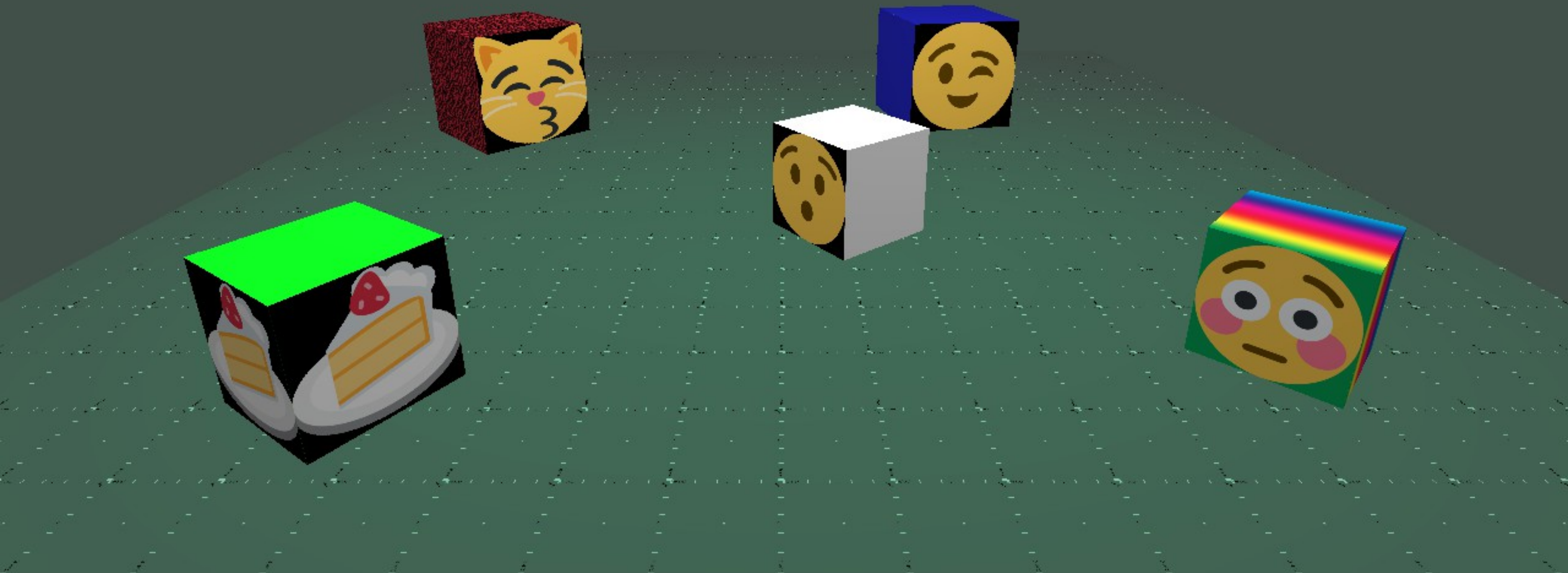
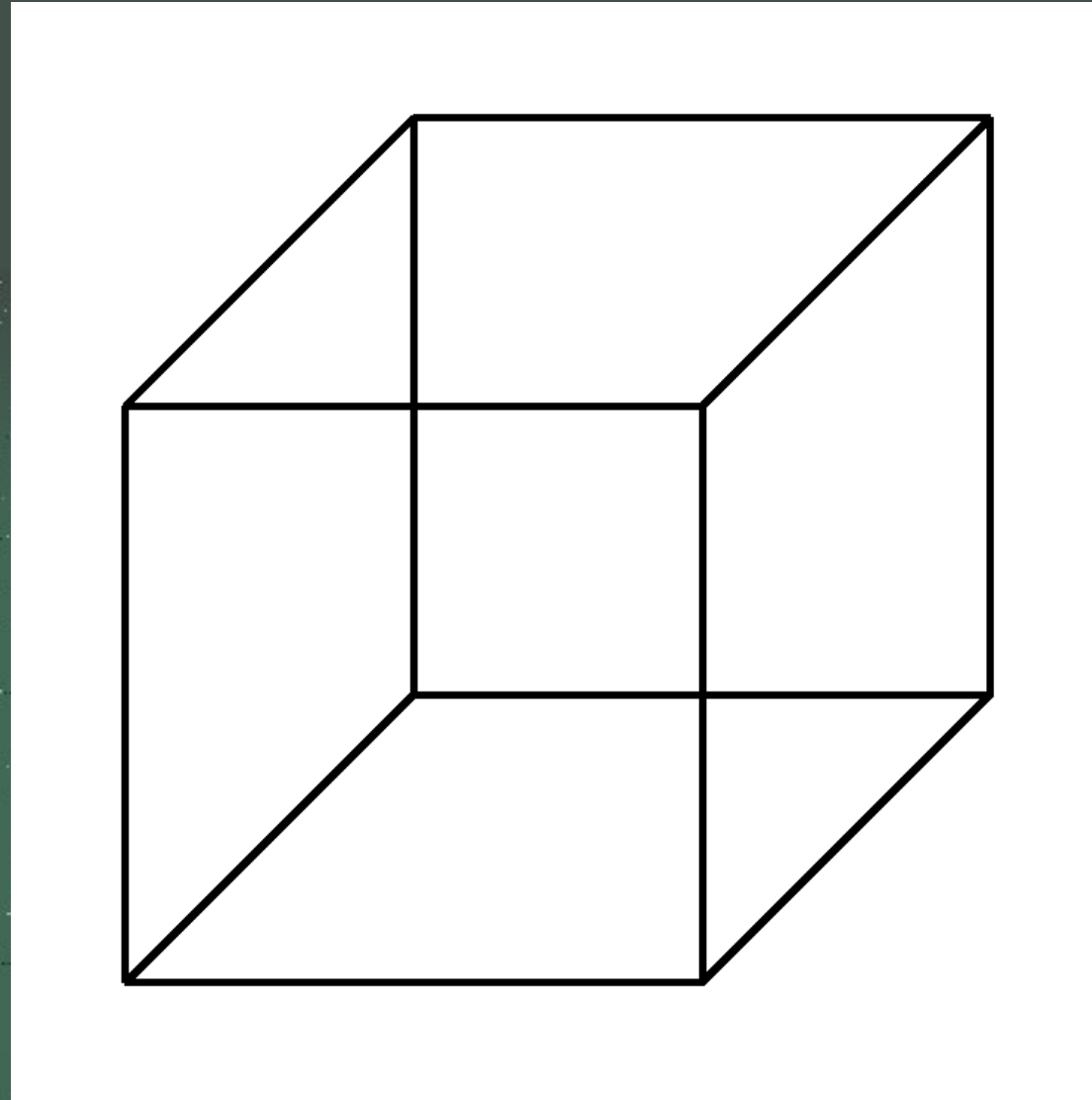


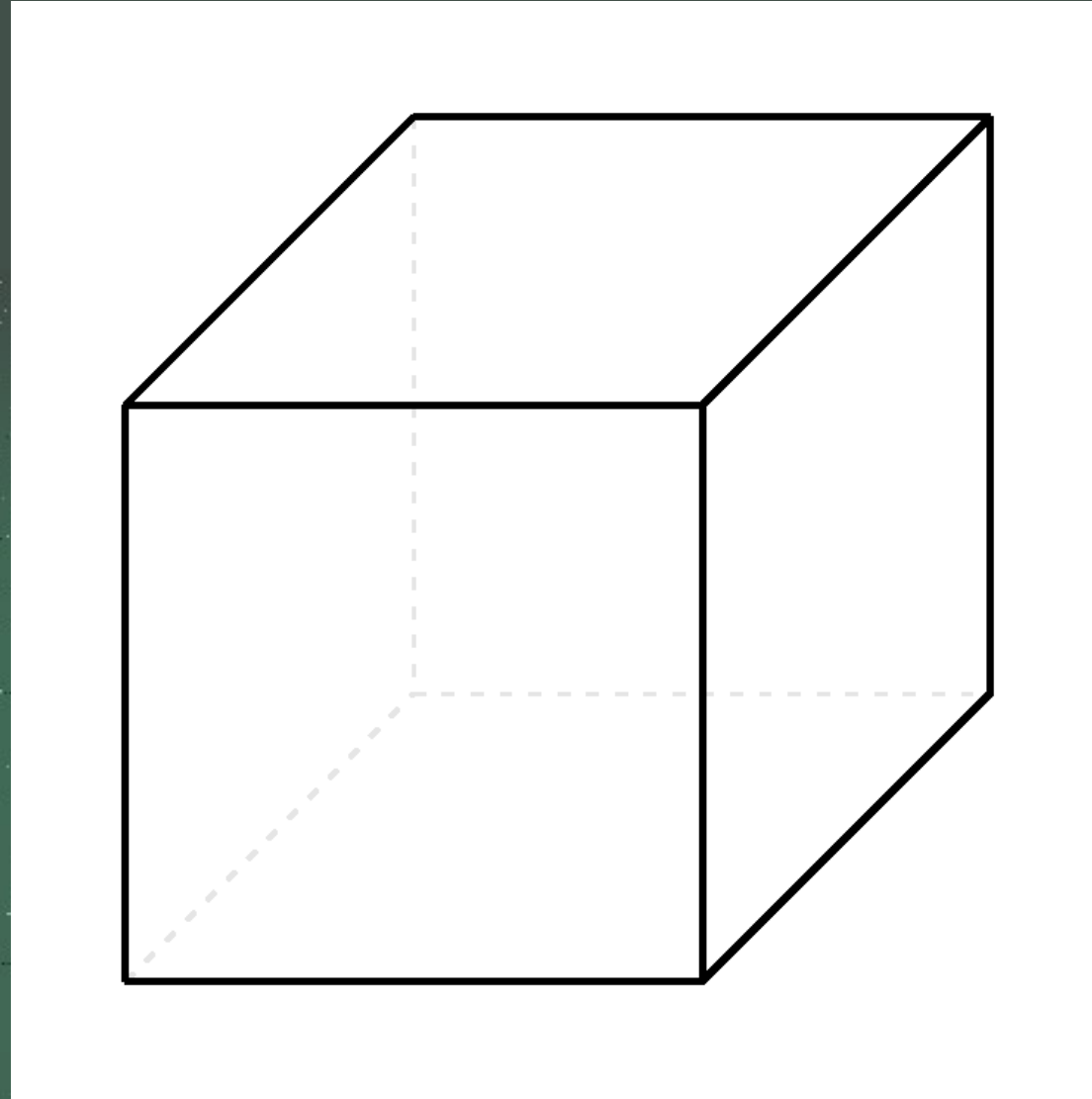
Neckerworld – A Computer Vision Game



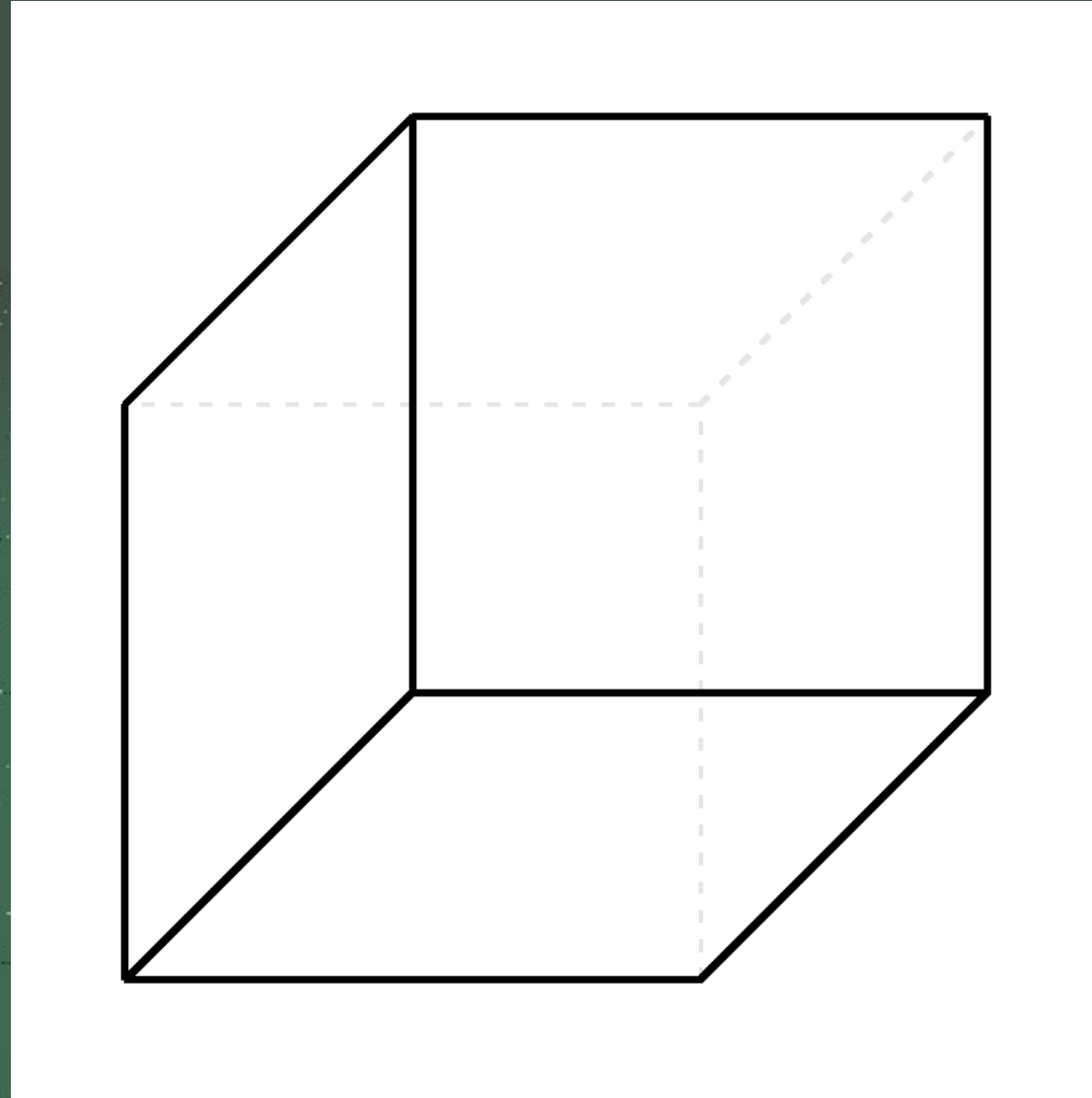
The Necker Cube Illusion



The Necker Cube Illusion

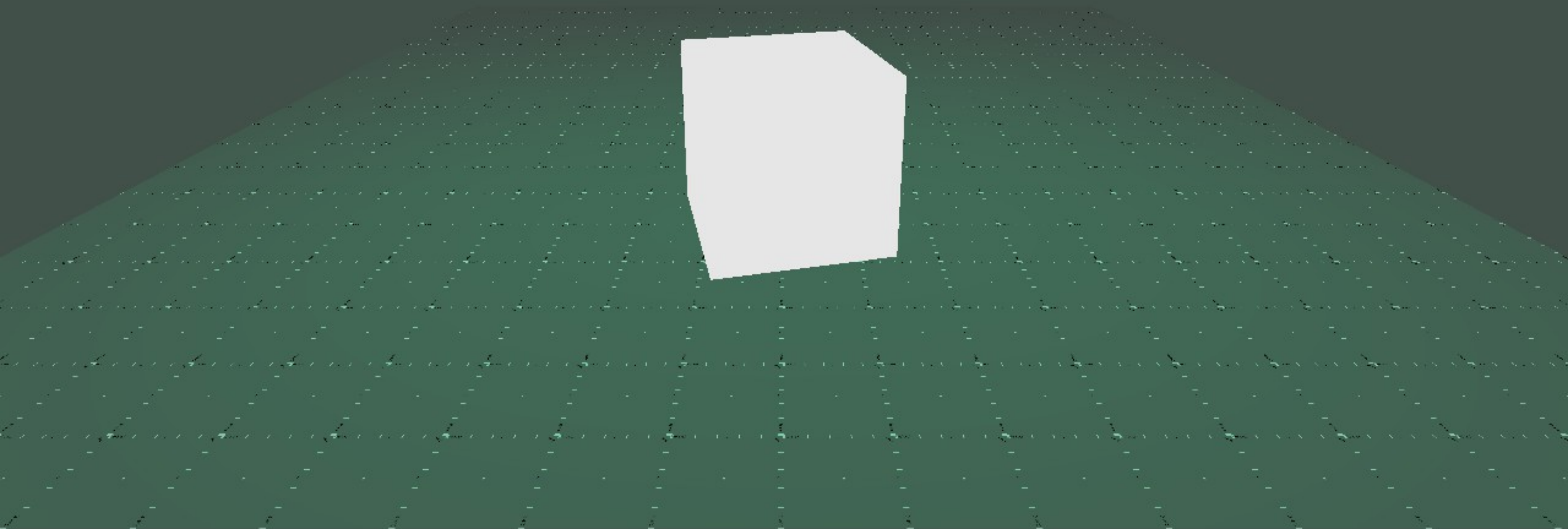


The Necker Cube Illusion



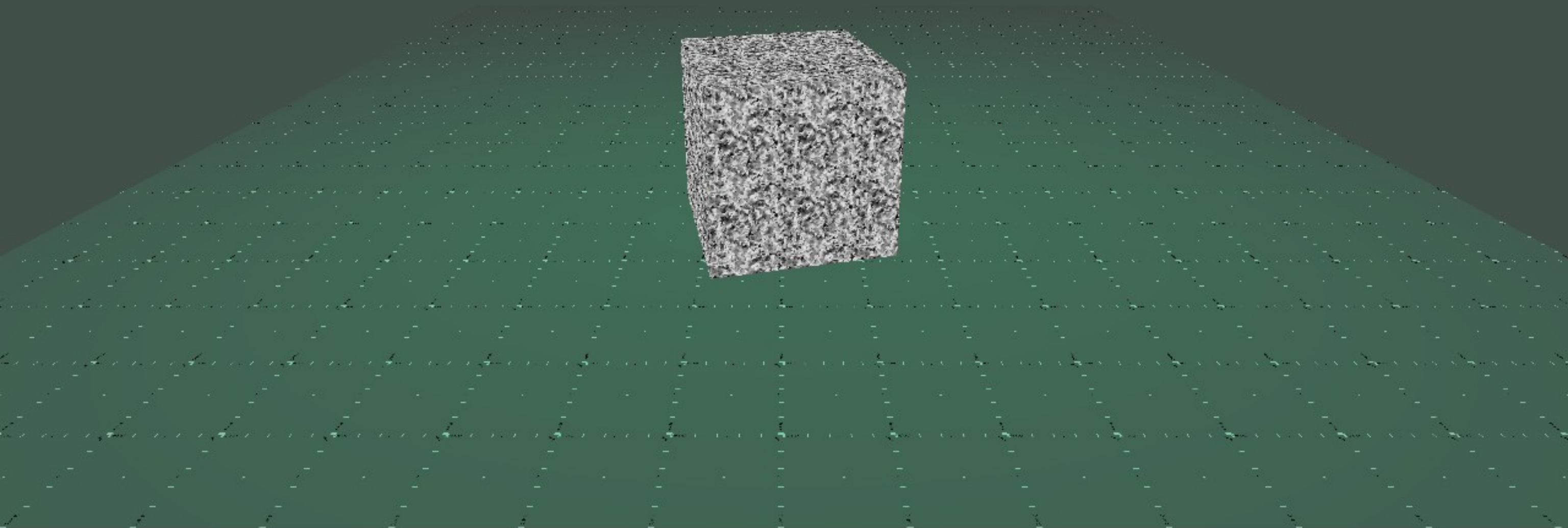
The Cube – A Basis for Studies of Visual Perception

Colored Surface Only



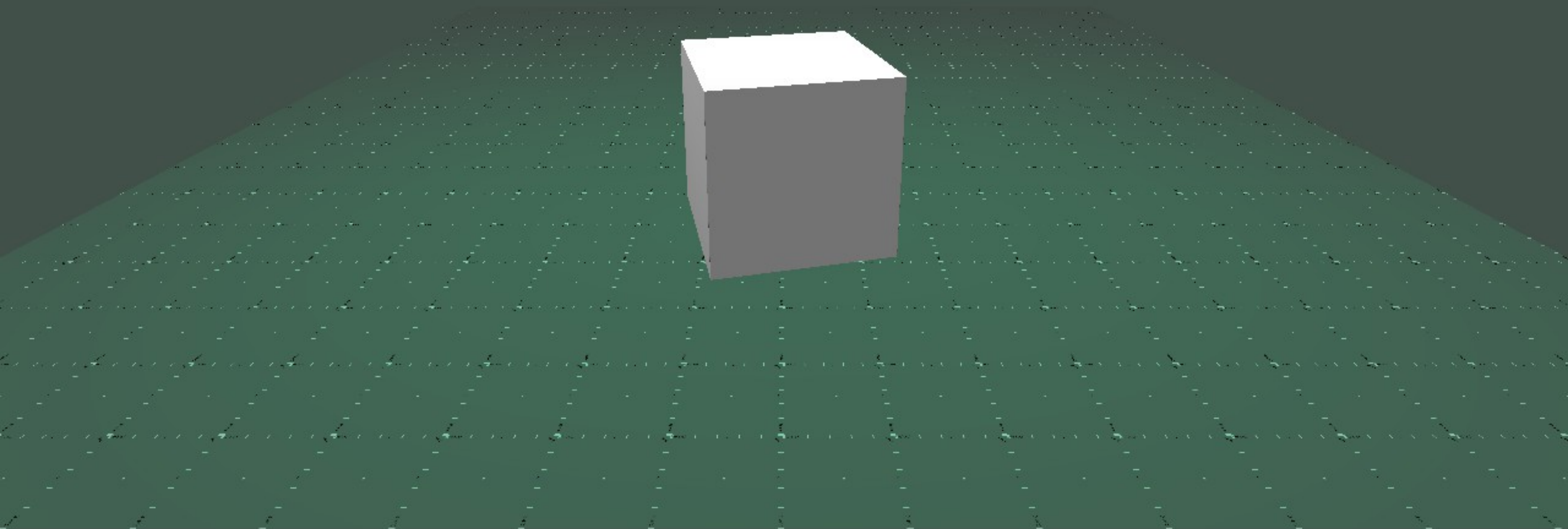
The Cube – A Basis for Studies of Visual Perception

Textured Surfaces



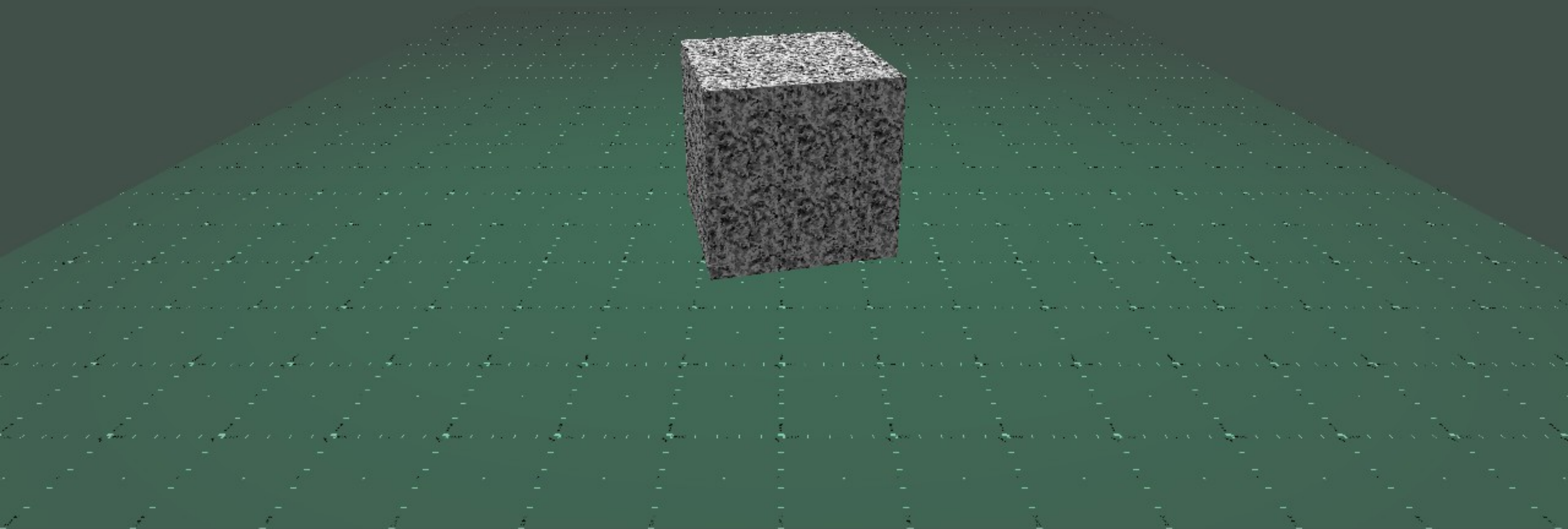
The Cube – A Basis for Studies of Visual Perception

Shaded Surfaces



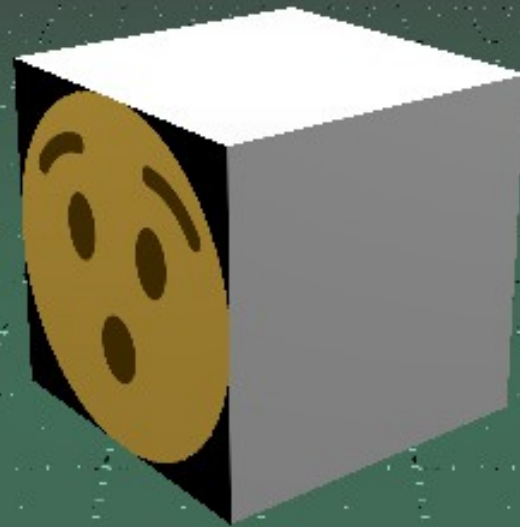
The Cube – A Basis for Studies of Visual Perception

Shaded Textured Surfaces

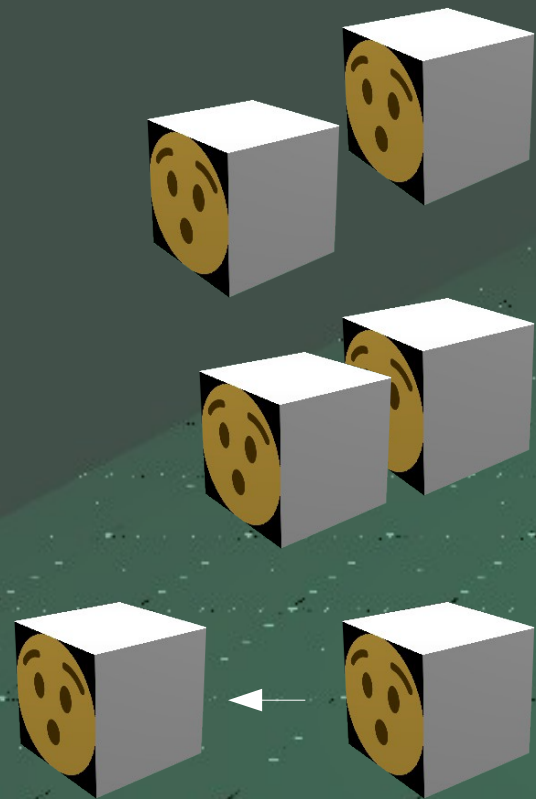


The Cube – A Basis for Studies of Visual Perception

Shaded Surfaces with Features



The Cube – A Basis for Studies of Visual Perception



Studies and experiments in size constancy

Rules about occlusion of image objects

Perceived motion

Neckerworld – A Computer Vision Game

Visual Systems are very different

They are uniquely engineered to serve the needs of the organism

They have evolved over 100's of millions of years

The human visual system serves humans well,
but not zebras, owls, rats, bees, or spiders

Neckerworld – A Computer Vision Game

Three guiding principals of the human visual system:

Find something to eat

Don't get eaten

Find a mate

Neckerworld – Game Design

All players and resources in the game are cubes

The cube players are guided solely through autonomous computer vision programs

No human manual control or input permitted

Requires competent programs to do object detection and playing field knowledge representation

Neckerworld – Game Design

Game points are scored through three activities:

Finding and reaching food resources

Killing off predators

Mating and having child cubes

Neckerworld – Game Technology

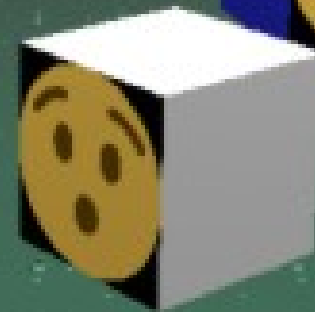
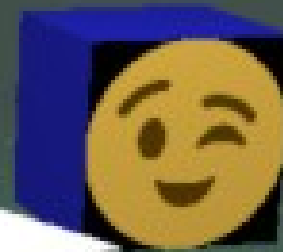


Neckerworld – Game Players

Predators



Males



Females

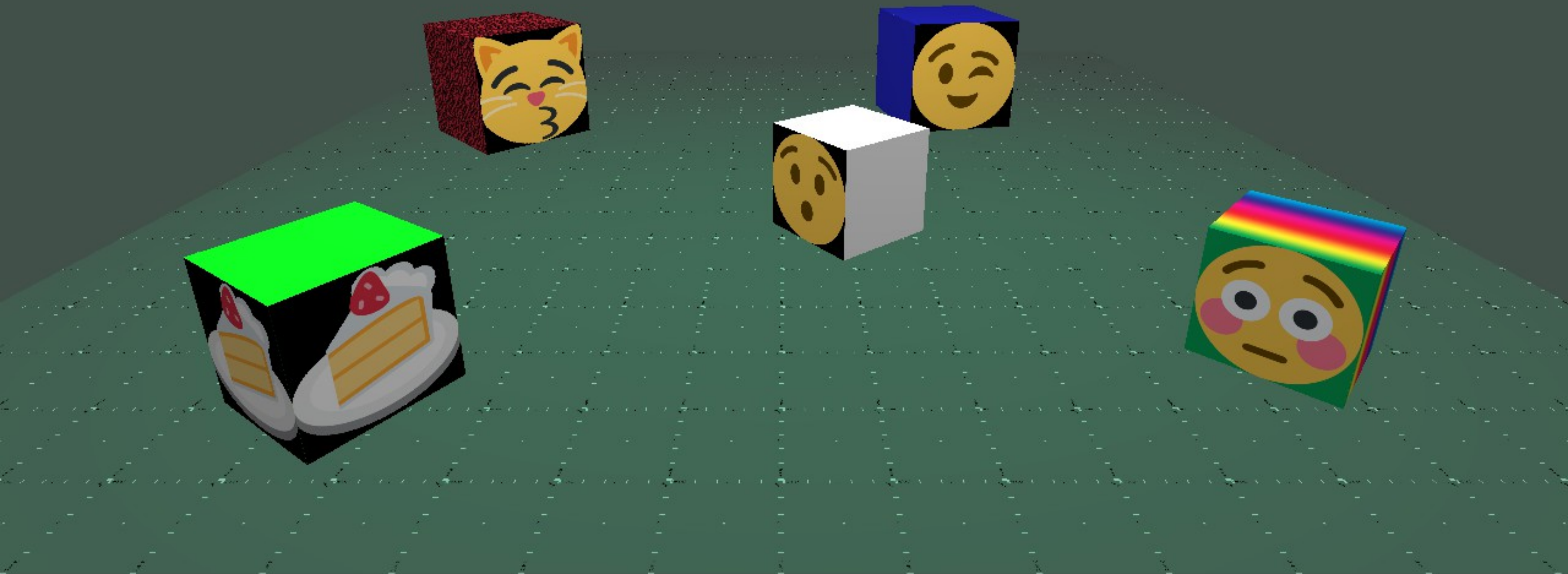


Resources

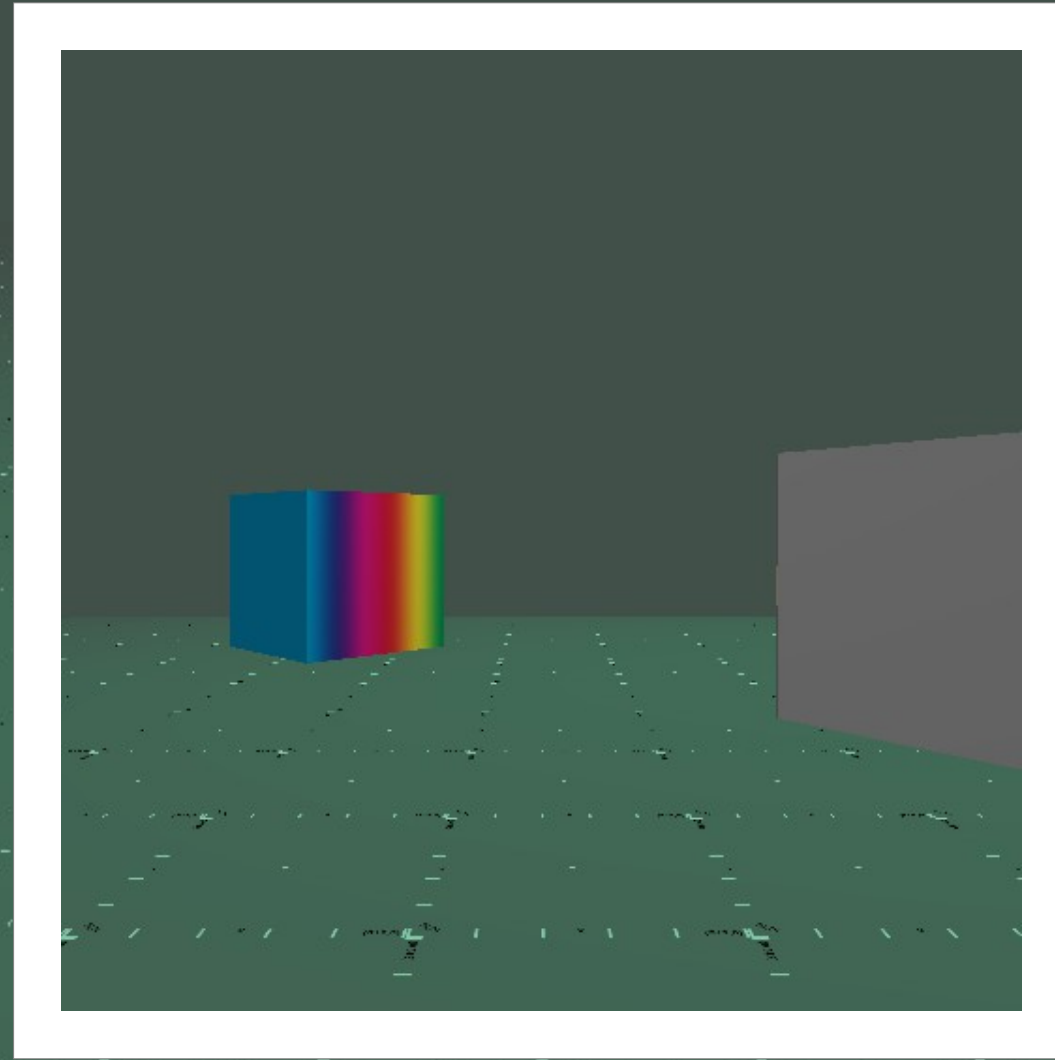


Enbies

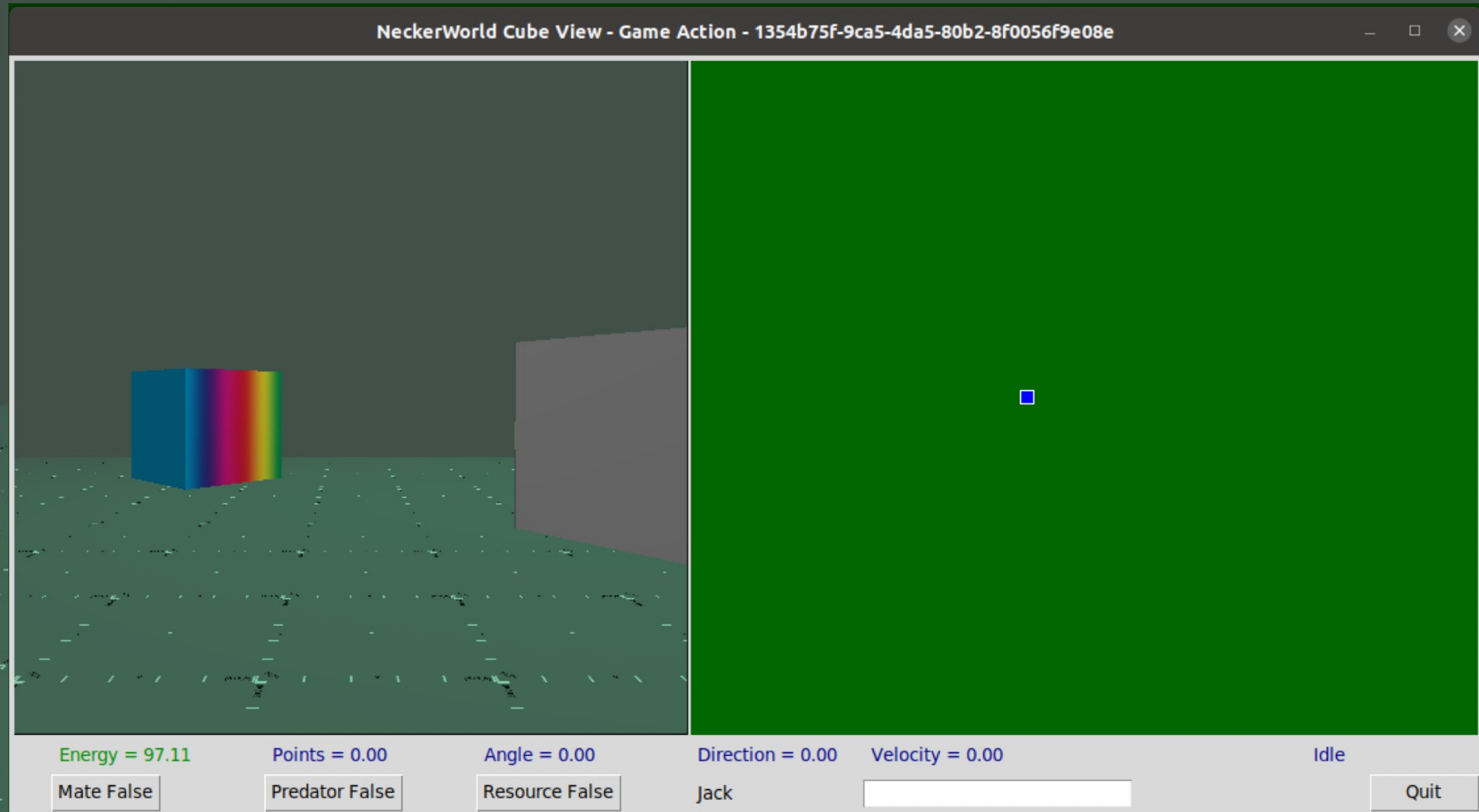
Neckerworld – Field View



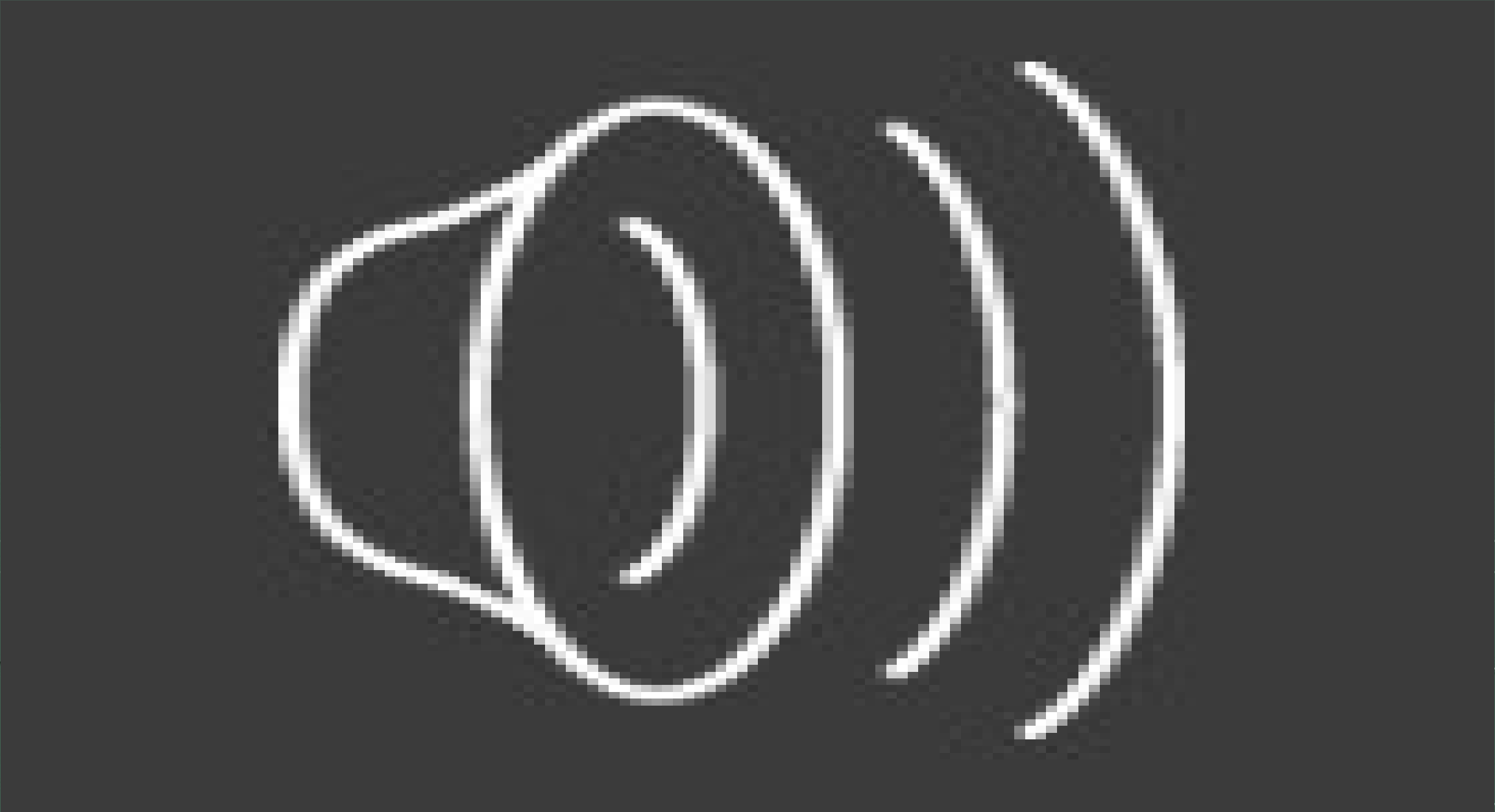
Neckerworld – Cube's Eye View



Neckerworld – Cube Control Panel



Neckerworld – Game On



Neckerworld – Fundamental Questions

Given only the cube view, why do we perceive a larger 3D space?

Given constant motion of the view, why does the world appear stable?

How do we internally represent the objects around us?

What is the relationship between object detection and internal representations?

And many more ...

Neckerworld – AI and ML

Object detection – identifying an object in an image, placing a bounding box around the object and assigning a probability of a class to it.

Object classification – assigning a class to an image.

Image segmentation – identifying all pixels associated with a particular subset of an image.

Neckerworld – Object Detection Goals

Determine if there is one or more objects in the image.

Identify the type of object.

Provide a probability for the type.

Draw a bounding box around the object.

Determine its spatial position relative to the camera.

Neckerworld – Object Detection Outcomes

There is an object and you nailed it.

There were no objects and you agreed.

There was an object but you didn't see it.

There were no objects but you said you found one.

Neckerworld – Object Detection Score


95% sure it's a Female

50% sure it's a Male

10% chance that it's a Predator

1% chance it's a Resource.

Neckerworld – Object Bounding Box



Predictions

1 object

predators	0.9789677	0.98
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Neckerworld – Object Detection

Create a visual neural net model.

Train the neural net to identify the object.

Validate the model/training with validation images.

Test the model with final test images.

Deploy the model into production.

Neckerworld – Object Detection

← Necker_World

LABEL STATS

EXPORT DATA

IMPORT

IMAGES

TRAIN

EVALUATE

TEST & USE

Object detection

All images13,081

Labeled13,081

Unlabeled0

Filter labels

+

⋮

females2,707

males2,780

others225

predators1,278


resources6,091

ADD NEW LABEL

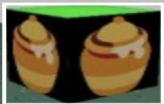
Filter

Filter images

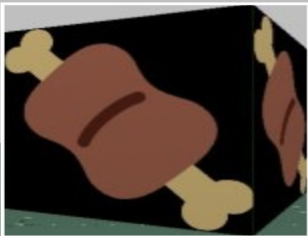
☐ Select all



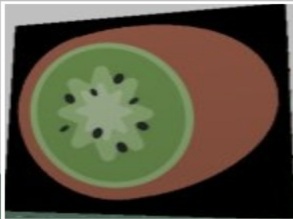
resources(1)




resources(1)




resources(1)




resources(1)



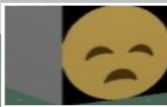
females(1)



predators(1)



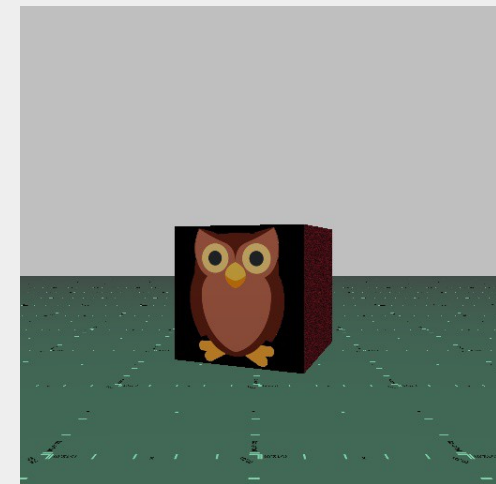
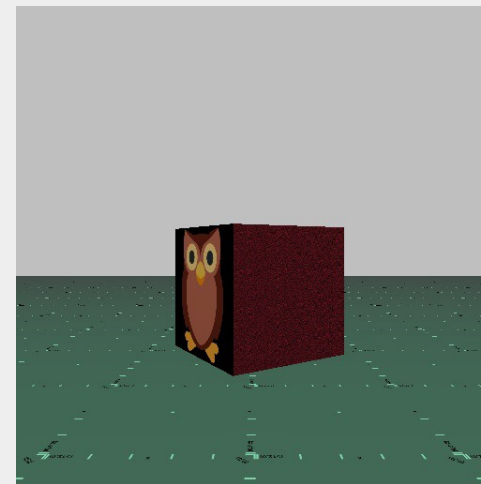
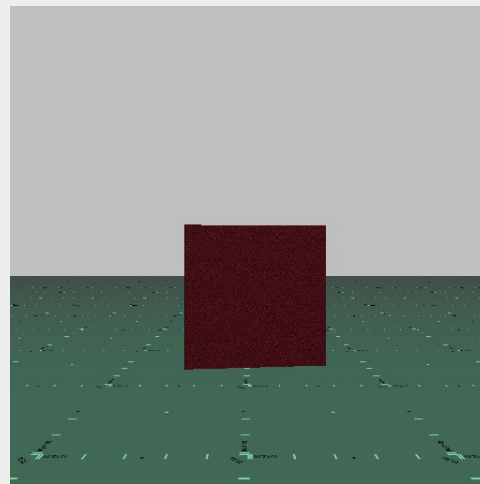
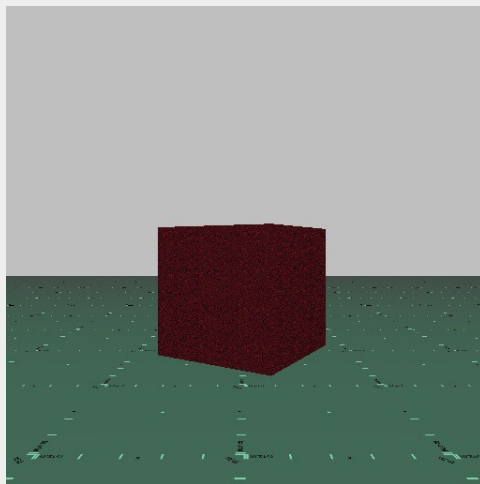
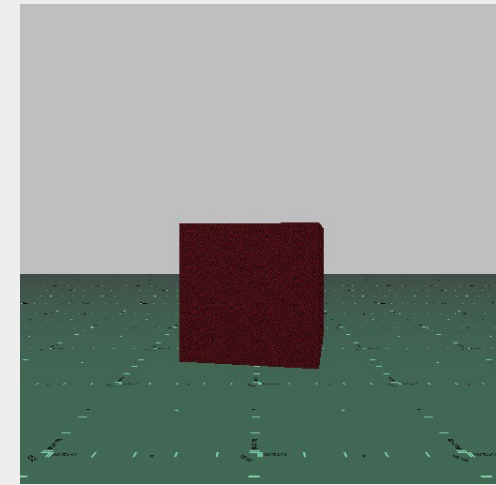
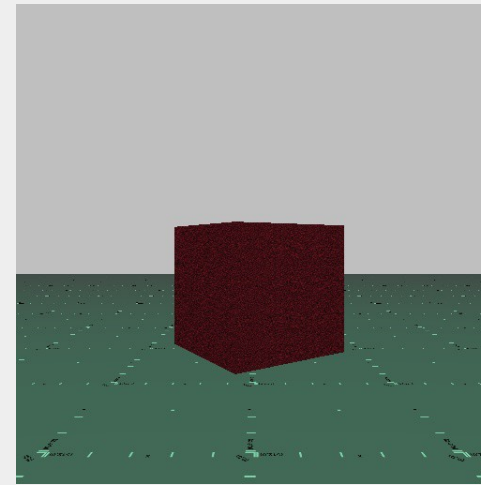
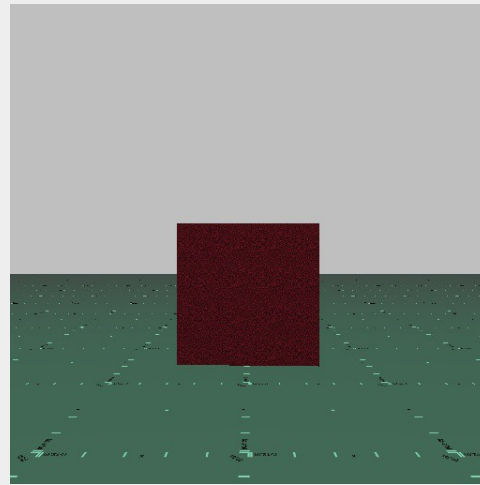
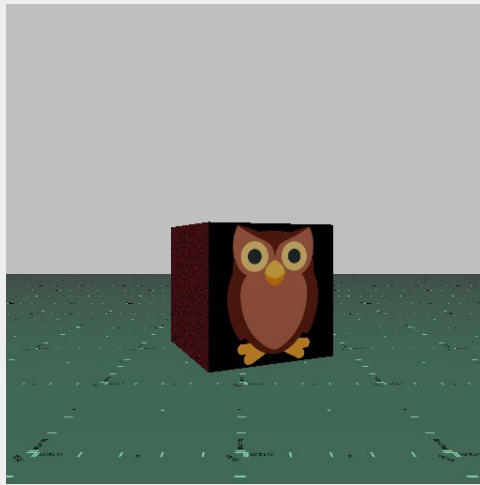
resources(1)



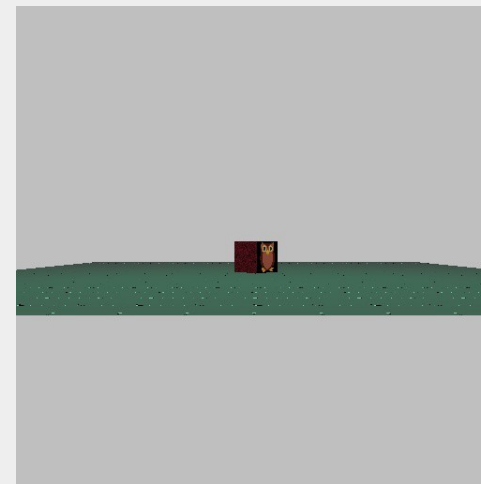
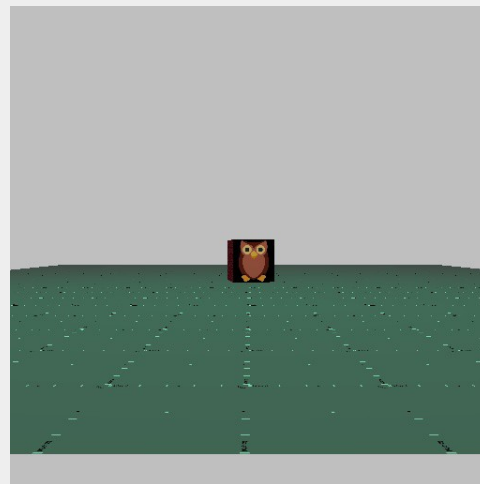
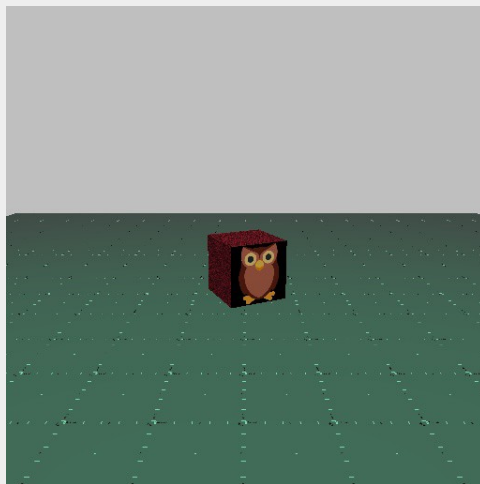
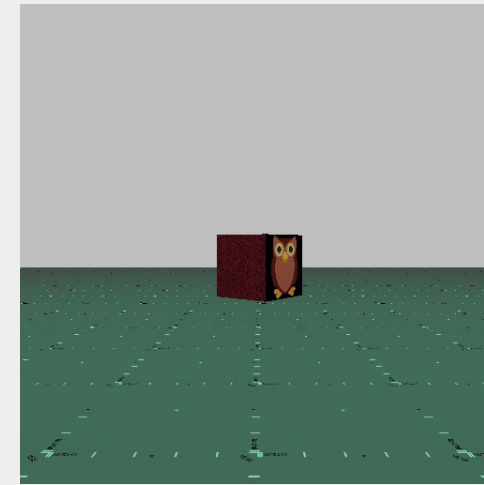
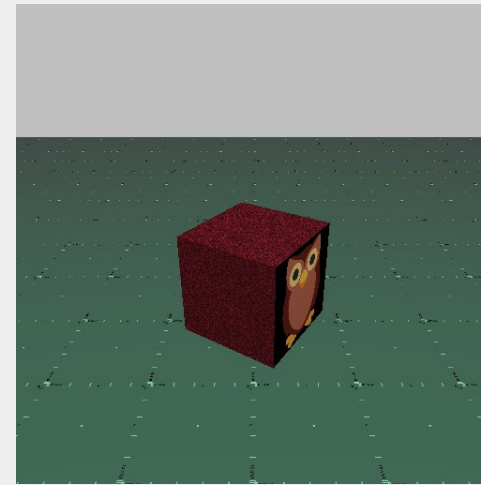
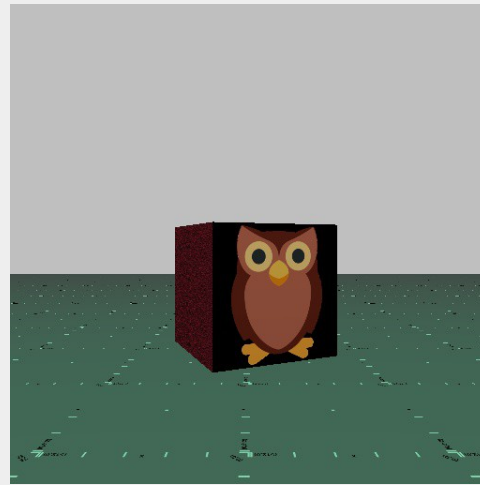
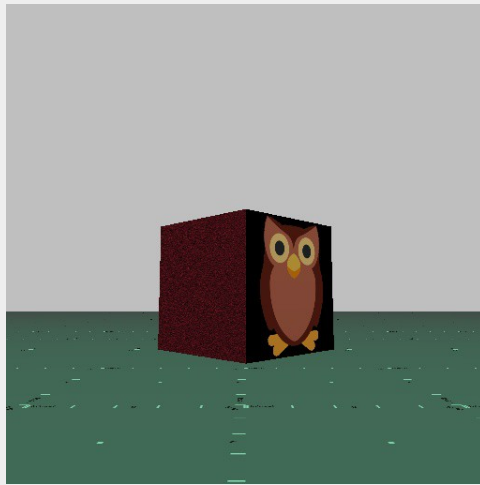
females(1)

Images per page: 501 – 50 of many<>

Neckerworld – Generate 8 Random Rotations



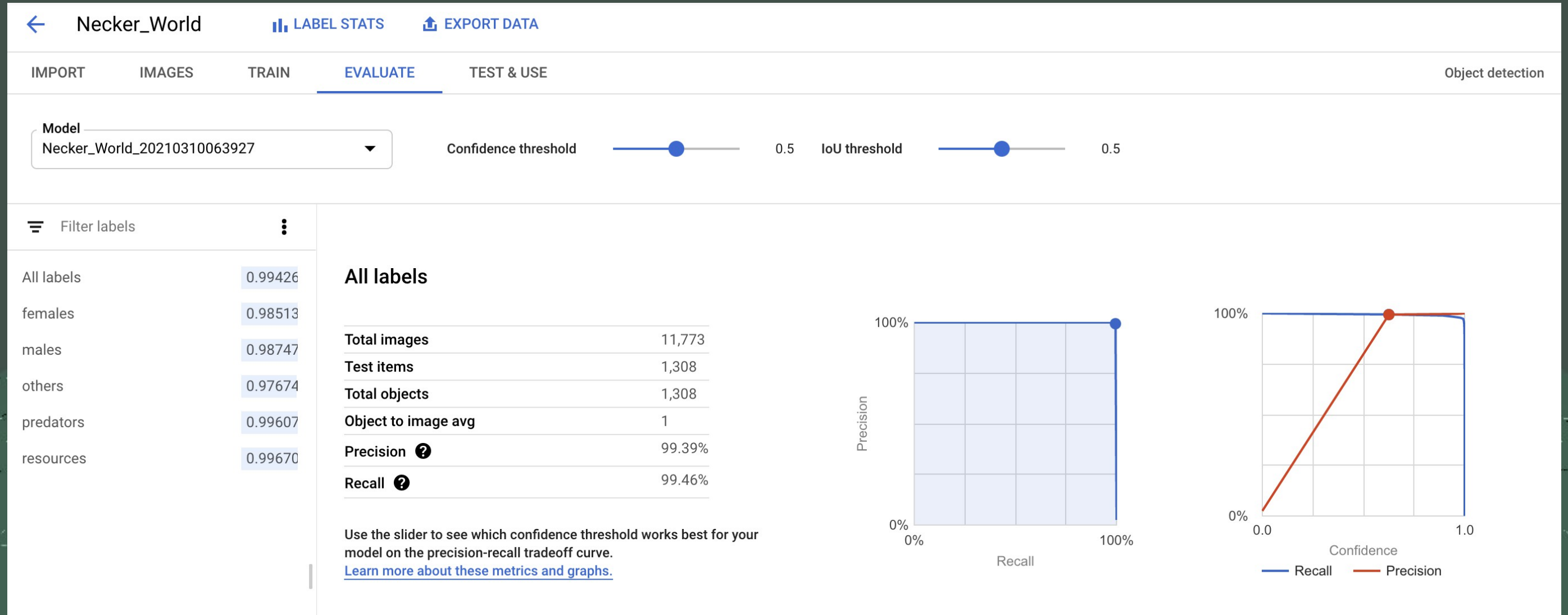
Neckerworld – Create 7 Different Views



Neckerworld – Training Images

37	Male Players
+ 36	Female Players
+ 3	Enby Players
+ 17	Predators
+ 81	Resources
x 7	Unique Views
x 8	Random Rotations
= 9744	Training Images

Neckerworld – Training Results



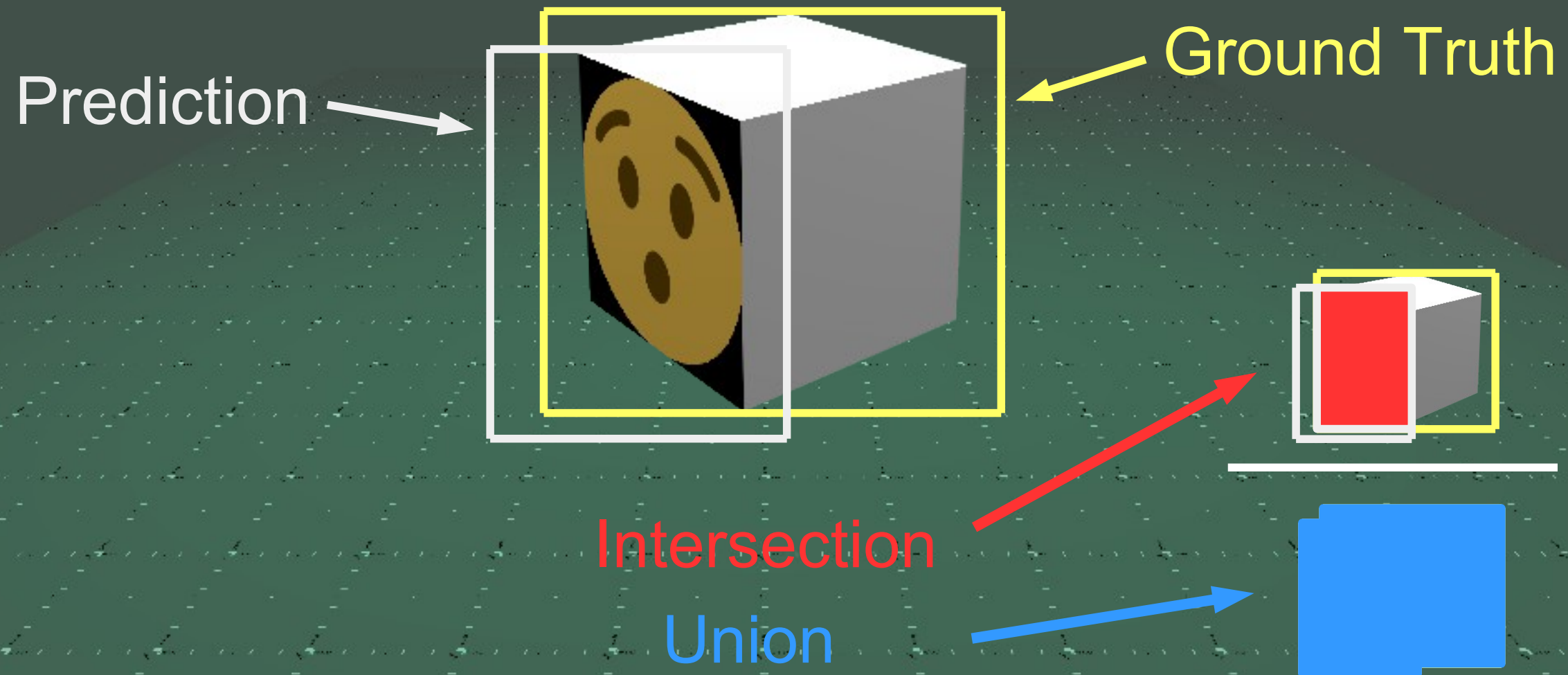
Neckerworld – Precision, Recall and IoU

Precision - is the ability of a classifier to identify relevant objects only. It is the proportion of true positive detections.

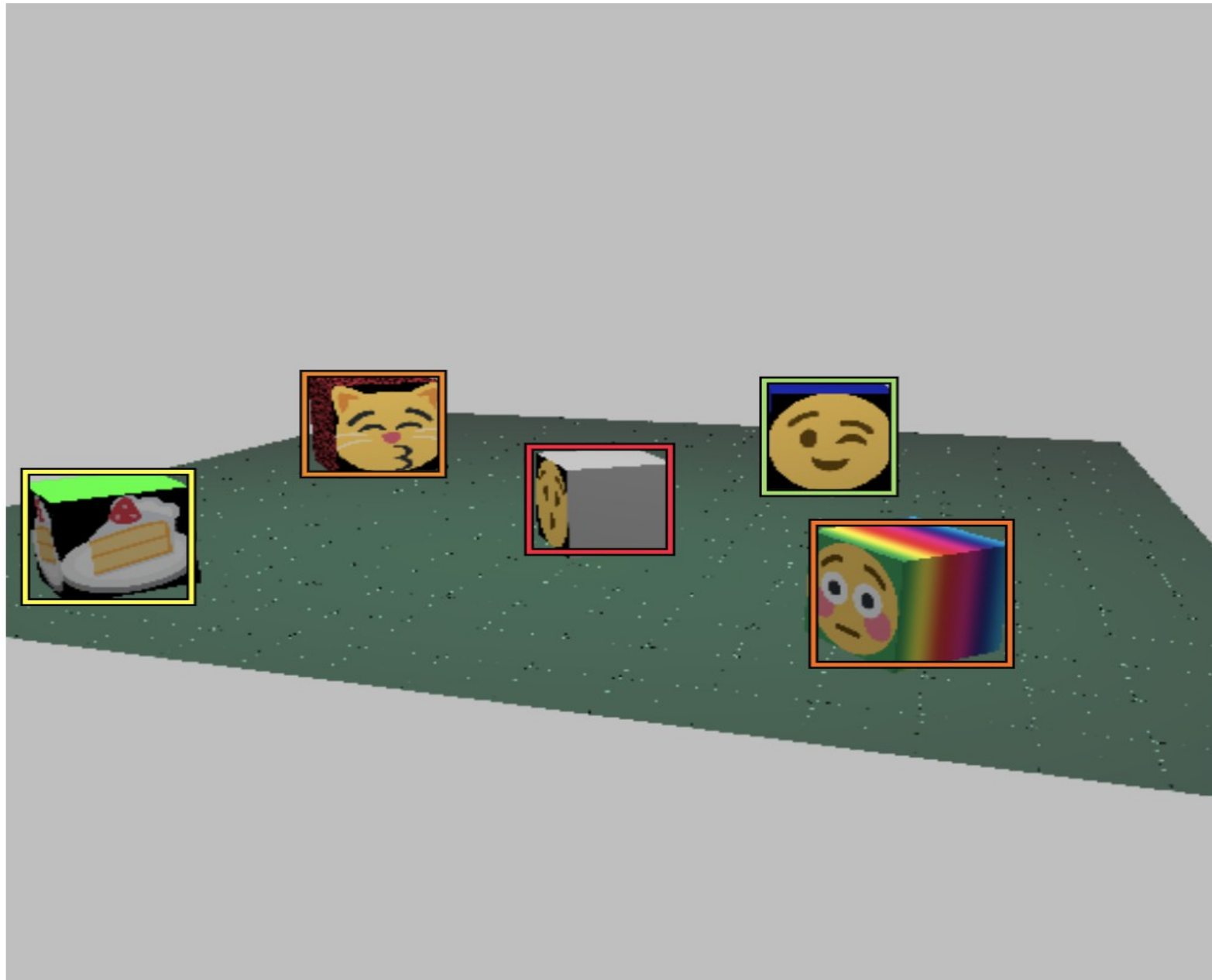
Recall - measures the ability of the model to find all relevant cases (that is, all ground-truths) - the proportion of true positives detected among all ground-truths.

Intersection over Union - evaluates the overlap between the ground-truth mask and the predicted mask.

Neckerworld – Intersection over Union (IoU)



Neckerworld – Predictions

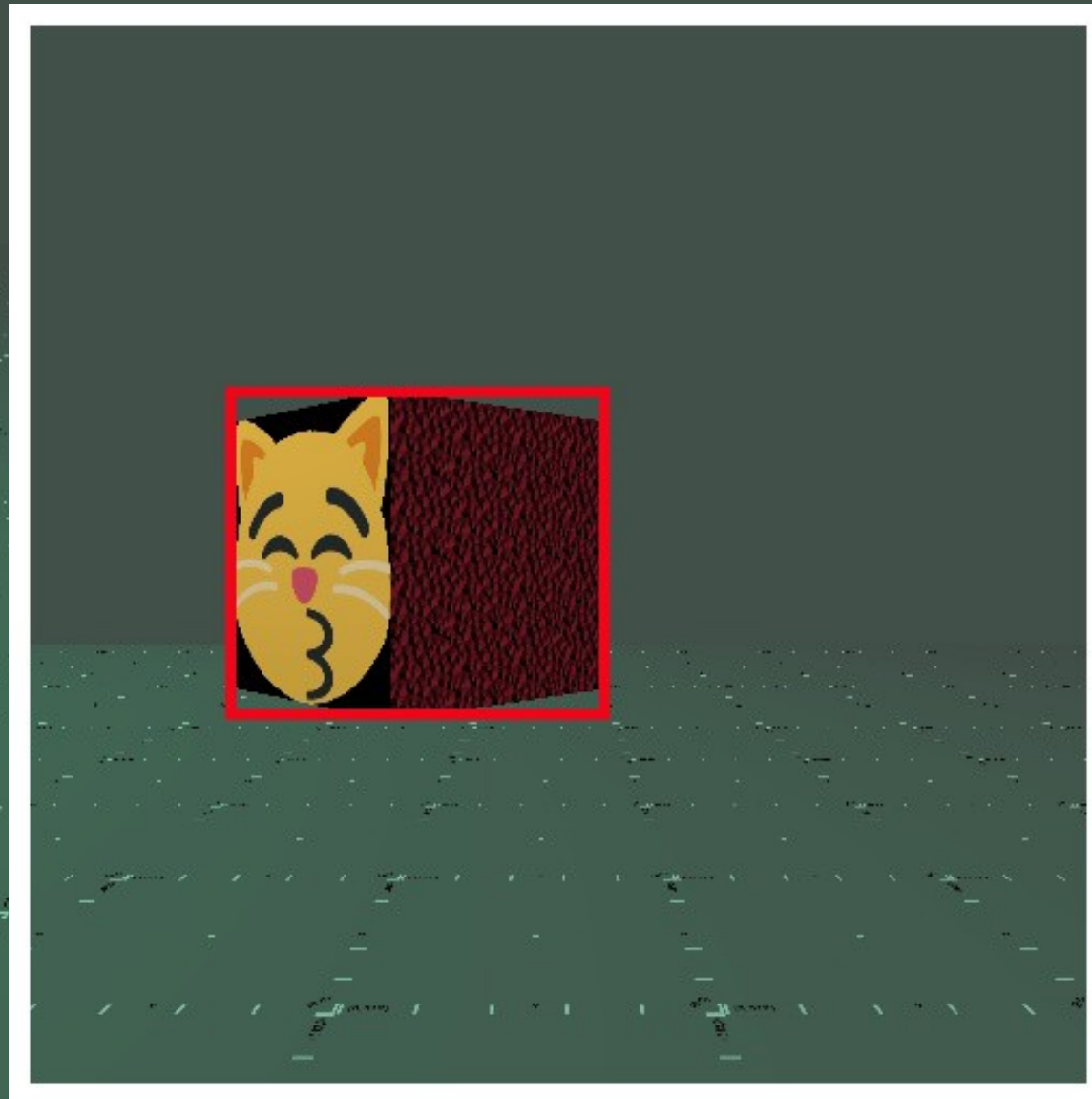


Predictions

5 objects

males	0.9998056	1.00
others	0.9986324	1.00
resources	0.9980274	1.00
females	0.9933228	0.99
predators	0.9867263	0.99

Neckerworld – Inverse Perspective Projection

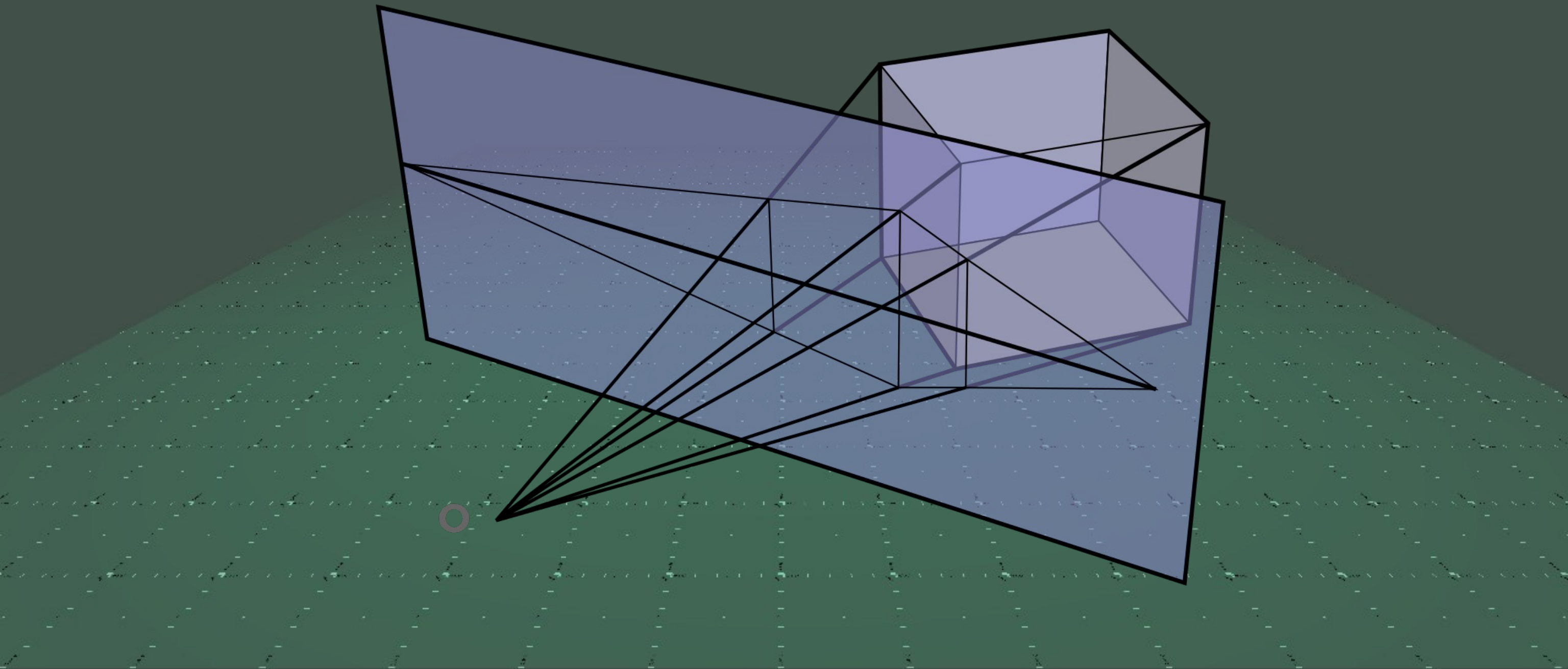


Neckerworld – Perspective Projection in Art



Masolino da Panicale's St. Peter Healing a Cripple and the Raising of Tabitha (c. 1423), the earliest extant artwork known to use a consistent vanishing point.

Neckerworld – Perspective Projection Plane



Neckerworld – Coordinate Systems

Object Coordinates

World Coordinates

Camera or View Coordinates

Normalized Display Coordinates

Viewport Coordinates

Window Coordinates

Screen Coordinates

Neckerworld – A Computer Vision Game

Questions?

Contact

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hank.magnuski@gmail.com

Neckerworld – A Computer Vision Game

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