lab1

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1 LAB 1 - Wykrywanie krawędzi metodą Canny'jego

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[1]:
```
import torch
import torch.nn as nn
import numpy as np
from PIL import Image, ImageOps
import torchvision.transforms as T
```

[2]:
```
def preview(tensor):
    preview = tensor.squeeze(0)
    return T.ToPILImage()(preview)

def save(pil, name):
    return pil.save(f'images/{name}.png', "PNG")
```

1.0.1 Load image

[3]:
```
img = original =  Image.open("sample.jpg")
img
save(img, "0_original")
```

[4]:
```
img = T.ToTensor()(img)
img = img.unsqueeze(0)  # == reshape(1, 2, w, h)
```

1.0.2 Convert RGB to grayscale

[5]:
```
# 0.299  Red + 0.587  Green + 0.114  Blue.
def rgb_to_grayscale_kernel():
    kernel = torch.tensor([0.299, 0.587, 0.114], dtype=torch.float32)
    return kernel.reshape((1, 3, 1, 1))
```

[6]:
```
kernel = rgb_to_grayscale_kernel()
rgb_to_gray_conv = nn.Conv2d(in_channels=3, out_channels=1, kernel_size=1,␣
 ↪bias=False)
rgb_to_gray_conv.weight = nn.Parameter(kernel)
```

[7]:
```
img = rgb_to_gray_conv(img)
```

[8]:
```
pil = preview(img)
save(pil, "1_gray_scale")
pil
```

[8]:

1.0.3 Apply average pooling

Do wykrywania krawędzi zastosujemy MaxPool ponieważ nie rozmazuje krawędzi tak jak AvgPool. Przy pullingu gdzie kernel size = 2 różnica pomiędzy tymi dwoma jest prawie niezauważalna.

[9]:
```
avg_poll_conv = nn.MaxPool2d(kernel_size=2)
print(img.shape)
img = avg_poll_conv(img)

pil = preview(img)
save(pil, "2_resized")
pil
```

```
torch.Size([1, 1, 360, 540])
```

[9]:

1.0.4 Apply gaussian blur

[10]:
```
def gaussian_kernel(size, sigma=1):
    assert size % 2 == 1, "Kernel size must be an odd number"
    half = int(size) // 2
    x, y = np.mgrid[-half : half + 1, -half : half + 1]
    normal = 1 / (2.0 * np.pi * sigma**2)
    g = np.exp(-((x**2 + y**2) / (2.0 * sigma**2))) * normal
    return torch.tensor(g, dtype=torch.float32).reshape(1, 1, size, size)
```

[11]:
```
blur_size = 21
kernel = gaussian_kernel(blur_size)
blur_conv = nn.Conv2d(
    in_channels=1, out_channels=1, kernel_size=kernel.shape, bias=False
)
blur_conv.weight = nn.Parameter(kernel)
img = blur_conv(img)
```

[12]:
```
pil = preview(img)
save(pil, "3_blured")
pil
```

[12]:

1.0.5 Calculate gradient

[13]:
```
def gradient_kernel():
    kernel = torch.tensor(
        [
            [[[1, 2, 1], [0, 0, 0], [-1, -2, -1]]],
            [[[1, 0, -1], [2, 0, -2], [1, 0, -1]]],
        ],
        dtype=torch.float32,
    )
    return kernel.reshape(2, 1, 3, 3)
```

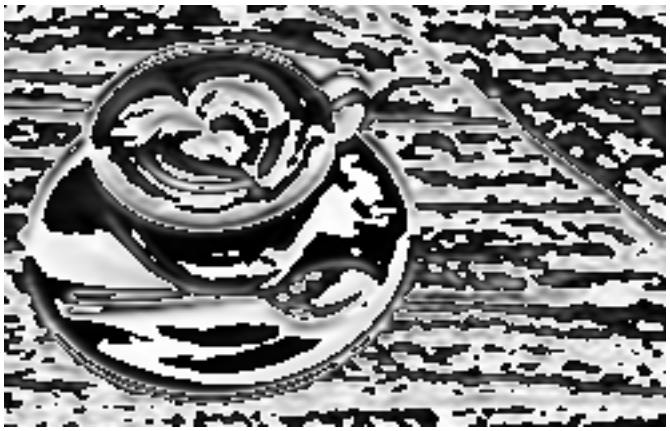
[14]:
```
kernel = gradient_kernel()
print(kernel)
gradient_conv = nn.Conv2d(
    in_channels=1, out_channels=2, kernel_size=3, bias=False, #stride=(1, 1,␣
 ↪1), padding=(0, 0, 0), dilation=(0, 0, 0)
)
gradient_conv.weight = nn.Parameter(kernel)
img = gradient_conv(img)
```

```
tensor([[[[ 1.,  2.,  1.],
          [ 0.,  0.,  0.],
          [-1., -2., -1.]]],


        [[[ 1.,  0., -1.],
          [ 2.,  0., -2.],
          [ 1.,  0., -1.]]]])
```

[15]:
```
pil = preview(img[:, 0, :, :])
save(pil, "4_sobel_x")
```

```
pil
```

[15]:



[16]:
```
pil = preview(img[:, 1, :, :])
save(pil, "5_sobel_y")
pil
```

[16]:

[17]:
```
class Gradient(nn.Module):
    def forward(self, x):
        return torch.concat(
            ((torch.sqrt(torch.sum(torch.square(x), dim=1))).unsqueeze(1),
            torch.arctan(x[:, 0, :, :] / x[:, 1, :, :]).unsqueeze(1)),
            dim=1,
        )
```

[18]:
```
gradient_layer = Gradient()
img = gradient_layer(img)
img.shape
```

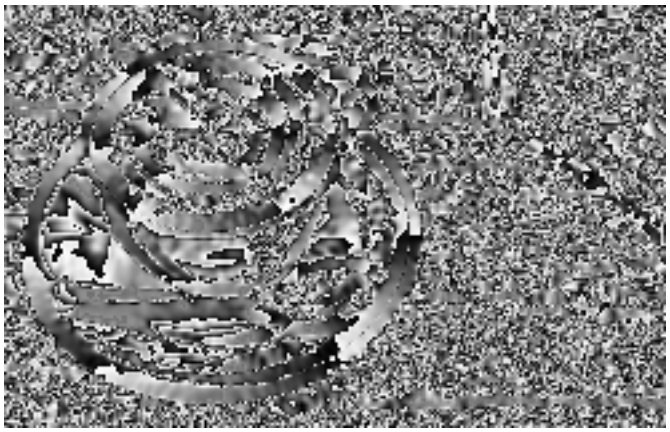
[18]:
```
torch.Size([1, 2, 158, 248])
```

[19]:
```
pil = preview(img[:, 0, :, :])
save(pil, "6_gradient_value")
pil
```

[19]:

[20]:
```
pil = preview(img[:, 1, :, :])
save(pil, "7_gradient_direction")
pil
```

[20]:



[21]:
```
test = img
test.shape
```

[21]:
```
torch.Size([1, 2, 158, 248])
```

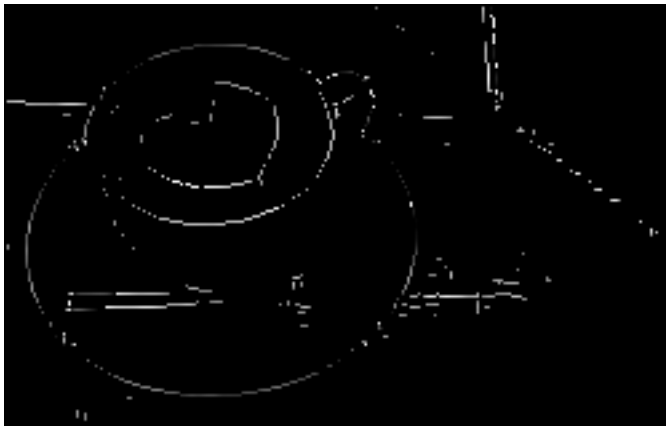
[22]:
```
class NonMaxSuppression(nn.Module):
    def forward(self, img):
        M, N = img.shape[-2:]
```

```
        D = img[0, 1, :, :]
        img = img[0, 0, :, :]
        # return img

        Z = np.zeros((M, N), dtype=np.float32)
        angle = D * 180.0 / np.pi
        angle[angle < 0] += 180
        for i in range(1, M - 1):
            for j in range(1, N - 1):
                try:
                    q = float("inf")
                    r = float("inf")
                    # angle 0
                    if (0 <= angle[i, j] < 22.5) or (157.5 <= angle[i, j] <=␣
↪180):
                        q = img[i, j + 1]
                        r = img[i, j - 1]
                    # angle 45
                    elif 22.5 <= angle[i, j] < 67.5:
                        q = img[i + 1, j - 1]
                        r = img[i - 1, j + 1]
                    # angle 90
                    elif 67.5 <= angle[i, j] < 112.5:
                        q = img[i + 1, j]
                        r = img[i - 1, j]
                    # angle 135
                    elif 112.5 <= angle[i, j] < 157.5:
                        q = img[i - 1, j - 1]
                        r = img[i + 1, j + 1]
                    if (img[i, j] >= q) and (img[i, j] >= r):
                        Z[i, j] = img[i, j]
                    else:
                        Z[i, j] = 0
                except IndexError as e:
                    pass

        return torch.tensor(Z, dtype=torch.float32).reshape(
            1, 1, Z.shape[-2], Z.shape[-1]
        )
```

[23]:
```
non_max_suppression_layer = NonMaxSuppression()
img = non_max_suppression_layer(img)

pil = preview(img)
save(pil, "8_non_max_suppresion")
```

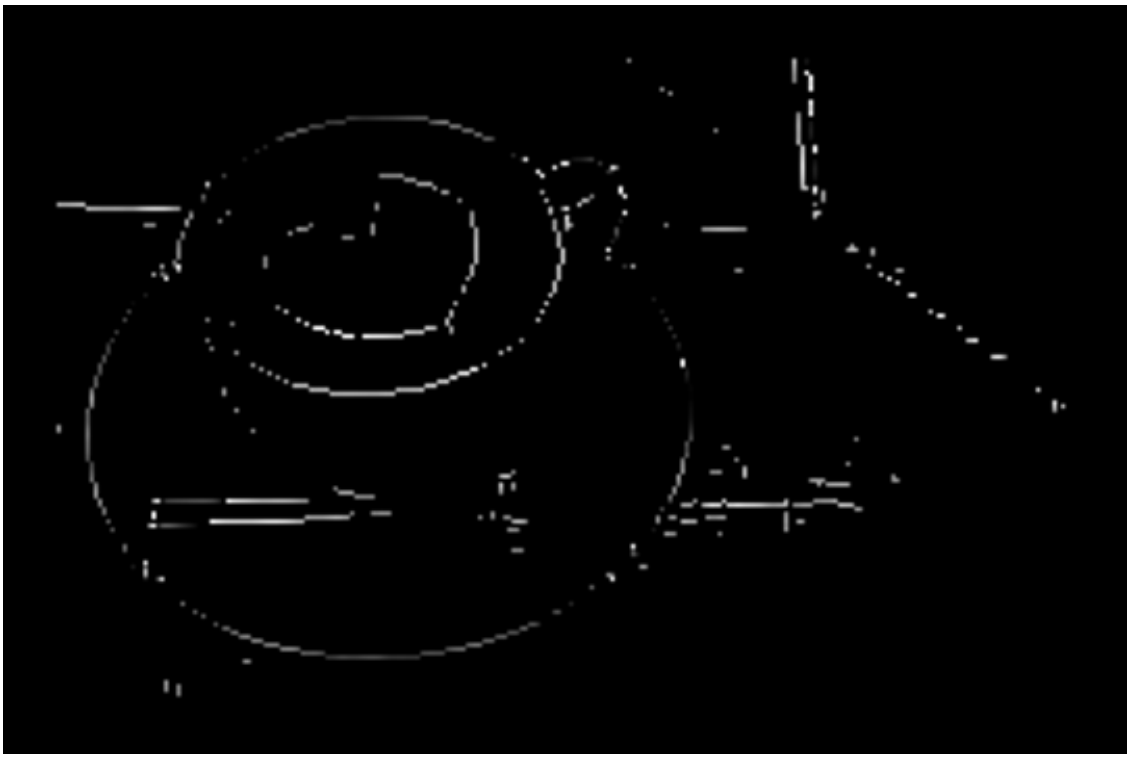
[24]:
```
TRESHHOLD = 0.5

class ReLU(nn.Module):
    def forward(self, x):
        x[x < TRESHHOLD] = 0.
        return x

relu = ReLU()
img = relu(img)
final = preview(img)
save(final, "9_relu")
final
```

[24]:



[25]:
```
expanded = ImageOps.expand(final, border=12, fill="black")
resized = expanded.resize(original.size)
save(resized, "10_final_resized")
resized
```

[25]:



Żeby krawędzie pokrywały się z orginalnym obrazkiem należy dodać marginesy na końcowy obrazek. Aleternatywnie na każdym etapie obróbki trzebaby dbać o poprawny padding, żeby filtry konwolucyjne nie zmieniały wielkości obrazu.

[26]:
```
overlayed = original.copy()
overlayed.paste(resized, (0,0), resized)
save(overlayed, "11_overlayed")
overlayed
```

[26]: