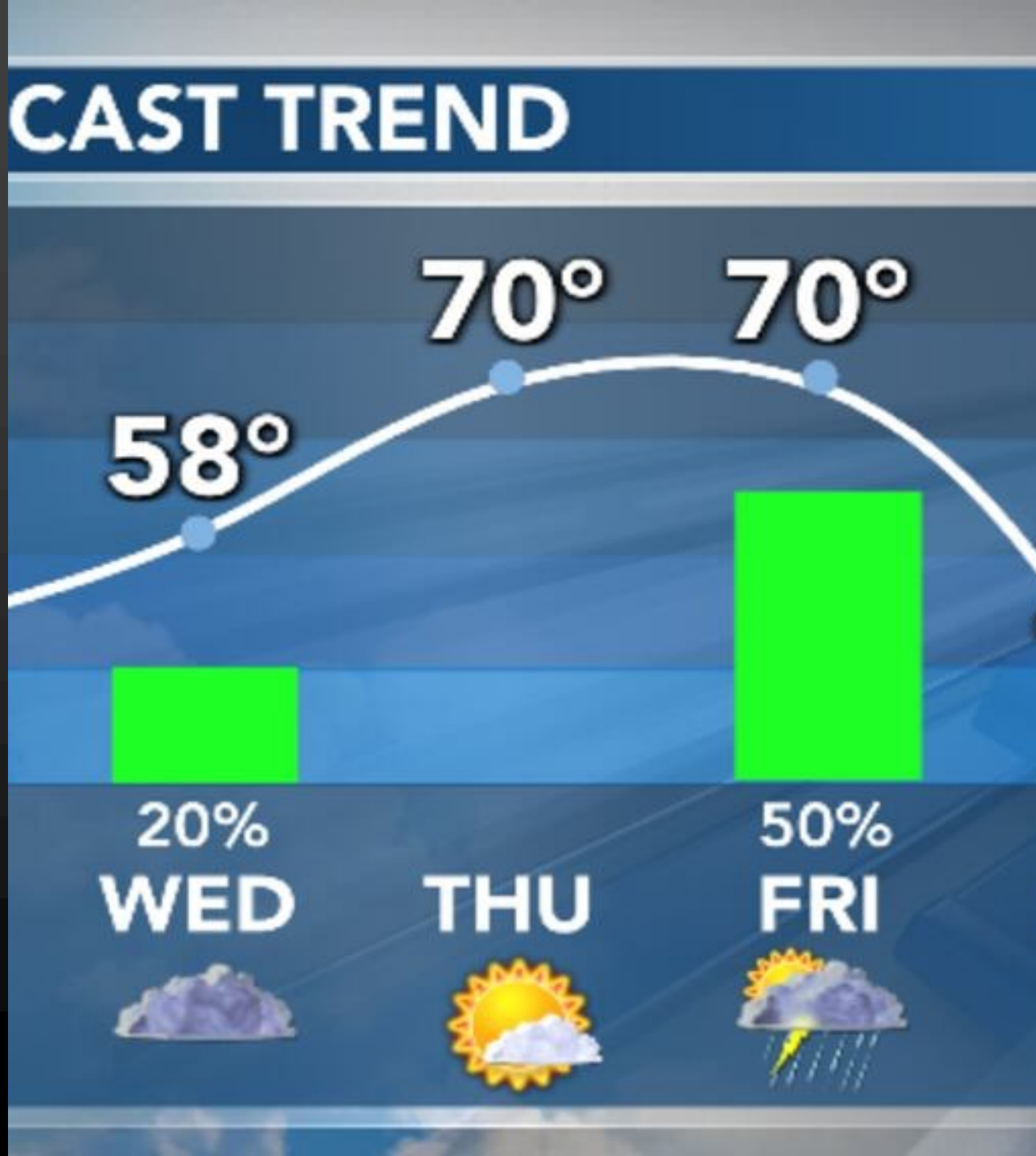
# Long-range weather forecasting using Radial Basis Function

A presentation at ICAAN

Ceasar Kabue Waweru



# About Me

## Ceasar Waweru Kabue (CWK)

- print("**Who am I**")
  - Problem-solver
  - Cyber security expert
  - Computer Scientist and Researcher
  - Application Tester
  - Son, brother and friend

# INTRODUCTION

1. What is weather?
2. What is weather forecasting
3. Existing models
4. What is the problem?
5. What is the research gap Vs research objectives?
6. Radial Basis Function Network
7. North-Eastern Kenya
8. Results
9. Demo
10. Conclusion

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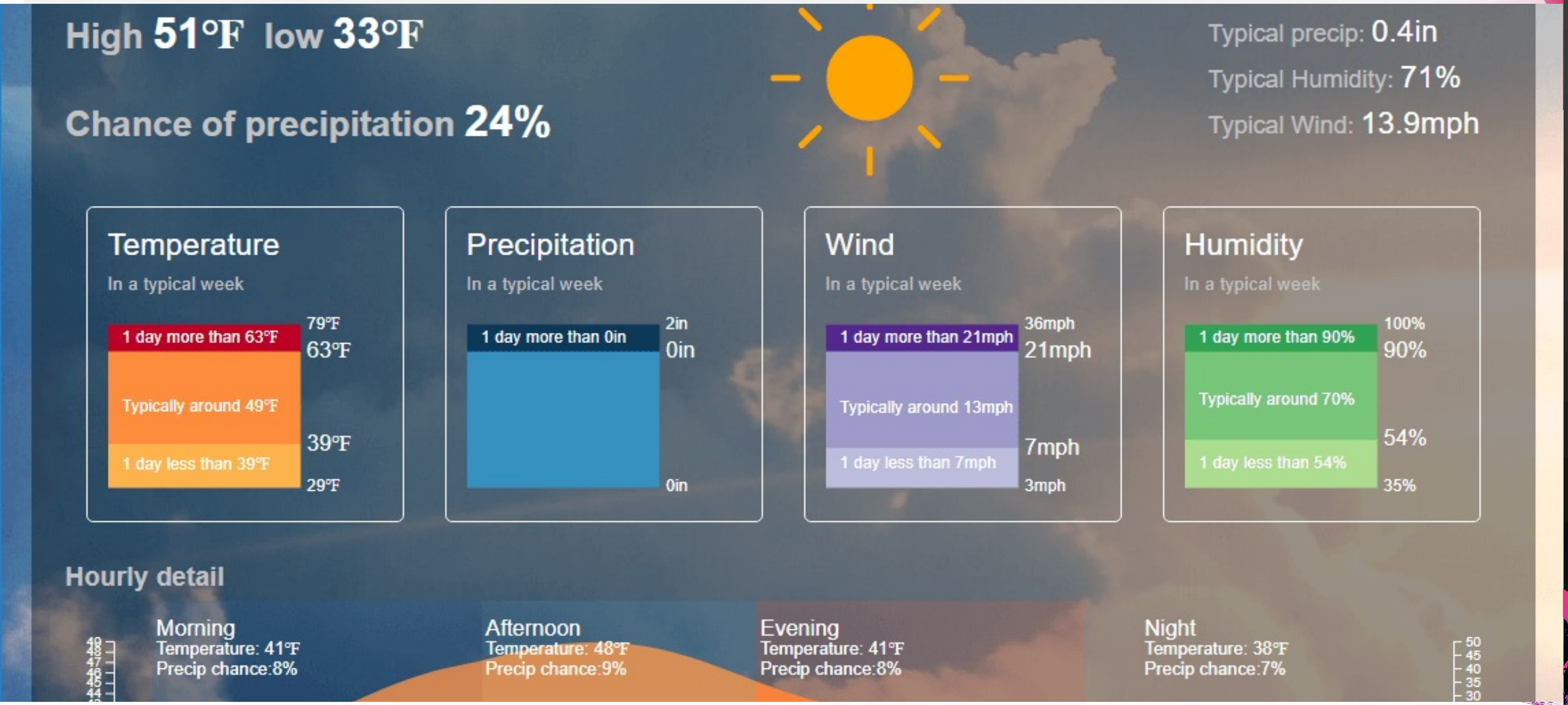
# WEATHER VS PREDICTION

1. The state of the atmosphere of a location/ place.
2. Use of science and technology

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# WEATHER FORECASTING MODELS

## SCIENTIFIC TECHNOLOGICAL MODELS (MACHINE LEARNING/DEEP LEARNING)

1. Artificial Neural Network Models
    1. Radial Basis Function Network (RBFN)
    2. Back Propagation Network (BPN)
    3. Multi-layer Perceptron Network (MLPN)
    4. Elmans Recurrent Neural Network (ERNN)
2. Support Vector Machines (SVM)
3. K Nearest Neighbout Model (KNN)
4. Genetics Algorithm (GA)
5. Generic Programming (GP)
6. Random Forest (RF)
7. Hybrid Models

## NUMERICAL WEATHER PREDICTION MODELS

1. Statistical models
2. Mathematical models
3. Satelite-based Models.

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# PROBLEMS IN WEATHER FORECASTING

1. Computational Complexity- Solution to Weather Differential Equations.
2. Level of accuracy of the weather prediction model.
3. Mapping of weather model with the problem of interest.
4. Chaotic/ Unpredictable nature of weather

# RESEARCH GAP VS OBJECTIVES

## RESEARCH GAP

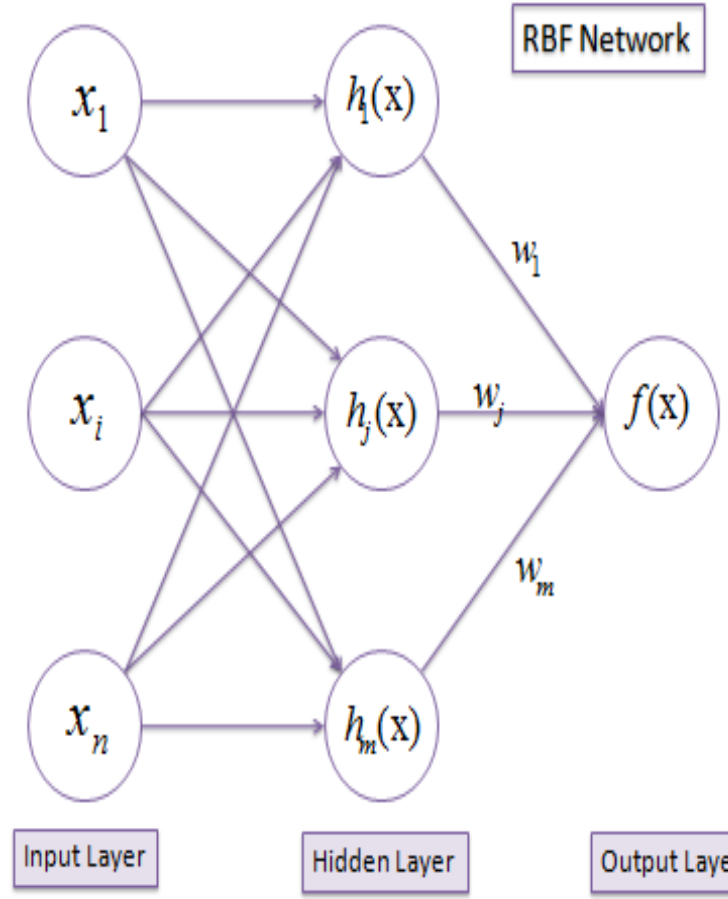
1. Only short-range (Mins to hours) weather forecasting model.
2. Single-Parametric Prediction Approach.
3. Few weather prediction research conducted in the African location.

## RESEARCH OBJECTIVES

1. Long-range (days, weeks, months) weather forecasting model.
2. Multi-Parametric Prediction Approach.
3. Case Study of Kenya-North Eastern, Marsabit

# RADIAL BASIS FUNCTION NEURAL NETWORK

It is a customized instance of a neural network that uses the radial basis fuction as the activation function for the weights of the input variables.




$$f(x) = \sum_{j=1}^{m} w_j h_j(x)$$

$$h(x) = \exp\left(-\frac{(x-c)^2}{r^2}\right)$$

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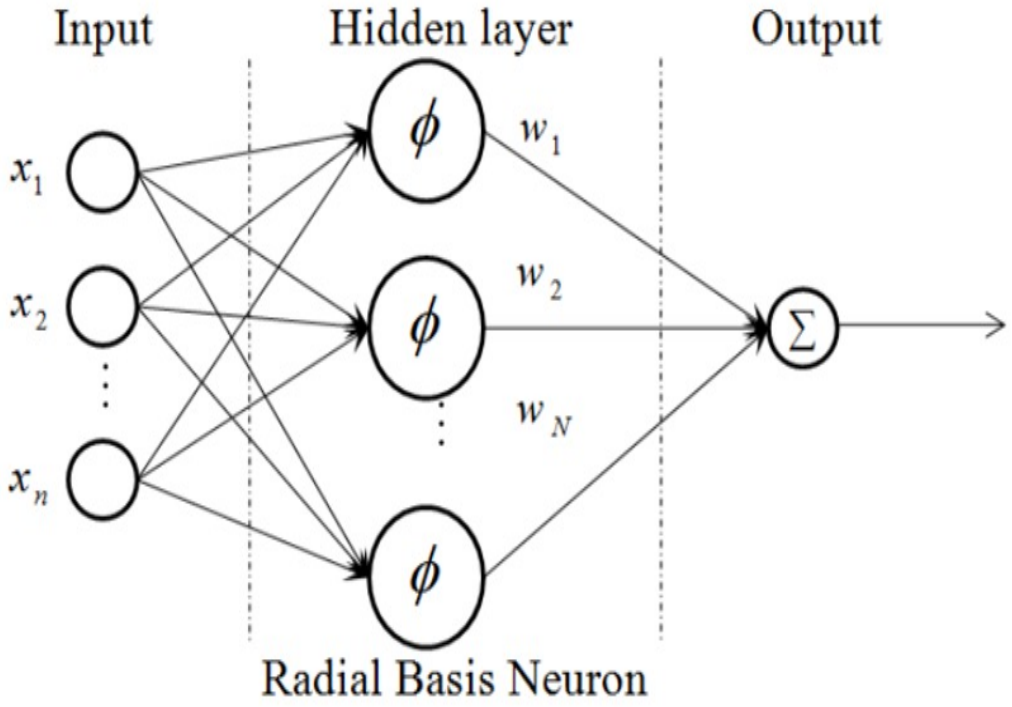
# RBFN FOR LONG-RANGE WEATHER PREDICTION

## INPUT VARIABLES

| X VARIABLE | SI UNIT |
|---|---|
| Temperature | (°C) |
| Humidity | $(\frac{gm}{m_3})$ |
| Windspeed | (m/s) |
| Sea Level | (p) |

## OUTPUT VARIABLE

| Y VARIABLE | SI UNIT |
|---|---|
| Rainfall | (mm) |



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# LOWER LEVEL IMPLEMENTATION

| LAYER TYPE | VARIABLE | UNITS |
|---|---|---|
| Input Layer | 1. Temperature<br>2. Humidity<br>3. Windspeed<br>4. Sea Level | 5 |
| Hidden Layer (RBF Neuron) | Gaussian function | 10 50 100 |
| Output Layer | Rainfall | 1 |

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# KENYA-NORTH EASTERN KENYA

The East African region, according to reports is one of the fastest-growing economies in Africa. Inside it, Kenya is ranked as the fastest-growing economy with an annual average growth of 5% between 2010 and 2018, with a Gross Domestic Product (GDP) of USD 95 Billion. Its economy is described as diverse and dynamic by USAID. Furthermore, it serves as an entry point for the larger East Africa. (USAID, RSM Consulting)

In Kenya's GDP, approximately 33% of this is agriculture, greatly affected by the level of accuracy of weather prediction.

The North Eastern, according to reports is adversely affected by the level of accuracy or lack thereof.

It comprises of

1. Marsabit,
2. Moandera
3. Wajir
4. Garissa



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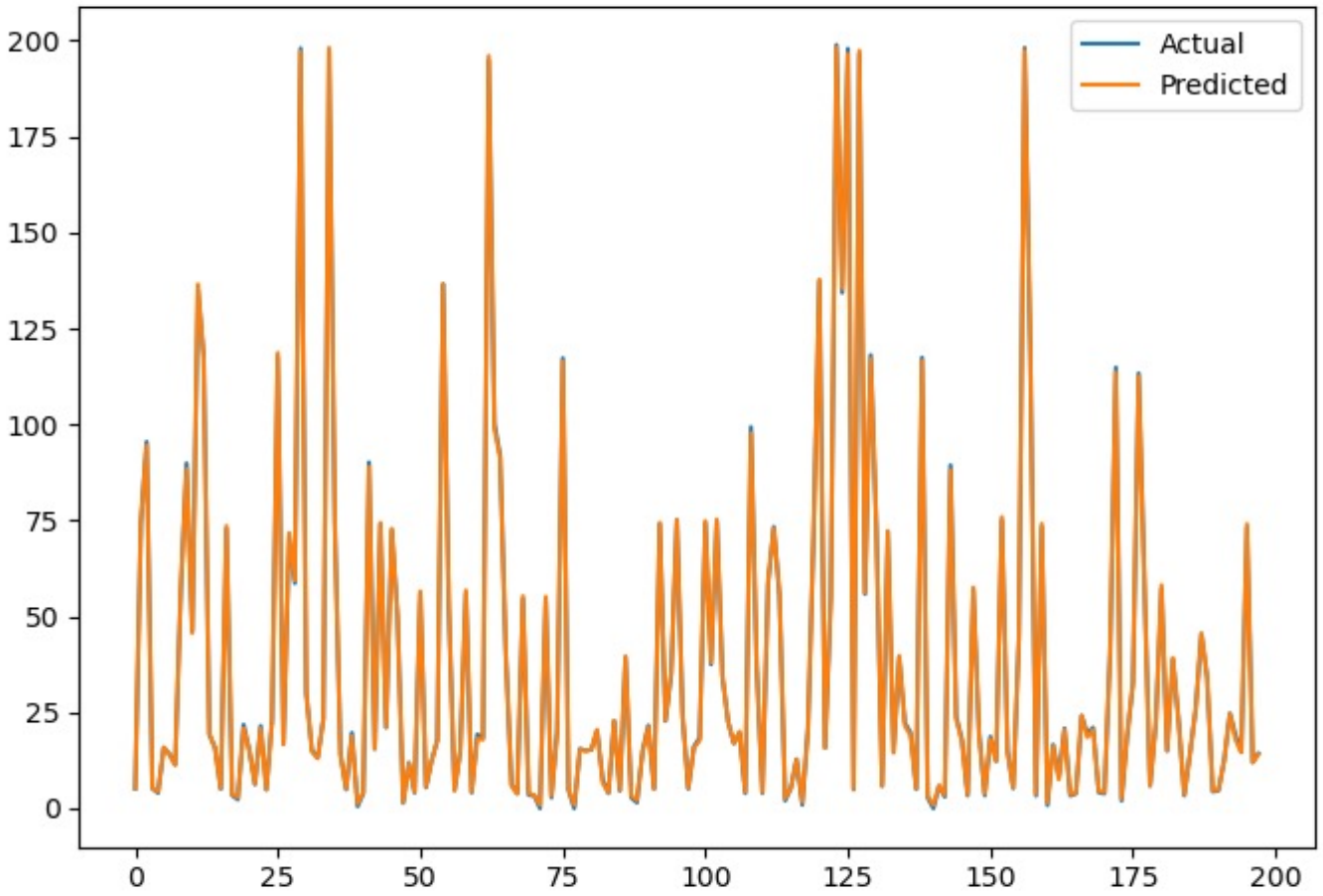
# ACTUAL VS PREDICTED RAINFALL



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   1.54429012  16.23958709   7.51822795  20.46770983   3.6
7629311
   4.05860247  24.12168461  18.52059798  20.46851853   4.5
1261846
   4.20427461  41.02084256 113.61758072   2.60985758  19.2
4907672
  32.63817096 112.58384853  59.83892559   5.95761141  21.6
6642214
  58.16556325  15.05825482  39.22810389  22.60661144   3.6
7531089
  14.2574695   25.69443018  45.56312207  34.52591655   4.6
490994
   4.83566672  12.42560317  24.60499879  17.87460922  14.5
5071871
                          2963  14.08530697]
Mean Squared Error: 0.3466960675048389
```

# RESULTS OF THE RBFN MODEL

## ACCURACY OF THE MODEL

The RBFN model accurately predicted the long-range weather for North Eastern with an accuracy of 99.7%- <MSE-034666960>.

The annual predictions have been plotted against the actual weather for 2013-2023.

The model has predicted the weather for North Eastern for 2024-2034 with an accuracy of 99.7%

## Application

These predictions can be used to understand the climate of this region and help in decision-making, planning, and disaster management purposes just to mention but a few.

These predcitions can further help the government to improve the economy of this region which will further positively impact Kenya's growing GDP.

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# Thank You

Ceasar Waweru Kabue

ceasarwaweru@gmail.com