Task 1: *(traditional augmentation techniques)*

> **Original experiment** training progress:
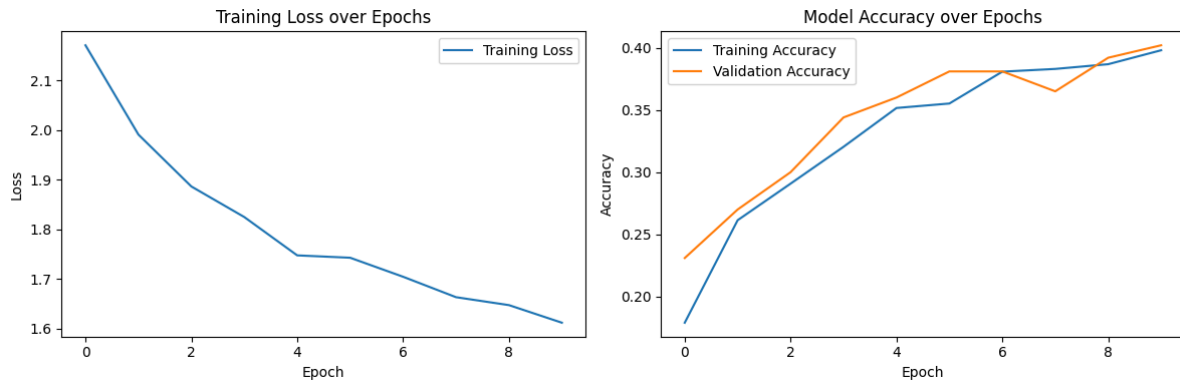
> Console output:

> *Epoch 1, Loss: 2.1704, Train Acc: 0.179, Val Acc: 0.231*
> *Epoch 2, Loss: 1.9907, Train Acc: 0.261, Val Acc: 0.270*
> *Epoch 3, Loss: 1.8863, Train Acc: 0.291, Val Acc: 0.300*
> *Epoch 4, Loss: 1.8247, Train Acc: 0.320, Val Acc: 0.344*
> *Epoch 5, Loss: 1.7476, Train Acc: 0.352, Val Acc: 0.360*
> *Epoch 6, Loss: 1.7429, Train Acc: 0.355, Val Acc: 0.381*
> *Epoch 7, Loss: 1.7046, Train Acc: 0.381, Val Acc: 0.381*
> *Epoch 8, Loss: 1.6635, Train Acc: 0.383, Val Acc: 0.365*
> *Epoch 9, Loss: 1.6475, Train Acc: 0.387, Val Acc: 0.392*
> *Epoch 10, Loss: 1.6121, Train Acc: 0.398, Val Acc: 0.402*
> *Final Acc: 0.402*

> Experiment with **Random horizontal flipping**
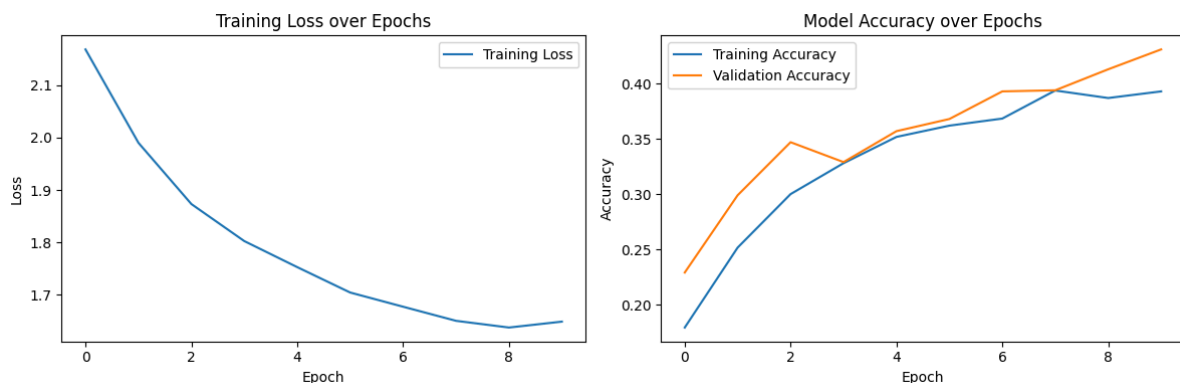
> Console output:

> Epoch 1, Loss: 2.1683, Train Acc: 0.179, Val Acc: 0.229
> Epoch 2, Loss: 1.9901, Train Acc: 0.252, Val Acc: 0.299
> Epoch 3, Loss: 1.8733, Train Acc: 0.300, Val Acc: 0.347

Epoch 4, Loss: 1.8025, Train Acc: 0.328, Val Acc: 0.329
Epoch 5, Loss: 1.7529, Train Acc: 0.352, Val Acc: 0.357
Epoch 6, Loss: 1.7044, Train Acc: 0.362, Val Acc: 0.368
Epoch 7, Loss: 1.6773, Train Acc: 0.368, Val Acc: 0.393
Epoch 8, Loss: 1.6504, Train Acc: 0.394, Val Acc: 0.394
Epoch 9, Loss: 1.6376, Train Acc: 0.387, Val Acc: 0.413
Epoch 10, Loss: 1.6488, Train Acc: 0.393, Val Acc: 0.431
Final Acc: 0.431

> Experiment with **Random rotations**
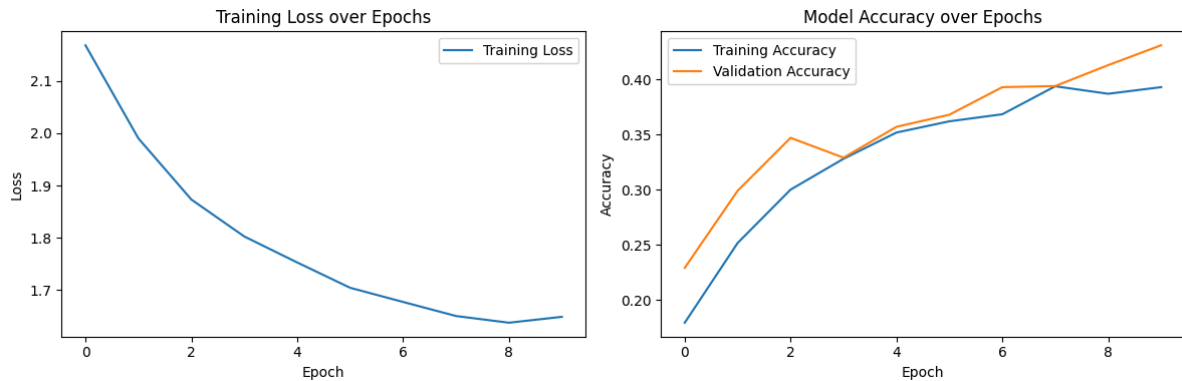
> <u>Console output:</u>
Epoch 1, Loss: 2.1791, Train Acc: 0.173, Val Acc: 0.231
Epoch 2, Loss: 2.0204, Train Acc: 0.243, Val Acc: 0.271
Epoch 3, Loss: 1.9237, Train Acc: 0.285, Val Acc: 0.338
Epoch 4, Loss: 1.8603, Train Acc: 0.312, Val Acc: 0.316
Epoch 5, Loss: 1.8111, Train Acc: 0.327, Val Acc: 0.360
Epoch 6, Loss: 1.7485, Train Acc: 0.345, Val Acc: 0.355
Epoch 7, Loss: 1.7342, Train Acc: 0.342, Val Acc: 0.372
Epoch 8, Loss: 1.6950, Train Acc: 0.376, Val Acc: 0.379
Epoch 9, Loss: 1.6840, Train Acc: 0.372, Val Acc: 0.390
Epoch 10, Loss: 1.6893, Train Acc: 0.382, Val Acc: 0.421
Final Acc: 0.421

> Experiment with **Random cropping**
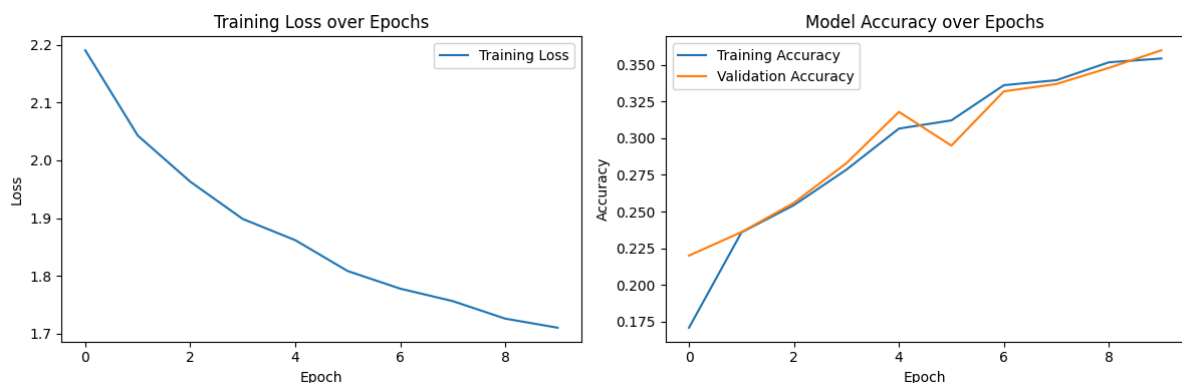
> Console output:

Epoch 1, Loss: 2.1905, Train Acc: 0.171, Val Acc: 0.220
Epoch 2, Loss: 2.0429, Train Acc: 0.236, Val Acc: 0.236
Epoch 3, Loss: 1.9632, Train Acc: 0.254, Val Acc: 0.256
Epoch 4, Loss: 1.8987, Train Acc: 0.279, Val Acc: 0.283
Epoch 5, Loss: 1.8620, Train Acc: 0.307, Val Acc: 0.318
Epoch 6, Loss: 1.8085, Train Acc: 0.312, Val Acc: 0.295
Epoch 7, Loss: 1.7780, Train Acc: 0.336, Val Acc: 0.332
Epoch 8, Loss: 1.7565, Train Acc: 0.340, Val Acc: 0.337
Epoch 9, Loss: 1.7262, Train Acc: 0.352, Val Acc: 0.348
Epoch 10, Loss: 1.7104, Train Acc: 0.354, Val Acc: 0.360
Final Acc: 0.360

> Experiment with **Color jittering**
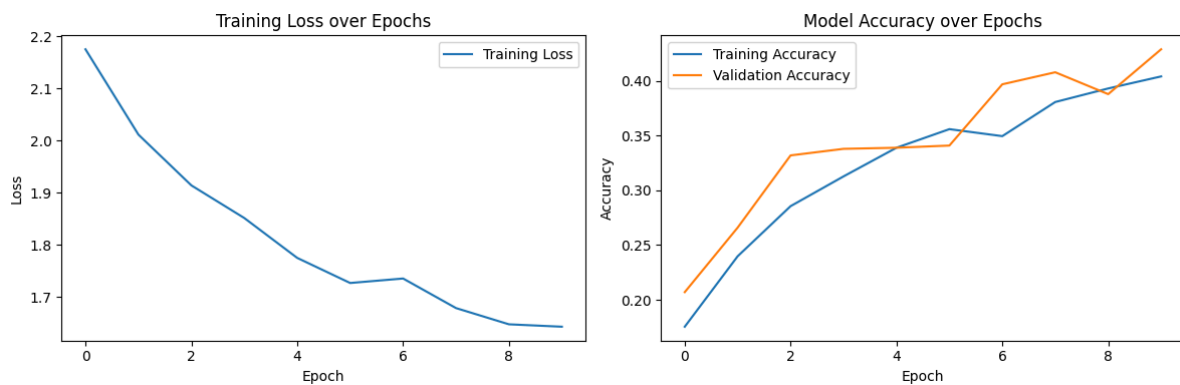
> Console output:

Epoch 1, Loss: 2.1751, Train Acc: 0.175, Val Acc: 0.207
Epoch 2, Loss: 2.0115, Train Acc: 0.240, Val Acc: 0.266
Epoch 3, Loss: 1.9142, Train Acc: 0.286, Val Acc: 0.332
Epoch 4, Loss: 1.8516, Train Acc: 0.313, Val Acc: 0.338
Epoch 5, Loss: 1.7752, Train Acc: 0.339, Val Acc: 0.339
Epoch 6, Loss: 1.7271, Train Acc: 0.356, Val Acc: 0.341
Epoch 7, Loss: 1.7357, Train Acc: 0.350, Val Acc: 0.397
Epoch 8, Loss: 1.6789, Train Acc: 0.381, Val Acc: 0.408
Epoch 9, Loss: 1.6478, Train Acc: 0.393, Val Acc: 0.388
Epoch 10, Loss: 1.6432, Train Acc: 0.404, Val Acc: 0.429
Acc: 0.429

> Experiment with **All techniques combined**
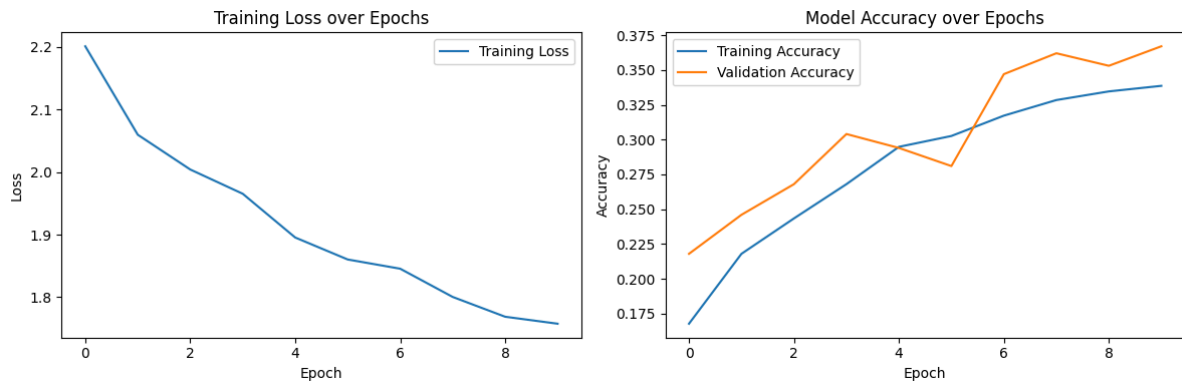
> Console output:

Epoch 1, Loss: 2.2008, Train Acc: 0.168, Val Acc: 0.218
Epoch 2, Loss: 2.0595, Train Acc: 0.218, Val Acc: 0.246
Epoch 3, Loss: 2.0040, Train Acc: 0.243, Val Acc: 0.268
Epoch 4, Loss: 1.9653, Train Acc: 0.268, Val Acc: 0.304
Epoch 5, Loss: 1.8954, Train Acc: 0.295, Val Acc: 0.294
Epoch 6, Loss: 1.8603, Train Acc: 0.303, Val Acc: 0.281
Epoch 7, Loss: 1.8456, Train Acc: 0.317, Val Acc: 0.347
Epoch 8, Loss: 1.8005, Train Acc: 0.328, Val Acc: 0.362
Epoch 9, Loss: 1.7689, Train Acc: 0.335, Val Acc: 0.353
Epoch 10, Loss: 1.7577, Train Acc: 0.339, Val Acc: 0.367
Final Acc: 0.367

**Task 2:** *(MixUp and CutMix augmentation strategies)*

> **MixUp Strategy**
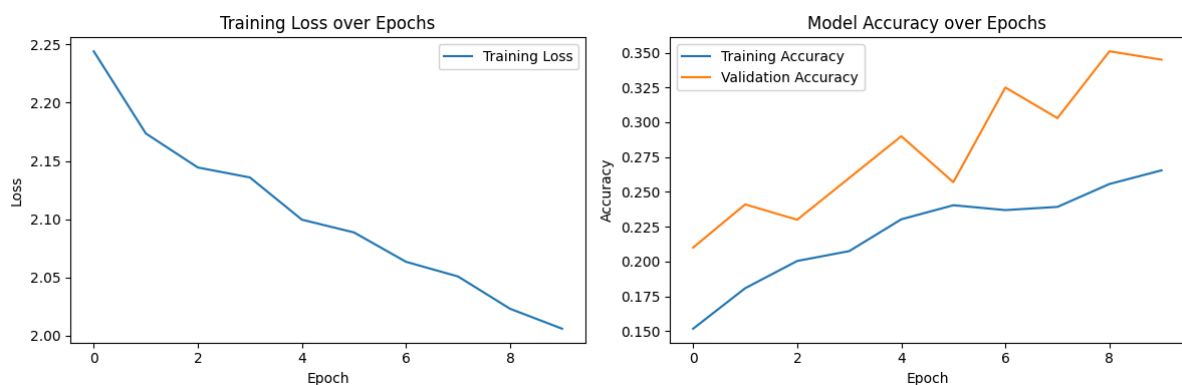
Epoch 1, Loss: 2.2441, Train Acc: 0.152, Val Acc: 0.210
Epoch 2, Loss: 2.1736, Train Acc: 0.181, Val Acc: 0.241
Epoch 3, Loss: 2.1444, Train Acc: 0.200, Val Acc: 0.230
Epoch 4, Loss: 2.1359, Train Acc: 0.207, Val Acc: 0.260
Epoch 5, Loss: 2.0996, Train Acc: 0.230, Val Acc: 0.290
Epoch 6, Loss: 2.0887, Train Acc: 0.240, Val Acc: 0.257
Epoch 7, Loss: 2.0635, Train Acc: 0.237, Val Acc: 0.325
Epoch 8, Loss: 2.0509, Train Acc: 0.239, Val Acc: 0.303

Epoch 9, Loss: 2.0232, Train Acc: 0.256, Val Acc: 0.351
Epoch 10, Loss: 2.0061, Train Acc: 0.265, Val Acc: 0.345
Final Acc: 0.345

> CutMix Strategy
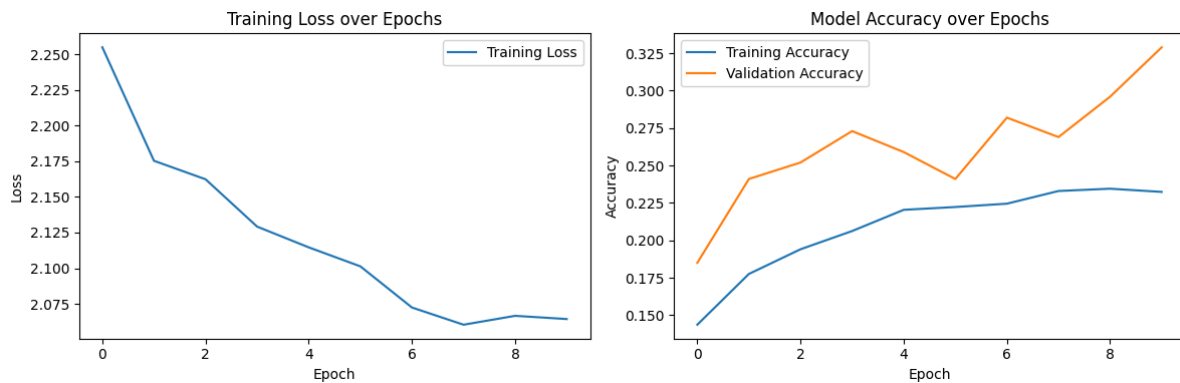
Epoch 1, Loss: 2.2549, Train Acc: 0.144, Val Acc: 0.185
Epoch 2, Loss: 2.1753, Train Acc: 0.178, Val Acc: 0.241
Epoch 2, Loss: 2.1753, Train Acc: 0.178, Val Acc: 0.241
Epoch 3, Loss: 2.1623, Train Acc: 0.194, Val Acc: 0.252
Epoch 4, Loss: 2.1291, Train Acc: 0.206, Val Acc: 0.273
Epoch 5, Loss: 2.1146, Train Acc: 0.220, Val Acc: 0.259
Epoch 6, Loss: 2.1013, Train Acc: 0.222, Val Acc: 0.241
Epoch 7, Loss: 2.0724, Train Acc: 0.224, Val Acc: 0.282
Epoch 8, Loss: 2.0604, Train Acc: 0.233, Val Acc: 0.269
Epoch 9, Loss: 2.0666, Train Acc: 0.235, Val Acc: 0.296
Epoch 10, Loss: 2.0644, Train Acc: 0.232, Val Acc: 0.329
Final Acc: 0.329

> Both strategies (50-50 probability)
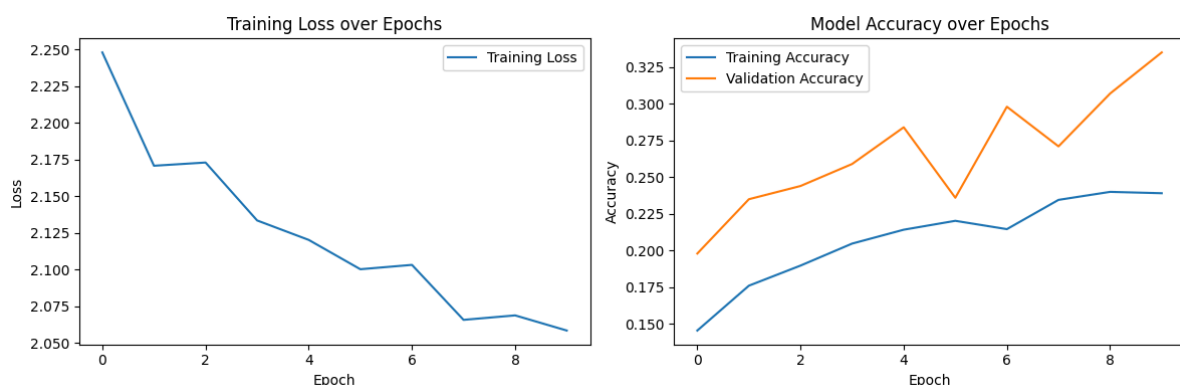
Epoch 1, Loss: 2.2481, Train Acc: 0.146, Val Acc: 0.198
Epoch 2, Loss: 2.1708, Train Acc: 0.176, Val Acc: 0.235
Epoch 3, Loss: 2.1730, Train Acc: 0.190, Val Acc: 0.244
Epoch 4, Loss: 2.1335, Train Acc: 0.205, Val Acc: 0.259
Epoch 5, Loss: 2.1202, Train Acc: 0.214, Val Acc: 0.284
Epoch 6, Loss: 2.1002, Train Acc: 0.220, Val Acc: 0.236

Epoch 7, Loss: 2.1032, Train Acc: 0.215, Val Acc: 0.298
Epoch 8, Loss: 2.0656, Train Acc: 0.235, Val Acc: 0.271
Epoch 9, Loss: 2.0687, Train Acc: 0.240, Val Acc: 0.307
Epoch 10, Loss: 2.0584, Train Acc: 0.239, Val Acc: 0.335
Acc: 0.335

Task 3: *(Conclusions on model convergence&accuracy.using different strategies)*

- In our experiment, we've got these results based on only 10 epochs of training, we wanted to have an overview of impacts made by those techniques. So, a longer training periods might reveal different patterns, especially for advanced augmentation techniques which typically require more epochs to show their full potential.

>> Traditional augmentation techniques

- Random Horizontal Flipping:
    - Best performer of all technies (43.1%)
    - Steady improvement from 22.9% to 43.1%
    - Most consistent learning curve

- Colour Jittering:
    - Second best fo all techniques(42.9%)
    - Strong final performance
    - More volatile learning curve
    - Sharp improvement in later epochs (39.7% to 42.9%)

- Random Rotations
    - Third best (42.1%)
    - Good final performance
    - Stable learning progression

- Random Cropping:
    - Lowest performer (36.0%)
    - Slower learning rate
    - Limited improvement over epochs

- Combined Traditional Techniques
    - Performance dropped to 36.7%
    - Suggests possible over-regularization
    - Slower learning rate compared to individual techniques

>> Advanced Techniques Results

- MixUp (Final Acc 34.5%)
  - Lower overall performance
  - More stable learning curve
  - Consistent but slower improvement
  - Better than CutMix in final accuracy

- CutMix (Final Acc 32.9%)
  - Lowest performing strategy
  - Most aggressive learning pattern
  - Shows potential underfitting
  - Might benefit from longer training

- Combined MixUp/CutMix (50-50) (Final Acc 33.5%)
  - Balanced performance between both techniques
  - More stable than individual advanced techniques
  - Shows similar learning pattern to MixUp

>> Final thoughts:

- Simpler augmentations (flipping, jittering) seem to perform better in short-term training

- Advanced techniques show potential but likely need more epochs in training

- Combining traditional techniques didn't yield better results apparently :))

- Each technique shows distinct learning patterns and convergence rates