中国科学技术大学
University of Science and Technology of China

数字图像处理
Digital Image Processing

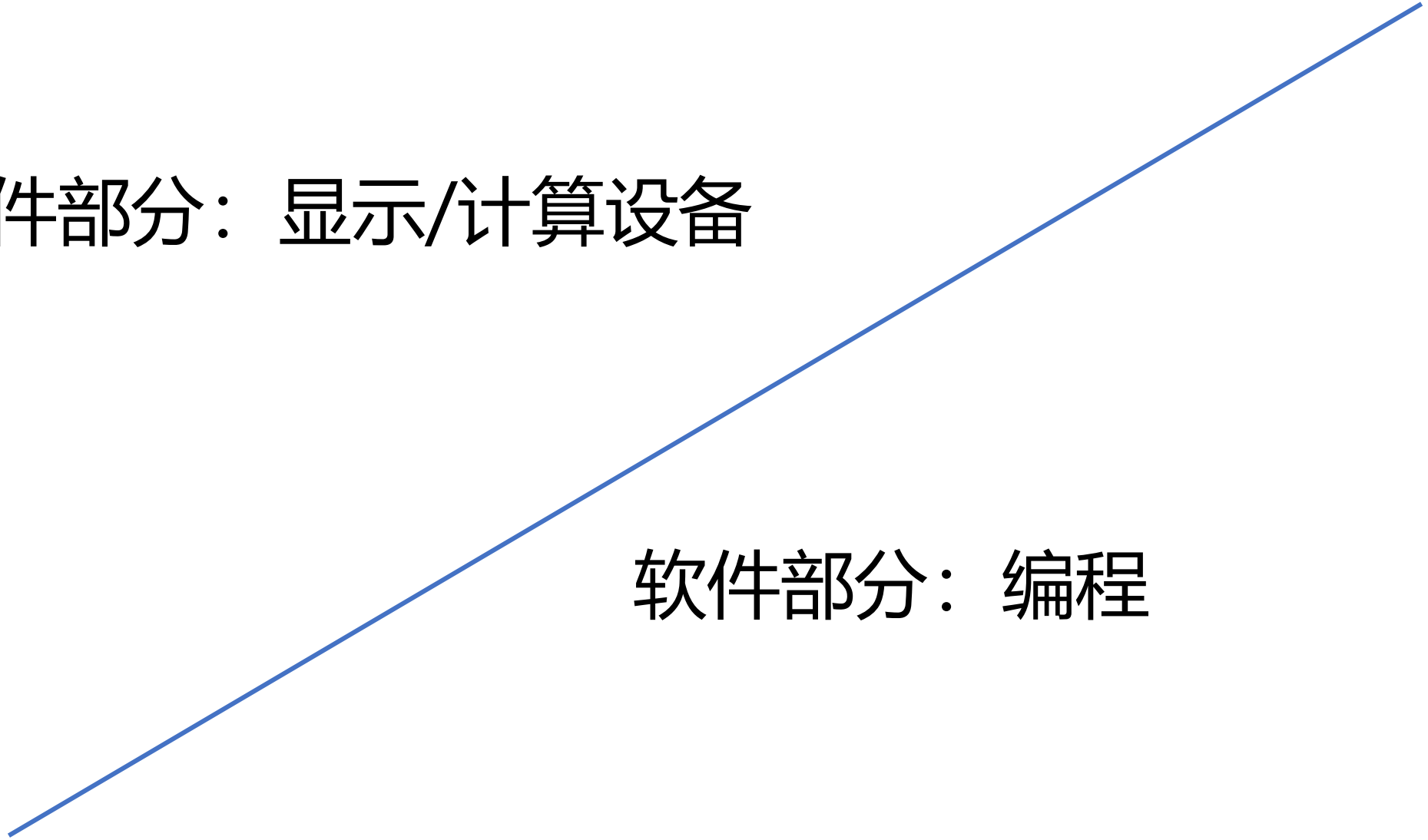


郭玉东
数学科学学院
https://yudongguo.github.io/

数字图像处理

Digital Part

硬件部分：显示/计算设备



软件部分：编程

计算设备三选一

NVIDIA显卡的电脑

实验室GPU服务器

云服务器

Recommend Ubuntu VS Code shadowsocks

https://cp.cloudnx.cc/

编程推荐Python

https://github.com/walter201230/Python
https://codec.wang/docs/opencv
https://github.com/datawhalechina/thorough-pytorch

数字图像处理

Image Part

- What’s Image
- How to Digitalize 表示/存储/可视化
- How it’s produced

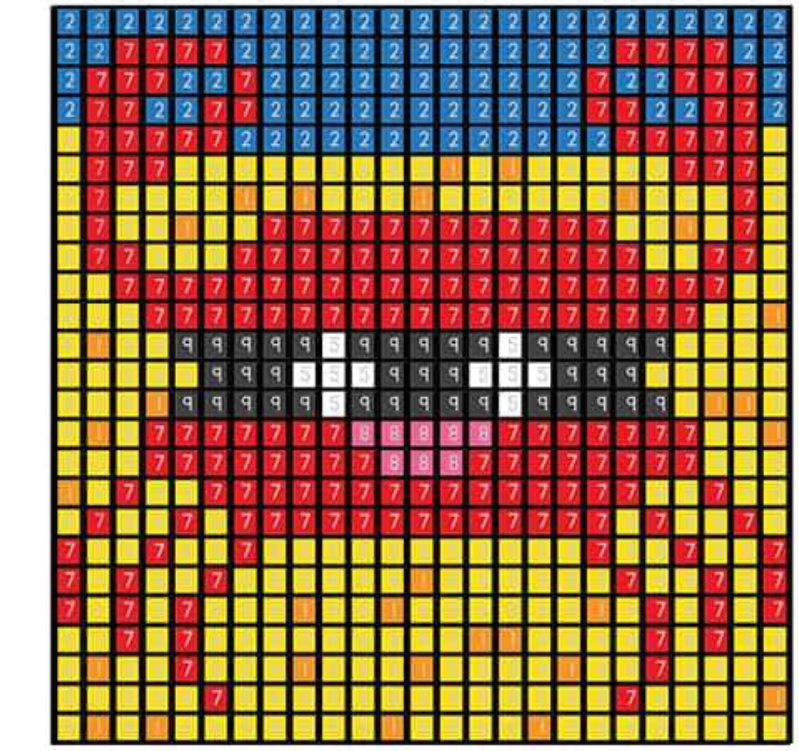
What’s Image

Painting

Photo

Computer Graphics Rendering

Naive Representation



Summer I

Pixel Perfect Pictures

Use the code below to color the grid and reveal the picture.

1 = Orange	3 = Peach	5 = White	7 = Red	9 = Black
2 = Blue	4 = Brown	6 = Yellow	8 = Pink	

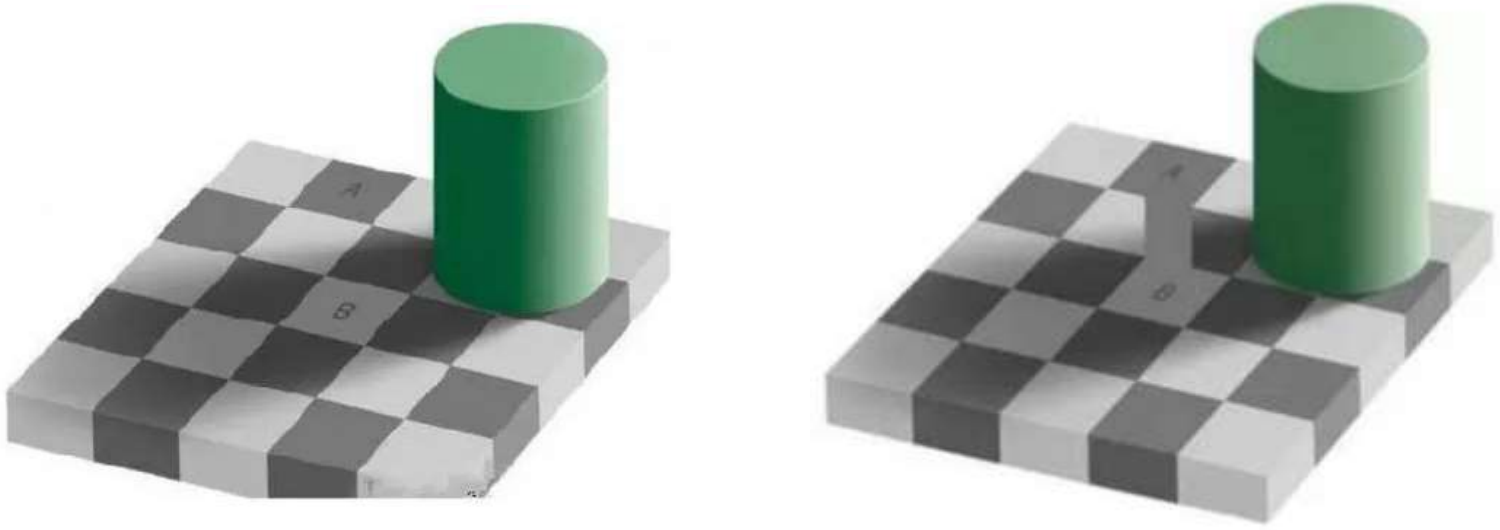
SUPERSTAR WORKSHEETS

The set of Pixels

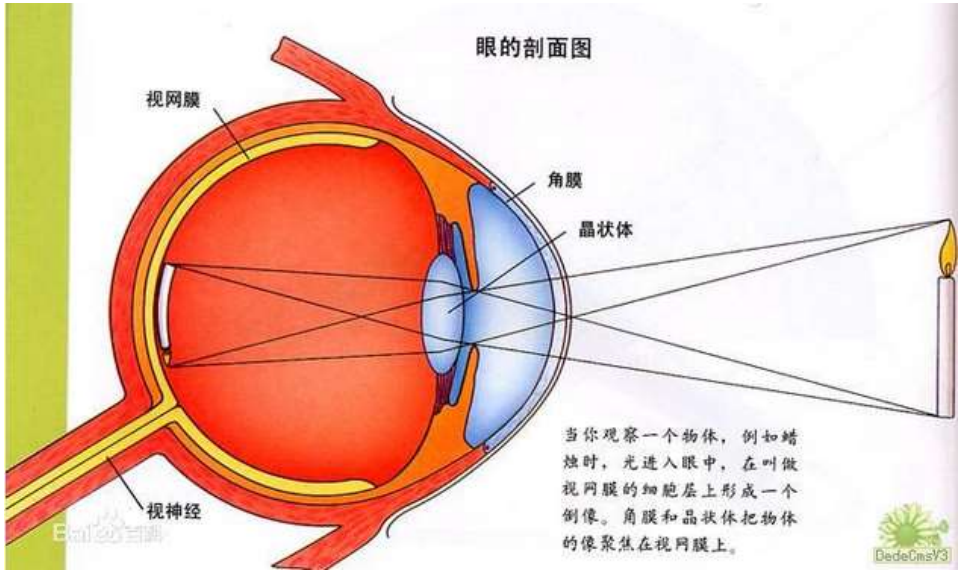
Colors的有序排列

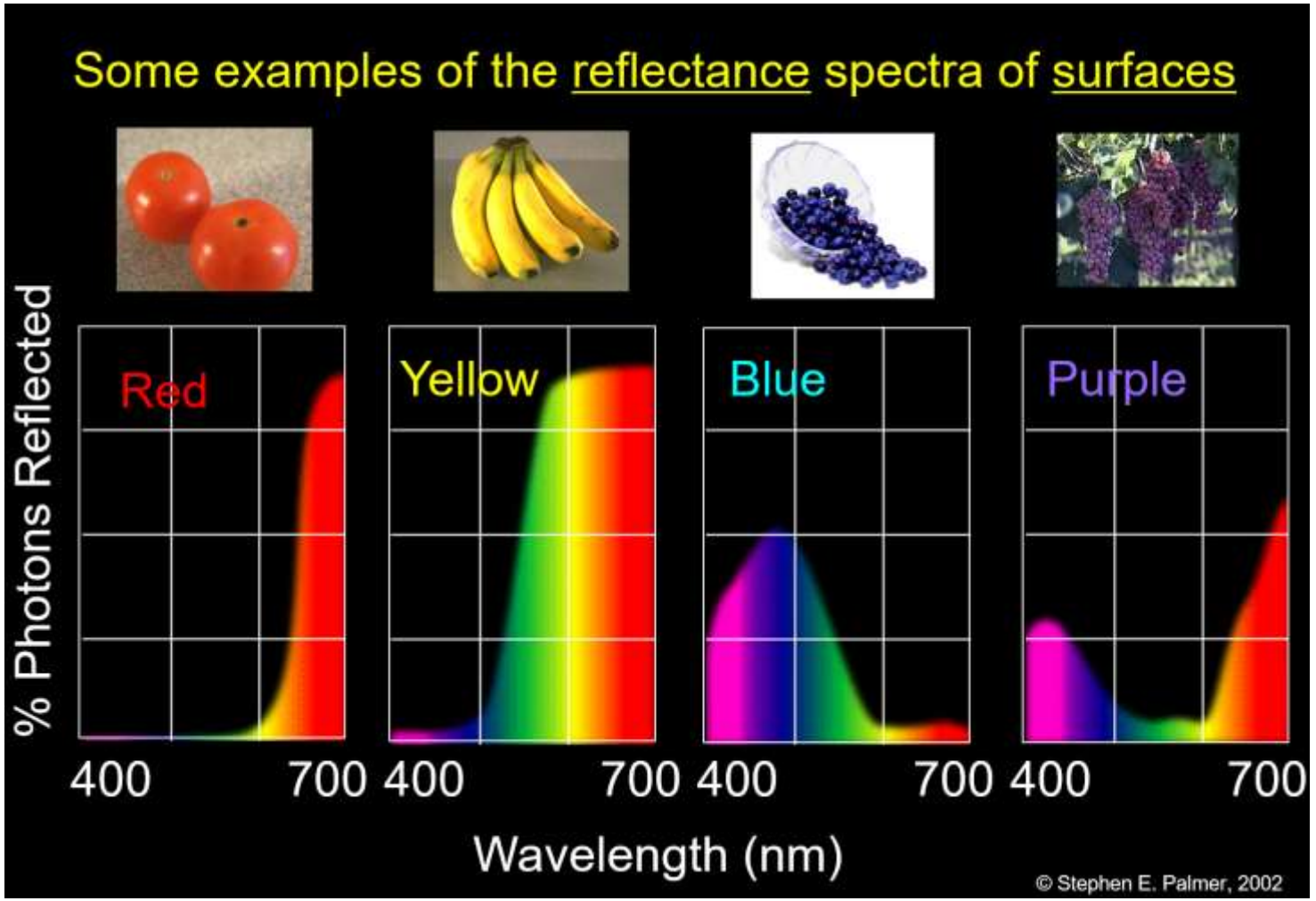
色彩如何产生

- 客观物理因素
  - 光
  - 材质
- 视觉感知因素



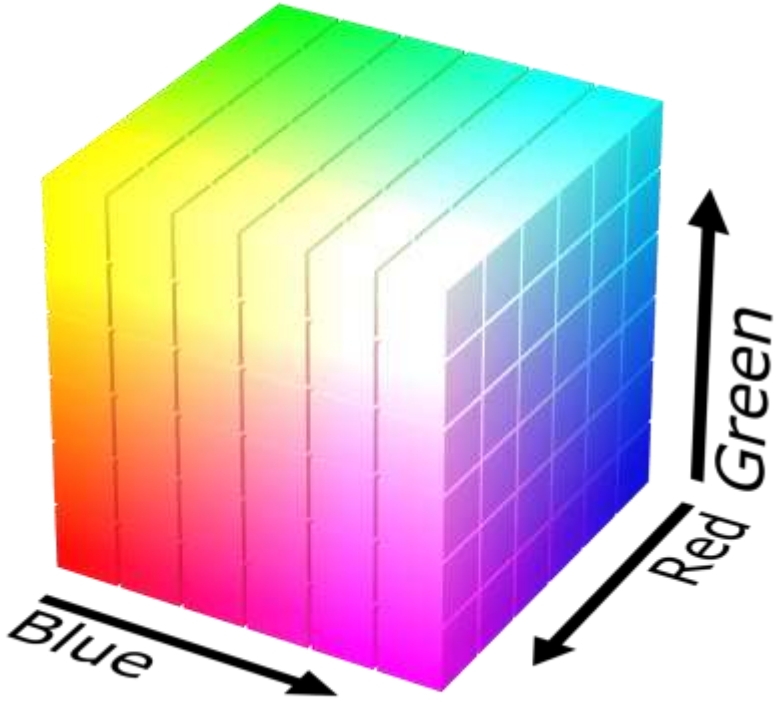
人类如何感知色彩


眼的剖面图
视网膜
角膜
晶状体
视神经
当你观察一个物体，例如蜡烛时，光进入眼中，在叫做视网膜的细胞层上形成一个倒像。角膜和晶状体把物体的像聚焦在视网膜上。


Some examples of the reflectance spectra of surfaces
% Photons Reflected
Red
Yellow
Blue
Purple
400
700
Wavelength (nm)
© Stephen E. Palmer, 2002

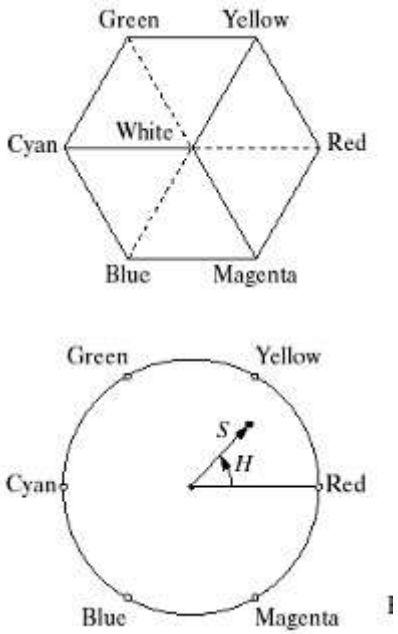
Digitalization of Color

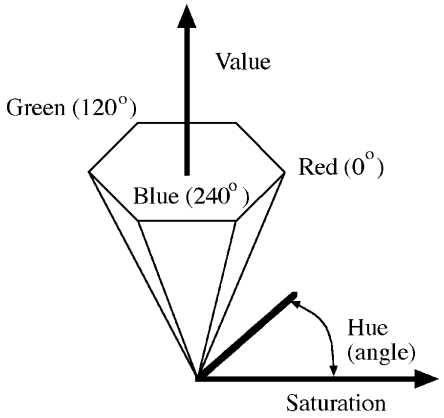
Color = a R + b G + c B

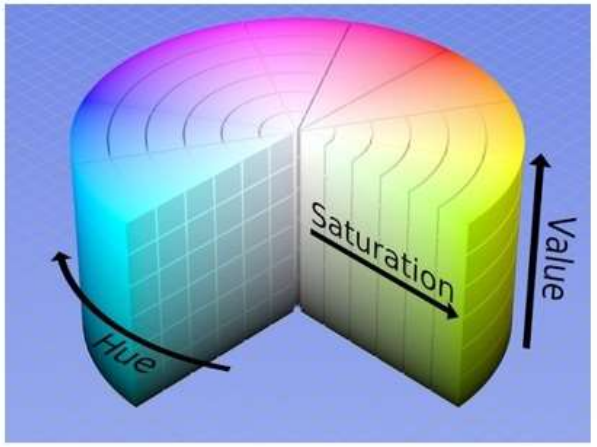


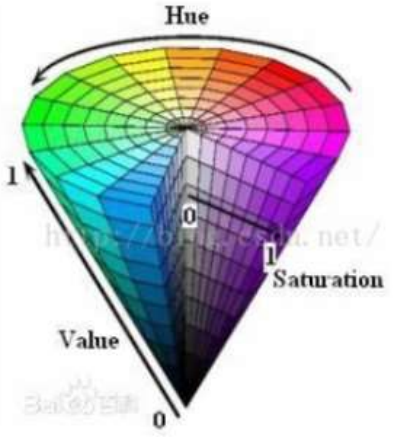
颜色三原色：红、绿、蓝

Different Spaces of Color





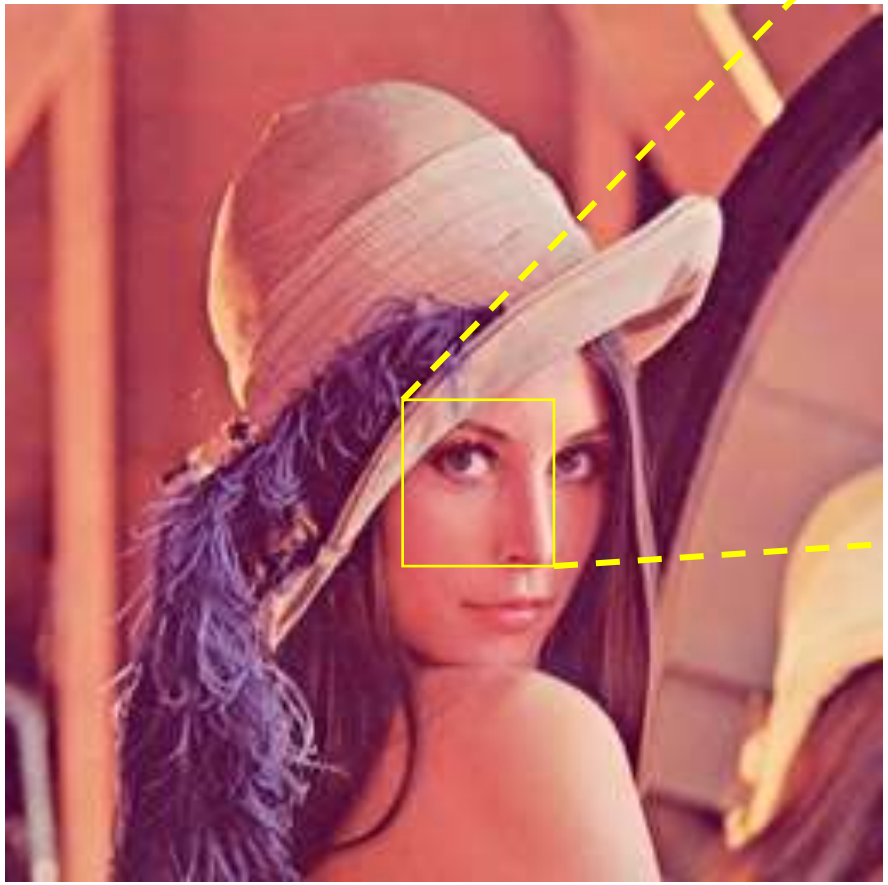


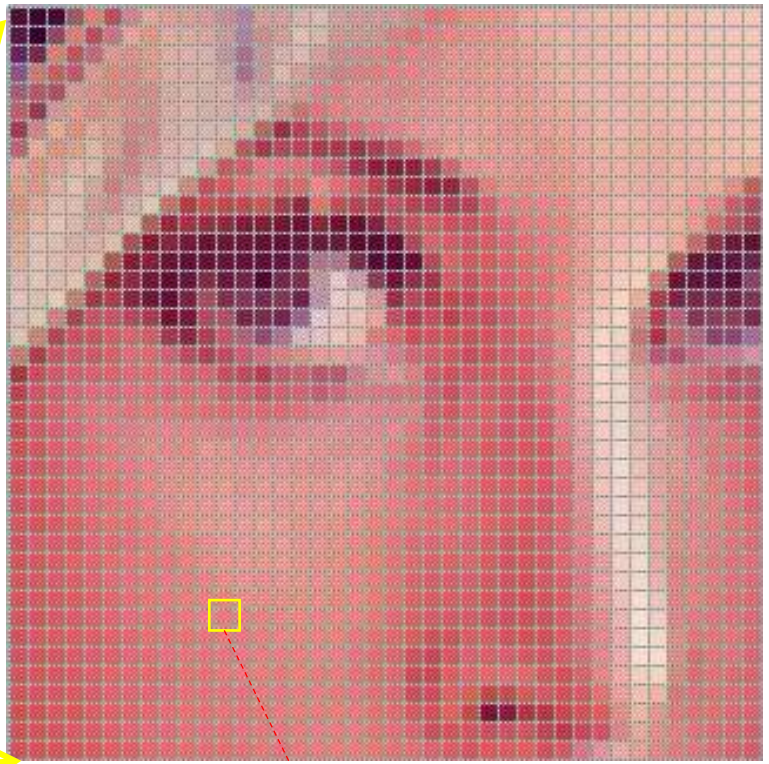


- RGB
- HSV/HSL
- CMY
- CIE XYZ
- $l\alpha\beta$

- Hue（色度）, Saturation （饱和度）, Value /Lightness（亮度/值）
  - RGB cube on its vertex
- Decouples the three components (a bit)
- Use rgb2hsv() and hsv2rgb() in Matlab

RGB Image Representation





0.6 R + 0.3 G + 0.1 B

如何产生图像

Paint:利用物理材料创造想象世界

Non-professional paintings

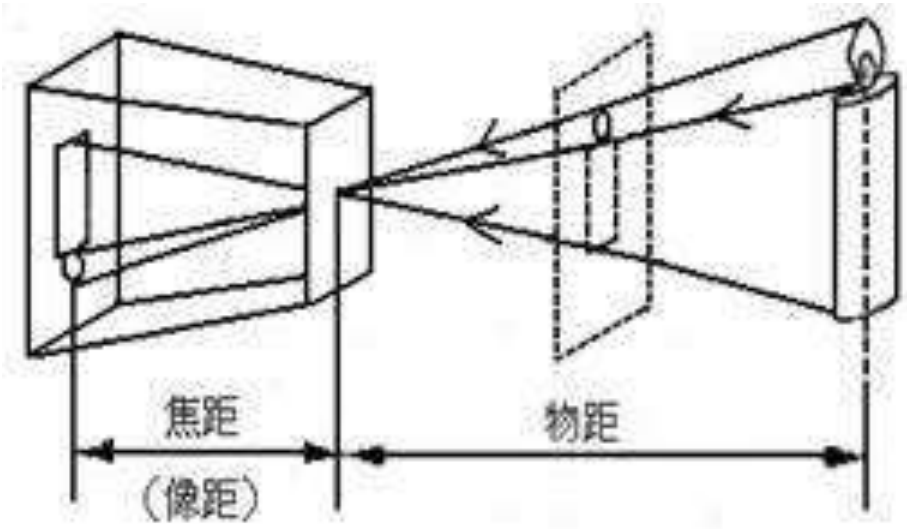
Professional painting arts

Photorealistic paintings

FILM:模拟人眼感光成像过程

Daguerrotype, 1839

针孔成像原理


焦距
（像距）
物距

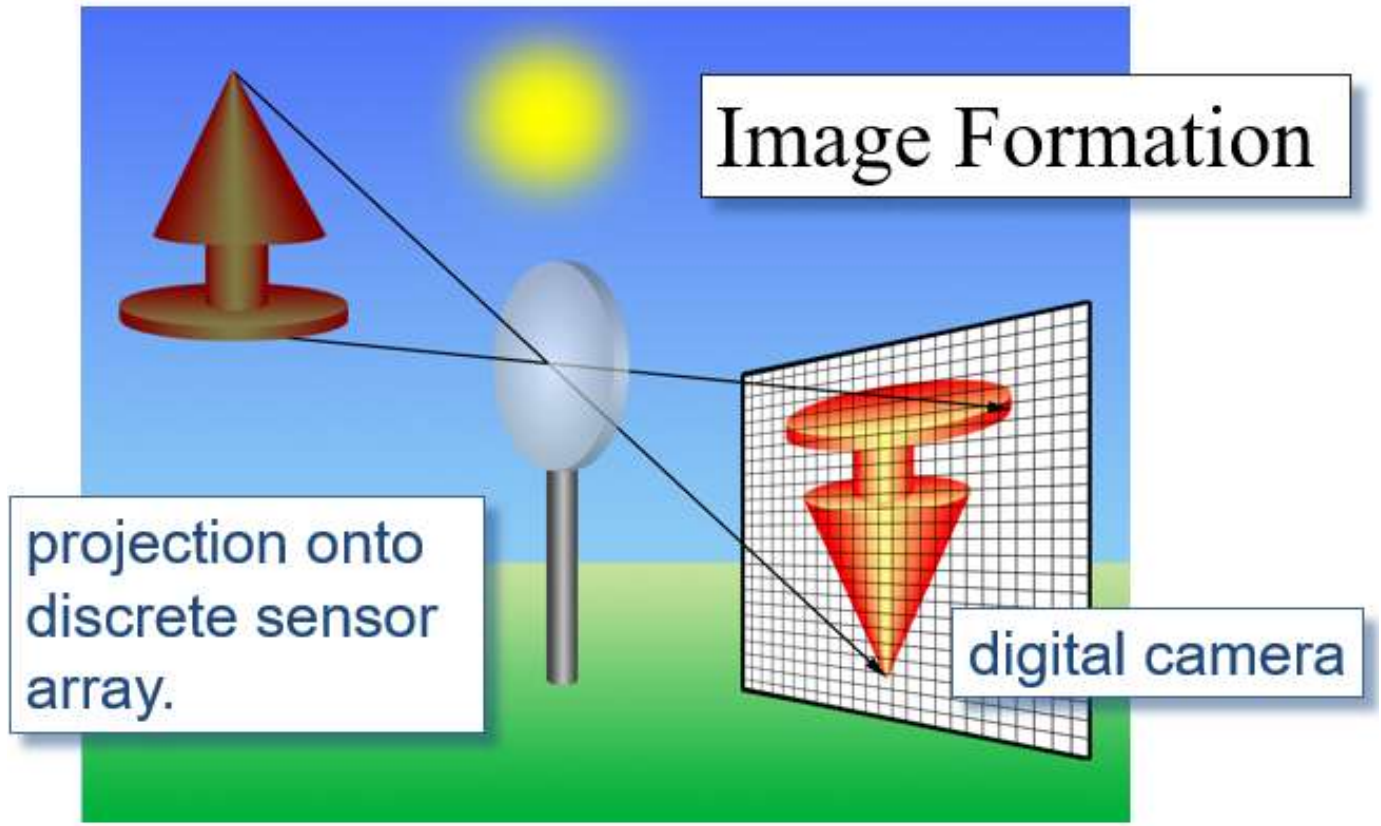


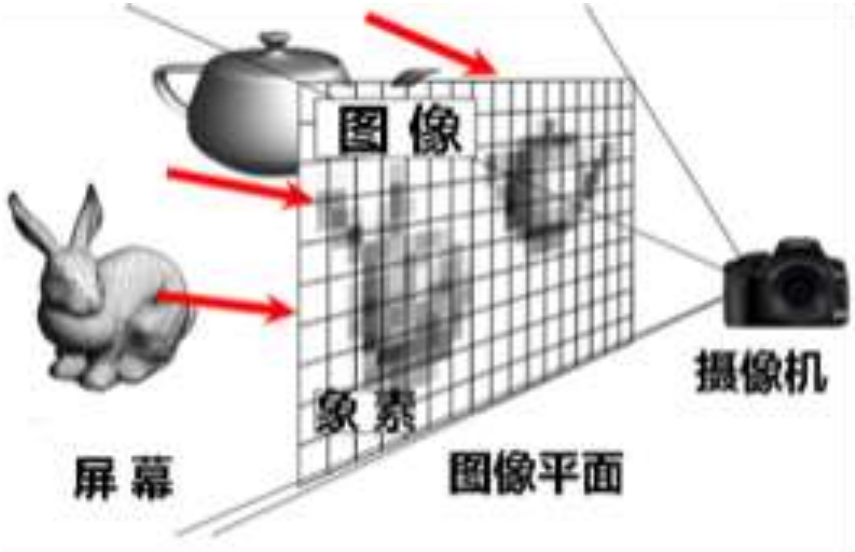
Image Formation
projection onto discrete sensor array.
digital camera

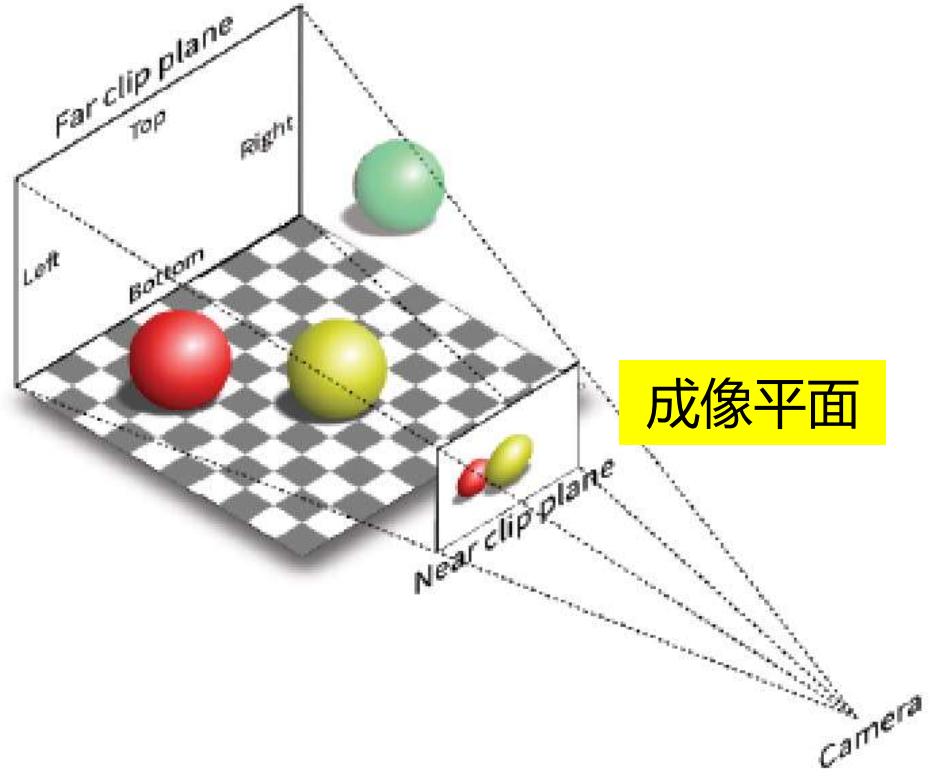
Graphics Rendering: 建模+渲染

输出：照片级图片

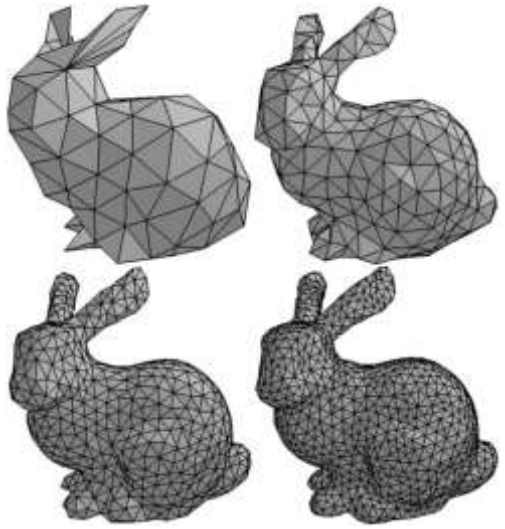
输入：几何、材质、纹理、光源、视点…

Graphics Rendering: 建模+渲染





Graphics Rendering: 建模+渲染



建模（设计）
Modeling

动画（仿真）
Animation

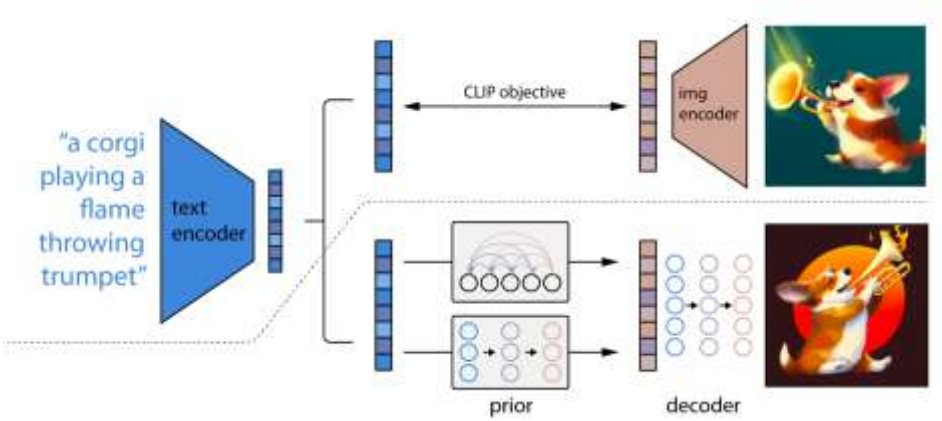
渲染（绘制）
Rendering

仿几何之真　　仿运动之真　　仿色彩之真

刘利刚老师：《计算机图形学》（2020）本科课程（含课件、录频、编程作业）
http://staff.ustc.edu.cn/~lgliu/Courses/ComputerGraphics_2020_spring-summer/default.htm

AI合成: 深度生成模型

StyleGans



Diffusion Models

Video: Image + Time Dimension

Video产生

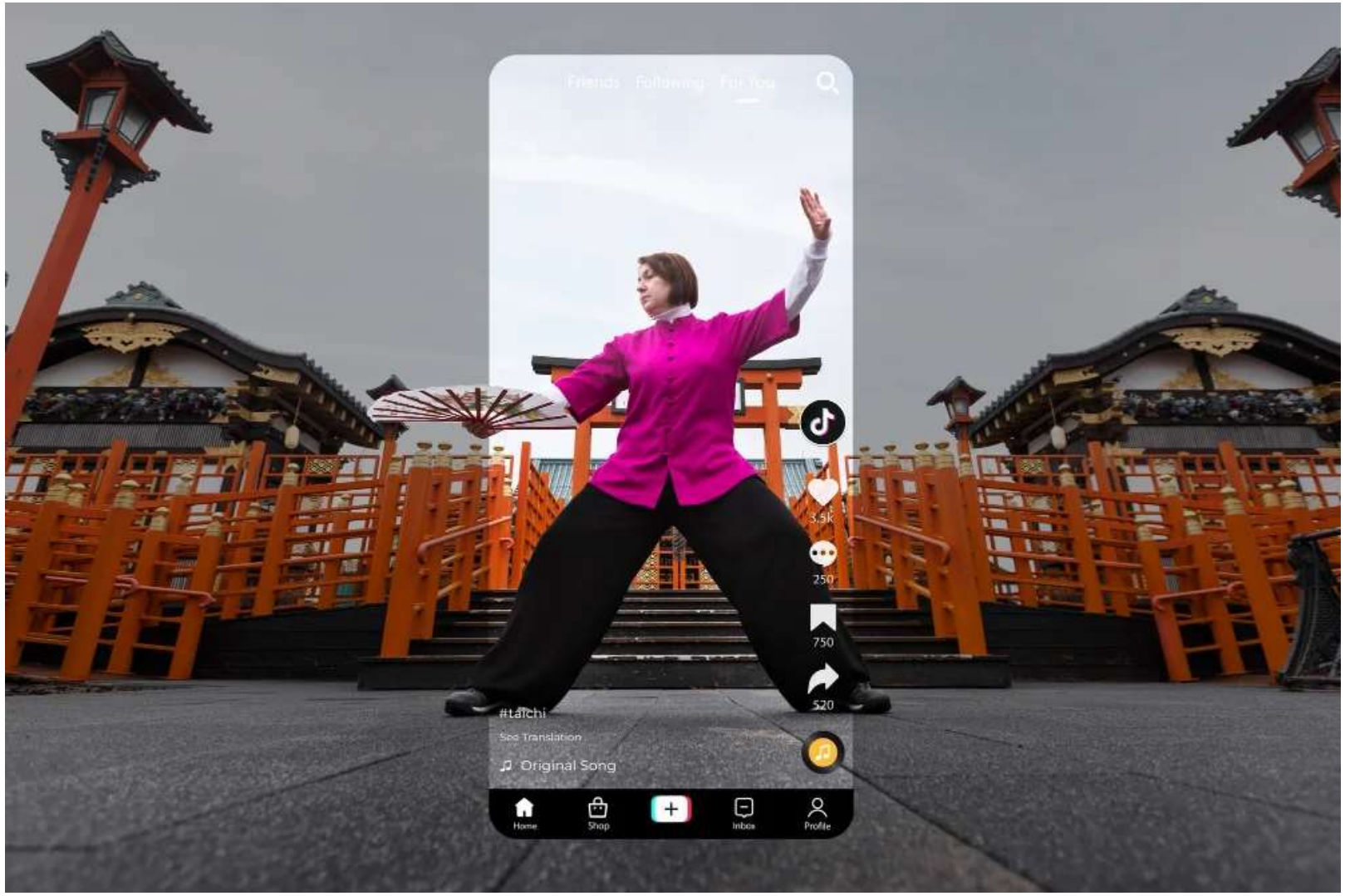
Prompt: A stylish woman walks down a Tokyo street filled with warm glowing neon and animated city signage. She wears a black leather jacket, a long red dress, and black boots, and carries a black purse. She wears sunglasses and red lipstick. She walks confidently and casually. The street is damp and reflective, creating a mirror effect of the colorful lights. Many pedestrians walk about.

数字图像处理

Processing Part

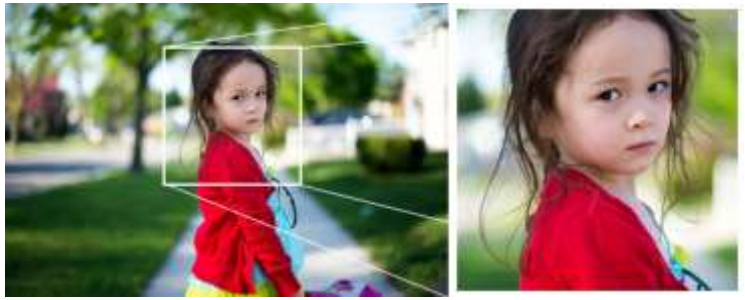
- 有哪些形式的图像处理
- 这些处理有什么用：Applications
- 大概是怎么实现的

Basic — 图像裁剪 / 变形

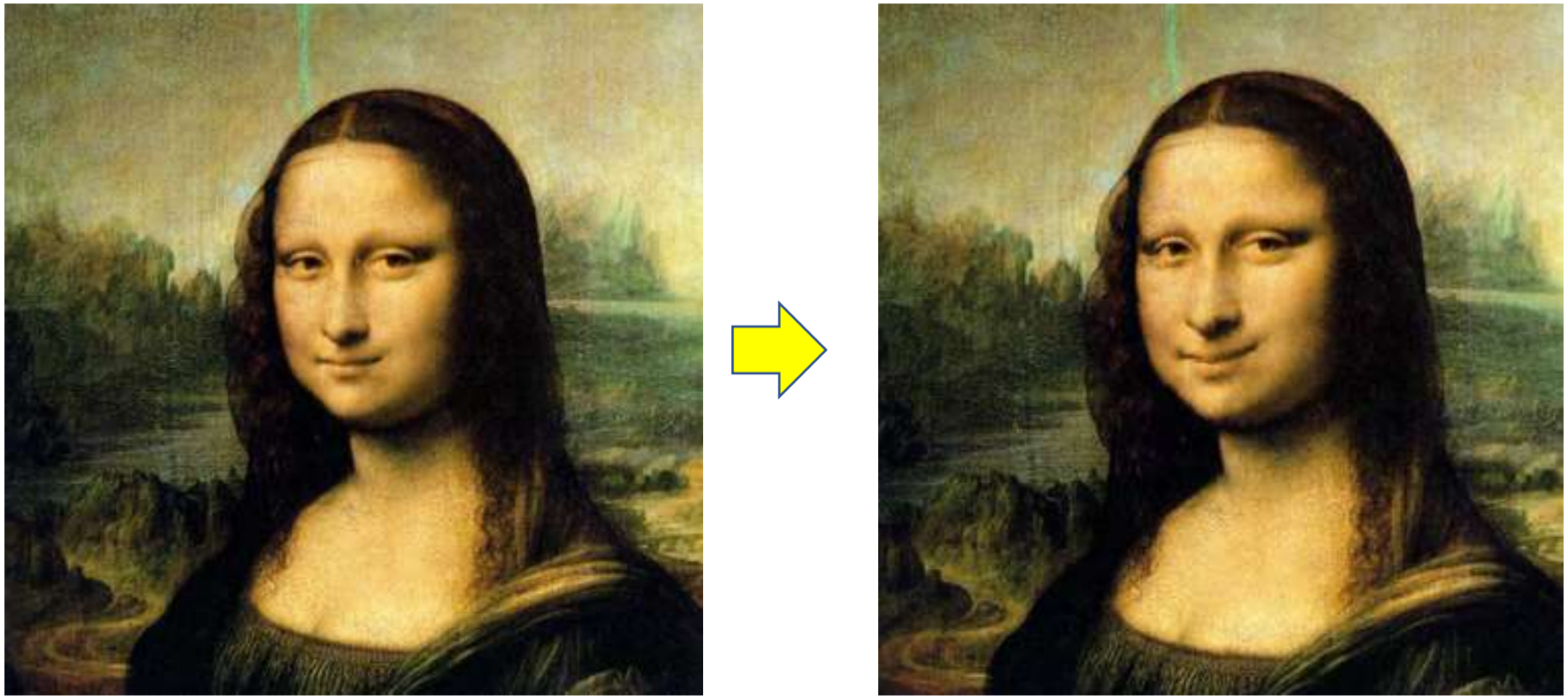


电脑直播->
手机直播

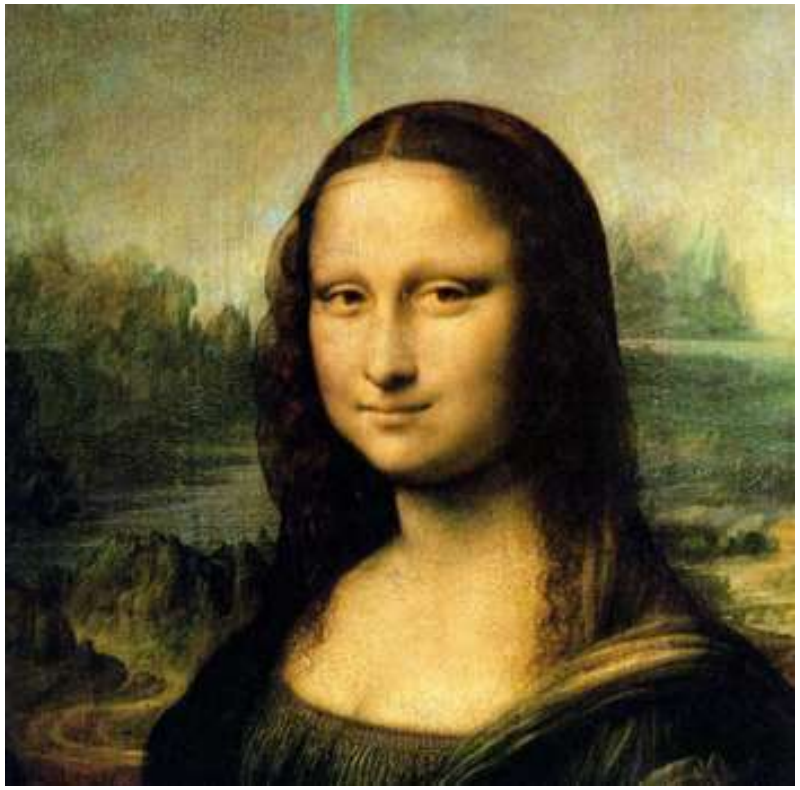
突出主体

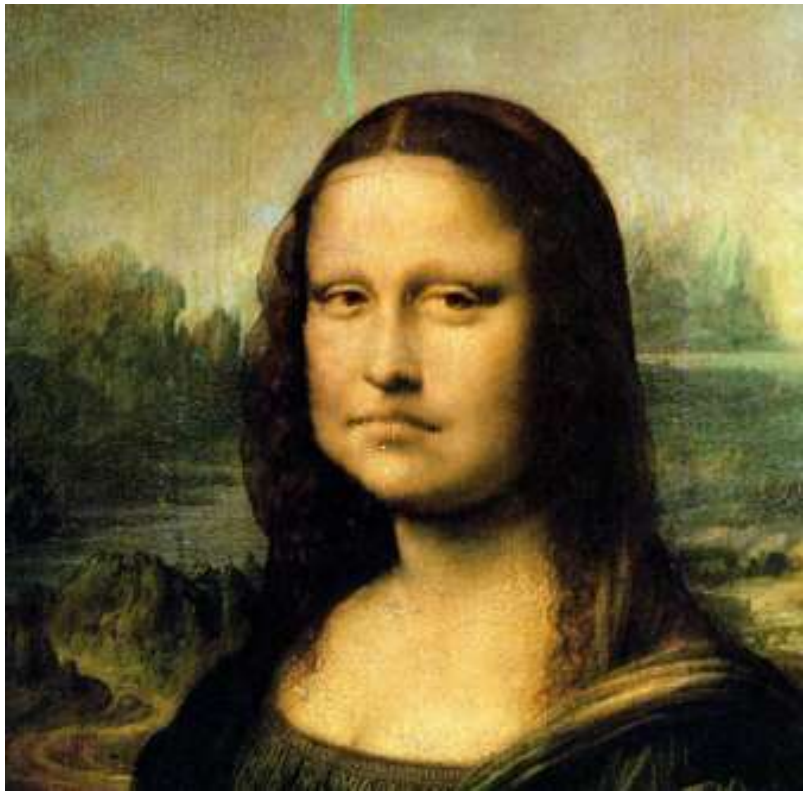


Basic — 图像裁剪 / 变形

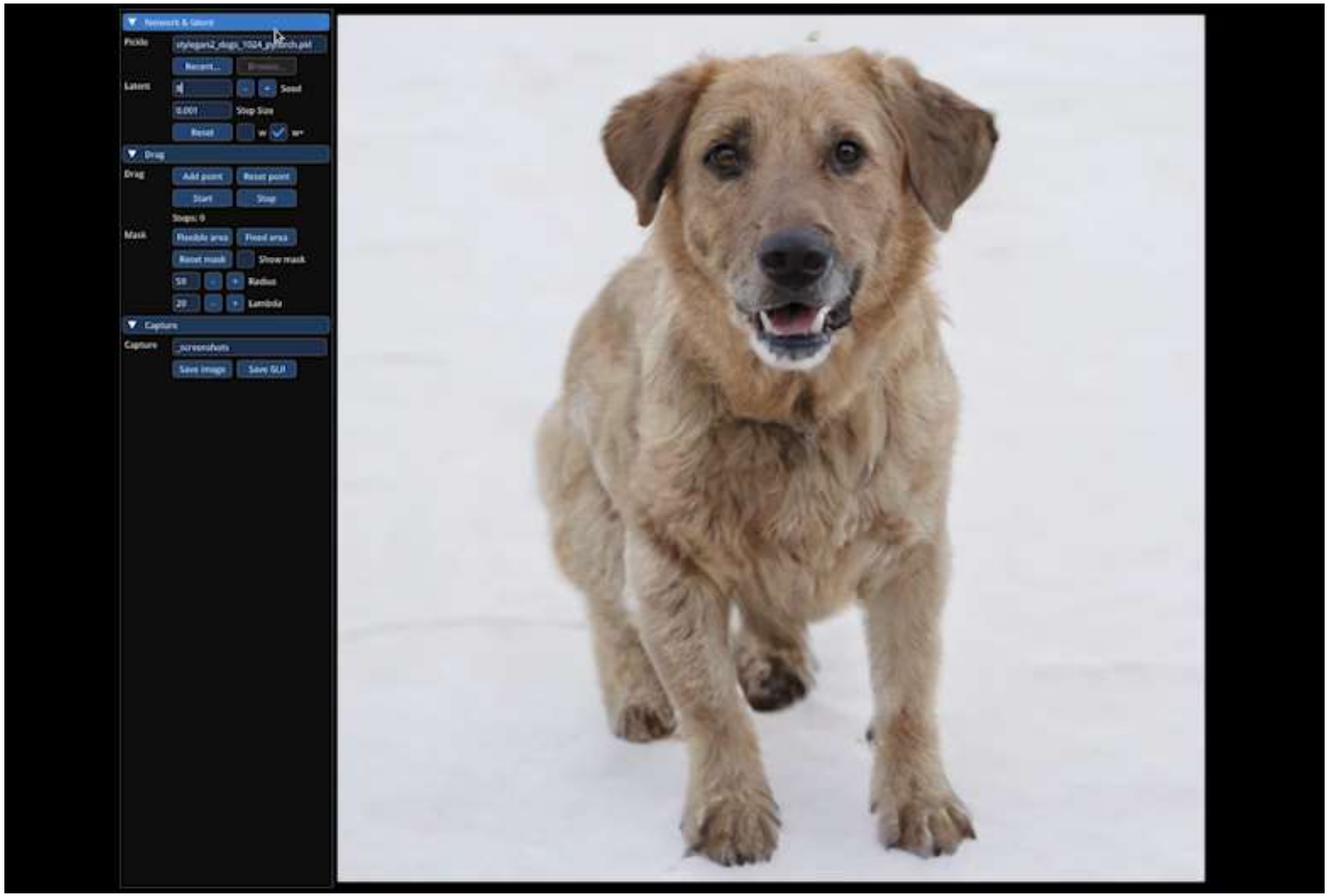


Basic — 图像裁剪 / 变形





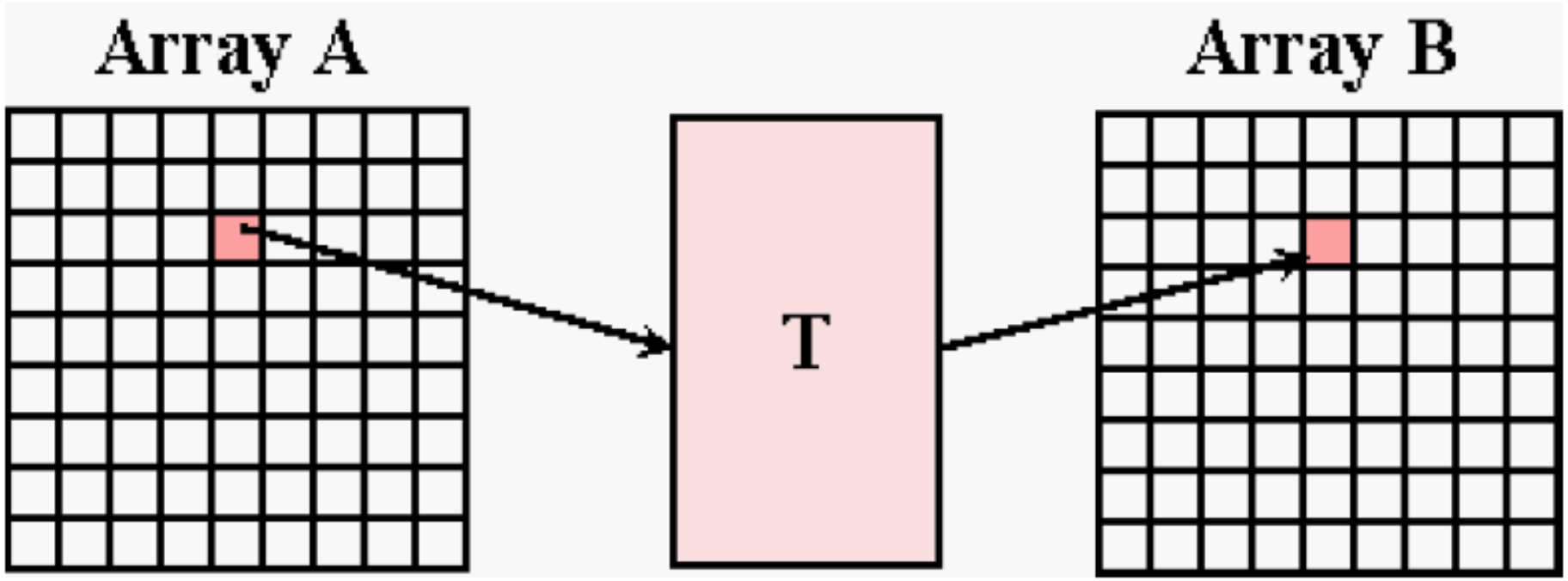
Basic — 图像裁剪 / 变形



[Drag Your GAN]

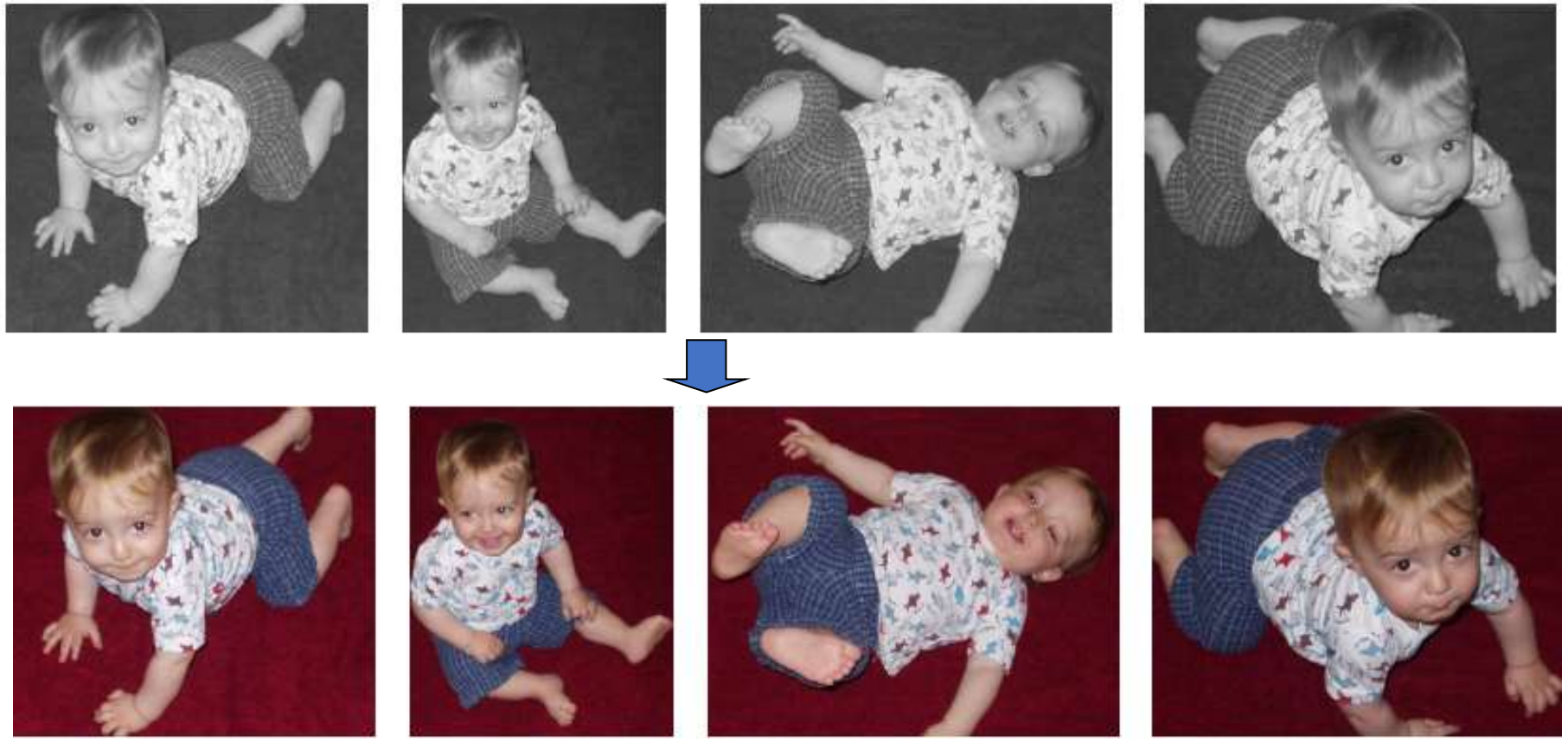
图像裁剪 / 变形 Basic Idea

$$\mathbf{B}[x, y] = T\big[\mathbf{A}[x, y]\big]$$

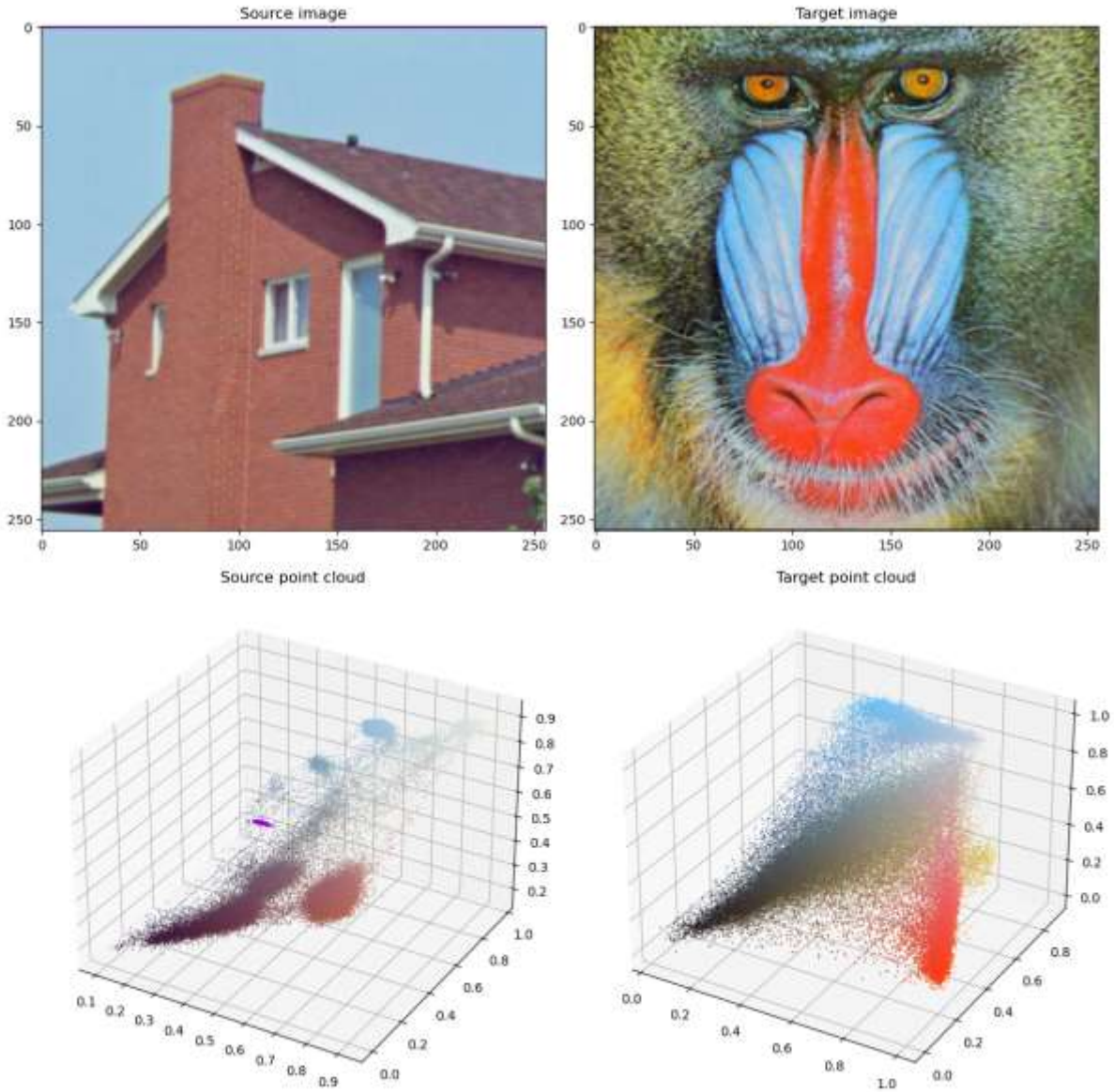


Basic — 图像颜色变换

Basic — 图像颜色变换

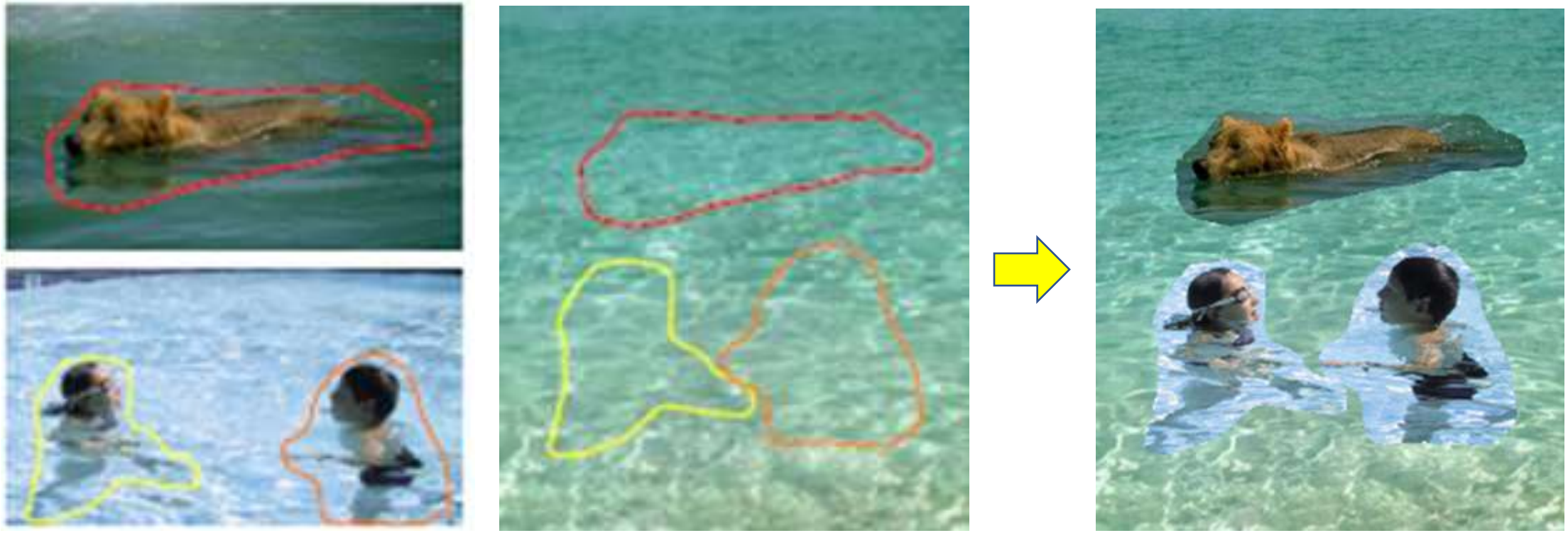


图像颜色变换Basic Idea



把图像看作颜色分布

两类变换复合



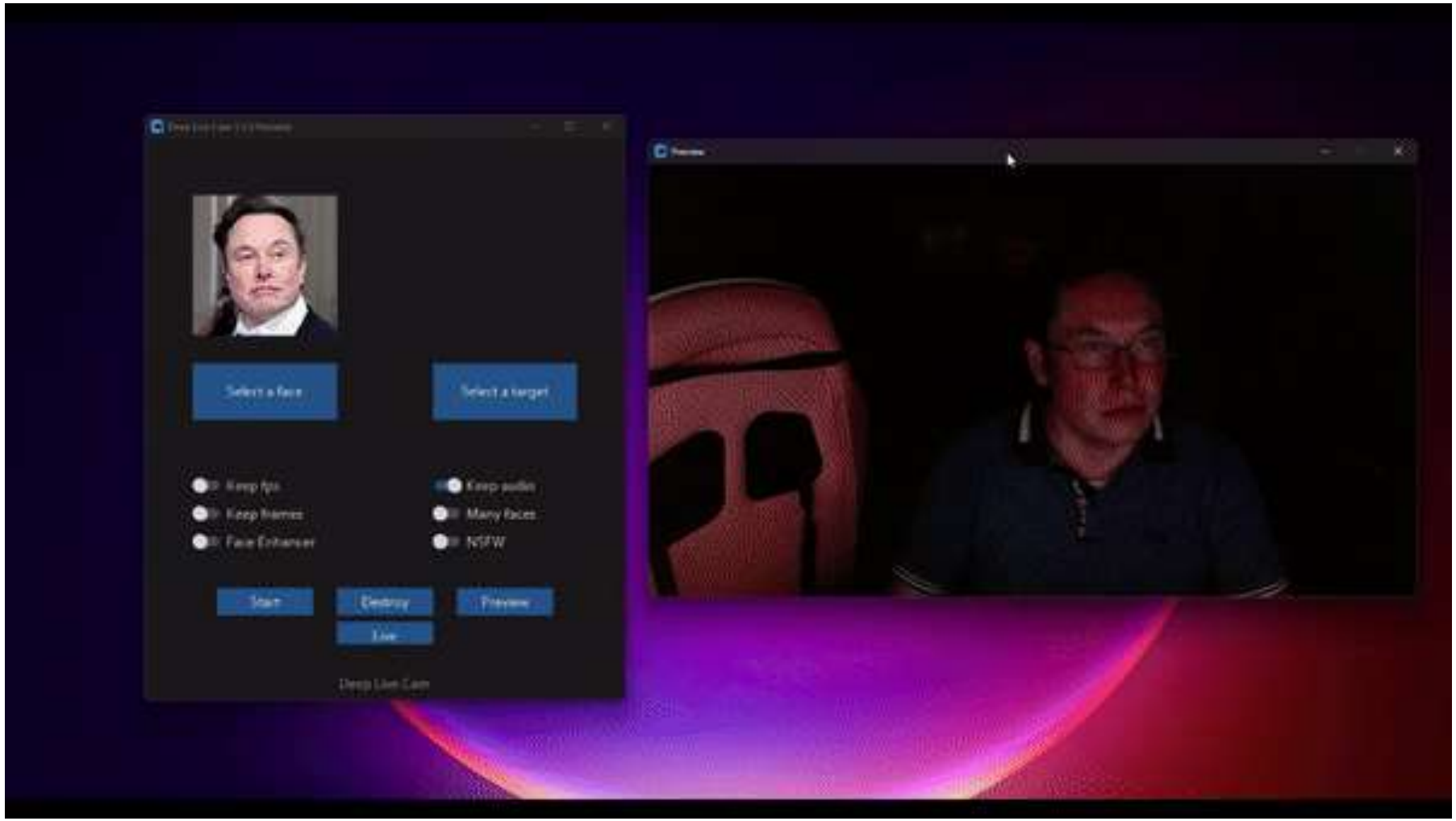
两类变换复合

cloning

seamless cloning

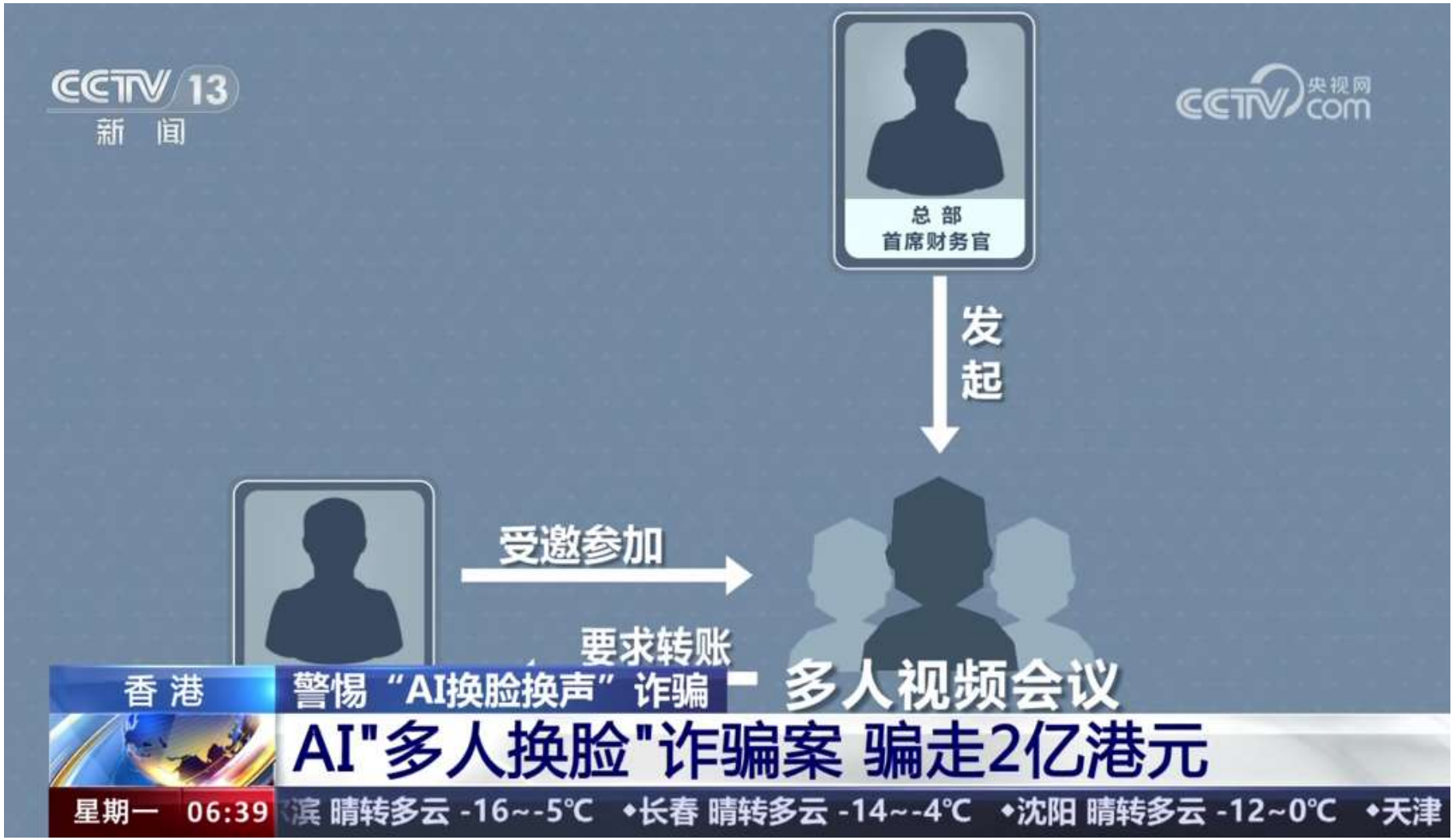
进阶 — 图像/视频美颜

视频换脸



https://github.com/hacksider/Deep-Live-Cam

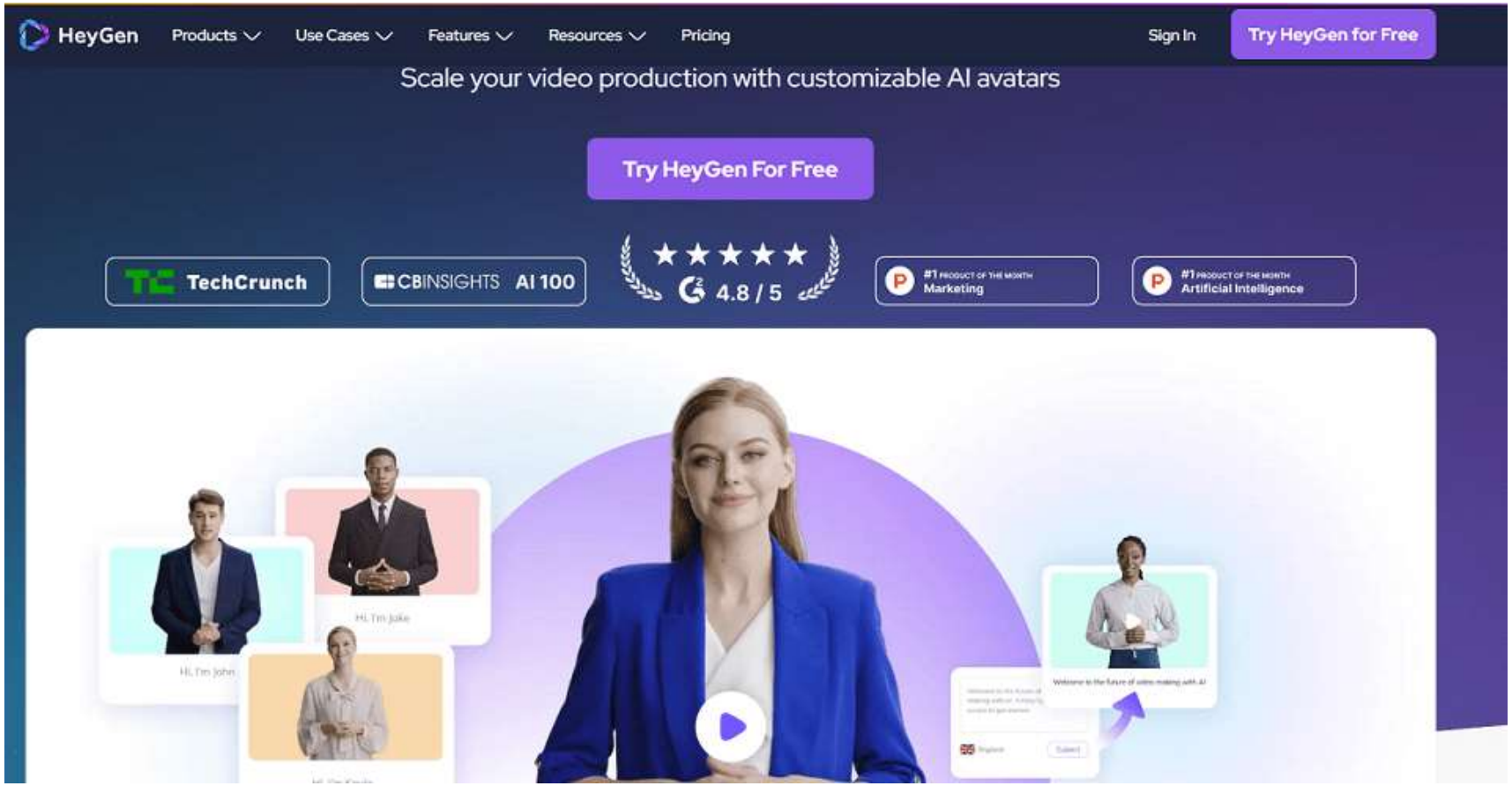
视频换脸


CCTV 13
新 闻
CCTV 央视网 .com
总 部
首席财务官
发
起
受邀参加
要求转账
多人视频会议
香 港
警惕“AI换脸换声”诈骗
AI"多人换脸"诈骗案 骗走2亿港元
星期一 06:39
滨 晴转多云 -16~-5℃
长春 晴转多云 -14~-4℃
沈阳 晴转多云 -12~0℃
天津

“霉霉说中文”

https://github.com/YudongGuo/AD-NeRF

财富密码



HeyGen获5亿美元估值融资6000万美元

06-27 08:52 听新闻

作者：一财科技 责编：宁佳彦 举报

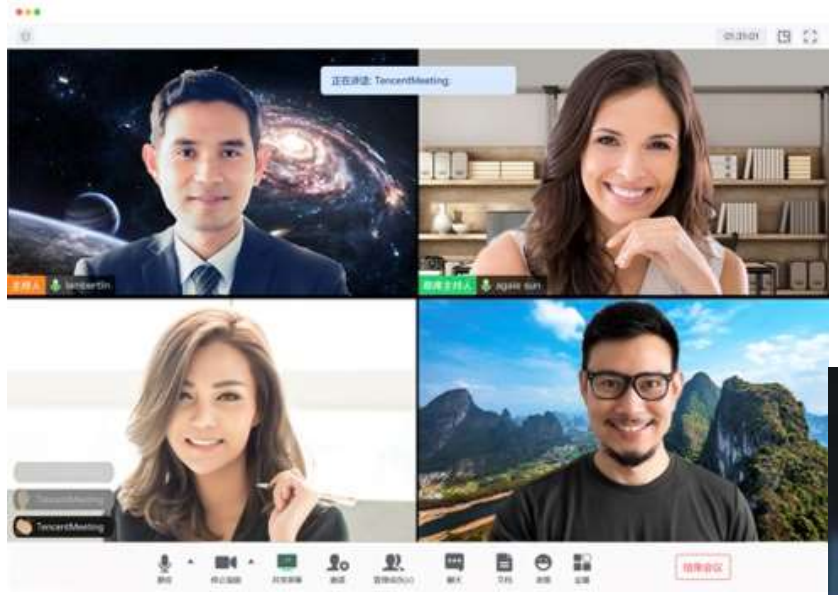
人工智能初创公司HeyGen可以让使用者快速建立外形逼真的头像，该公司已按照5亿美元的估值在融资轮中筹集了6000万美元。

此轮融资由Benchmark领投，Conviction、Thrive Capital和Bond Capital等参投。作为交易的一部分，Benchmark的合伙人拉扎尔特（Victor Lazarte）将加入HeyGen董事会。

图像抠图

https://github.com/PeterL1n/RobustVideoMatting

图像抠图 — 换背景



https://www.bilibili.com/video/BV1ZT4y117Qy/

合照生成

生成艺术照


妙鸭相机
封面照经本人授权使用
真实照片
制作数字分身
生成写真
精修下载
STEP 1
STEP 2
STEP 3
生成我的写真


默片
更换动作
更换模板

图像/视频超分

https://github.com/IceClear/StableSR

老电影修复

https://github.com/sczhou/Upscale-A-Video

深度、法向图

https://fuxiao0719.github.io/projects/geowizard/

AR Effects


CAMERA
Abra
CP 113

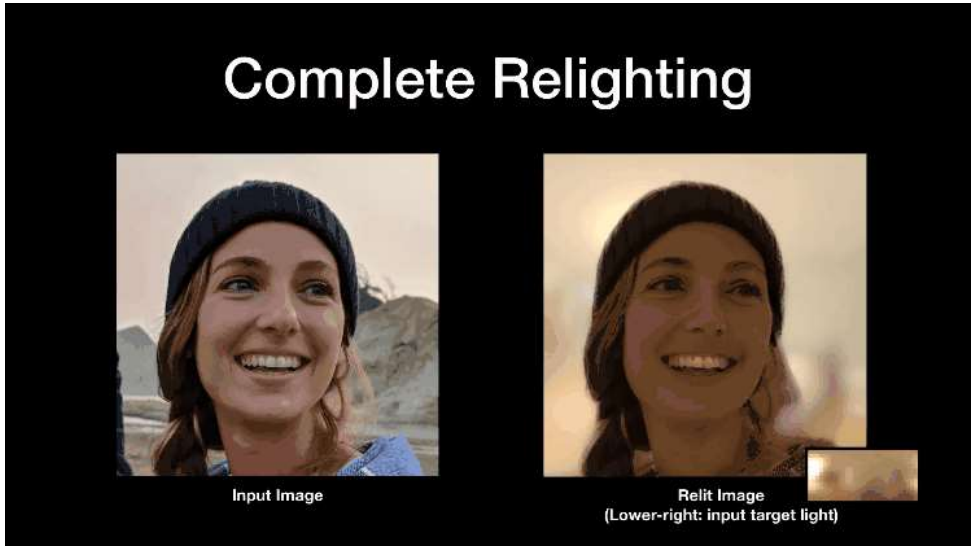

Complete Relighting
Input Image
Relit Image
(Lower-right: input target light)

Image to 3D

https://sv3d.github.io/

Image Animation

https://humanaigc.github.io/emote-portrait-alive/

Image to Video

课程相关事项

课件及作业主页

https://github.com/YudongGuo/DIP-Teaching

通过本课程，理想情况你能学到：

- 了解图像处理的数学建模思维和方法
- 理解上述图像/视频处理的最新进展与基本原理
- 实现科研项目的方法：文献阅读、数学建模、算法实现
  - （自学）熟练掌握计算机视觉/图形学相关的编程工具
  - 通关多次作业熟练掌握视觉相关科研项目实现的完整流程

没有教材，以在线教程、文献、github为主

- 编程基础较弱的同学建议自学slides前面列的在线教程
- 建议课下阅读课程中提到的英文文献
- 初期作业会提供实现的大概框架，后期不提供
- 需要投入精力在工程实现上，严禁抄袭作业

课程作业和考试

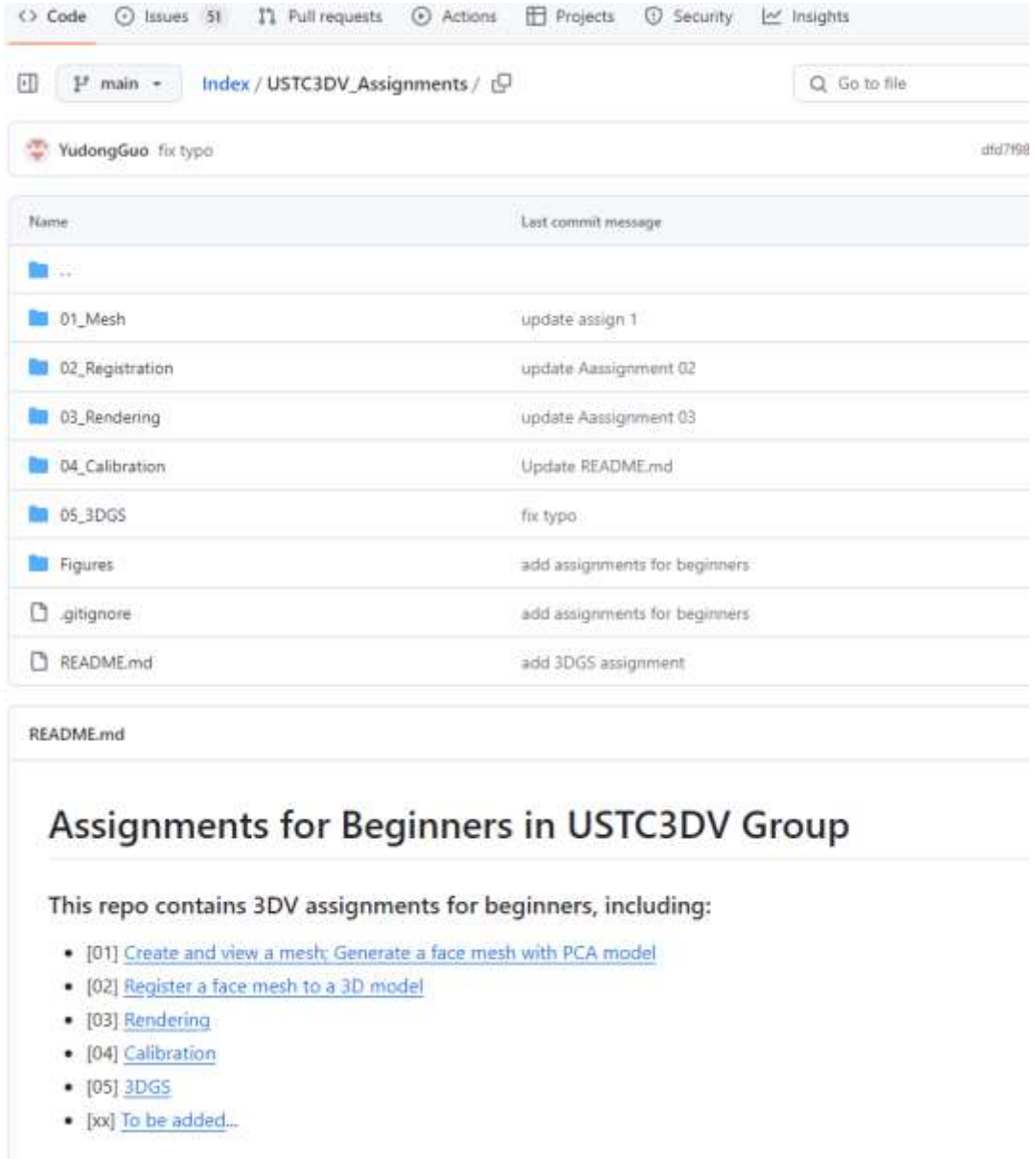
- 平时程序作业：70%，估计4-5次
- 期末大程序作业：30%

作业提交及要求

- 作业递交通过创建github repo
- 每位同学发送github作业repo链接到

我的邮箱gyd2011@mail.ustc.edu.cn

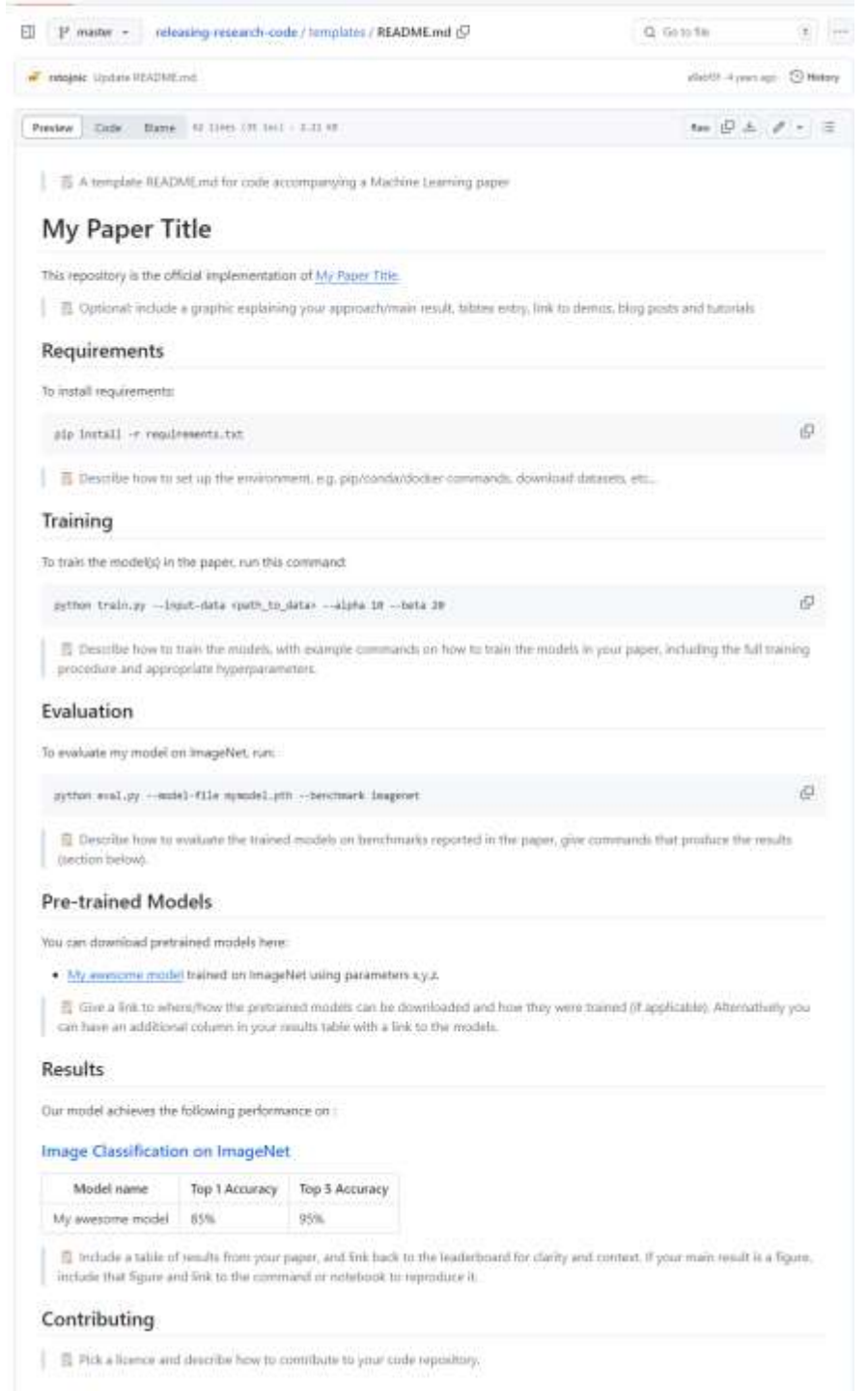
- 后面作业在自己repo下创建子文件夹



作业格式要求

- 作业报告：类论文
  - 代码运行的说明，包括installation, running script
  - 明确的输入和输出
  - 测试结果和分析、小结等，可附图片或视频链接
  - 若是合作项目，需说明具体分工
  - 报告需规范
  - 在报告中说明所参考的来源：参考论文、代码等

https://github.com/paperswithcode/releasing-research-code/blob/master/templates/README.md



master · releasing-research-code / templates / README.md

Preview Code Blame

A template README.md for code accompanying a Machine Learning paper

My Paper Title

This repository is the official implementation of My Paper Title.

Optional: include a graphic explaining your approach/main result, bibtex entry, link to demos, blog posts and tutorials

Requirements

To install requirements:

```
pip install -r requirements.txt
```

Describe how to set up the environment, e.g. pip/conda/docker commands, download datasets, etc...

Training

To train the model(s) in the paper, run this command:

```
python train.py --input-data <path_to_data> --alpha 10 --beta 20
```

Describe how to train the models, with example commands on how to train the models in your paper, including the full training procedure and appropriate hyperparameters.

Evaluation

To evaluate my model on ImageNet, run:

```
python eval.py --model-file mymodel.pth --benchmark imagenet
```

Describe how to evaluate the trained models on benchmarks reported in the paper, give commands that produce the results (section below).

Pre-trained Models

You can download pretrained models here:

- My awesome model trained on ImageNet using parameters x,y,z.

Give a link to where/how the pretrained models can be downloaded and how they were trained (if applicable). Alternatively you can have an additional column in your results table with a link to the models.

Results

Our model achieves the following performance on :

Image Classification on ImageNet

Model name	Top 1 Accuracy	Top 5 Accuracy
My awesome model	85%	95%

Include a table of results from your paper, and link back to the leaderboard for clarity and context. If your main result is a figure, include that figure and link to the command or notebook to reproduce it.

Contributing

Pick a licence and describe how to contribute to your code repository.

中国科学技术大学

University of Science and Technology of China

Q & A