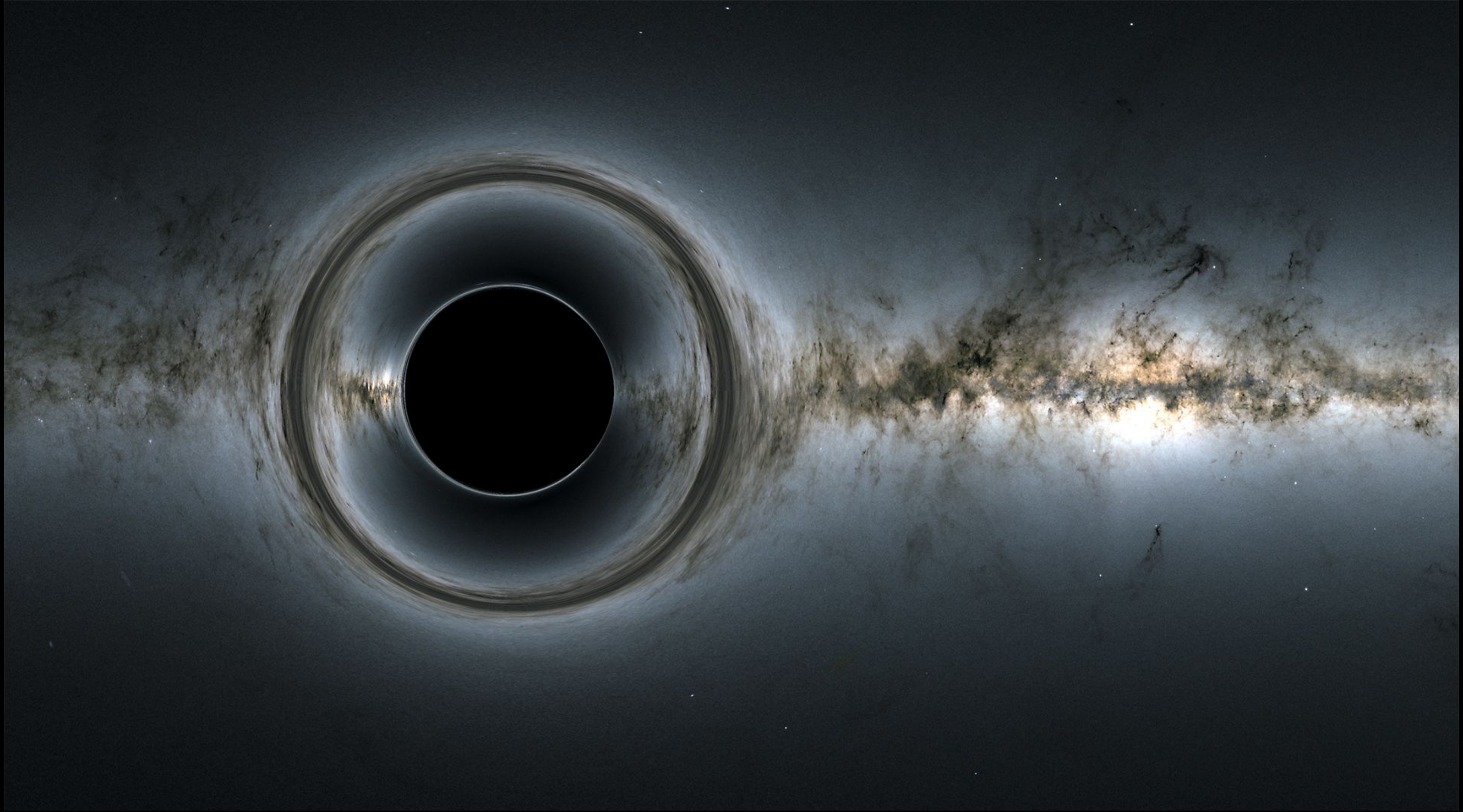
differentiable computer vision

an introduction to kornia

Edgar Riba

Open Source Vision Foundation - OpenCV.org
Computer Vision Center (CVC-UAB) - Institut de Robotica Industrial (CSIC-UPC)



Q: > Where is Classical Computer Vision in Deep Learning ?

A: > ...

Q: > Where is Classical Computer Vision in Deep Learning ?

A: > Black hole area

kornia

Open Source Differentiable Computer Vision Library for PyTorch

kornia

planet Kornia

wiki

+2400 stars

+260 forks

+50 contributors

Apache 2 Licence

THE APACHE SOFTWARE FOUNDATION

kornia

Core features

1. Differentiable
2. Transparent API
3. Parallel Programming
4. Distributed
5. Production → JIT

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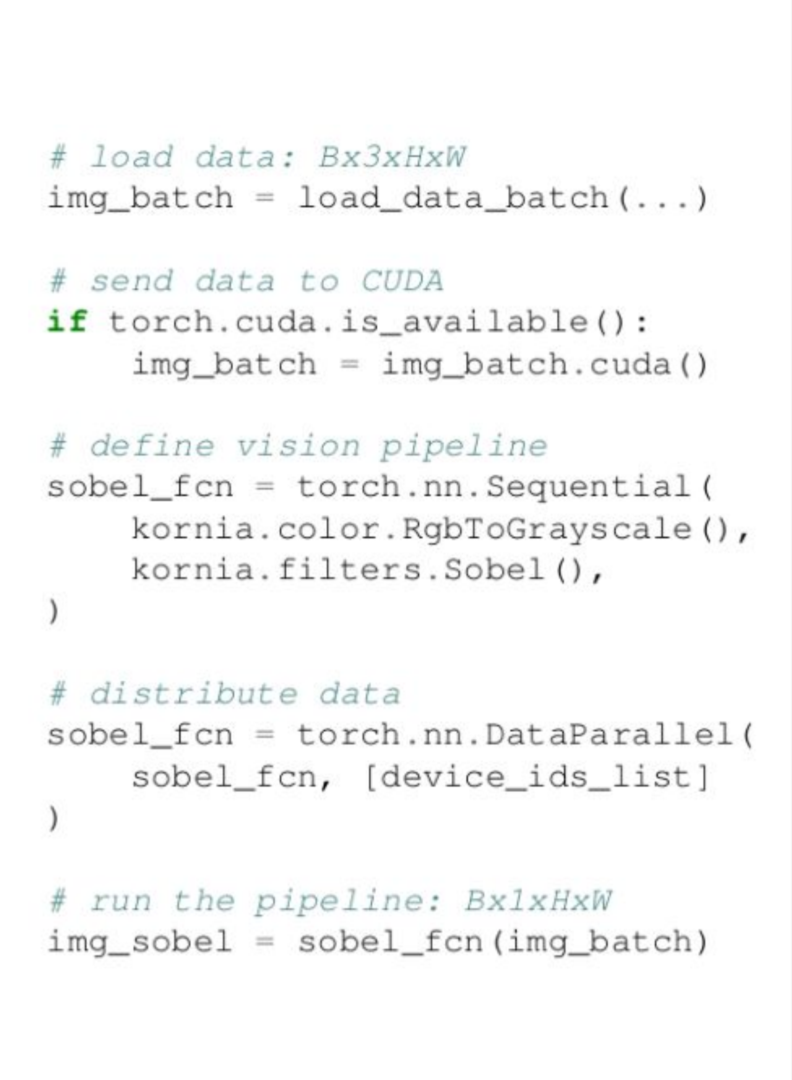
Core features



```
# load data: Bx3xHxW
img_batch = load_data_batch(...)

# send data to CUDA
if torch.cuda.is_available():
    img_batch = img_batch.cuda()

# define vision pipeline
sobel_fcn = torch.nn.Sequential(
    kornia.color.RgbToGrayscale(),
    kornia.filters.Sobel(),
)

# distribute data
sobel_fcn = torch.nn.DataParallel(
    sobel_fcn, [device_ids_list]
)

# run the pipeline: Bx1xHxW
img_sobel = sobel_fcn(img_batch)
```

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Basic functionality

Data augmentation

Image enhancement

Color space conversions

2D feature detection

Image filtering

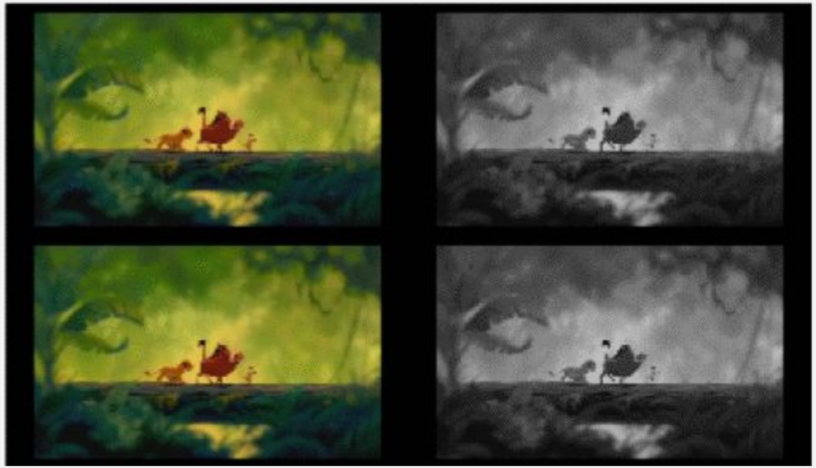
Edge detection

Geometric transformations

3D geometry

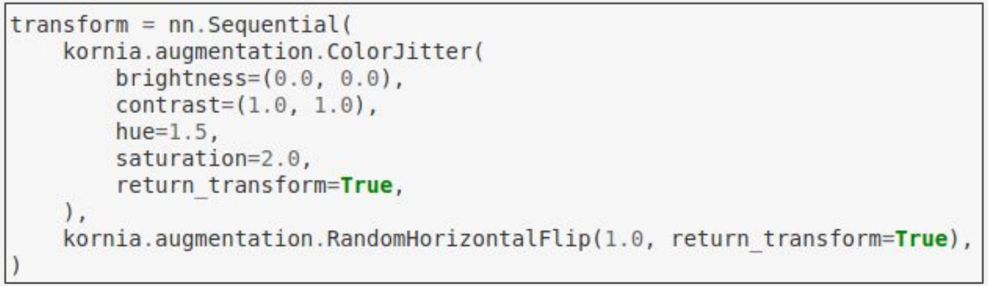
Vision loss functions

kornia



Data augmentation

- Random sampling using *torch.distributions*
- Compatible with torchvision
- Batched, GPU
- Return and chain spatial transforms



```
transform = nn.Sequential(
    kornia.augmentation.ColorJitter(
        brightness=(0.0, 0.0),
        contrast=(1.0, 1.0),
        hue=1.5,
        saturation=2.0,
        return_transform=True,
    ),
    kornia.augmentation.RandomHorizontalFlip(1.0, return_transform=True),
)
```

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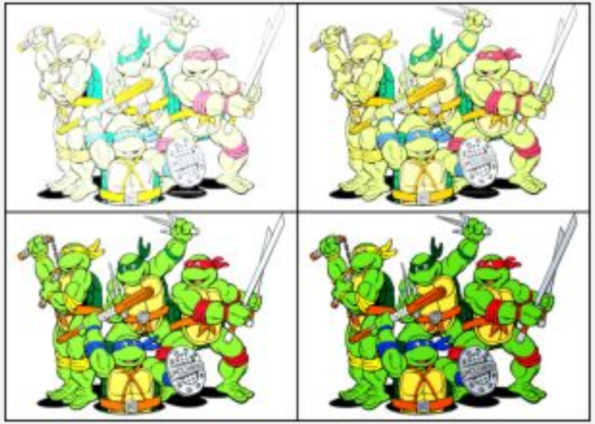
Image Enhancement

- Image tensors normalization
- ZCA mean/whiten
- Image Histogram 1d/2d
- contrast, brightness, gamma, hue, saturation

Gamma



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Color space conversions

- RGB, RGBA, Grayscale
- HSV, HLS
- Luv, Lab
- XYZ, YCbCr, Yuv

RGB to Grayscale

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2D feature detection

- Harris, Hessian, DoG
- Scale Space framework
- NMS , ConvSoftMax2d/3d
- Local Affine Frames (LAF)
- Differentiable SIFT, Deep descriptors

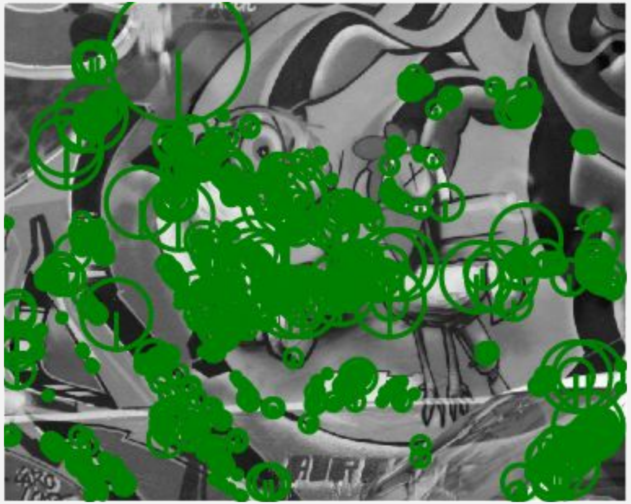

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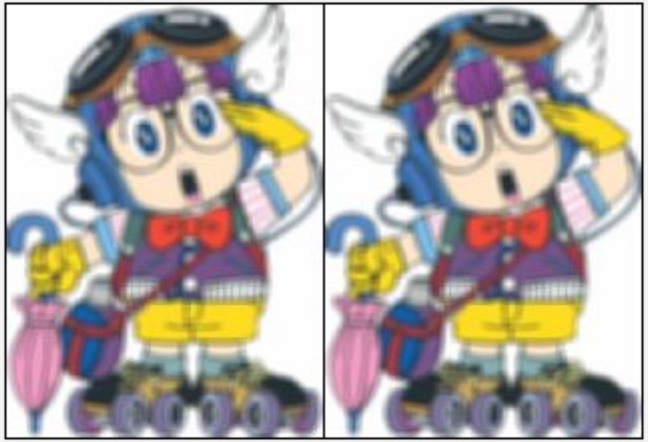
Image filtering

- Filter 2D / 3D
- Kernels API: gaussian, laplacian, sobel
- Blurring: median, box, gaussian, motion

Gaussian Blur



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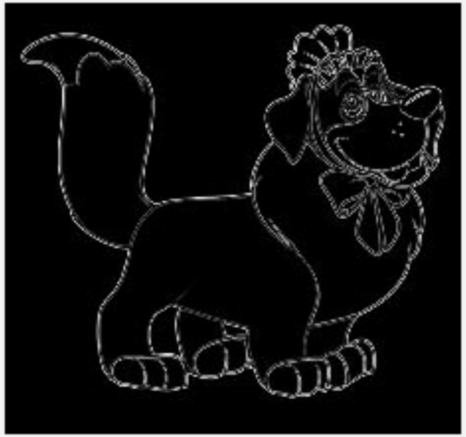
Edge detection

- Laplacian
- Sobel
- Spatial gradient 2d/3d

Sobel



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Geometric transformations

- Rotate, translate, scale, shear, resize
- Gaussian pyramid, PyUp, PyrDown
- Crop: center crop, crop and resize
- Flip: horizontal/vertical, rot180

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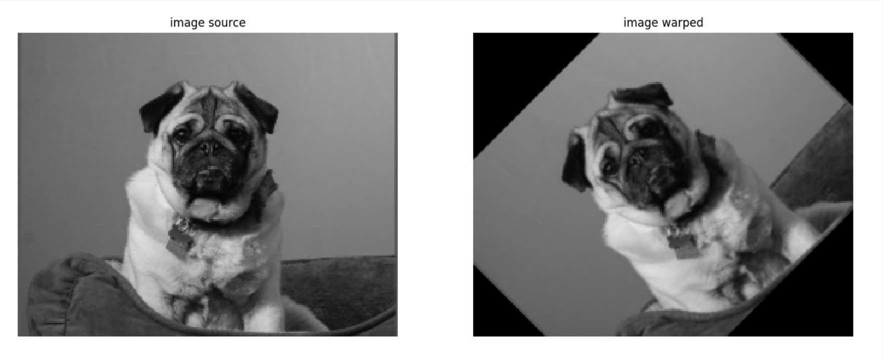
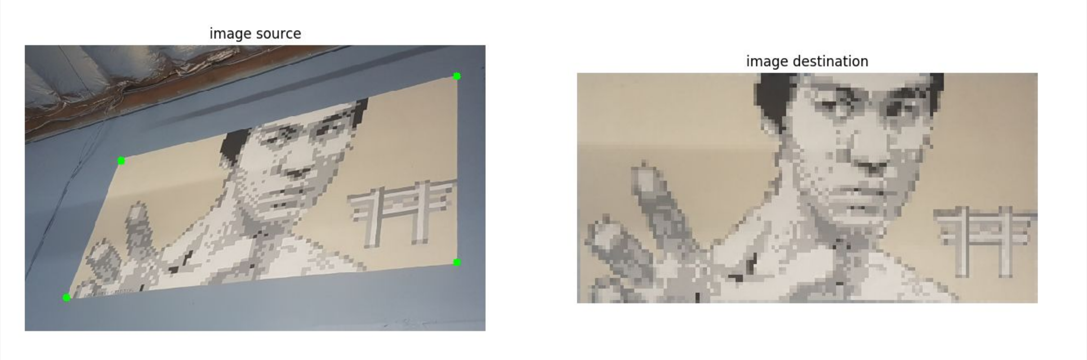
Geometric transformations

- warp_affine
- warp_perspective
- get_perspective_transform
- get_rotation_matrix2d



Warp Affine

Warp Perspective



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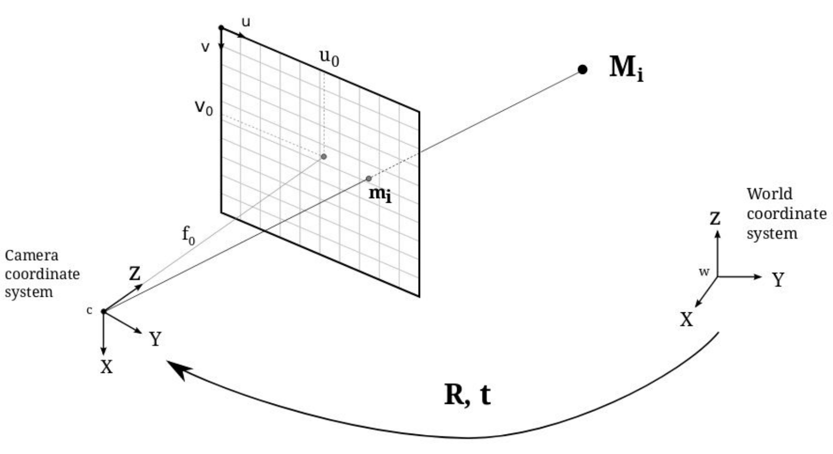
3D Geometry

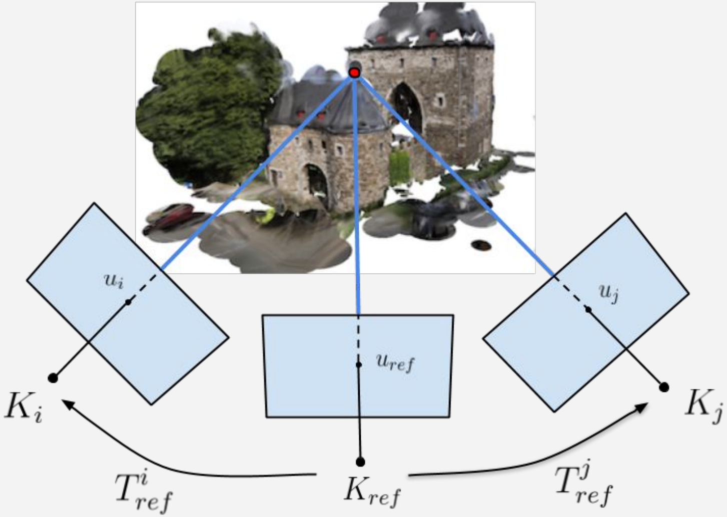
- Pinhole and perspective camera API

- Conversions: homogeneous, euclidean, rotation matrix, quaternion, axis-angle, normalize_coordinates

- Subpixel: conv/soft_softargmax2d/3d, conv_quad_interp3d

- Epipolar, Lie algebra and SfM utilities





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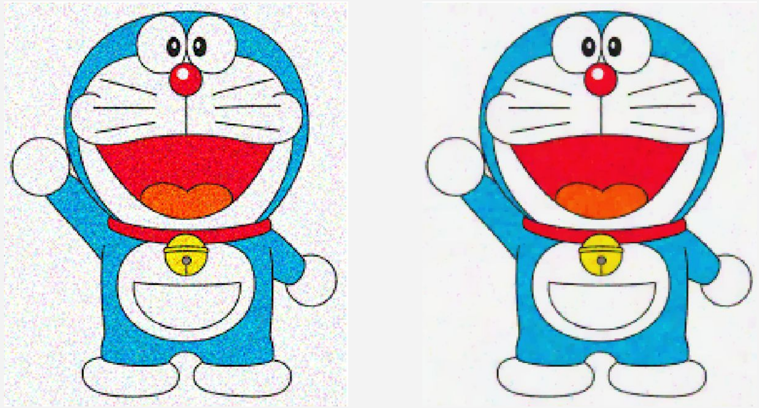
Vision loss functions

Specific Loss functions

- Image reconstruction
- Semantic segmentation
- Heatmaps



Total Variation

SSIM, PSNR

Focal Loss

...

kornia

development

1. **Easy to install**
2. Easy to use
3. OpenCV syntax
4. Ecosystem Integration

1. Easy to install

- Install from pip or source

From pip:

```
pip install kornia
```

From source:

```
python setup.py install
```

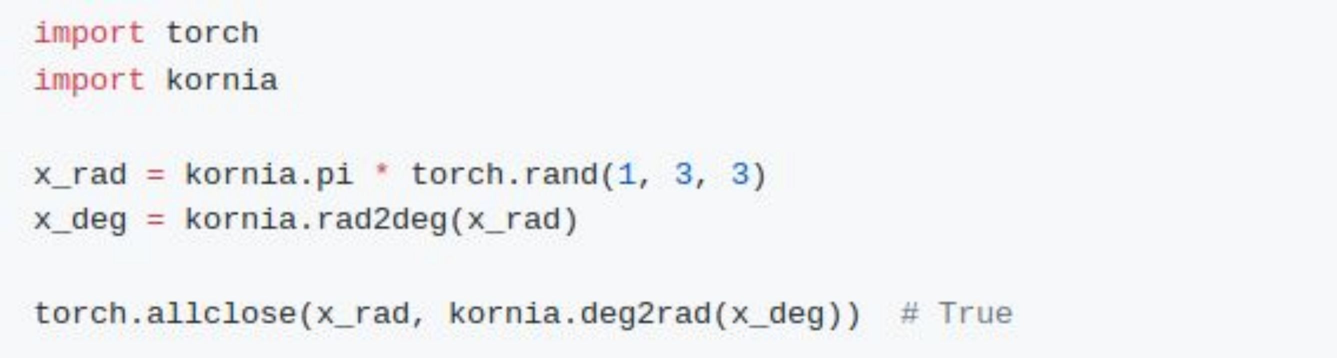
kornia is dependency-free - **ONLY PyTorch**

kornia
development

1. Easy to install
2. **Easy to use**
3. OpenCV syntax
4. Ecosystem Integration

2. Easy to import and use

- Import from any *Python >= 3.6* script
- Compatible with any *torch.Tensor* operator



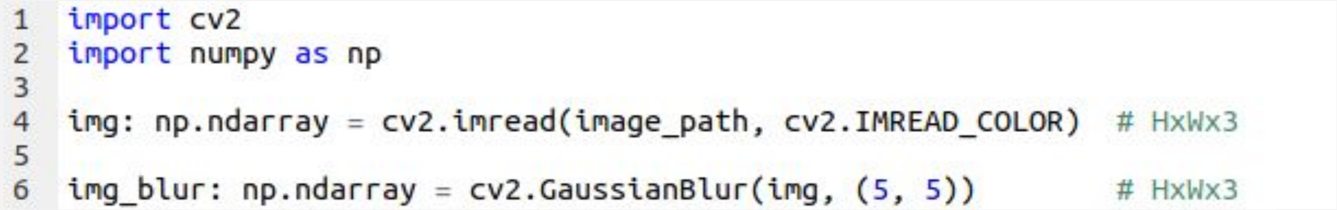
```python
import torch
import kornia

x_rad = kornia.pi * torch.rand(1, 3, 3)
x_deg = kornia.rad2deg(x_rad)

torch.allclose(x_rad, kornia.deg2rad(x_deg))  # True
```

kornia

development

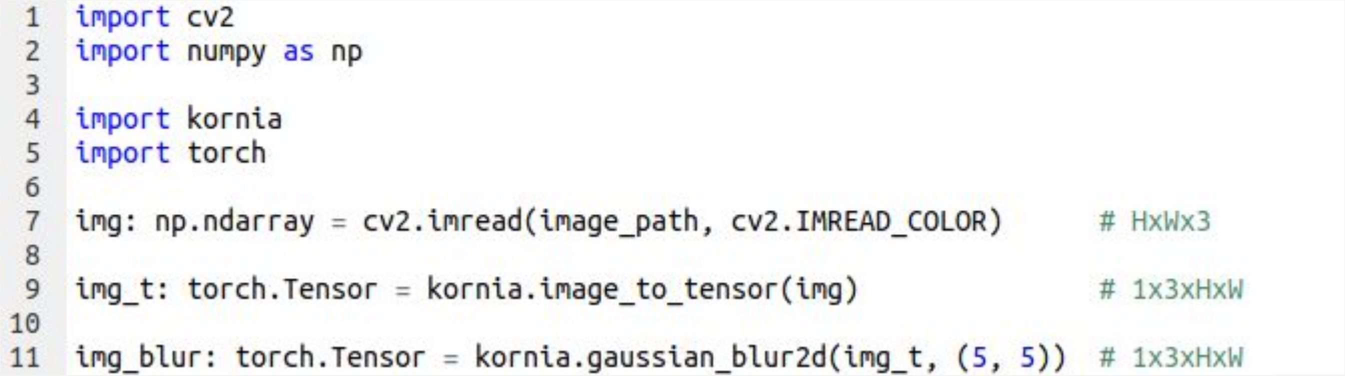
1. Easy to install
2. Easy to use
3. **OpenCV syntax**
4. Ecosystem Integration

3. OpenCV Syntax (I)



```python
import cv2
import numpy as np

img: np.ndarray = cv2.imread(image_path, cv2.IMREAD_COLOR)  # HxWx3

img_blur: np.ndarray = cv2.GaussianBlur(img, (5, 5))        # HxWx3
```

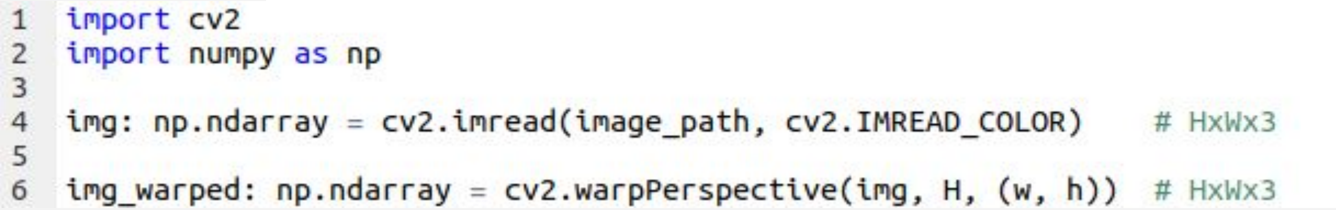
OpenCV



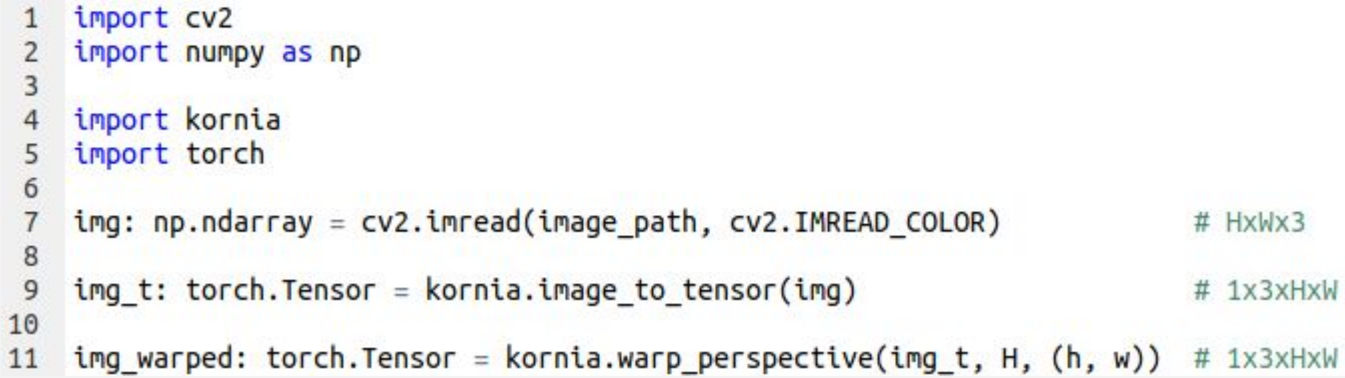
```python
import cv2
import numpy as np

import kornia
import torch

img: np.ndarray = cv2.imread(image_path, cv2.IMREAD_COLOR)      # HxWx3

img_t: torch.Tensor = kornia.image_to_tensor(img)               # 1x3xHxW

img_blur: torch.Tensor = kornia.gaussian_blur2d(img_t, (5, 5))  # 1x3xHxW
```

kornia

3. OpenCV Syntax (II)



```python
import cv2
import numpy as np

img: np.ndarray = cv2.imread(image_path, cv2.IMREAD_COLOR)    # HxWx3

img_warped: np.ndarray = cv2.warpPerspective(img, H, (w, h))   # HxWx3
```



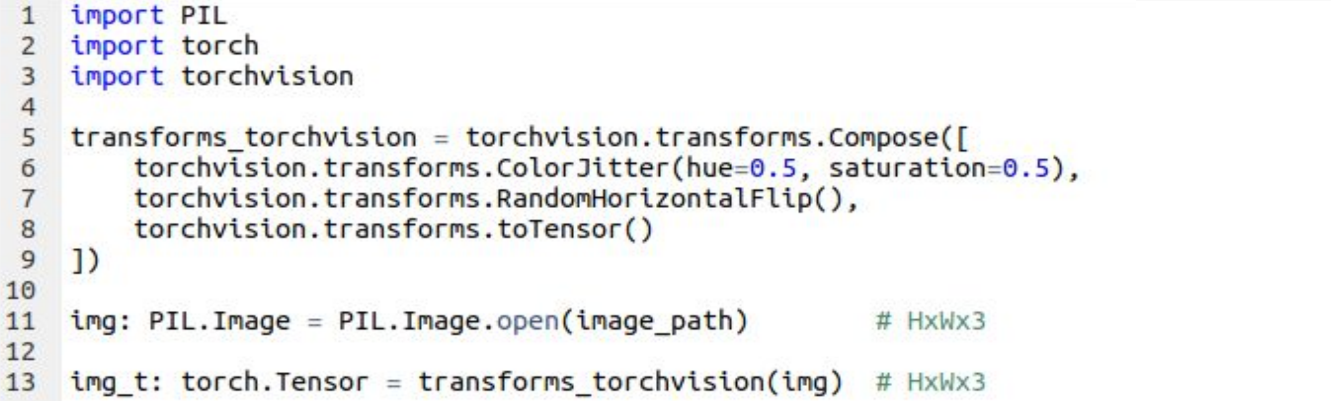
```python
import cv2
import numpy as np

import kornia
import torch

img: np.ndarray = cv2.imread(image_path, cv2.IMREAD_COLOR)            # HxWx3

img_t: torch.Tensor = kornia.image_to_tensor(img)                      # 1x3xHxW

img_warped: torch.Tensor = kornia.warp_perspective(img_t, H, (h, w))   # 1x3xHxW
```

kornia

development

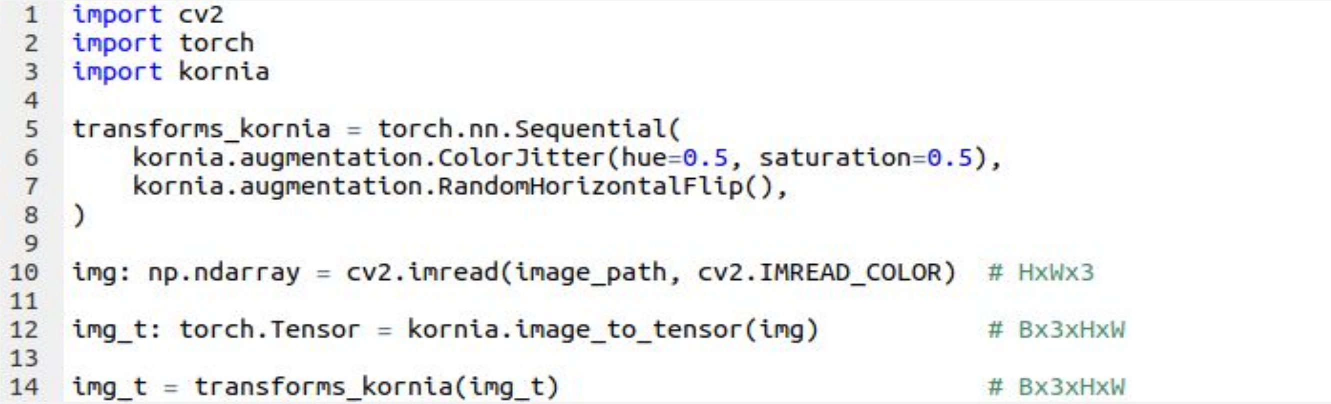
1. Easy to install
2. Easy to use
3. OpenCV syntax
4. **Ecosystem Integration**

3. Compatibility ***torchvision***



```python
import PIL
import torch
import torchvision

transforms_torchvision = torchvision.transforms.Compose([
    torchvision.transforms.ColorJitter(hue=0.5, saturation=0.5),
    torchvision.transforms.RandomHorizontalFlip(),
    torchvision.transforms.toTensor()
])

img: PIL.Image = PIL.Image.open(image_path)          # HxWx3

img_t: torch.Tensor = transforms_torchvision(img)  # HxWx3
```

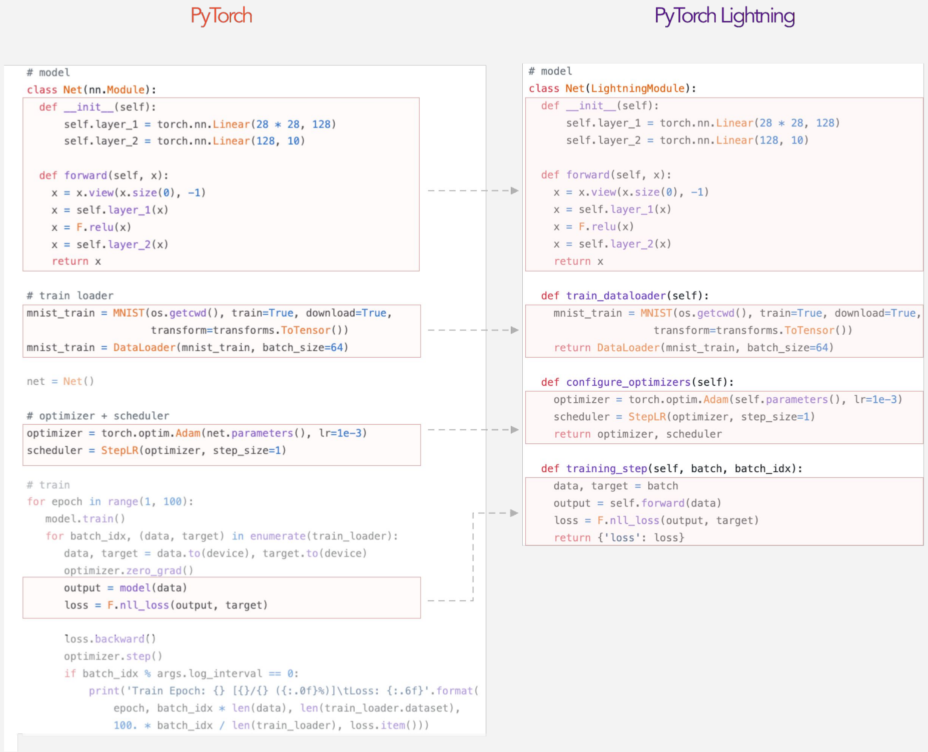
PyTorch



```python
import cv2
import torch
import kornia

transforms_kornia = torch.nn.Sequential(
    kornia.augmentation.ColorJitter(hue=0.5, saturation=0.5),
    kornia.augmentation.RandomHorizontalFlip(),
)

img: np.ndarray = cv2.imread(image_path, cv2.IMREAD_COLOR)  # HxWx3

img_t: torch.Tensor = kornia.image_to_tensor(img)           # Bx3xHxW

img_t = transforms_kornia(img_t)                            # Bx3xHxW
```

kornia

3. Compatibility PyTorch Lightning

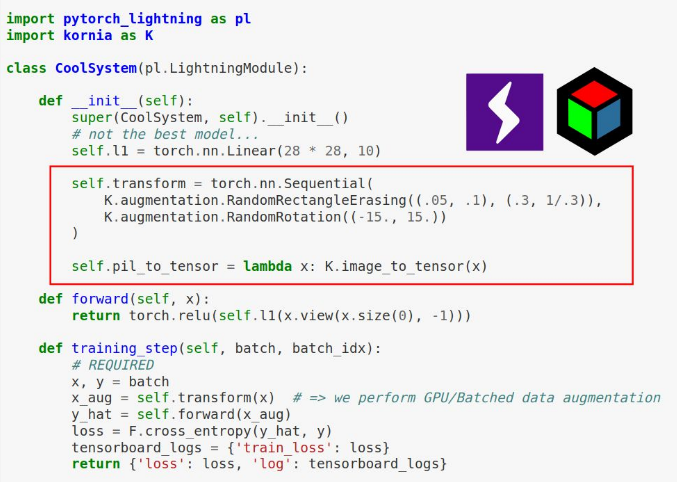


PyTorch

```
# model
class Net(nn.Module):
  def __init__(self):
      self.layer_1 = torch.nn.Linear(28 * 28, 128)
      self.layer_2 = torch.nn.Linear(128, 10)

  def forward(self, x):
    x = x.view(x.size(0), -1)
    x = self.layer_1(x)
    x = F.relu(x)
    x = self.layer_2(x)
    return x

# train loader
mnist_train = MNIST(os.getcwd(), train=True, download=True,
                    transform=transforms.ToTensor())
mnist_train = DataLoader(mnist_train, batch_size=64)

net = Net()

# optimizer + scheduler
optimizer = torch.optim.Adam(net.parameters(), lr=1e-3)
scheduler = StepLR(optimizer, step_size=1)

# train
for epoch in range(1, 100):
   model.train()
   for batch_idx, (data, target) in enumerate(train_loader):
      data, target = data.to(device), target.to(device)
      optimizer.zero_grad()
      output = model(data)
      loss = F.nll_loss(output, target)

      loss.backward()
      optimizer.step()
      if batch_idx % args.log_interval == 0:
          print('Train Epoch: {} [{}/{} ({:.0f}%)]\tLoss: {:.6f}'.format(
              epoch, batch_idx * len(data), len(train_loader.dataset),
              100. * batch_idx / len(train_loader), loss.item()))
```

PyTorch Lightning

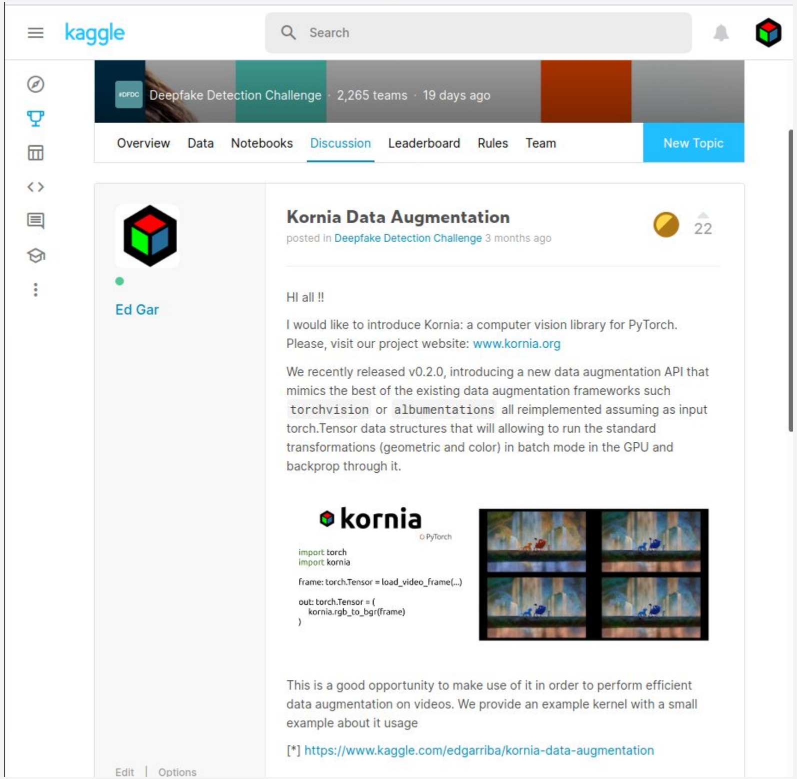
```
# model
class Net(LightningModule):
  def __init__(self):
      self.layer_1 = torch.nn.Linear(28 * 28, 128)
      self.layer_2 = torch.nn.Linear(128, 10)

  def forward(self, x):
    x = x.view(x.size(0), -1)
    x = self.layer_1(x)
    x = F.relu(x)
    x = self.layer_2(x)
    return x

  def train_dataloader(self):
    mnist_train = MNIST(os.getcwd(), train=True, download=True,
                        transform=transforms.ToTensor())
    return DataLoader(mnist_train, batch_size=64)

  def configure_optimizers(self):
    optimizer = torch.optim.Adam(self.parameters(), lr=1e-3)
    scheduler = StepLR(optimizer, step_size=1)
    return optimizer, scheduler

  def training_step(self, batch, batch_idx):
    data, target = batch
    output = self.forward(data)
    loss = F.nll_loss(output, target)
    return {'loss': loss}
```



```
import pytorch_lightning as pl
import kornia as K

class CoolSystem(pl.LightningModule):

    def __init__(self):
        super(CoolSystem, self).__init__()
        # not the best model...
        self.l1 = torch.nn.Linear(28 * 28, 10)

        self.transform = torch.nn.Sequential(
            K.augmentation.RandomRectangleErasing((.05, .1), (.3, 1/.3)),
            K.augmentation.RandomRotation((-15., 15.))
        )

        self.pil_to_tensor = lambda x: K.image_to_tensor(x)

    def forward(self, x):
        return torch.relu(self.l1(x.view(x.size(0), -1)))

    def training_step(self, batch, batch_idx):
        # REQUIRED
        x, y = batch
        x_aug = self.transform(x)  # => we perform GPU/Batched data augmentation
        y_hat = self.forward(x_aug)
        loss = F.cross_entropy(y_hat, y)
        tensorboard_logs = {'train_loss': loss}
        return {'loss': loss, 'log': tensorboard_logs}
```

3. Compatibility

kaggle fast.ai



Kornia Data Augmentation

posted in Deepfake Detection Challenge 3 months ago

HI all !!

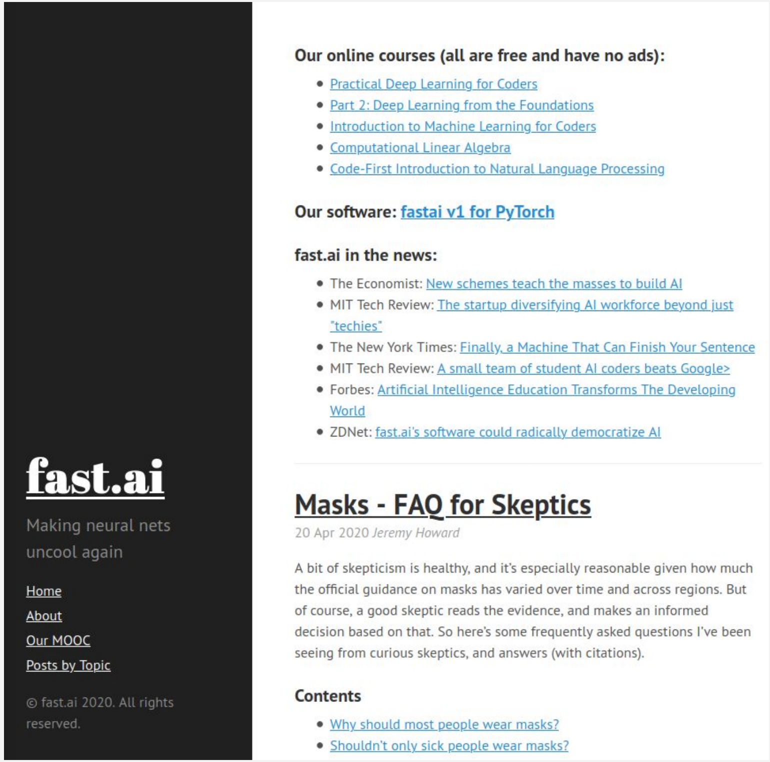
I would like to introduce Kornia: a computer vision library for PyTorch. Please, visit our project website: www.kornia.org

We recently released v0.2.0, introducing a new data augmentation API that mimics the best of the existing data augmentation frameworks such `torchvision` or `albumentations` all reimplemented assuming as input torch.Tensor data structures that will allowing to run the standard transformations (geometric and color) in batch mode in the GPU and backprop through it.

```
import torch
import kornia

frame: torch.Tensor = load_video_frame(...)

out: torch.Tensor = (
    kornia.rgb_to_bgr(frame)
)
```

This is a good opportunity to make use of it in order to perform efficient data augmentation on videos. We provide an example kernel with a small example about it usage

[*] https://www.kaggle.com/edgarriba/kornia-data-augmentation



Our online courses (all are free and have no ads):

- Practical Deep Learning for Coders
- Part 2: Deep Learning from the Foundations
- Introduction to Machine Learning for Coders
- Computational Linear Algebra
- Code-First Introduction to Natural Language Processing

Our software: fastai v1 for PyTorch

fast.ai in the news:

- The Economist: New schemes teach the masses to build AI
- MIT Tech Review: The startup diversifying AI workforce beyond just "techies"
- The New York Times: Finally, a Machine That Can Finish Your Sentence
- MIT Tech Review: A small team of student AI coders beats Google>
- Forbes: Artificial Intelligence Education Transforms The Developing World
- ZDNet: fast.ai's software could radically democratize AI

Masks - FAQ for Skeptics

20 Apr 2020 *Jeremy Howard*

A bit of skepticism is healthy, and it's especially reasonable given how much the official guidance on masks has varied over time and across regions. But of course, a good skeptic reads the evidence, and makes an informed decision based on that. So here's some frequently asked questions I've been seeing from curious skeptics, and answers (with citations).

Contents

- Why should most people wear masks?
- Shouldn't only sick people wear masks?

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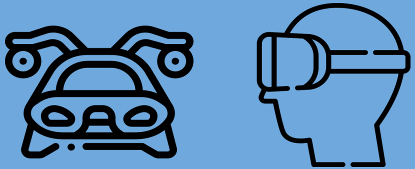
Future plans



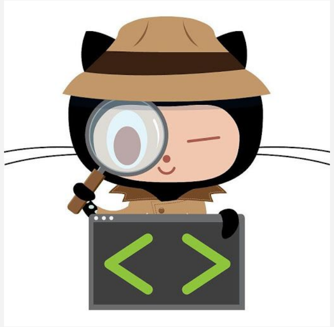
kornia

3D transformations

TorchScriptable

Structure From Motion

We need your help
and feedback !



For users

User chat for Q&A:

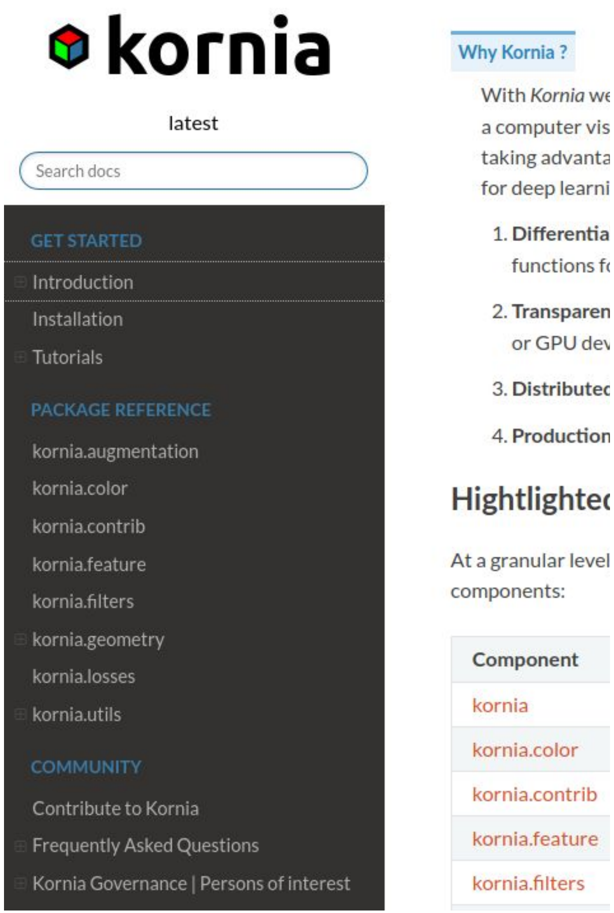
https://discuss.pytorch.org/c/vision/kornia

Official documents:

https://kornia.readthedocs.io/en/latest

SPHINX

Read the Docs



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latest

Search docs

GET STARTED

Introduction

Installation

Tutorials

PACKAGE REFERENCE

kornia.augmentation

kornia.color

kornia.contrib

kornia.feature

kornia.filters

kornia.geometry

kornia.losses

kornia.utils

COMMUNITY

Contribute to Kornia

Frequently Asked Questions

Kornia Governance | Persons of interest

Why Kornia ?

With *Kornia* we
a computer vis
taking advanta
for deep learni

1. **Differentia**
functions fo
2. **Transparen**
or GPU dev
3. **Distributec**
4. **Production**

Hightlightec

At a granular level
components:

Component
kornia
kornia.color
kornia.contrib
kornia.feature
kornia.filters

For developers

Check out our contributions call
https://github.com/kornia/kornia/issues/53

or

Check out docs, and our issues marked as “contributions welcome”:
https://github.com/kornia/kornia/blob/master/CONTRIBUTING.rst

Extra material

Examples:

https://github.com/kornia/kornia-examples

Tutorials:

https://kornia.readthedocs.io/en/latest/tutorials/index.html

www.kornia.org

twitter: @kornia_foss

code: https://github.com/kornia/kornia