Deep Learning

Exercise 7: Transfer Learning

Instructor: Manuel Günther
Email: guenther@ifi.uzh.ch
Office: AND 2.54

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Outline

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Obtaining Pre-Trained Networks

Pre-Defined Networks

- Networks implemented in `torchvision.models`
  → See `http://pytorch.org/vision/stable/models.html`
- Create pre-defined network, e.g.:
  `network = torchvision.models.resnet18()`
- Download pre-trained (on ImageNet) network:
  `network = torchvision.models.resnet18(pretrained=True)`

Input Normalization

- RGB color images in resolution $3 \times 244 \times 244$ with pixels $[0, 1]$
- Normalized by subtracting mean $(0.485, 0.456, 0.406)$ and dividing by variance $(0.229, 0.224, 0.225)$

Turn Networks to Deep Feature Extractors

Problem

- Pre-trained networks return logits
- We only get object of ResNet class
- Need to overwrite `forward`

Redefining `_forward_impl`

- Rewrite function:

```
def my_forward(self, x):
```

- Bind `my_forward` to object:

```
net = torchvision.models.resnet18(
      pretrained=True)
net._forward_impl = types.MethodType(
      my_forward, net)
```

ResNet (Implementation)

```
def _forward_impl(self, x):
    x = self.conv1(x)
    x = self.bn1(x)
    x = self.relu(x)
    x = self.maxpool(x)

    x = self.layer1(x)
    x = self.layer2(x)
    x = self.layer3(x)
    x = self.layer4(x)

    x = self.avgpool(x)
    x = torch.flatten(x, 1)
    ## x = self.fc(x)

    return x

def forward(self, x):
    return self._forward_impl(x)
```

Outline

Dataset

Face Recognition Dataset

- Images of 15 people
- Grayscale images as .gif
- File: `subjectXX.situation`
- 11 different variations:

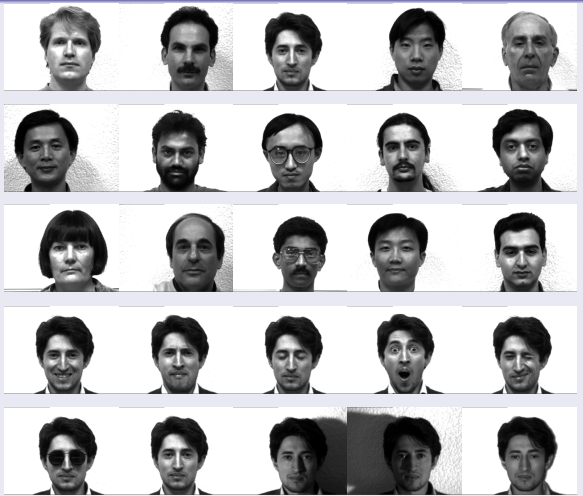
happy, sad, sleepy, surprised, wink
glasses, noglasses, left, right, center

- Load: `PIL.Image.open(...)`

Download Face Data

`http://vision.ucsd.edu/content/yale-face-database`

Images

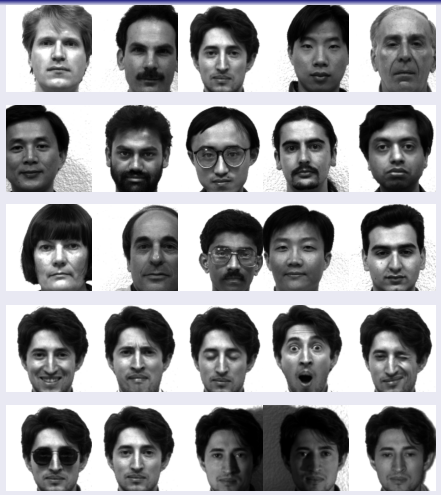


Dataset

Image Preprocessing

1. Scale image to 300 pixel height:
   `torchvision.transforms.Resize(300)`
2. Take 224×224 center crop:
   `torchvision.transforms.CenterCrop(224)`
3. Convert to Tensor:
   `torchvision.transforms.ToTensor()`
4. Convert to 3-plane image:
   `tensor.repeat(3,1,1)`
5. Normalize (see above)
6. Add batchsize dimension:
   `tensor.unsqueeze(0)`

Images



Face Identification

Gallery

- Extract features for `normal` images
- Associate features with subject

  $\Rightarrow$ 15 features in gallery

Exemplary Results

normal	happy	sad	sleepy
15/15	14/15	15/15	15/15

surprised	wink	glasses	noglasses
13/15	15/15	15/15	13/15

leftlight	rightlight	centerlight	total
12/15	12/15	11/14	150/164

Probing

- Go through all variations
- Go through all subjects
- Extract feature for image
- Compare to all gallery features

  $\rightarrow$ Compute gallery subject with lowest distance to probe
- Compare best gallery subject with probe subject

  $\rightarrow$ Same subject: correctly identified
- Count correct identifications

Face Identification

Task 1: Pre-Trained Network

- Download pre-trained network via `torchvision`
  → Try out versions (18, 32, ...)
- Turn network into deep feature extractor

Task 2: Feature Extraction

- Write a function that:
  1. Loads image via `PIL`
  2. Crops the face
  3. Transforms image to `tensor`
  4. Extracts the deep feature
  5. Returns `flatten`ed version as a `numpy` array

Face Identification

Task 3: Build Gallery

1. Store features for `normal` images

Task 4: Probing

1. Take all images of all subjects
   → Split by variation
2. Extract features for image
3. Compare to all gallery features
   → `scipy.spatial.distance.euclidean`
4. Count correctly classified faces
   → Split by variation
   → Compute total

Task 5: Variations (Optional)

1. Different network topologies
2. Other distance functions
3. Different preprocessing
   → Face detection?
4. Raw pixel values of cropped faces as features
5. Different variation in gallery
   → `happy`, `glasses`, `rightlight`