Modify the data loader to return extended binary labels

```
104 # Dataset
                                                                                            144 # Dataset
105 #################
                                                                                            145 ##################
106
                                                                                            146
107-
108 class AFADDatasetAge(Dataset):
                                                                                            147 class AFADDatasetAge(Dataset):
         """Custom Dataset for loading AFAD face images"""
                                                                                                     """Custom Dataset for loading AFAD face images"""
109
                                                                                            148
                                                                                            149
110
111
         def __init__(self, csv_path, img_dir, transform=None):
                                                                                                     def __init__(self, csv_path, img_dir, transform=None):
                                                                                            150
112
                                                                                            151
113
             df = pd.read_csv(csv_path, index_col=0)
                                                                                            152
                                                                                                         df = pd.read_csv(csv_path, index_col=0)
114
                                                                                                         self.img dir = img dir
             self.img_dir = img_dir
                                                                                            153
115
             self.csv_path = csv_path
                                                                                            154
                                                                                                         self.csv_path = csv_path
116
             self.img_paths = df['path']
                                                                                            155
                                                                                                         self.img_paths = df['path']
117
             self.y = df['age'].values
                                                                                            156
                                                                                                         self.y = df['age'].values
118
             self.transform = transform
                                                                                            157
                                                                                                         self.transform = transform
119
                                                                                            158
120
                                                                                            159
         def __getitem__(self, index):
                                                                                                     def __getitem__(self, index):
121
              img = Image.open(os.path.join(self.img_dir,
                                                                                            160
                                                                                                          img = Image.open(os.path.join(self.img_dir,
122
                                            self.img_paths[index]))
                                                                                                                                        self.img_paths[index]))
                                                                                            161
123
                                                                                            162
124
             if self.transform is not None:
                                                                                            163
                                                                                                         if self.transform is not None:
125
                  img = self.transform(img)
                                                                                            164
                                                                                                             img = self.transform(img)
126
                                                                                            165
127
             label = self.y[index]
                                                                                            166
                                                                                                          label = self.y[index]
                                                                                                          levels = [1]*label + [0]*(NUM_CLASSES - 1 - label)
                                                                                            167 +
                                                                                            168 +
                                                                                                          levels = torch.tensor(levels, dtype=torch.float32)
```

Add the CORAL layer:

207 class ResNet(nn.Module):

```
256
 208
                                                                                              257
                                                                                                       def __init__(self, block, layers, num_classes, grayscale):
 209
          def __init__(self, block, layers, num_classes, grayscale):
                                                                                              258+
                                                                                                           self.num_classes = num_classes
                                                                                                           self.inplanes = 64
              self.inplanes = 64
 210
                                                                                              259
 211
              if grayscale:
                                                                                              260
                                                                                                           if grayscale:
 212
                  in_dim = 1
                                                                                              261
                                                                                                               in_dim = 1
                                                                                                           else:
 213
              else:
                                                                                              262
 214
                  in_dim = 3
                                                                                              263
                                                                                                               in_dim = 3
              super(ResNet, self).__init__()
 215
                                                                                              264
                                                                                                           super(ResNet, self).__init__()
 216
              self.conv1 = nn.Conv2d(in_dim, 64, kernel_size=7, stride=2, padding=3,
                                                                                              265
                                                                                                           self.conv1 = nn.Conv2d(in_dim, 64, kernel_size=7, stride=2, padding=3,
 217
                                     bias=False)
                                                                                              266
                                                                                                                                   bias=False)
 218
                                                                                              267
              self.bn1 = nn.BatchNorm2d(64)
                                                                                                           self.bn1 = nn.BatchNorm2d(64)
              self.relu = nn.ReLU(inplace=True)
219
                                                                                              268
                                                                                                           self.relu = nn.ReLU(inplace=True)
 220
                                                                                                           self.maxpool = nn.MaxPool2d(kernel_size=3, stride=2, padding=1)
              self.maxpool = nn.MaxPool2d(kernel_size=3, stride=2, padding=1)
                                                                                              269
 221
              self.layer1 = self._make_layer(block, 64, layers[0])
                                                                                              270
                                                                                                           self.layer1 = self._make_layer(block, 64, layers[0])
 222
              self.layer2 = self._make_layer(block, 128, layers[1], stride=2)
                                                                                                           self.layer2 = self._make_layer(block, 128, layers[1], stride=2)
                                                                                              271
              self.layer3 = self._make_layer(block, 256, layers[2], stride=2)
                                                                                                           self.layer3 = self._make_layer(block, 256, layers[2], stride=2)
 223
                                                                                              272
              self.layer4 = self._make_layer(block, 512, layers[3], stride=2)
 224
                                                                                                           self.layer4 = self._make_layer(block, 512, layers[3], stride=2)
                                                                                              273
 225
              self.avgpool = nn.AvgPool2d(4)
                                                                                              274
                                                                                                           self.avgpool = nn.AvgPool2d(4)
 226-
              self.fc = nn.Linear(512, self.num_classes)
                                                                                              275+
                                                                                                           self.fc = nn.Linear(512, 1, bias=False)
                                                                                                           self.linear_1_bias = nn.Parameter(torch.zeros(
                                                                                              276 +
                                                                                                               self.num_classes-1).float())
                                                                                              277+
```

255 class ResNet(nn.Module):

Modify the forward method accordingly:

```
def forward(self, x):
253
                                                                                              304
                                                                                                        def forward(self, x):
254
             x = self.conv1(x)
                                                                                              305
                                                                                                            x = self.conv1(x)
255
             x = self.bn1(x)
                                                                                              306
                                                                                                            x = self.bn1(x)
256
             x = self.relu(x)
                                                                                                            x = self.relu(x)
                                                                                              307
257
             x = self.maxpool(x)
                                                                                                            x = self.maxpool(x)
                                                                                              308
258
                                                                                              309
259
             x = self.layer1(x)
                                                                                                            x = self.layer1(x)
                                                                                              310
260
             x = self.layer2(x)
                                                                                                            x = self.layer2(x)
                                                                                              311
             x = self.layer3(x)
                                                                                              312
                                                                                                            x = self.layer3(x)
261
262
             x = self.layer4(x)
                                                                                              313
                                                                                                            x = self.layer4(x)
263-
             x = self.avgpool(x)
264
                                                                                              314
                                                                                              315+
                                                                                                            x = self.avgpool(x)
             x = x.view(x.size(0), -1)
                                                                                                            x = x.view(x.size(0), -1)
265
                                                                                              316
266
             logits = self.fc(x)
                                                                                                            logits = self.fc(x)
                                                                                              317
267-
             probas = F.softmax(logits, dim=1)
                                                                                              318+
                                                                                                            logits = logits + self.linear_1_bias
                                                                                                            probas = torch.sigmoid(logits)
                                                                                              319+
                                                                                              320
                                                                                                            return logits, probas
268
             return logits, probas
```

Add the CORAL loss:

```
# Initialize Cost, Model, and Optimizer
                                                                        333 # Initialize Cost, Model, and Optimizer
    *************************************
                                                                            ************************************
283
                                                                        335
                                                                        336+ def cost_fn(logits, levels, imp):
                                                                        337+
                                                                               val = (-torch.sum((F.logsigmoid(logits)*levels
                                                                        338+
                                                                                             + (F.logsigmoid(logits) - logits)*(1-levels))*imp,
                                                                        339+
                                                                                     dim=1))
                                                                        340 +
                                                                               return torch.mean(val)
                                                                        341 +
                                                                        342 +
```

Modify the training loop accordingly:

```
best_mae, best_rmse, best_epoch = 999, 999, -1
                                                                                                 best_mae, best_rmse, best_epoch = 999, 999, -1
    for epoch in range(num_epochs):
                                                                                            372 for epoch in range(num_epochs):
315
                                                                                            373
316
         model.train()
                                                                                            374
                                                                                                     model.train()
         for batch_idx, (features, targets) in enumerate(train_loader):
                                                                                            375 +
                                                                                                      for batch_idx, (features, targets, levels) in enumerate(train_loader):
317-
                                                                                            376
318
319
                                                                                            377
             features = features.to(DEVICE)
                                                                                                         features = features.to(DEVICE)
                                                                                            378 +
                                                                                                         targets = targets
320
             targets = targets.to(DEVICE)
                                                                                            379
                                                                                                         targets = targets.to(DEVICE)
                                                                                            380 +
                                                                                                          levels = levels.to(DEVICE)
                                                                                            381
321
322
             # FORWARD AND BACK PROP
                                                                                            382
                                                                                                         # FORWARD AND BACK PROP
323
                                                                                            383
             logits, probas = model(features)
                                                                                                         logits, probas = model(features)
                                                                                                         cost = cost_fn(logits, levels, imp)
324-
             cost = F.cross_entropy(logits, targets)
                                                                                            384 +
325
                                                                                                         optimizer.zero_grad()
             optimizer.zero_grad()
                                                                                            385
326
                                                                                            386
327
             cost.backward()
                                                                                            387
                                                                                                         cost.backward()
328
                                                                                            388
329
             # UPDATE MODEL PARAMETERS
                                                                                            389
                                                                                                         # UPDATE MODEL PARAMETERS
330
             optimizer.step()
                                                                                            390
                                                                                                         optimizer.step()
331
                                                                                            391
             # LOGGING
332
                                                                                            392
                                                                                                         # LOGGING
333
             if not batch_idx % 50:
                                                                                            393
                                                                                                         if not batch_idx % 50:
334
                 s = ('Epoch: %03d/%03d | Batch %04d/%04d | Cost: %.4f'
                                                                                            394
                                                                                                              s = ('Epoch: %03d/%03d | Batch %04d/%04d | Cost: %.4f'
335
                      % (epoch+1, num_epochs, batch_idx,
                                                                                            395
                                                                                                                   % (epoch+1, num_epochs, batch_idx,
336
                          len(train_dataset)//BATCH_SIZE, cost))
                                                                                            396
                                                                                                                       len(train_dataset)//BATCH_SIZE, cost))
337
                 print(s)
                                                                                            397
                                                                                                             print(s)
338
                 with open(LOGFILE, 'a') as f:
                                                                                            398
                                                                                                              with open(LOGFILE, 'a') as f:
339
                     f.write('%s\n' % s)
                                                                                            399
                                                                                                                  f.write('%s\n' % s)
340
                                                                                            400
341
         model.eval()
                                                                                            401
                                                                                                     model.eval()
342
         with torch.set_grad_enabled(False):
                                                                                            402
                                                                                                     with torch.set_grad_enabled(False):
343-
             test_mae, test_mse = compute_mae_and_mse(model, test_loader,
                                                                                            403 +
                                                                                                          valid_mae, valid_mse = compute_mae_and_mse(model, valid_loader,
344
                                                       device=DEVICE)
                                                                                            404
                                                                                                                                                     device=DEVICE)
```