



## DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

**COURSE CODE: DJ19DSC501**

**DATE:**

**COURSE NAME: Machine Learning - II**

**CLASS: AY 2023-24**

Jhanvi Parekh

60009210033

D11

### **LAB EXPERIMENT NO.10**

#### **AIM :**

Build Explainable AI to improve human decision making using a two-choice classification experiment with real world data.

#### **THEORY:**

**Explainable artificial intelligence (XAI)** is a set of processes and methods that allows human users to comprehend and trust the results and output created by machine learning algorithms. Explainable AI is used to describe an AI model, its expected impact and potential biases. It helps characterize model accuracy, fairness, transparency and outcomes in AI-powered decision making. Explainable AI is crucial for an organization in building trust and confidence when putting AI models into production. AI explainability also helps an organization adopt a responsible approach to AI development.

As AI becomes more advanced, humans are challenged to comprehend and retrace how the algorithm came to a result. The whole calculation process is turned into what is commonly referred to as a “black box” that is impossible to interpret. These black box models are created directly from the data. And, not even the engineers or data scientists who create the algorithm can understand or explain what exactly is happening inside them or how the AI algorithm arrived at a specific result. There are many advantages to understanding how an AI-enabled system has led to a specific output. Explanability can help developers ensure that the system is working as expected, it might be



necessary to meet regulatory standards, or it might be important in allowing those affected by a decision to challenge or change that outcome.

### **Industry Need of XAI.**

It is crucial for an organization to have a full understanding of the AI decision-making processes with model monitoring and accountability of AI and not to trust them blindly. Explainable AI can help humans understand and explain machine learning (ML) algorithms, deep learning and neural networks.

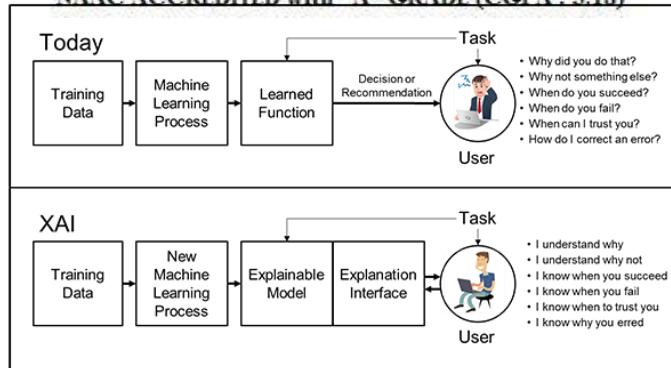
ML models are often thought of as black boxes that are impossible to interpret. Neural networks used in deep learning are some of the hardest for a human to understand. Bias, often based on race, gender, age or location, has been a long-standing risk in training AI models. Further, AI model performance can drift or degrade because production data differs from training data. This makes it crucial for a business to continuously monitor and manage models to promote AI explainability while measuring the business impact of using such algorithms. Explainable AI also helps promote end user trust, model auditability and productive use of AI. It also mitigates compliance, legal, security and reputational risks of production AI.

Explainable AI is one of the key requirements for implementing responsible AI, a methodology for the large-scale implementation of AI methods in real organizations with fairness, model explainability and accountability. To help adopt AI responsibly, organizations need to embed ethical principles into AI applications and processes by building AI systems based on trust and transparency.

With explainable AI, a business can troubleshoot and improve model performance while helping stakeholders understand the behaviors of AI models. Investigating model behaviors through tracking model insights on deployment status, fairness, quality and drift is essential to scaling AI. Continuous model evaluation empowers a business to compare model predictions, quantify model risk and optimize model performance. Displaying positive and negative values in model behaviors with data used to generate explanation speeds model evaluations. A data and AI platform can generate feature attributions for model predictions and empower teams to visually investigate model behavior with interactive charts and exportable documents.



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### Tasks to be performed:

1. Take any appropriate dataset [Breast\_Cancer Dataset]
1. Perform any 3 XAI methods on this dataset [SHAP, LIME, SHAPASH]
2. Describe the model and its results [summaries, visualizations, numerical descriptions].
3. At the end of each implementation, explain how the use of that particular XAI technique helped in making the model more explainable.

### LINK:

<https://colab.research.google.com/drive/1Vu9Ecik4F8OJVSc2SIx4g6kMFGGvPKFn?usp=sharing>



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Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-packages (from lime) (3.7.1)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from lime) (1.23.5)
Requirement already satisfied: scipy in /usr/local/lib/python3.10/dist-packages (from lime) (1.11.4)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages (from lime) (4.66.1)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.10/dist-packages (from lime) (1.2.2)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.10/dist-packages (from lime) (0.19.3)
Requirement already satisfied: networkx>=2.2 in /usr/local/lib/python3.10/dist-packages (from lime) (3.2.1)
Requirement already satisfied: pillow!=7.1.0,!=7.1.1,!=8.3.0,>=6.1.0 in /usr/local/lib/python3.10/dist-packages (from scikit-image>=0.12->lime) (9.4.0)
Requirement already satisfied: imageio>=2.4.1 in /usr/local/lib/python3.10/dist-packages (from scikit-image>=0.12->lime) (2.31.6)
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Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.7->matplotlib>lime) (1.16.0)

[19] pip install shap
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Requirement already satisfied: numba in /usr/local/lib/python3.10/dist-packages (from shap) (0.58.1)
Requirement already satisfied: cloudpickle in /usr/local/lib/python3.10/dist-packages (from shap) (2.2.1)
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Requirement already satisfied: python-dateutil>=2.8.1 in /usr/local/lib/python3.10/dist-packages (from pandas>shap) (2.8.2)
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Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.8.1->pandas>shap) (1.16.0)

[20] import pandas as pd
      from sklearn.model_selection import train_test_split
      from sklearn.datasets import load_breast_cancer
      import xgboost as xgb
      from sklearn.metrics import accuracy_score
      import shap

# Read the DataFrame, first using the feature data
  
```

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Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.8.1->pandas>shap) (1.16.0)
```

[x] import pandas as pd
from sklearn.model\_selection import train\_test\_split
from sklearn.datasets import load\_breast\_cancer
import xgboost as xgb
from sklearn.metrics import accuracy\_score
import shap

# read the DataFrame, first using the feature data
data = load\_breast\_cancer()

df = pd.DataFrame(data.data, columns=data.feature\_names)

# Add a target column, and fill it with the target data
df['target'] = data.target

# Set up the data for modelling
y=df['target'].to\_frame() # define Y
X=df[df.columns.difference(['target'])] # define X

X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.20, random\_state=42) # create train and test

# build model - Xgboost
xgb\_mod=xgb.XGBClassifier(random\_state=42,gpu\_id=0) # build classifier Gradient Boosted decision trees

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```
[20] df['target'] = data.target
# Set up the data for modelling
y=df['target'].to_frame() # define Y
X=df[df.columns.difference(['target'])] # define X

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.20, random_state=42) # create train and test

# build model - Xgboost
xgb_mod=xgb.XGBClassifier(random_state=42,gpu_id=0) # build classifier Gradient Boosted decision trees
xgb_mod=xgb_mod.fit(X_train,y_train.values.ravel())
# make prediction and check model accuracy
y_pred = xgb_mod.predict(X_test)
# Performance
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy: %.2f%%" % (accuracy * 100.0))

[19:10:40] WARNING: /workspace/src/context.cc:44: No visible GPU is found, setting device to CPU.
Accuracy: 95.61%
```

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#LIME
[x] # Utilizing our same xgb_mod model object created above
# Import packages
import lime
import lime.lime_tabular
import numpy as np
import xgboost

##### create explainer #####
# we use the dataframes splits created above for SHAP

explainer = lime.lime_tabular.LimeTabularExplainer(X_test.to_numpy(), feature_names=X_test.columns, class_names=['0', '1'], verbose=True)

##### visualizations #####
exp = explainer.explain_instance(X_test.iloc[0], xgb_mod.predict_proba, num_features=20)
exp.show_in_notebook(show_table=True)

Intercept 0.5664052535227609
Prediction_local [0.73658007]
Right: 0.9952324
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Intercept 0.5664052535227609
Prediction_local [0.73658007]
Right: 0.9952324
Prediction probabilities
0 1
0.00 1.00
0.23 < worst concavity...
0.03 < mean concave p...
14.95 < worst radius...
0.28 < worst symmetry...
0.07 < worst concave p...
0.03 < mean concave p...
16.22 < mean texture...
18.62 < mean area...
31.25 < worst texture...
64.01 < worst perim...
Feature Value
worst area 677.90
worst concavity 0.27
worst concave points 0.10
mean concave points 0.04
mean texture 18.60
worst radius 14.97
mean area 481.90
worst texture 24.64
worst perimeter 96.05
worst symmetry 0.30
23s [22]
#SHAP
# Generate the tree explainer and SHAP values
explainer = shap.TreeExplainer(xgb_mod) # fast and exact method to estimate SHAP values for tree models and ensembles of trees,
shap_values = explainer.shap_values(X)
expected_value = explainer.expected_value
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**#SHAP**

```

# Generate the Tree explainer and SHAP values
explainer = shap.TreeExplainer(xgb_mod) #fast and exact method to estimate SHAP values for tree models and ensembles of trees,
shap_values = explainer.shap_values(X)

expected_value = explainer.expected_value

##### visualizations #####
# Generate summary dot plot
shap.summary_plot(shap_values, X, title="SHAP summary plot")

# Generate summary bar plot
shap.summary_plot(shap_values, X, plot_type="bar")

# Generate waterfall plot
shap.plots.waterfall.waterfall_legacy(expected_value, shap_values[79], features=X.loc[79,:], feature_names=X.columns, max_display=15, show=True)

# Generate dependence plot
shap.dependence_plot("worst concave points", shap_values, X, interaction_index="mean concave points")

# Generate multiple dependence plots
for name in X_train.columns:
    shap.dependence_plot(name, shap_values, X)
    shap.dependence_plot("worst concave points", shap_values, X, interaction_index="mean concave points")
    shap.force_plot(explainer.expected_value, shap_values[:100,:], X.iloc[:100,:])
    shap.force_plot(explainer.expected_value, shap_values[0,:], X.iloc[0,:])
    shap.decision_plot(expected_value, shap_values[79], link='logit', features=X.loc[79,:], feature_names=(X.columns.tolist()), show=True, title="Decision Plot")

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**# Generate waterfall plot**

```

shap.plots.waterfall.waterfall_legacy(expected_value, shap_values[79], features=X.loc[79,:], feature_names=X.columns, max_display=15, show=True)

# Generate dependence plot
shap.dependence_plot("worst concave points", shap_values, X, interaction_index="mean concave points")

# Generate multiple dependence plots
for name in X_train.columns:
    shap.dependence_plot(name, shap_values, X)
    shap.dependence_plot("worst concave points", shap_values, X, interaction_index="mean concave points")
    shap.force_plot(explainer.expected_value, shap_values[:100,:], X.iloc[:100,:])
    shap.force_plot(explainer.expected_value, shap_values[0,:], X.iloc[0,:])
    shap.decision_plot(expected_value, shap_values[79], link='logit', features=X.loc[79,:], feature_names=(X.columns.tolist()), show=True, title="Decision Plot")

```

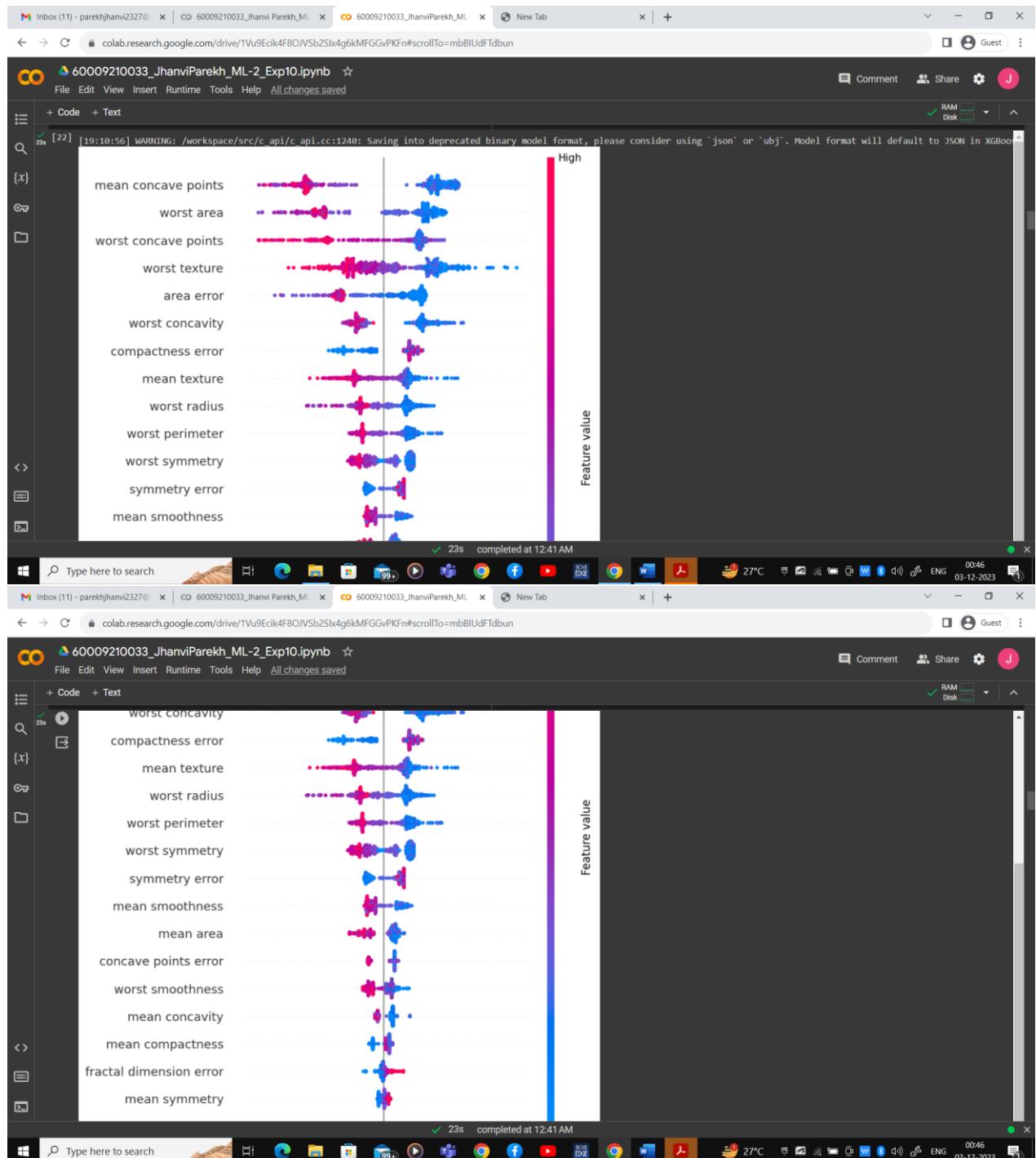
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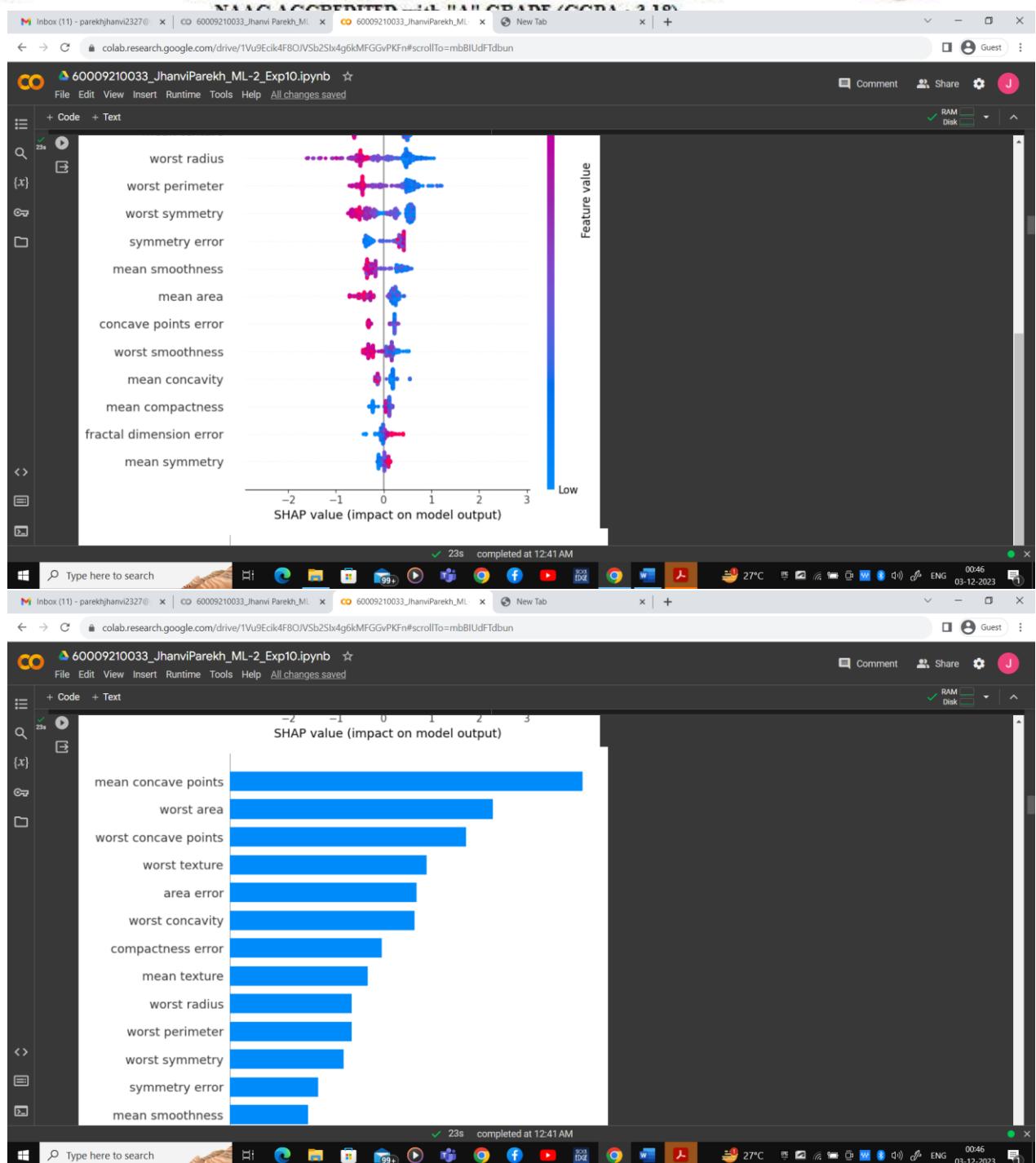


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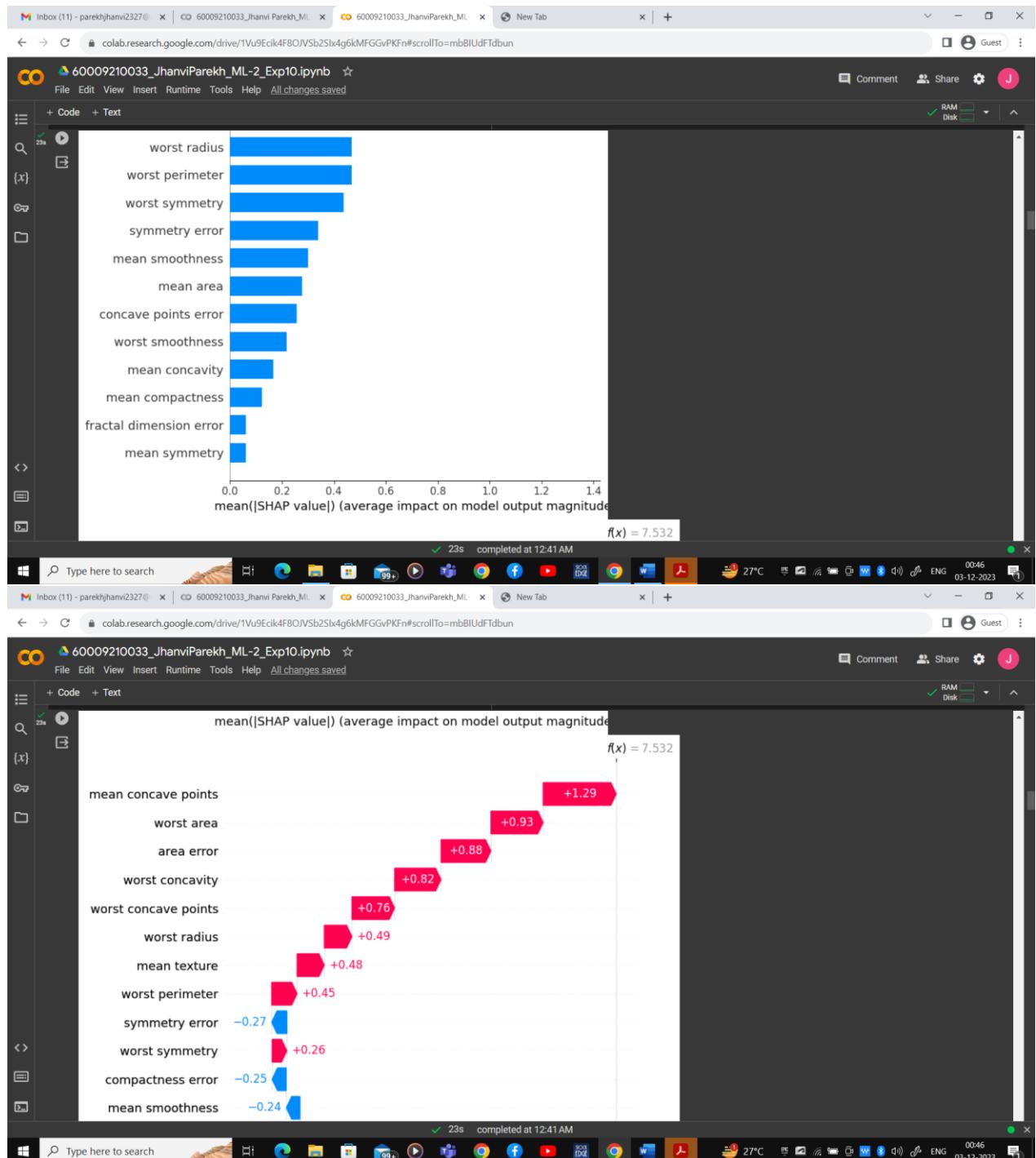


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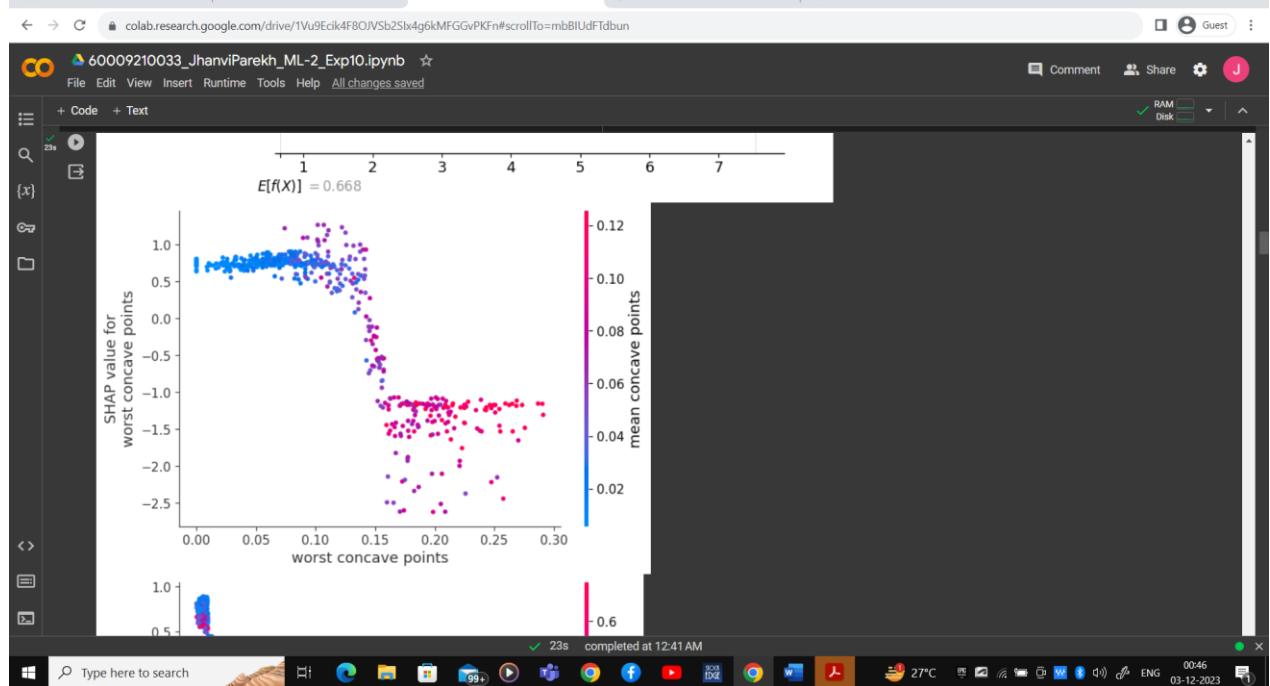
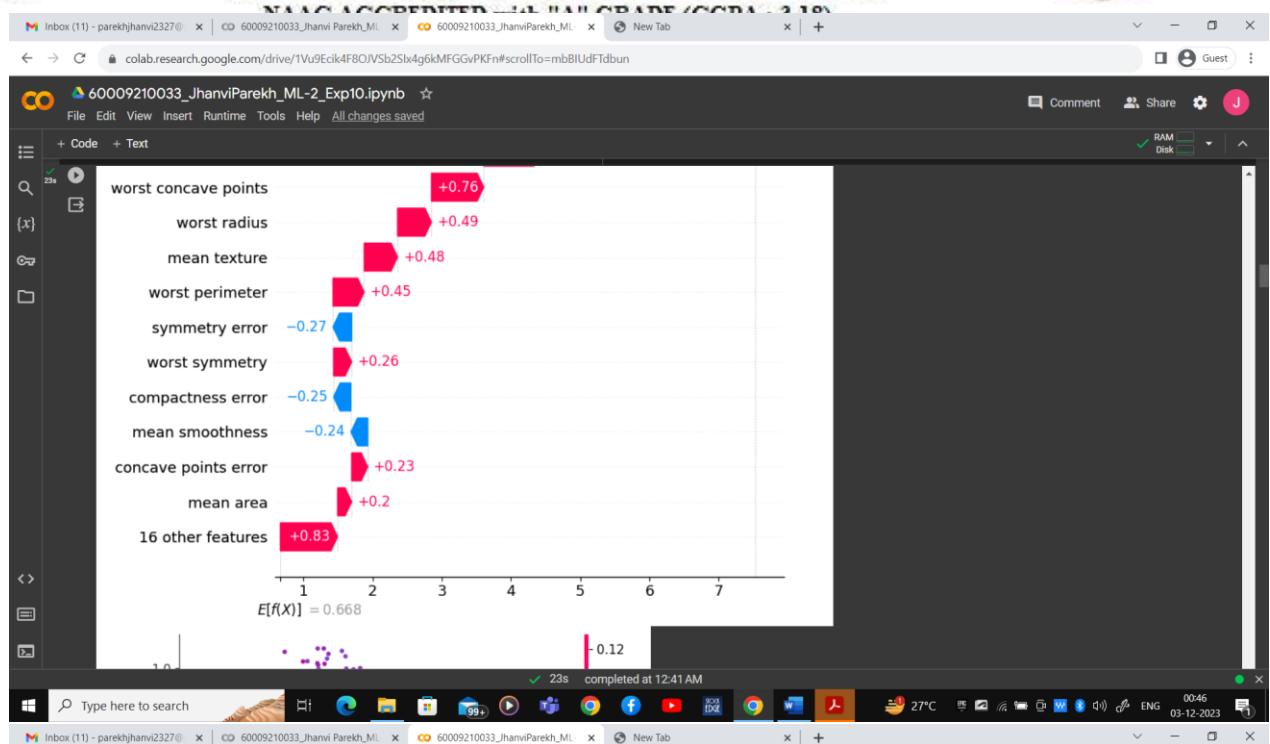


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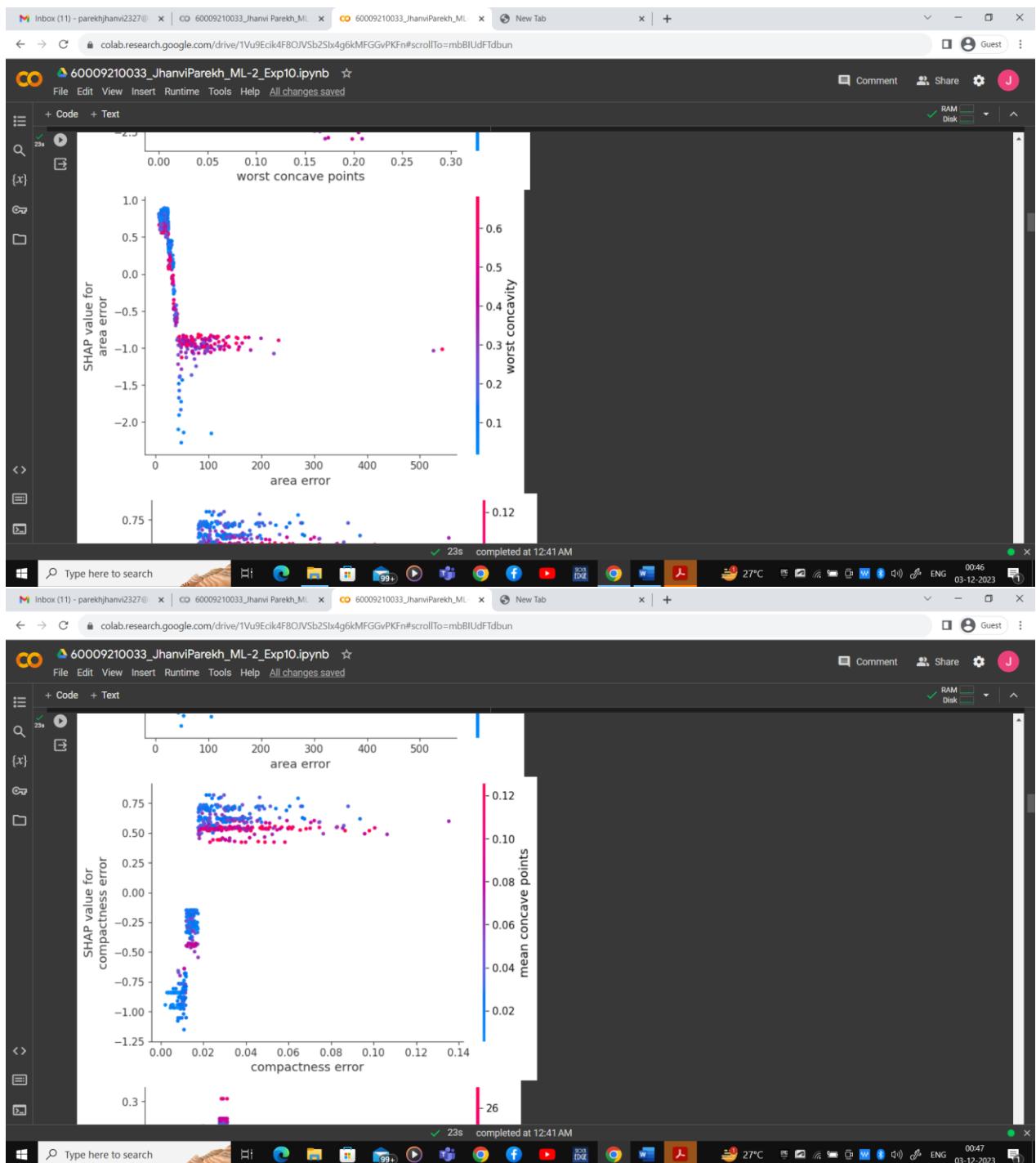


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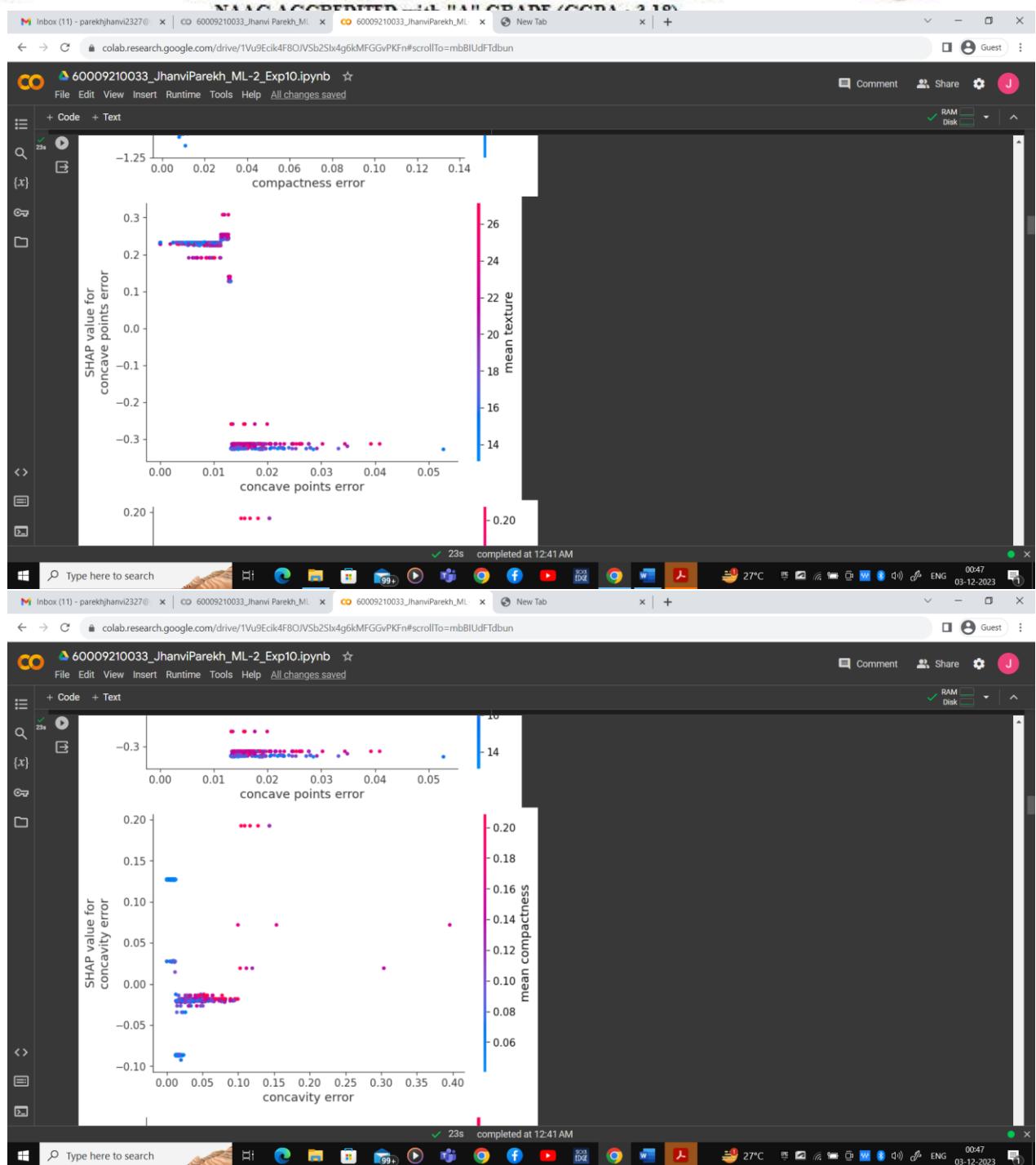


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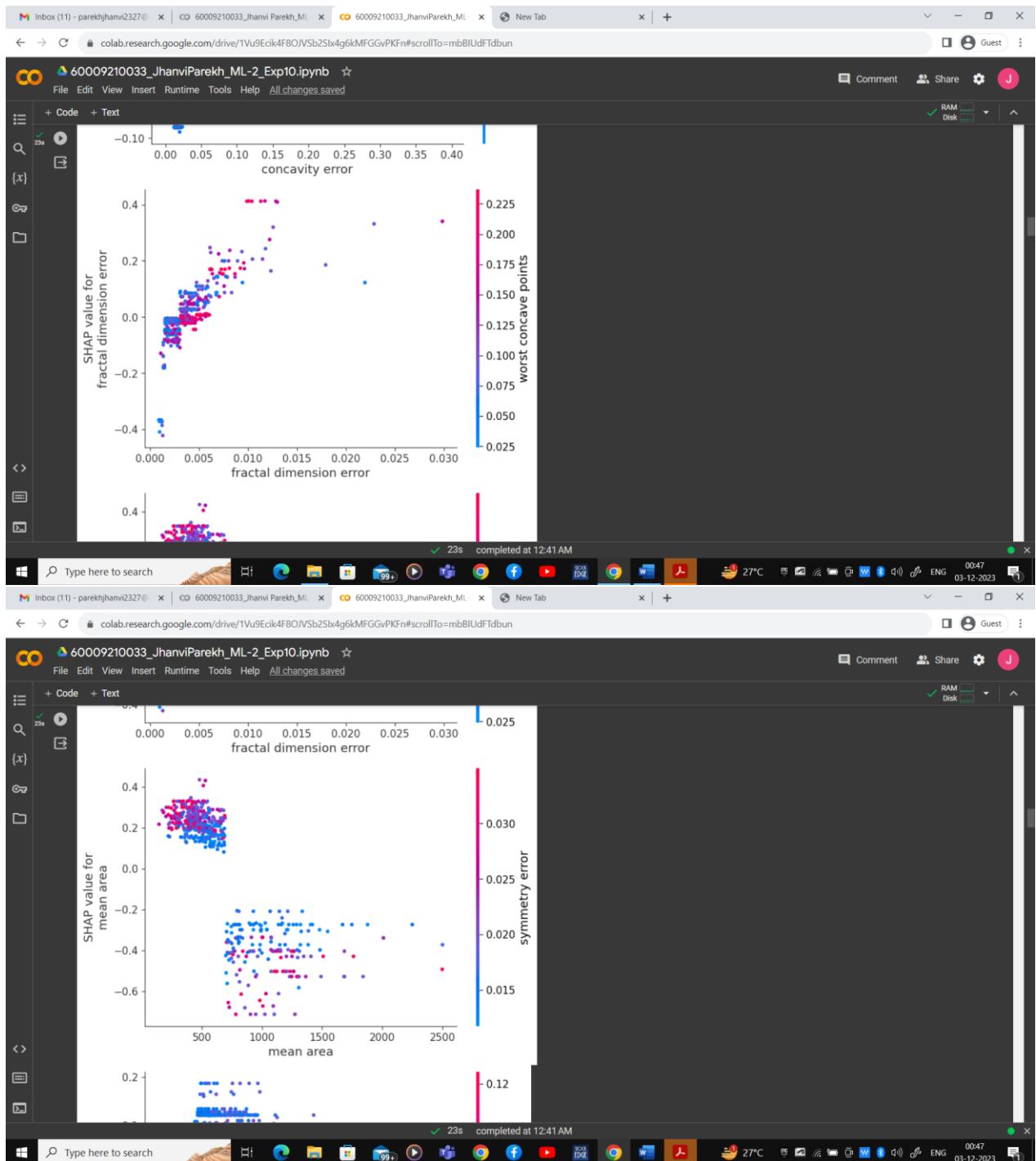


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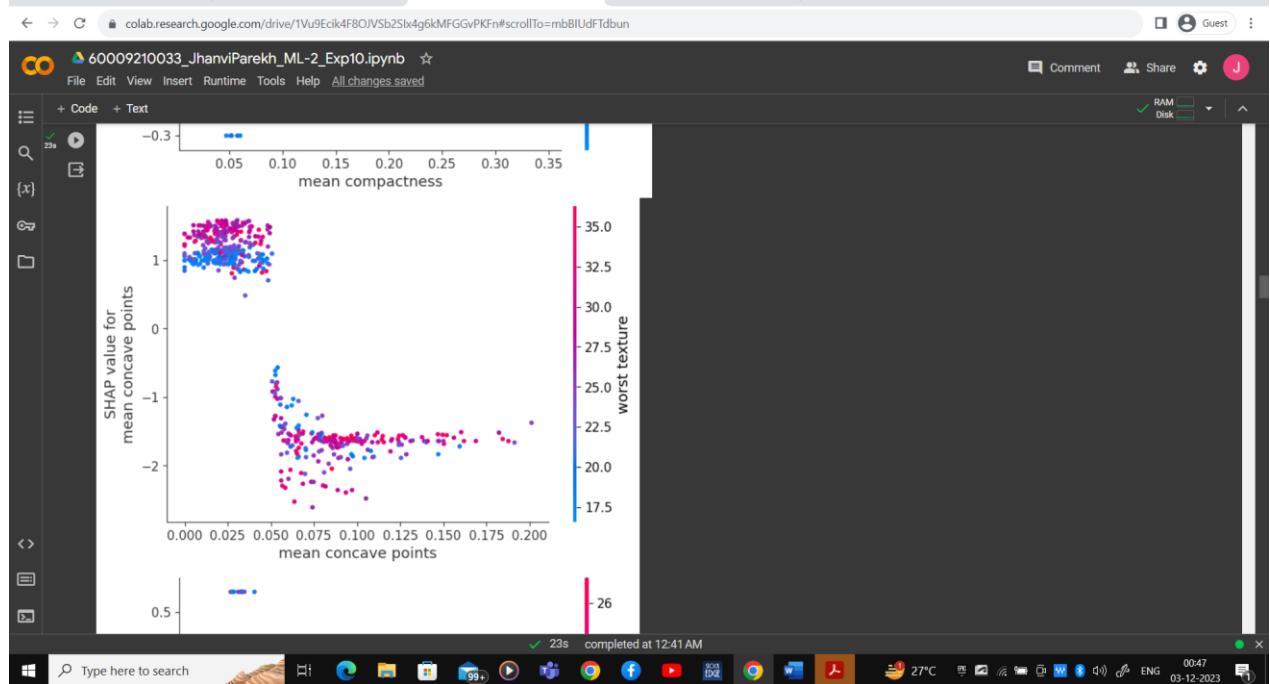
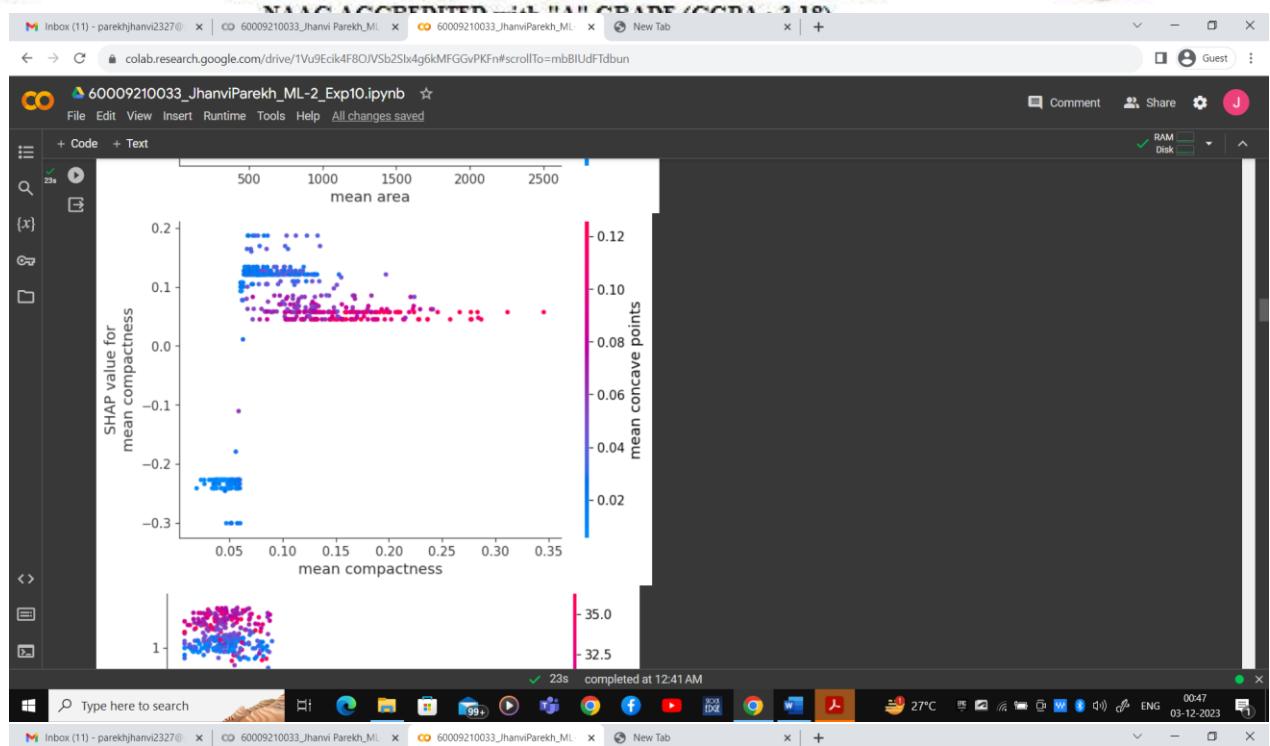


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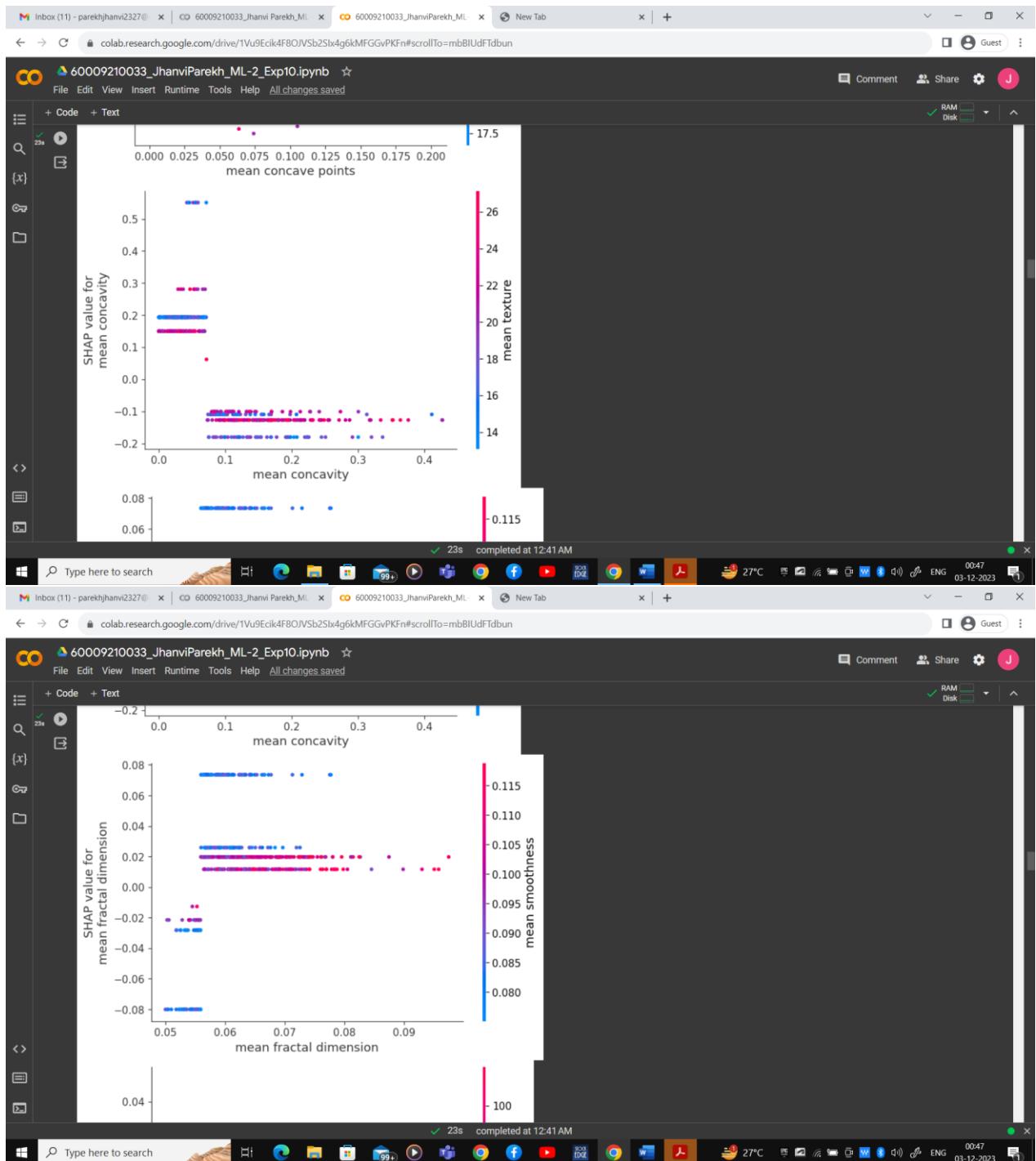


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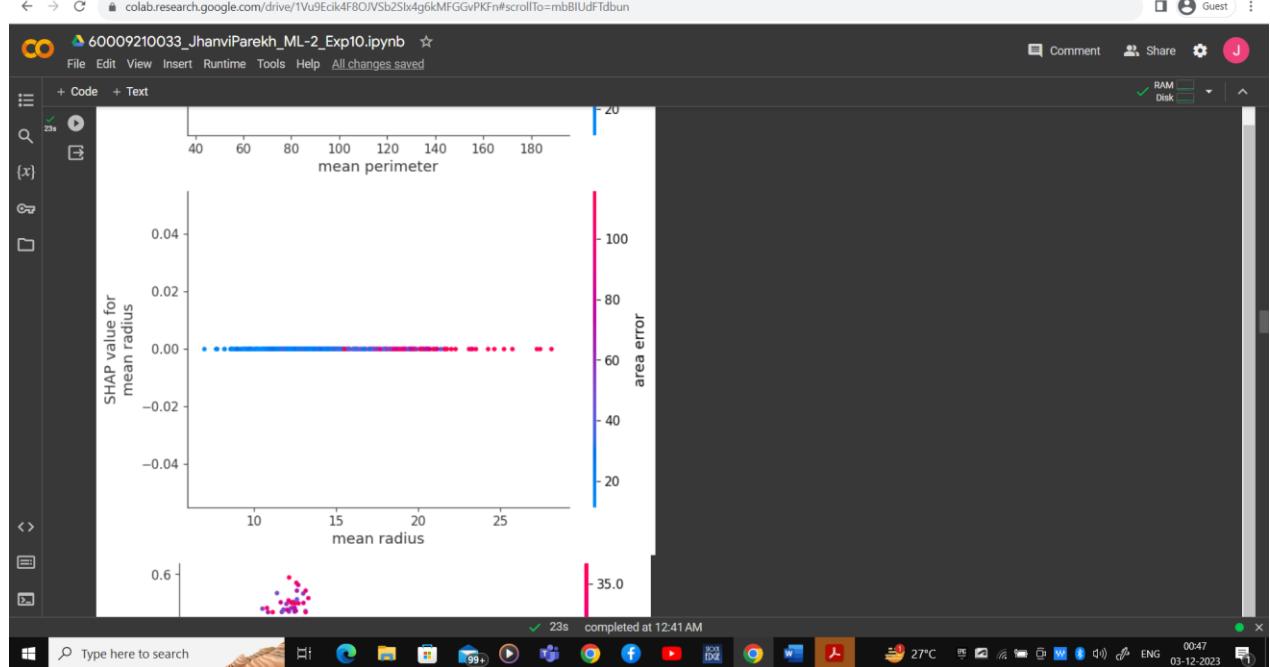
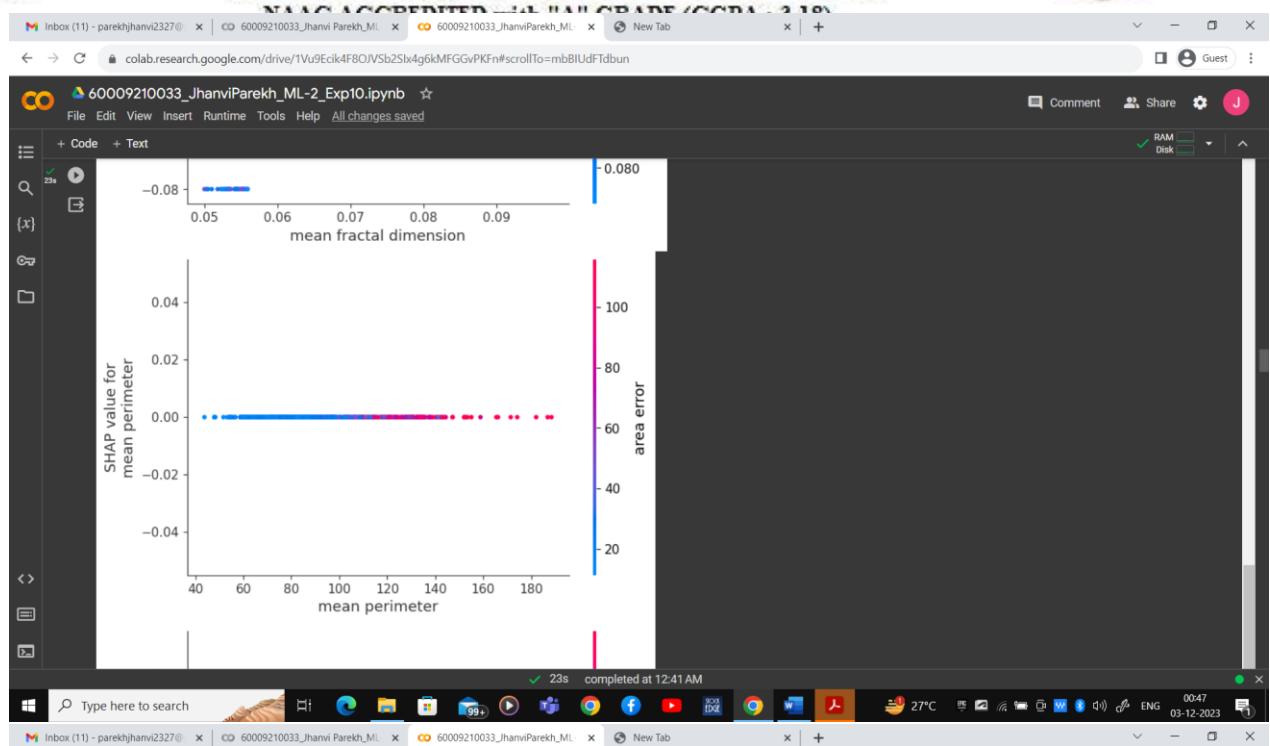


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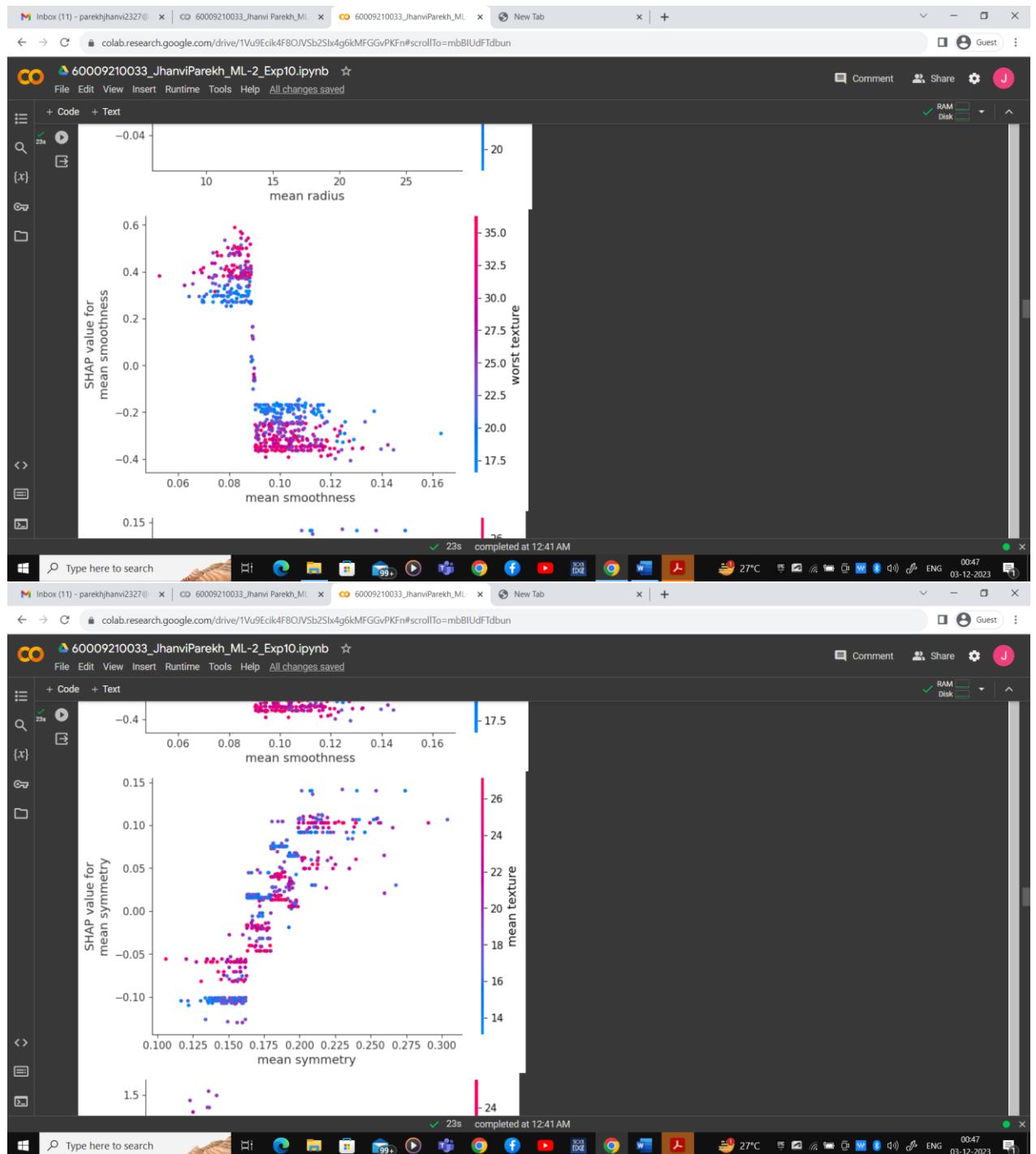


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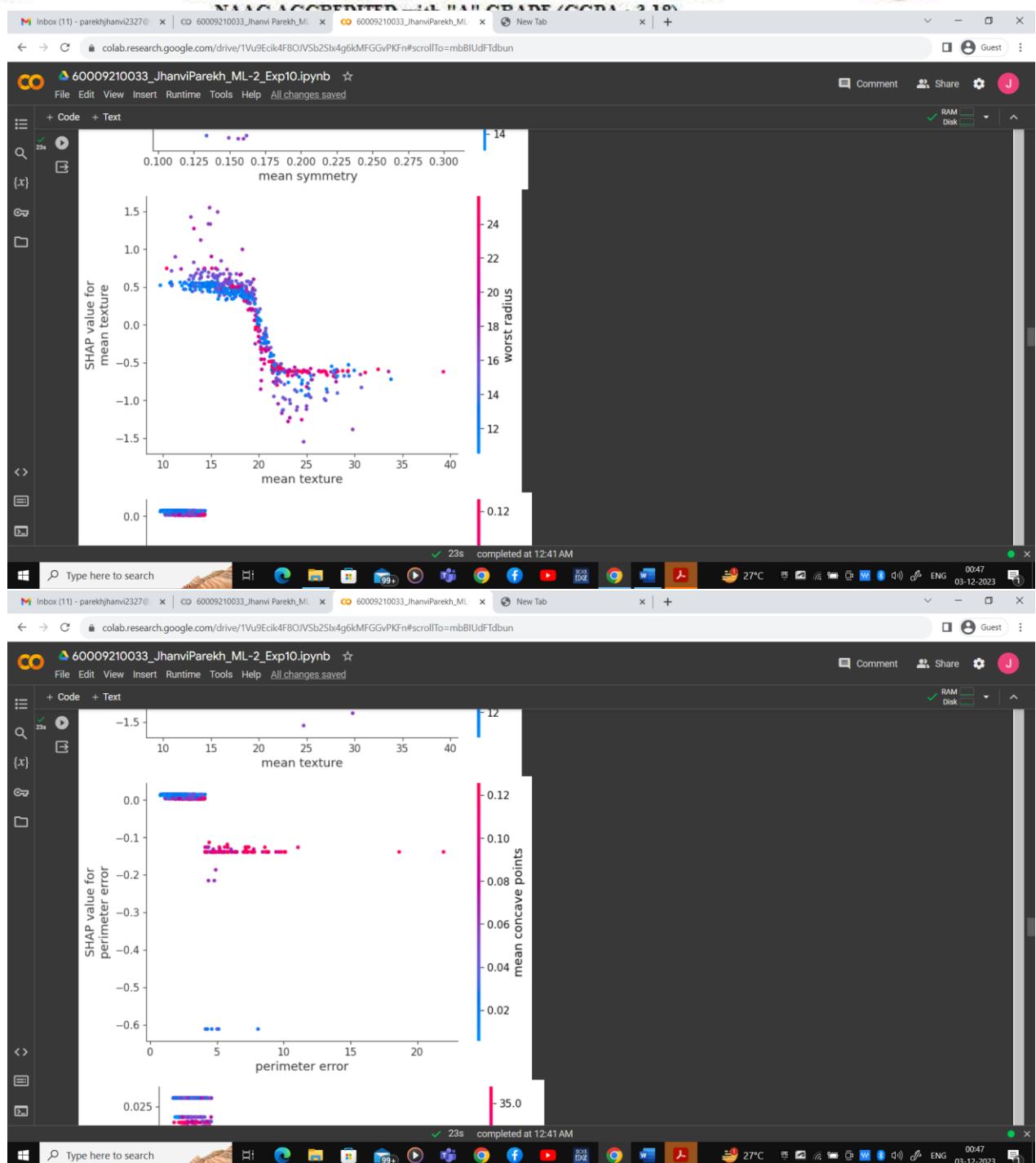


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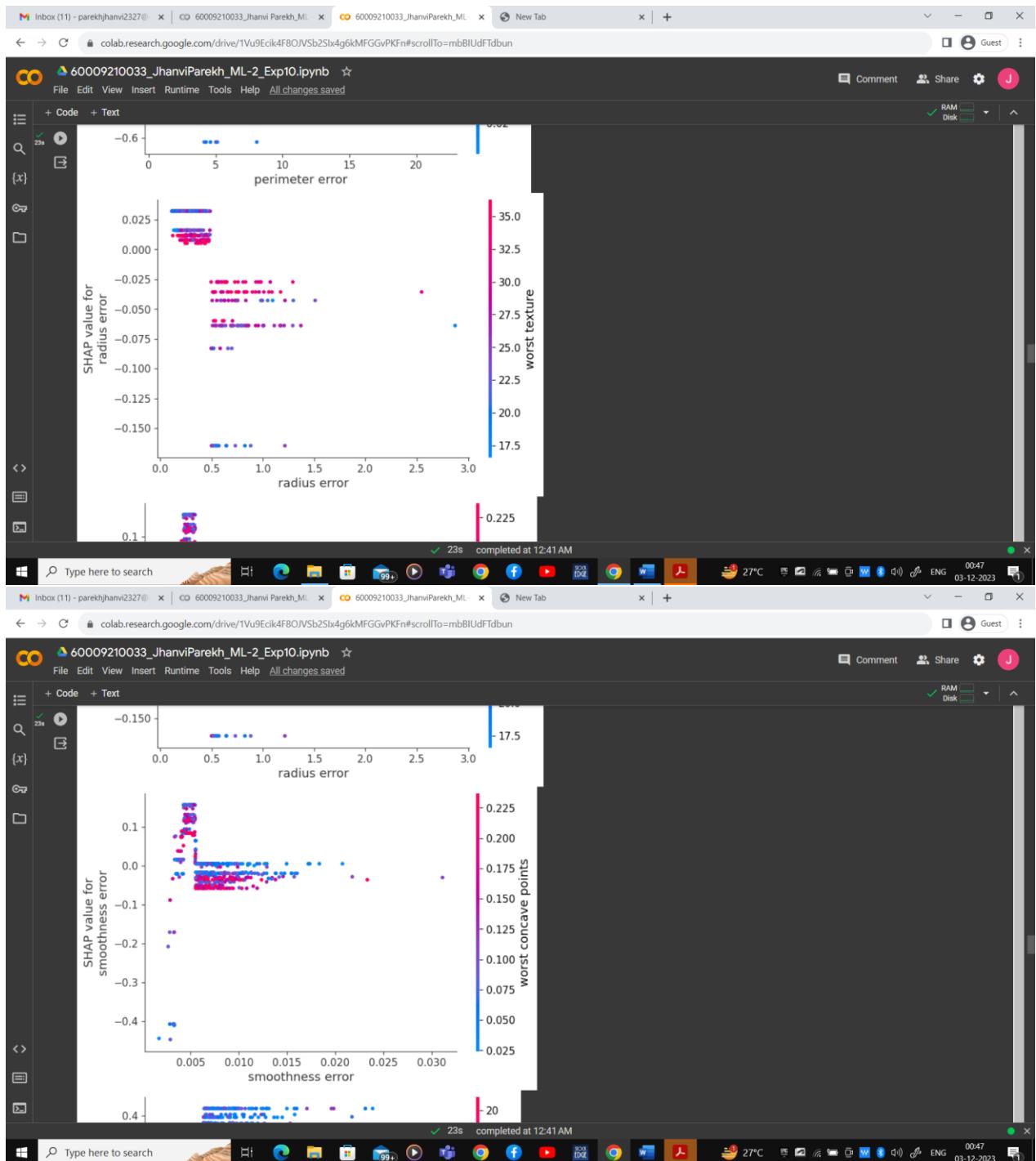


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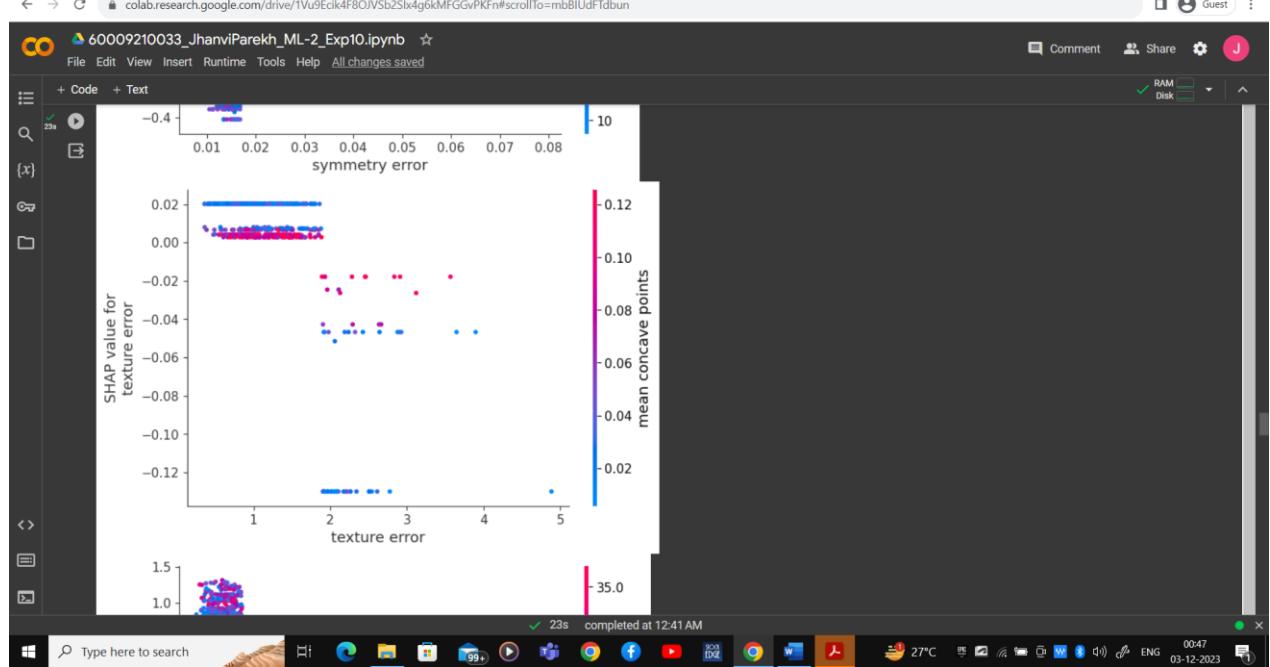
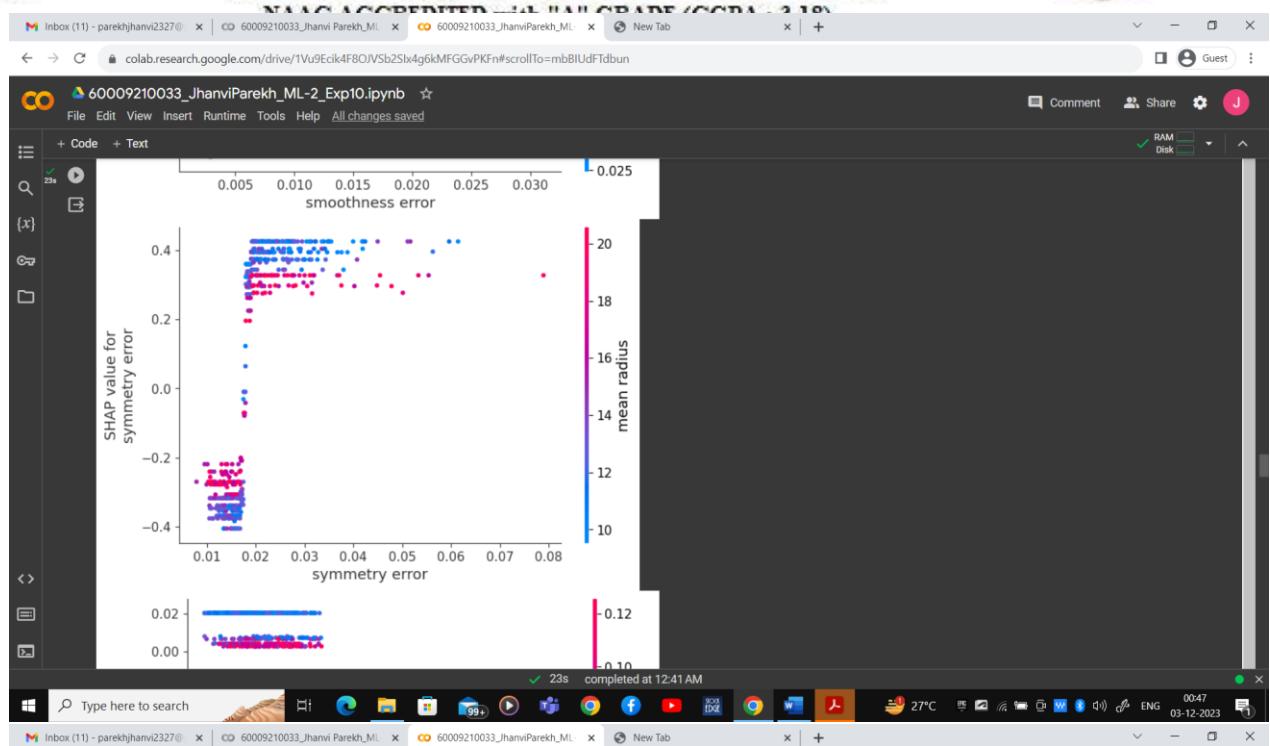


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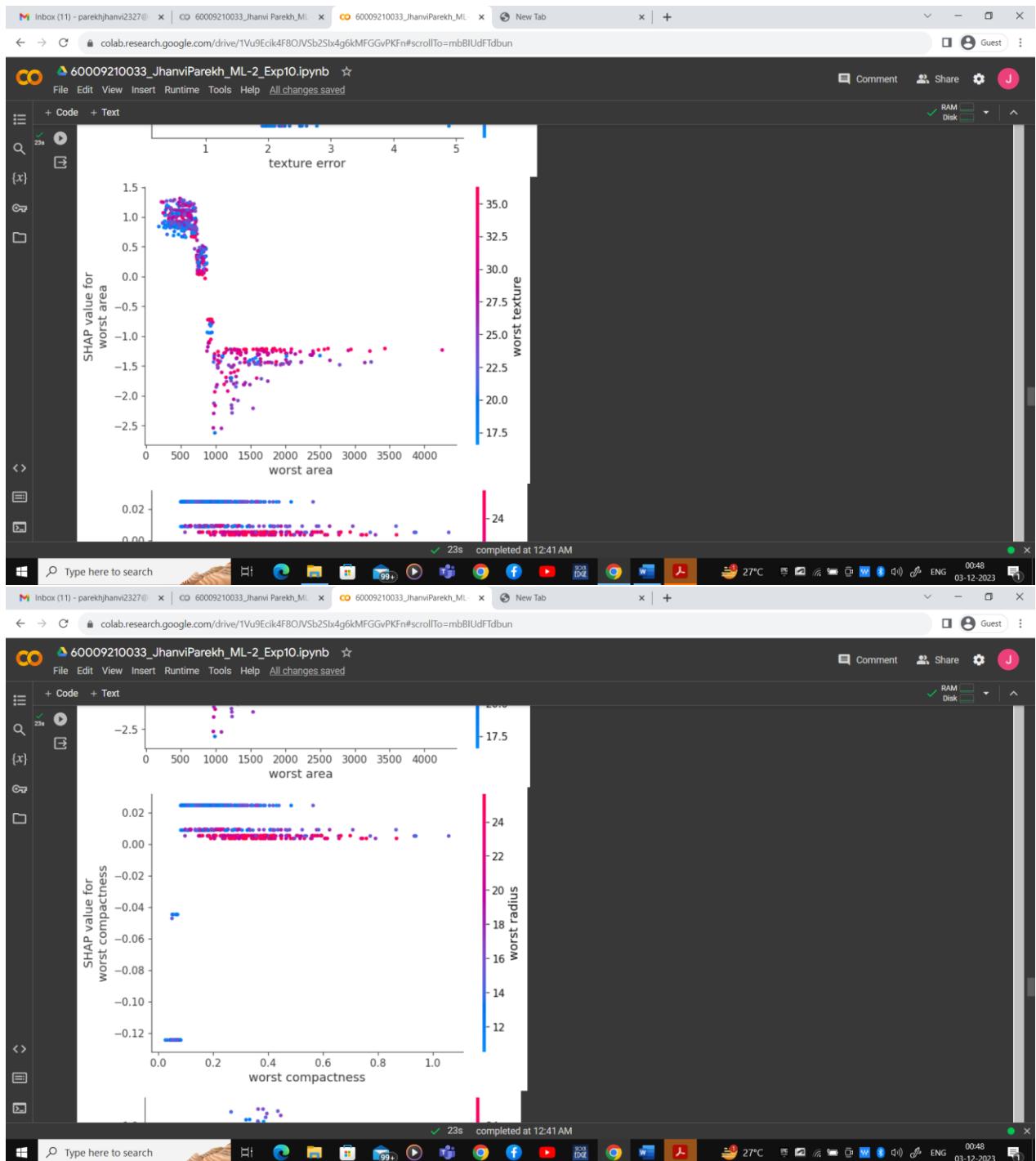


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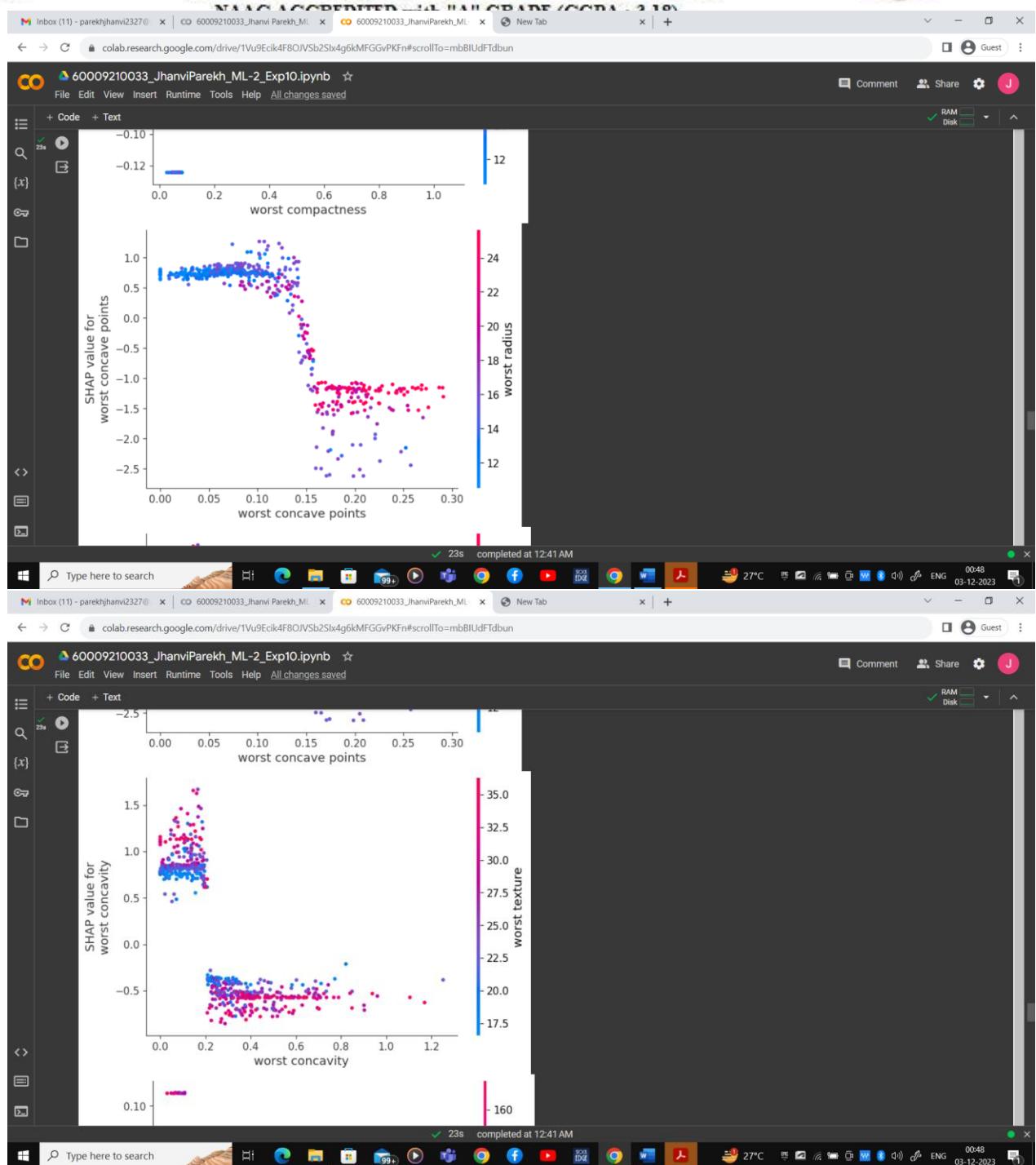


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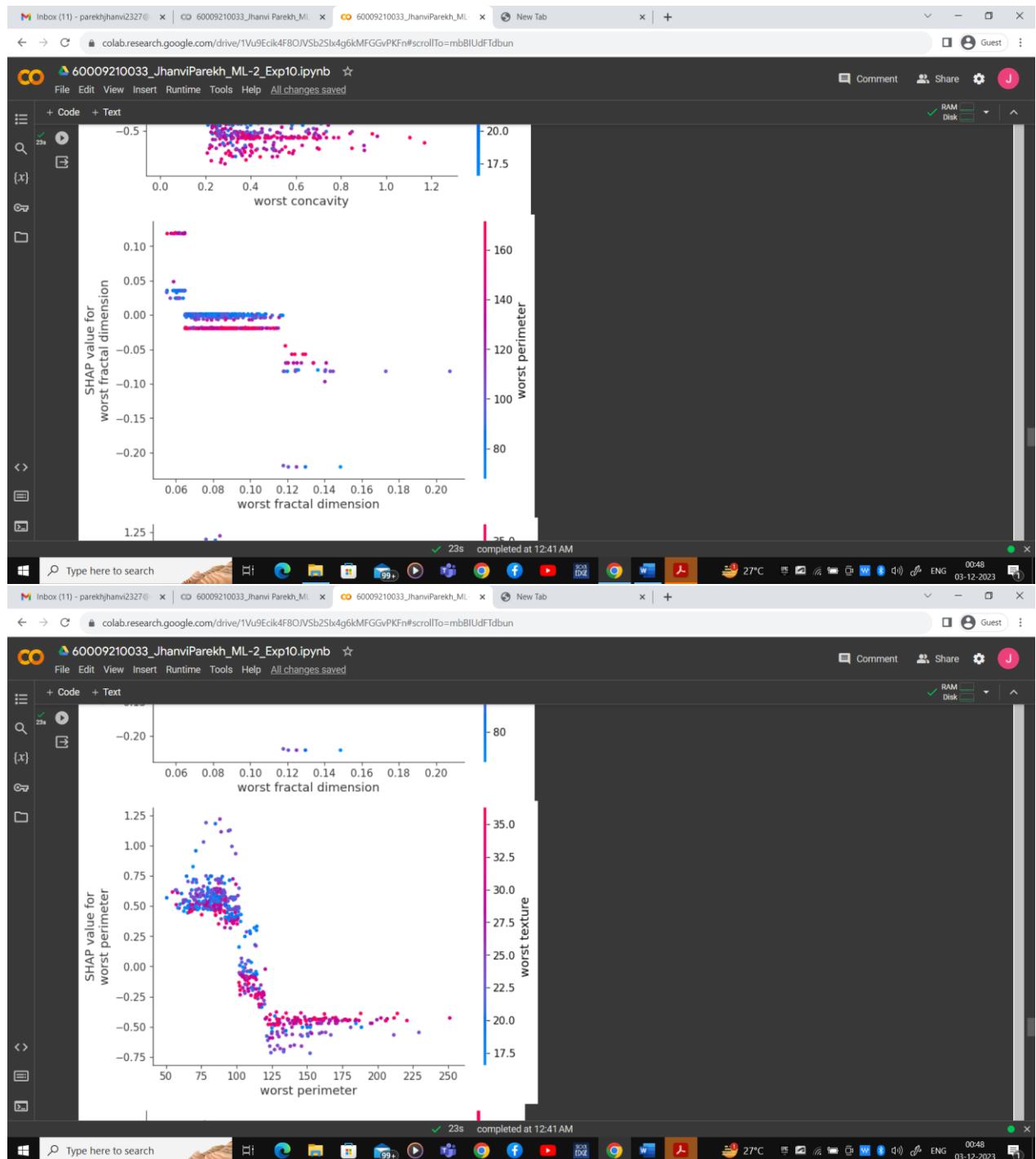


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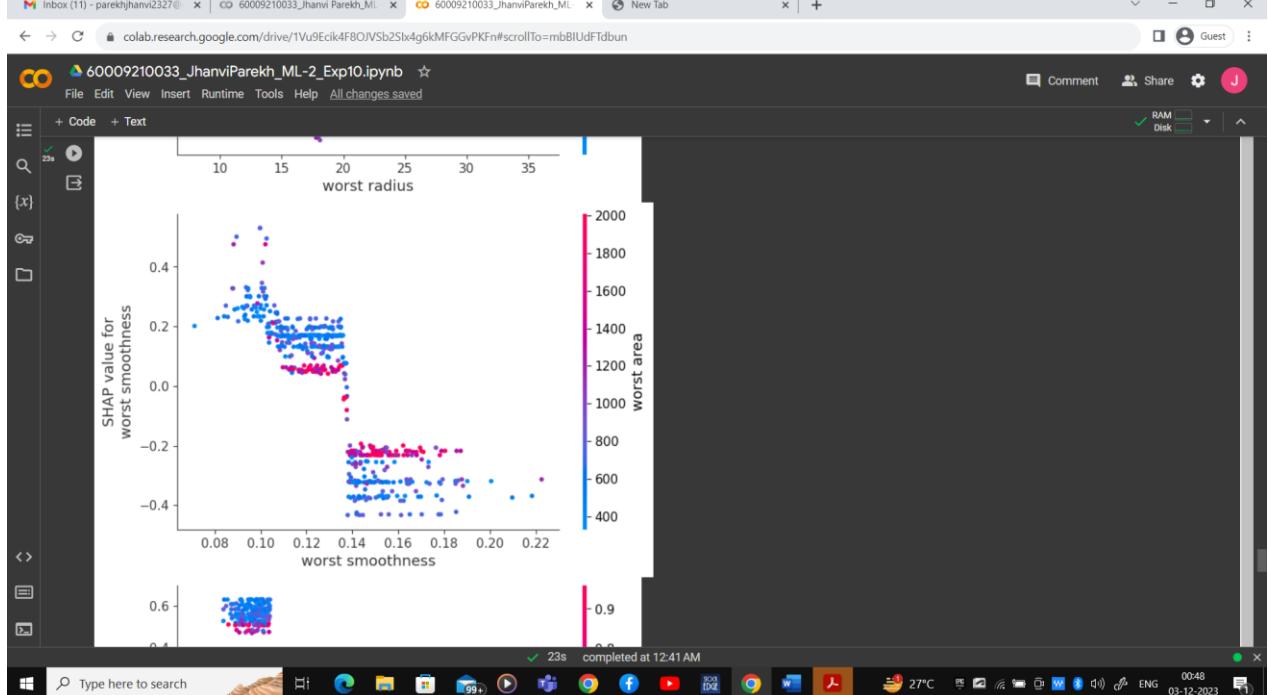
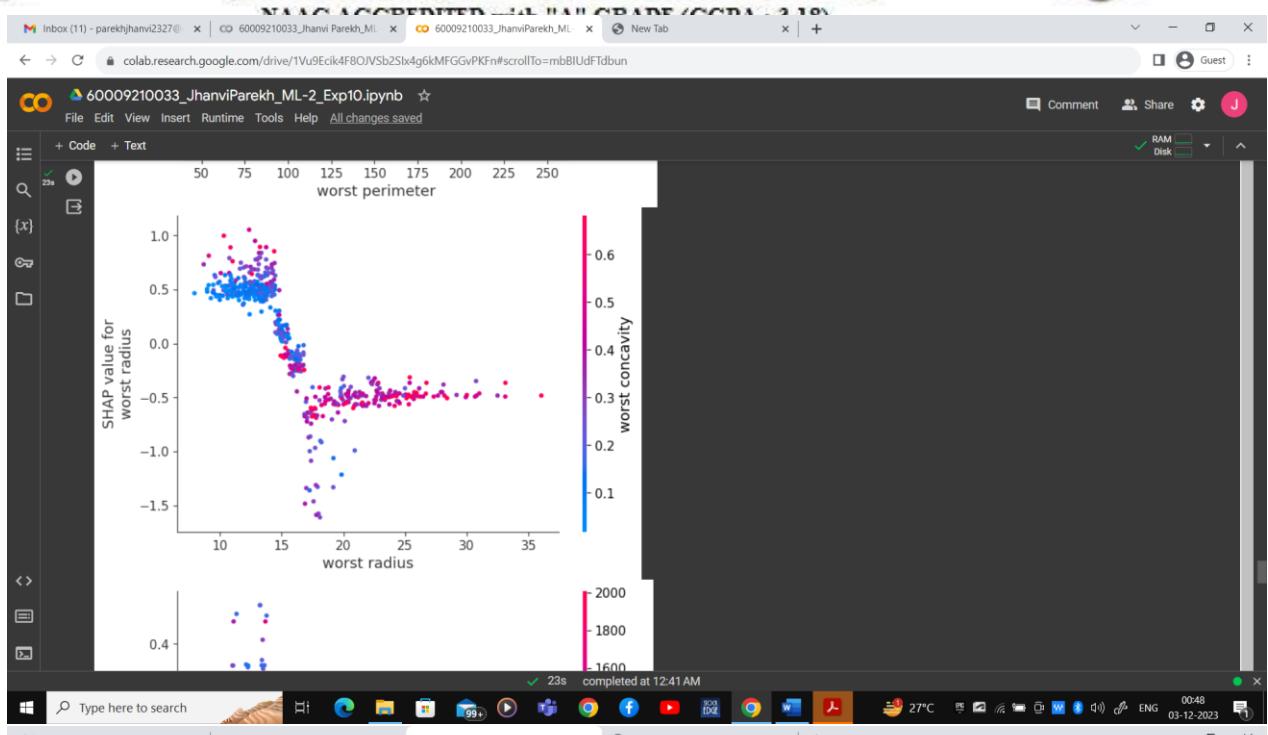


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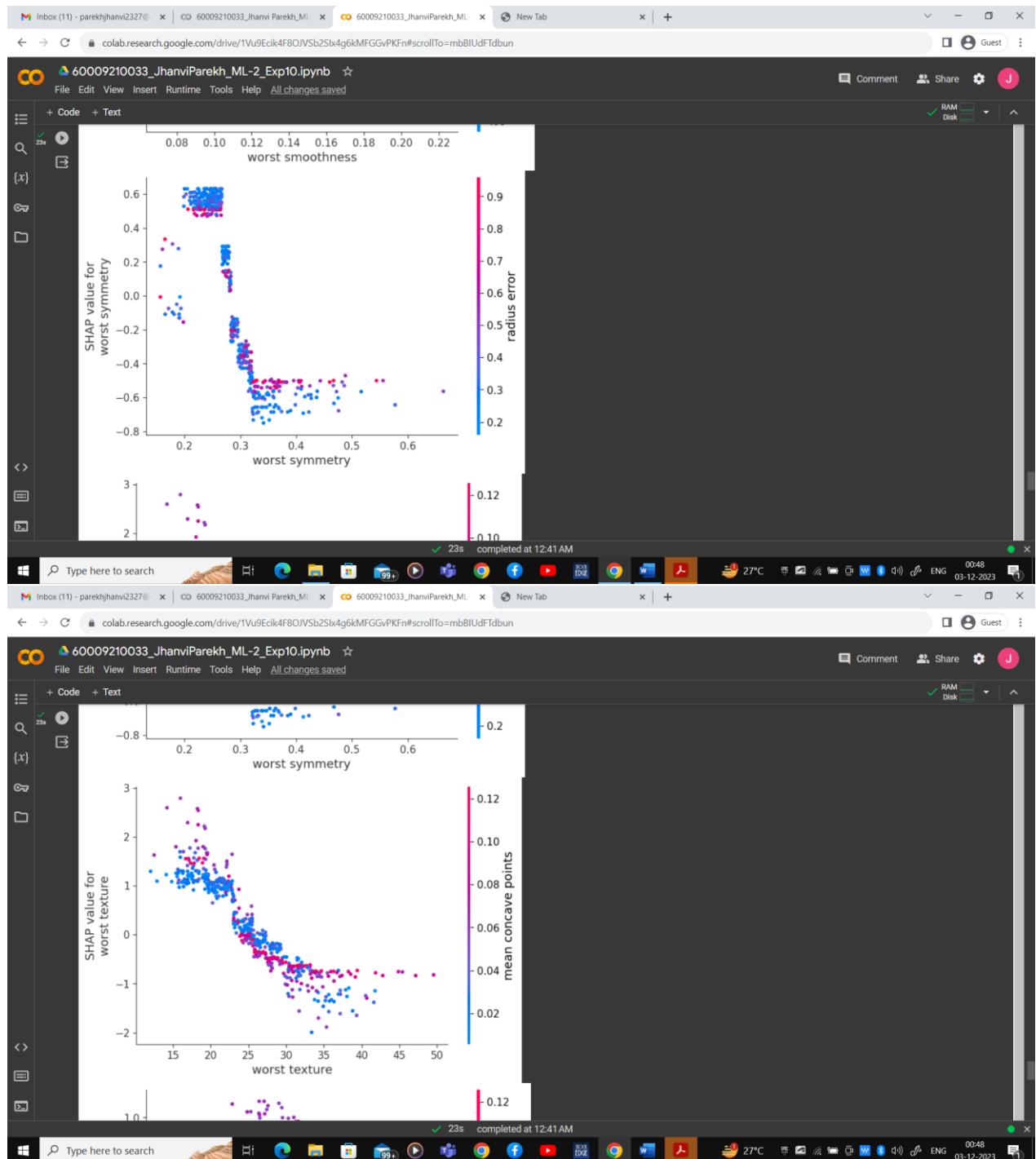


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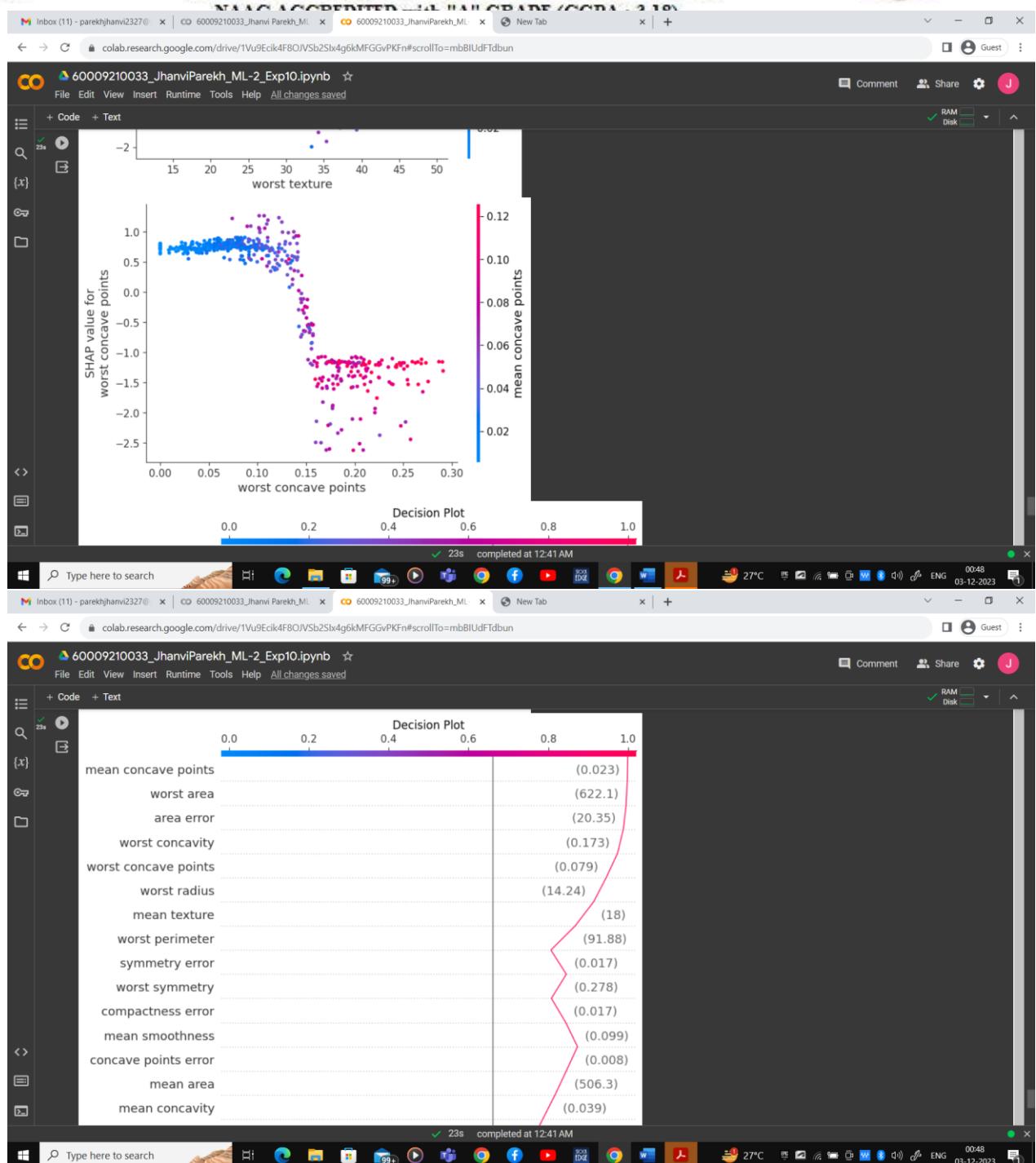


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