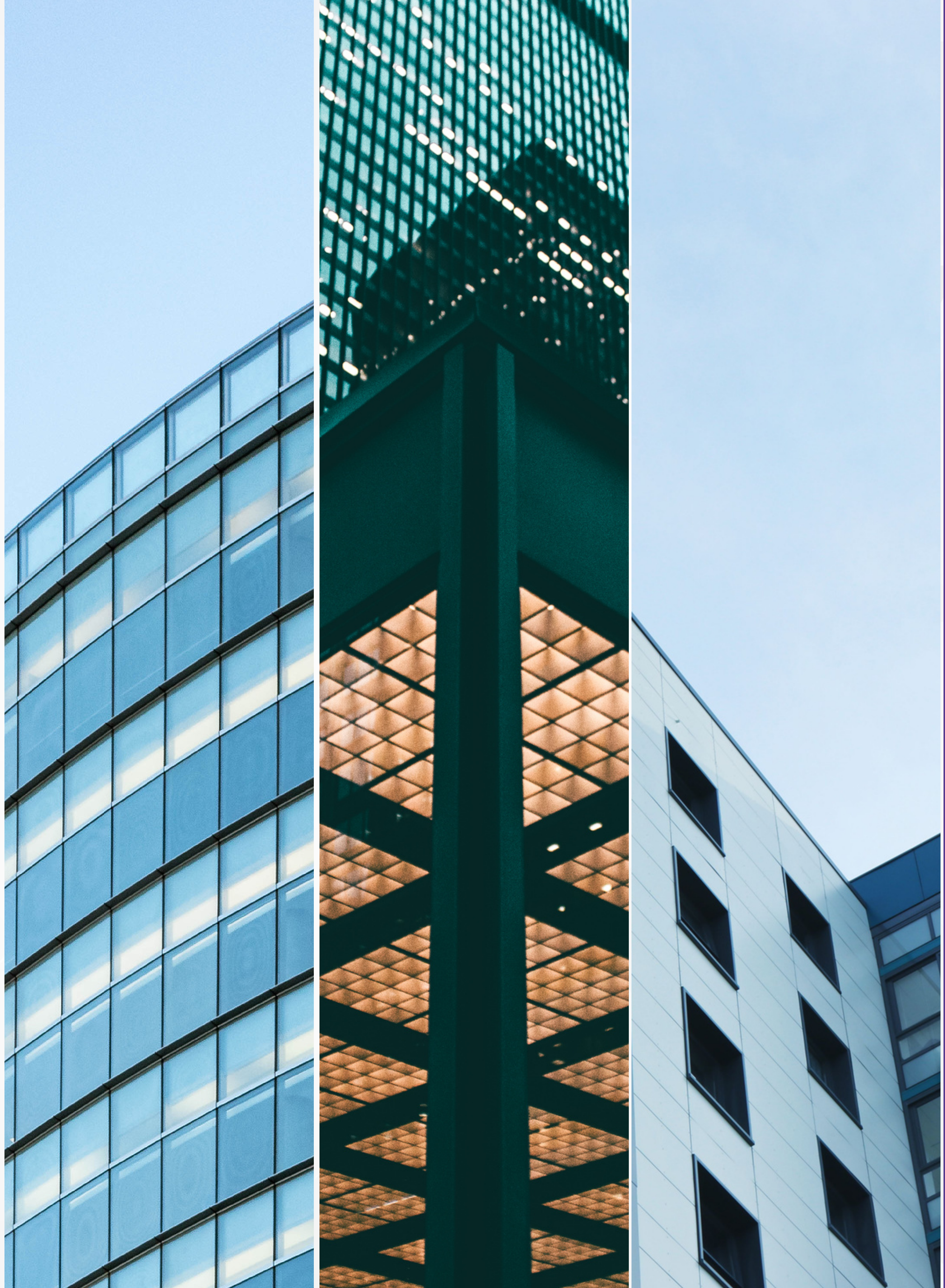
PREDICTION OF
ROCK PROPERTIES

Application of Machine Learning in
predicting Mechanical Properties of Rocks

ROCK PROPERTIES

- Density
- Porosity
- P-wave Velocity
- Point Load Strength Index
- Uniaxial Compressive Strength(UCS)
- Elasticity
- Brazilian Tensile Strength



DENSITY

- Density of the Rock= Mass/Volume

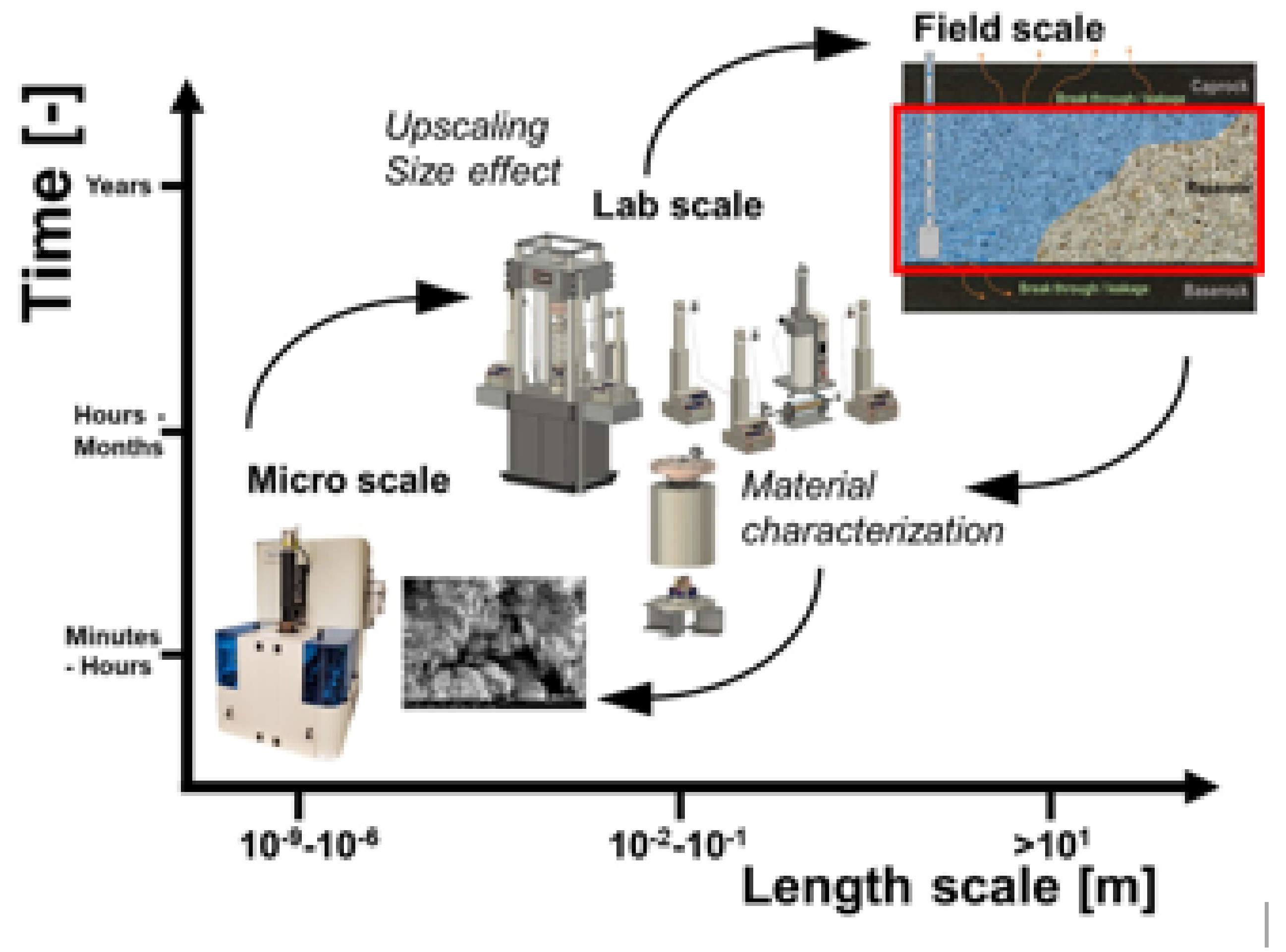
- How is it Calculated:

    - Measuring Mass:
      Requires a Balance Scale
    - Measuring Volume:
      Can be found by Submersion

POROSITY

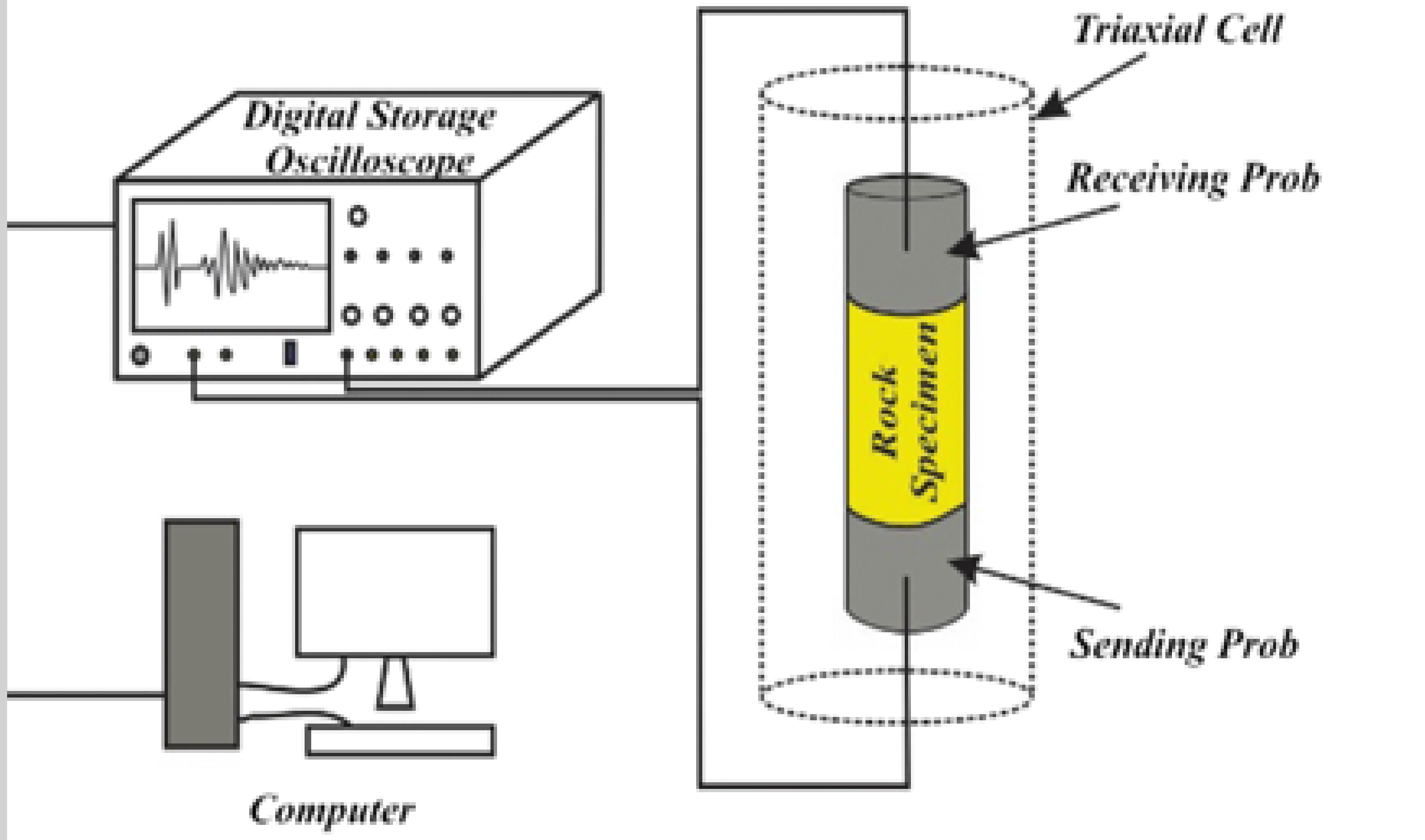
- Porosity is a measure of the open space or voids within a rock or soil
- porosity= (%)=(Volume of Voids/ Total Rock Volume)×100
- How is it Calculated:
  - Mercury Intrusion Porosimetry:

Mercury intrusion porosimetry is a laboratory technique used to measure the distribution of pore sizes in a rock sample. The method involves immersing the rock sample in mercury and applying pressure, which forces the mercury into the open pores. The intrusion volume at different pressure levels is then measured. By analyzing the relationship between pressure and intrusion volume, scientists can determine the size and distribution of pores, providing insights into the rock's porosity characteristics



P-WAVE VELOCITY

- It is the speed at which compressional or primary seismic waves travel through a material, such as rocks
- P-wave velocity (Vp=d/t)
- How is it Calculated: P-wave velocity in rock is determined by introducing P-waves into a rock sample using a seismic source, measuring the travel time with seismometers



POINT LOAD INDEX

- The Point Load Strength Index (PLSI) is a measure used in geotechnical and rock mechanics to assess the strength of rock or geological formations.
- P load=2P/d
- How is it Calculated:
  - The PLSI test involves applying a concentrated load to a rock specimen using a pointed tip. The load is applied parallel to the bedding plane or foliation of the rock. The test measures the point load strength, which is the force required to fracture the rock divided by the cross-sectional area of the rock specimen at the point of loading.

UCS

UNIAXIAL COMPRESSIVE STRENGTH

- It represents the maximum stress that a cylindrical or cubical rock sample can sustain under a uniaxial (vertical) compressive load without failing
- UCS = Maximum Axial Load/Cross-sectional Area of the Rock Specimen
- How is it Calculated:

  The UCS test involves preparing a cylindrical or cubical rock specimen with standardized dimensions. The specimen is then loaded axially in a hydraulic testing machine until failure occurs. The applied load and the dimensions of the specimen are used to calculate the UCS.

ELASTICITY

- Elasticity, specifically Young's Modulus (E), is a measure of the stiffness or rigidity of a rock. It indicates the rock's ability to deform under stress and return to its original shape once the stress is removed.
- E = stress applied to the rock/ resulting strain (deformation)
- How is it Calculated:

  , the stress is usually uniaxial compressive stress, and strain is the resulting axial strain.

BRAZILIAN TENSILE STRENGTH

- The Brazilian Test is valuable for estimating the tensile strength of rocks, which is an essential parameter in understanding the overall mechanical behavior of rocks
- T_b = 2p/pi D
- How is it Calculated:

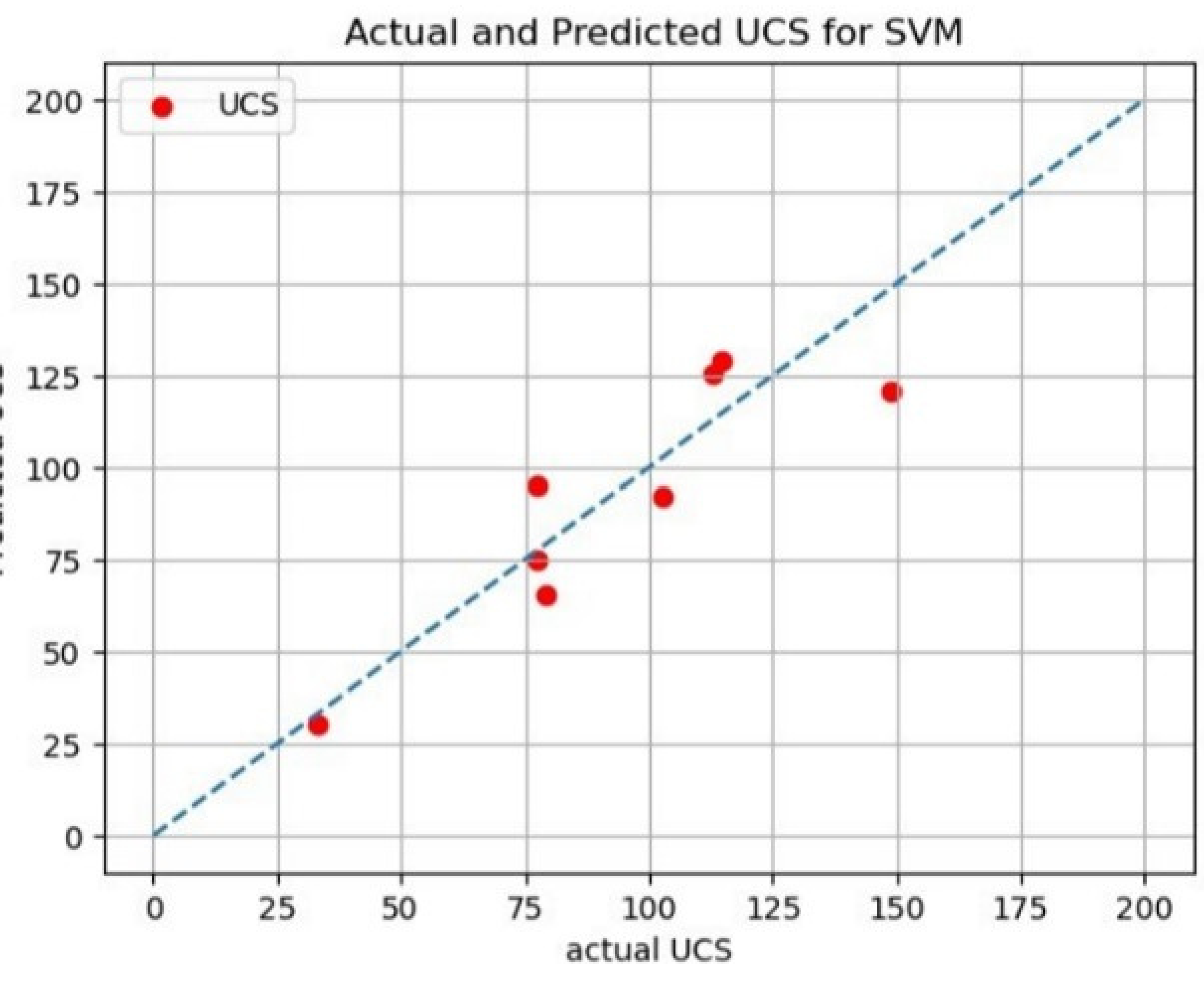
Brazilian Test, is a method used to determine the tensile strength of rocks. In this test, a cylindrical rock specimen is subjected to diametral loading, causing the rock to fail in tension along a diameter perpendicular to the loading direction.

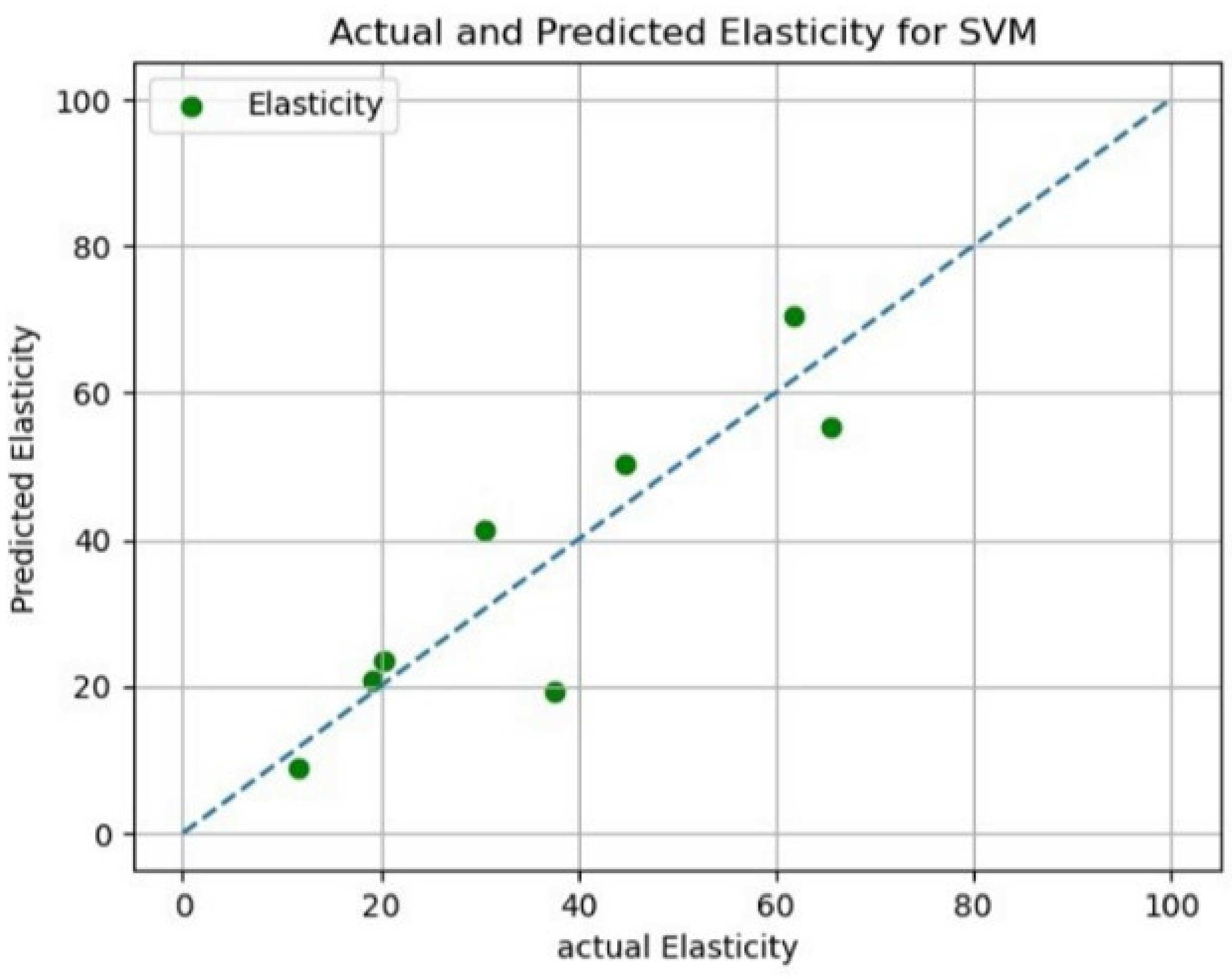
WHY MACHINE LEARNING

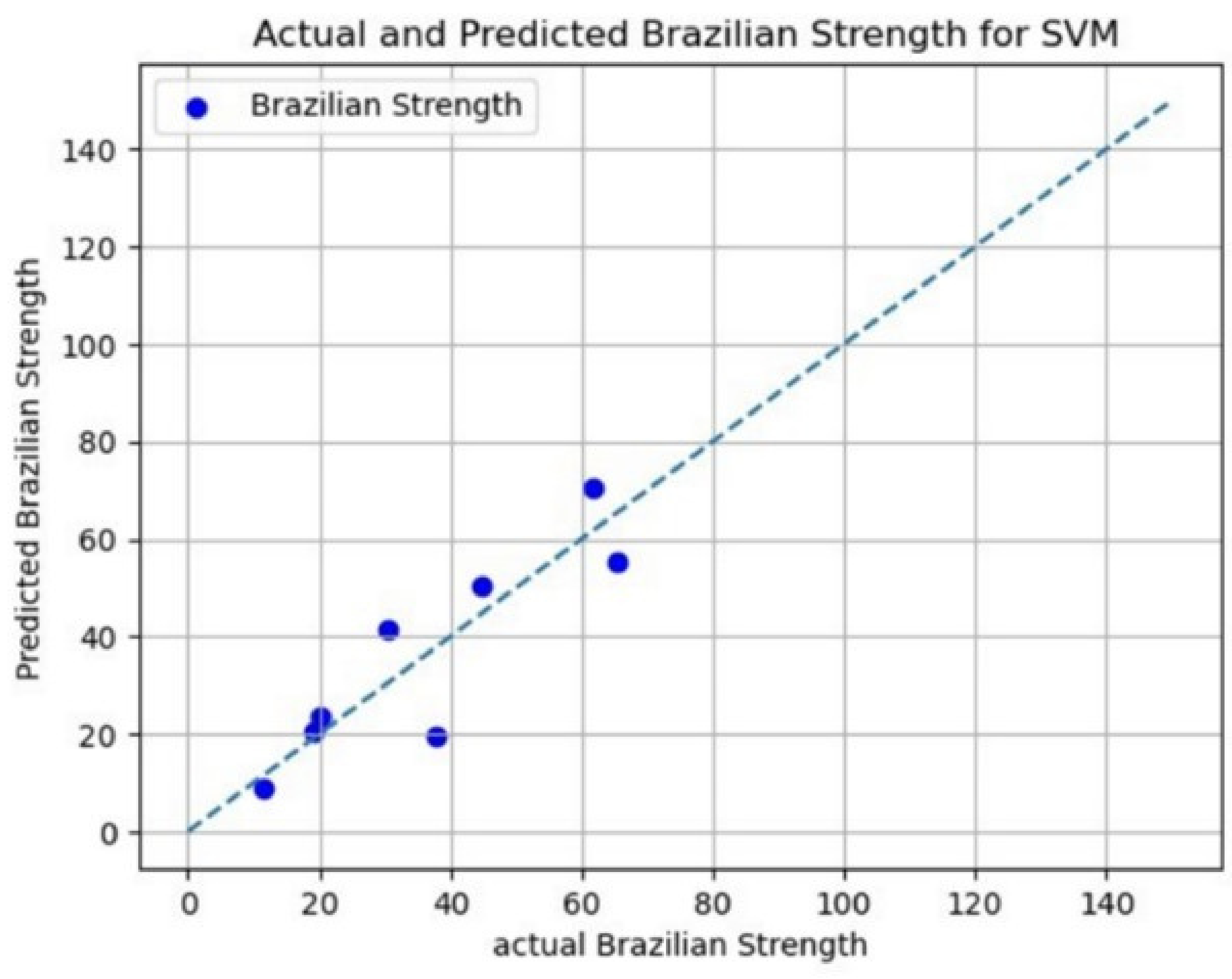
- Data-driven Predictions
- Multivariable Analysis
- Improved Accuracy
- Pattern Recognition
- Uncertainty Estimation
- Cost Reduction
- Real-time Monitoring
- Time effectiveness

- SVM
- BPNN
- RF
- Linear Regression
- KNN

RESULTS

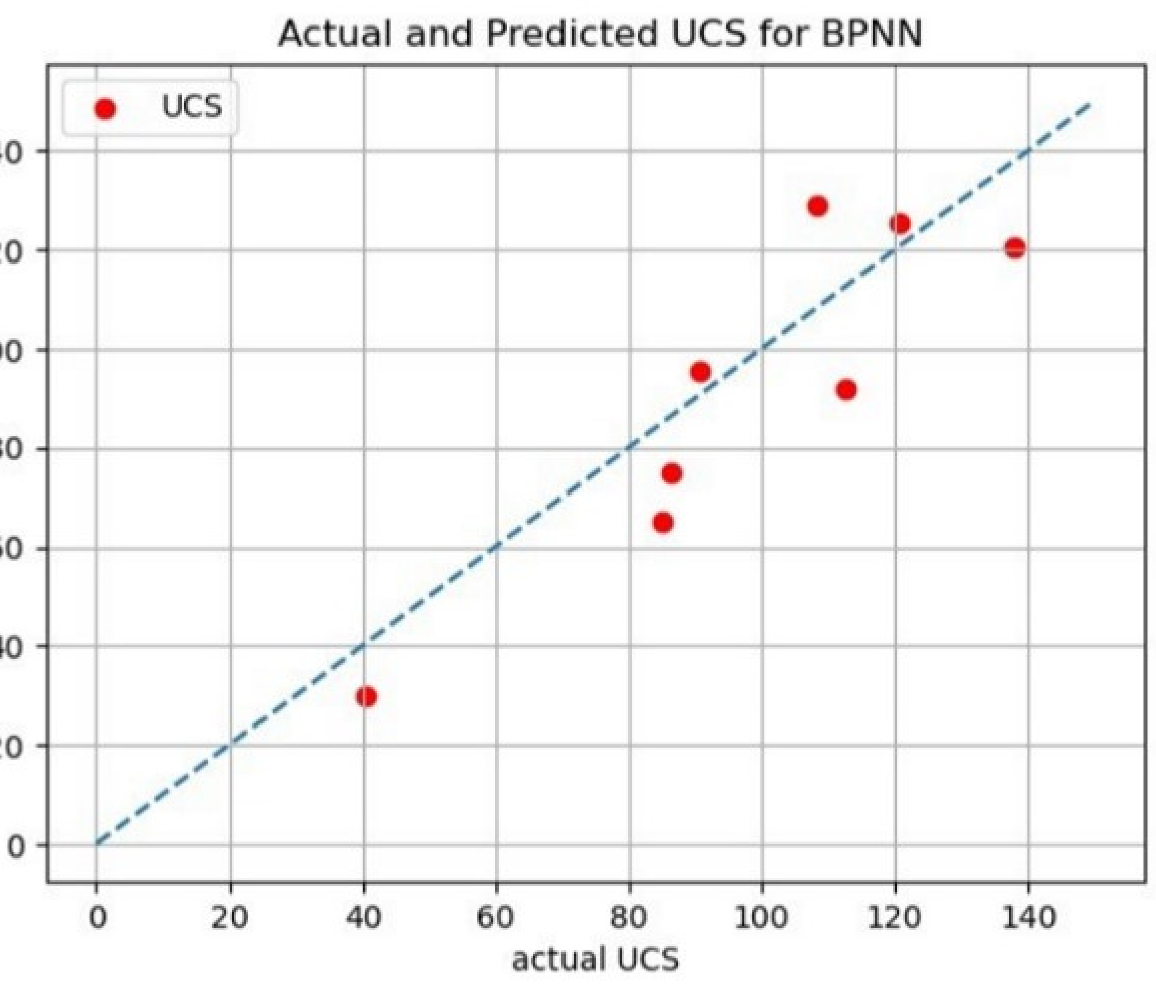

Actual and Predicted UCS for SVM
UCS
actual UCS

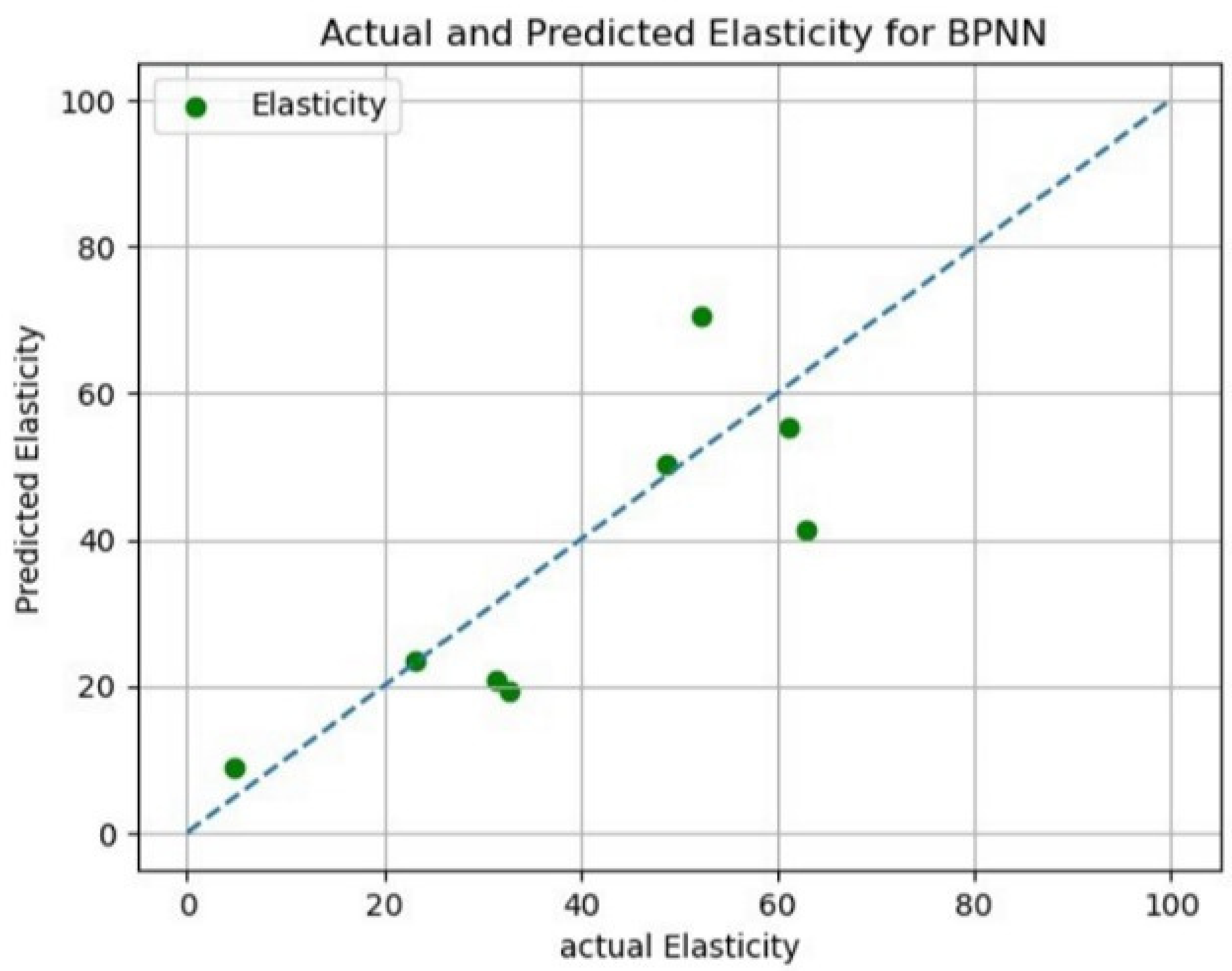

Actual and Predicted Elasticity for SVM
Elasticity
Predicted Elasticity
actual Elasticity

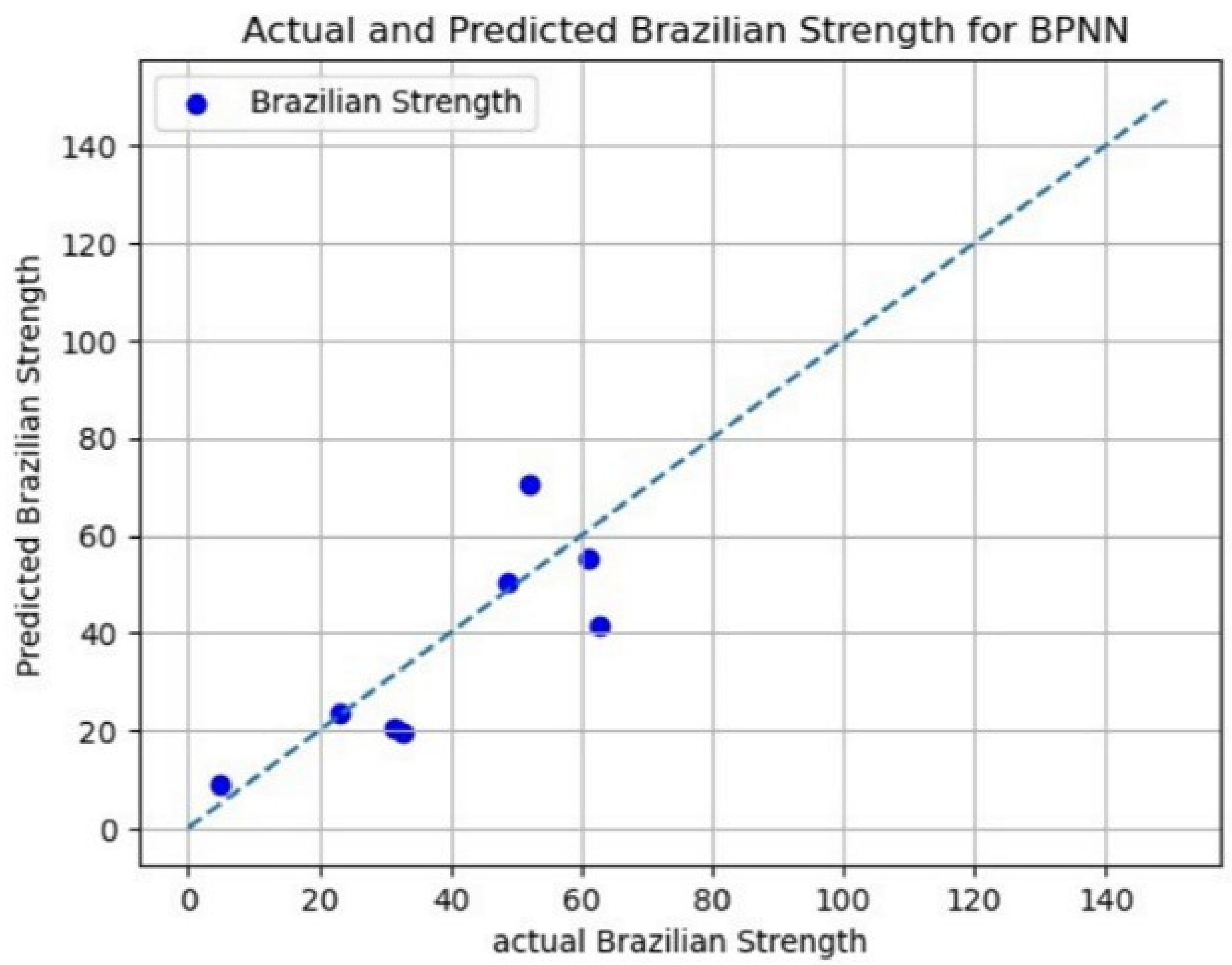

Actual and Predicted Brazilian Strength for SVM
Brazilian Strength
Predicted Brazilian Strength
actual Brazilian Strength

SVM

RESULTS

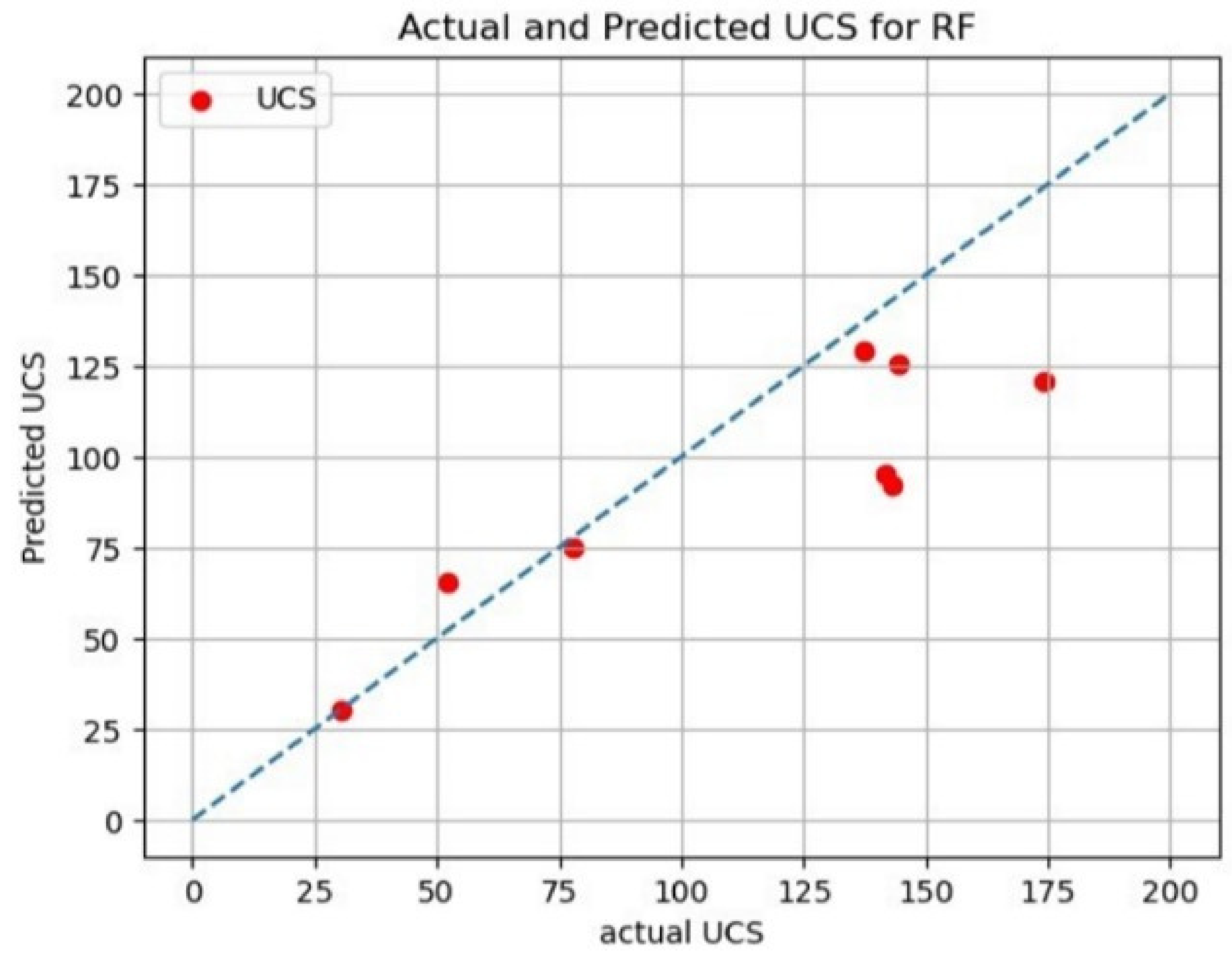


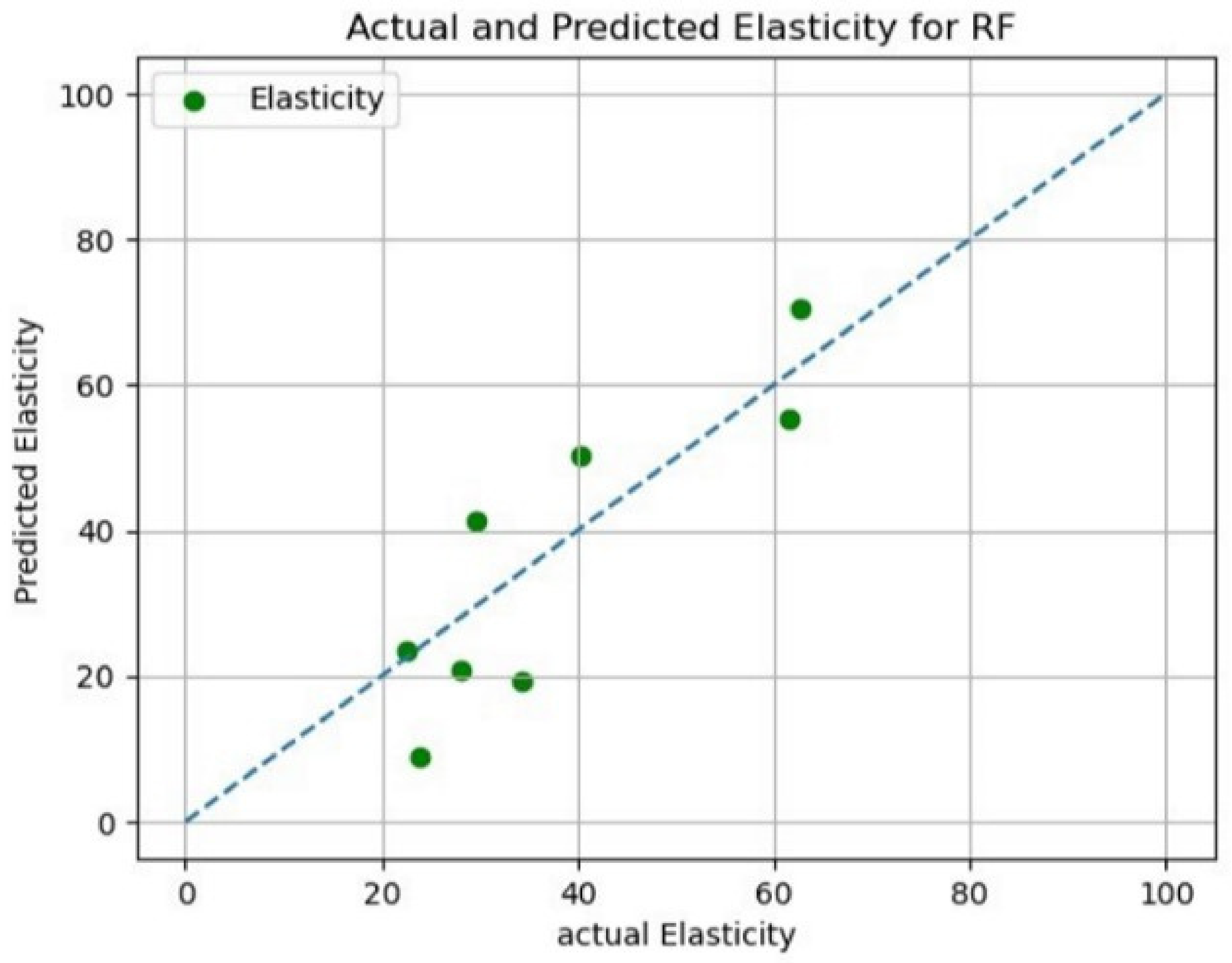


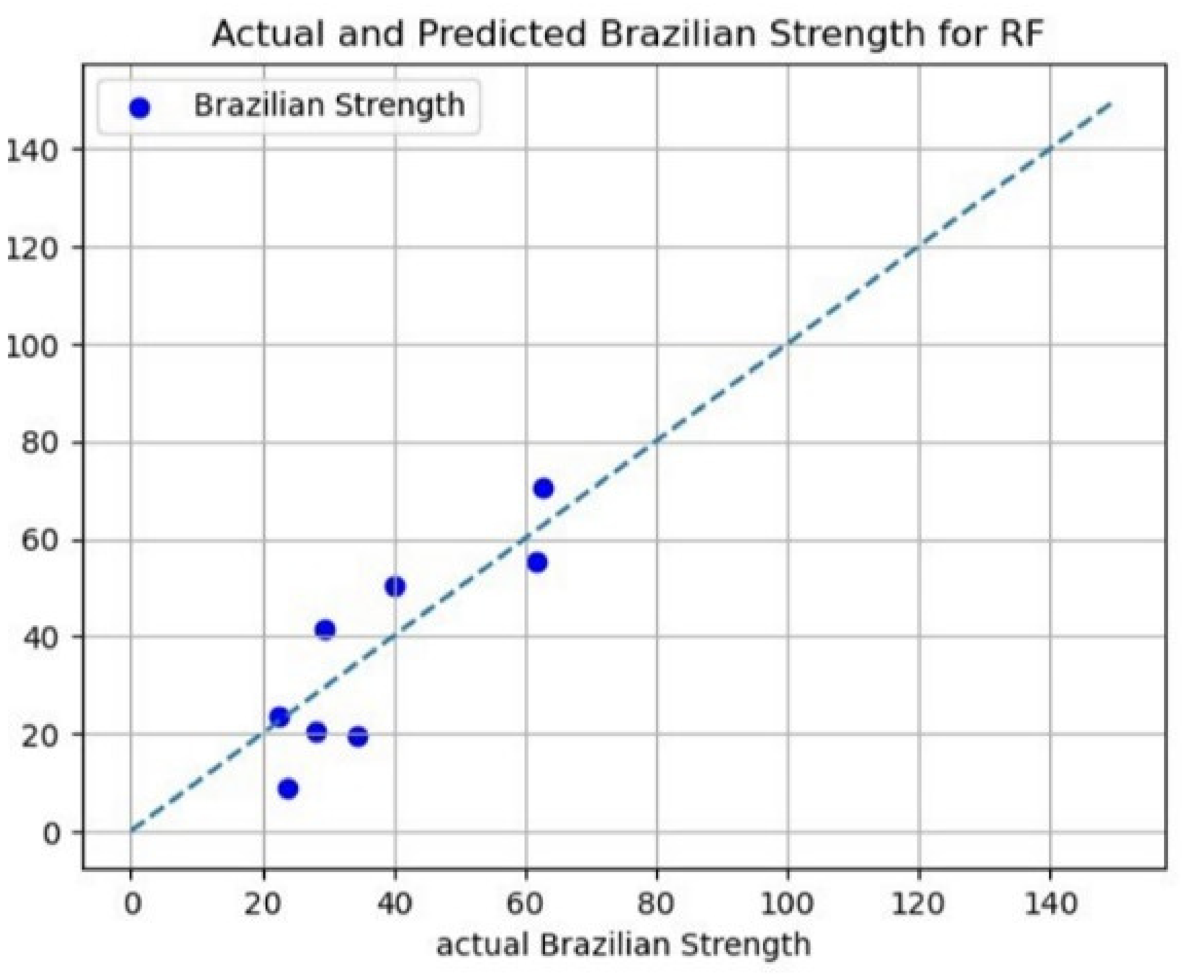


BPNN

RESULTS

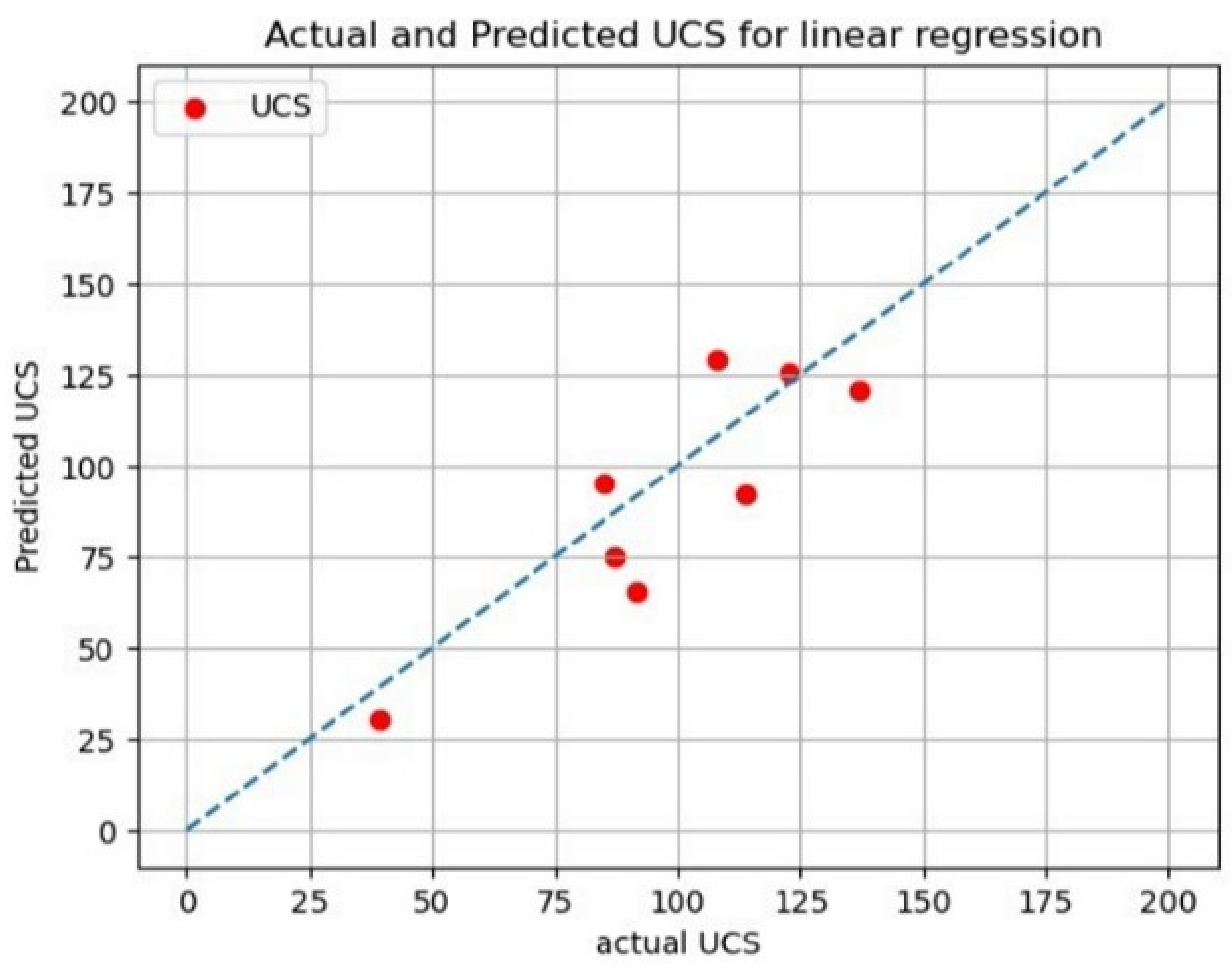


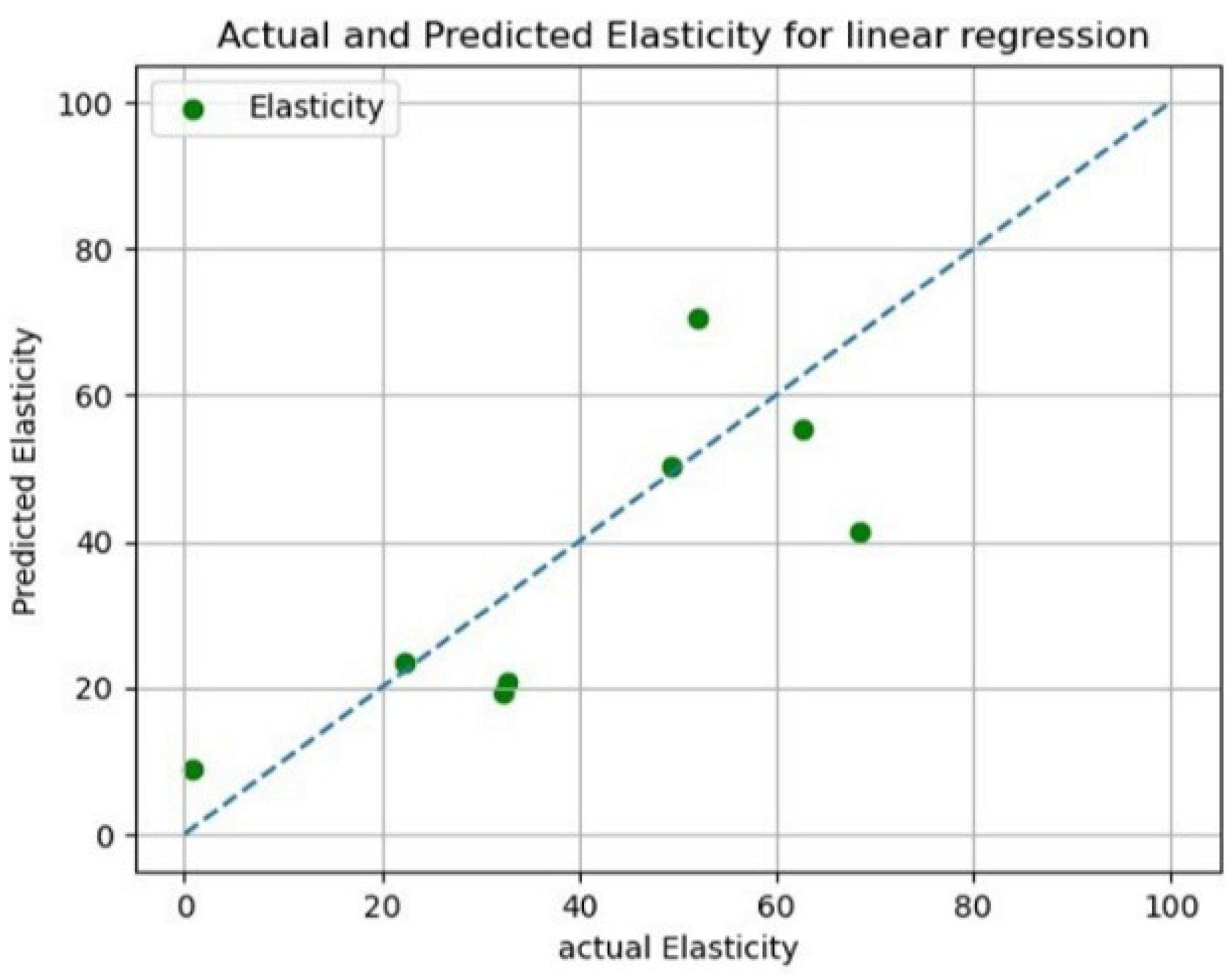


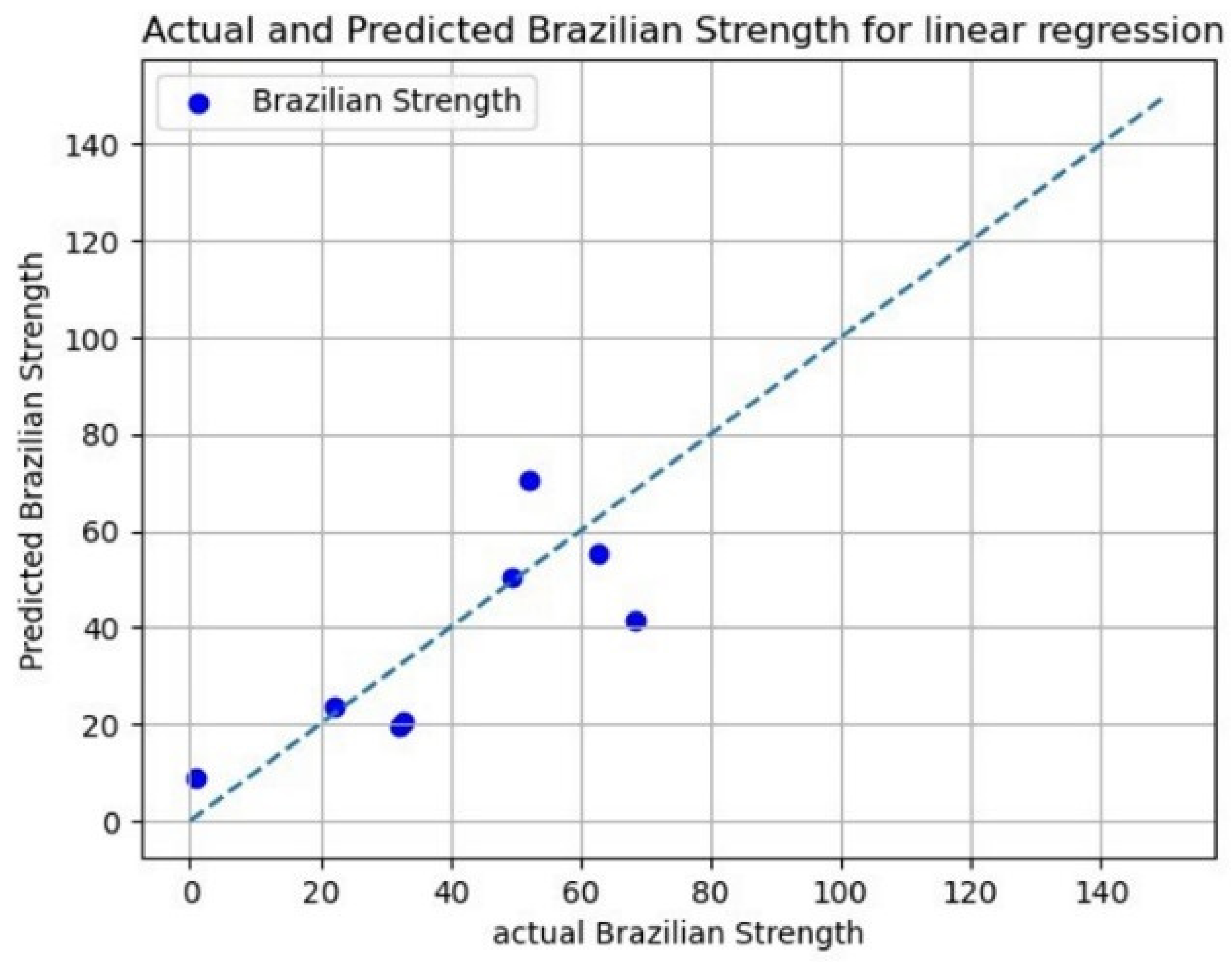


RF(RANDOM FORESTS)

RESULTS

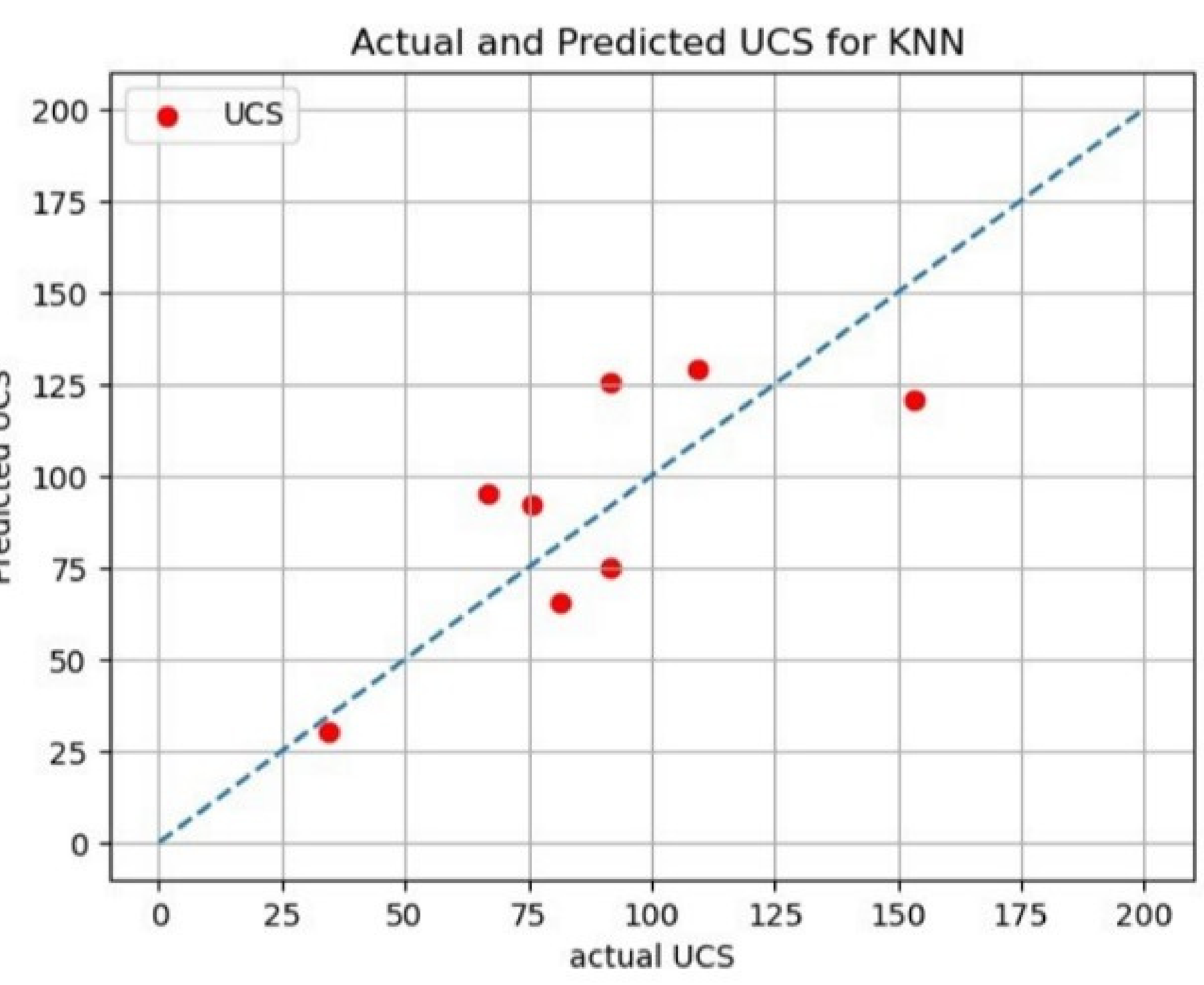


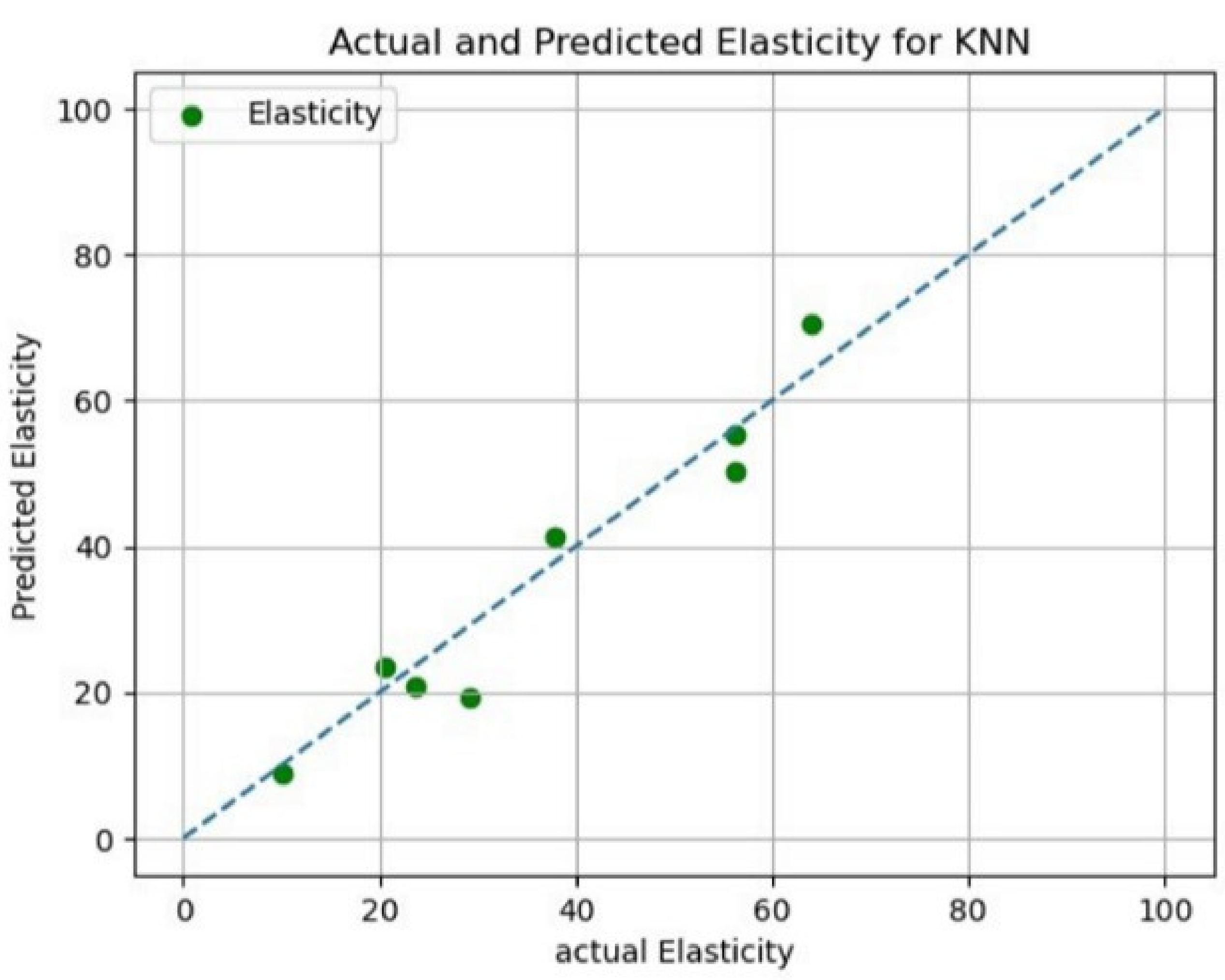


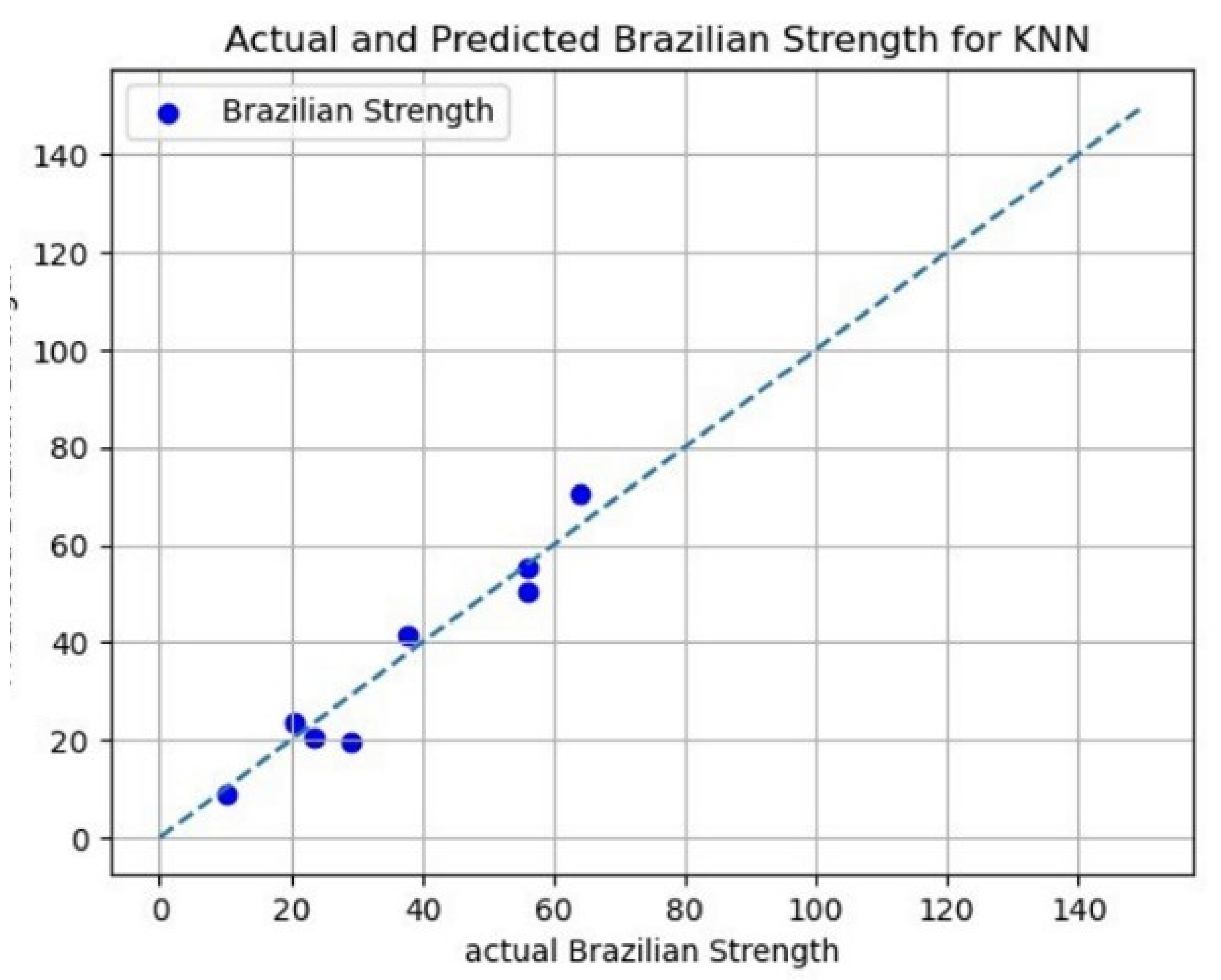


LINEAR REGRESSION

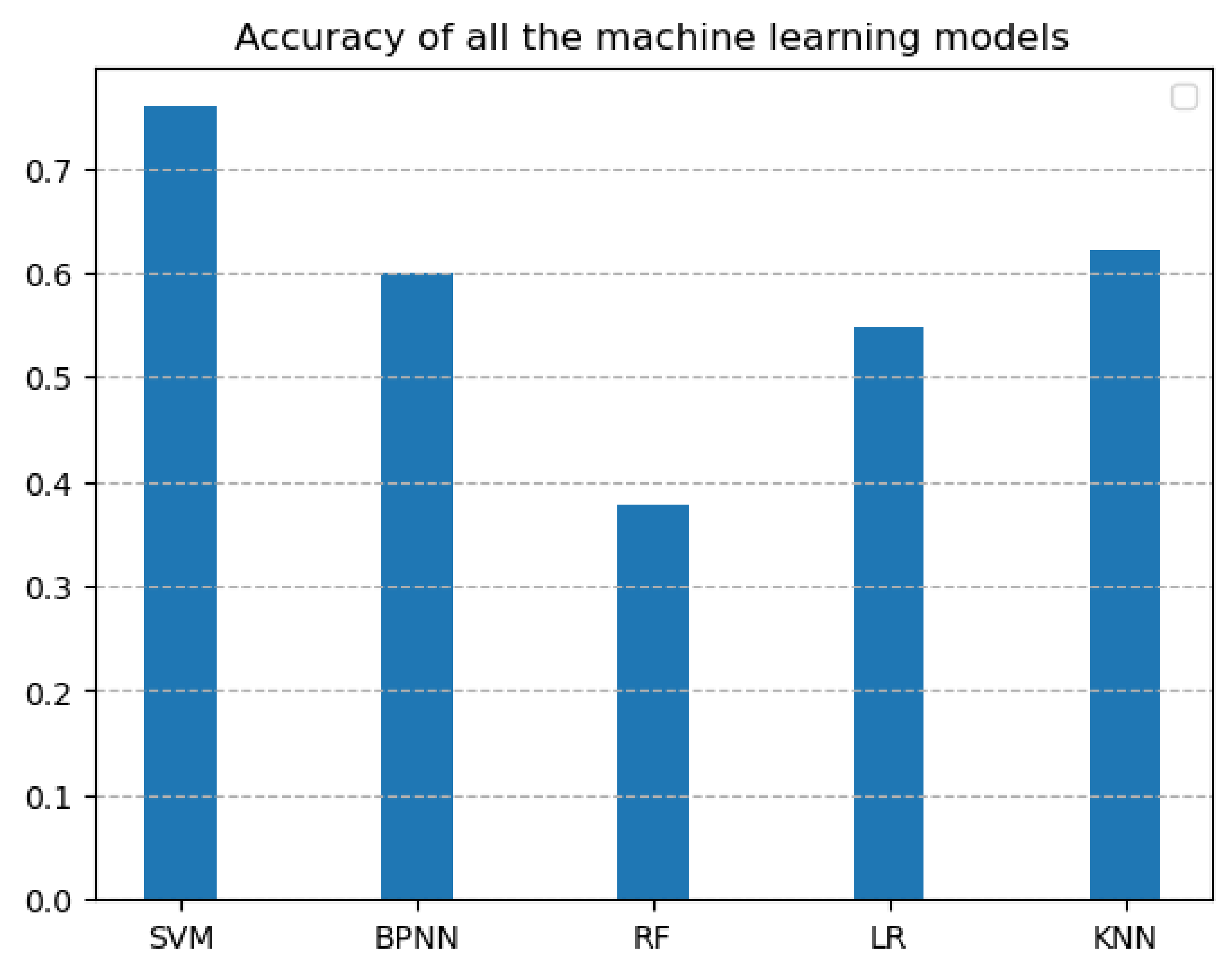
RESULTS


Actual and Predicted UCS for KNN
UCS
actual UCS


Actual and Predicted Elasticity for KNN
Elasticity
Predicted Elasticity
actual Elasticity


Actual and Predicted Brazilian Strength for KNN
Brazilian Strength
actual Brazilian Strength

KNN



OVERALL ACCURACY

Our results demonstrated that the SVM-based model shows a better performance than all the other models

THANK YOU

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