

Using device: cuda

## TRAINING

Data split:

Training: 18325 images

Validation: 5235 images

Test: 2619 images

Model parameters: 21,600,842

Starting training for 100 epochs

Epoch 1/100

Training: 100% 144/144 [00:21<00:00, 6.60it/s, Loss=2.364, Acc=20.21%]

Train Loss: 2.3638, Train Acc: 20.21%

Val Loss: 2.1166, Val Acc: 25.69%

!!!New best model saved! Val Acc: 25.69%

Epoch 2/100

Training: 100% 144/144 [00:21<00:00, 6.78it/s, Loss=2.106, Acc=25.87%]

Train Loss: 2.1065, Train Acc: 25.87%

Val Loss: 1.9843, Val Acc: 34.02%

!!!New best model saved! Val Acc: 34.02%

Epoch 3/100

Training: 100% 144/144 [00:21<00:00, 6.64it/s, Loss=2.002, Acc=31.79%]

Train Loss: 2.0021, Train Acc: 31.79%

Val Loss: 1.9164, Val Acc: 38.82%

!!!New best model saved! Val Acc: 38.82%

Epoch 4/100

Training: 100% 144/144 [00:21<00:00, 6.66it/s, Loss=1.910, Acc=37.22%]

Train Loss: 1.9099, Train Acc: 37.22%

Val Loss: 1.8914, Val Acc: 40.08%

!!!New best model saved! Val Acc: 40.08%

Epoch 5/100

Training: 100% 144/144 [00:21<00:00, 6.84it/s, Loss=1.811, Acc=42.00%]

Train Loss: 1.8114, Train Acc: 42.00%

Val Loss: 1.9074, Val Acc: 41.49%

!!!New best model saved! Val Acc: 41.49%

Epoch 6/100

Training: 100% 144/144 [00:21<00:00, 6.57it/s, Loss=1.713, Acc=46.71%]

Train Loss: 1.7134, Train Acc: 46.71%

Val Loss: 1.6607, Val Acc: 53.01%

!!!New best model saved! Val Acc: 53.01%

Epoch 7/100

Training: 100% 144/144 [00:21<00:00, 6.75it/s, Loss=1.624, Acc=50.94%]

Train Loss: 1.6239, Train Acc: 50.94%  
Val Loss: 1.7055, Val Acc: 46.44%

Epoch 8/100

Training: 100% 144/144 [00:21<00:00, 6.68it/s, Loss=1.575, Acc=53.09%]  
Train Loss: 1.5746, Train Acc: 53.09%  
Val Loss: 1.6161, Val Acc: 57.59%  
!!!New best model saved! Val Acc: 57.59%

Epoch 9/100

Training: 100% 144/144 [00:21<00:00, 6.75it/s, Loss=1.517, Acc=56.09%]  
Train Loss: 1.5173, Train Acc: 56.09%  
Val Loss: 1.5665, Val Acc: 60.44%  
!!!New best model saved! Val Acc: 60.44%

Epoch 10/100

Training: 100% 144/144 [00:21<00:00, 6.73it/s, Loss=1.477, Acc=57.33%]  
Train Loss: 1.4766, Train Acc: 57.33%  
Val Loss: 1.5294, Val Acc: 61.03%  
!!!New best model saved! Val Acc: 61.03%

Epoch 11/100

Training: 100% 144/144 [00:20<00:00, 6.90it/s, Loss=1.429, Acc=59.89%]  
Train Loss: 1.4289, Train Acc: 59.89%  
Val Loss: 1.5749, Val Acc: 55.47%

Epoch 12/100

Training: 100% 144/144 [00:21<00:00, 6.69it/s, Loss=1.399, Acc=61.15%]  
Train Loss: 1.3995, Train Acc: 61.15%  
Val Loss: 1.4612, Val Acc: 62.98%  
!!!New best model saved! Val Acc: 62.98%

Epoch 13/100

Training: 100% 144/144 [00:21<00:00, 6.77it/s, Loss=1.374, Acc=62.62%]  
Train Loss: 1.3743, Train Acc: 62.62%  
Val Loss: 1.4935, Val Acc: 58.15%

Epoch 14/100

Training: 100% 144/144 [00:21<00:00, 6.80it/s, Loss=1.333, Acc=64.44%]  
Train Loss: 1.3326, Train Acc: 64.44%  
Val Loss: 1.3666, Val Acc: 68.18%  
!!!New best model saved! Val Acc: 68.18%

Epoch 15/100

Training: 100% 144/144 [00:21<00:00, 6.79it/s, Loss=1.310, Acc=65.88%]  
Train Loss: 1.3102, Train Acc: 65.88%  
Val Loss: 1.4578, Val Acc: 64.34%

Epoch 16/100

Training: 100% 144/144 [00:21<00:00, 6.74it/s, Loss=1.286, Acc=66.86%]

Train Loss: 1.2860, Train Acc: 66.86%

Val Loss: 1.4280, Val Acc: 65.46%

Epoch 17/100

Training: 100% 144/144 [00:21<00:00, 6.61it/s, Loss=1.261, Acc=68.39%]

Train Loss: 1.2609, Train Acc: 68.39%

Val Loss: 1.3977, Val Acc: 67.62%

Epoch 18/100

Training: 100% 144/144 [00:21<00:00, 6.86it/s, Loss=1.224, Acc=69.95%]

Train Loss: 1.2237, Train Acc: 69.95%

Val Loss: 1.3017, Val Acc: 71.44%

!!!New best model saved! Val Acc: 71.44%

Epoch 19/100

Training: 100% 144/144 [00:21<00:00, 6.77it/s, Loss=1.207, Acc=70.94%]

Train Loss: 1.2075, Train Acc: 70.94%

Val Loss: 1.3299, Val Acc: 70.41%

Epoch 20/100

Training: 100% 144/144 [00:21<00:00, 6.77it/s, Loss=1.183, Acc=71.52%]

Train Loss: 1.1830, Train Acc: 71.52%

Val Loss: 1.3169, Val Acc: 70.07%

Epoch 21/100

Training: 100% 144/144 [00:20<00:00, 6.90it/s, Loss=1.152, Acc=73.39%]

Train Loss: 1.1520, Train Acc: 73.39%

Val Loss: 1.3453, Val Acc: 69.53%

Epoch 22/100

Training: 100% 144/144 [00:21<00:00, 6.63it/s, Loss=1.127, Acc=74.52%]

Train Loss: 1.1272, Train Acc: 74.52%

Val Loss: 1.2766, Val Acc: 71.65%

!!!New best model saved! Val Acc: 71.65%

Epoch 23/100

Training: 100% 144/144 [00:21<00:00, 6.83it/s, Loss=1.118, Acc=74.88%]

Train Loss: 1.1177, Train Acc: 74.88%

Val Loss: 1.2606, Val Acc: 74.02%

!!!New best model saved! Val Acc: 74.02%

Epoch 24/100

Training: 100% 144/144 [00:22<00:00, 6.51it/s, Loss=1.085, Acc=76.20%]

Train Loss: 1.0846, Train Acc: 76.20%

Val Loss: 1.1916, Val Acc: 76.77%

!!!New best model saved! Val Acc: 76.77%

Epoch 25/100

Training: 100% 144/144 [00:21<00:00, 6.85it/s, Loss=1.058, Acc=77.49%]

Train Loss: 1.0579, Train Acc: 77.49%

Val Loss: 1.1666, Val Acc: 74.67%

Epoch 26/100

Training: 100% 144/144 [00:21<00:00, 6.62it/s, Loss=1.052, Acc=77.39%]

Train Loss: 1.0522, Train Acc: 77.39%

Val Loss: 1.2540, Val Acc: 72.66%

Epoch 27/100

Training: 100% 144/144 [00:21<00:00, 6.71it/s, Loss=1.023, Acc=79.08%]

Train Loss: 1.0228, Train Acc: 79.08%

Val Loss: 1.1596, Val Acc: 76.29%

Epoch 28/100

Training: 100% 144/144 [00:21<00:00, 6.74it/s, Loss=0.989, Acc=80.63%]

Train Loss: 0.9886, Train Acc: 80.63%

Val Loss: 1.1659, Val Acc: 76.47%

Epoch 29/100

Training: 100% 144/144 [00:21<00:00, 6.83it/s, Loss=0.972, Acc=81.52%]

Train Loss: 0.9724, Train Acc: 81.52%

Val Loss: 1.2841, Val Acc: 70.07%

Epoch 30/100

Training: 100% 144/144 [00:21<00:00, 6.61it/s, Loss=0.913, Acc=84.09%]

Train Loss: 0.9135, Train Acc: 84.09%

Val Loss: 1.1337, Val Acc: 75.63%

Epoch 31/100

Training: 100% 144/144 [00:21<00:00, 6.74it/s, Loss=0.869, Acc=86.19%]

Train Loss: 0.8691, Train Acc: 86.19%

Val Loss: 1.0511, Val Acc: 80.74%

!!!New best model saved! Val Acc: 80.74%

Epoch 32/100

Training: 100% 144/144 [00:21<00:00, 6.56it/s, Loss=0.858, Acc=86.65%]

Train Loss: 0.8583, Train Acc: 86.65%

Val Loss: 1.0393, Val Acc: 80.76%

!!!New best model saved! Val Acc: 80.76%

Epoch 33/100

Training: 100% 144/144 [00:21<00:00, 6.70it/s, Loss=0.846, Acc=87.50%]

Train Loss: 0.8457, Train Acc: 87.50%

Val Loss: 1.0195, Val Acc: 82.16%

!!!New best model saved! Val Acc: 82.16%

Epoch 34/100

Training: 100% 144/144 [00:21<00:00, 6.57it/s, Loss=0.827, Acc=88.37%]

Train Loss: 0.8272, Train Acc: 88.37%

Val Loss: 1.0301, Val Acc: 80.08%

Epoch 35/100

Training: 100% 144/144 [00:21<00:00, 6.67it/s, Loss=0.819, Acc=88.58%]

Train Loss: 0.8195, Train Acc: 88.58%

Val Loss: 1.0122, Val Acc: 81.09%

Epoch 36/100

Training: 100% 144/144 [00:21<00:00, 6.64it/s, Loss=0.802, Acc=89.41%]

Train Loss: 0.8017, Train Acc: 89.41%

Val Loss: 1.0570, Val Acc: 80.25%

Epoch 37/100

Training: 100% 144/144 [00:21<00:00, 6.82it/s, Loss=0.794, Acc=89.59%]

Train Loss: 0.7943, Train Acc: 89.59%

Val Loss: 0.9983, Val Acc: 81.91%

Epoch 38/100

Training: 100% 144/144 [00:21<00:00, 6.83it/s, Loss=0.788, Acc=89.88%]

Train Loss: 0.7876, Train Acc: 89.88%

Val Loss: 1.0239, Val Acc: 81.18%

Epoch 39/100

Training: 100% 144/144 [00:21<00:00, 6.83it/s, Loss=0.755, Acc=91.59%]

Train Loss: 0.7545, Train Acc: 91.59%

Val Loss: 0.9703, Val Acc: 83.42%

!!!New best model saved! Val Acc: 83.42%

Epoch 40/100

Training: 100% 144/144 [00:21<00:00, 6.63it/s, Loss=0.733, Acc=91.95%]

Train Loss: 0.7333, Train Acc: 91.95%

Val Loss: 0.9444, Val Acc: 84.18%

!!!New best model saved! Val Acc: 84.18%

Epoch 41/100

Training: 100% 144/144 [00:21<00:00, 6.72it/s, Loss=0.722, Acc=92.64%]

Train Loss: 0.7218, Train Acc: 92.64%

Val Loss: 0.9588, Val Acc: 83.36%

Epoch 42/100

Training: 100% 144/144 [00:21<00:00, 6.59it/s, Loss=0.714, Acc=93.10%]

Train Loss: 0.7143, Train Acc: 93.10%

Val Loss: 0.9839, Val Acc: 82.48%

Epoch 43/100

Training: 100% 144/144 [00:21<00:00, 6.78it/s, Loss=0.714, Acc=92.81%]

Train Loss: 0.7136, Train Acc: 92.81%

Val Loss: 0.9648, Val Acc: 83.36%

Epoch 44/100

Training: 100% 144/144 [00:20<00:00, 6.87it/s, Loss=0.714, Acc=92.99%]

Train Loss: 0.7138, Train Acc: 92.99%

Val Loss: 0.9637, Val Acc: 83.00%

Epoch 45/100

Training: 100% 144/144 [00:20<00:00, 6.93it/s, Loss=0.711, Acc=93.05%]

Train Loss: 0.7112, Train Acc: 93.05%

Val Loss: 0.9528, Val Acc: 82.75%

Epoch 46/100

Training: 100% 144/144 [00:21<00:00, 6.74it/s, Loss=0.695, Acc=93.76%]

Train Loss: 0.6953, Train Acc: 93.76%

Val Loss: 0.9216, Val Acc: 84.43%

!!!New best model saved! Val Acc: 84.43%

Epoch 47/100

Training: 100% 144/144 [00:21<00:00, 6.84it/s, Loss=0.682, Acc=94.40%]

Train Loss: 0.6821, Train Acc: 94.40%

Val Loss: 0.9279, Val Acc: 84.32%

Epoch 48/100

Training: 100% 144/144 [00:21<00:00, 6.65it/s, Loss=0.680, Acc=94.30%]

Train Loss: 0.6795, Train Acc: 94.30%

Val Loss: 0.9386, Val Acc: 83.84%

Epoch 49/100

Training: 100% 144/144 [00:20<00:00, 6.92it/s, Loss=0.678, Acc=94.23%]

Train Loss: 0.6785, Train Acc: 94.23%

Val Loss: 0.9434, Val Acc: 84.05%

Epoch 50/100

Training: 100% 144/144 [00:21<00:00, 6.82it/s, Loss=0.671, Acc=94.67%]

Train Loss: 0.6706, Train Acc: 94.67%

Val Loss: 0.9384, Val Acc: 84.09%

Epoch 51/100

Training: 100% 144/144 [00:21<00:00, 6.70it/s, Loss=0.671, Acc=94.66%]

Train Loss: 0.6711, Train Acc: 94.66%

Val Loss: 0.9361, Val Acc: 83.63%

Epoch 52/100

Training: 100% 144/144 [00:21<00:00, 6.66it/s, Loss=0.664, Acc=94.94%]

Train Loss: 0.6640, Train Acc: 94.94%  
Val Loss: 0.9208, Val Acc: 84.39%

Epoch 53/100

Training: 100% 144/144 [00:21<00:00, 6.80it/s, Loss=0.665, Acc=94.83%]  
Train Loss: 0.6651, Train Acc: 94.83%  
Val Loss: 0.9256, Val Acc: 84.34%

Epoch 54/100

Training: 100% 144/144 [00:21<00:00, 6.75it/s, Loss=0.665, Acc=94.86%]  
Train Loss: 0.6648, Train Acc: 94.86%  
Val Loss: 0.9164, Val Acc: 84.62%  
!!!New best model saved! Val Acc: 84.62%

Epoch 55/100

Training: 100% 144/144 [00:21<00:00, 6.60it/s, Loss=0.658, Acc=95.29%]  
Train Loss: 0.6576, Train Acc: 95.29%  
Val Loss: 0.9245, Val Acc: 84.28%

Epoch 56/100

Training: 100% 144/144 [00:20<00:00, 6.93it/s, Loss=0.656, Acc=95.33%]  
Train Loss: 0.6562, Train Acc: 95.33%  
Val Loss: 0.9247, Val Acc: 84.01%

Epoch 57/100

Training: 100% 144/144 [00:21<00:00, 6.73it/s, Loss=0.658, Acc=95.14%]  
Train Loss: 0.6578, Train Acc: 95.14%  
Val Loss: 0.9185, Val Acc: 84.20%

Epoch 58/100

Training: 100% 144/144 [00:21<00:00, 6.80it/s, Loss=0.652, Acc=95.36%]  
Train Loss: 0.6520, Train Acc: 95.36%  
Val Loss: 0.9229, Val Acc: 84.18%

Epoch 59/100

Training: 100% 144/144 [00:21<00:00, 6.70it/s, Loss=0.647, Acc=95.61%]  
Train Loss: 0.6474, Train Acc: 95.61%  
Val Loss: 0.9164, Val Acc: 84.53%

Epoch 60/100

Training: 100% 144/144 [00:20<00:00, 6.87it/s, Loss=0.651, Acc=95.41%]  
Train Loss: 0.6512, Train Acc: 95.41%  
Val Loss: 0.9191, Val Acc: 84.16%

Epoch 61/100

Training: 100% 144/144 [00:21<00:00, 6.74it/s, Loss=0.646, Acc=95.63%]  
Train Loss: 0.6464, Train Acc: 95.63%  
Val Loss: 0.9161, Val Acc: 84.45%

Epoch 62/100

Training: 100% 144/144 [00:20<00:00, 6.86it/s, Loss=0.648, Acc=95.60%]

Train Loss: 0.6482, Train Acc: 95.60%

Val Loss: 0.9237, Val Acc: 84.09%

Epoch 63/100

Training: 100% 144/144 [00:21<00:00, 6.73it/s, Loss=0.648, Acc=95.38%]

Train Loss: 0.6482, Train Acc: 95.38%

Val Loss: 0.9200, Val Acc: 84.37%

Epoch 64/100

Training: 100% 144/144 [00:20<00:00, 6.94it/s, Loss=0.644, Acc=95.64%]

Train Loss: 0.6442, Train Acc: 95.64%

Val Loss: 0.9183, Val Acc: 84.53%

Early stopping at epoch 64

Training completed. Best validation accuracy: 84.62%

Figure(1200x400)

Training curves saved to results/training\_curves.png



## EVALUATION

Data split:

Training: 18325 images

Validation: 5235 images

Test: 2619 images

Loaded model from models/best\_model.pth

Evaluating model

Testing: 100% 21/21 [00:03<00:00, 6.21it/s]

Test Results:

Test Loss: 0.6220

Test Accuracy: 85.53%

Correct predictions: 2240/2619

### Detailed Classification Report:

	precision	recall	f1-score	support
dog	0.8596	0.8802	0.8698	501
horse	0.9127	0.7684	0.8343	272
elephant	0.9014	0.8366	0.8678	153
butterfly	0.9065	0.8661	0.8858	224
chicken	0.9017	0.9110	0.9063	292
cat	0.8758	0.7882	0.8297	170
cow	0.6518	0.7604	0.7019	192
sheep	0.7845	0.8161	0.8000	174
spider	0.9145	0.9264	0.9204	462
squirrel	0.7600	0.8492	0.8021	179
accuracy			0.8553	2619
macro avg	0.8469	0.8403	0.8418	2619
weighted avg	0.8600	0.8553	0.8562	2619

Classification report saved to results/classification\_report.txt

Figure(1000x800)

Confusion matrix saved to results/confusion\_matrix.png

Figure(1200x600)

Sample predictions saved to results/sample\_predictions.png