KENTECH
Korea Institute of Energy Technology

Visionary Course – Energy AI
Week 05

Apr. 5, 2022

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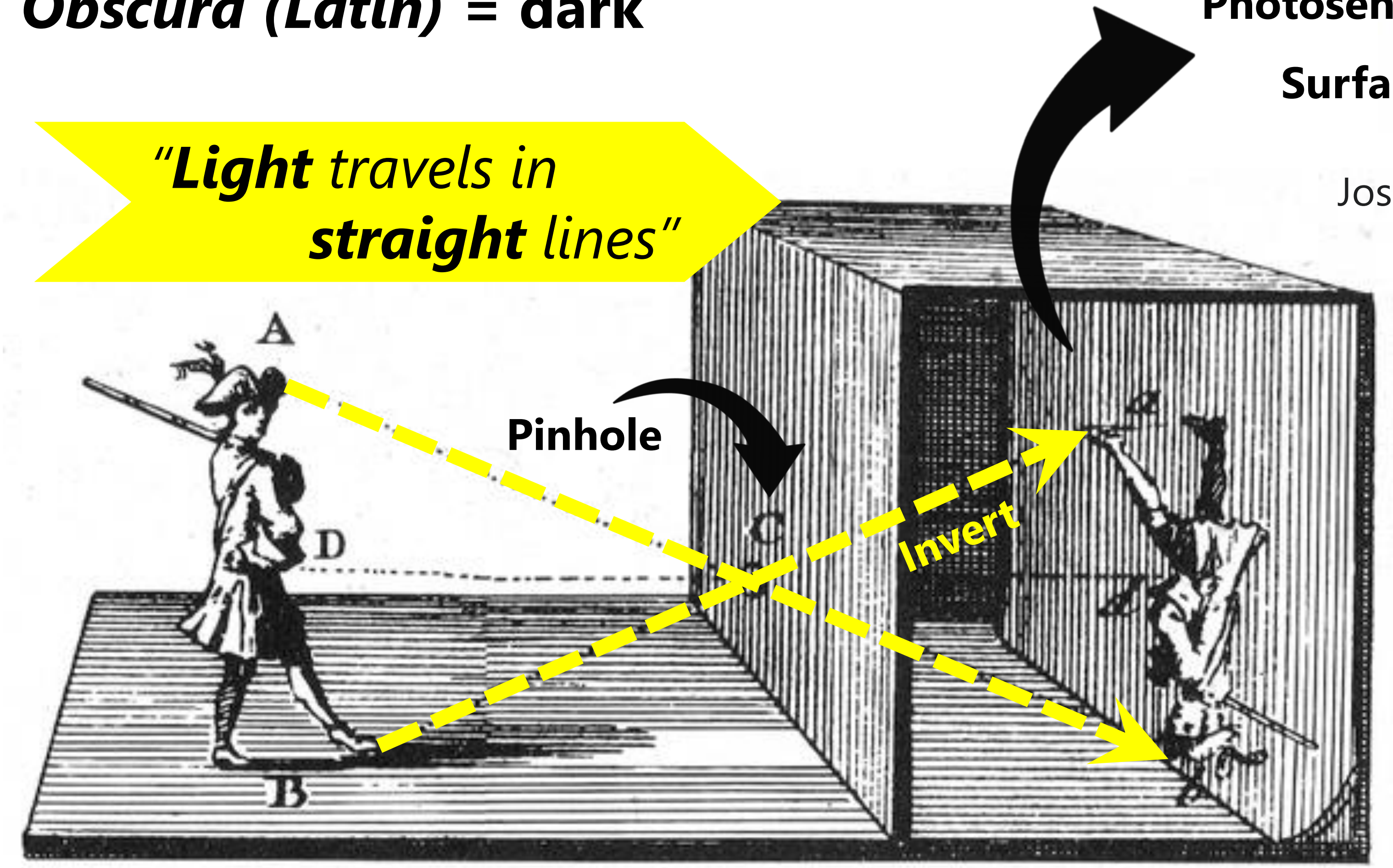
Week 05b – Brief Overview of Pinhole Camera

Camera Obscura – *Darken Room*

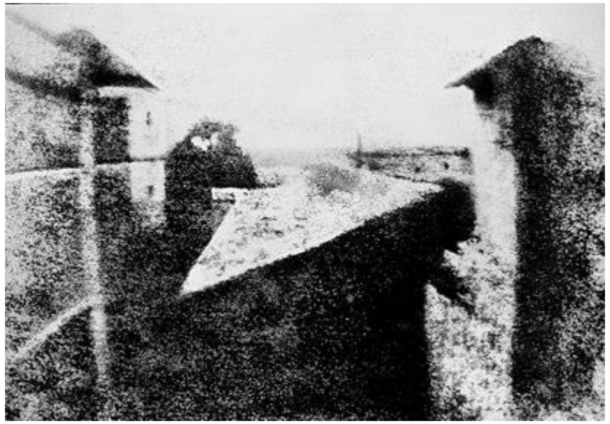
Camera (Latin) **= room or chamber**

Obscura (Latin) **= dark**



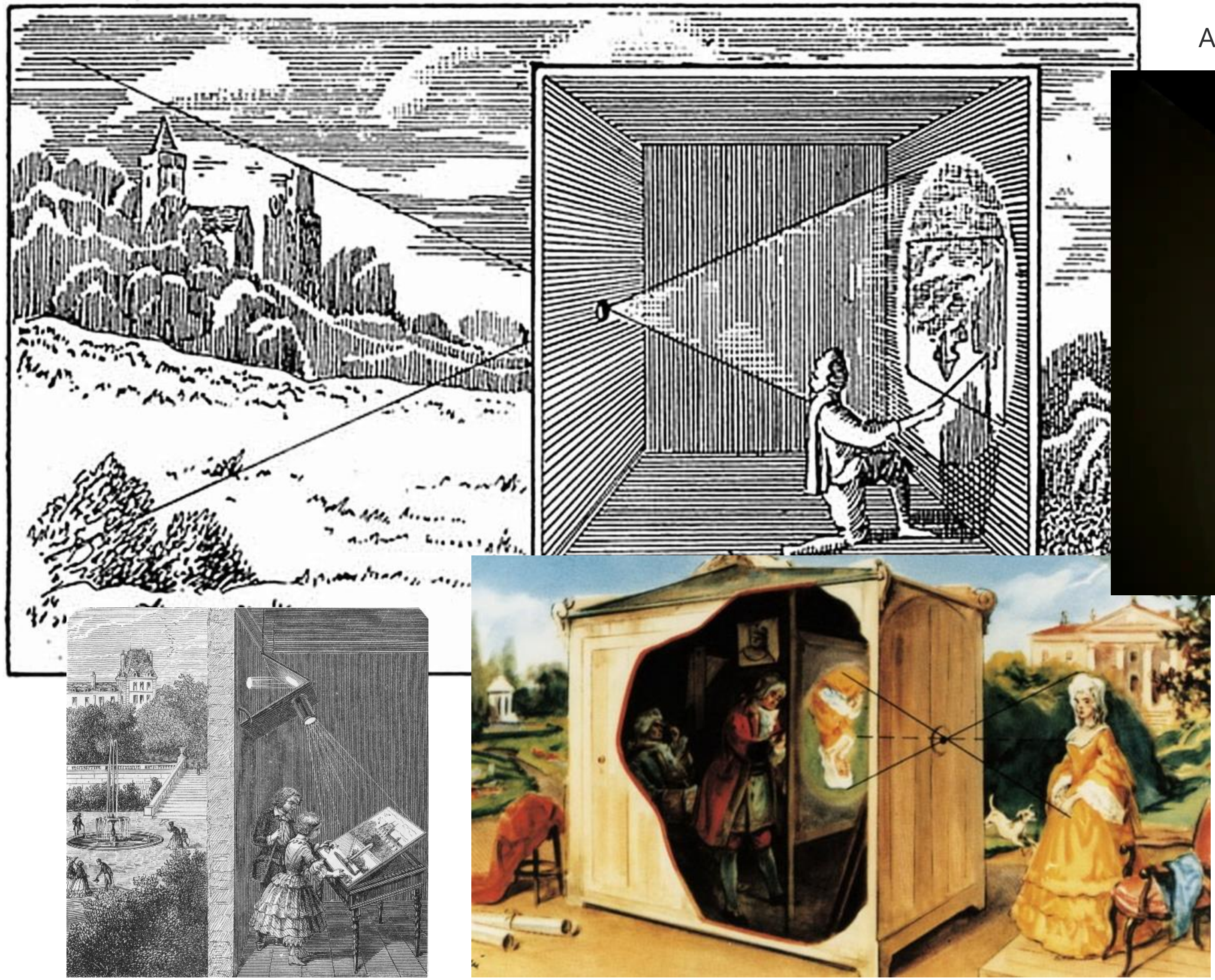
Joseph Nicéphore Niépce
(1765 – 1833)

The inventor of photography



The first photograph
→ It took 8 hours

Camera Obscura – Based on *Art*



Amazing, cheap, fun way to experiment during COVID-19 quarantine

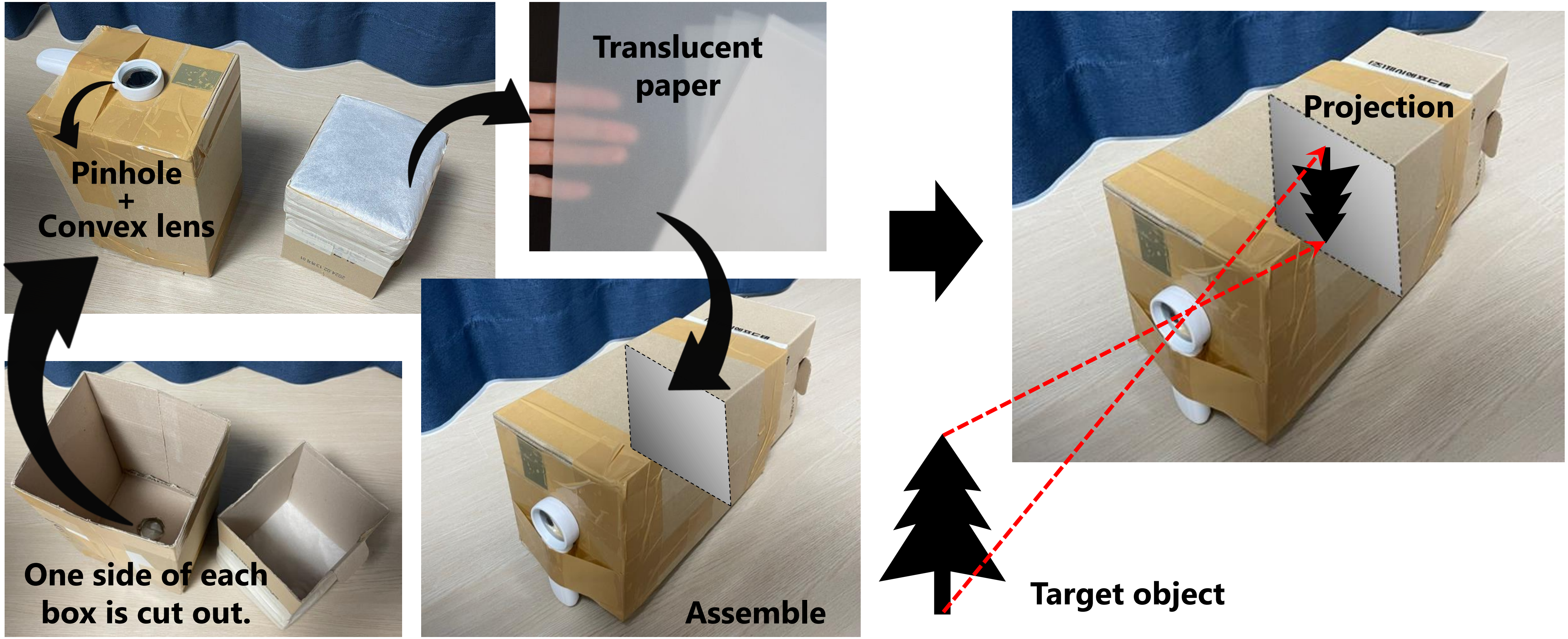
By Mathieu Stern

Inviting nature into your home!

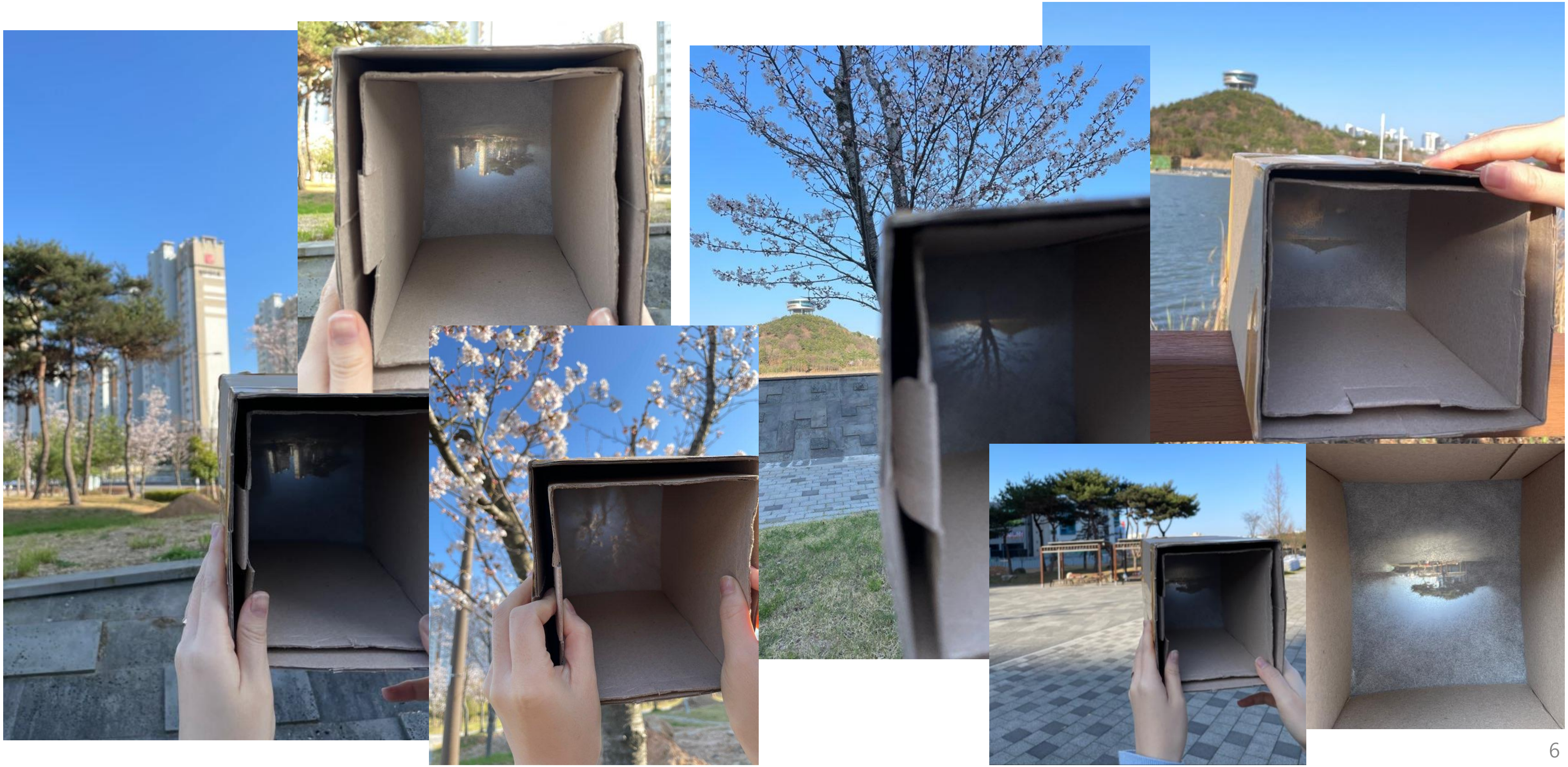
Agents of Change: Camera Obscura (Art Land Magazine)

Camera Obscura – Making

Preparation: two boxes, convex lens, translucent paper

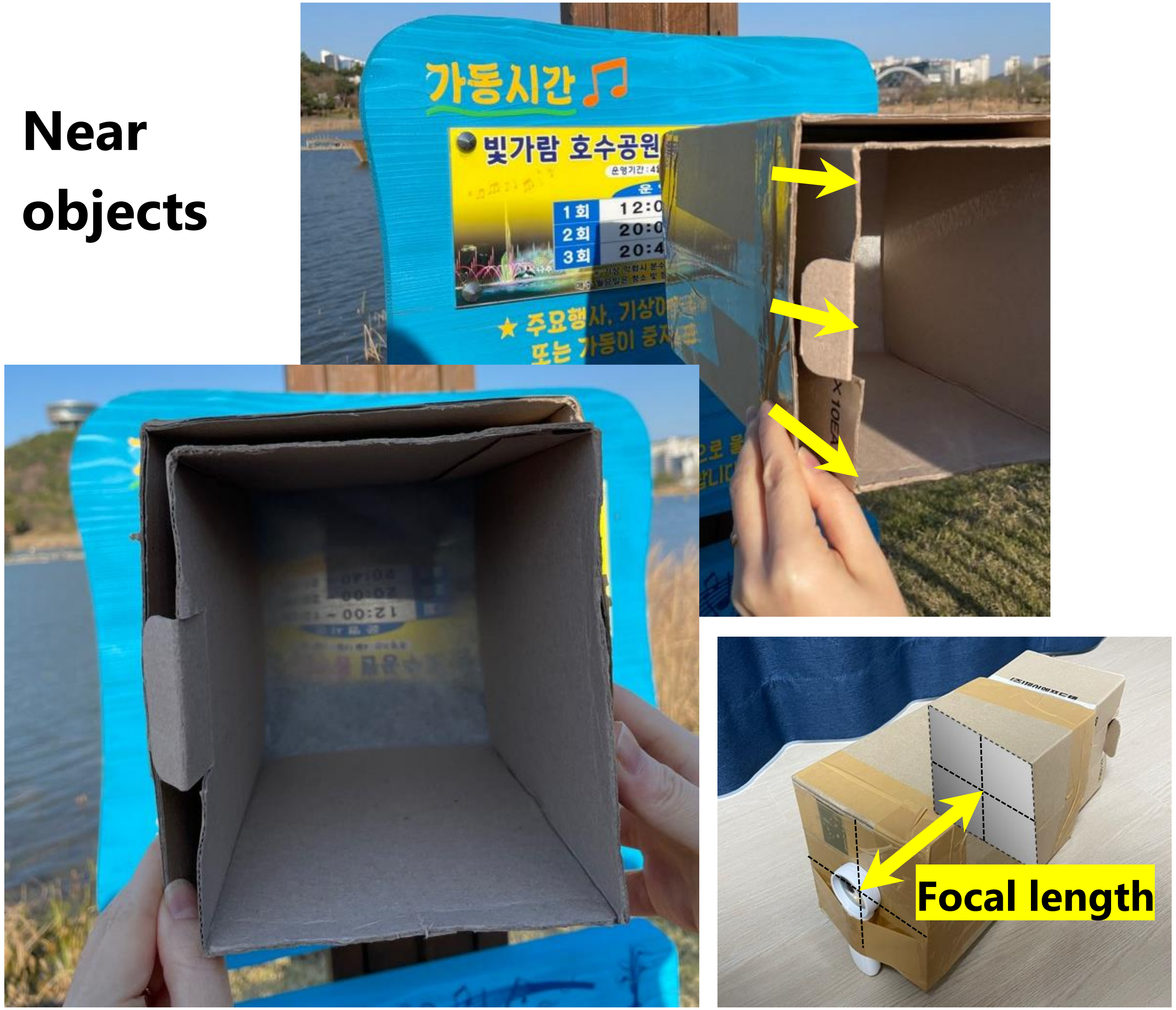


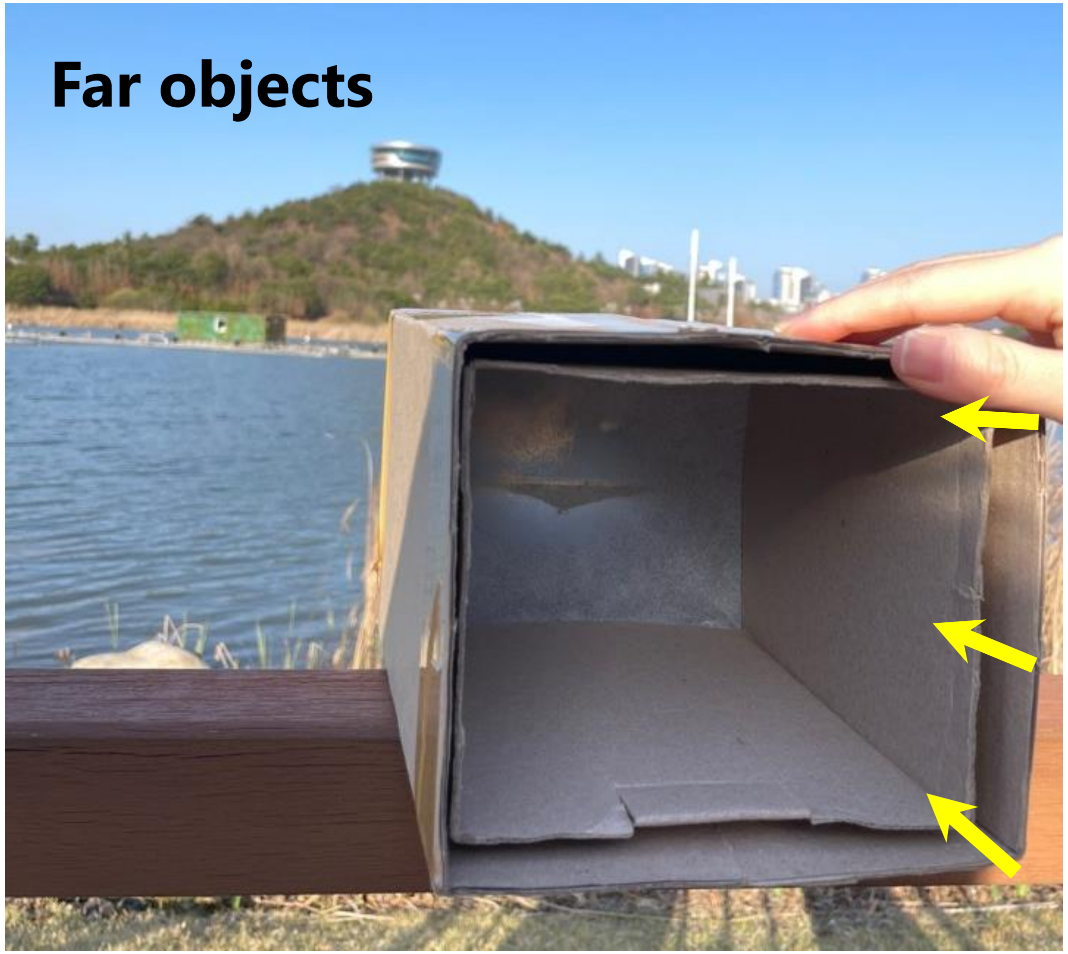
Camera Obscura – Experiments



Camera Obscura – About Focal Length

Near objects





→ **Near** objects: focal length ↑

→ **Far** objects: focal length ↓

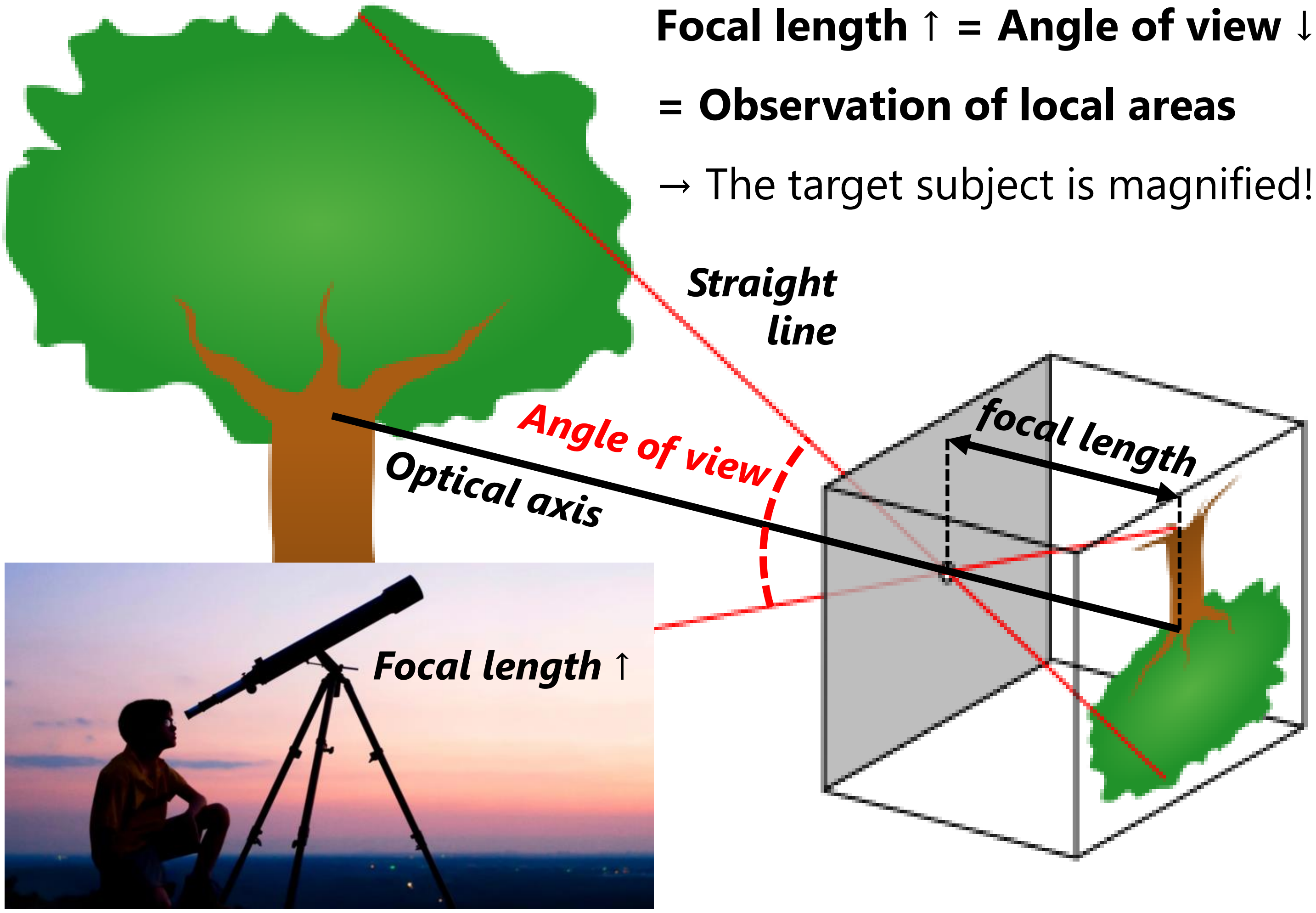
Pinhole Camera Model

Simplified example of ray optics

Focal length ↑ = Angle of view ↓

= Observation of local areas

→ The target subject is magnified!



Next class
we will make it!

***Resolution** (for image, “spatial”)

→ The number of pixels in each dimension

***Frame rate** (for video, “temporal”)

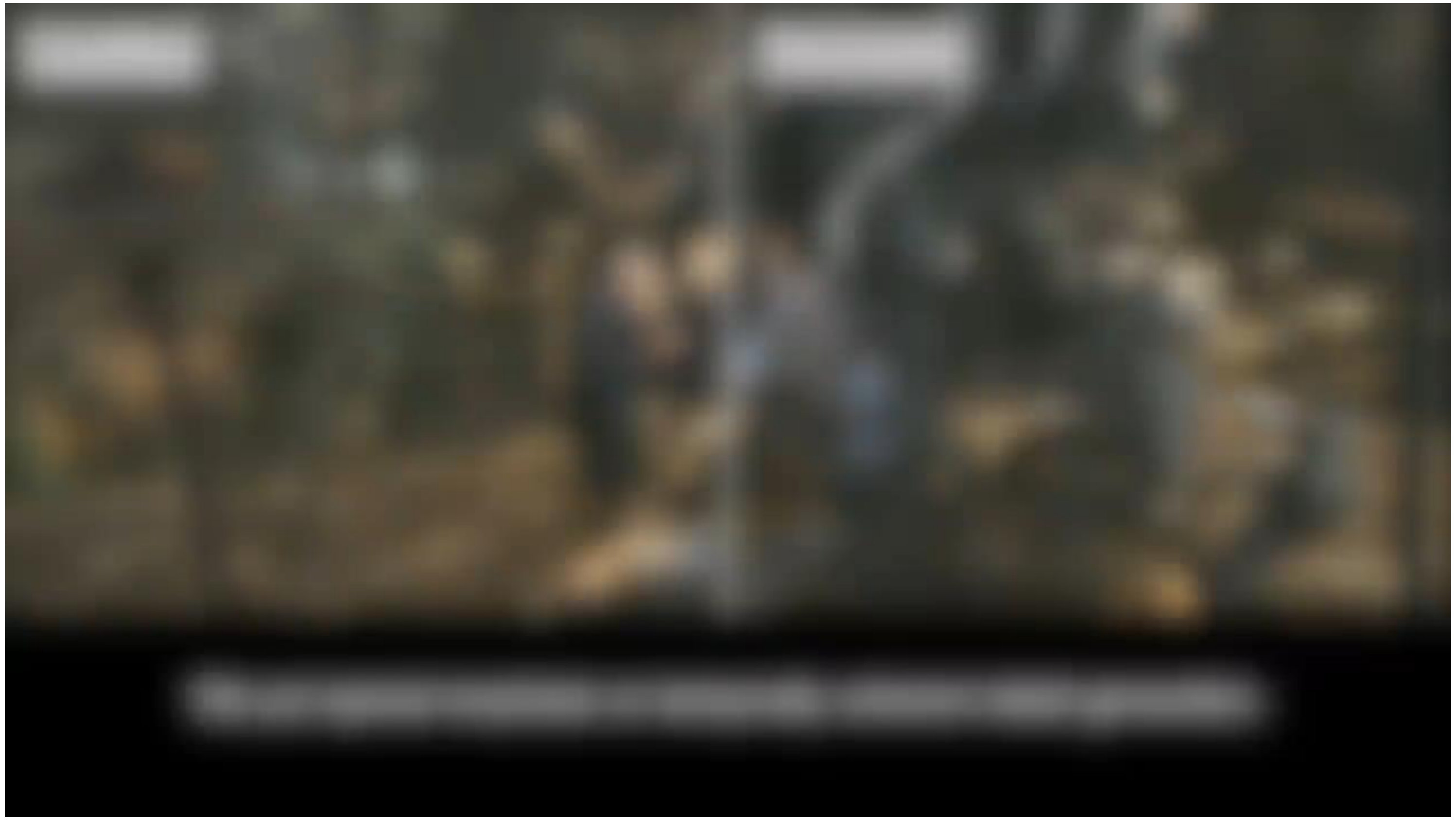
→ The number of image frames per second

Screen = Photographic film = CCD sensor

About Resolution

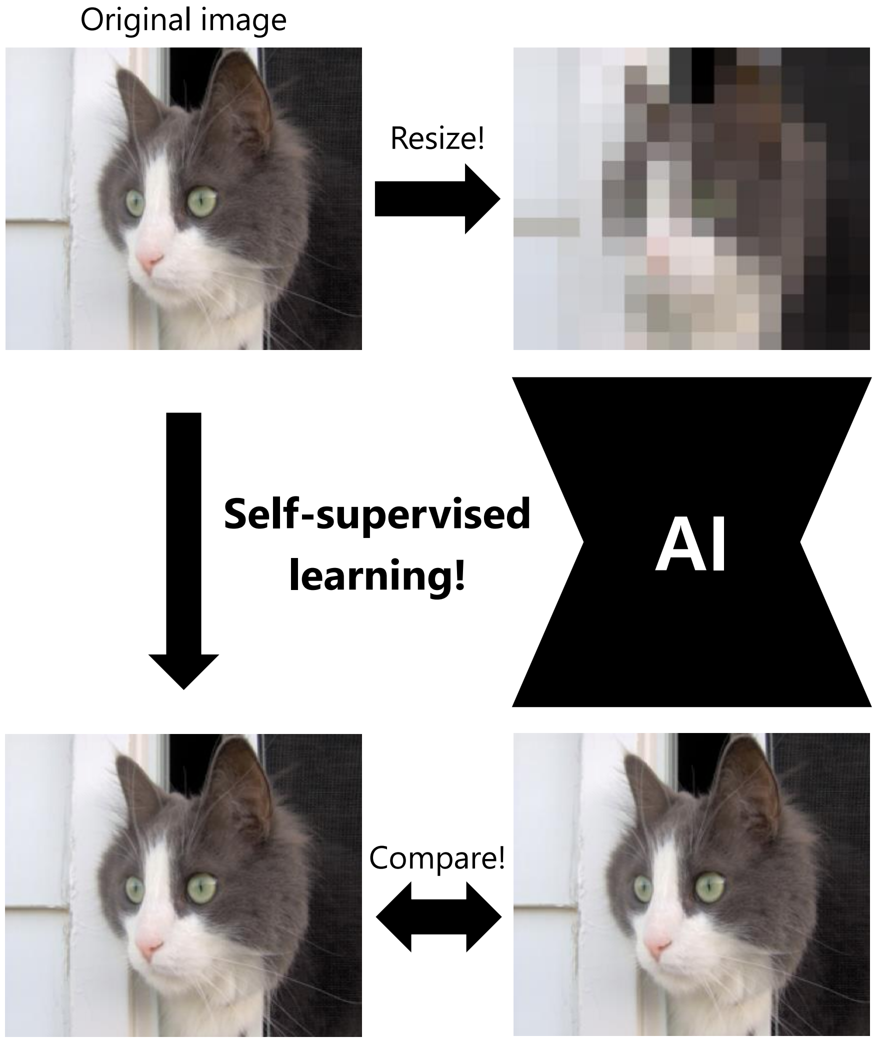
Example of deep learning application:

→ Image super resolution, “**spatial** processing”



TecoGAN (*SIGGRAPH’19*)

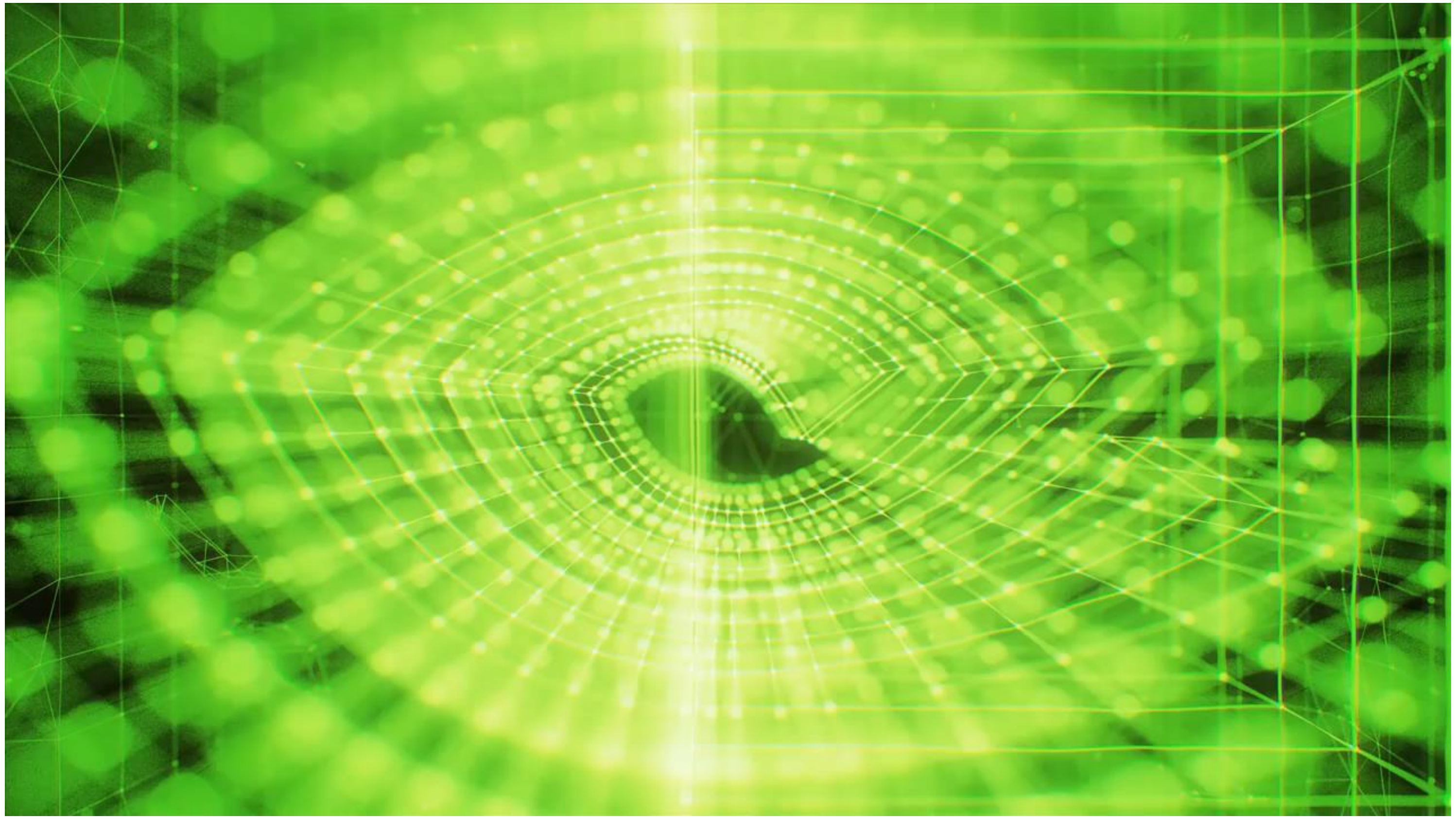
How to train?



About Frame Rate

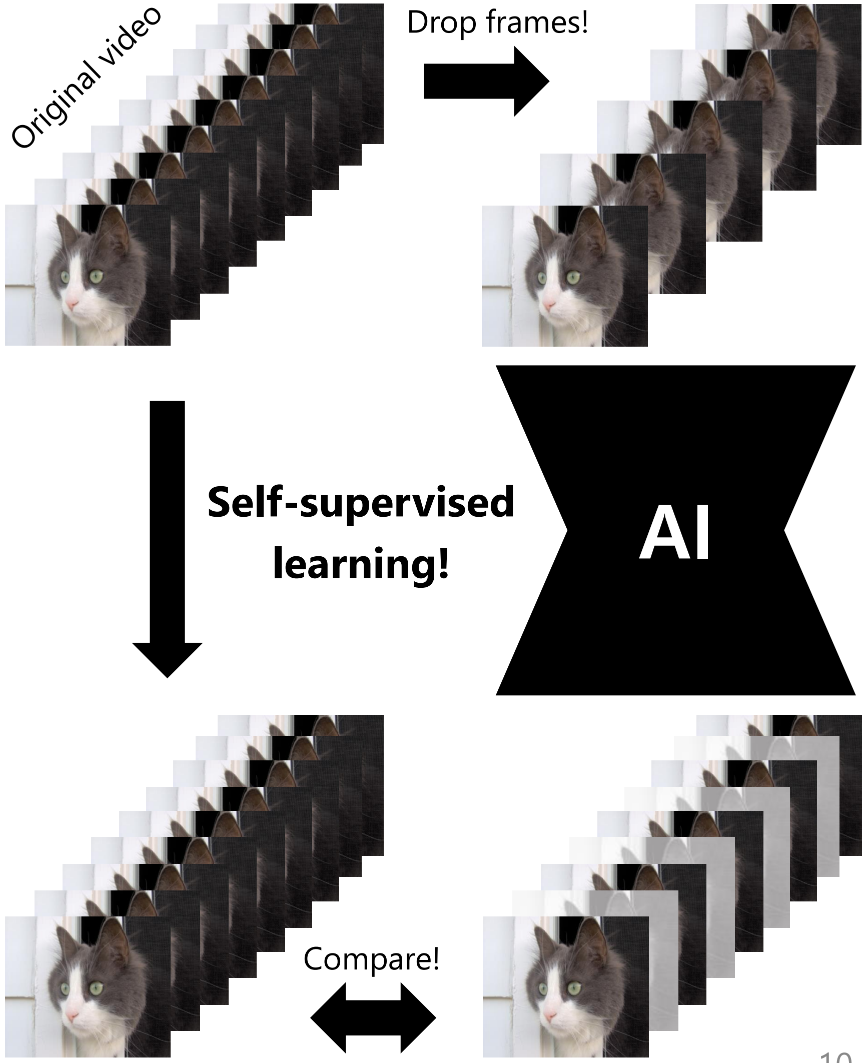
Example of deep learning application:

→ Video frame interpolation, “**temporal** processing”



Transforming Standard Video Into Slow Motion with AI
(Research at NVIDIA, 2018)

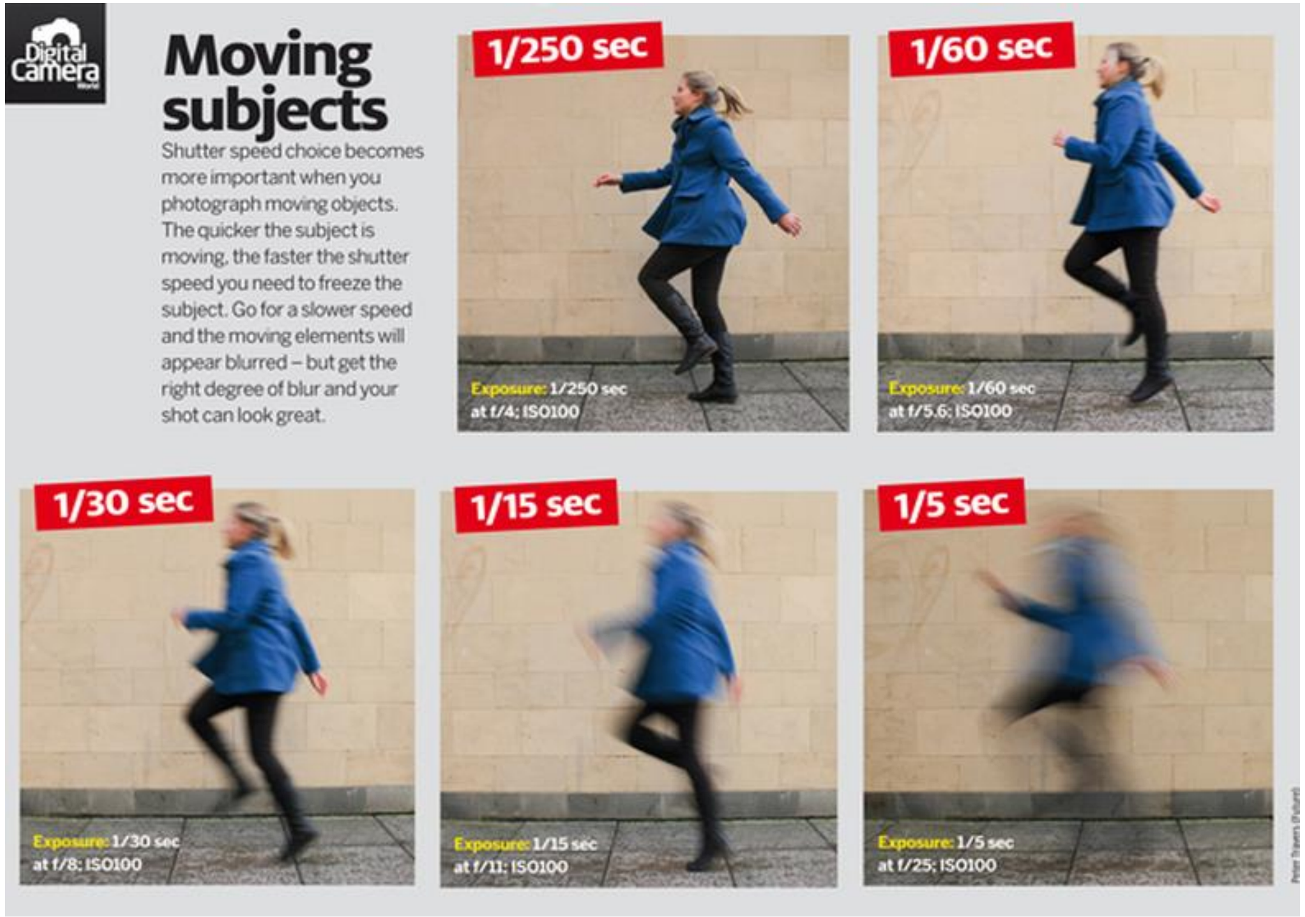
How to train?



About Shutter Speed

A.k.a., exposure time:

The length of time that the digital sensor inside the camera is exposed to light



Moving subjects

Shutter speed choice becomes more important when you photograph moving objects. The quicker the subject is moving, the faster the shutter speed you need to freeze the subject. Go for a slower speed and the moving elements will appear blurred – but get the right degree of blur and your shot can look great.

1/250 sec

Exposure: 1/250 sec at f/4; ISO100

1/60 sec

Exposure: 1/60 sec at f/5.6; ISO100

1/30 sec

Exposure: 1/30 sec at f/8; ISO100

1/15 sec

Exposure: 1/15 sec at f/11; ISO100

1/5 sec

Exposure: 1/5 sec at f/25; ISO100

→ **How shutter speed affects motion.**

"The faster your shutter speed,

the sharper your image will be."

mrs-cook.weebly.com

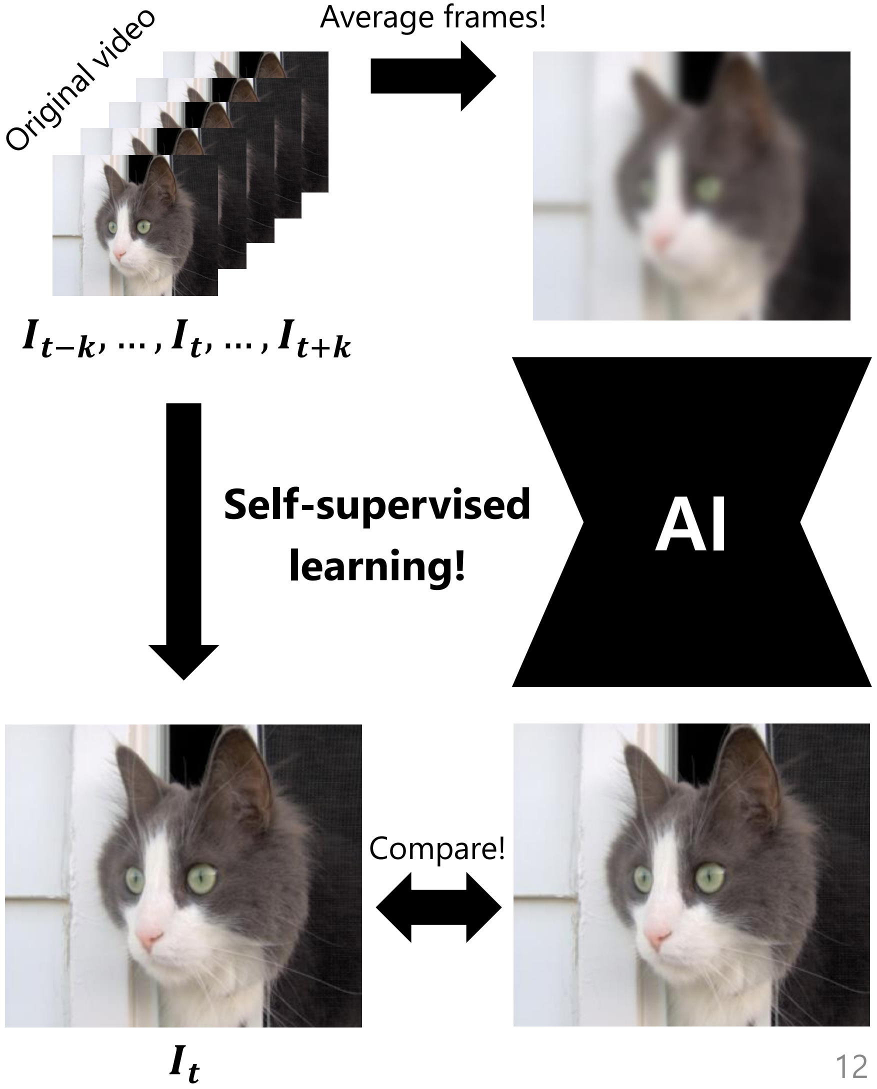
About Shutter Speed

Example of deep learning application:

→ Motion deblurring

Fix Blurry Photos with Motion Deblur AI (by AKVIS, 2021)

How to train?



Original video

Average frames!

$I_{t-k}, \dots, I_t, \dots, I_{t+k}$

Self-supervised learning!

AI

Compare!

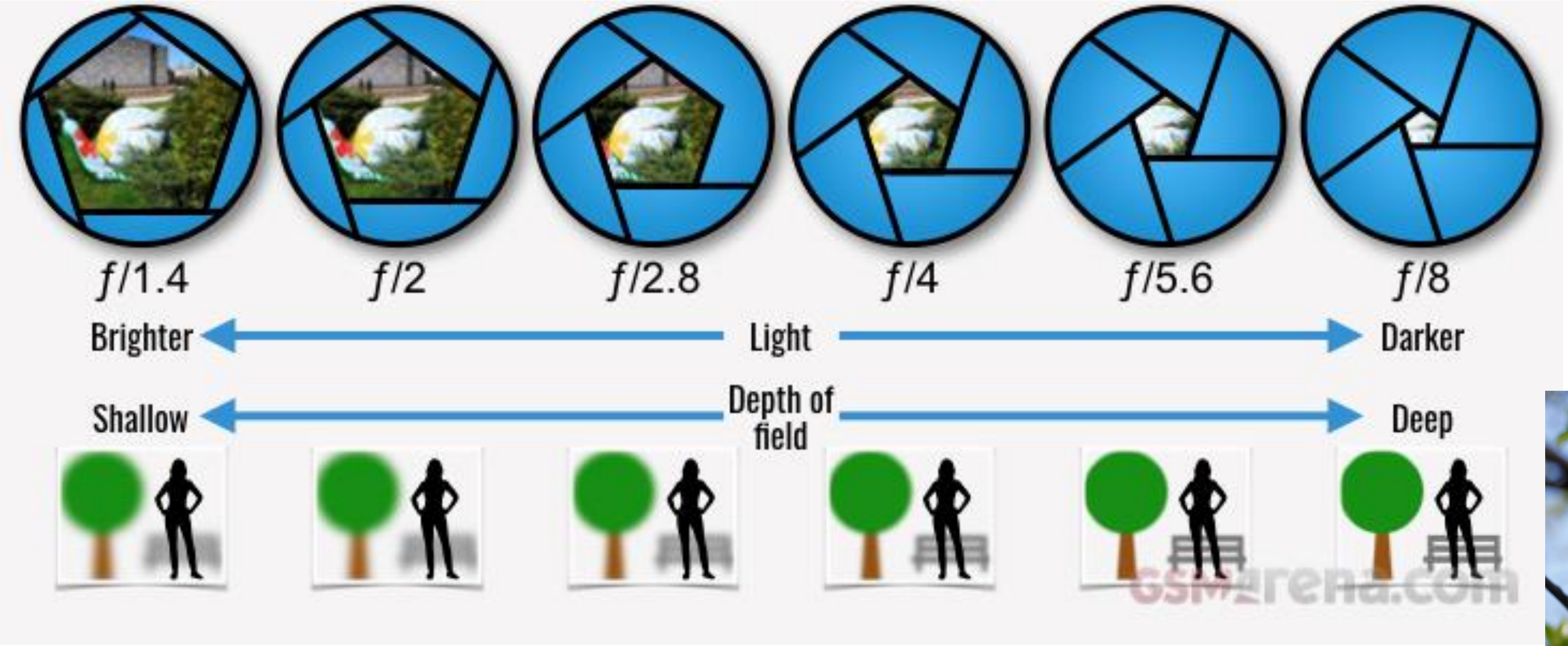
I_t

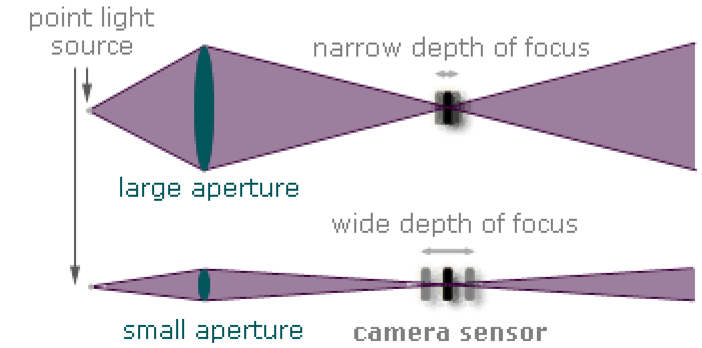
Aperture

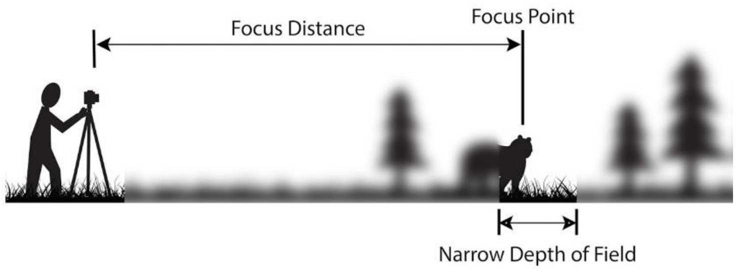
A hole through which light travels

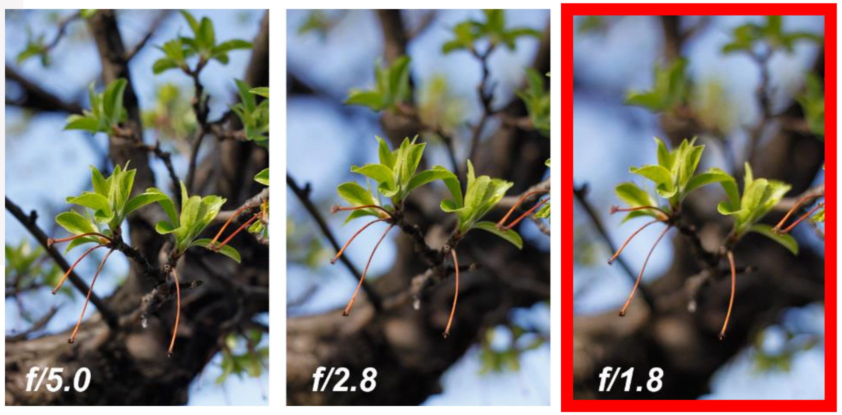
→ Controls the amount of the light

→ Controls depth-of-field (DoF)









Out focus

= **shallow** depth of field

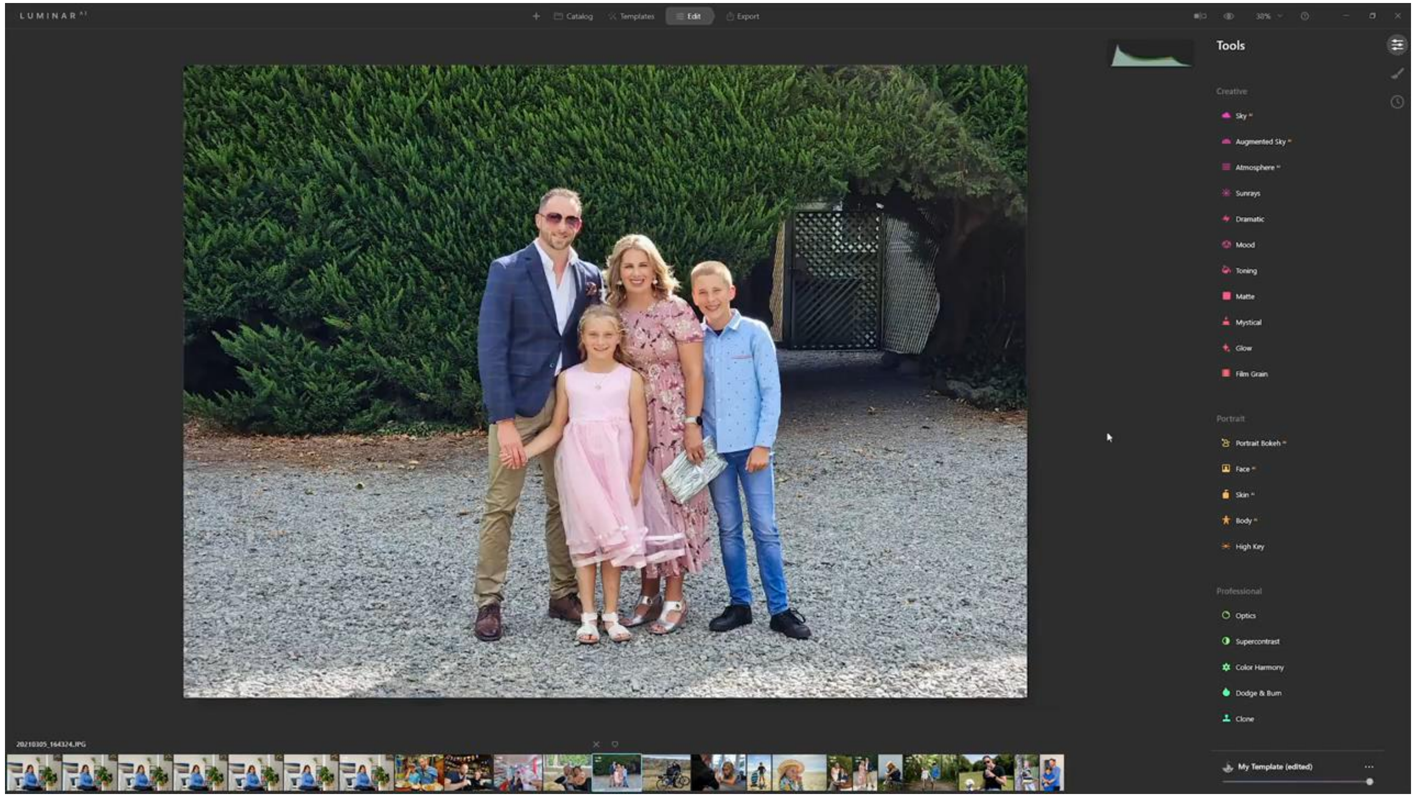
→ Helps concentrate on the subject!

[1] gsmarena.com [2] boostyourphotography.com [3] cambridgeincolour.com

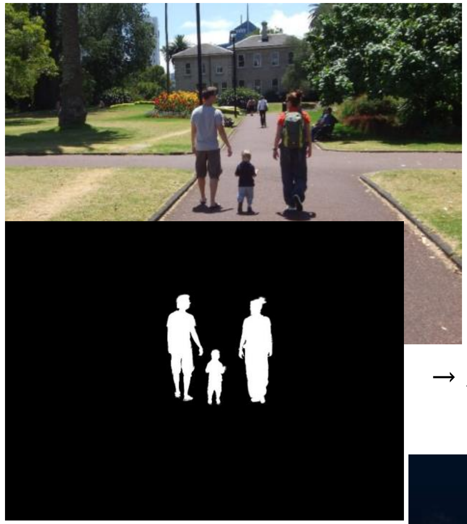
Out Focusing

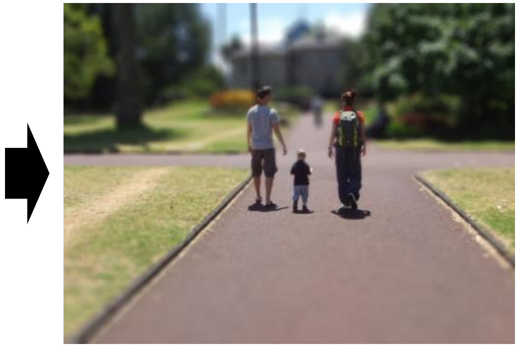
Technically difficult for smartphone cameras 🤔

→ Computer vision & AI make this possible!

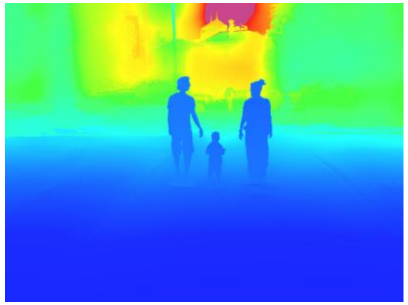


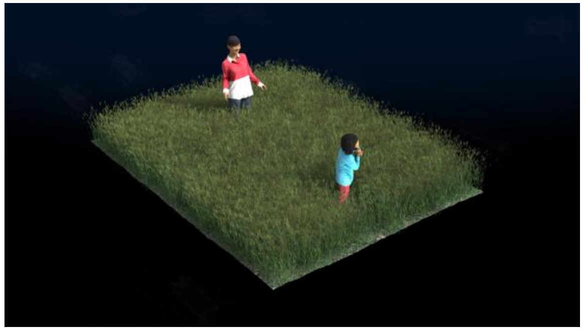
Automatic bokeh by Luminar AI (2021)





→ AI model for binary **segmentation**





→ All we need is just a **depth!**

[1] Liu, et al., “Bokeh Effects Based on Stereo Vision” (2015)

3D Photography

The most recent photographic effects

→ AI makes any images cinematic!

We will learn 3D vision later!

by Facebook

(*SIGGRAPH* 2020)

Summary of a Basic Camera Model

Characteristics of a pinhole camera

- Camera obscura
- Focal length
- Aperture & depth of field
- Shutter speed & exposure time

What AI can enhance images and videos

- Self-supervised learning
  - Image super resolution
  - Video frame interpolation
  - Motion deblurring
- Segmentation and depth
- 3D photography

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Week 05b – Image Processing Puzzle

Basic Python Library: NumPy

https://replit.com/team/VC-Spring-2022
(team-based project)

NumPy

→ There are many strong operation functions for "**multi-dimensional arrays**"

```
import numpy as np

a = np.array([1,2,3])
print(a)          # [2 3 4]
print(a.dtype)    # int64
b = np.array([1.2, 3.5, 5.1])
print(b.dtype)    # float64
print(a**2)
print(a.sum())
print(a.mean())
print(a.min())
print(a.max())
```

Please try basic math operations.

→ **Matrix operation, linear algebra**

```
a = np.arange(8)
print(a)        # [0 1 2 3 4 5 6 7]
b = a.reshape(2, 4)
print(b)
c = a.T
print(b)

print(a.shape)
print(b.shape)
print(c.shape)
print(b.sum(axis=0))
print(b.sum(axis=1))
```

Please use shell commands in Replit,

```
>> python basic_test.py
```

Please discuss each print line.

Python Functions

Please try to implement these functions (in basic_test.py) for summation, subtraction, and multiplication.

In the code, there are some functions.

→ Plot image (show_image) & close the plot (close_image)

```
def show_image(i, img):
        plt.figure(i)
        plt.imshow(img)
        plt.xticks([]); plt.yticks([])
        plt.ion(); plt.show()

def close_image(i):
        if i == 0:
                plt.close('all’)
        else:
                plt.close(i)
```

```
def do_sum(a, b):
        output = a + b
        return output

def do_subtract(a, b):
        output = a - b
        return output

def do_multiply(a, b):
        output = a * b
        return output
```

Now, Let's Play with Images!

Solve image processing puzzles.

→ Multiple image processing missions to make specific images.

→ If you need, please refer below pages.

Numpy: https://numpy.org/doc/stable/reference/

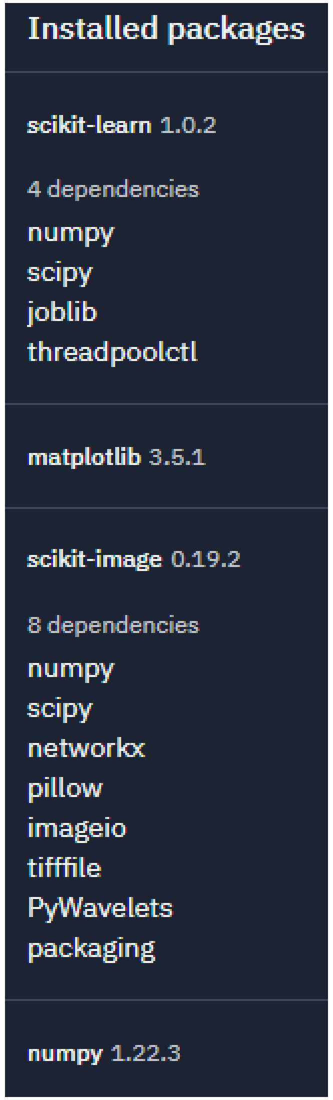
Scikit-learn image: https://scikit-image.org/

PIL image: https://pillow.readthedocs.io/en/stable/reference/Image.html

VIEW Lab: https://view.kentech.ac.kr/lecture/2022s/supp

Please join a breakout room, and discuss with your teammate.

If you need helps, please raise your hands.



Installed packages

scikit-learn 1.0.2

4 dependencies

numpy
scipy
joblib
threadpoolctl

matplotlib 3.5.1

scikit-image 0.19.2

8 dependencies

numpy
scipy
networkx
pillow
imageio
tifffile
PyWavelets
packaging

numpy 1.22.3