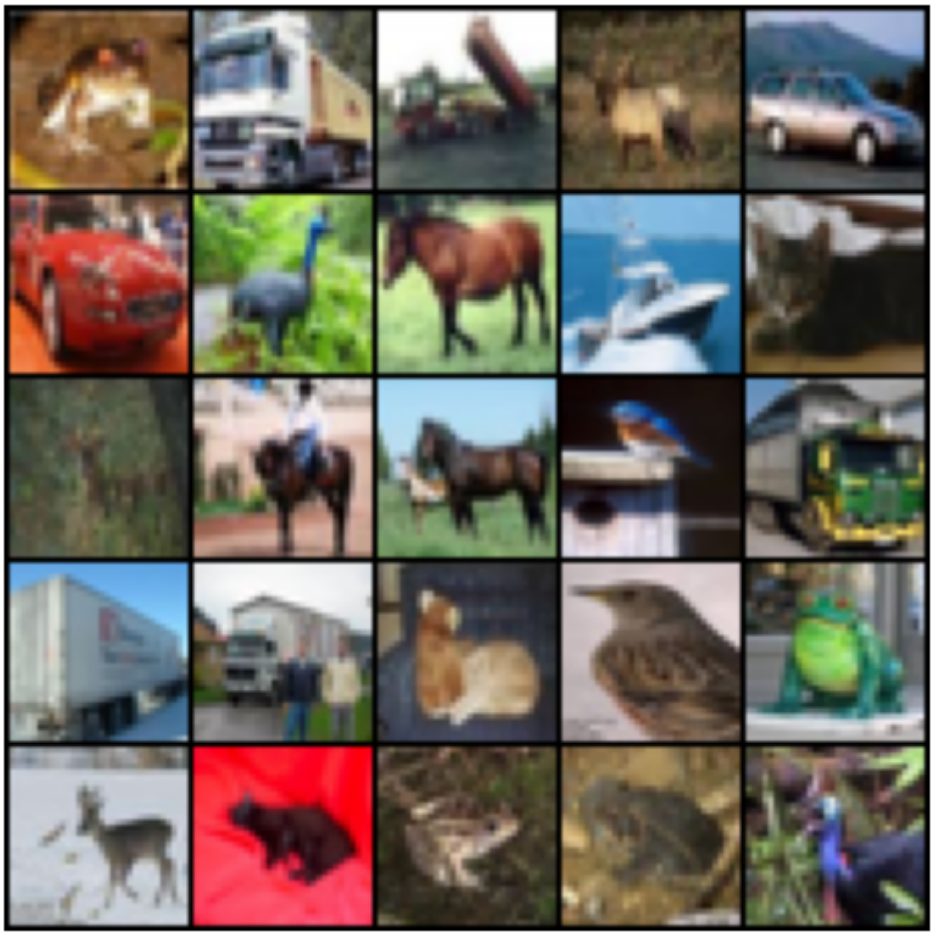
In [1]:
```
import torch
import torchvision
import matplotlib.pyplot as plt
import numpy as np

# The below two lines are optional and are just there to avoid any SSL
# related errors while downloading the CIFAR-10 dataset
import ssl
ssl._create_default_https_context = ssl._create_unverified_context

#Defining plotting settings
plt.rcParams['figure.figsize'] = 14, 6

#Initializing normalizing transform for the dataset
normalize_transform = torchvision.transforms.Compose([
        torchvision.transforms.ToTensor(),
        torchvision.transforms.Normalize(mean = (0.5, 0.5, 0.5),
                                                                    std = (0.5

#Downloading the CIFAR10 dataset into train and test sets
train_dataset = torchvision.datasets.CIFAR10(
        root="./CIFAR10/train", train=True,
        transform=normalize_transform,
        download=True)

test_dataset = torchvision.datasets.CIFAR10(
        root="./CIFAR10/test", train=False,
        transform=normalize_transform,
        download=True)

#Generating data loaders from the corresponding datasets
batch_size = 128
train_loader = torch.utils.data.DataLoader(train_dataset, batch_size=batch_size)
test_loader = torch.utils.data.DataLoader(test_dataset, batch_size=batch_size)

# Plotting 25 images from the 1st batch
dataiter = iter(train_loader)
images, labels = next(dataiter)  # Retrieve the data from the DataLoader object
plt.imshow(np.transpose(torchvision.utils.make_grid(
    images[:25], normalize=True, padding=1, nrow=5).numpy(), (1, 2, 0)))
plt.axis('off')
```

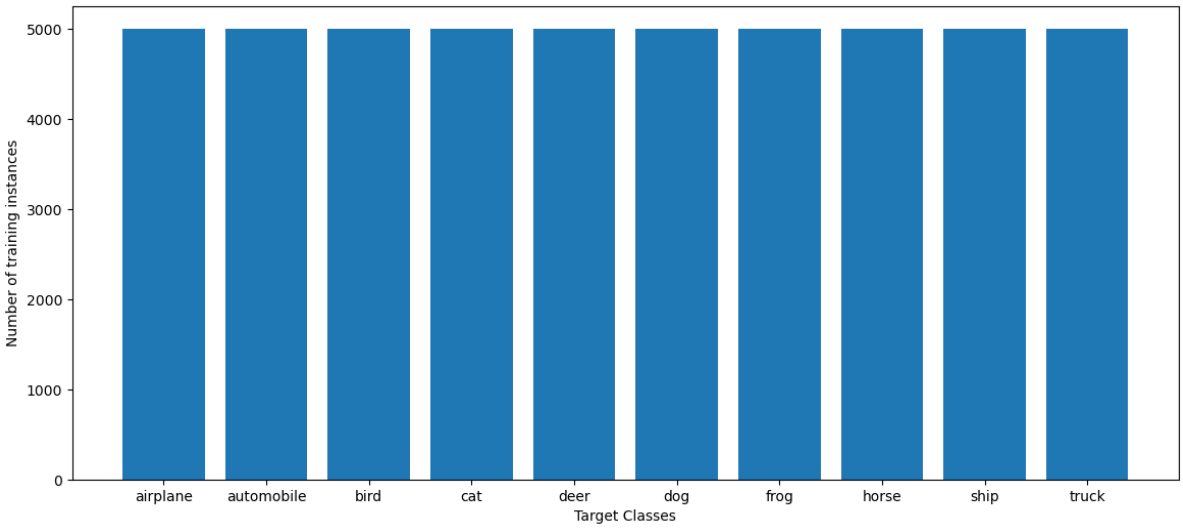
```
Files already downloaded and verified
Files already downloaded and verified
```

Out[1]:
```
(-0.5, 165.5, 165.5, -0.5)
```



In [2]:
```
#Iterating over the training dataset and storing the target class for each sample
classes = []
for batch_idx, data in enumerate(train_loader, 0):
        x, y = data
        classes.extend(y.tolist())

#Calculating the unique classes and the respective counts and plotting them
unique, counts = np.unique(classes, return_counts=True)
names = list(test_dataset.class_to_idx.keys())
plt.bar(names, counts)
plt.xlabel("Target Classes")
plt.ylabel("Number of training instances")
```

Out[2]:
```
Text(0, 0.5, 'Number of training instances')
```



In [4]:
```
class CNN(torch.nn.Module):
    def __init__(self):
        super().__init__()
        self.model = torch.nn.Sequential(
            #Input = 3 x 32 x 32, Output = 32 x 32 x 32
            torch.nn.Conv2d(in_channels = 3, out_channels = 32, kernel_size = 3, p
            torch.nn.ReLU(),
            #Input = 32 x 32 x 32, Output = 32 x 16 x 16
            torch.nn.MaxPool2d(kernel_size=2),

            #Input = 32 x 16 x 16, Output = 64 x 16 x 16
            torch.nn.Conv2d(in_channels = 32, out_channels = 64, kernel_size = 3,
            torch.nn.ReLU(),
            #Input = 64 x 16 x 16, Output = 64 x 8 x 8
            torch.nn.MaxPool2d(kernel_size=2),

            #Input = 64 x 8 x 8, Output = 64 x 8 x 8
            torch.nn.Conv2d(in_channels = 64, out_channels = 64, kernel_size = 3,
            torch.nn.ReLU(),
            #Input = 64 x 8 x 8, Output = 64 x 4 x 4
            torch.nn.MaxPool2d(kernel_size=2),

            torch.nn.Flatten(),
            torch.nn.Linear(64*4*4, 512),
            torch.nn.ReLU(),
            torch.nn.Linear(512, 10)
        )

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

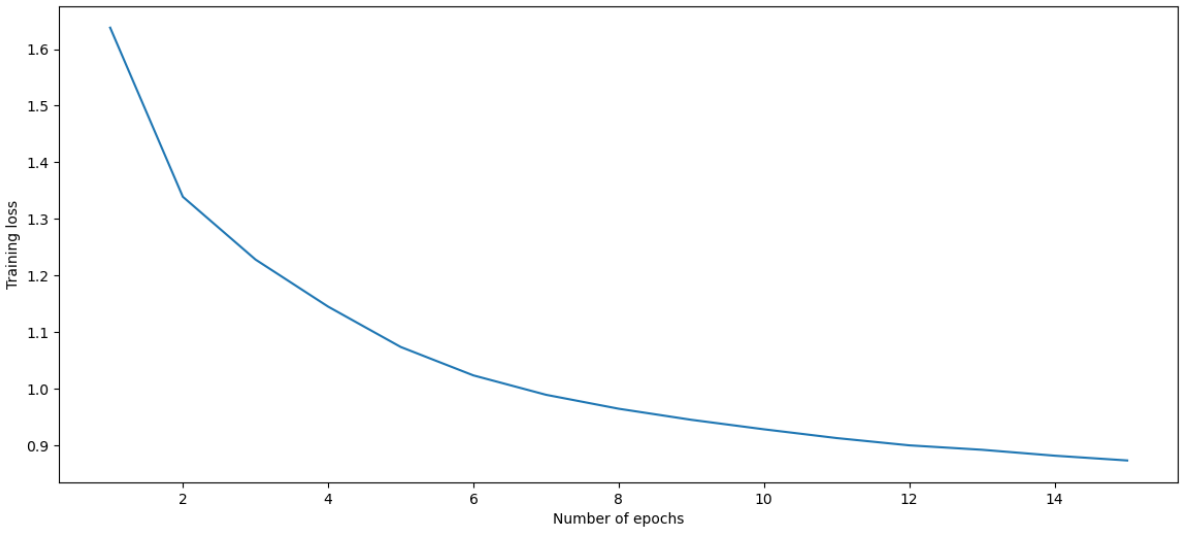
In [5]:
```
#Selecting the appropriate training device
device = 'cuda' if torch.cuda.is_available() else 'cpu'
model = CNN().to(device)

#Defining the model hyper parameters
num_epochs = 15
learning_rate = 0.001
weight_decay = 0.01
criterion = torch.nn.CrossEntropyLoss()
optimizer = torch.optim.Adam(model.parameters(), lr=learning_rate, weight_decay=we

#Training process begins
train_loss_list = []
for epoch in range(num_epochs):
        print(f'Epoch {epoch+1}/{num_epochs}:', end = ' ')
        train_loss = 0

        #Iterating over the training dataset in batches
        model.train()
        for i, (images, labels) in enumerate(train_loader):

                #Extracting images and target labels for the batch being iterated
                images = images.to(device)
                labels = labels.to(device)

                #Calculating the model output and the cross entropy loss
                outputs = model(images)
                loss = criterion(outputs, labels)

                #Updating weights according to calculated loss
                optimizer.zero_grad()
                loss.backward()
```

```
                optimizer.step()
                train_loss += loss.item()

        #Printing loss for each epoch
        train_loss_list.append(train_loss/len(train_loader))
        print(f"Training loss = {train_loss_list[-1]}")

#Plotting loss for all epochs
plt.plot(range(1,num_epochs+1), train_loss_list)
plt.xlabel("Number of epochs")
plt.ylabel("Training loss")
```

```
Epoch 1/15: Training loss = 1.6377787708931262
Epoch 2/15: Training loss = 1.3394147148522575
Epoch 3/15: Training loss = 1.2286743913465143
Epoch 4/15: Training loss = 1.1455938479174739
Epoch 5/15: Training loss = 1.0743517945794498
Epoch 6/15: Training loss = 1.0242248886381573
Epoch 7/15: Training loss = 0.9900085558671781
Epoch 8/15: Training loss = 0.9653904512715157
Epoch 9/15: Training loss = 0.9458632784731248
Epoch 10/15: Training loss = 0.929119180687858
Epoch 11/15: Training loss = 0.9136293592965207
Epoch 12/15: Training loss = 0.900781111034286
Epoch 13/15: Training loss = 0.8929806723619056
Epoch 14/15: Training loss = 0.882560054207092
Epoch 15/15: Training loss = 0.8741338605161213
```

Out[5]:

```
Text(0, 0.5, 'Training loss')
```



In [6]:

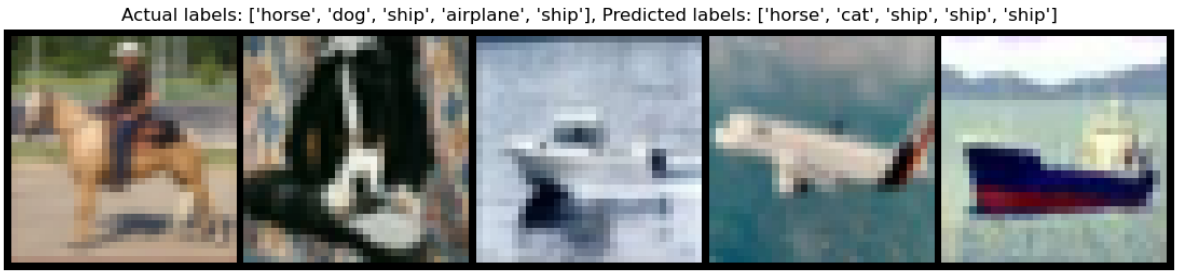
```
test_acc=0
model.eval()

with torch.no_grad():
    #Iterating over the training dataset in batches
    for i, (images, labels) in enumerate(test_loader):

        images = images.to(device)
        y_true = labels.to(device)

        #Calculating outputs for the batch being iterated
        outputs = model(images)

        #Calculated prediction labels from models
        _, y_pred = torch.max(outputs.data, 1)

        #Comparing predicted and true labels
        test_acc += (y_pred == y_true).sum().item()
```

```
    print(f"Test set accuracy = {100 * test_acc / len(test_dataset)} %")
```

```
Test set accuracy = 69.3 %
```

In [7]:
```
#Generating predictions for 'num_images' amount of images from the last batch of te
num_images = 5
y_true_name = [names[y_true[idx]] for idx in range(num_images)]
y_pred_name = [names[y_pred[idx]] for idx in range(num_images)]

#Generating the title for the plot
title = f"Actual labels: {y_true_name}, Predicted labels: {y_pred_name}"

#Finally plotting the images with their actual and predicted labels in the title
plt.imshow(np.transpose(torchvision.utils.make_grid(images[:num_images].cpu(), nor
plt.title(title)
plt.axis("off")
```

Out[7]:
```
(-0.5, 165.5, 33.5, -0.5)
```



In [ ]:
```

```