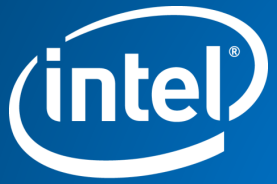

Advanced Techniques for CNNs and Keras

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Data Augmentation

- One practical obstacle to building image classifiers is obtaining labeled training data.
- Finding images is difficult.
- Labeling images is time consuming and costly.
- How can me make the most out of the labelled data we have?

Data Augmentation

- If this is a chair:

Data Augmentation

- If this is a chair…

- Then so is this!

Data Augmentation

- If this is a chair…

- Also this:

Data Augmentation

- If this is a chair…

- Also this:

Data Augmentation

- By slightly altering images, we can increase our effective data size.
- Also allows the neural network to learn invariance to certain transformations.
- But we need to be careful – this can have unintended consequences.

Data Augmentation

Would not want a self-driving car to think these mean the same thing!

Data Flows in Keras

- Keras has a convenient mechanism for Data Augmentation.
- Requires use of “Data Generators”

- To date, we have used the standard `model.fit` mechanism
- Holds entire dataset in memory
- Reads the batches one by one out of memory

Data Flows in Keras

- Alternative mechanism is to use a “data generator”
- Idea: define a generator object which “serves” the batches of data.
- Then use `model.fit` with `datagen.flow`
- Generators can be used to serve images from disk to conserve working memory

ImageDataGenerator

- Keras has an `ImageDataGenerator` class which permits "real-time" data-augmentation.
- When a batch of images is served, you can specify random changes to be made to the image.
- These include shifting, rotating, flipping, and various normalizations of the pixel values.

ImageDataGenerator

```
keras.preprocessing.image.ImageDataGenerator(
    featurewise_center=False, samplewise_center=False,
    featurewise_std_normalization=False,
    samplewise_std_normalization=False,
    zca_whitening=False,
    rotation_range=0.,
    width_shift_range=0.,
    height_shift_range=0.,
    shear_range=0., zoom_range=0., channel_shift_range=0.,
    fill_mode='nearest', cval=0.,
    horizontal_flip=False, vertical_flip=False,
    rescale=None, preprocessing_function=None,
    data_format=K.image_data_format())
```

Shifting Images

```
keras.preprocessing.image.ImageDataGenerator(
    width_shift_range=0.,
    height_shift_range=0.,
    ...)
```

```
width_shift_range=0.1
```

Shifting Images (how to fill in)

```
keras.preprocessing.image.ImageDataGenerator(
    ...,
    fill_mode='nearest', cval=0.,
    ...)
```

```
cval used with fill_mode='constant'
```

```
fill_mode: {"constant", "nearest", "reflect" or "wrap"}
    'constant': kkkkkkkk|abcd|kkkkkkkk (cval=k)
    'nearest': aaaaaaaa|abcd|dddddddd
    'reflect': abcddcba|abcd|dcbaabcd
    'wrap': abcdabcd|abcd|abcdabcd
```

Rotating Images

```
keras.preprocessing.image.ImageDataGenerator(
    ...,
    rotation_range=0.,
    ...)
```

```
rotation_range=30
```

Flipping Images

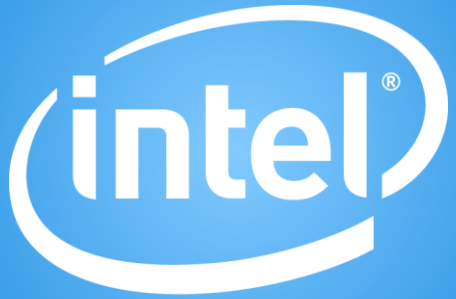
```
keras.preprocessing.image.ImageDataGenerator(
    ...,
    horizontal_flip=False, vertical_flip=False,
    ...)
```

Example

```
datagen = keras.preprocessing.image.ImageDataGenerator(
    rotation_range=20,
    width_shift_range=0.2,
    height_shift_range=0.2,
    horizontal_flip=True,
    zoom_range=0.2)

train_generator = datagen.flow(X, y, batch_size=32)

model.fit(train_generator, epochs=10)
```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