# MUSHROOM TOXICITY DETECTION

WITH

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# MOTIVATION

- There are many mushroom poisoning outbreaks because people can’t tell whether a mushroom is toxic.
- We were interested in exploring how far a relatively simple convolutional neural network (CNN) or/and MLP can go in performing a task realted to plant species detection.
- Our motivation is to apply what we have learned in machine learning to address a meaningful real-world challenge, even with modest resources.

# BACKGROUND

- A Global Health Problem:
- Worldwide, hundreds of people die each year from wild mushroom poisoning, and experts believe the actual number is higher due to underreporting.

- Human visual identification is unreliable:
- Since humans are not good at this, machines can be trained on thousands of samples and give more accurate results.

# RELATED WORK

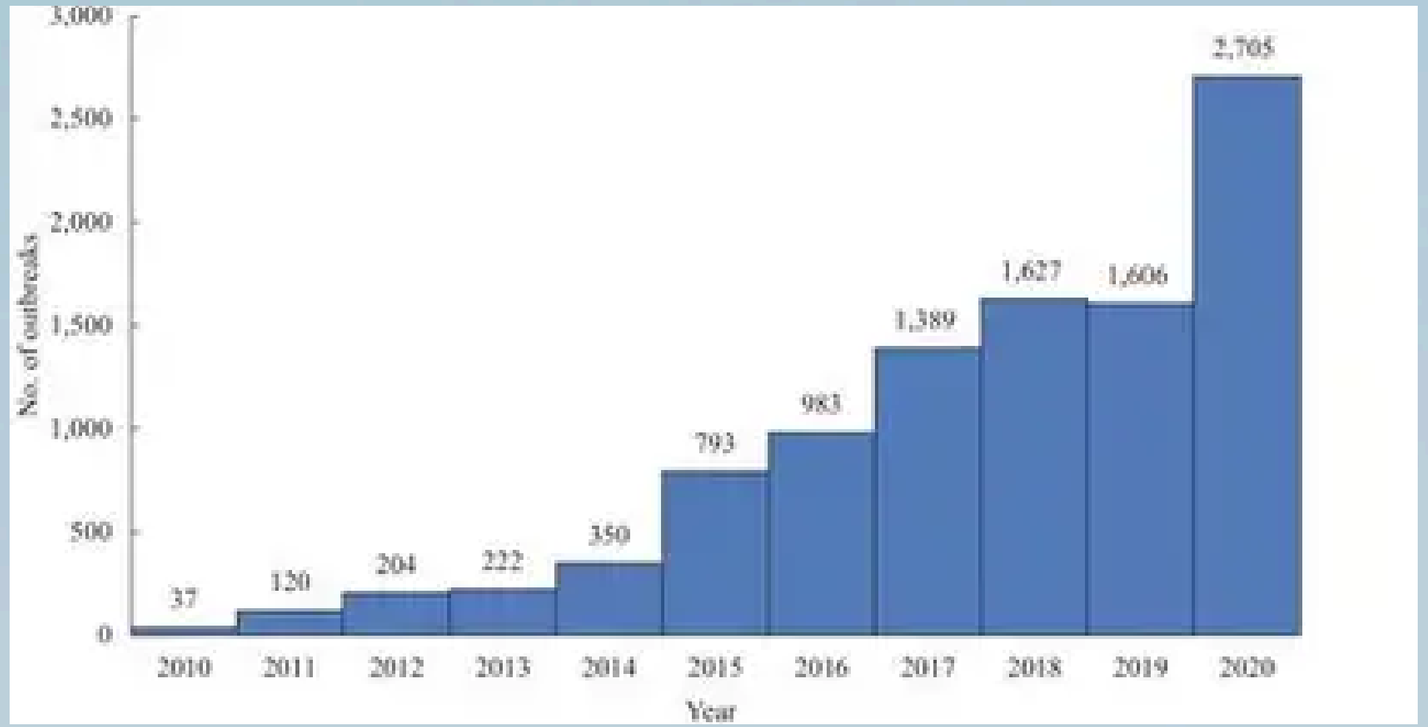
- Improved AlexNet for poisonous vs edible mushrooms (Thailand / general):
- Ketwongsa et al. (2022) propose an improved AlexNet-based CNN to classify poisonous vs edible mushrooms from images. They report high accuracy on their dataset and show that deep networks outperform traditional feature-based methods.
- Automatic mushroom species classification for wild mushrooms:
- Wang et al. (2022) present an automatic mushroom species classification model, aiming to help consumers avoid eating toxic wild mushrooms. Their model achieves strong performance on a curated species dataset and demonstrates that CNNs can handle fine-grained species differences.

# TARGET TASK

- Identify toxic mushrooms from 3000 mushroom images photographed in different environments.
- Reach about 70% accuracy.
- Optimize running time and validation accuracy.

INTUITIVE FIGURE

# INTUITIVE GRAPH




Above is a figure that clearlshows the increasing trend of mushroom poisoning outbreaks in China, justifying our the meaninfulness and the need of our study.

PROPOSED SOLUTION

# ANALYSIS PLAN

- Data Analysis: Labeling & Splitting, Randomization
- CNN & MobileNetV2
- Optimization: Add features
- Testing
- Compare and Select the Best.
- Conclusion: Graphs, Tables, Accuracy rates.

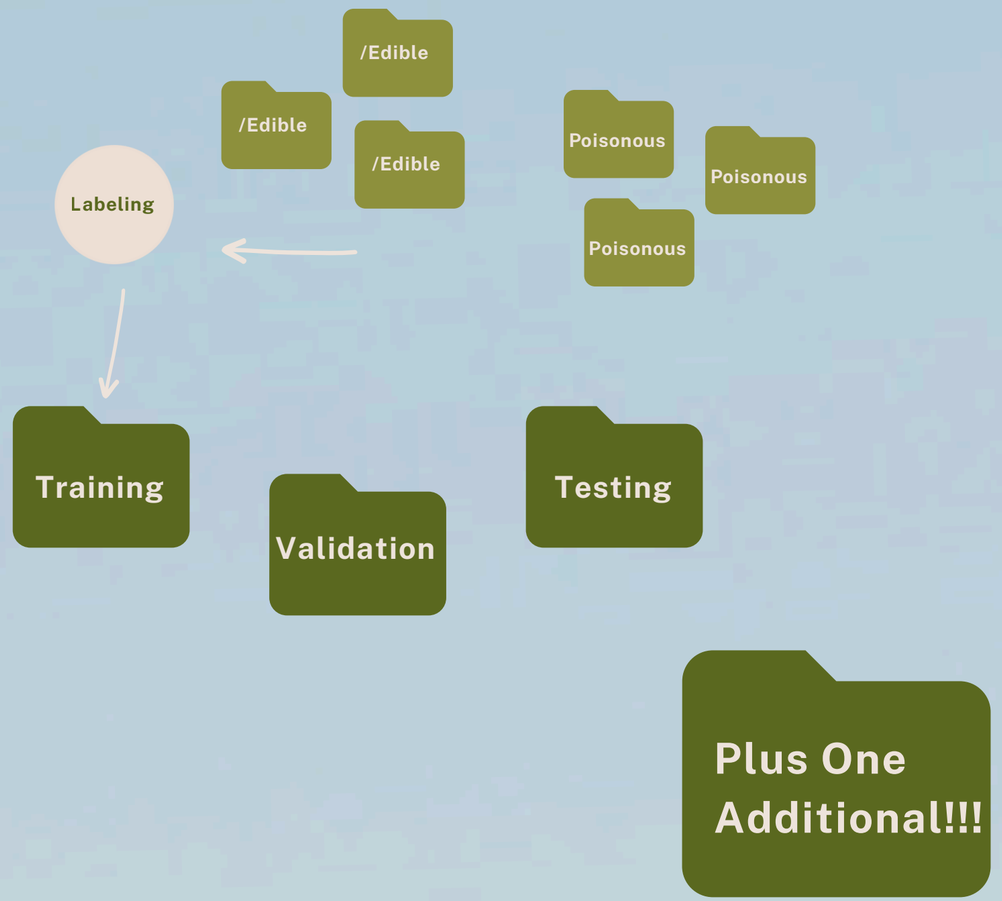
# DATA SUMMARY

- **image-mushroom-dataset**
- https://www.kaggle.com/datasets/quanghn2001/image-mushroom-dataset

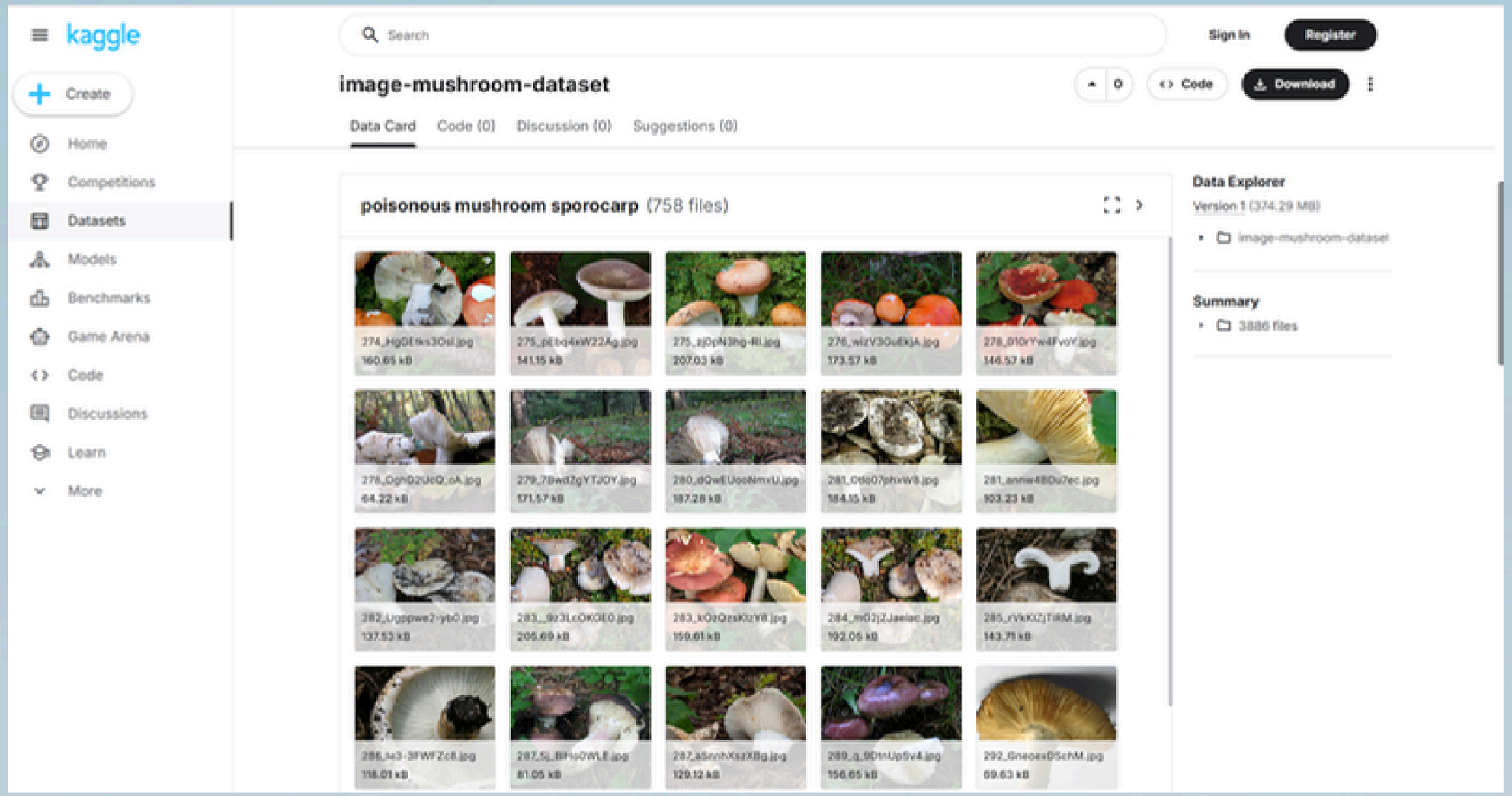
- The dataset contained 3000+ labeled images. (Edible VS. Poisonous)

- Split: 2000+ Training (80% Training Set / 20% Validation Set), & 300 Testing images.

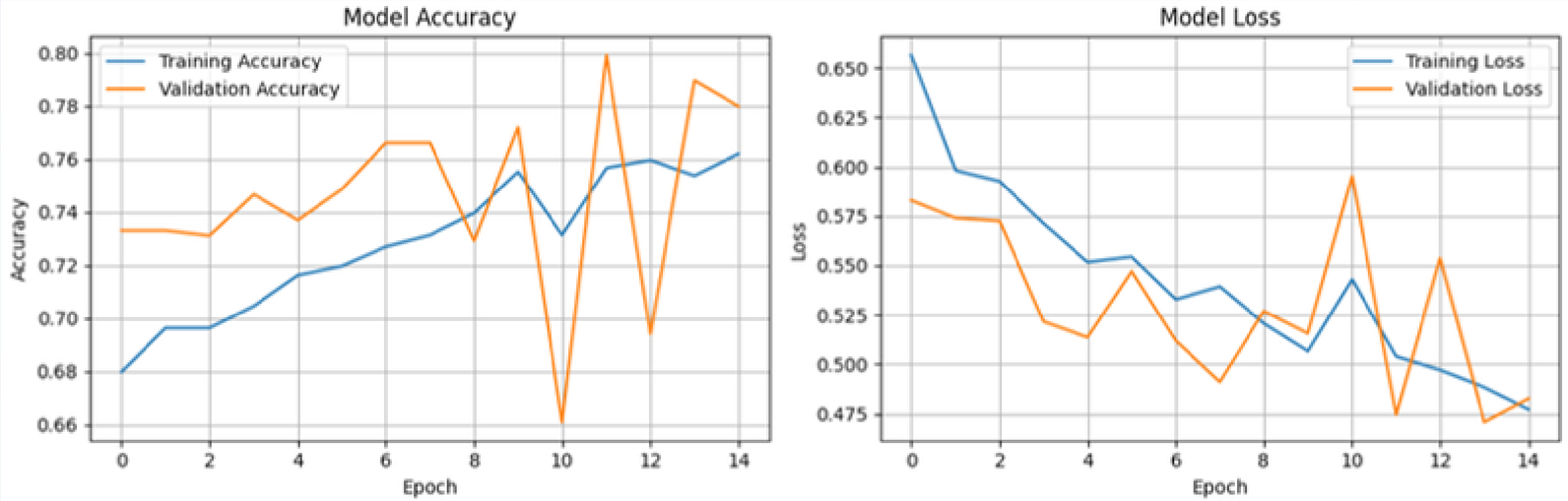
- Labeling: In our case, all images in the edible/ folder are labeled edible, and all images in the poisonous/ folder are labeled poisonous. (Deleted the 400 random labels. Plus one additional dataset)



# DATA SUMMARY

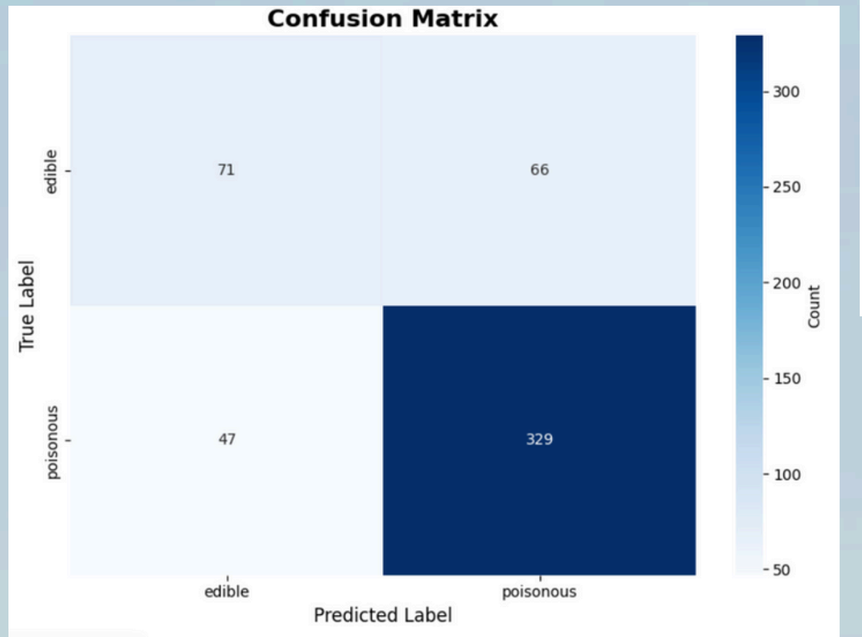


# BASELINE CNN MODEL RESULTS



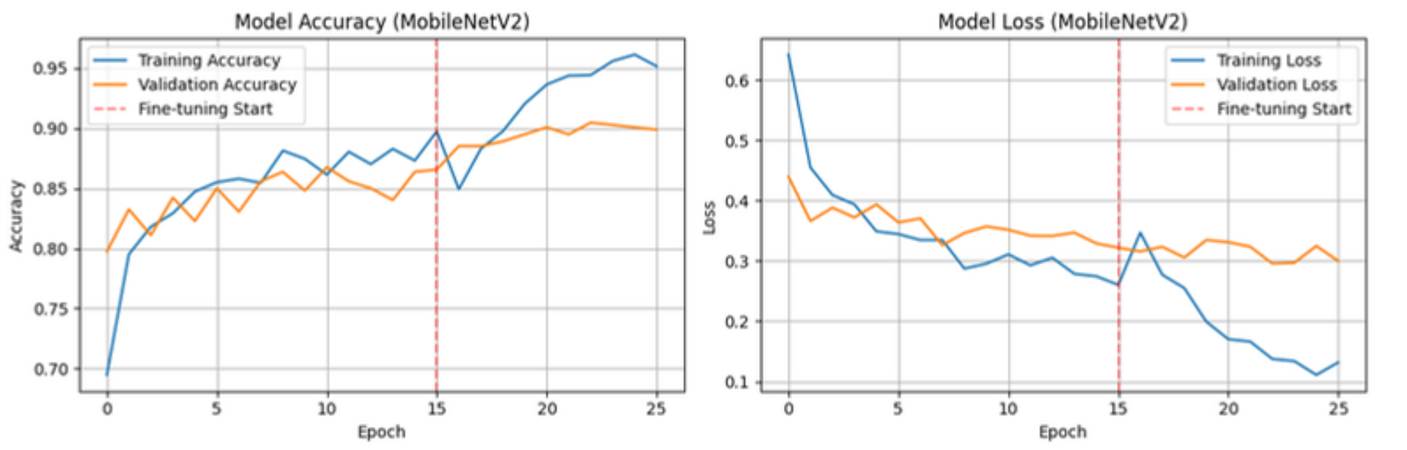

```
accuracy: 0.7772 - loss: 0.4876
```

```
Final validation accuracy: 0.7797
Final validation loss: 0.4826
```



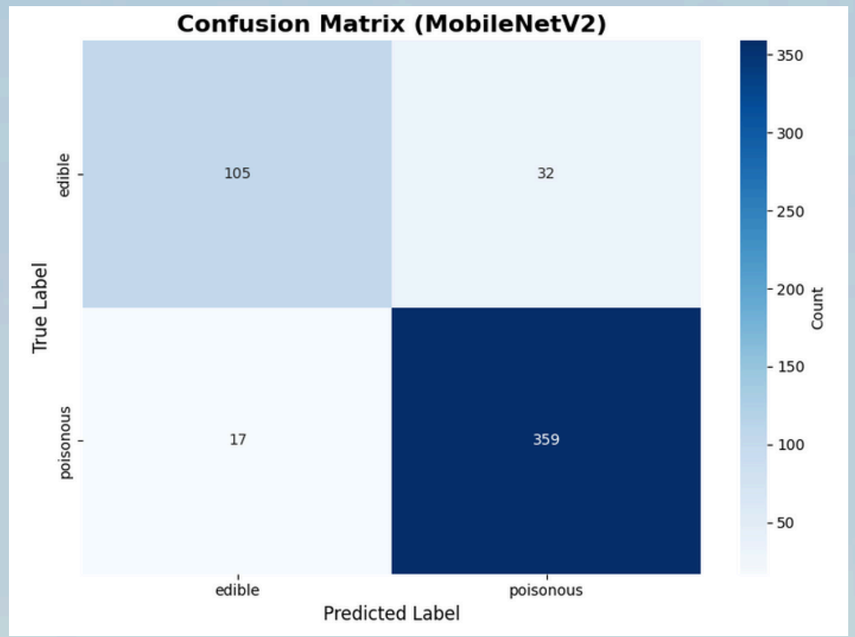

```
Classification Report:
================================================
              precision    recall  f1-score   support

      edible       0.60      0.52      0.56       137
   poisonous       0.83      0.88      0.85       376

    accuracy                           0.78       513
   macro avg       0.72      0.70      0.71       513
weighted avg       0.77      0.78      0.77       513


Detailed Metrics:
================================================
True Negatives (TN):  71
False Positives (FP): 66
False Negatives (FN): 47
True Positives (TP):  329

Overall Accuracy:  0.7797
Precision:         0.8329
Recall:            0.8750
F1-Score:          0.8534
```

# MOBILENETV2 + FINE-TUNNING CNN MODEL RESULTS




```
accuracy: 0.9139 - loss: 0.2969
```

```
Final validation accuracy: 0.9045
Final validation loss: 0.2957
```




```
Classification Report:
================================================
              precision    recall  f1-score   support

      edible       0.86      0.77      0.81       137
   poisonous       0.92      0.95      0.94       376

    accuracy                           0.90       513
   macro avg       0.89      0.86      0.87       513
weighted avg       0.90      0.90      0.90       513


Detailed Metrics:
================================================
True Negatives (TN):  105
False Positives (FP): 32
False Negatives (FN): 17
True Positives (TP):  359

Overall Accuracy:  0.9045
Precision:         0.9182
Recall:            0.9548
F1-Score:          0.9361
```

# ANALYSIS

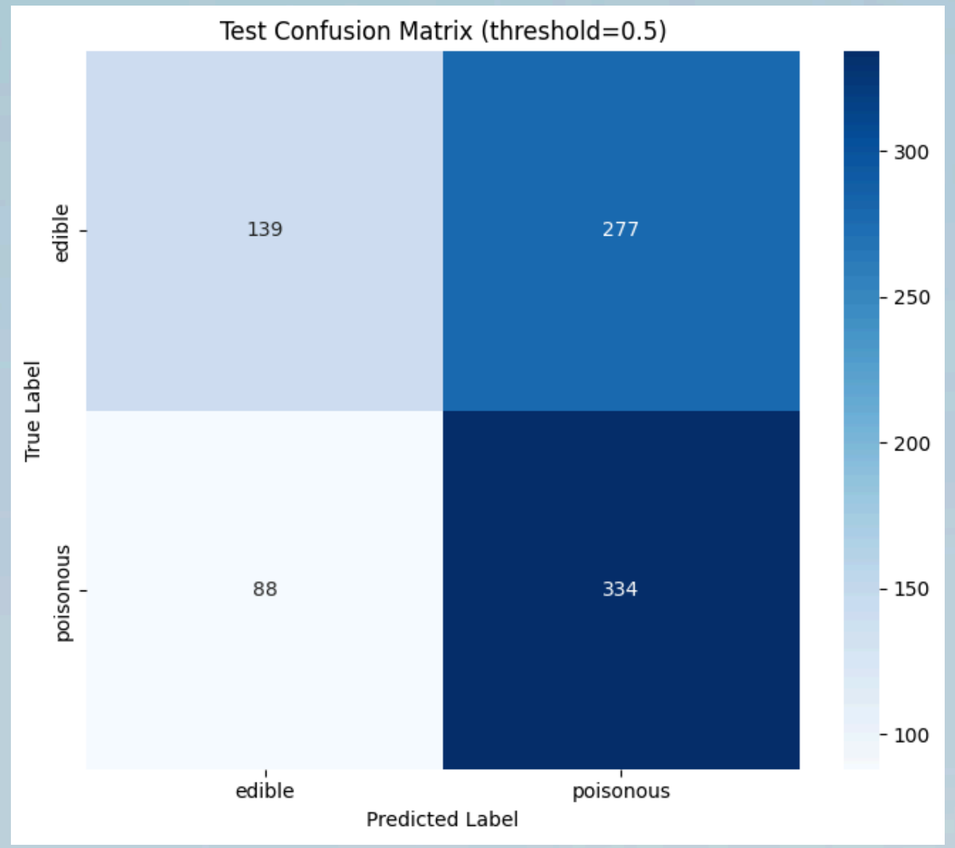
```
Test accuracy: 0.4800
Test loss:     0.8638
```

```
edible: 759
poisonous: 1808
```

```
Test accuracy: 0.5644
Test loss:     1.5081
```

- The predicting is not much better compare to random guess, does that mean we failed?
  - No. We put a focus on recall! That is to say, we don't want poisonous mushrooms to be classified as edible.
  - To do that, we trained the data with a rather imbalanced dataset.

# OTHER METRICS EXCEPT ACCURACY




```
Classification Report (Test Set):
============================================================
              precision    recall  f1-score   support

      edible       0.61      0.33      0.43       416
   poisonous       0.55      0.79      0.65       422
```

# FINAL OPTIMIZED MODEL RESULTS

- DATASET ADDED: HTTPS://WWW.KAGGLE.COM/DATASETS/MARCOSVOLPATO/EDIBLE-AND-POISONOUS-FUNGI/DATA
- FINE-TUNING DELETED

**POISONOUS MUSHROOMS**

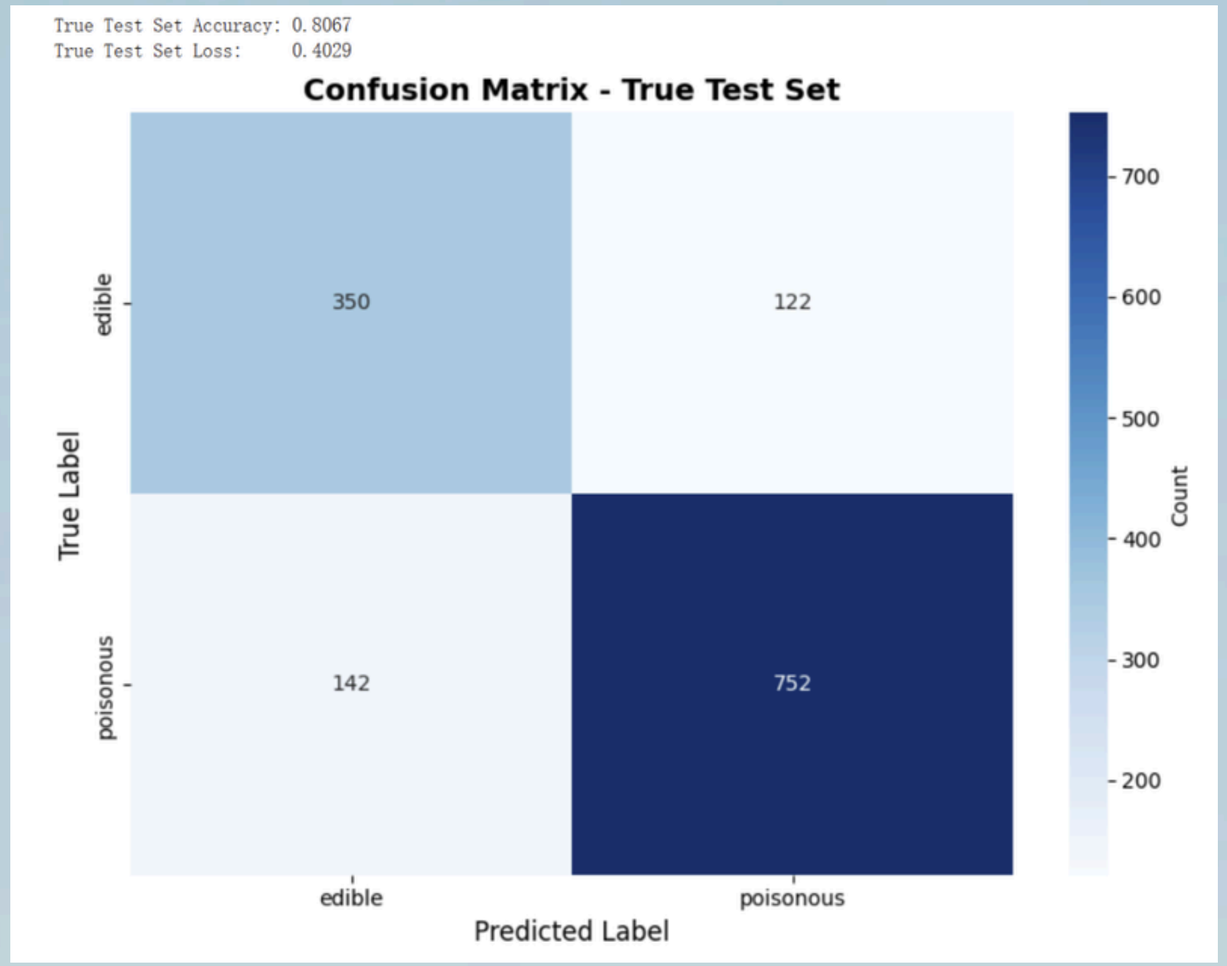
- CORRECTLY IDENTIFIED 752 / 894
- RECALL ≈ 84%
- 16% OF POISONOUS MUSHROOMS ARE MISCLASSIFIED AS EDIBLE (HIGH RISK)

**EDIBLE MUSHROOMS**

- CORRECTLY IDENTIFIED 350 / 472
- RECALL ≈ 74%
- 122 EDIBLE MUSHROOMS ARE INCORRECTLY LABELED AS POISONOUS

**OVERALL EVALUATION**

- MODEL SHOWS MODERATE PERFORMANCE
- ACCURACY IS ACCEPTABLE, BUT ERROR RATE IS STILL TOO HIGH FOR SAFE USE, ESPECIALLY FOR POISONOUS CASES



# FUTURE

- Use a more diverse set of images, train on more samples, and evaluate on a larger test set. (pictures of different daytimes, lights, colors, angles, etc.)

- Improve performance and reduce overfitting. (Add additional features: eg, more effective validation, regularization)

- Try to train the models with different threshold or different weights on the train dataset. e.g. >0.5 threshold for classifying as poisonous or edible pictures to have heavier weight when training to find a reasonable accuracy and recall tradeoff.

## REFERENCE


- Li, H.-J., Zhang, H.-S., Zhang, Y.-Z., et al. (2020). Mushroom Poisoning Outbreaks — China, 2019. China CDC Weekly, 2(2), 19–24. https://doi.org/10.46234/ccdcw2020.005
- https://www.researchgate.net/publication/359553408_A_New_Deep_Learning_Model_for_the_Classification_of_Poisonous_and_Edible_Mushrooms_Based_on_Improved_AlexNet_Convolutional_Neural_Network
- https://onlinelibrary.wiley.com/doi/full/10.1155/2022/1173102?msockid=0278f1d25948690f3cfce774581e6823


THE END
THANK YOU