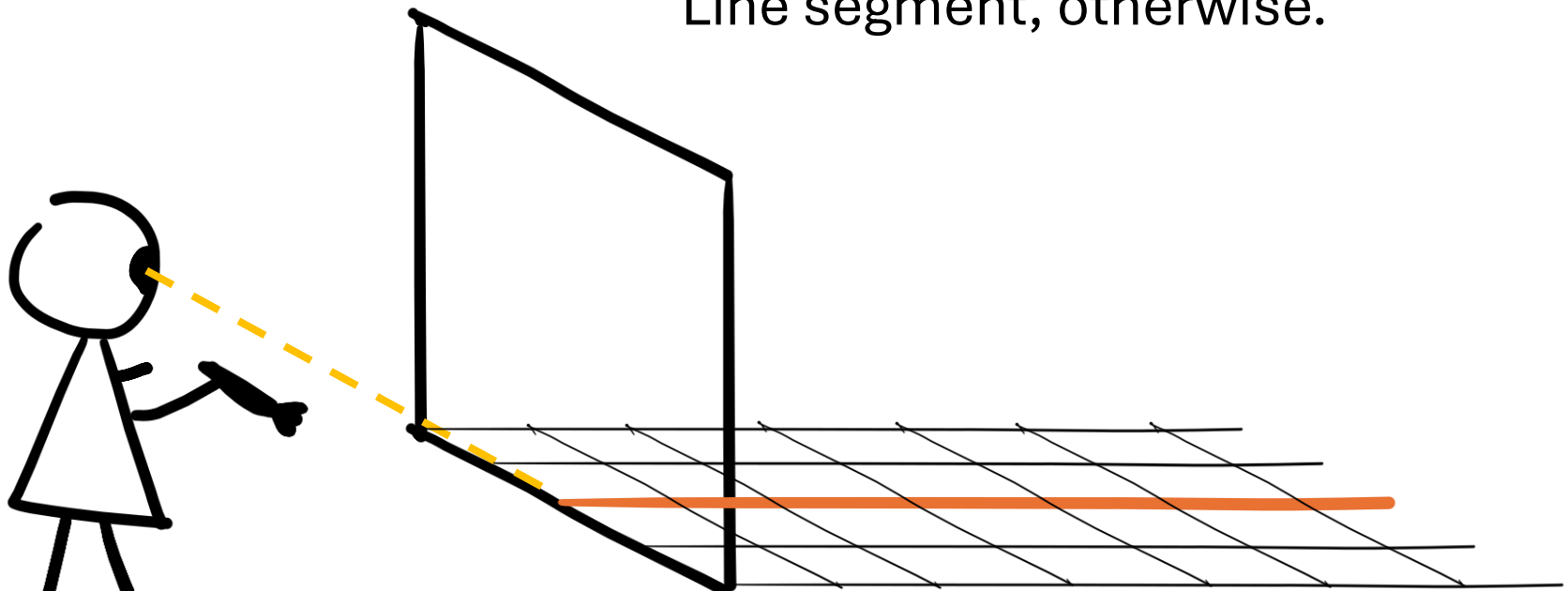
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on line of sight.



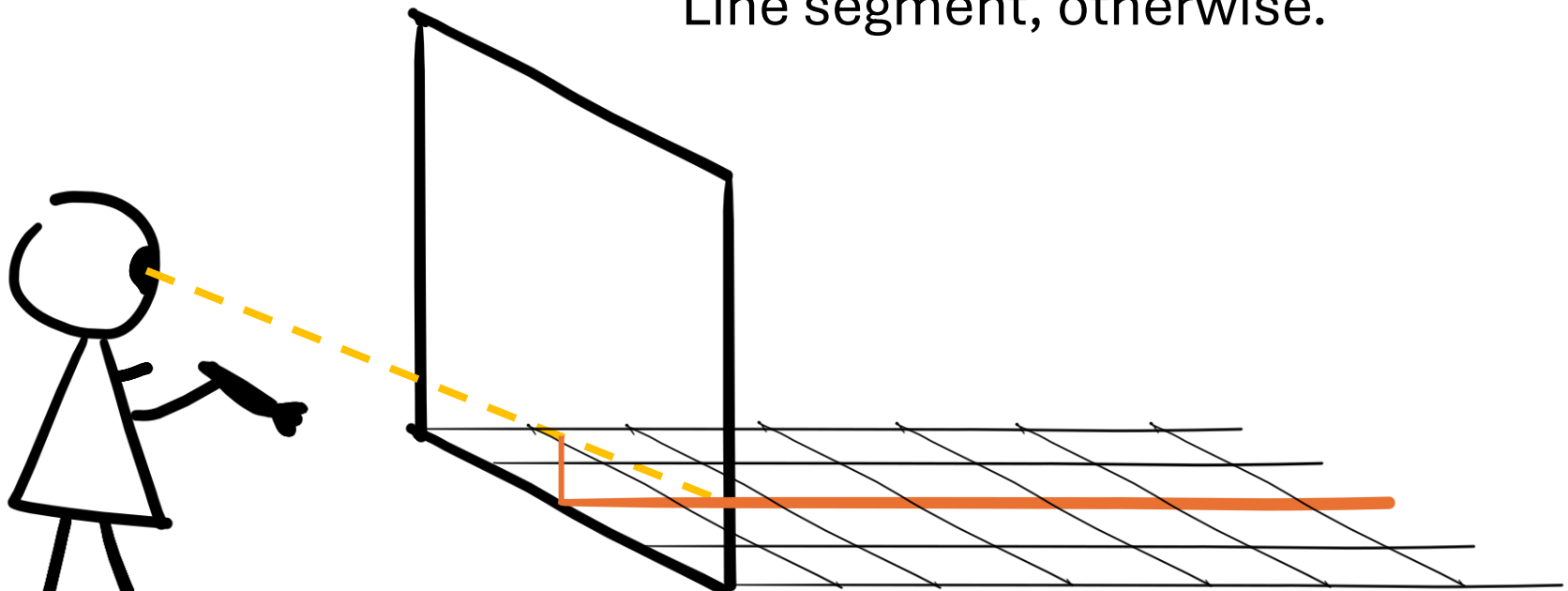
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



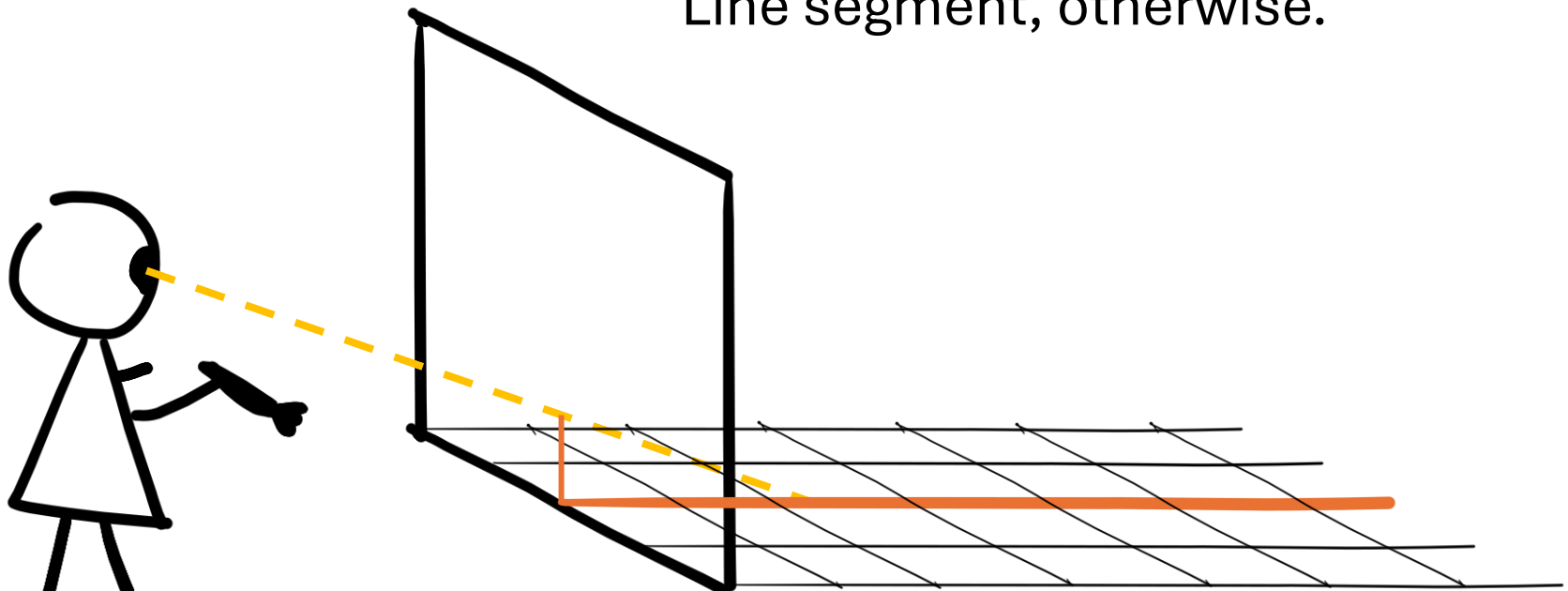
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



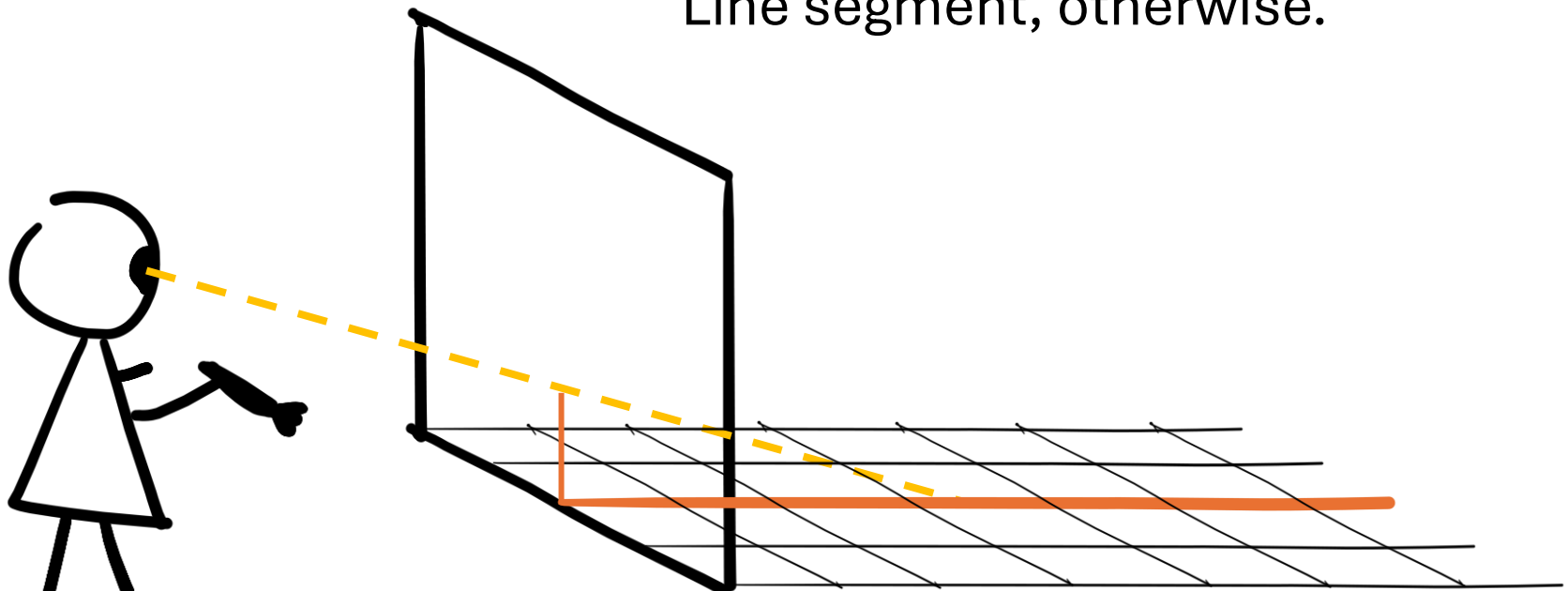
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



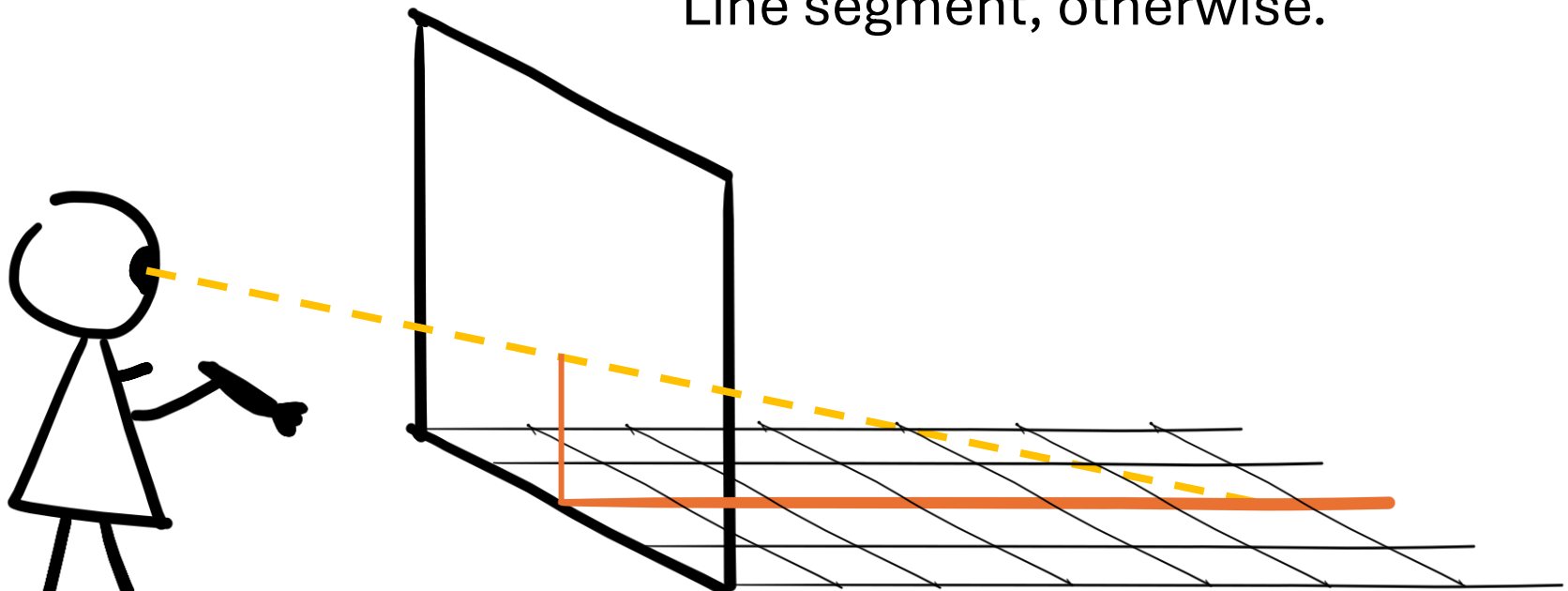
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



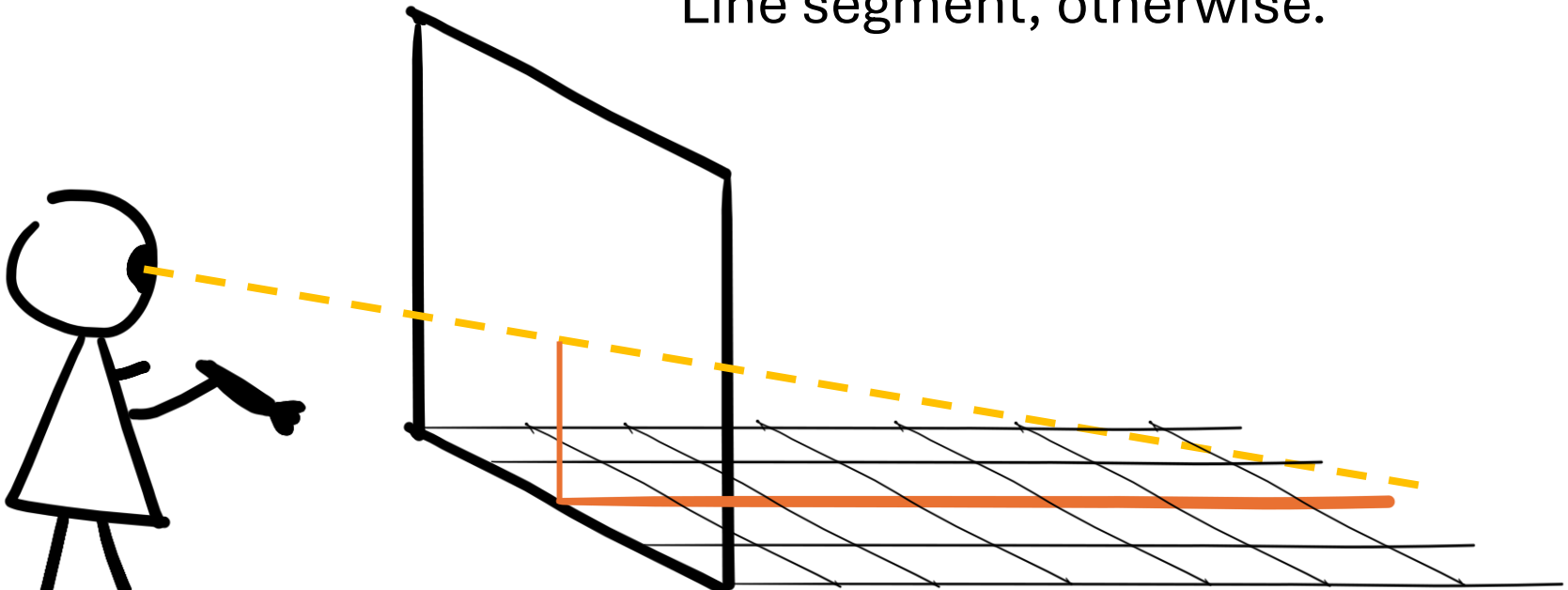
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



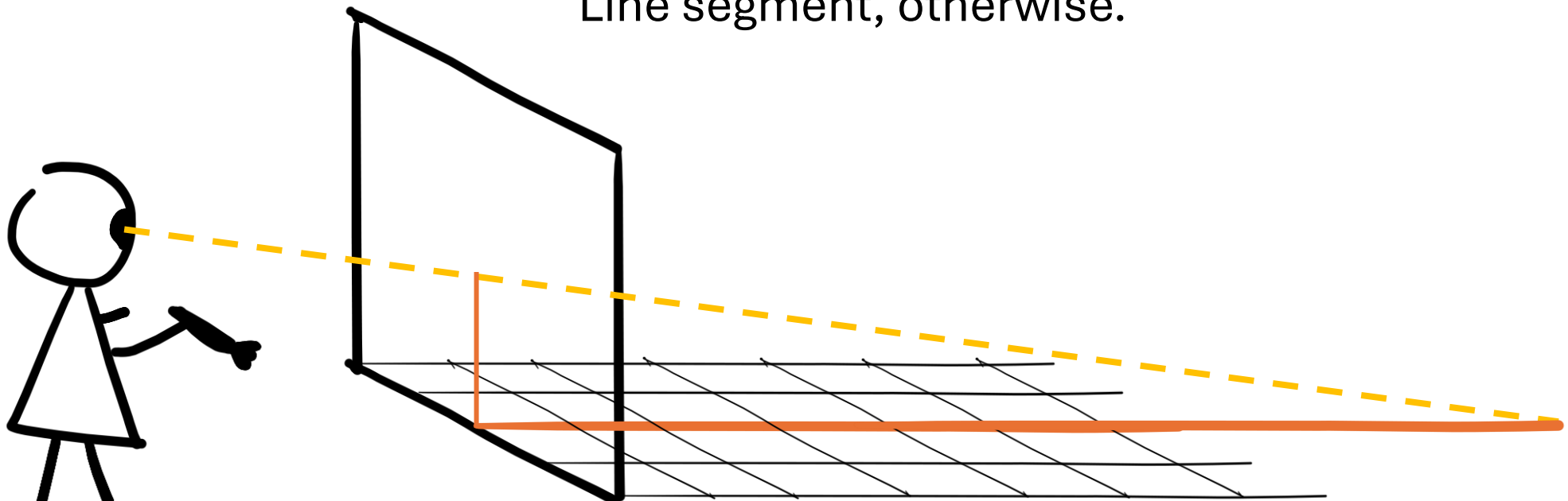
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



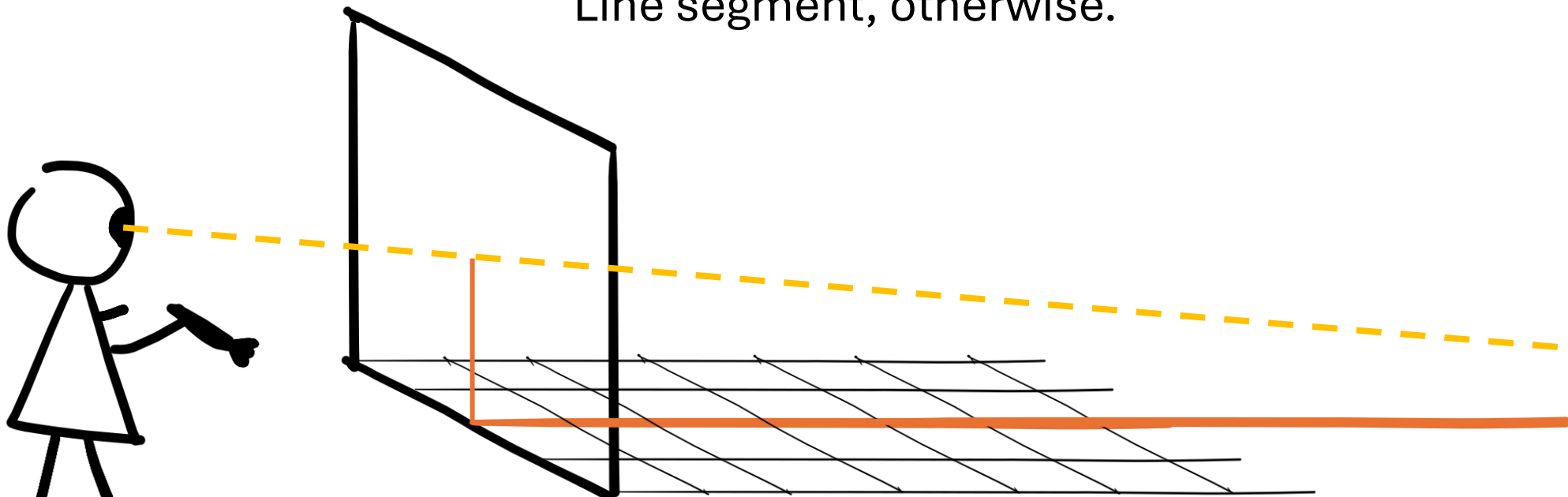
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



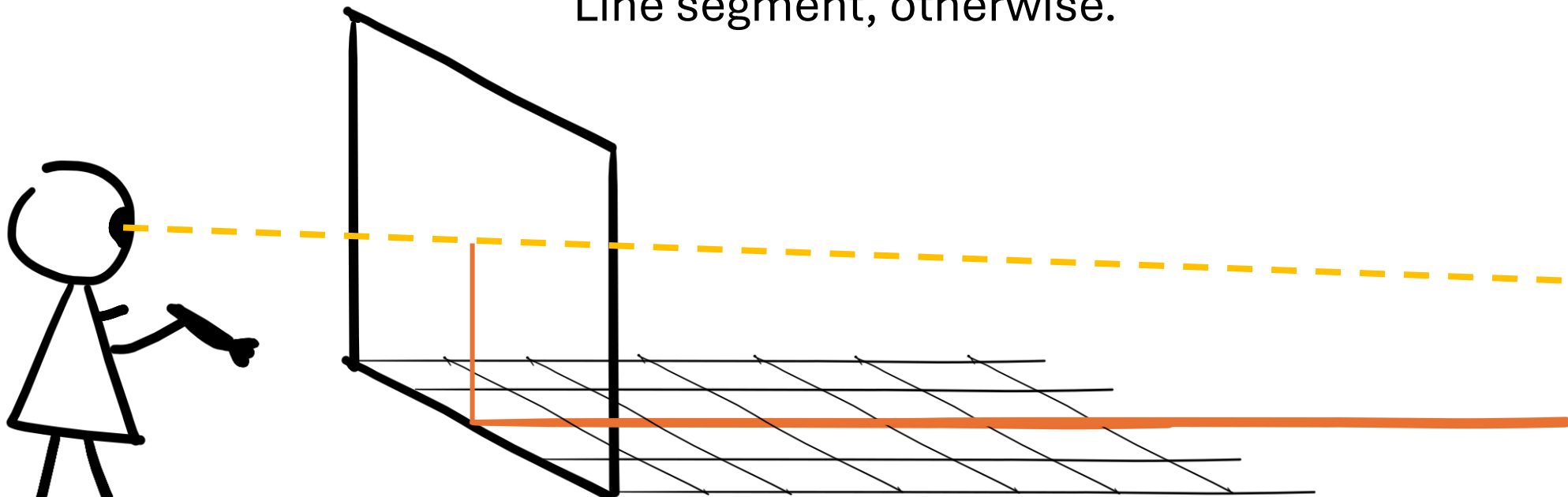
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



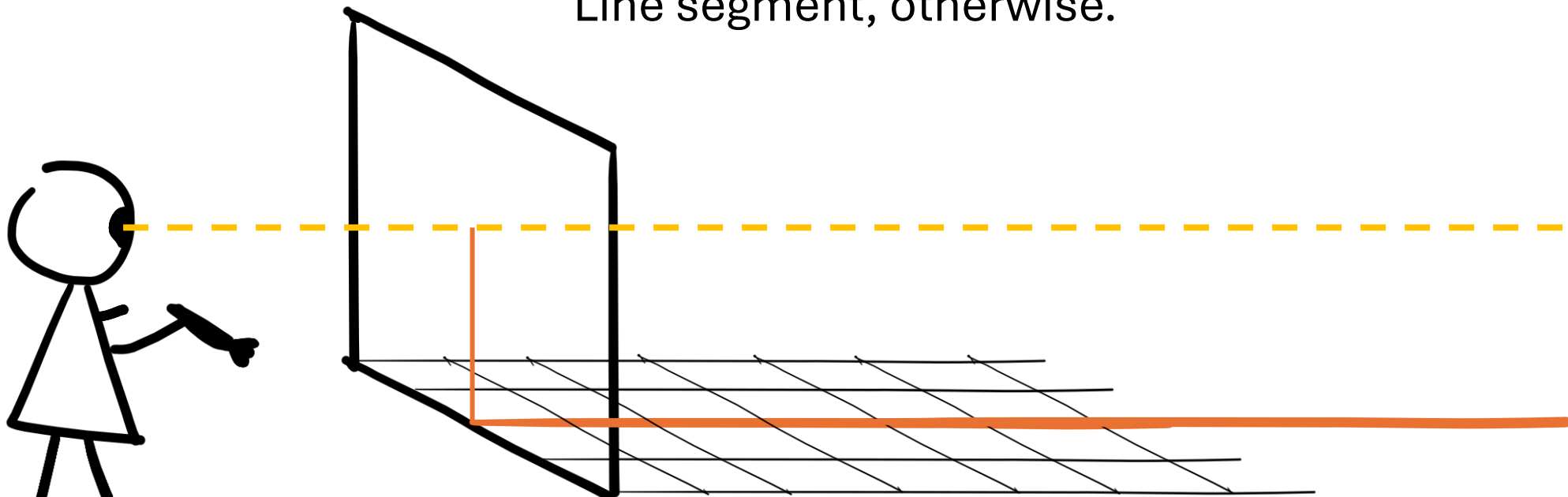
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



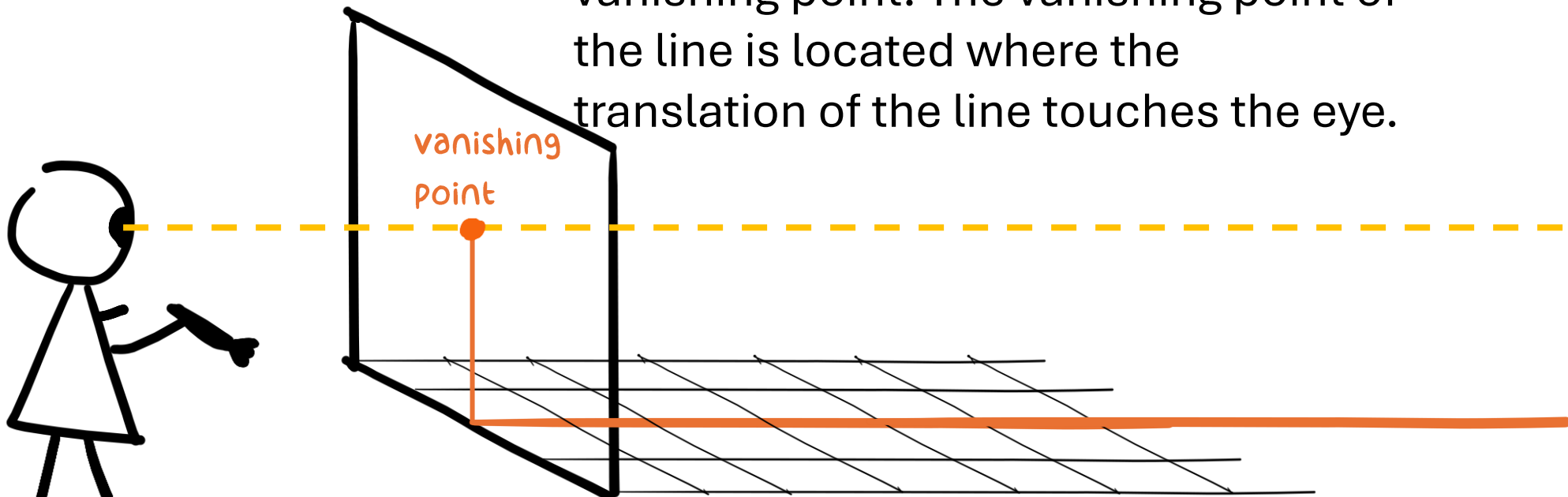
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Point, if on the line of sight. Line segment, otherwise.



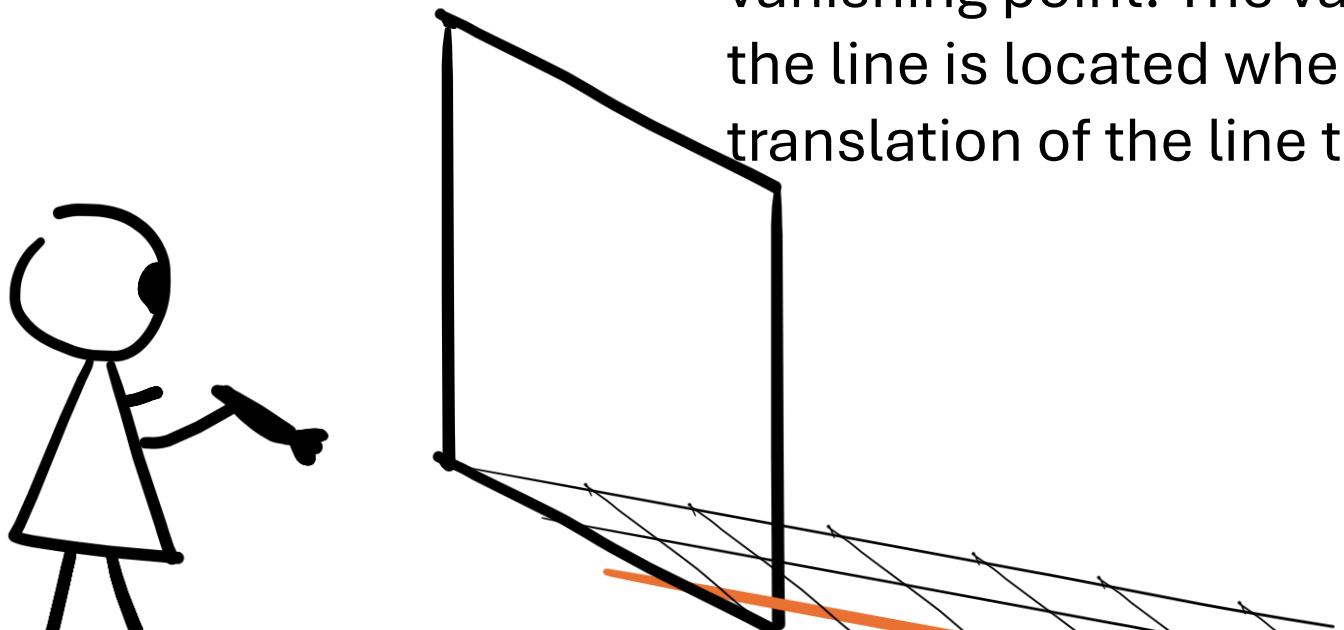
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point. The vanishing point of the line is located where the translation of the line touches the eye.



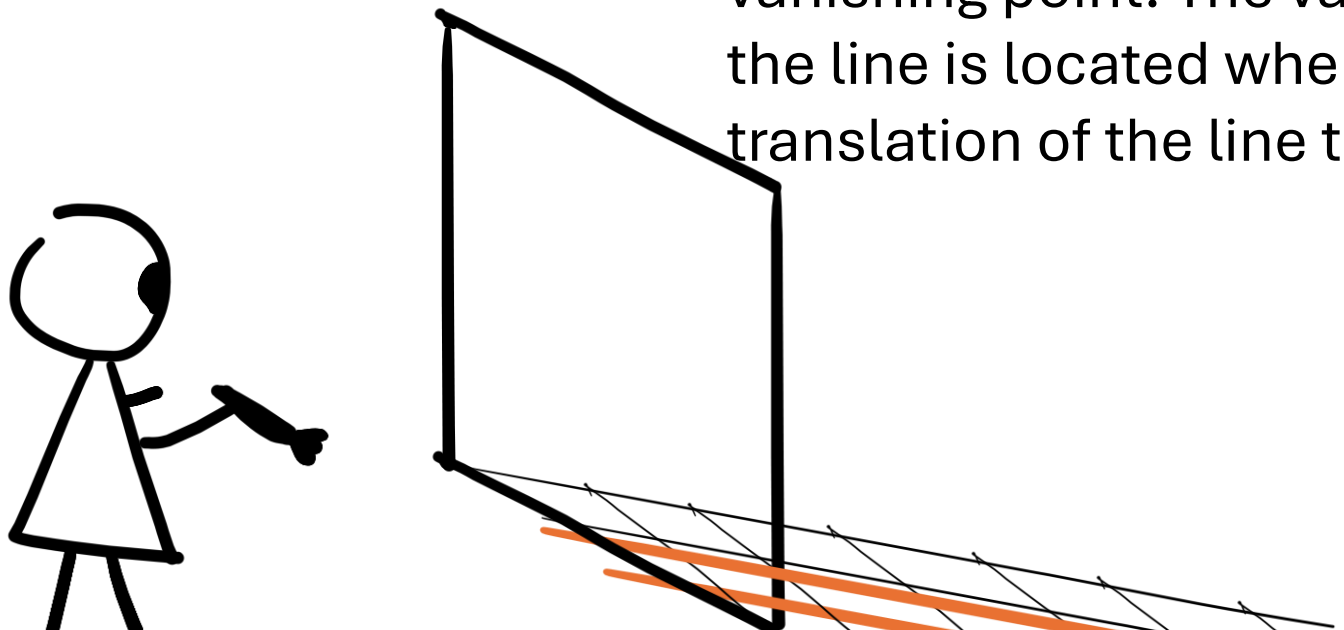
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point. The vanishing point of the line is located where the translation of the line touches the eye.



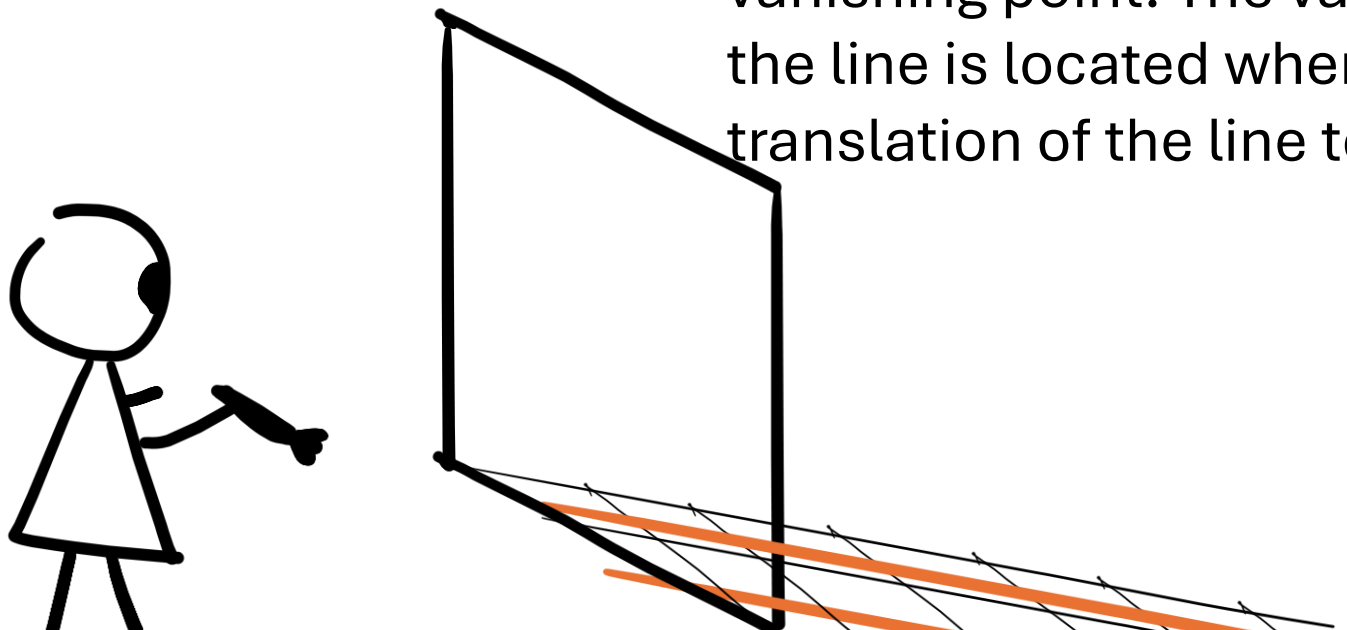
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point. The vanishing point of the line is located where the translation of the line touches the eye.



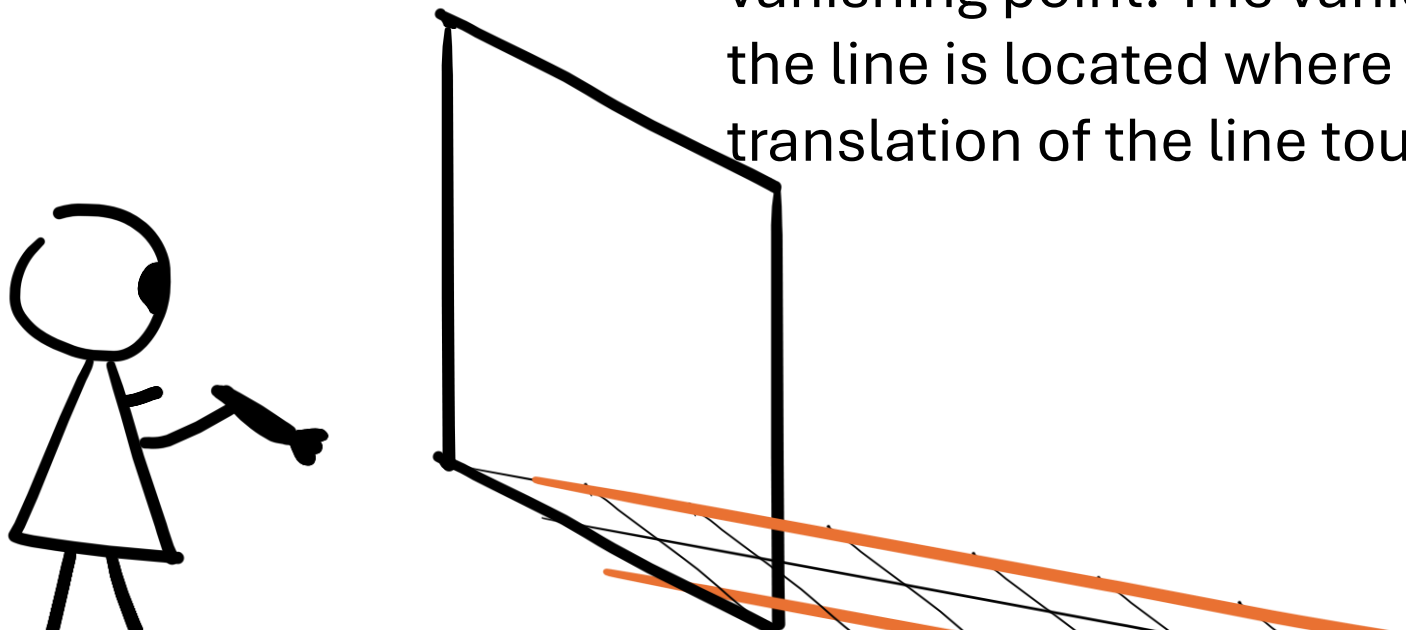
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point. The vanishing point of the line is located where the translation of the line touches the eye.



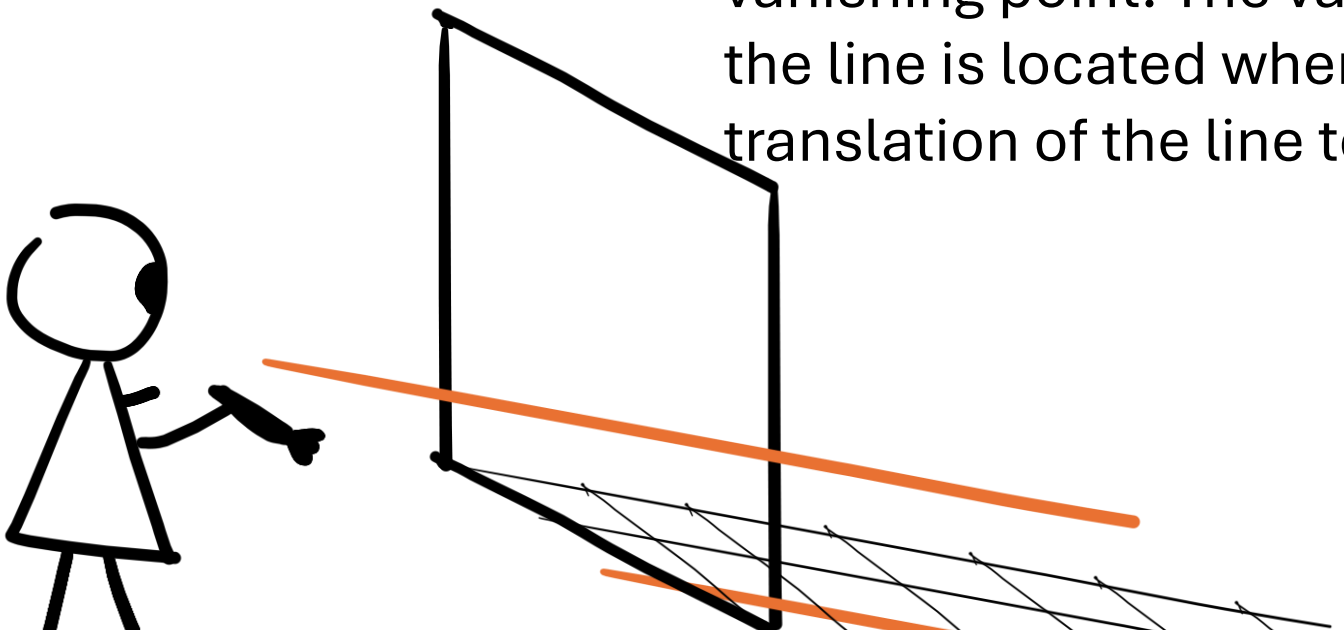
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point. The vanishing point of the line is located where the translation of the line touches the eye.



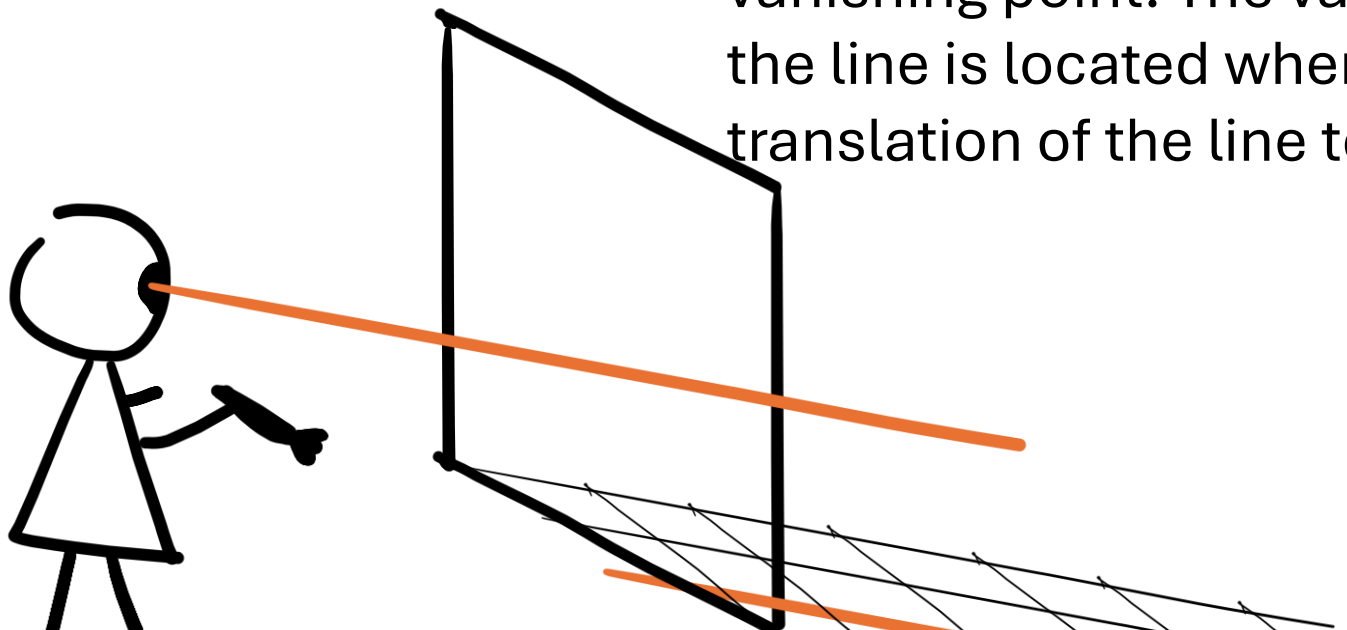
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point. The vanishing point of the line is located where the translation of the line touches the eye.



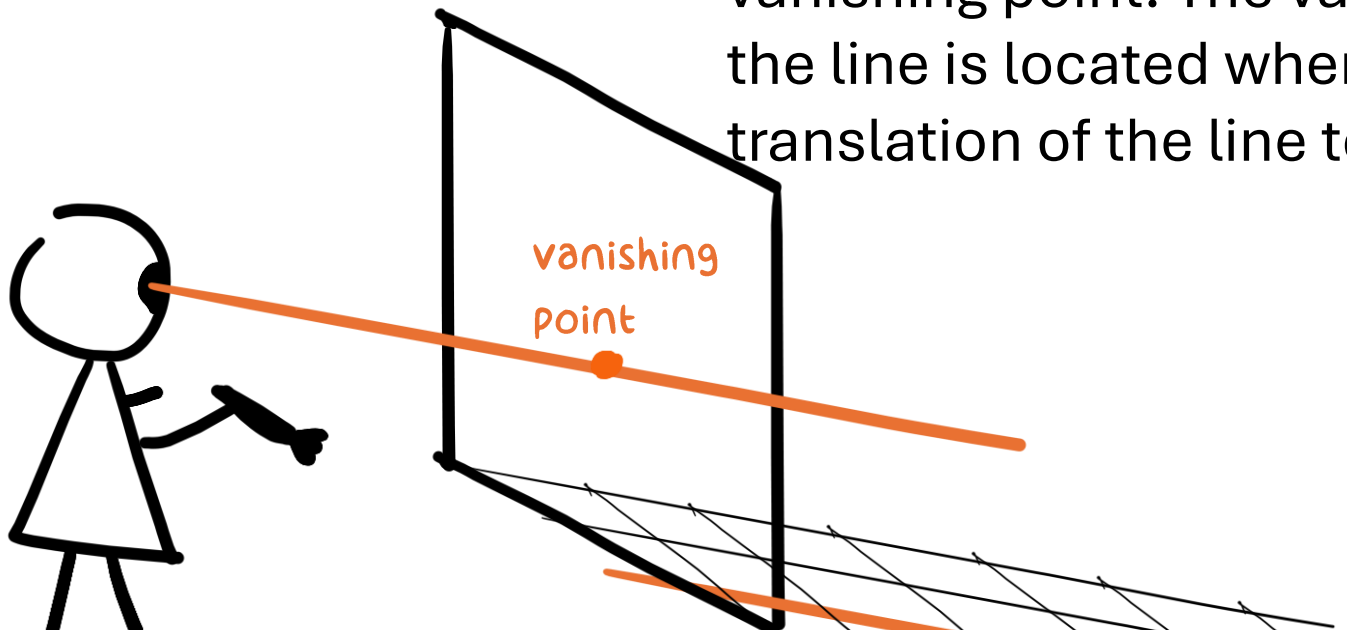
Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point. The vanishing point of the line is located where the translation of the line touches the eye.



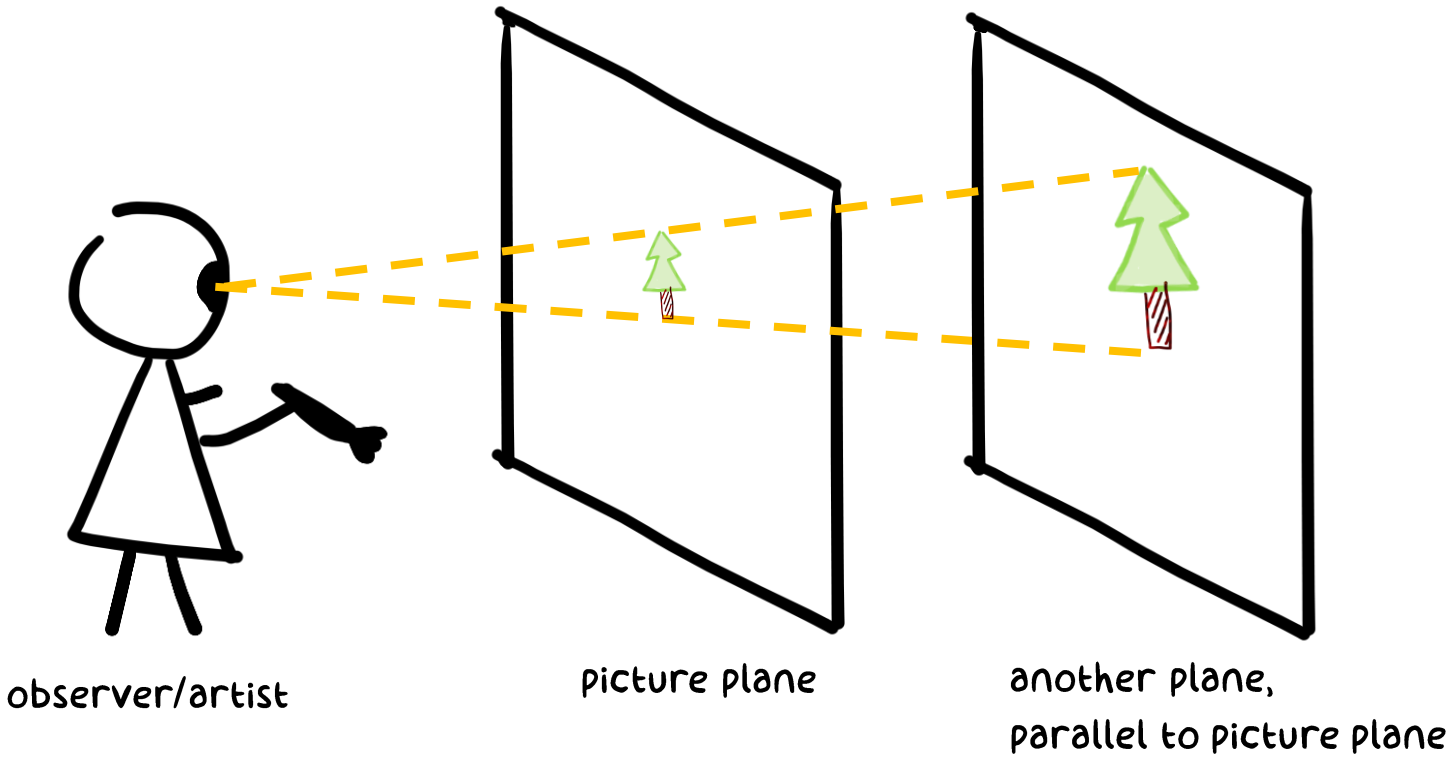
Dictionary

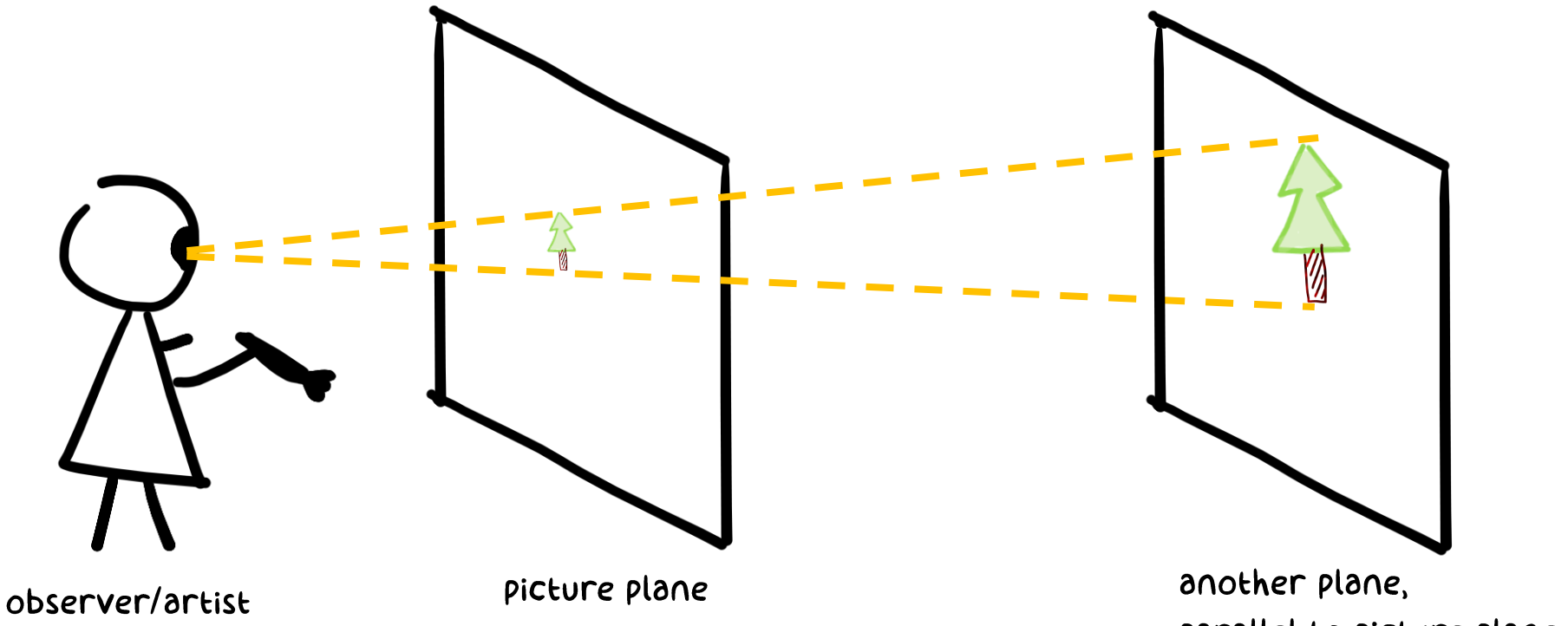
Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point. The vanishing point of the line is located where the translation of the line touches the eye.



Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point.
Plane parallel to picture plane	Plane, image looks smaller the further away it is from the observer


observer/artist
picture plane
another plane,
parallel to picture plane


observer/artist
picture plane
another plane,
parallel to picture plane

Dictionary

Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point.
Plane parallel to picture plane	Plane

Dictionary

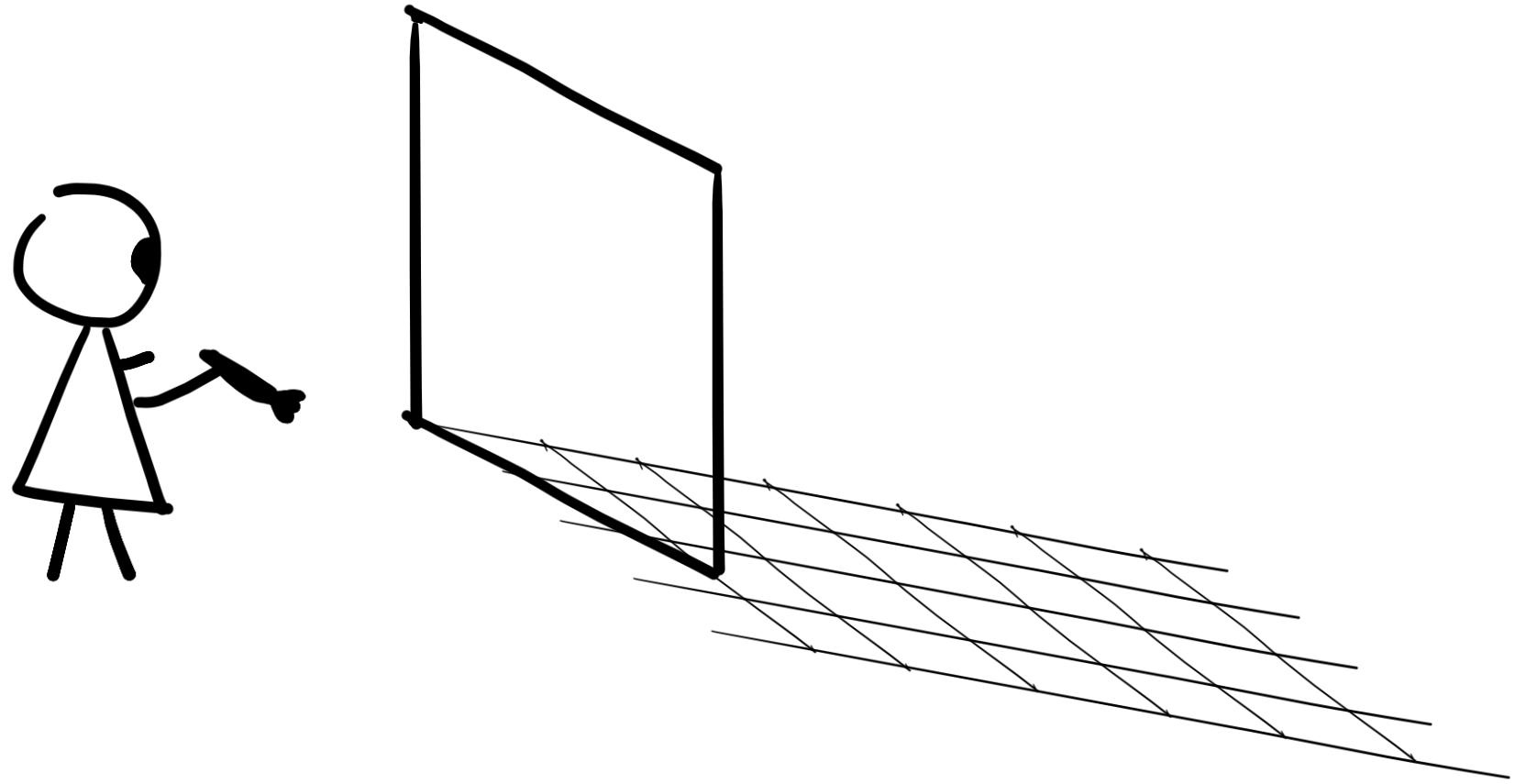
Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point.
Plane parallel to picture plane	Plane
Plane not parallel to picture plane	Plane cut off by a horizon line

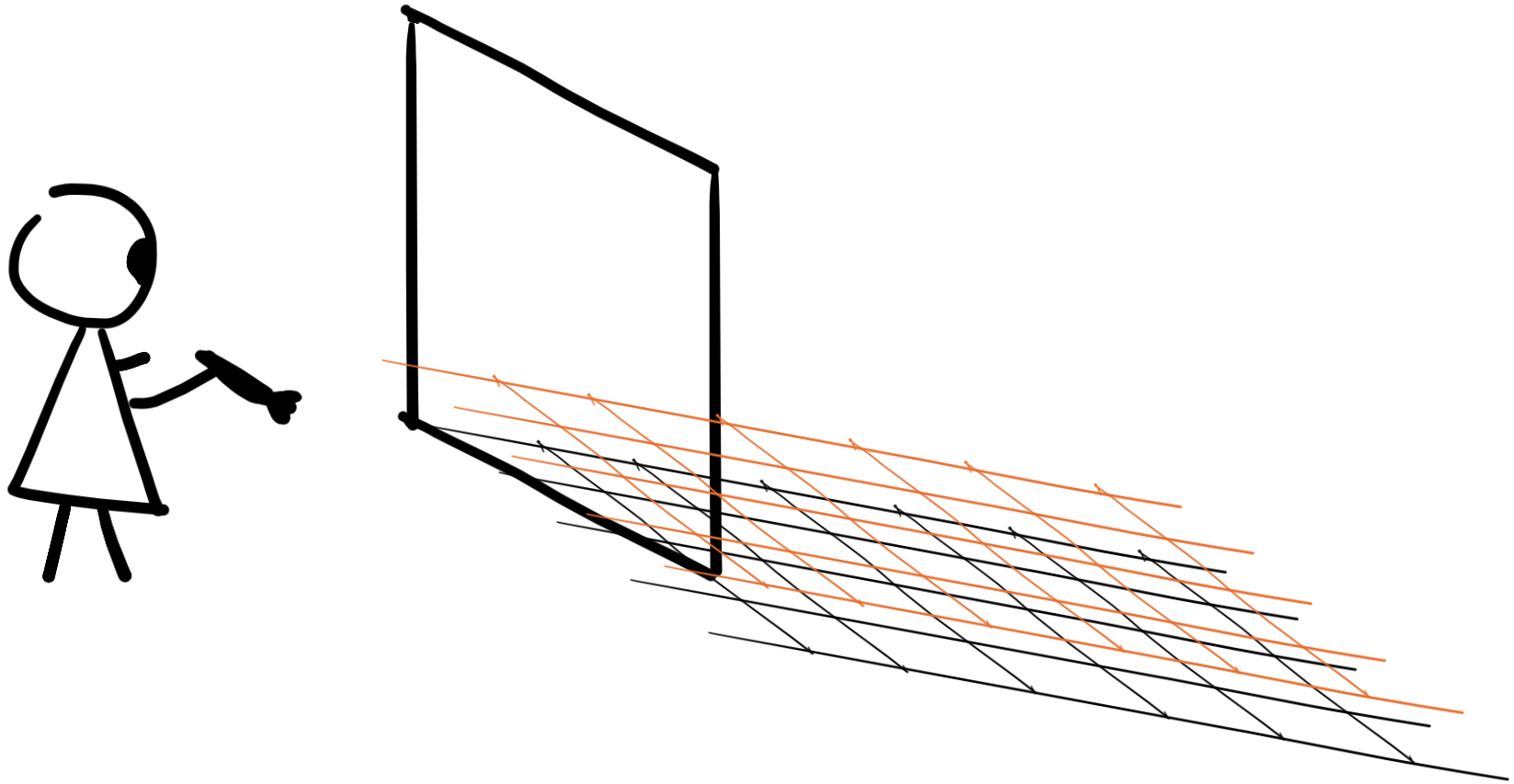
Ground plane with its horizon.

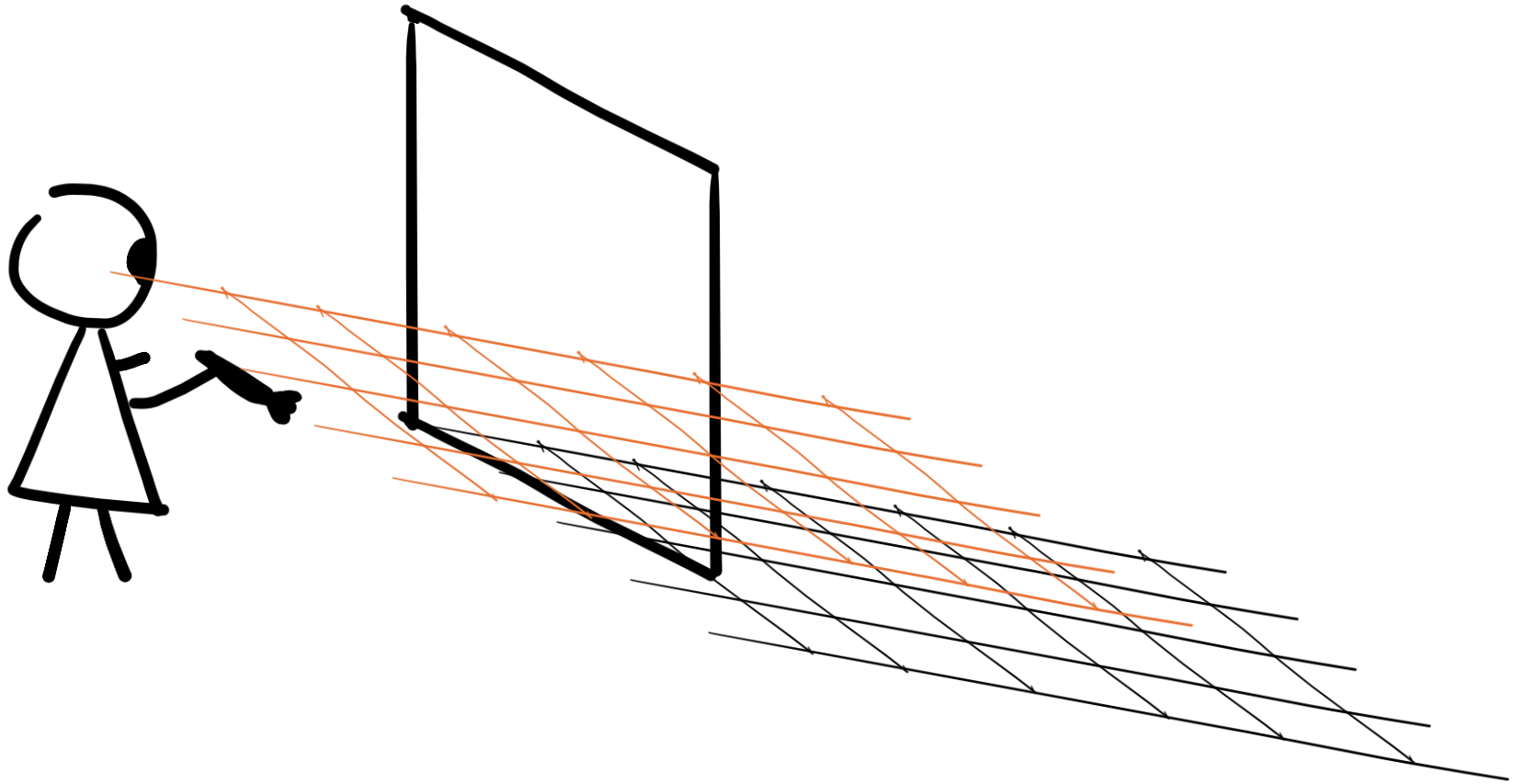
Ground plane with its horizon.

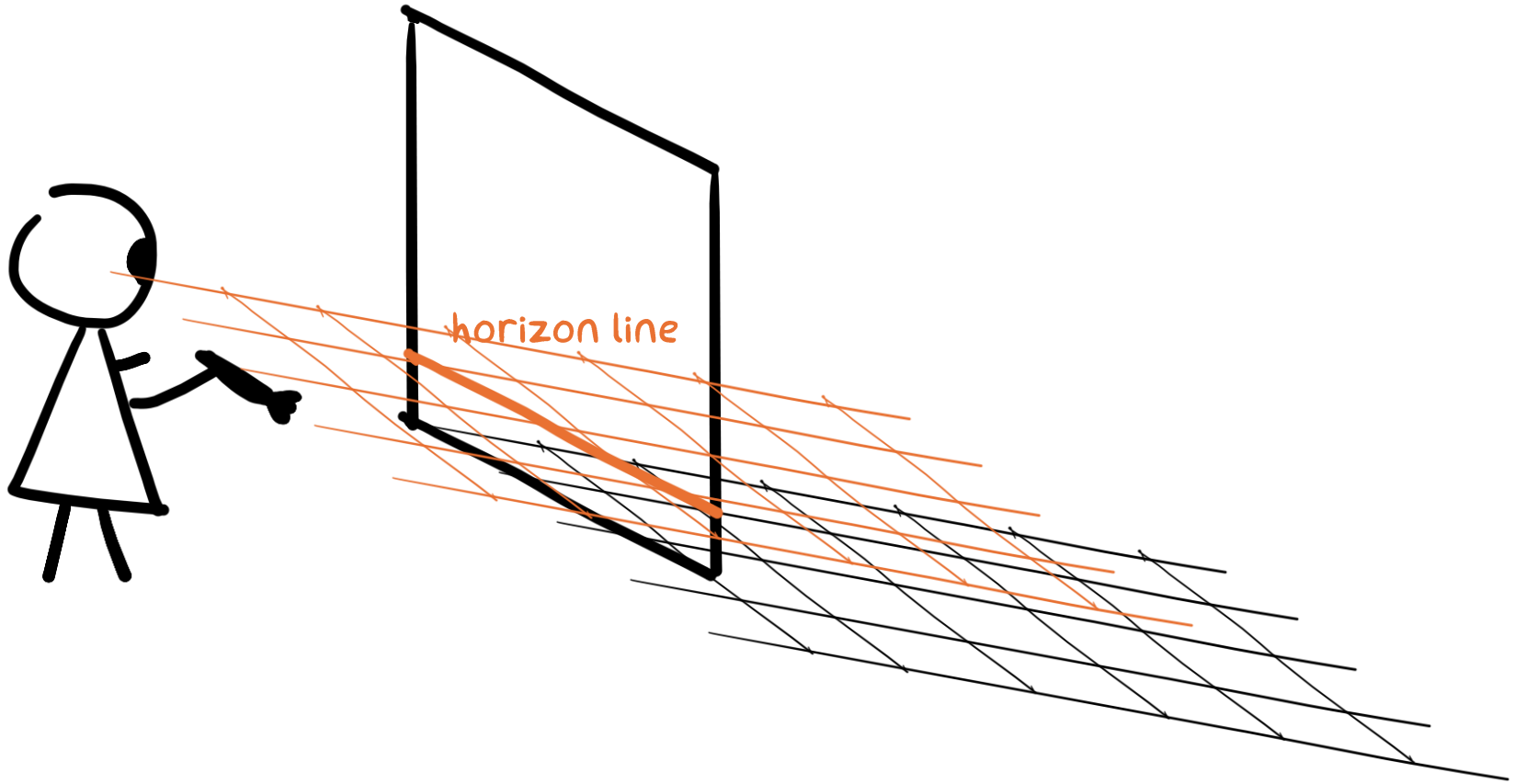
Dictionary

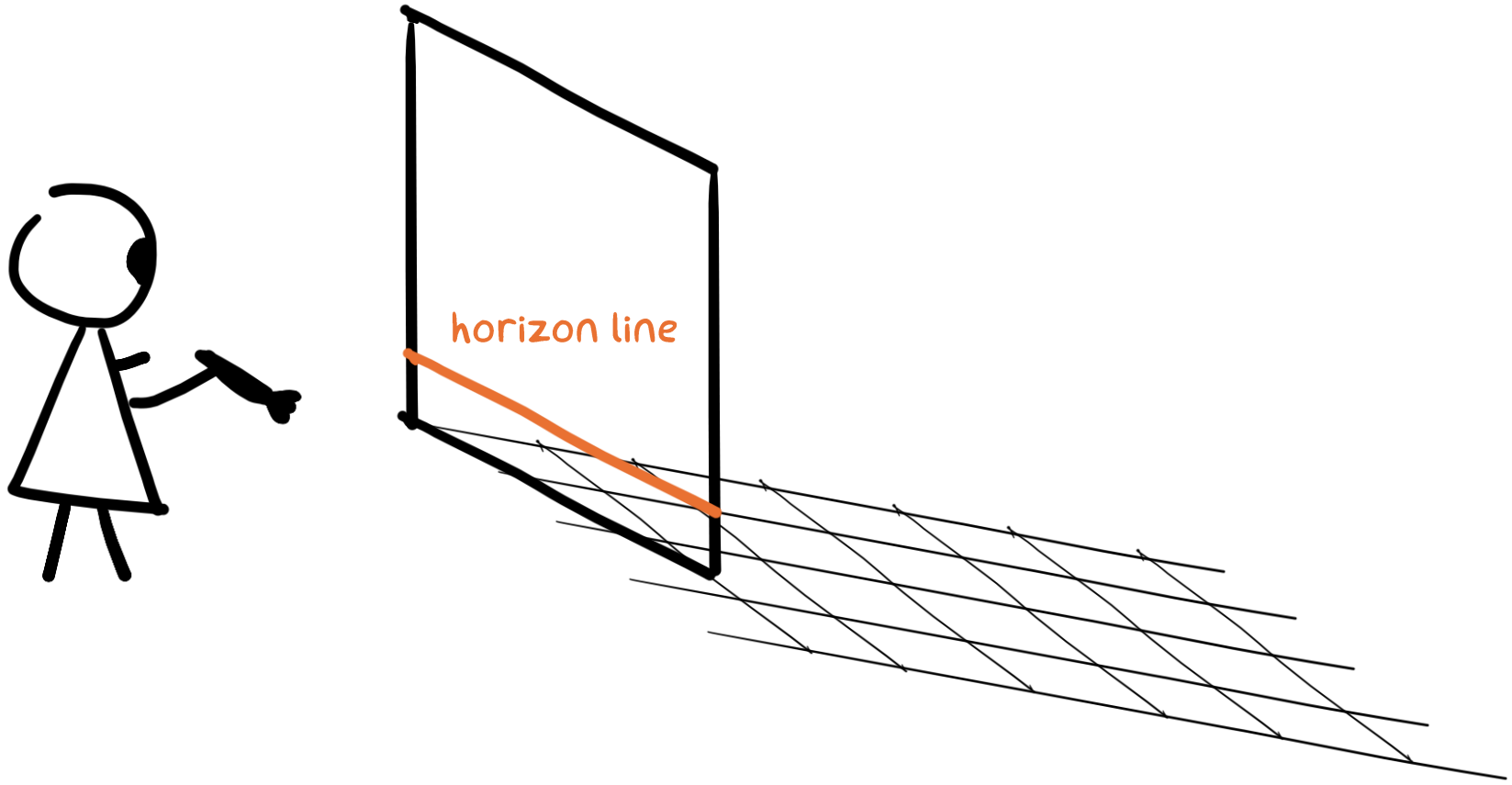
Real world	Picture plane
Point	Point
Line parallel to picture plane	Line
Line not parallel to picture plane	Line segment or point, together with a vanishing point.
Plane parallel to picture plane	Plane
Plane not parallel to picture plane	Plane cut off by a horizon line. Horizon line is located where a translation of the plane touches the eye.





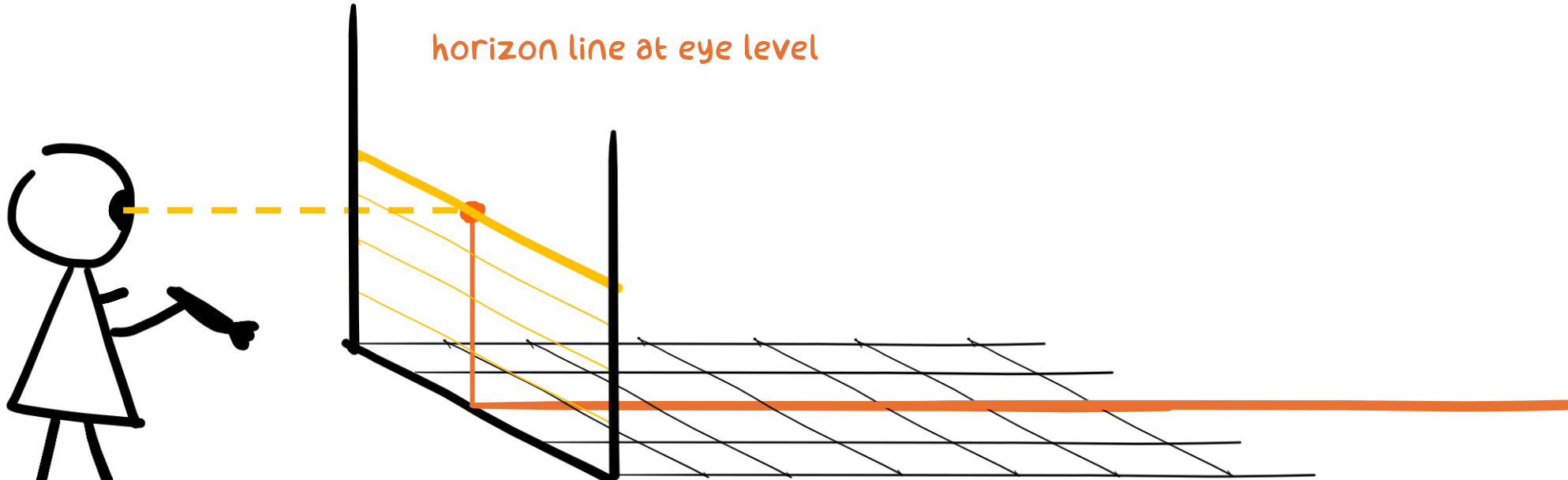



horizon line


horizon line

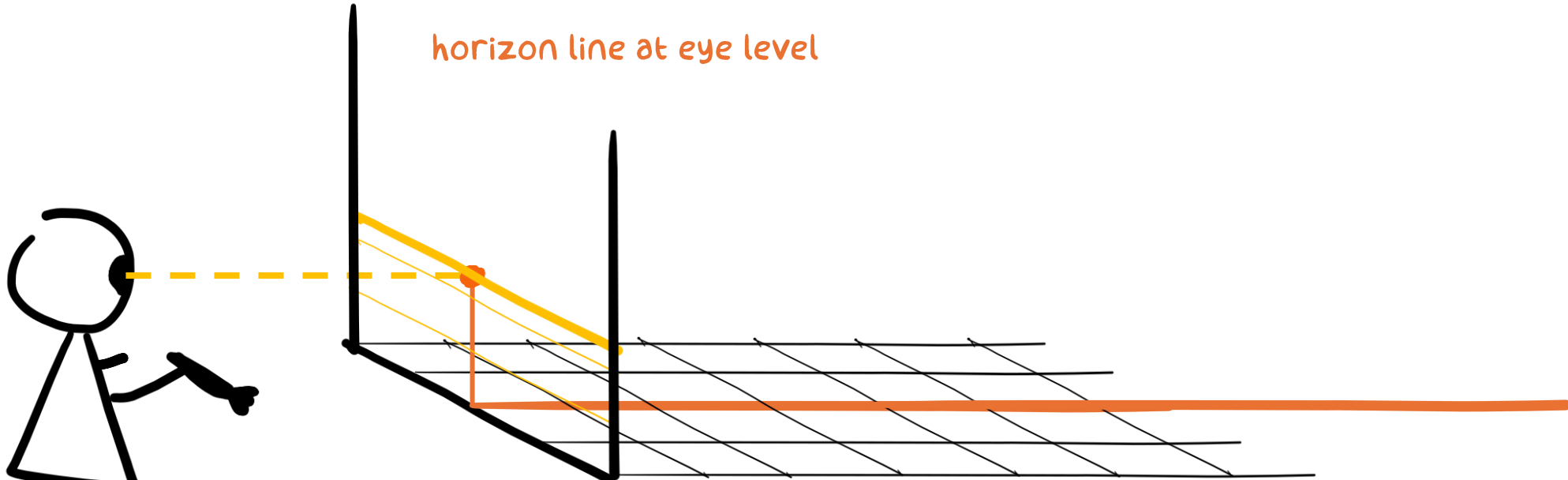
Useful consequences

- For a person standing upright and perpendicular to the ground plane, the horizon of the ground plane is at eye level.



Useful consequences

- For a person standing upright and perpendicular to the ground plane, the horizon of the ground plane is at eye level.



Useful consequences

- For a person standing upright and perpendicular to the ground plane, the horizon of the ground plane is at eye level.
- The viewing point of an uncropped photo is in the middle of the photo.

Useful consequences

- For a person standing upright and perpendicular to the ground plane, the horizon of the ground plane is at eye level.
- The viewing point of an uncropped photo is in the middle of the photo.
  (Reason: Camera sensor is in the middle behind the camera lens.)

Vanishing Point Theorem

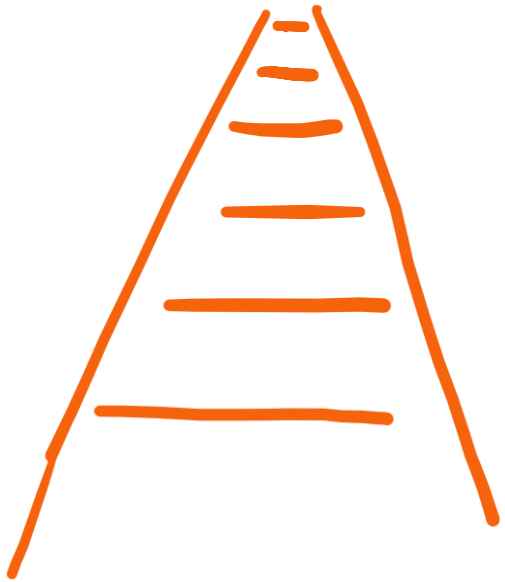
- Suppose two lines in the real world are not parallel to the picture plane. Then the lines are parallel precisely when their images in the picture share the same vanishing point.

Vanishing Point Theorem

- Suppose two lines in the real world are not parallel to the picture plane. Then the lines are parallel precisely when their images in the picture share the same vanishing point.
- Why? Imagine these lines are railroad tracks.

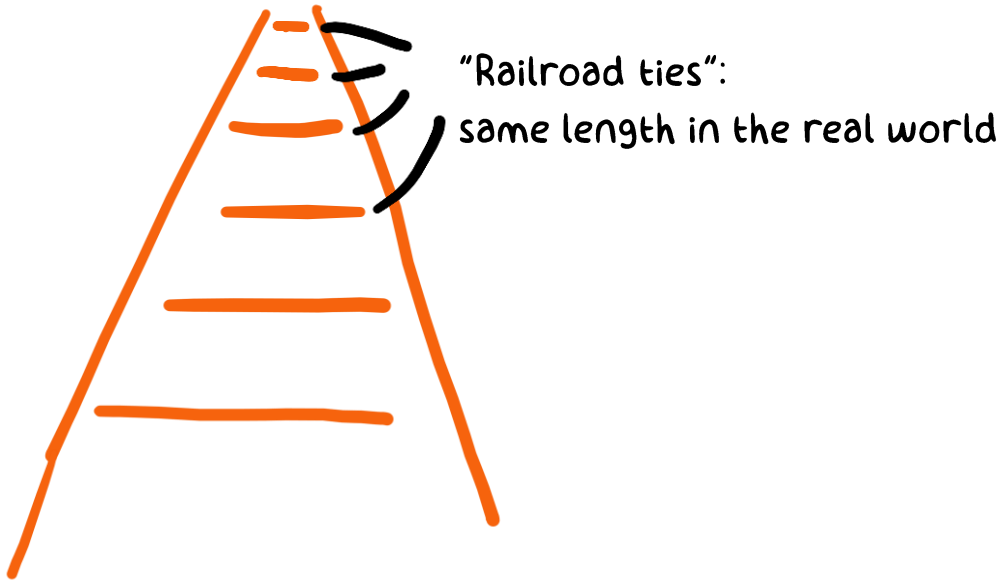
Vanishing Point Theorem

- Suppose two lines in the real world are not parallel to the picture plane. Then the lines are parallel precisely when their images in the picture share the same vanishing point.
- Why? Imagine these lines are railroad tracks.



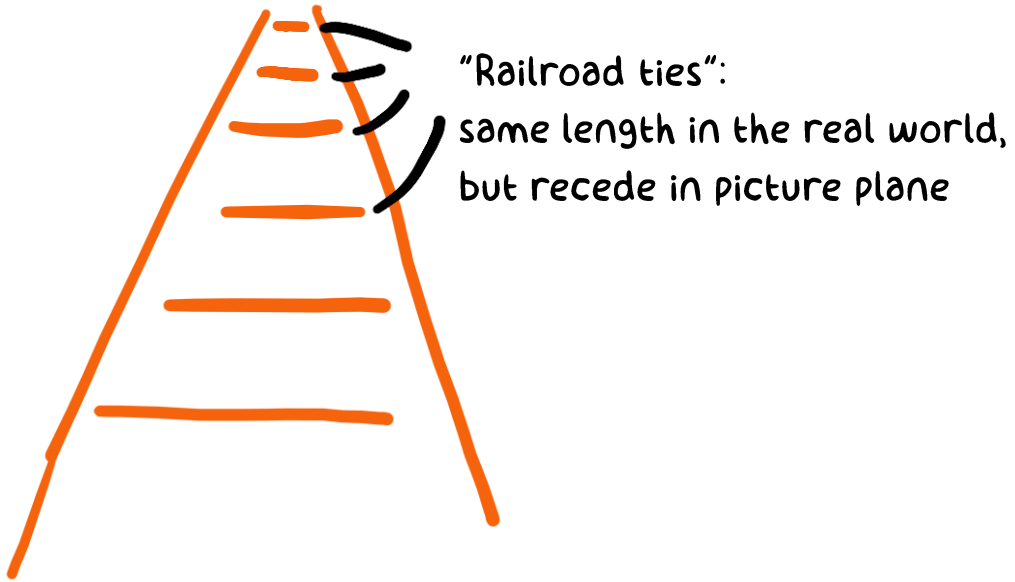
Vanishing Point Theorem

- Suppose two lines in the real world are not parallel to the picture plane. Then the lines are parallel precisely when their images in the picture share the same vanishing point.
- Why? Imagine these lines are railroad tracks.



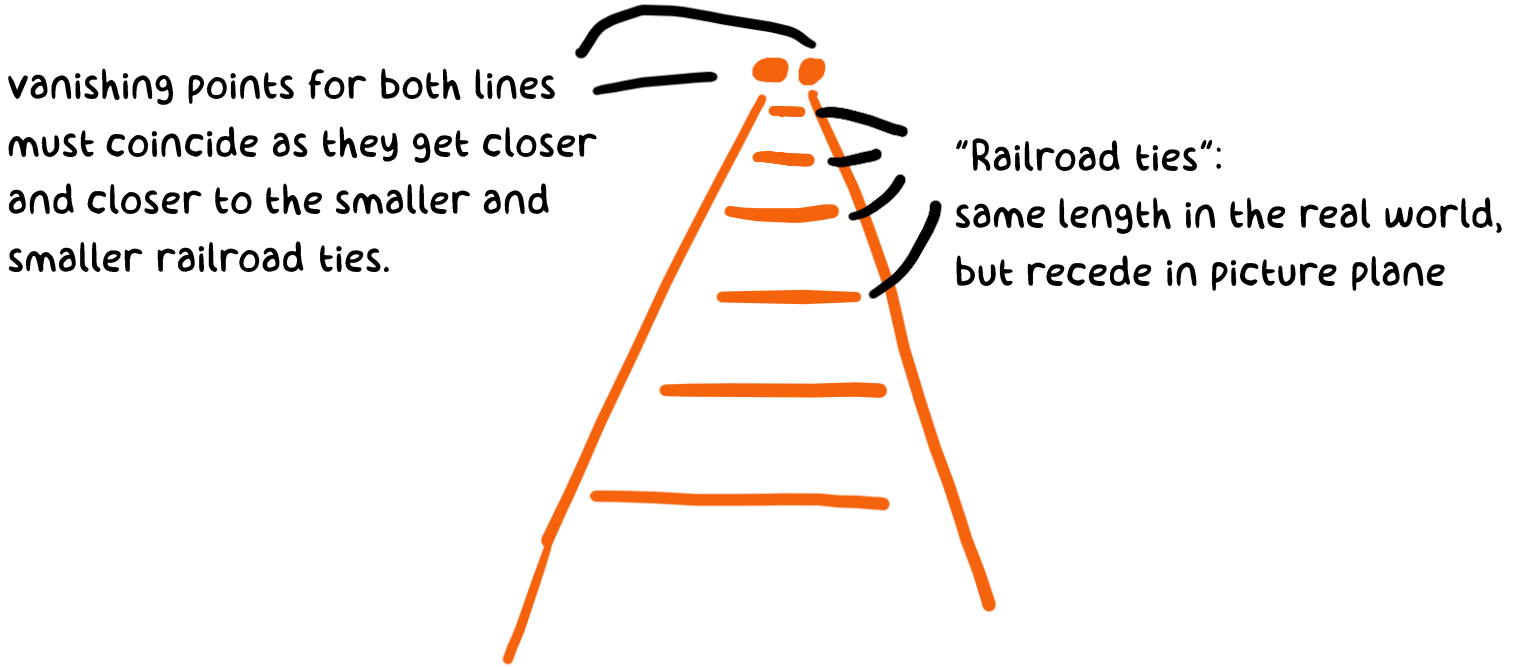
Vanishing Point Theorem

- Suppose two lines in the real world are not parallel to the picture plane. Then the lines are parallel precisely when their images in the picture share the same vanishing point.
- Why? Imagine these lines are railroad tracks.



Vanishing Point Theorem

- Suppose two lines in the real world are not parallel to the picture plane. Then the lines are parallel precisely when their images in the picture share the same vanishing point.
- Why? Imagine these lines are railroad tracks.



Parallel rails share the same vanishing points.

Parallel rails share the same vanishing points.

Parallel rails share the same vanishing points.

Parallel rails share the same vanishing points.

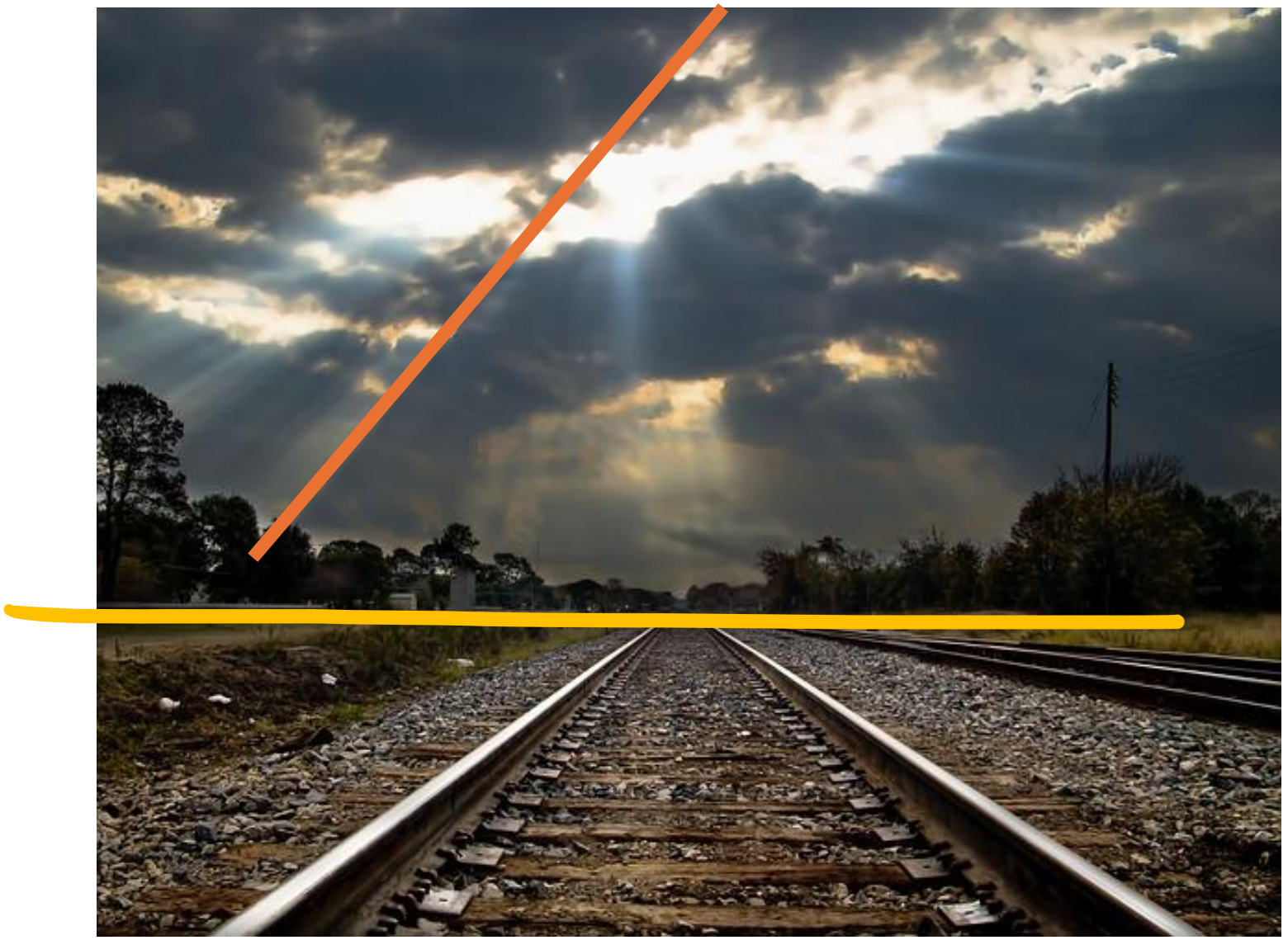
Parallel rails share the same vanishing points.

Parallel rails share the same vanishing points.
They lie on the ground plane so their vanishing points are on the ground plane's horizon.

Parallel rails share the same vanishing points.
They lie on the ground plane so their vanishing points are on the ground plane’s horizon.

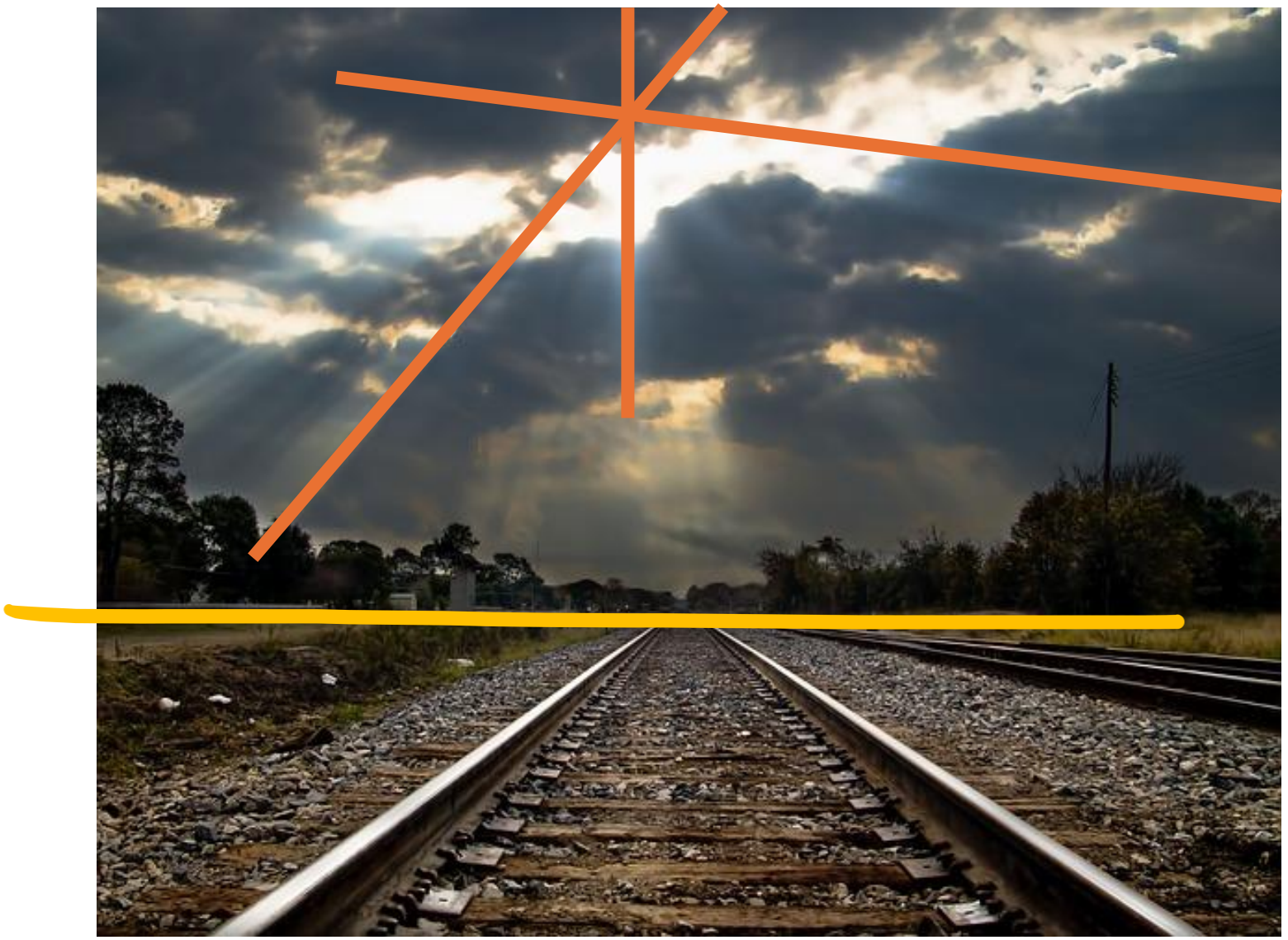
Do you see other vanishing points?

Because the sun is so far away, light rays are approximately parallel, with vanishing point at the sun.



Because the sun is so far away, light rays are approximately parallel, with vanishing point at the sun.

Because the sun is so far away, light rays are approximately parallel, with vanishing point at the sun.



Because the sun is so far away, light rays are approximately parallel, with vanishing point at the sun.

We found where the sun is even though it is obscured by clouds.

Edges of buildings are usually parallel, giving a vanishing point in the sky.

Edges of buildings are usually parallel, giving a vanishing point in the sky.

Problem 1

Look out the class window and see the four terraced seats.

Are they parallel?

Locate the horizon of this picture.

Problem 3

Consider the photo outside Business Building Room 223.

(a) Locate the horizon of the ground plane.

(b) Do you think this photo was cropped?

Problem 5 (link)

How many floors is The Neuss's room above LucidOnMC's room. What assumptions did you make to reach this conclusion?

r/mildlyinfuriating • 5 mo. ago
LucidOnMC

The “Ocean View” Hotel Room I booked

The_Nuess • 5mo ago

This was my stay in January. I was honestly happy
to everything, only like a minute or 2 walk to the b

10K Reply 1 Share

Problem 6

Consider the two photos outside Business Building Room 223.

(a) Locate the horizon of the ground plane.

(b) Assume the photo is uncropped. Is the camera situated at a height above the girl?

Full set of homework problems are in a different file.