

Basics of Machine Learning

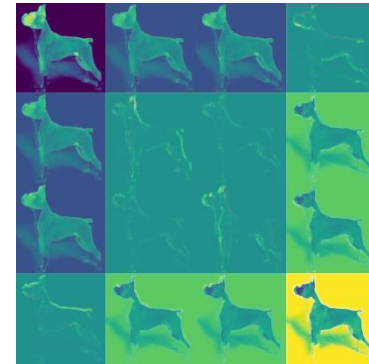
Dmitry Ryabokon, github.com/dryabokon





Lesson 17

Intro to Deep Learning



Intro to Deep Learning

Summary

- CNNs out of box
- Some datasets available for research
- Basic Operations

CNNs out of box

The popular networks

Classification

- LeNet [Model](#)
- AlexNet [Model](#)
- VGG [Model](#)
- ResNet [Paper](#)
- YOLO9000 [Paper](#)
- DenseNet [Paper](#)

Segmentation

- FCN8 [Paper](#)
- SegNet [Paper](#)
- U-Net [Paper](#)
- E-Net [Paper](#)
- ResNetFCN [Paper](#)
- PSPNet [Paper](#)
- Mask RCNN [Paper](#)

Detection

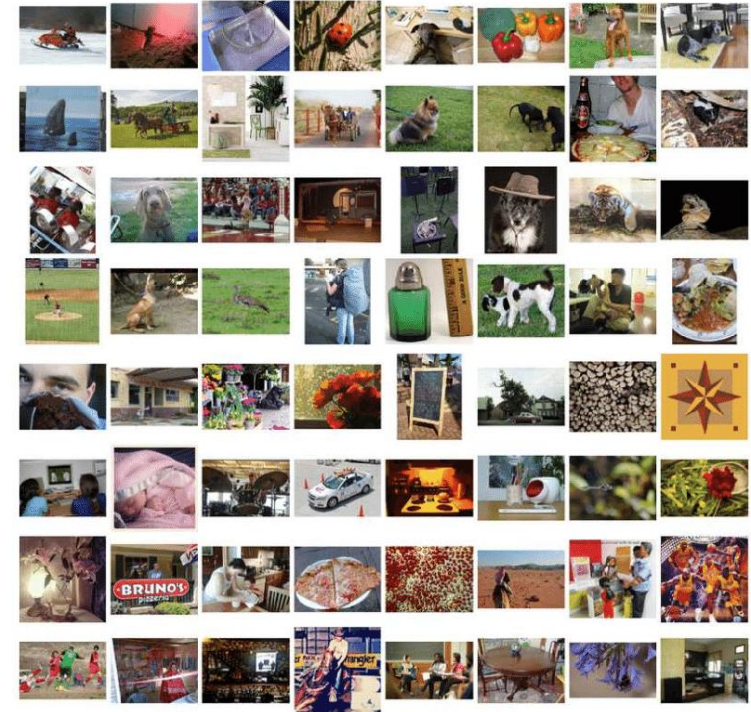
- Faster RCNN [Paper](#)
- SSD [Paper](#)
- YOLOv2 [Paper](#)
- R-FCN [Paper](#)

CNNs out of box

Some datasets available for research



MNIST: 10 classes, ~7000 ex. per class



ImageNet: 1000 classes, ~100 ex per class

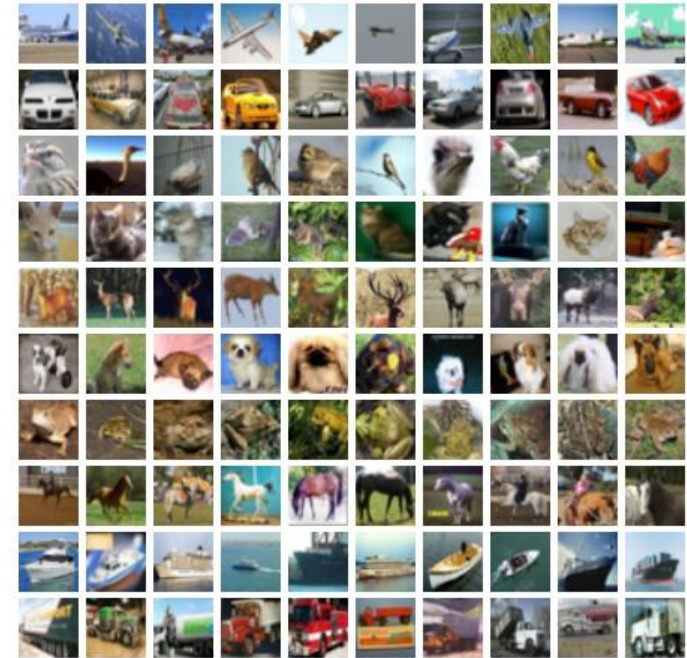
CNNs out of box

Some datasets available for research



The Street View House Numbers
10 classes, ~2000 ex. per class

airplane
automobile
bird
cat
deer
dog
frog
horse
ship
truck



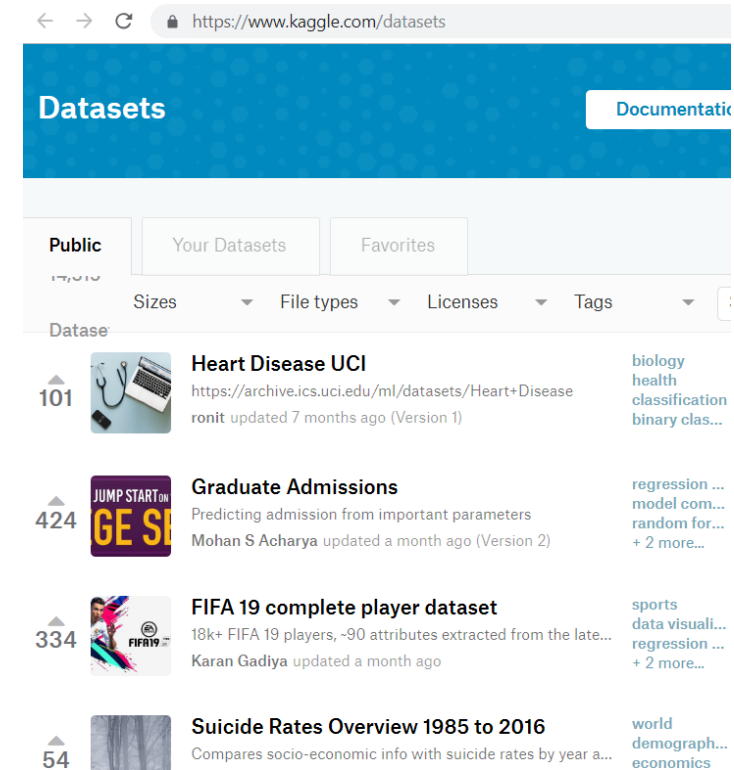
CIFAR: 10 classes, 6000 ex. per class
100 classes, 600 ex per class

CNNs out of box

Some datasets available for research



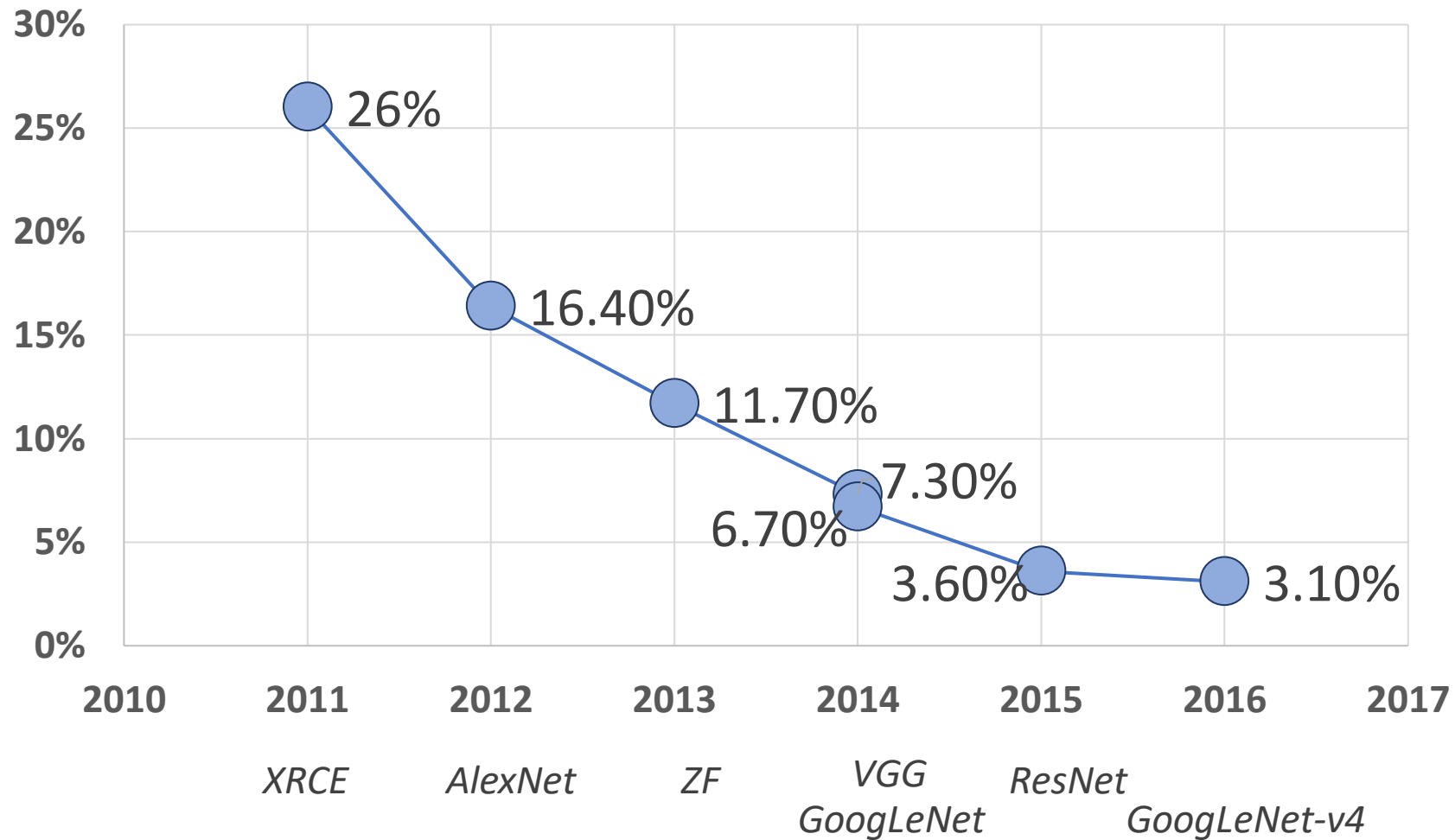
Olivetti database: 40 classes



.. and much more @ kaggle

CNNs out of box

ImageNet Classification error



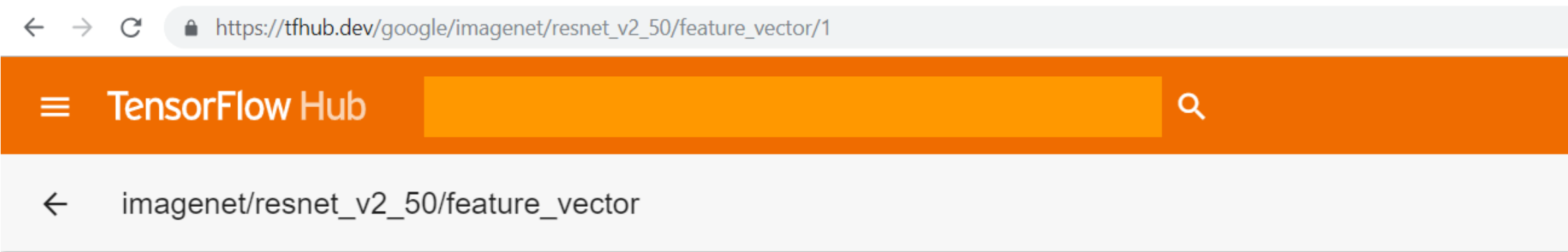
CNNs out of box

Usage of the neural networks

identify the name of a street (in France) from an image
compressing and decompressing images
semantic image segmentation
real-world image text extraction.
image classification
image-to-text
unsupervised learning
3D object reconstruction
image matching and retrieval
automatic speech recognition
localizing and identifying multiple objects in a single image
computer vision
discovery of latent 3D keypoints
predicting future video frames

<https://github.com/keras-team/keras/tree/master/examples>
<https://github.com/tensorflow/models/tree/master/research>

CNNs out of box



Usage

This module implements the common signature for computing [image feature vectors](#). It can be used like

```
module = hub.Module("https://tfhub.dev/google/imagenet/resnet_v2_50/feature_vector/1")
height, width = hub.get_expected_image_size(module)
images = ... # A batch of images with shape [batch_size, height, width, 3].
features = module(images) # Features with shape [batch_size, num_features].
```

...or using the signature name `image_feature_vector`. The output for each image in the batch is a feature vector of size `num_features = 2048`.

For this module, the size of the input image is fixed to `height x width = 224 x 224` pixels. The input `images` are expected to have color values in the range `[0,1]`, following the [common image input](#) conventions.

CNNs out of box

```
import tensorflow_hub as hub
import urllib.request
import cv2
import numpy
import json
import tensorflow as tf

# -----
URL = 'https://s3.amazonaws.com/deep-learning-models/image-models/imagenet_class_index.json'
data = json.loads(urllib.request.urlopen(URL).read().decode())
class_names = [data['%d'%i][1] for i in range(0,999)]
# -----

def example_predict():

    module = hub.Module("https://tfhub.dev/google/imagenet/resnet_v2_50/classification/1")
    img = cv2.imread('data/ex-natural/dog/dog_0000.jpg')
    img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    img = cv2.resize(img, (224, 224)).astype(numpy.float32)
    img = numpy.array([img]).astype(numpy.float32) / 255.0
    sess = tf.Session()
    sess.run(tf.global_variables_initializer())
    sess.run(tf.tables_initializer())

    outputs = module(dict(images=img), signature="image_classification", as_dict=True)
    prob = outputs["default"].eval(session=sess)[0]
    idx = numpy.argsort(-prob)[0]

    print(class_names[idx], prob[idx])
    sess.close()

    return

# -----
if __name__ == '__main__':
    example_predict()
```

CNNs out of box

← → ↻ <https://keras.io/getting-started/faq/#how-can-i-use-pre-trained-models-in-keras>

K Keras Documentation

Search docs

Home

Why use Keras

GETTING STARTED

Guide to the Sequential model

Guide to the Functional API

FAQ

How should I cite Keras?

How can I run Keras on GPU?

How can I run a Keras model on multiple GPUs?

What does "sample", "batch", "epoch" mean?

How can I save a Keras model?

Why is the training loss much higher than the testing loss?

How can I obtain the output of an intermediate layer?

How can I use Keras with datasets that don't fit in memory?

How can I interrupt training when the validation loss isn't decreasing?

How can I use pre-trained models in Keras?

Code and pre-trained weights are available for the following image classification models:

- Xception
- VGG16
- VGG19
- ResNet50
- Inception v3
- Inception-ResNet v2
- MobileNet v1
- DenseNet
- NASNet
- MobileNet v2

They can be imported from the module `keras.applications`:

```
from keras.applications.xception import Xception
from keras.applications.vgg16 import VGG16
from keras.applications.vgg19 import VGG19
from keras.applications.resnet50 import ResNet50
from keras.applications.inception_v3 import InceptionV3
from keras.applications.inception_resnet_v2 import InceptionResNetV2
from keras.applications.mobilenet import MobileNet
from keras.applications.densenet import DenseNet121
from keras.applications.densenet import DenseNet169
from keras.applications.densenet import DenseNet201
from keras.applications.nasnet import NASNetLarge
from keras.applications.nasnet import NASNetMobile
from keras.applications.mobilenet_v2 import MobileNetV2

model = VGG16(weights='imagenet', include_top=True)
```

CNNs out of box

```
from keras.applications import MobileNet
from keras.applications.xception import Xception
from keras.applications.mobilenet import preprocess_input
import urllib.request
import cv2
import numpy
import json
from keras import backend as K
K.set_image_dim_ordering('tf')
# -----
URL = 'https://s3.amazonaws.com/deep-learning-models/image-models/imagenet_class_index.json'
data = json.loads(urllib.request.urlopen(URL).read().decode())
class_names = [data['%d'%i][1] for i in range(0,999)]
# -----
def example_predict():

    CNN = MobileNet()
    #CNN = Xception()

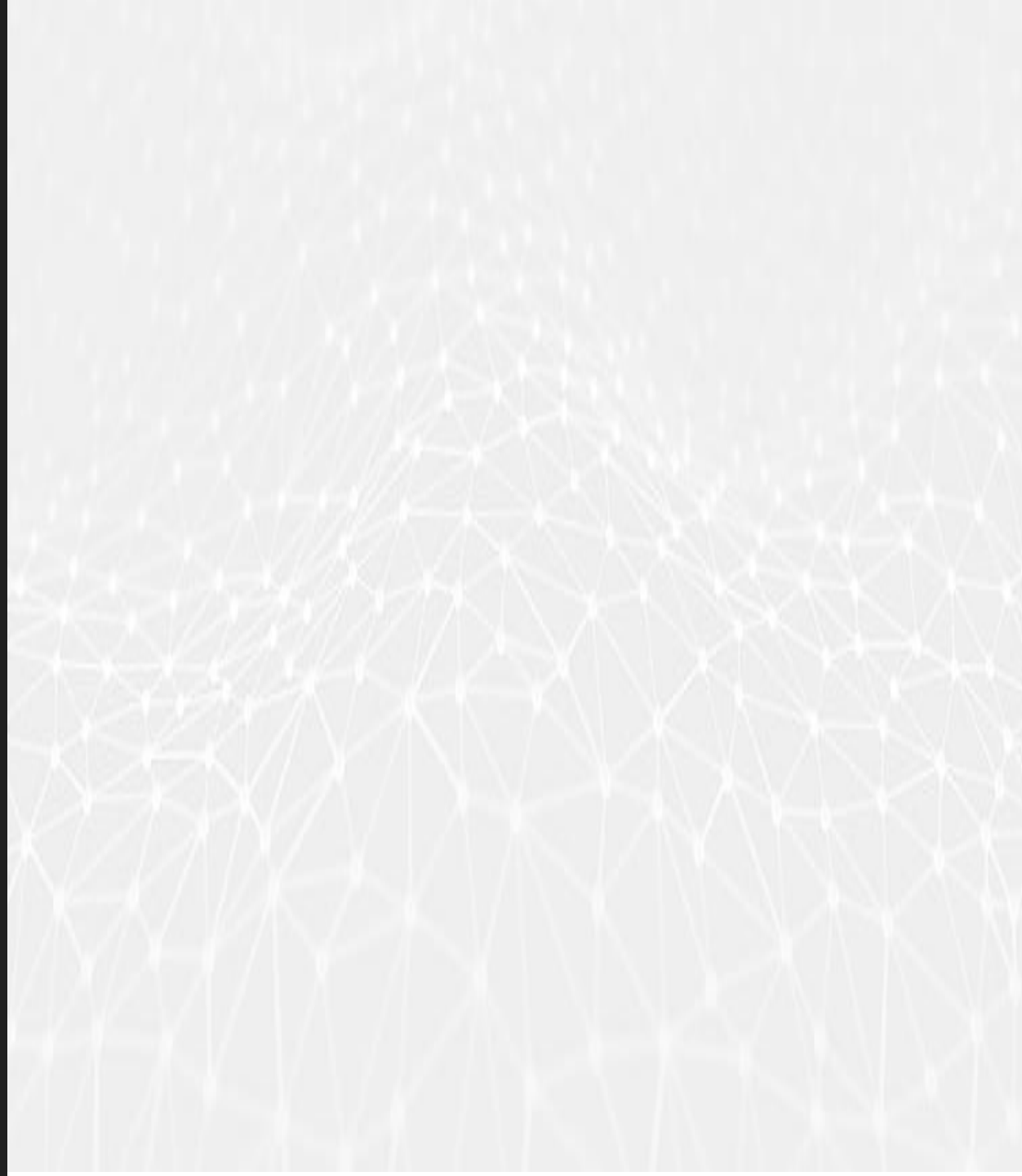
    img = cv2.imread('data/ex-natural/dog/dog_0000.jpg')
    img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    img = cv2.resize(img, (224, 224)).astype(numpy.float32)

    prob = CNN.predict(preprocess_input(numpy.array([img])))
    idx = numpy.argsort(-prob[0])[0]
    print(class_names[idx], prob[0, idx])

    return

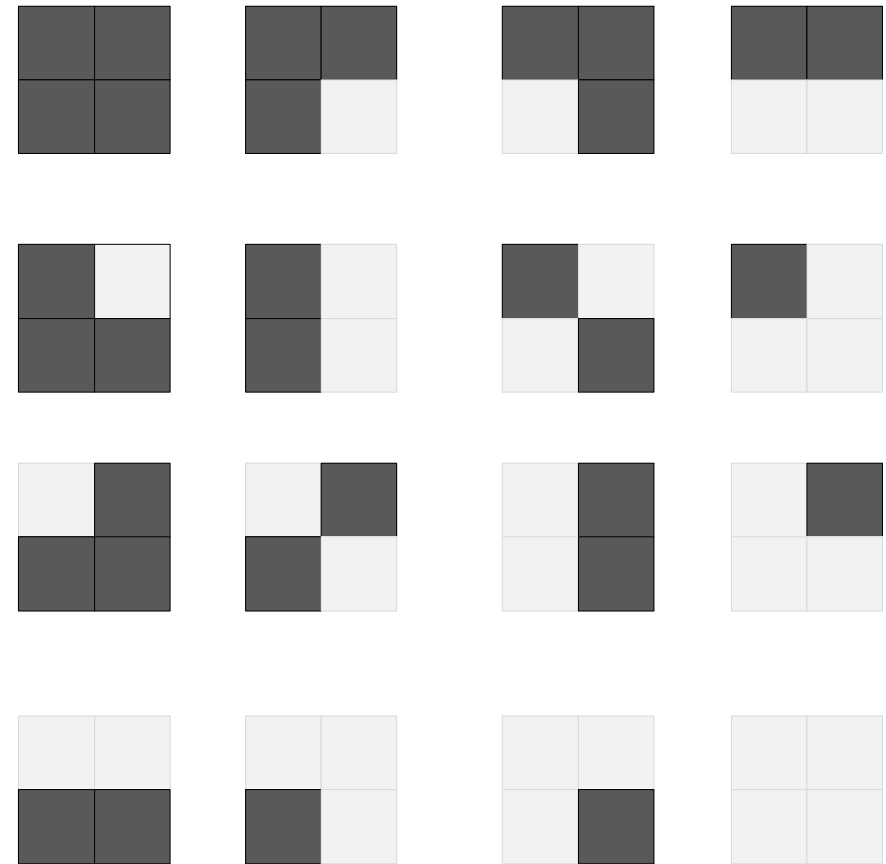
# -----
if __name__ == '__main__':
    example_predict()
```

Basic operations



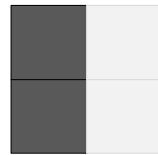
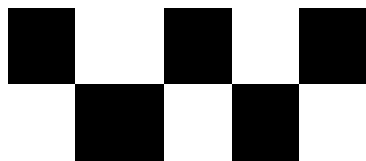
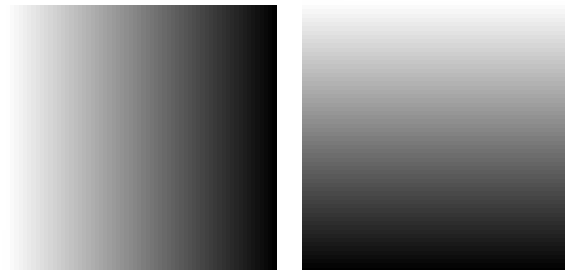
Basic operations

Convolution

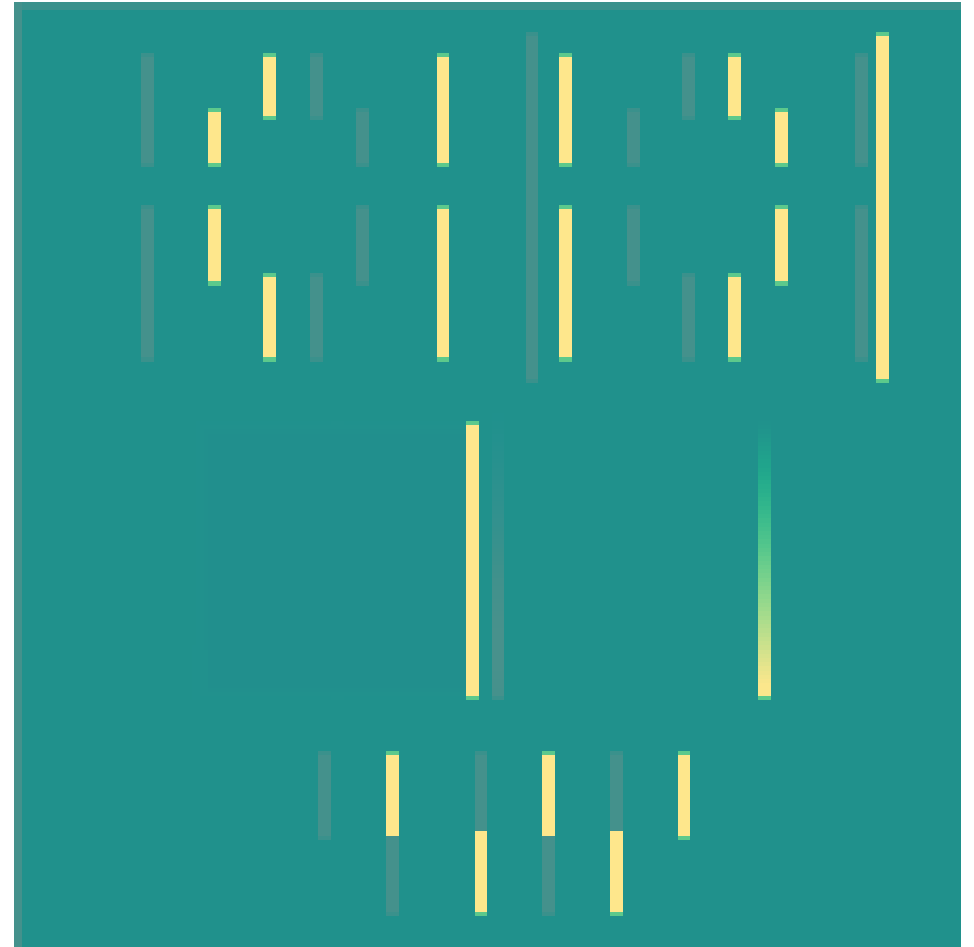


Basic operations

Convolution

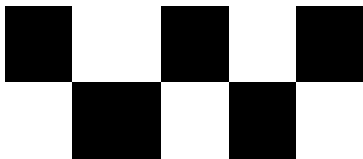
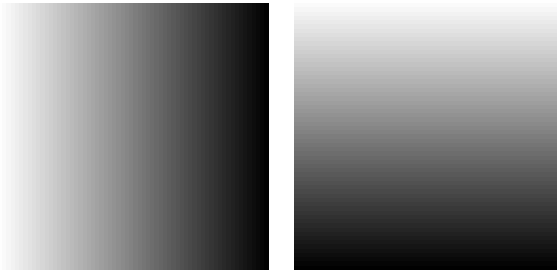
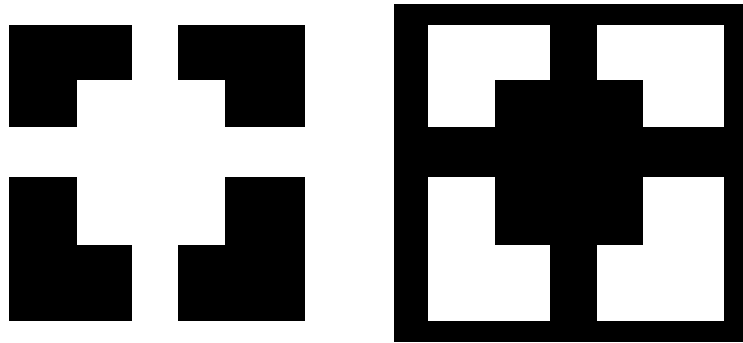


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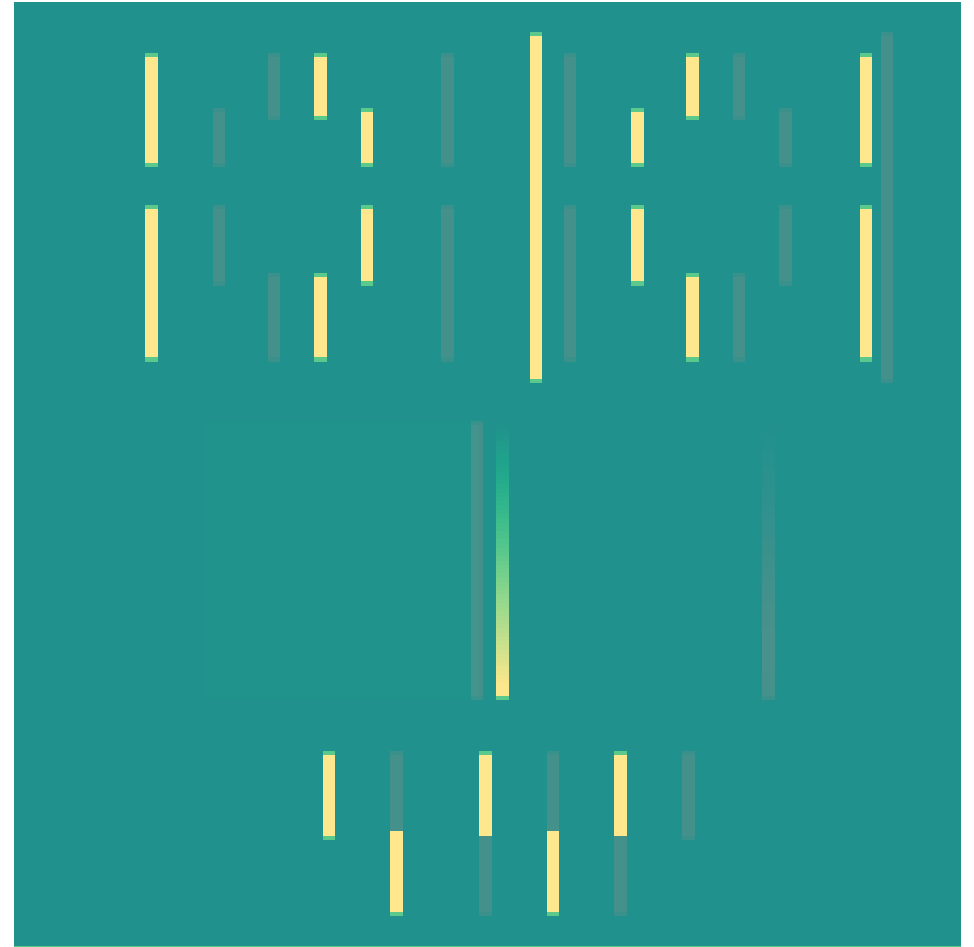


Basic operations

Convolution

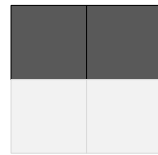
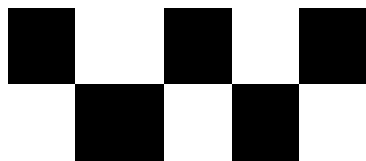
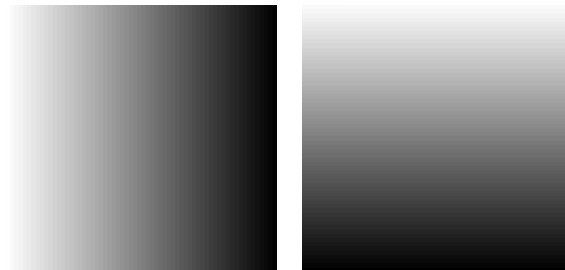


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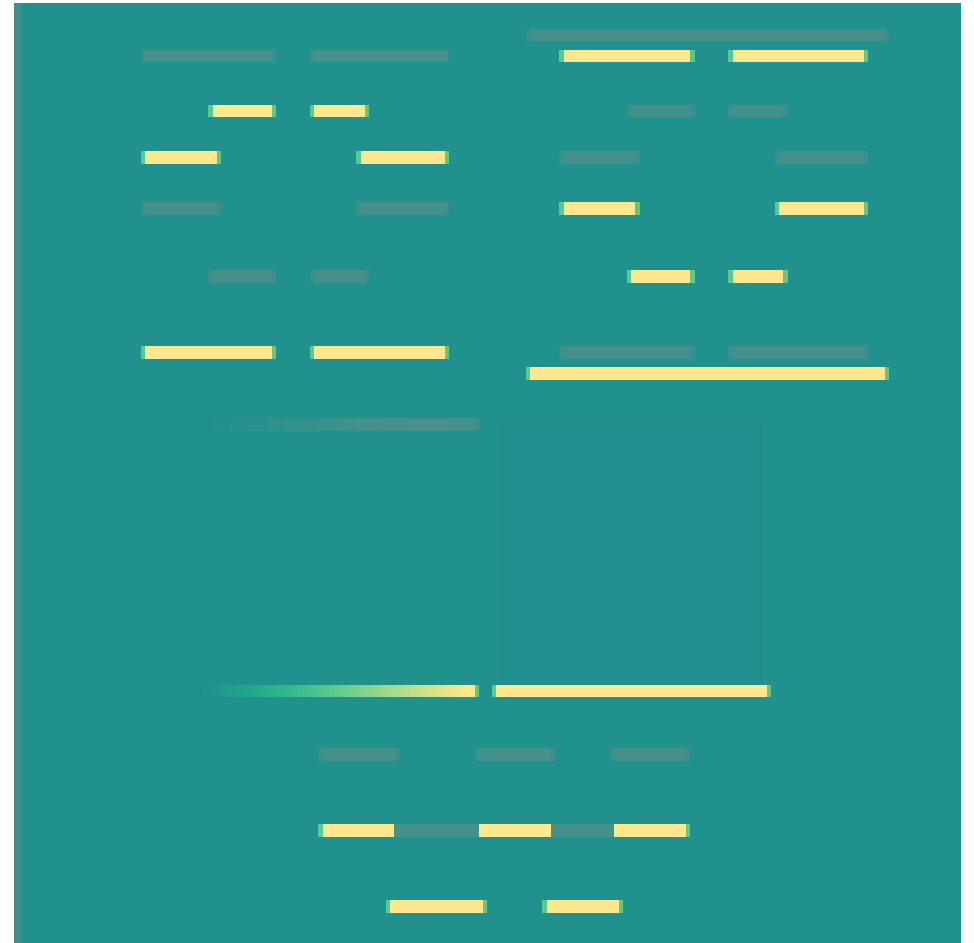


Basic operations

Convolution

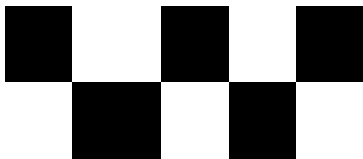
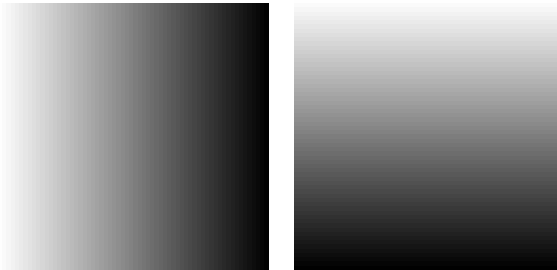
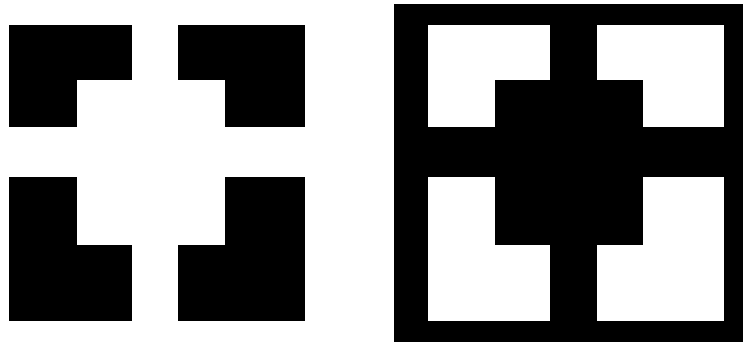


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Basic operations

Convolution

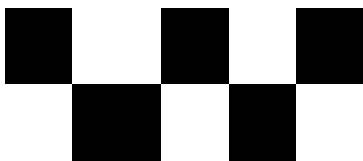
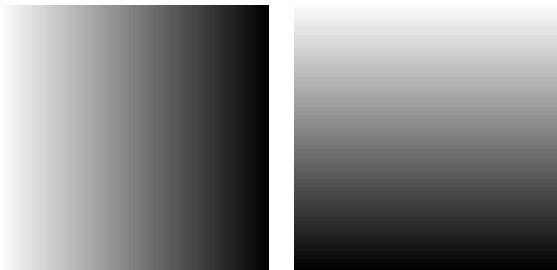


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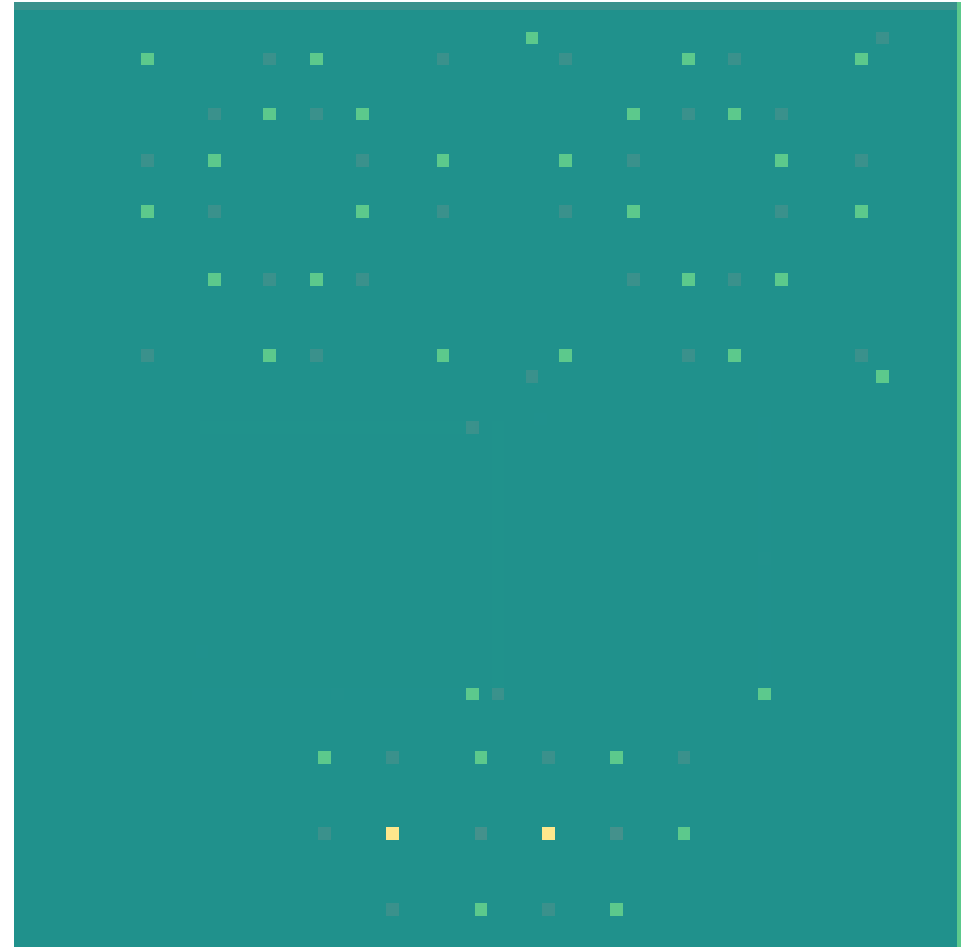


Basic operations

Convolution

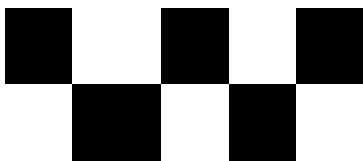
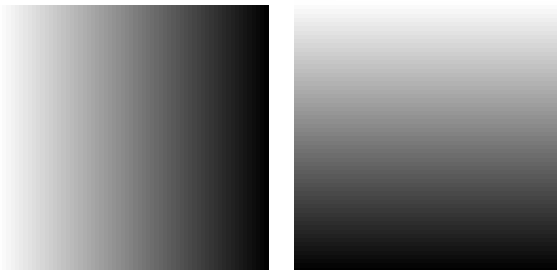


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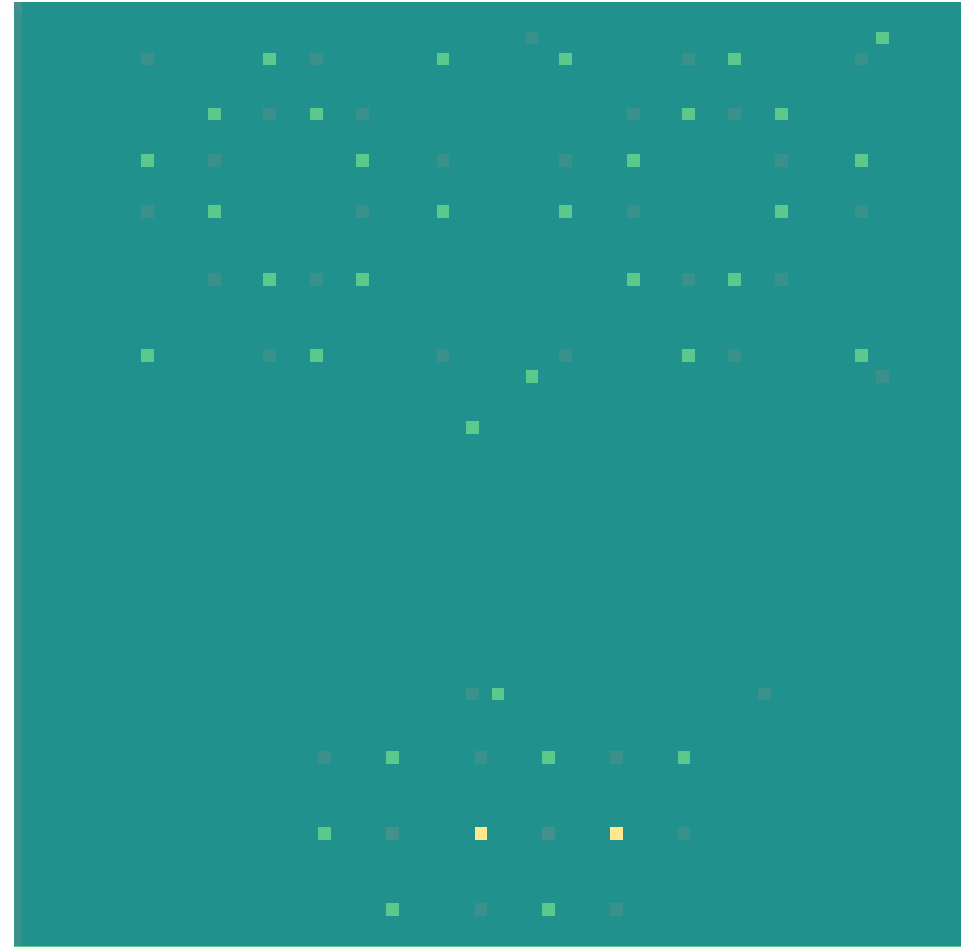


Basic operations

Convolution

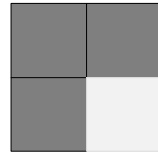
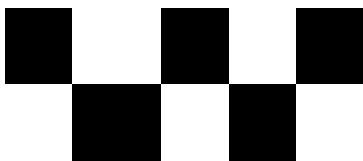
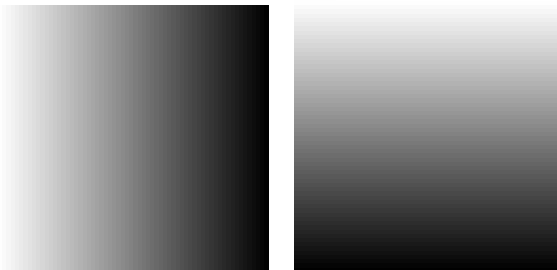


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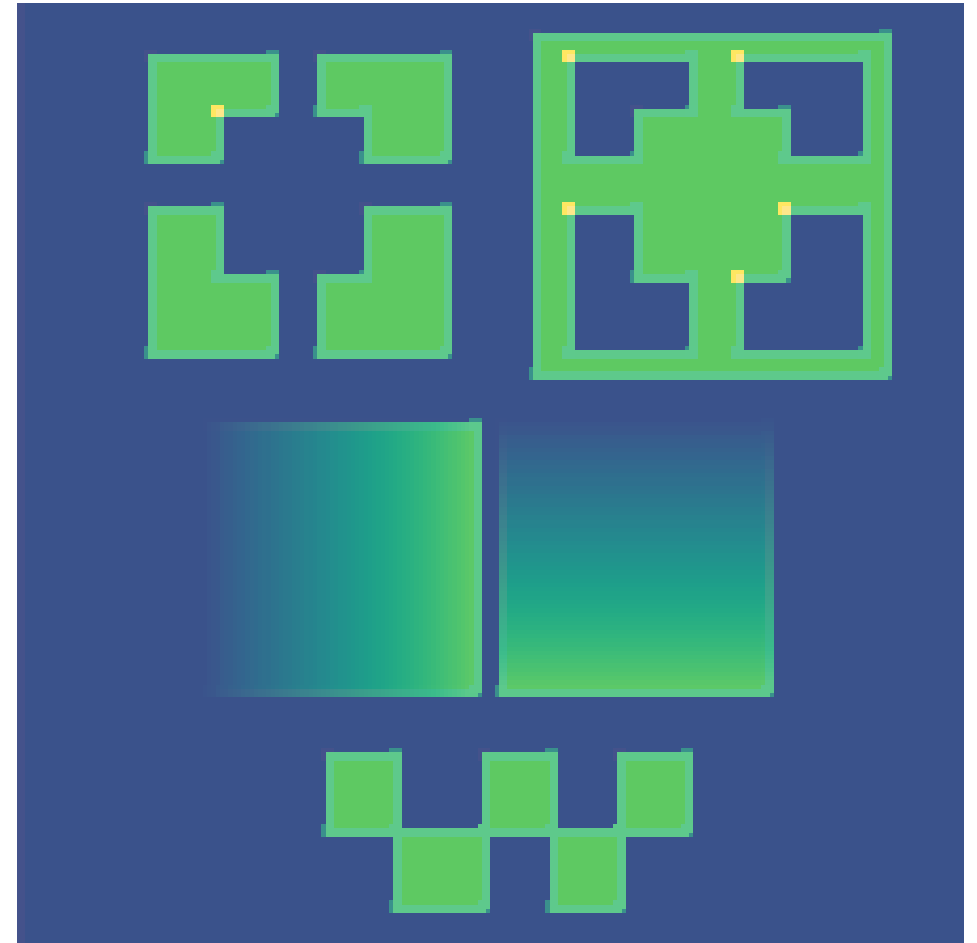


Basic operations

Convolution

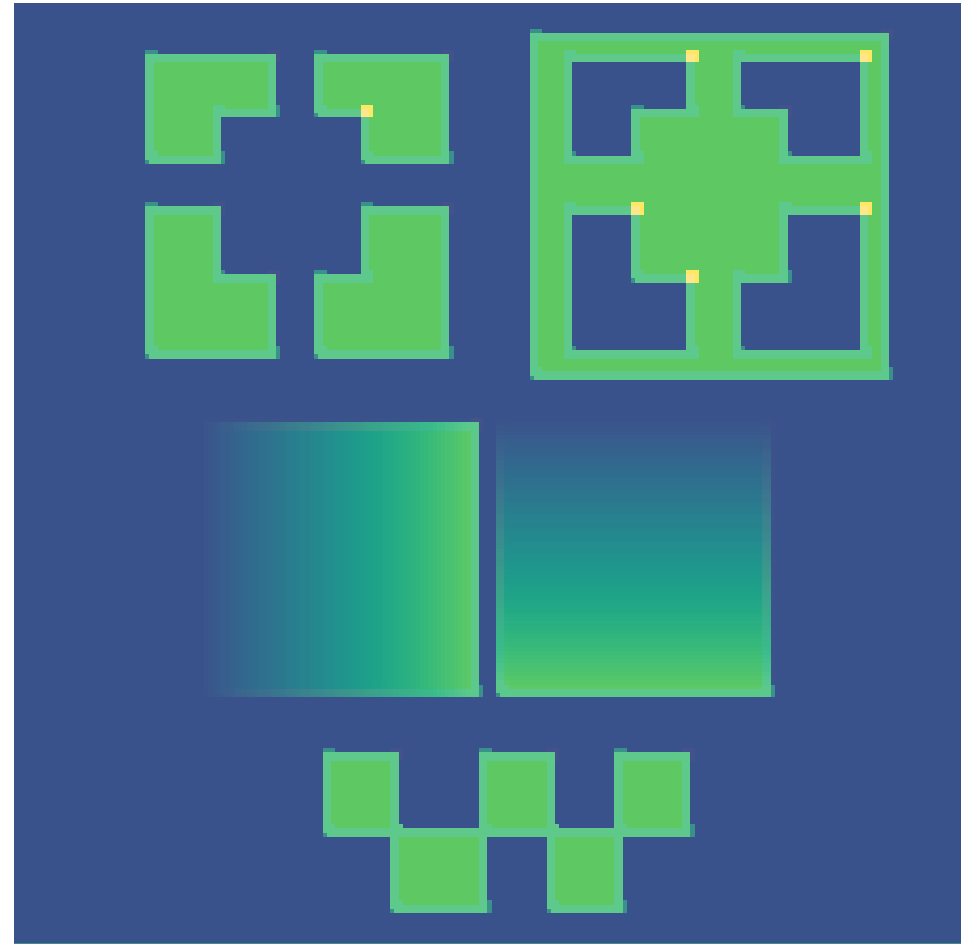
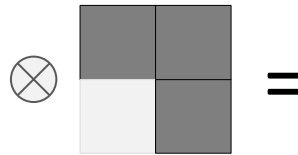
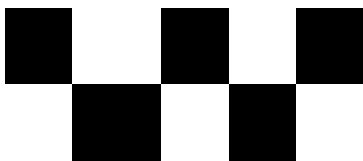
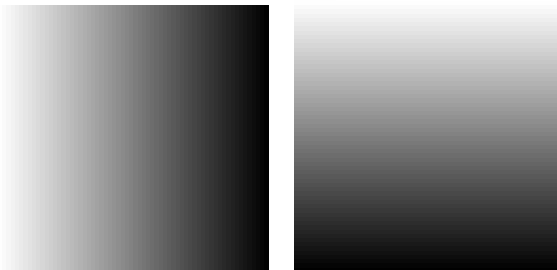


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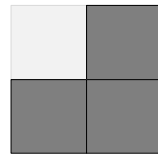
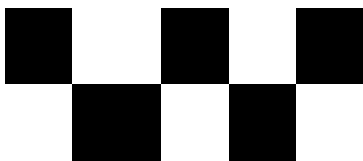
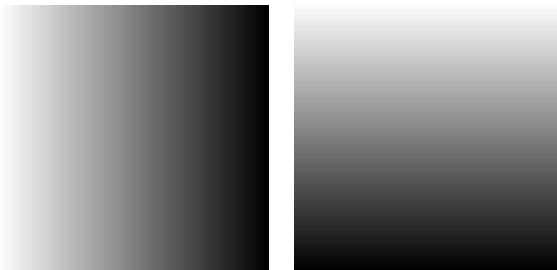
Basic operations

Convolution



Basic operations

Convolution

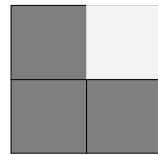
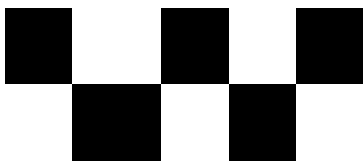
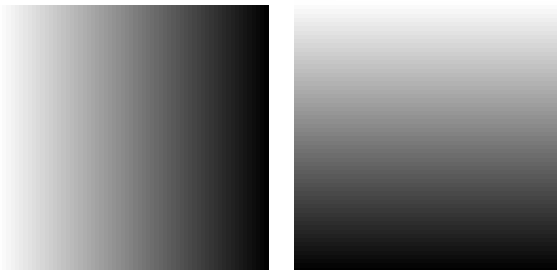


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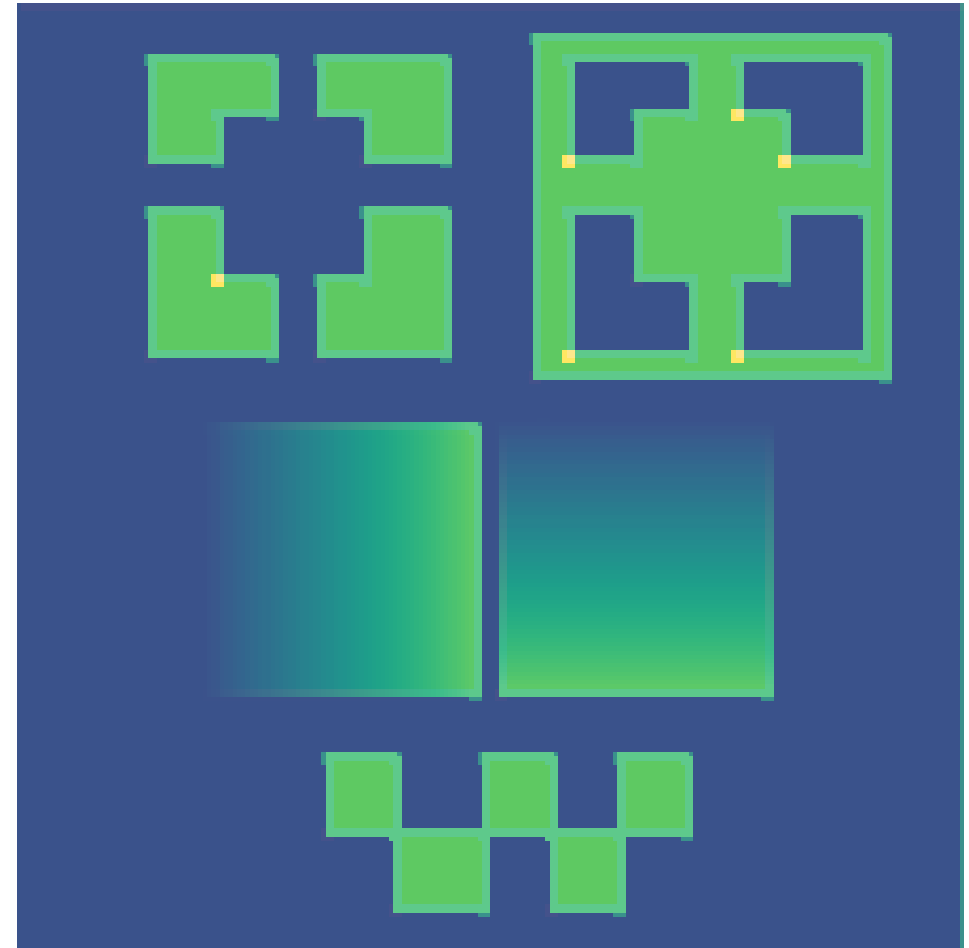


Basic operations

Convolution

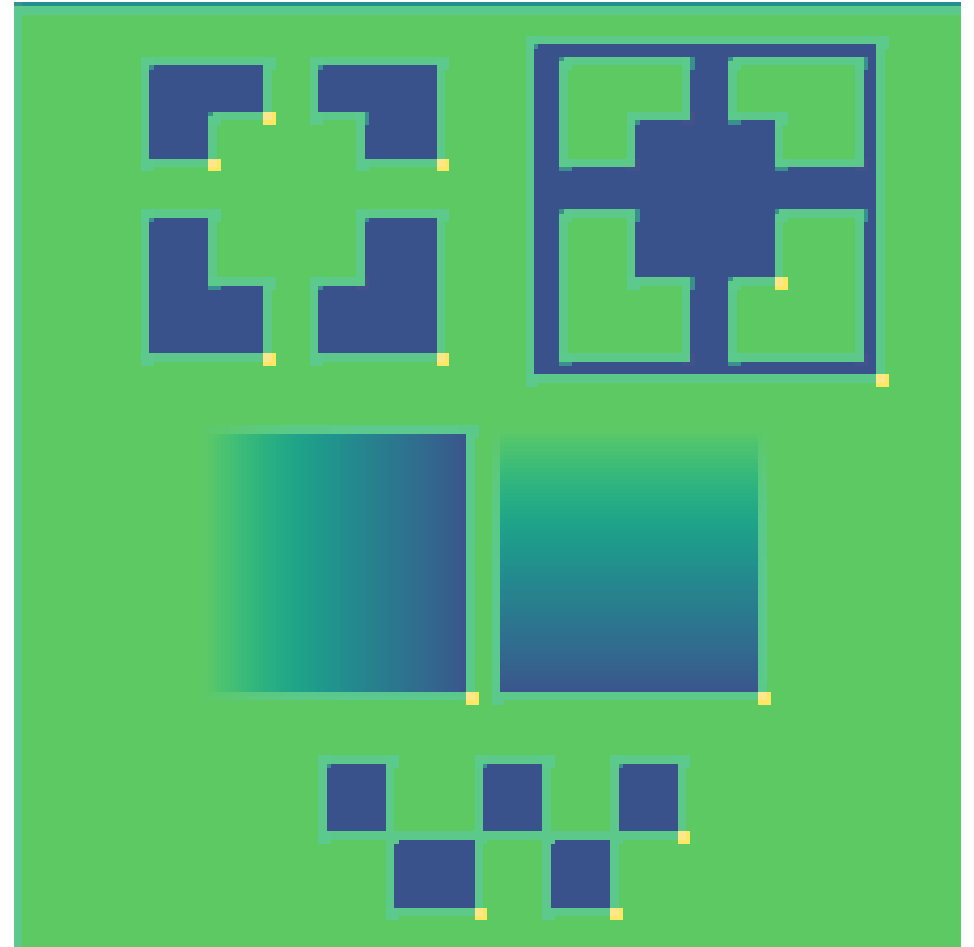
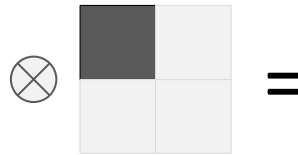
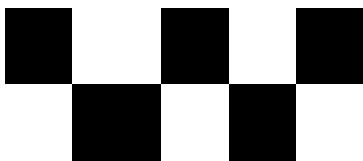
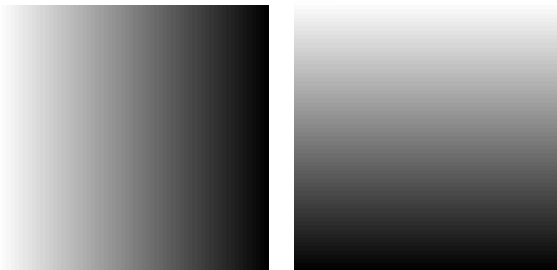


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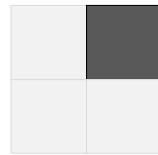
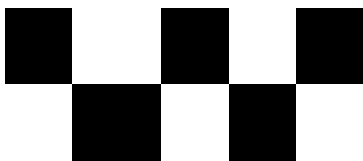
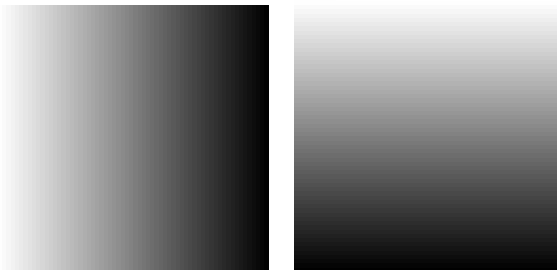
Basic operations

Convolution

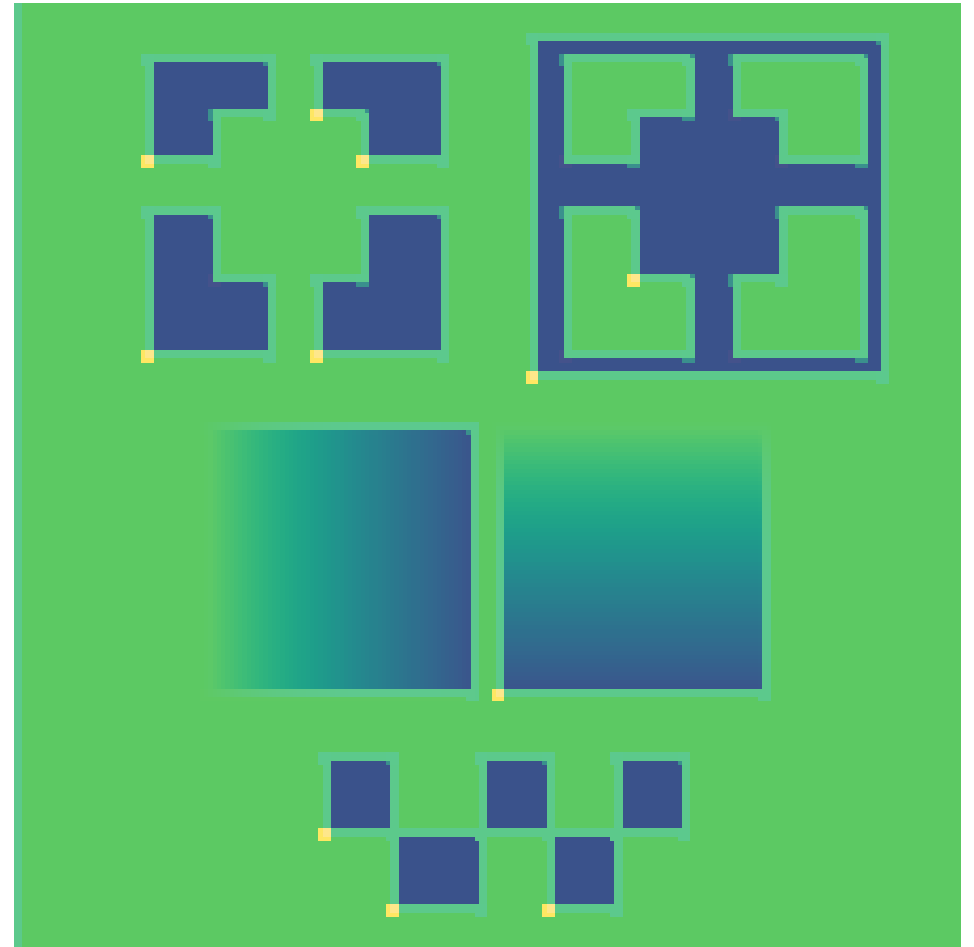


Basic operations

Convolution

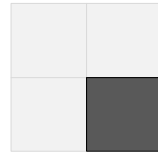
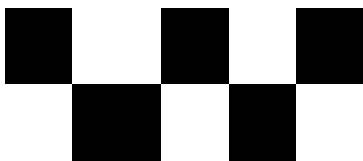
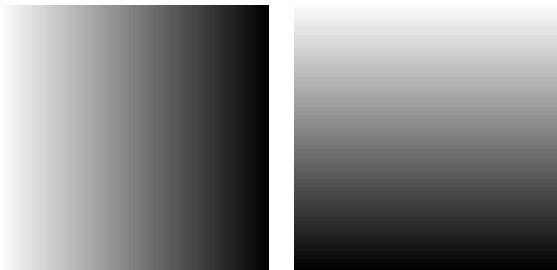


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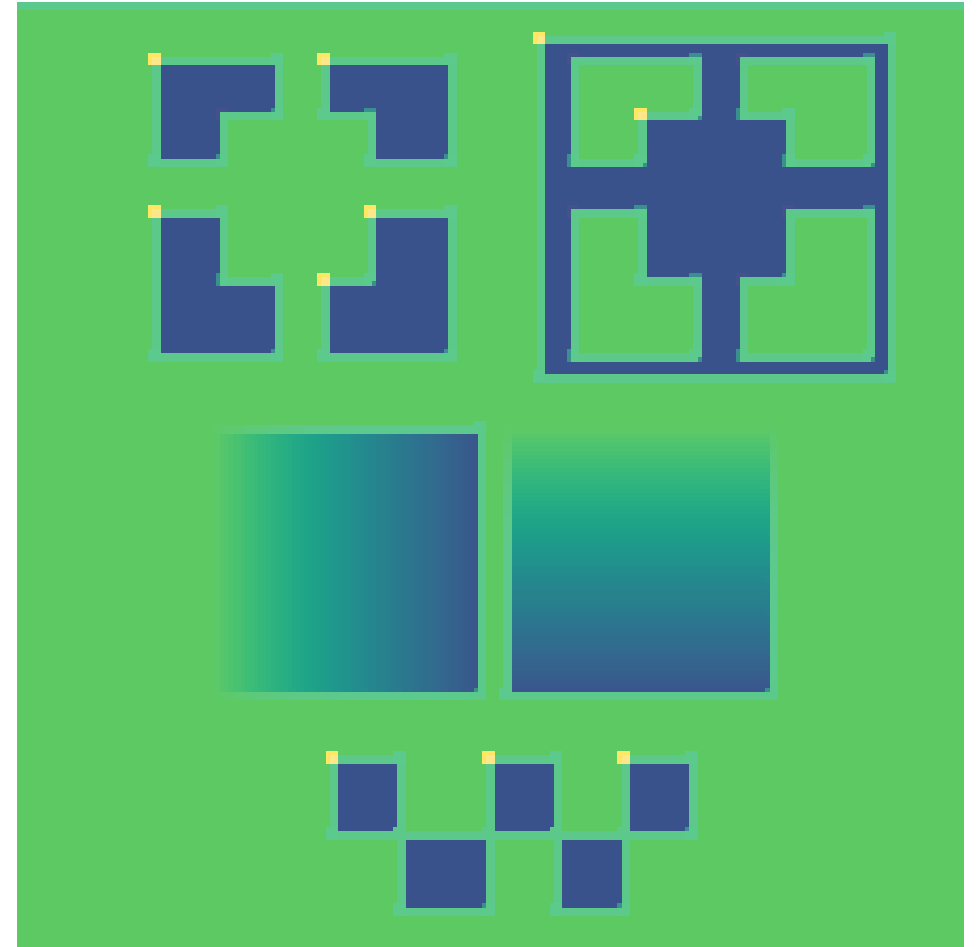


Basic operations

Convolution

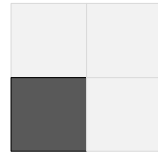
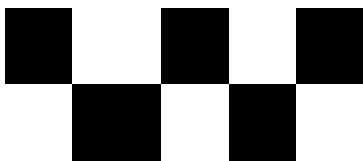
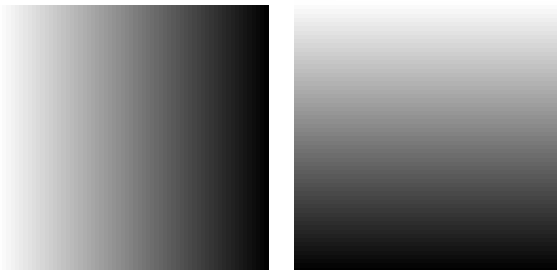


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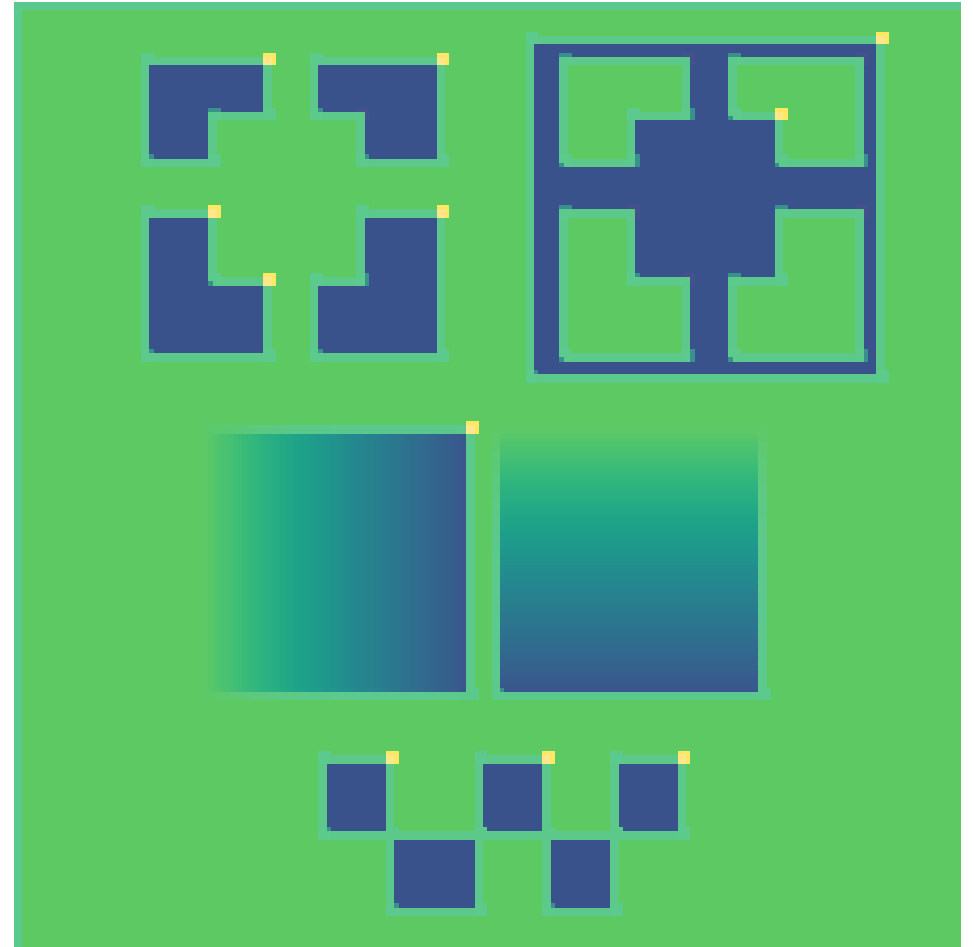


Basic operations

Convolution

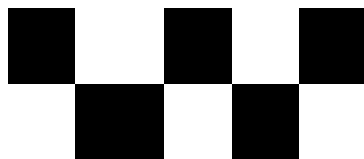
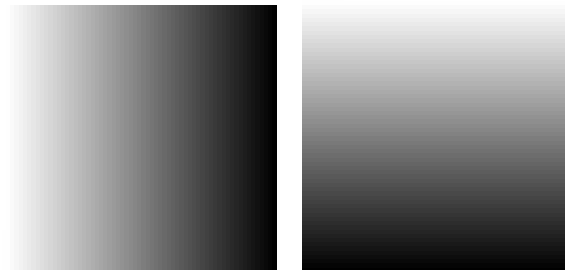
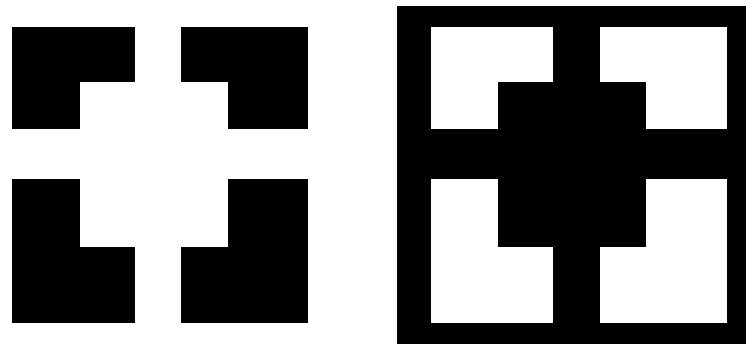


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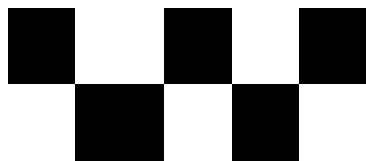
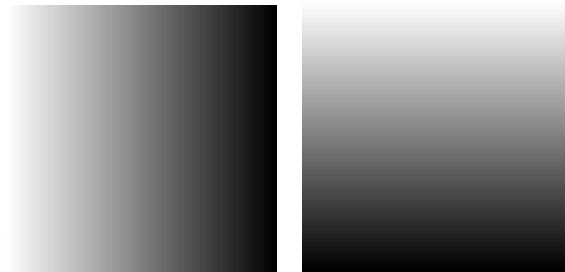
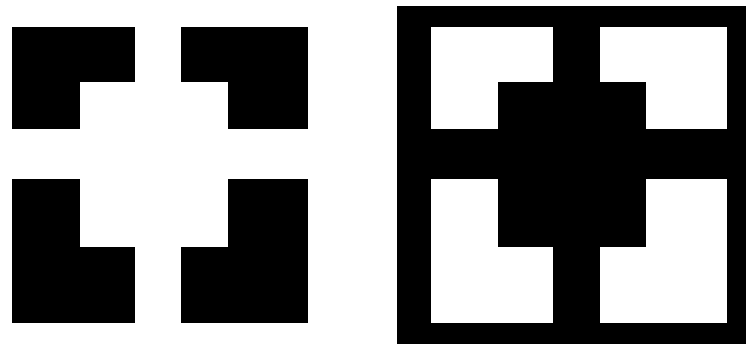
Basic operations

Convolution

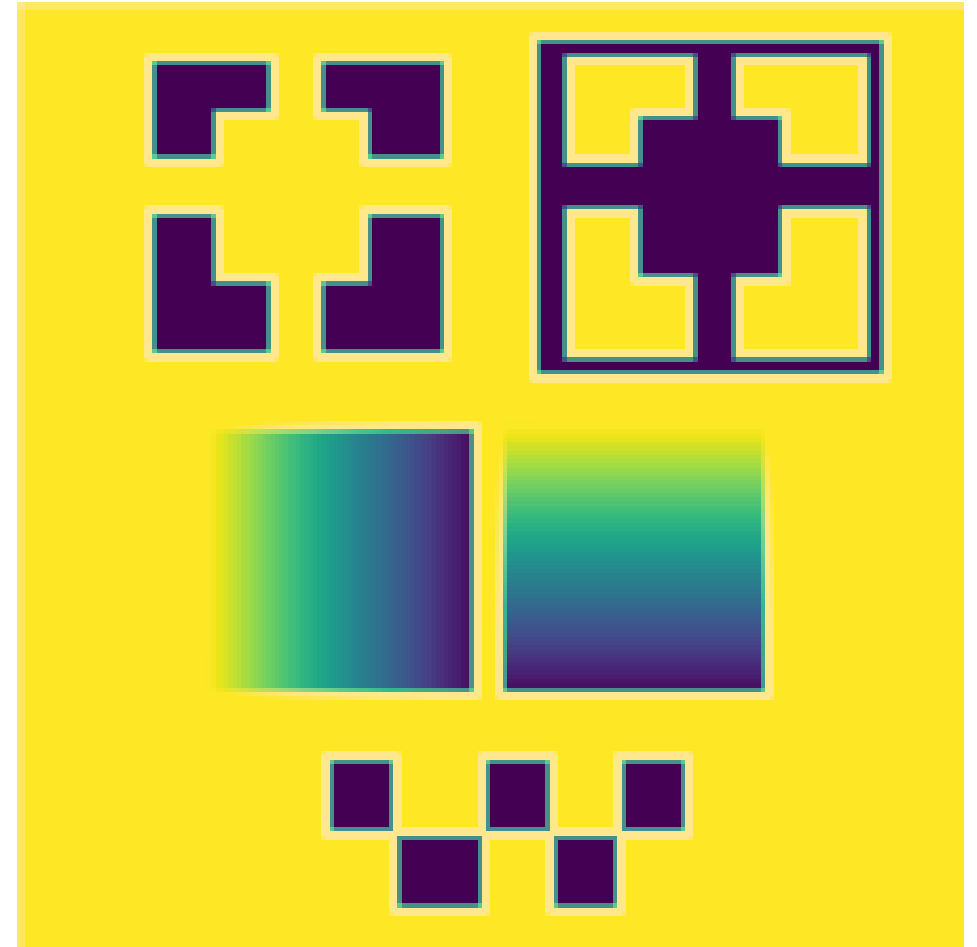


Basic operations

Convolution

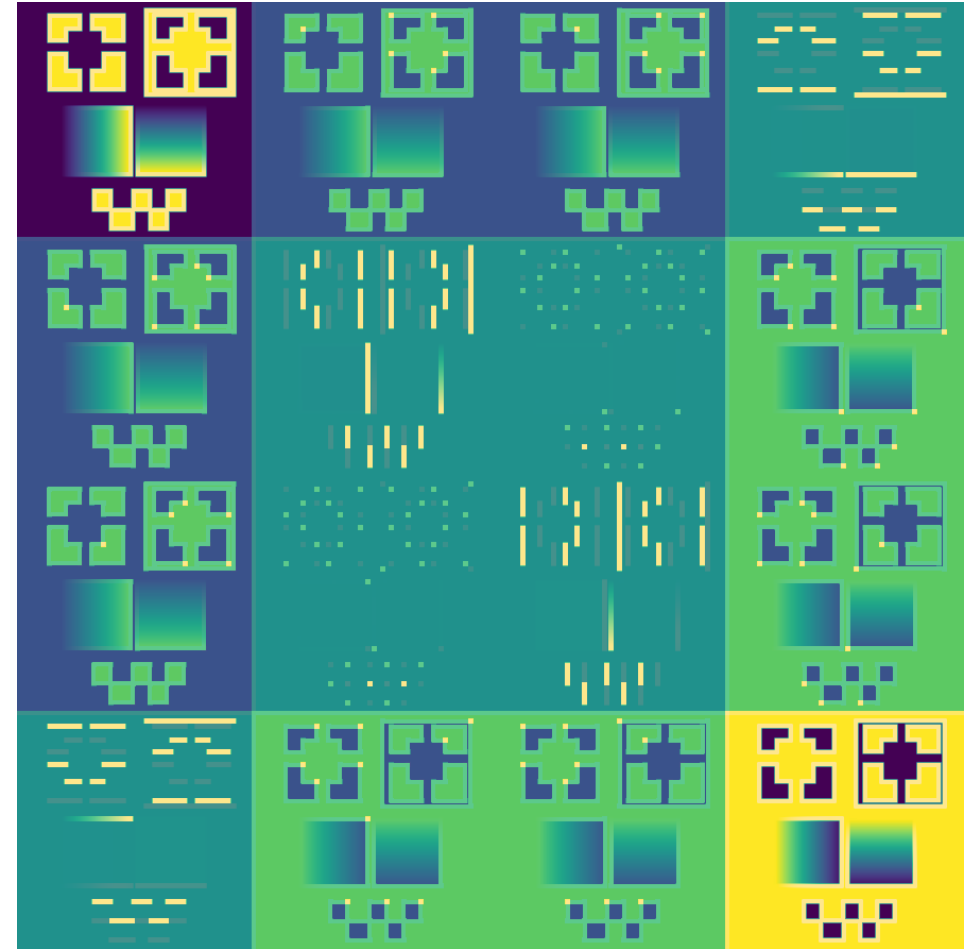
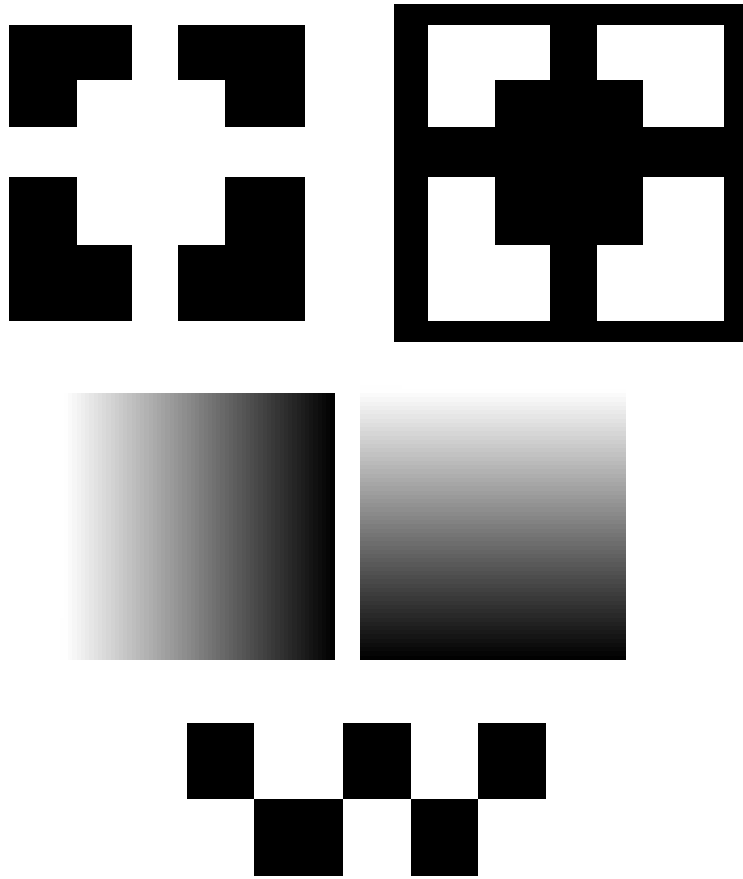


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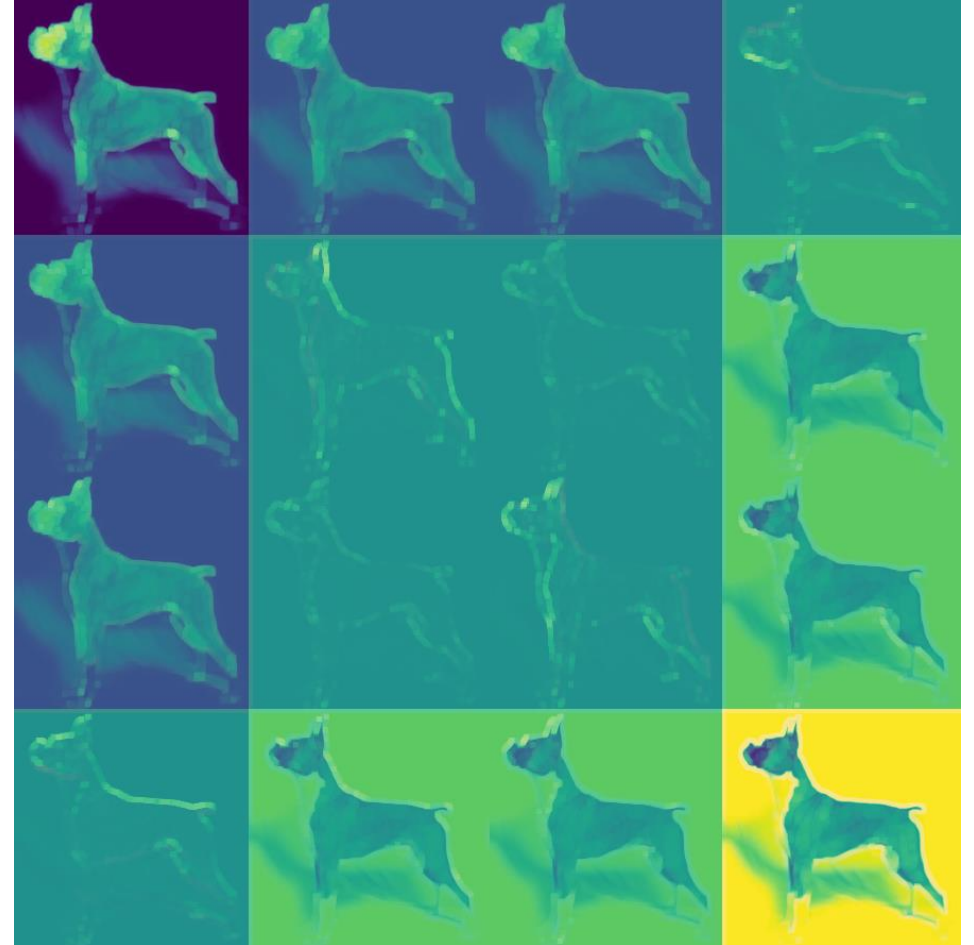
Basic operations

Convolution



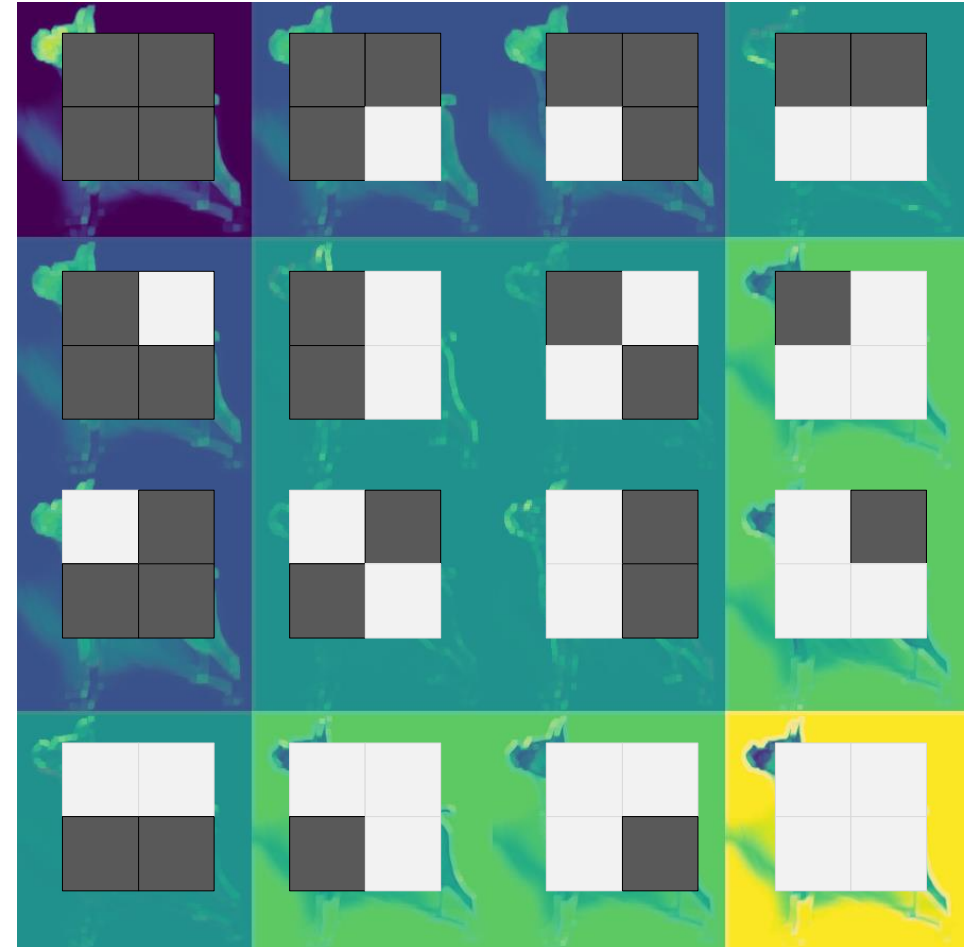
Basic operations

Convolution



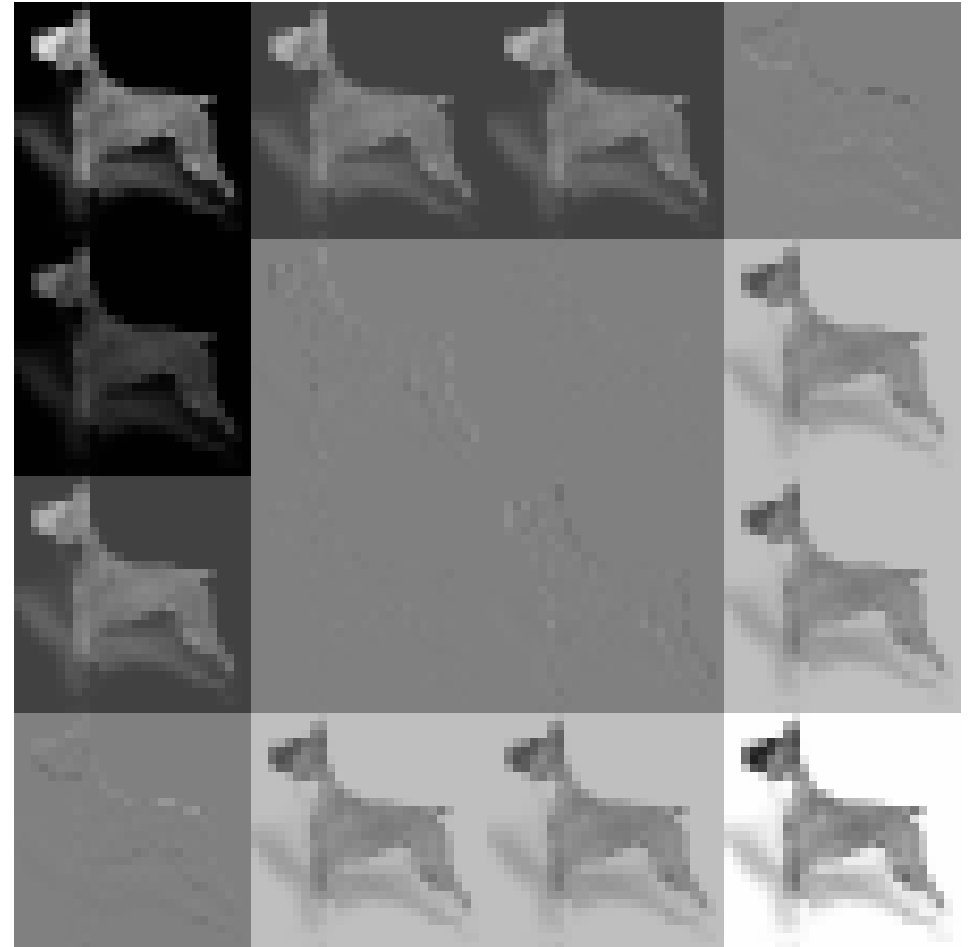
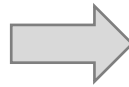
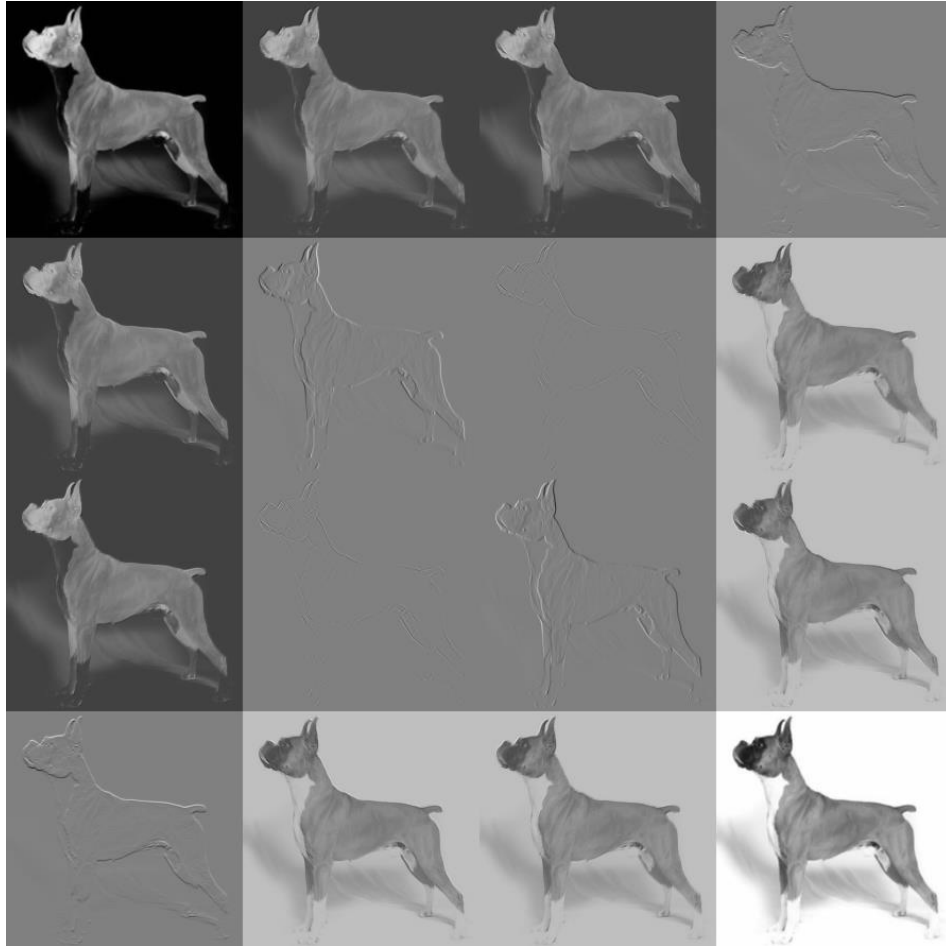
Basic operations

De-Convolution



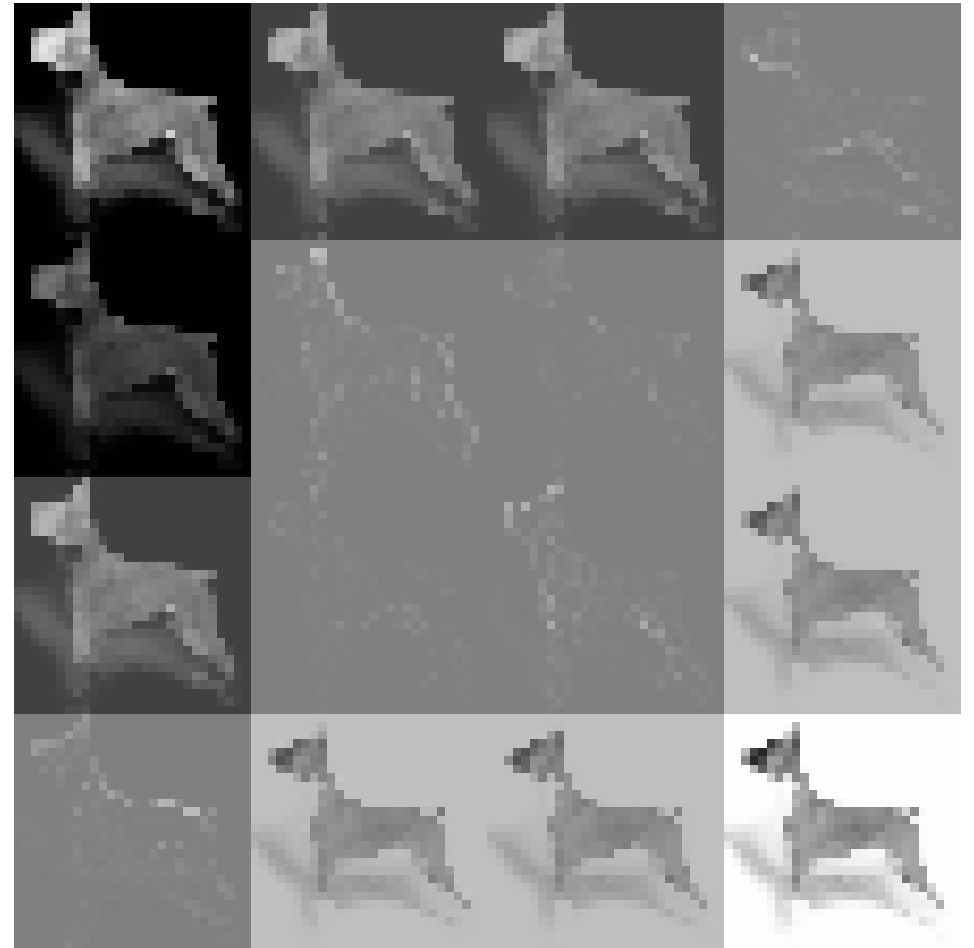
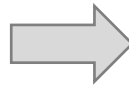
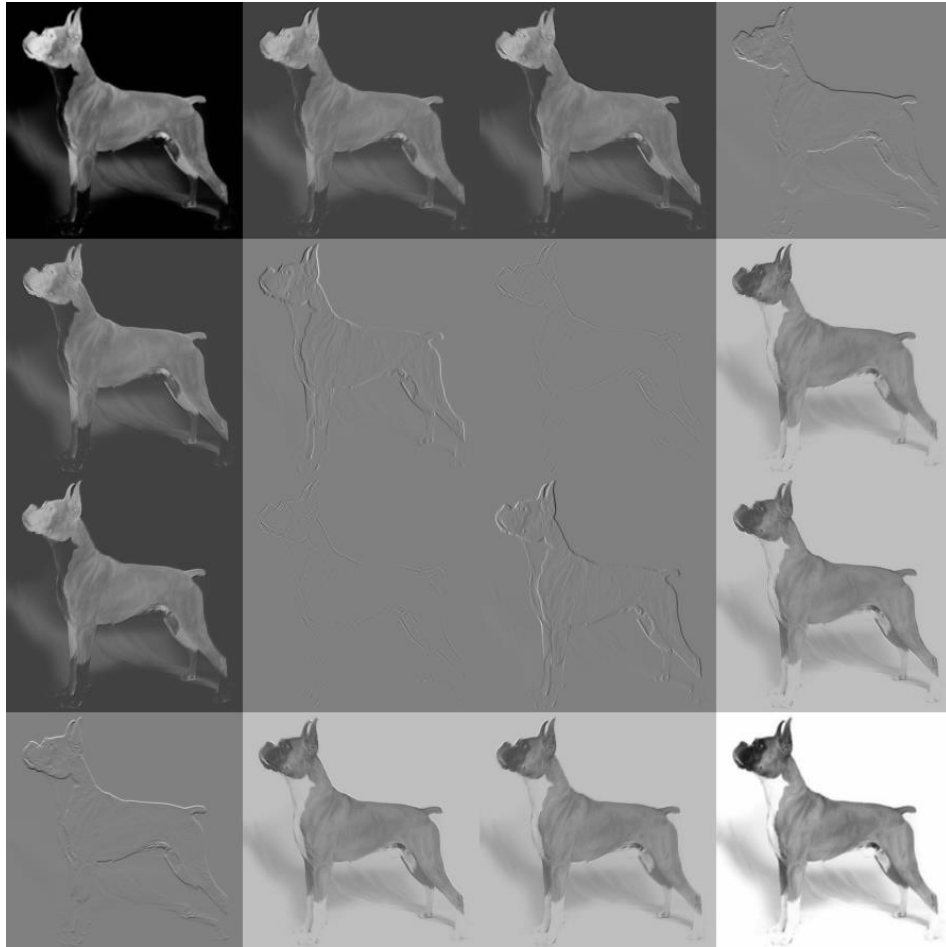
Basic operations

Pool: avg



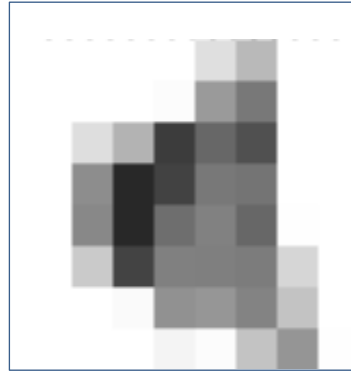
Basic operations

Pool: max



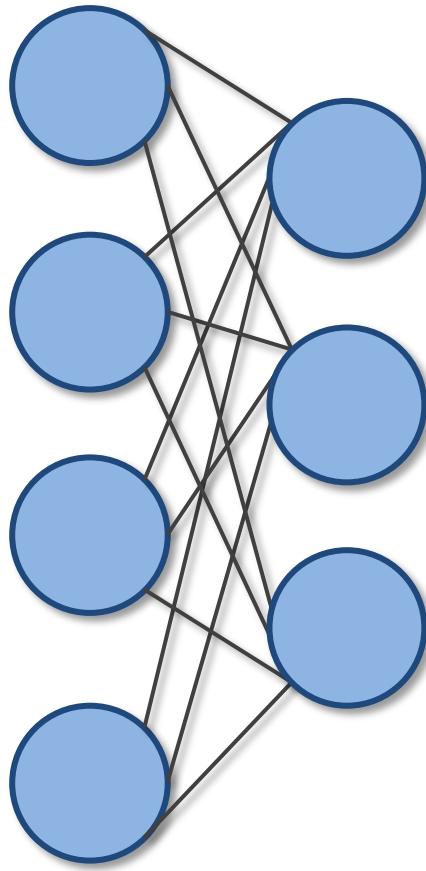
Basic operations

Flatten



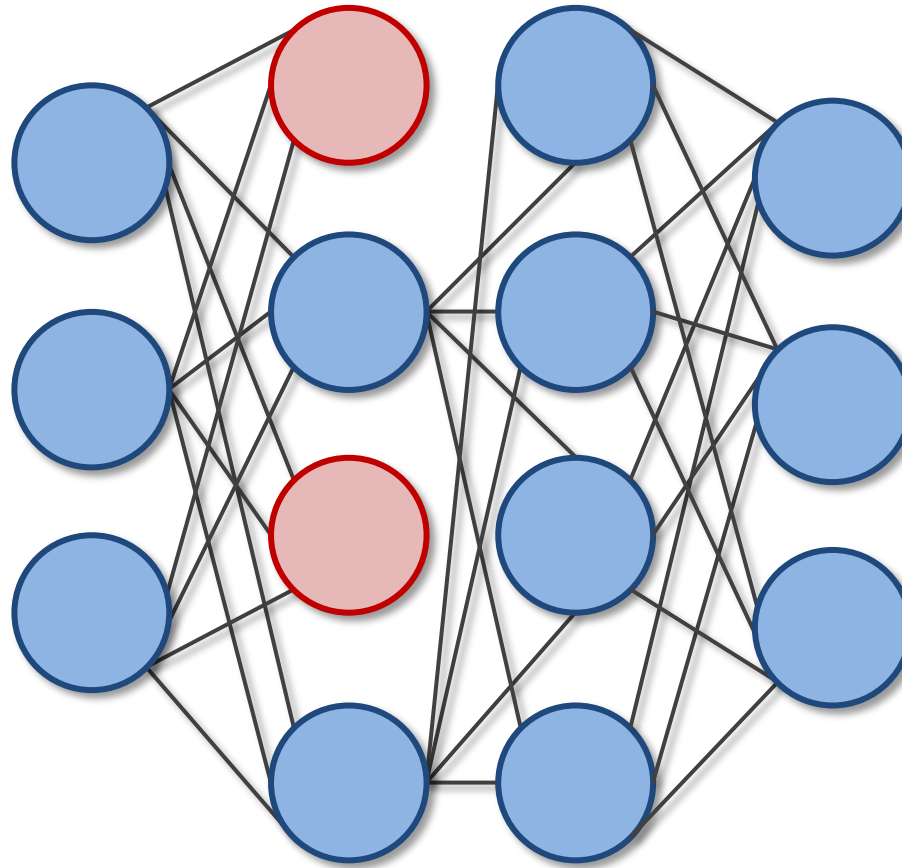
Basic operations

Fully Connected



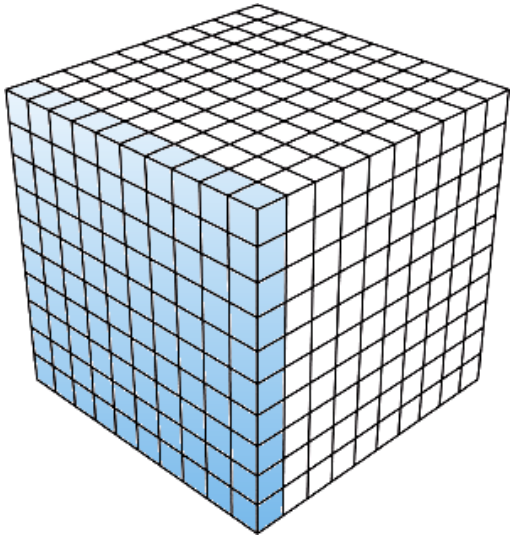
Basic operations

Dropout

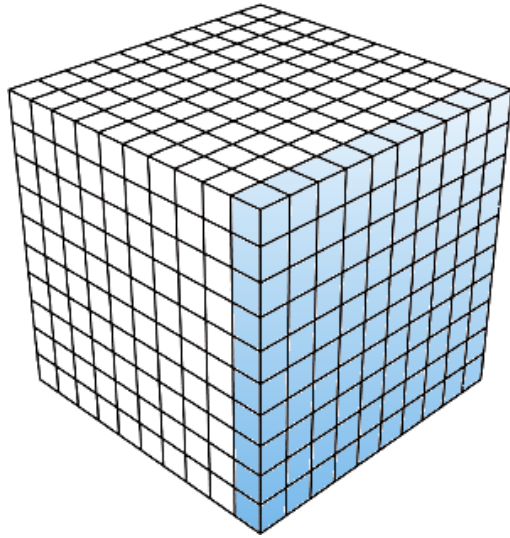


Basic operations

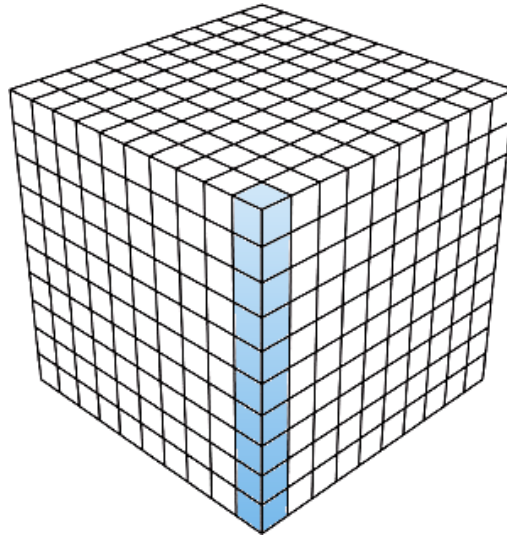
Normalization



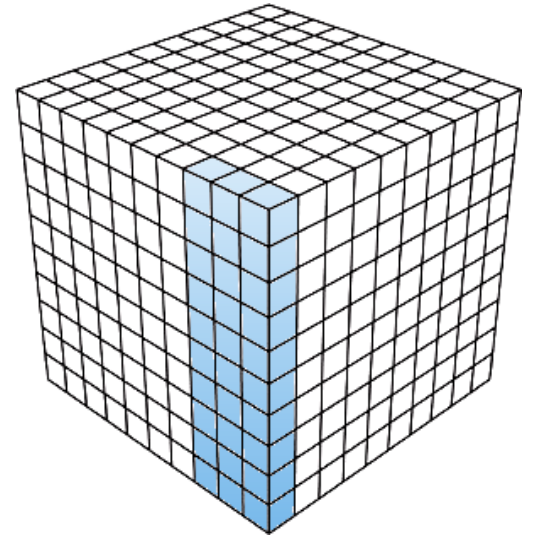
layer



batch



instance



group