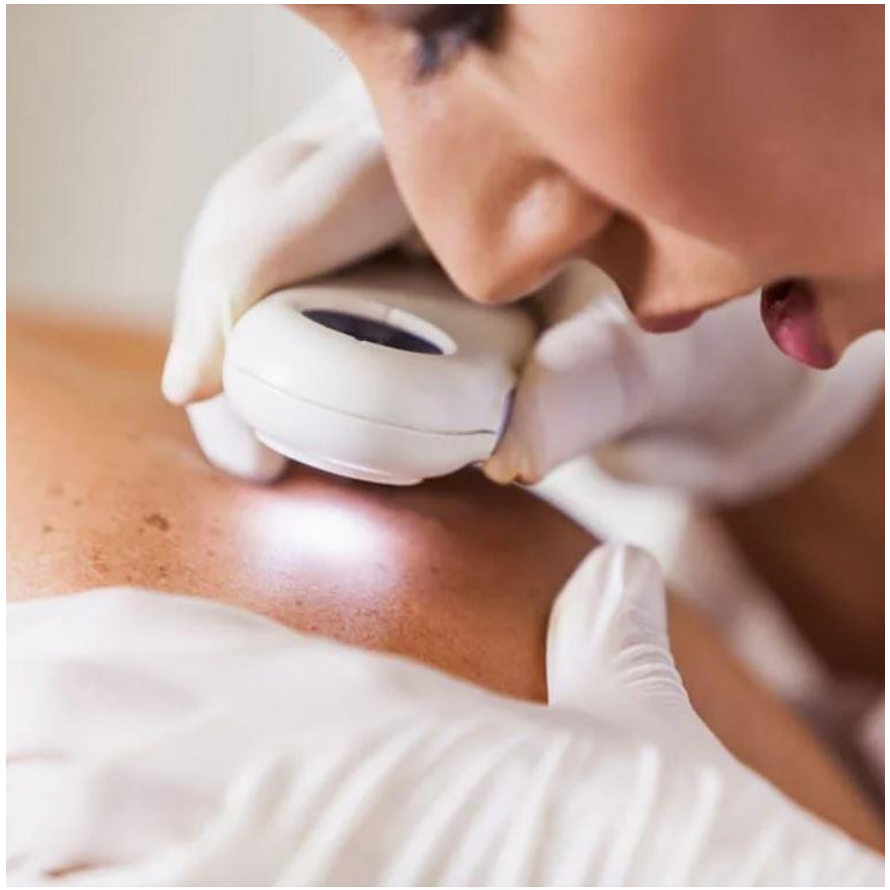
Computer Aided Pigmented Skin Lesion Classification

Ananalysis by Christopher Liedel

Use Case: Multi-Class Classification

Skin cancer is the most common human malignancy

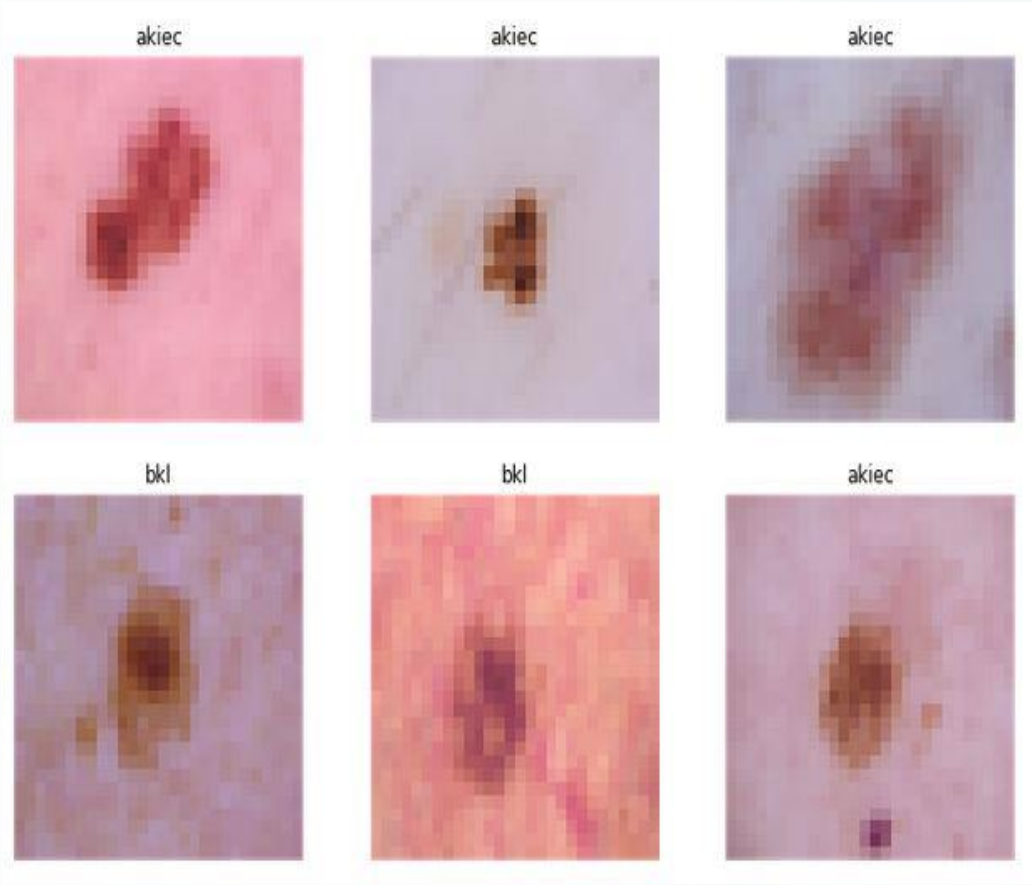
- Early detection of skin cancer allows for a more successful and simpler cure.
- Initial Diagnosis is performed in a clinical setting limiting access to medical care for some.
- Automating skin lesion classification can be used as diagnostic aid in a clinical setting.
- Automation of skin lesion classification through mobile devices can potentially expand needed low-cost medical care outside the clinic.



Data Used

Dataset: HAM_10000 (hmnist_28_28_RGB.csv) for pigmented skin lesion diagnosis.

- Contains 10,000 images of skin lesions, both benign and malignant.
- A labels column.



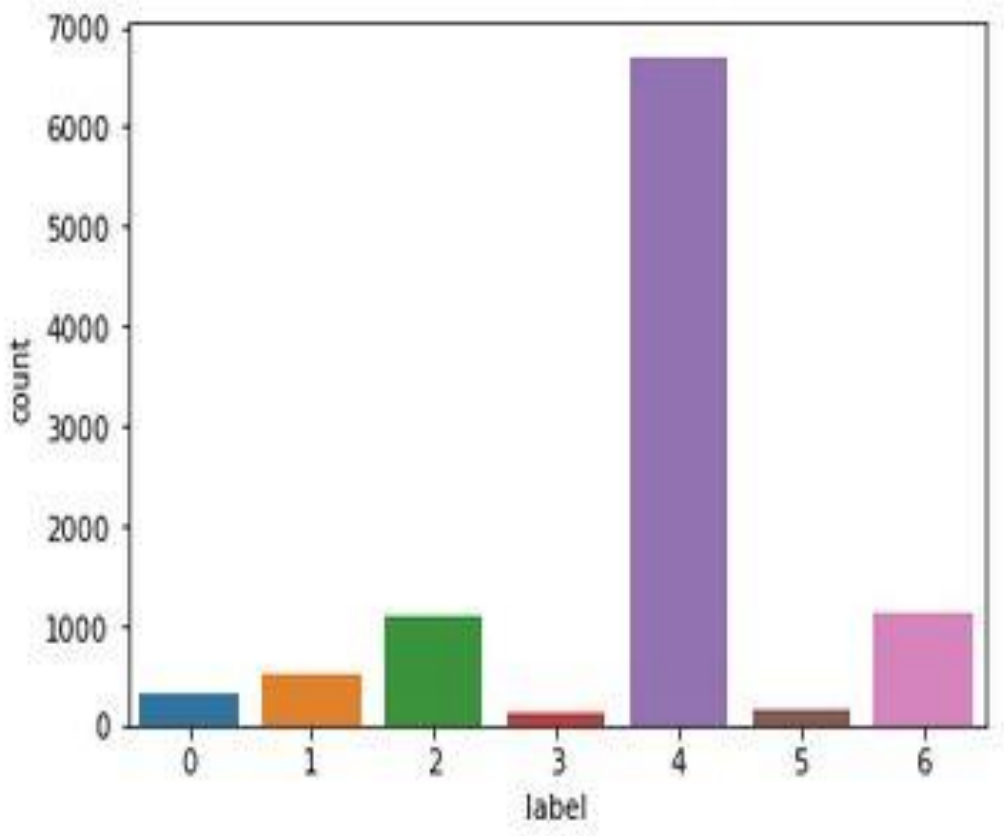
Metadata includes additional patient information including patient age, patient sex, and lesion location

HAM_10000_metadata.csv file

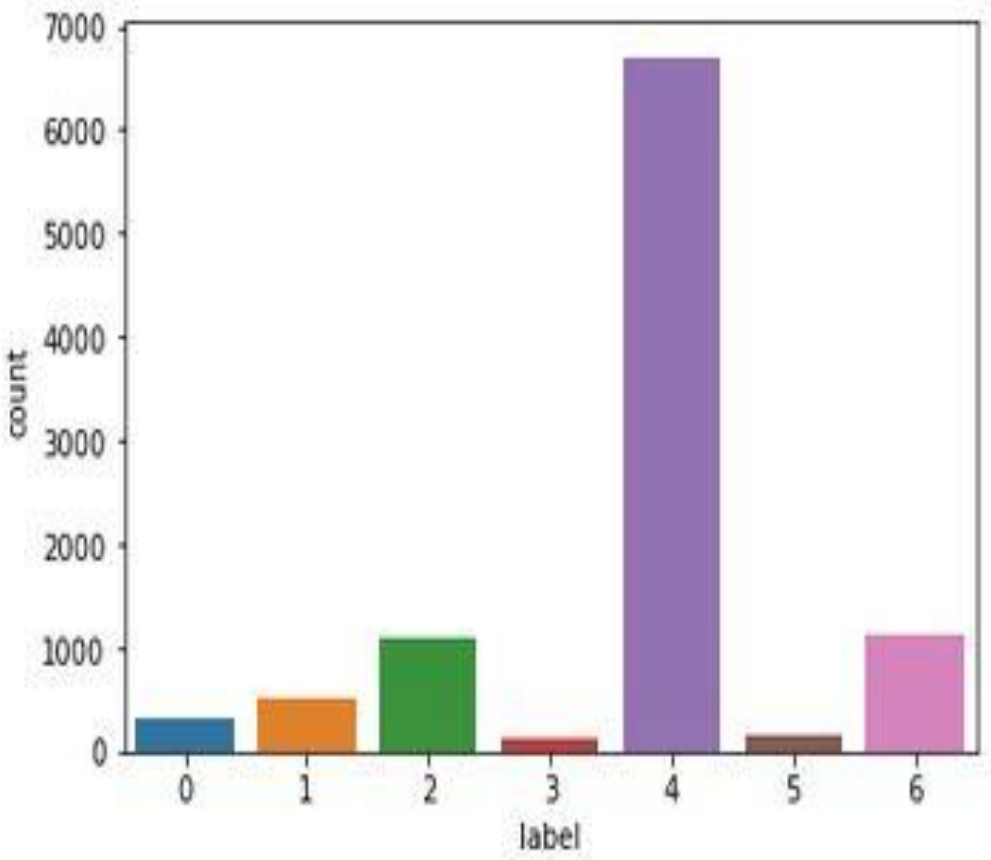
Dataset has 7 possible diagnoses:

- 0: nv - Melanocytic nevi
- 1: mel - Melanoma
- 2: bkl - Benign keratosis-like lesions
- 3: bcc - Basal cell carcinoma
- 4: akiec - Actinic keratoses
- 5: vasc - Vascular lesions
- 6: df – Dermatofibroma

Also includes image/lesion ID, dx_type, sex, age and location of lesion.

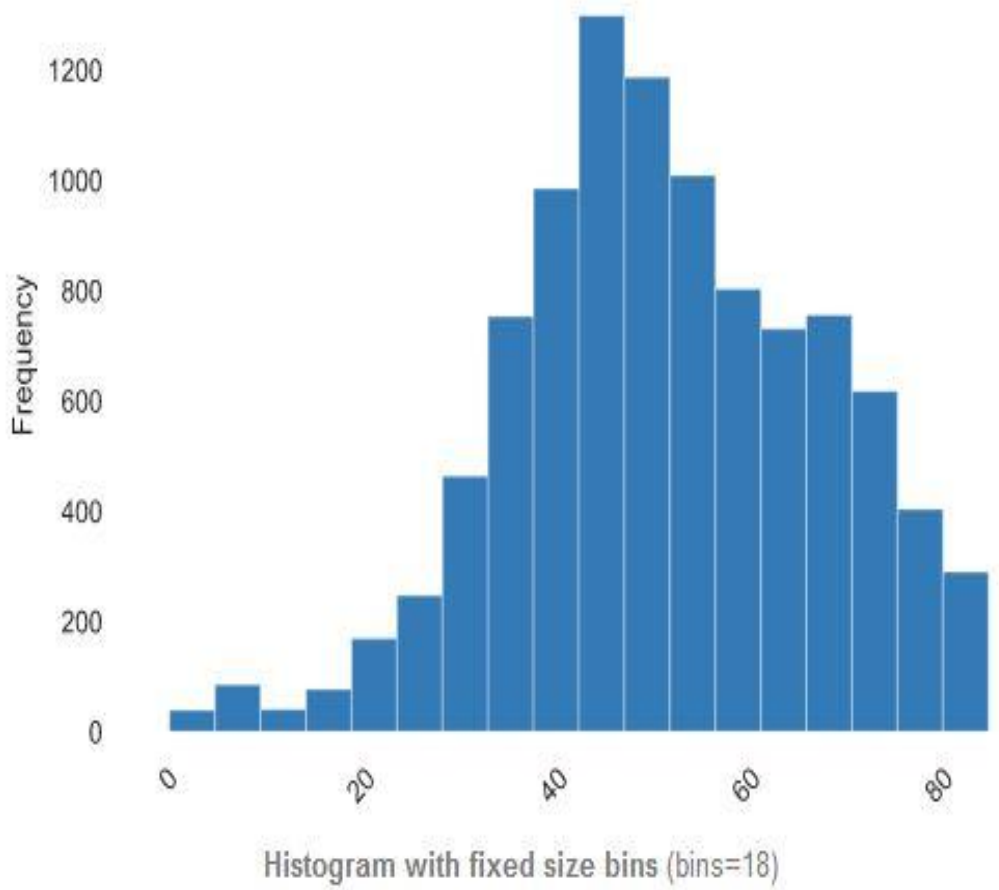


Melanocytic nevi are the most frequent lesion: 66.9%
Followed by melanoma: 11.1%



Value	Count	Frequency (%)
nv	6705	66.9%
mel	1113	11.1%
bkl	1099	11.0%
bcc	514	5.1%
akiec	327	3.3%
vasc	142	1.4%
df	115	1.1%

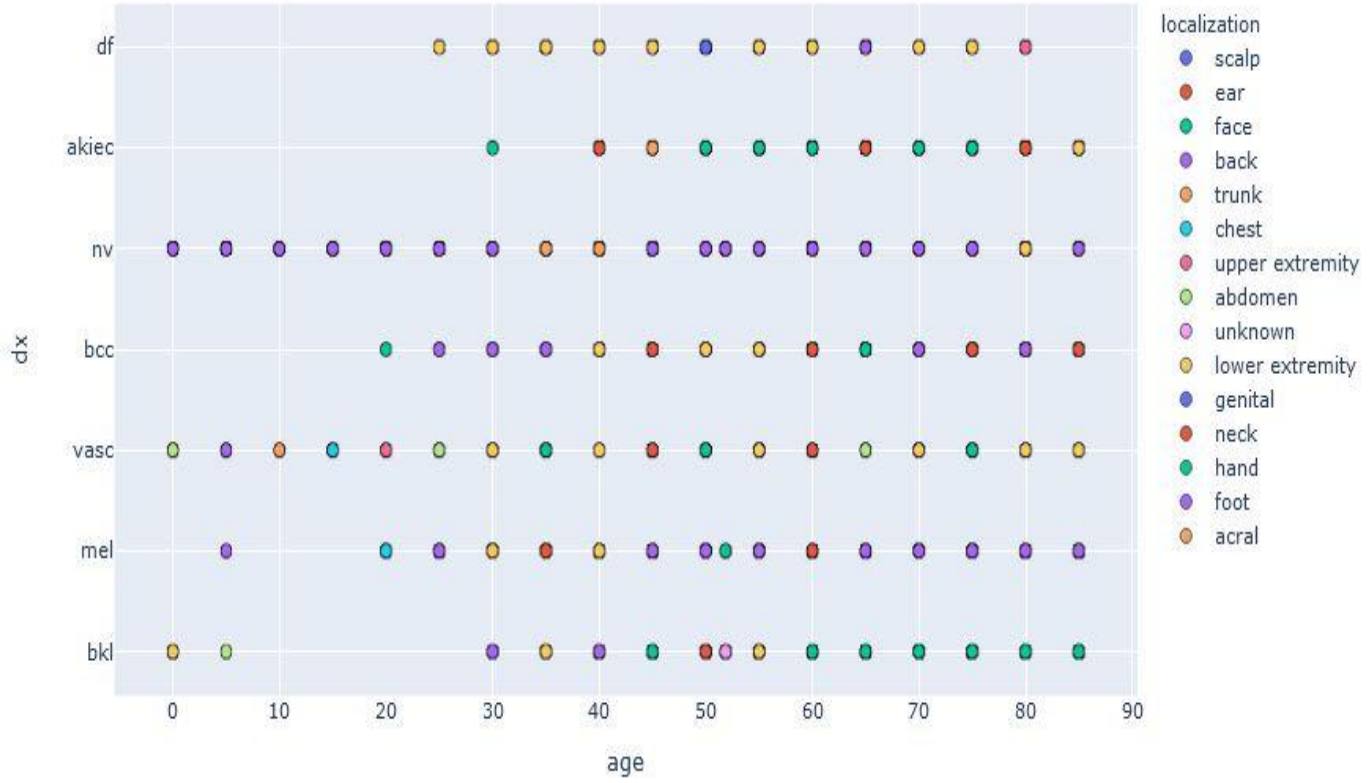
Most lesions diagnosed at age 45
Value:13%



Value	Count	Frequency (%)
45	1299	13.0%
50	1187	11.9%
55	1009	10.1%
40	985	9.8%
60	803	8.0%
70	756	7.5%
35	753	7.5%
65	731	7.3%
75	618	6.2%
30	464	4.6%
Other values (8)	1353	13.5%

Most lesions are found on an extremity: 24.2%

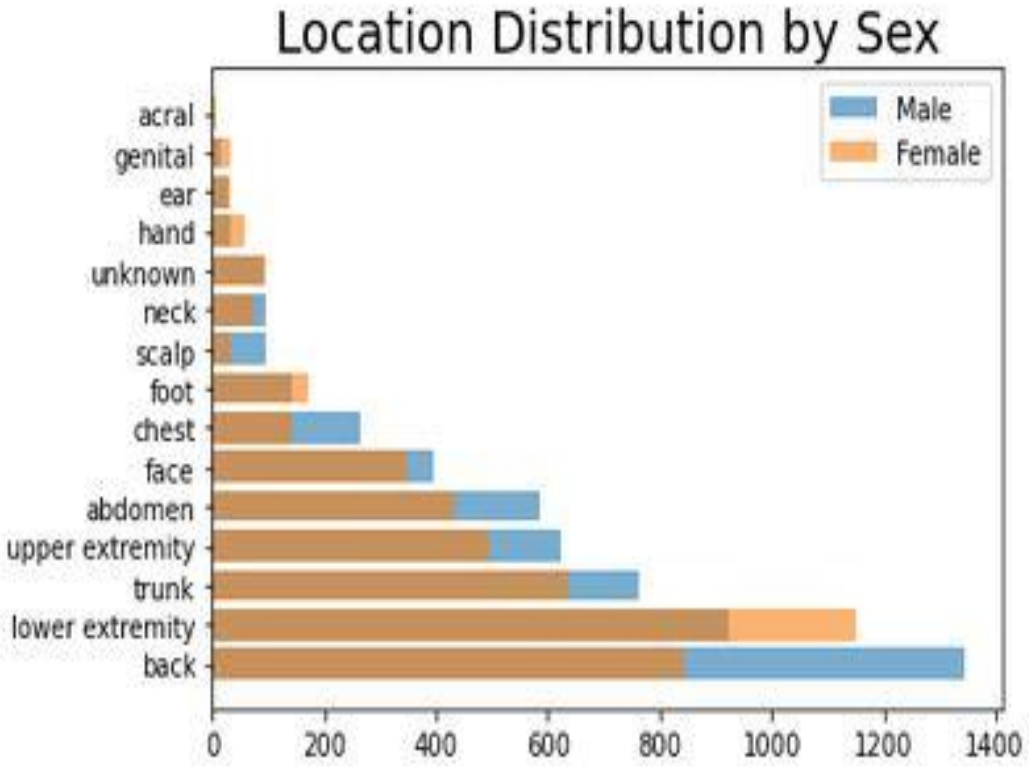
Age/Diagnosis/Location

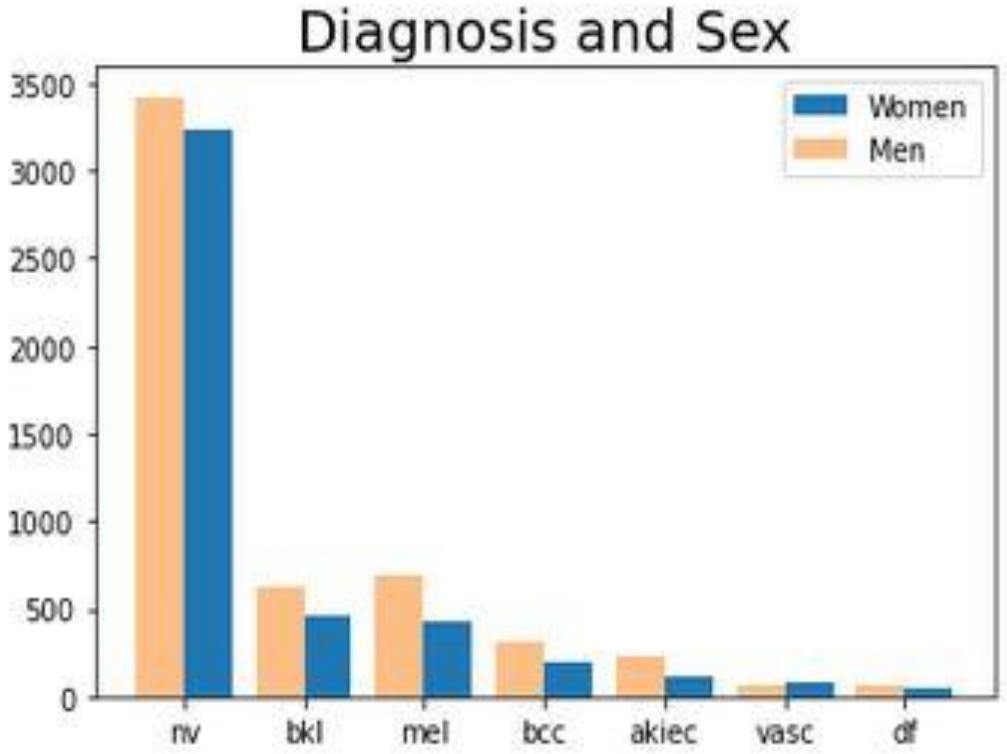


Value	Count	Frequency (%)
extremity	3195	24.2%
back	2192	16.6%
lower	2077	15.7%
trunk	1404	10.6%
upper	1118	8.5%
abdomen	1022	7.7%
face	745	5.6%
chest	407	3.1%
foot	319	2.4%
unknown	234	1.8%
Other values (6)	497	3.8%

Men have higher lesion counts than women

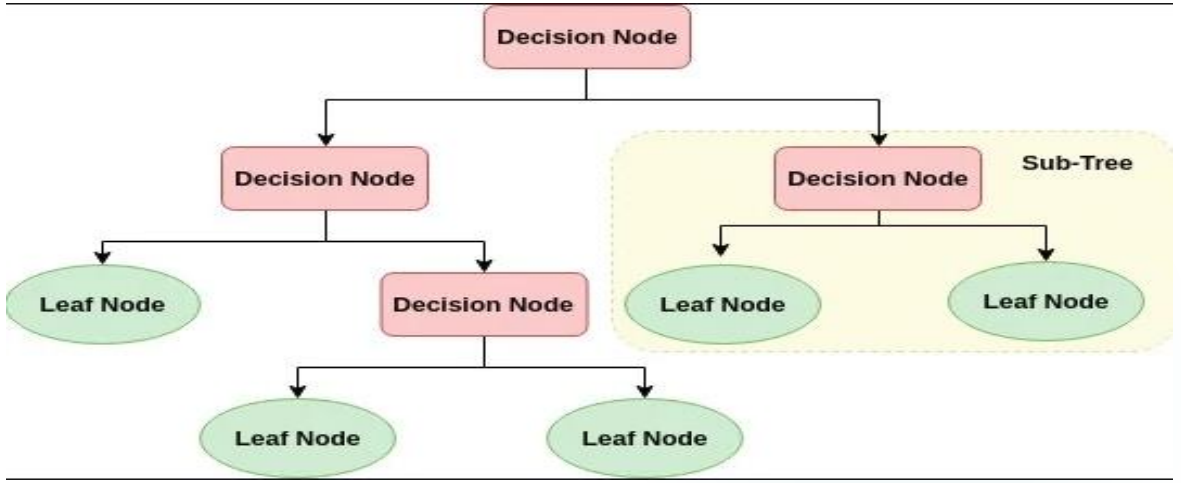
Sex/Diagnosis/Location



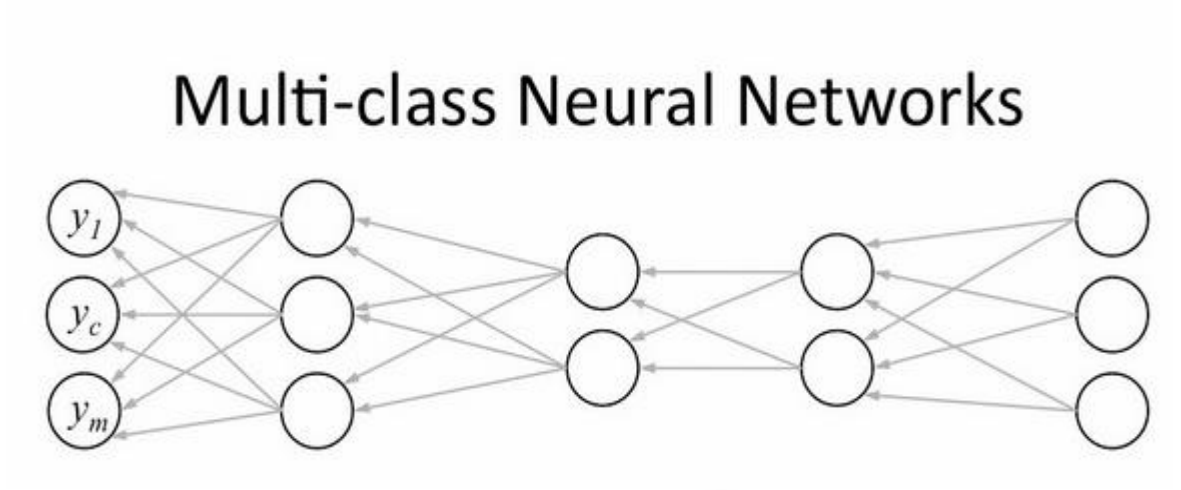


Machine Learning for Lesion Classification

- Predicting seven types of skin lesion is a multiclass classification problem



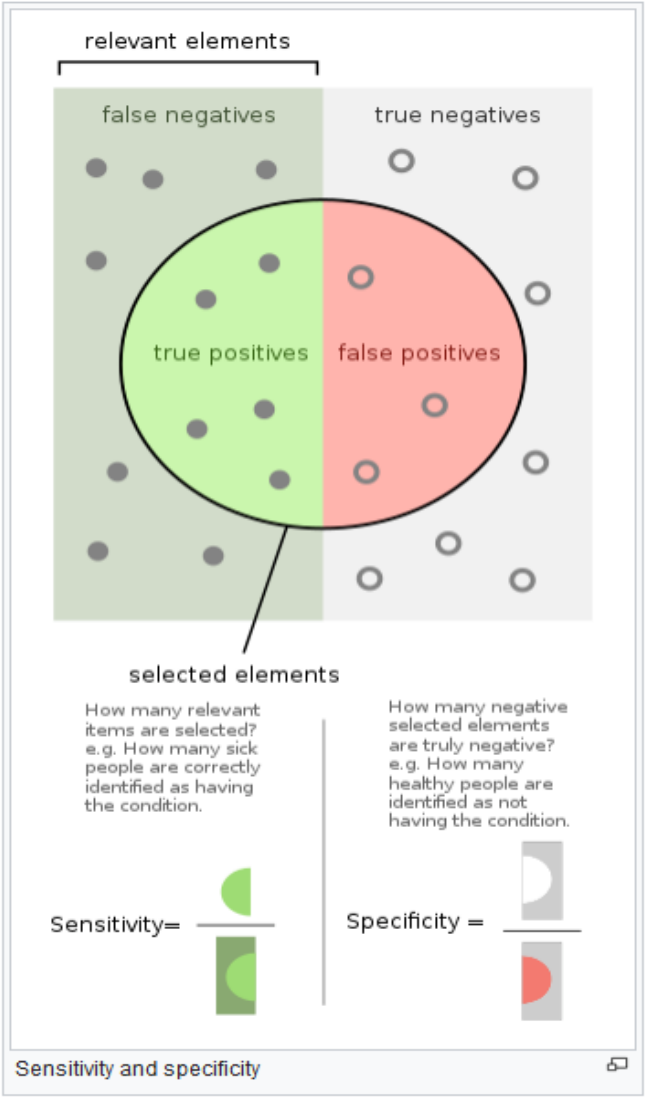
- Tree based algorithms and neural networks are evaluated for effectiveness with the use case



Evaluating Algorithm Performance

- Since we have multiple classes to predict, Accuracy along with Precision, Sensitivity (Recall), and Specificity are used to evaluate the models

- Accuracy: How often is the model correct?
- Precision: Positive predictive value
- Sensitivity (Recall): True positive rate
- Specificity: True negative rate



Best Model: Neural Network

Summary

Tuned, Fully Connected **Neural Network**

Accuracy, **Precision** and **Recall** of **0.98**

Specificity of **0.996**

Epochs: 100

Batch size: 850

1st hidden layer: 512 neurons

2nd hidden layer: 64 neurons

1st activation: elu

2nd activation: relu

Dropout: 0.2

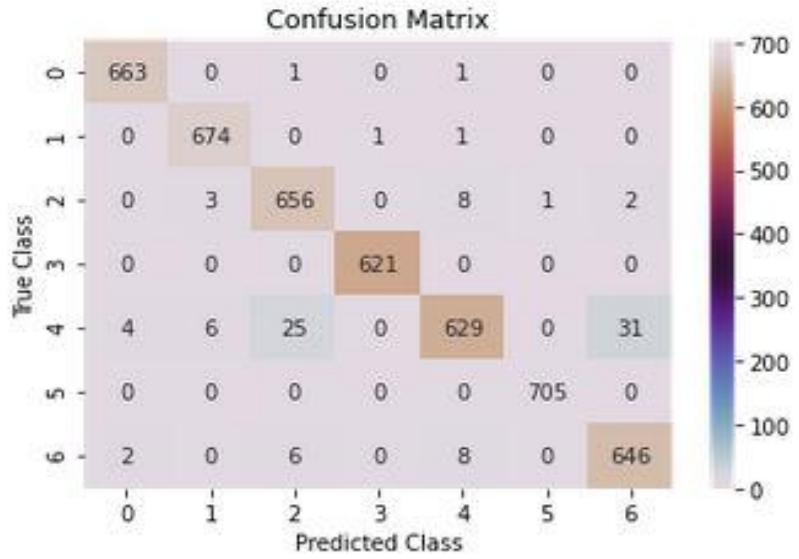
Output layer activation: softmax

Optimizer: nadam

Loss: sparse_categorical_crossentropy

Classification Report

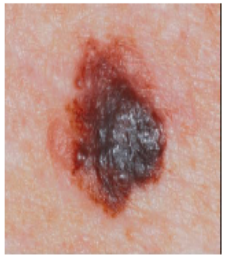
	precision	recall	f1-score	support
0	0.99	1.00	0.99	665
1	0.99	1.00	0.99	676
2	0.95	0.98	0.97	670
3	1.00	1.00	1.00	621
4	0.97	0.91	0.94	695
5	1.00	1.00	1.00	705
6	0.95	0.98	0.96	662
accuracy			0.98	4694
macro avg	0.98	0.98	0.98	4694
weighted avg	0.98	0.98	0.98	4694



Example of a prediction made using our best model

- The image used was selected from an external source and not taken from the dataset used to train and evaluate the model

```
from keras.preprocessing import image

img_path = ('./Desktop/mel2.jpg')
img = image.load_img(img_path, target_size=(158,158))
img
```

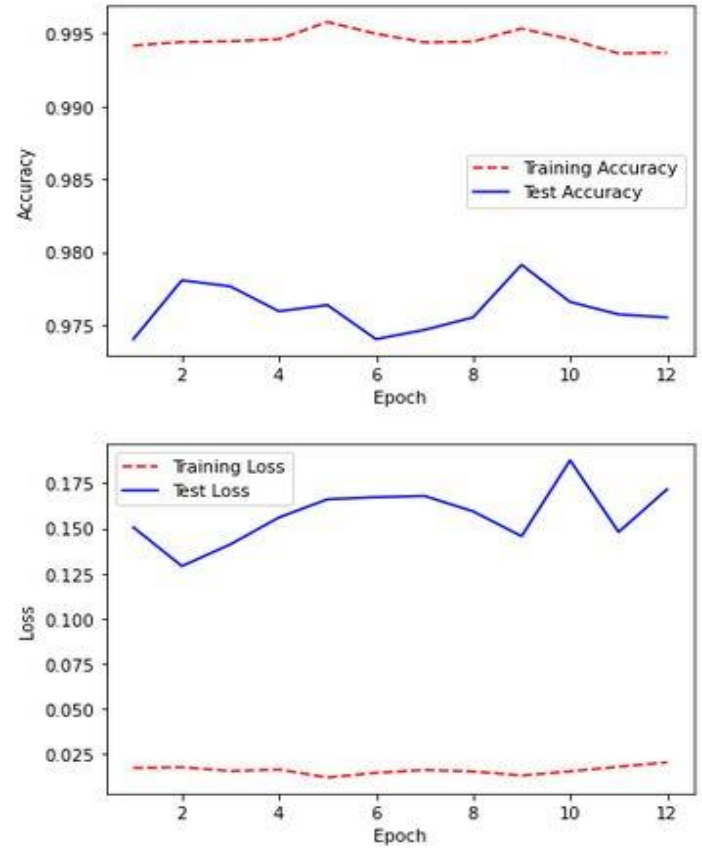


```
# Classify image not in the dataset
import cv2
img = cv2.imread('./Desktop/mel2.jpg',0)


img = cv2.resize(img,(58,58))
cv2.waitKey(0)
cv2.destroyAllWindows()

print(class_label)

prediction_cplx = tuned_model.predict_classes(img)

print('The predicted class of the lesion is:', prediction_cplx[1])
```

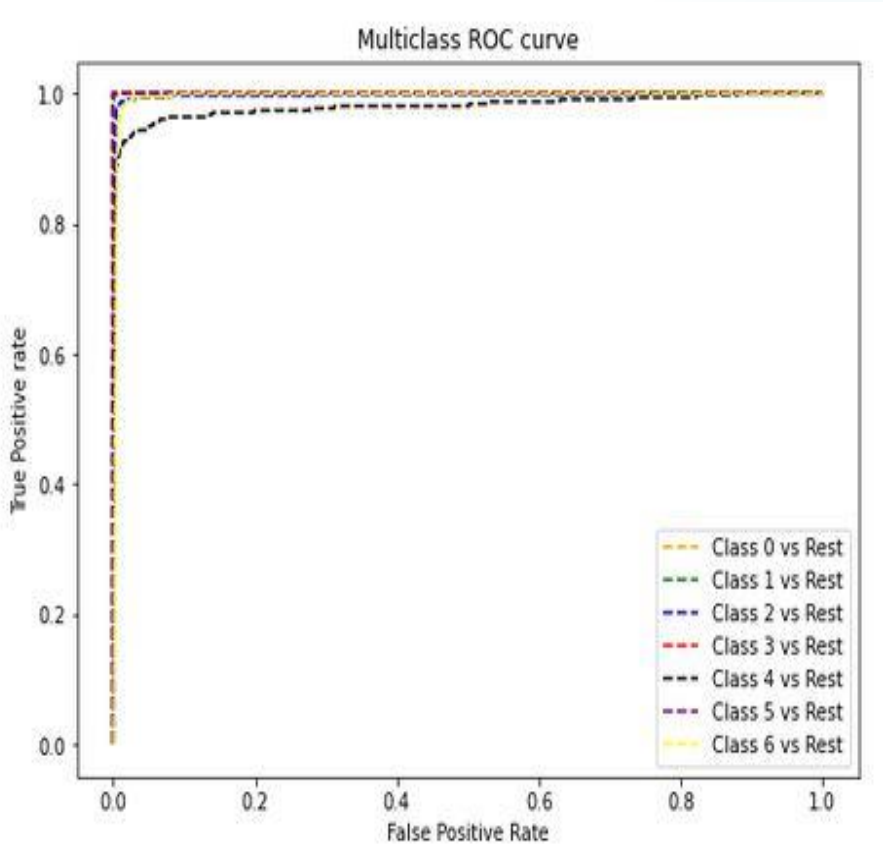
```
{0: 'nv: melanocytic nevi', 1: 'mel: melanoma', 2: 'bkl: benign keratosis-like lesion', 3: 'bcc: basal_cell_carcinoma', 4:
'akiec: actinic_keratoses', 5: 'vasc: vascular lesion', 6: 'df: dermatofibroma'}
The predicted class of the lesion is: 1
```

Performance Charts

Train and Test Performance



Probability Curves



XGBoost

Summary

Second best performing model is **XGBoost** with **accuracy**, **precision** and **recall** of **0.95**; **Specificity** of **0.991**

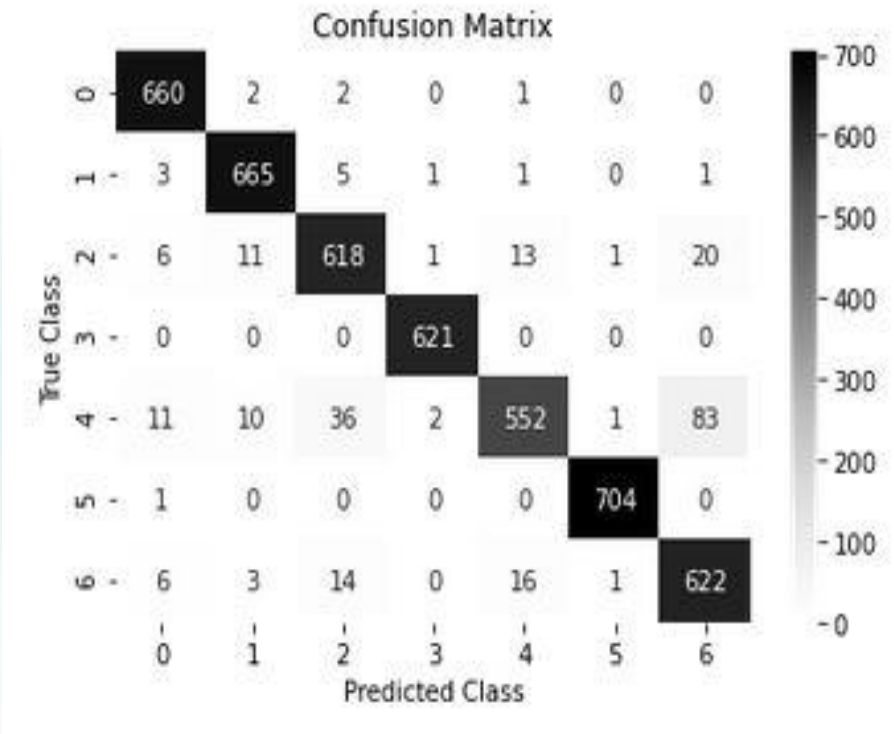
- max_depth : 7
- booster: "gbtree"
- num_classes: 7
- eval_metric: "mlogloss"
- objective: "multi:softprob"

Classification Report

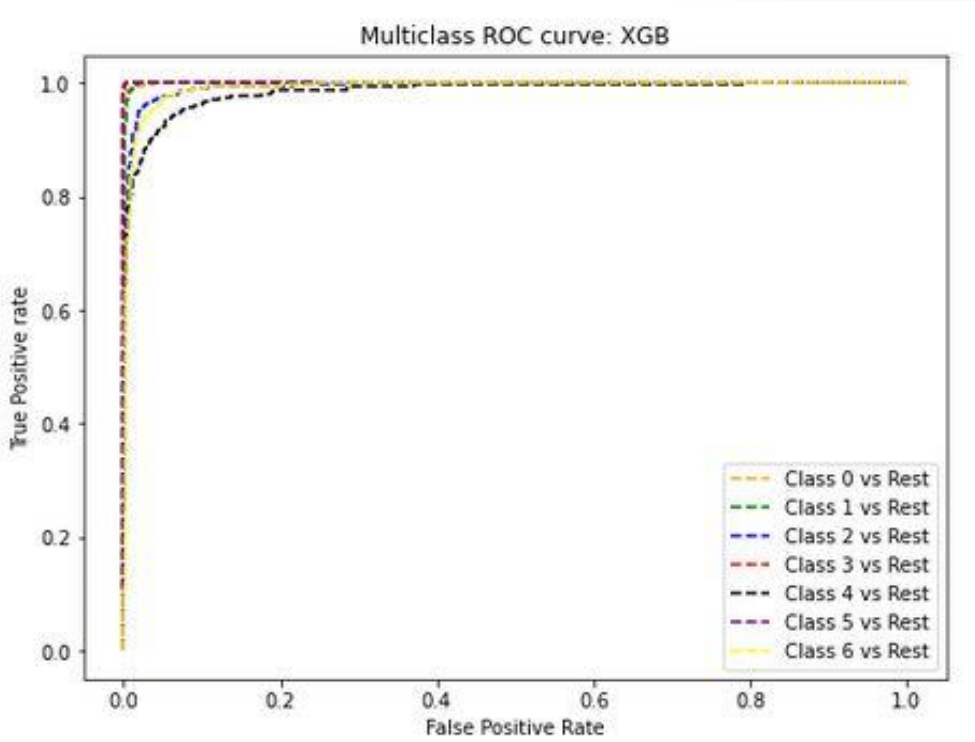
xgb:	precision	recall	f1-score	support
0	0.96	0.99	0.98	665
1	0.96	0.98	0.97	676
2	0.92	0.92	0.92	670
3	0.99	1.00	1.00	621
4	0.95	0.79	0.86	695
5	1.00	1.00	1.00	705
6	0.86	0.94	0.90	662
accuracy			0.95	4694
macro avg	0.95	0.95	0.95	4694
weighted avg	0.95	0.95	0.95	4694

XGBoost Performance

Prediction Results



Probability Curves



Using the model

Trained model can be used in an application placed on a tablet device or smart-phone.

- A digital image is taken of the lesion in question.
- Image enters the transformation pipeline.
- The prepared image is fed into the pre-trained model.
- Model predicts the lesion class.
- The model prediction can be used as and aid to diagnosis.

Can be used outside of a clinical setting expanding access to needed low-cost medical care.

Thank you!