# Work Summary

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# Introduction

1. Explanation Of Dataset
2. Indication Of Infected Thermogram
3. Feature Extraction
4. Classification
5. Summary and Inferences
6. References

**Problem Statement**

Classification of Diabetic Foot Ulcer Using Thermograms

# Feature Extraction

1. Textural Features
   - GLCM Properties
2. Histogram Features

# GLCM

## Defination

- It is a matrix
- It stand for
- **Gray-Level Co-occurance Matrix**
- Here **Gray-level** refers values of gray intensity in Source grayscale image.
- **Co-occurance Matrix** refers to each value in matrix is a frequency where any gray-level value occurs in pair.
- Here a Pair is Determined by two parameters d (Distance), θ (angle)

## Purpose

- It represent probability distribution of occuring pair in image
- Using this Various Properties can be calculated that gives some insignt into textural variation of the image
- Properties are
  1. Contrast
  2. Homogenity
  3. Entropy
  4. Correlation
  5. Energy/Angular Second Moment

# GLCM Properties: Contrast

## Formula

$$Contrast = \sum_{i,j} (i-j)^2 \texttt{GLCM}(i,j)$$

## Summary

$\texttt{Contrast} \propto LocalVariation$

## Significance

- Captures local variation in neighbouring pixels.
- **High Contrast**: glcm's values have significant intentsity change in neighbour pixel, i.e sharp edges.
- **Low Contrast**: Uniformity in Texture with minimal change in intensity.
- also known as intertia/variance

# GLCM Properties: Contrast


Figure 1: Image with Low Contrast

Figure 2: Image With High Contrast

# GLCM Properties: Homogenity

**Formula**

$$Homogenity = \sum_{i=0}^{L-1} \sum_{j=0}^{L-1} \frac{P(i,j)}{1+|i-j|}$$

**Significance**

- measures how close the distribution is to the GLCM Diagonal
- also known as Inverse Difference Moment

# GLCM Properties: Correlation

# GLCM Properties: Energy

# Histogram Features

## Mean

$$\mu = \sum_{g=0}^{L-1} gP(g)$$

## Variance

$$\sigma = \sum_{g=0}^{L-1} (g-\mu)^2 P(g)$$

## Entropy

$$Entropy = -\sum_{g=0}^{L-1} P(g) log P(g)$$

## Skew

$$Skew = \frac{1}{\sigma^3} \sum_{g=0}^{L-1} (g-\mu)^3 P(g)$$

# Histogram Features

**Kurtosis**

$$\gamma_2 = \frac{\sum_g (g-\mu)^4 \cdot P(g)}{\left(\sum_g (g-\mu)^2 \cdot P(g)\right)^2} - 3$$

# Classification

- All described features used to classify between a Healty and an Infected Foot.
- Classifiers were used
  1. Support Vector Machine.
  2. K Nearest Neighbour
  3. Random Forest
  4. Decision Tree

# Results: Accuracy

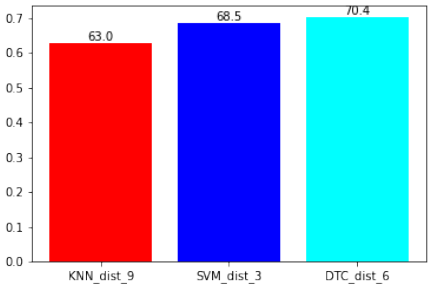


Figure 3: Accuracy

**Description**

| SVM | KNN | DT |
|---|---|---|
| 63% | 68.5% | 70.4% |

# Results: Precision

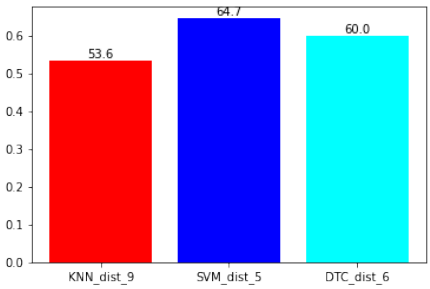


Figure 4: Precision

**Description**

| SVM | KNN | DT |
|---|---|---|
| 53.6% | 64.7% | 60.0% |

# Results: Recall

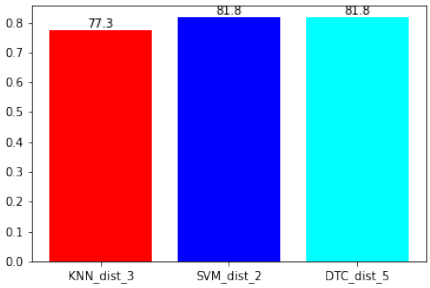


Figure 5: Recall

**Description**

| SVM | KNN | DT |
|---|---|---|
| 77% | 81.8% | 81.8% |

# Results: F1-Score

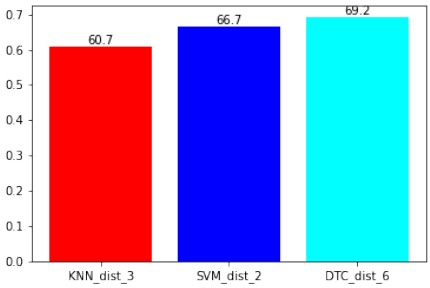


Figure 6: F1-Score

**Description**

| SVM | KNN | DT |
|---|---|---|
| 60.7% | 66.7% | 69.2% |

# Results: Accuracy

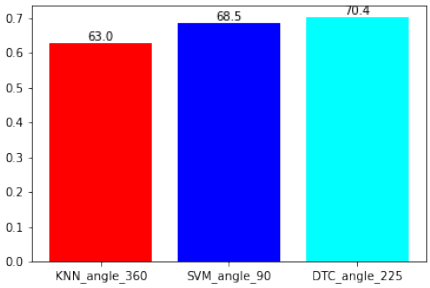


Figure 7: Accuracy

**Description**

| SVM | KNN | DT |
|---|---|---|
| 63% | 68.5% | 70.4% |

# Results: Precision

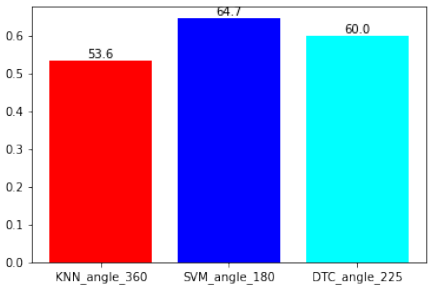


Figure 8: Precision

**Description**

| SVM | KNN | DT |
|---|---|---|
| 53.6% | 64.7% | 60.0% |

# Results: Recall

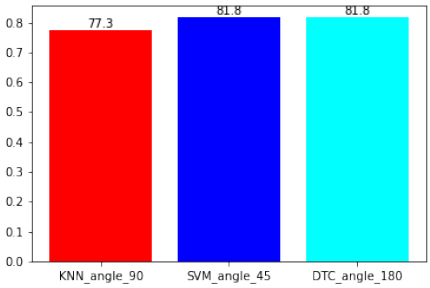


Figure 9: Recall

**Description**

| SVM | KNN | DT |
|---|---|---|
| 77.3% | 81.8% | 81.8% |

# Results: F1-Score

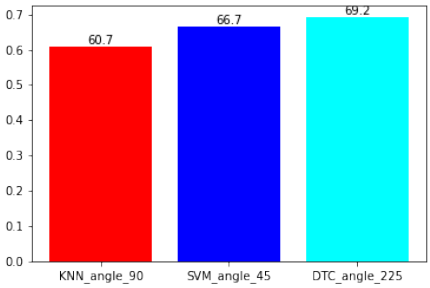


Figure 10: F1-Score

**Description**

| SVM | KNN | DT |
|---|---|---|
| 60.7% | 66.7% | 69.2% |

# Results: Variations (Distances)

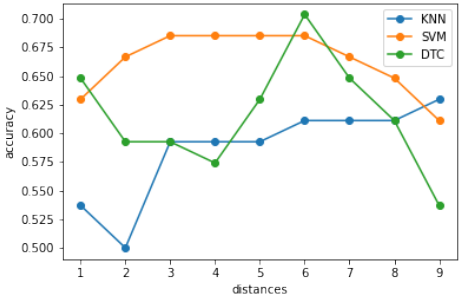


Figure 11: Accuracy Variation

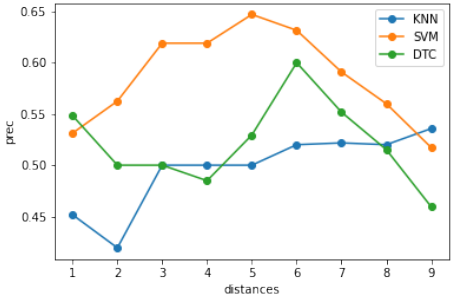


Figure 12: Precision Variation

# Results: Variations (Distances)

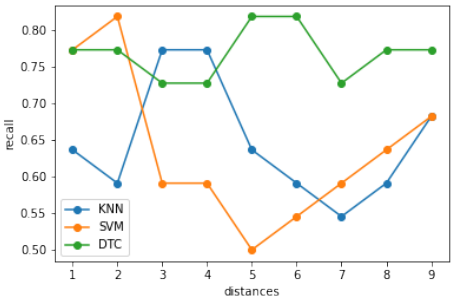


Figure 13: Recall Variation

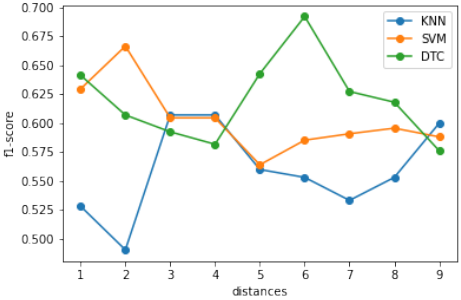


Figure 14: F1-Score Variation

# Results: Variations (Angle)

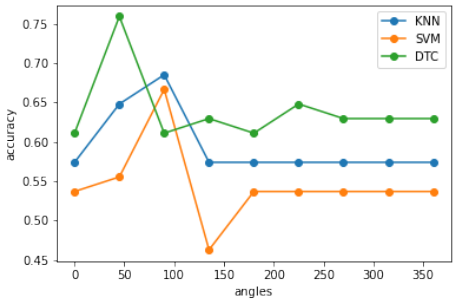


Figure 15: Accuracy Variation

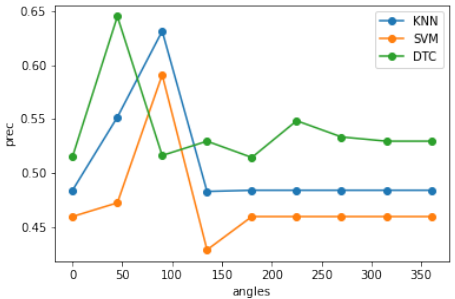


Figure 16: Precision Variation

# Results: Variations (Angle)

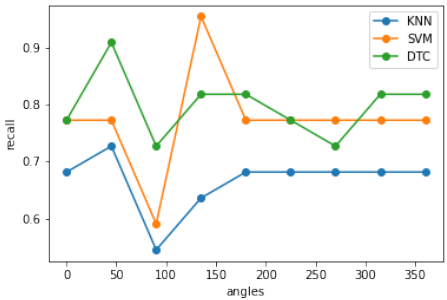


Figure 17: Recall Variation

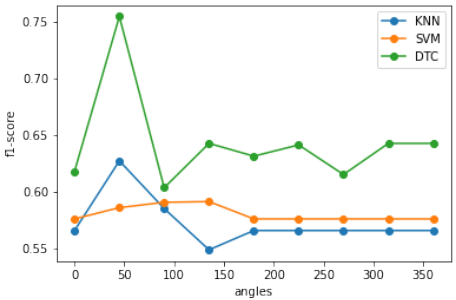


Figure 18: F1-Score Variation

# Conclusion

- From above results it can be seen that maximum acquired accuracy is 70% by **Decision Tree Classifier**

# References


1. Eid, Marwa M., Reem N. Yousef, and Mohamed A. Mohamed. “A proposed automated system to classify diabetic foot from thermography.” Int. J. Sci. Eng. Res 9 (2018): 371-381.