Configuration Manual

Analyze fillets, chamfers and holes on 3D geometrical STEP file

MSc Research Project in AI for business

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Project Submission Sheet

Student Name:	Zunaira Sohail……
Student ID:	x23391154……
Programme:	MSc in AI for Business…… **Year:** 2025
Module:	Practicum 2……
Lecturer:	Agatha Mattos……
Submission Due Date:	11-12-25……
Project Title:	Analyze fillets, chamfers and holes on 3D geometrical STEP file
Word Count:	869……

I hereby certify that the information contained in this (my submission) is information pertaining to research I conducted for this project. All information other than my own contribution will be fully referenced and listed in the relevant bibliography section at the rear of the project.
ALL internet material must be referenced in the references section. Students are encouraged to use the Harvard Referencing Standard supplied by the Library. To use other author's written or electronic work is illegal (plagiarism) and may result in disciplinary action. Students may be required to undergo a viva (oral examination) if there is suspicion about the validity of their submitted work.

Signature:	Zunaira……
Date:	08-12-25……

PLEASE READ THE FOLLOWING INSTRUCTIONS:

1. Please attach a completed copy of this sheet to each project (including multiple copies).
2. Projects should be submitted to your Programme Coordinator.
3. **You must ensure that you retain a HARD COPY of ALL projects**, both for your own reference and in case a project is lost or mislaid. It is not sufficient to keep a copy on computer. Please do not bind projects or place in covers unless specifically requested.
4. You must ensure that all projects are submitted to your Programme Coordinator on or before the required submission date. **Late submissions will incur penalties.**
5. All projects must be submitted and passed in order to successfully complete the year. **Any project/assignment not submitted will be marked as a fail.**
6. **Please check that you read AI and Academic Integrity Acknowledgement Supplments in this document**

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AI Acknowledgement Supplement

Practicum 2

Analyze fillets, chamfers and holes on 3D geometrical STEP file

Your Name/Student Number	Course	Date
Zunaira Sohail/ x23391154	MSc in AI for Business	08-12-25

This section is a supplement to the main assignment, to be used if AI was used in any capacity in the creation of your assignment; if you have queries about how to do this, please contact your lecturer. For an example of how to fill these sections out, please click here.

AI Acknowledgment

This section acknowledges the AI tools that were utilized in the process of completing this assignment.

Tool Name	Brief Description	Link to tool

Description of AI Usage

This section provides a more detailed description of how the AI tools were used in the assignment. It includes information about the prompts given to the AI tool, the responses received, and how these responses were utilized or modified in the assignment. **One table should be used for each tool used**.

[Insert Tool Name]	
[Insert Description of use]	
[Insert Sample prompt]	[Insert Sample response]

Evidence of AI Usage

This section includes evidence of significant prompts and responses used or generated through the AI tool. It should provide a clear understanding of the extent to which the AI tool was used in the assignment. Evidence may be attached via screenshots or text.

Additional Evidence:

[Place evidence here]

Additional Evidence:

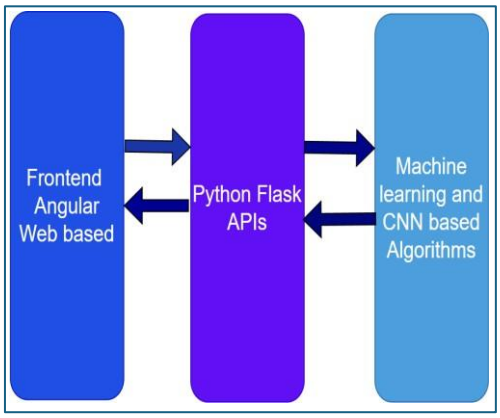
[Place evidence here]

Architecture:

1. High-Level Architecture:

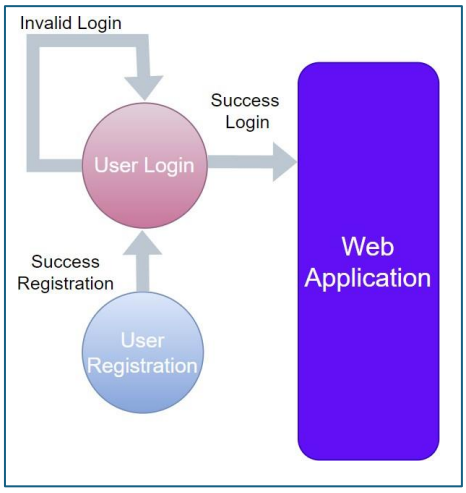
A three-tier architecture is used by the solution. The user interface is developed using Angular. A middleware layer built with Python's Flask framework handles user requests,

which then communicates with the learning algorithms and convolutional neural network architectures implemented.



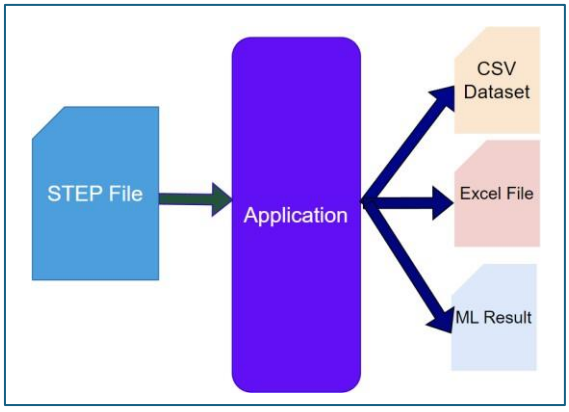
2. Identity Verification Process:

An account is created by new users by submitting their registration details and an email confirmation is received. Once registered, authentication is performed by users through the login interface to access the platform.



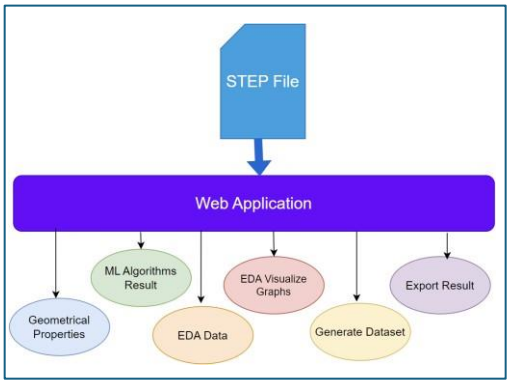
3. STEP File Processing Workflow:

After the main dashboard is entered by users, STEP format 3D geometry files are uploaded by them. These files are processed by the system and outputs are provided that can be downloaded in various formats.



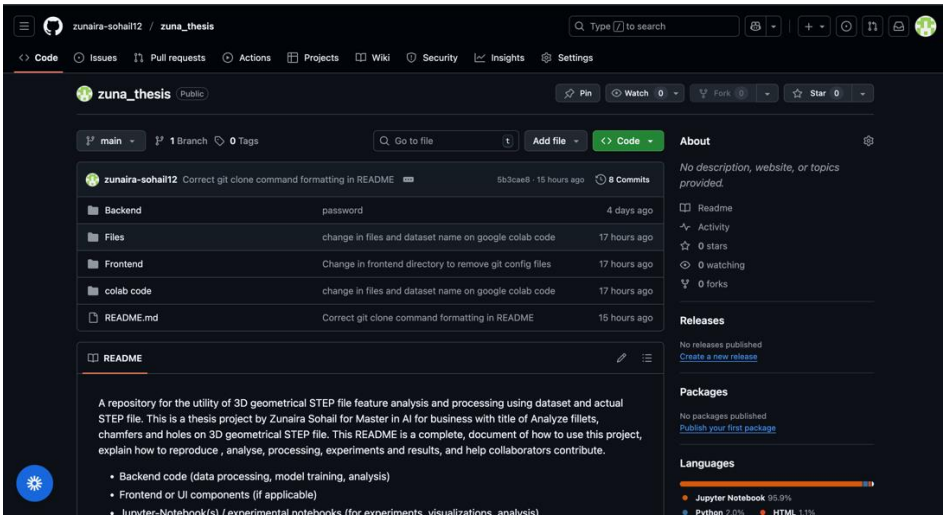
4. Uploading Files and Viewing Results:

Once a STEP file is successfully uploaded, EDA results can be explored, geometrical attributes can be inspected, visual charts can be viewed and models of ML can run to extract automated feature insights.



Step 1: Get the Source Code from GitHub

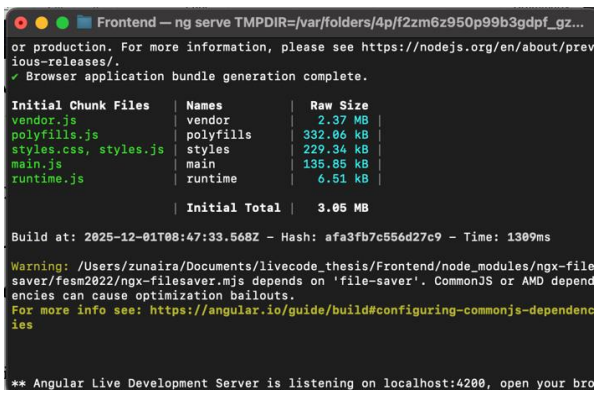
URL: https://github.com/zunaira-sohail12/zuna_thesis



Step 2: Launch the Angular Frontend:

Navigate into the /livecode_thesis folder of the cloned project and start the Angular server using:

ng serve



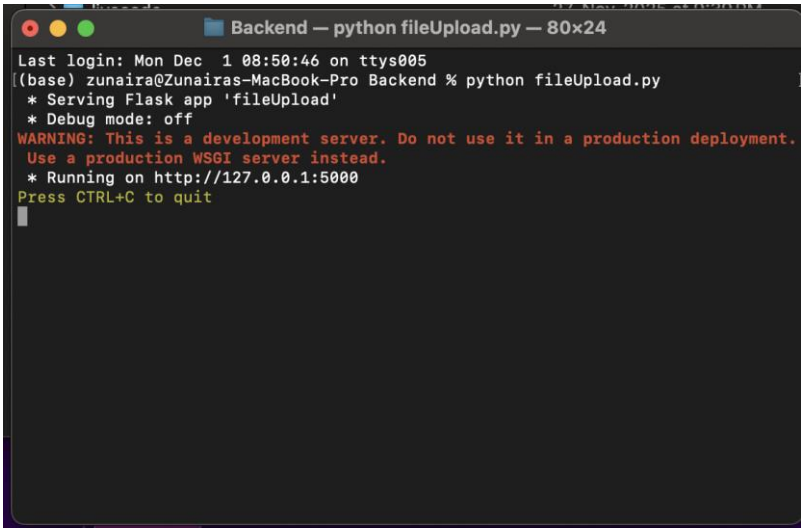
Ensure Node.js is installed by running: node -v

Step 3: Start the Python Backend:

Move to the /Backend directory and run the backend service:

python fileUpload.py

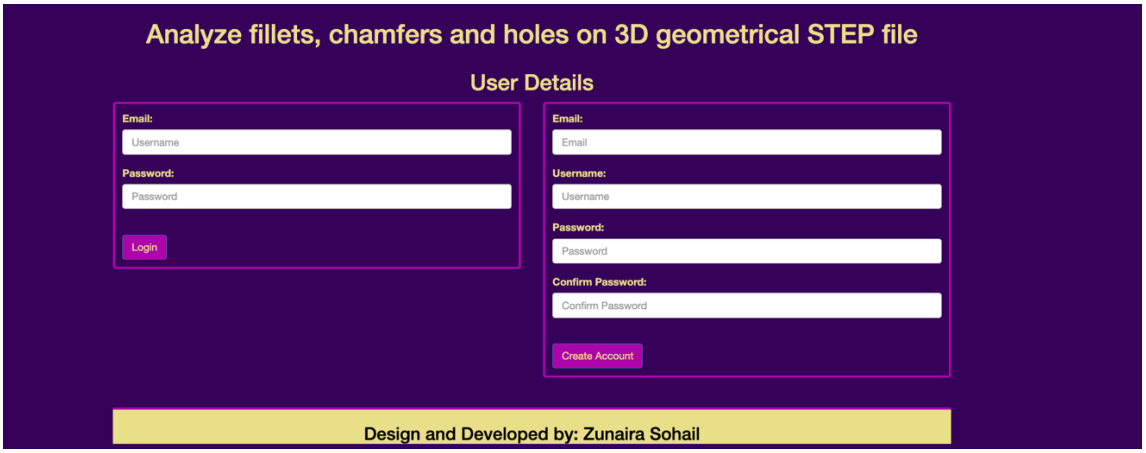
Verify Python installation with: python -v



Step 4: Access the Application:

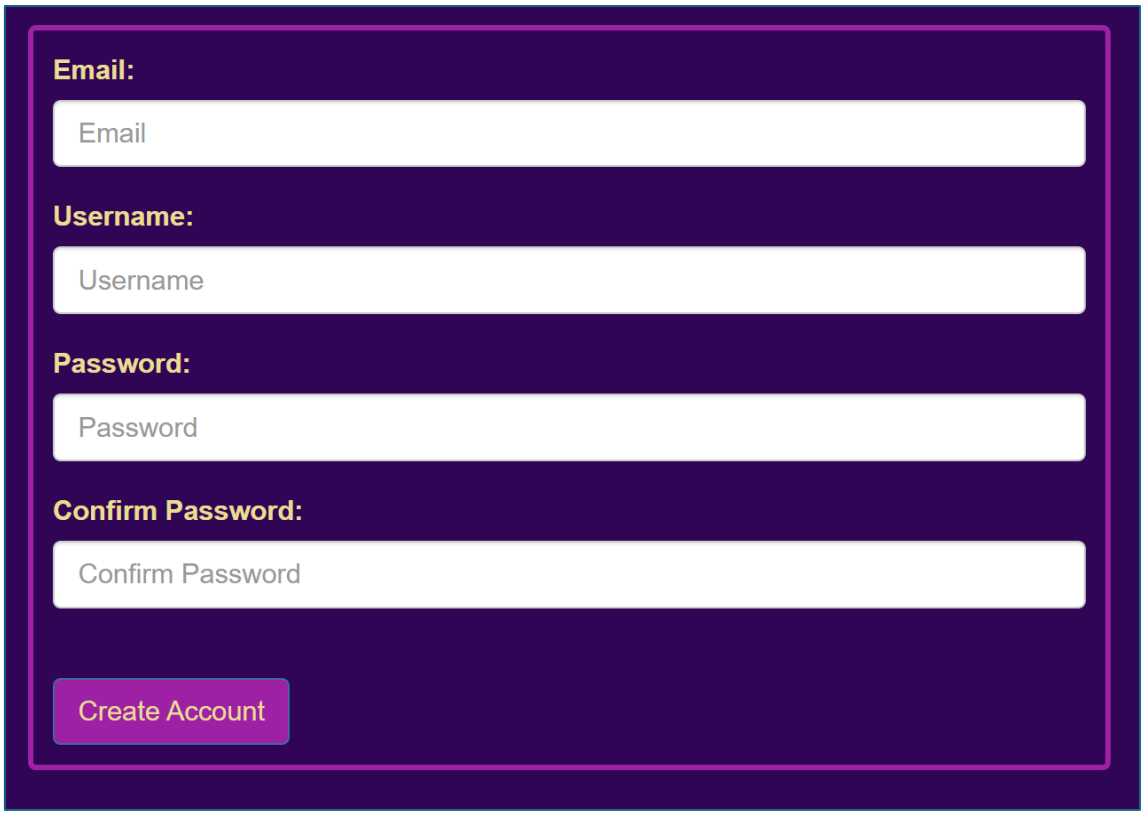
Open a browser and go to:

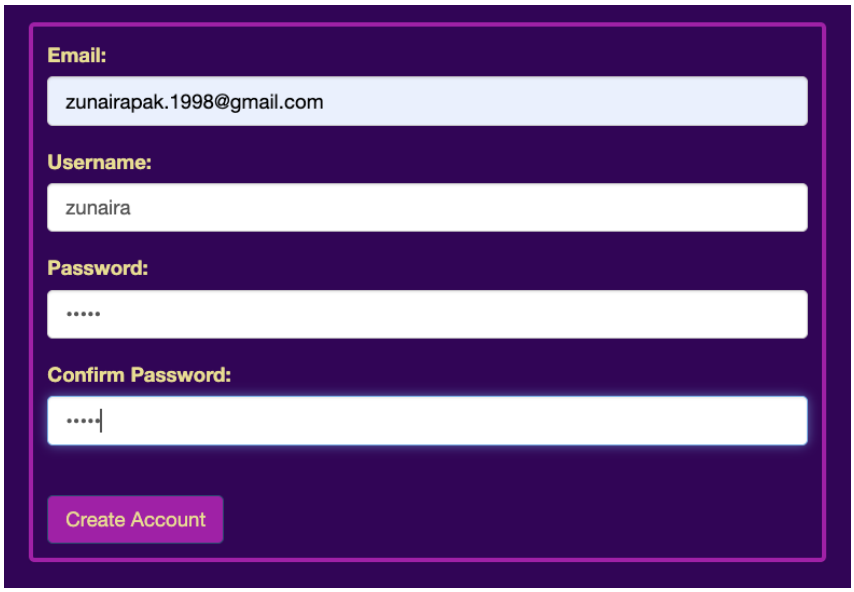
URL: http://localhost:4200/login
Here users will find the login panel on the left and the registration form on the right.



Step 5:

Enter an email, username, and password, then select “Create Account” to sign up.



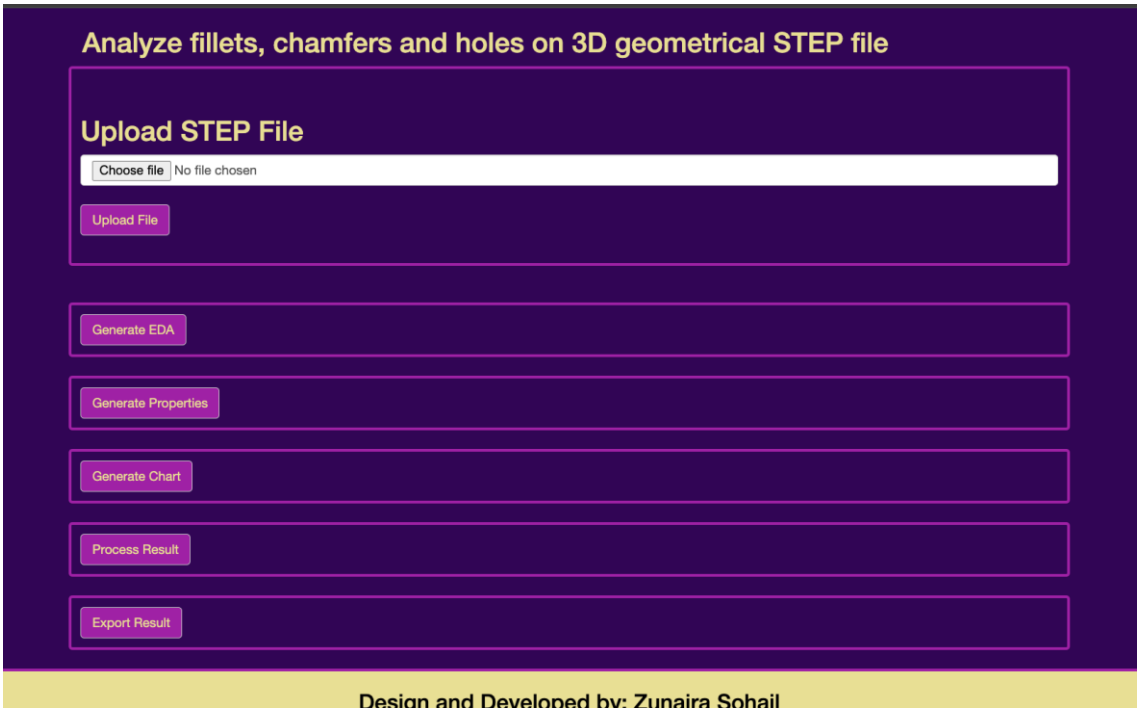


Step 6:

Use either your email or username along with your password to log into the system.

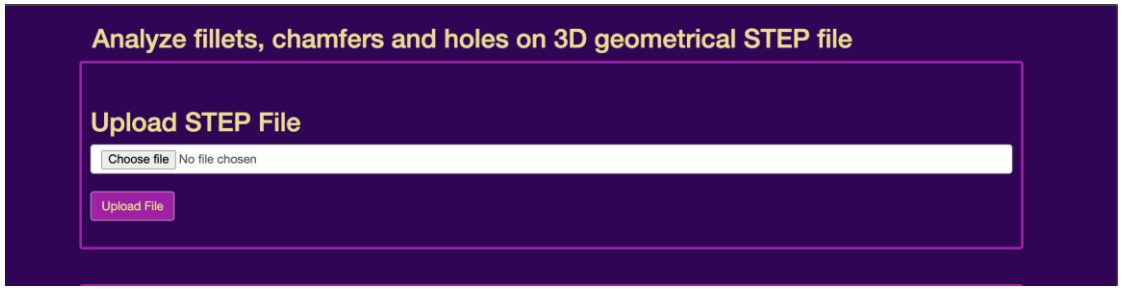
Step 7:

After successful login, users are directed to the primary application interface containing all available features.



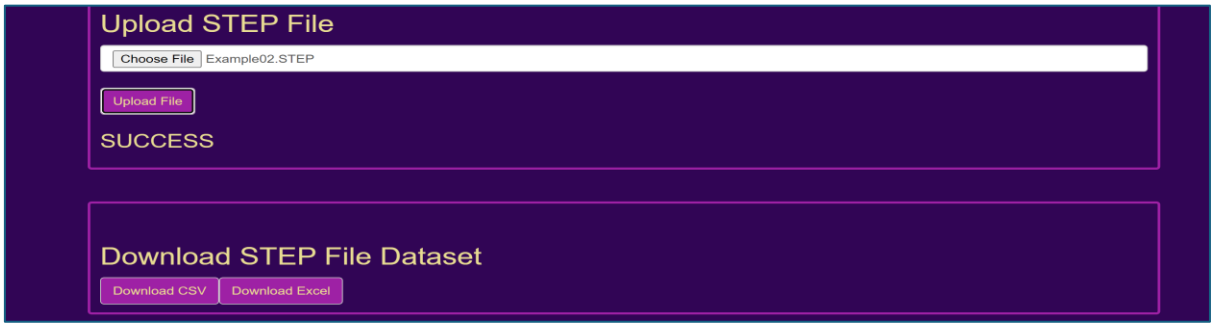
Step 8:

Select a STEP file from your computer and upload it for processing.



Step 9:

Once uploaded, the system allows the file to be exported in CSV or Excel format.



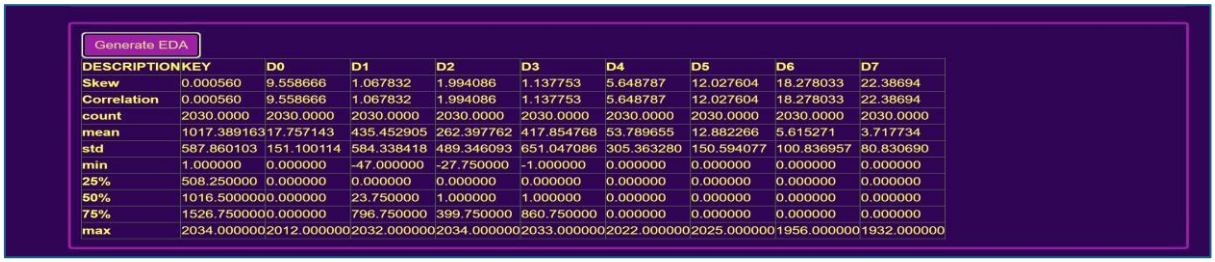
Sample Dataset:

KEY	ENTITY	D0	D1	D2	D3	D4	D5	D6	D7	REFERENCES
2	CARTESIAN	0	0	0	1148	0	0	0	0	[1148]
4	PRODUCT	0	1399	17.5	0	0	0	0	0	[1399]
5	PERSON	0	1820	1815	0	0	0	0	0	[1820, 1815]
6	CIRCLE	0	1235	259	0	0	0	0	0	[1235, 259]
7	EDGE_LOO	0	1403	2.75	0	0	0	0	0	[1403]
8	LINE	0	1221	10	0	0	0	0	0	[1221, 10]
9	CIRCLE	0	349	13	0	0	0	0	0	[349, 13]
10	LINE	0	1227	1000	0	0	0	0	0	[1227]
11	LINE	0	801	1000	0	0	0	0	0	[801]
12	VECTOR	0	350	1000	0	0	0	0	0	[350]
13	VECTOR	0	352	1000	0	0	0	0	0	[352]
14	VECTOR	0	268	78	0	0	0	0	0	[268, 78]
15	VECTOR	0	798	16	0	0	0	0	0	[798, 16]
16	LINE	0	799	1000	0	0	0	0	0	[799]
17	LINE	0	1234	253	0	0	0	0	0	[1234, 253]
18	VECTOR	0	1558	2.1	1.029744	0	0	0	0	[1558]
19	LINE	0	1915	1883	1913	2009	0	0	0	[1915, 1883, 1913, 2009]
20	CONICAL_S	0	1408	2.1	0	0	0	0	0	[1408]
21	EDGE_LOO	0	1790	1793	1788	1791	0	0	0	[1790, 1793, 1788, 1791]
22	CIRCLE	0	1206	1000	0	0	0	0	0	[1206]
23	EDGE_LOO	0	1420	3.3	0	0	0	0	0	[1420]
24	VECTOR	0	21	1	0	0	0	0	0	[21]
25	CYLINDRIC	0	194	1	0	0	0	0	0	[194]
26	FACE_OUTI	0	210	1	0	0	0	0	0	[210]

Step 10:

Selecting the EDA option generates a structured overview of the STEP file's data.

The "Generate EDA" section displays a statistical summary table analyzing data across eight dimensions (D0-D7) with 2,030 data points each. The table presents key descriptive statistics including skewness, correlation, count, mean, standard deviation, minimum, and percentile distributions (25%, 50%, 75%, and maximum values). Mean values range from approximately 70 to 518 across dimensions, with varying skewness indicating different distribution shapes. The percentile rows show quartile distributions, while minimum and maximum values define the data range for each dimension. This comprehensive statistical overview provides a quick snapshot of central tendencies, variability, and distribution characteristics across all measured dimensions in the dataset.



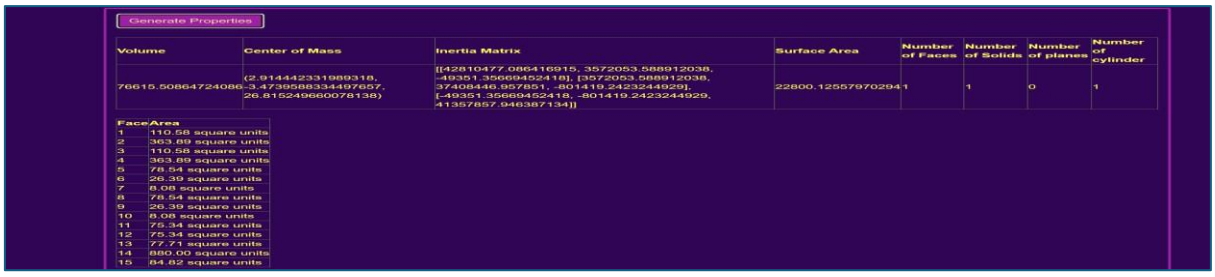
Generate EDA

DESCRIPTIONKEY	D0	D1	D2	D3	D4	D5	D6	D7
Skew	0.000560	9.558666	1.067832	1.994086	1.137753	5.648787	12.027604	18.278033	22.38694
Correlation	0.000560	9.558666	1.067832	1.994086	1.137753	5.648787	12.027604	18.278033	22.38694
count	2030.0000	2030.0000	2030.0000	2030.0000	2030.0000	2030.0000	2030.0000	2030.0000	2030.0000
mean	1017.38916317.757143		435.452905	262.397762	417.854768	53.789655	12.882266	5.615271	3.717734
std	587.860103	151.100114	584.338418	489.346093	651.047086	305.363280	150.594077	100.836957	80.830690
min	1.000000	0.000000	-47.000000	-27.750000	-1.000000	0.000000	0.000000	0.000000	0.000000
25%	508.250000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
50%	1016.5000000.000000		23.750000	1.000000	1.000000	0.000000	0.000000	0.000000	0.000000
75%	1526.7500000.000000		796.750000	399.750000	860.750000	0.000000	0.000000	0.000000	0.000000
max	2034.000000	2012.000000	2032.000000	2034.000000	2033.000000	2022.000000	2025.000000	1956.000000	1932.000000

Step 11:

This tab displays numerical and analytical geometry information derived from the uploaded file.

The "Generate Properties" section displays comprehensive geometric and physical data for a 3D object. The volume is measured at 70015.5009572086 cubic units, with a center of mass located at specific X, Y, Z coordinates. The inertia matrix shows a 3x3 array of values representing the object's rotational inertia properties and mass distribution. The total surface area is 22800.1259757024 square units. The geometric composition indicates 1 face, 0 solids, 1 shell, and 1 lump or similar structural element. Additionally, there's a "FreeFArea" breakdown listing 16 individual surface areas ranging from approximately 262 to 500 square units each, providing detailed measurements of the object's constituent surfaces.



Generate Properties

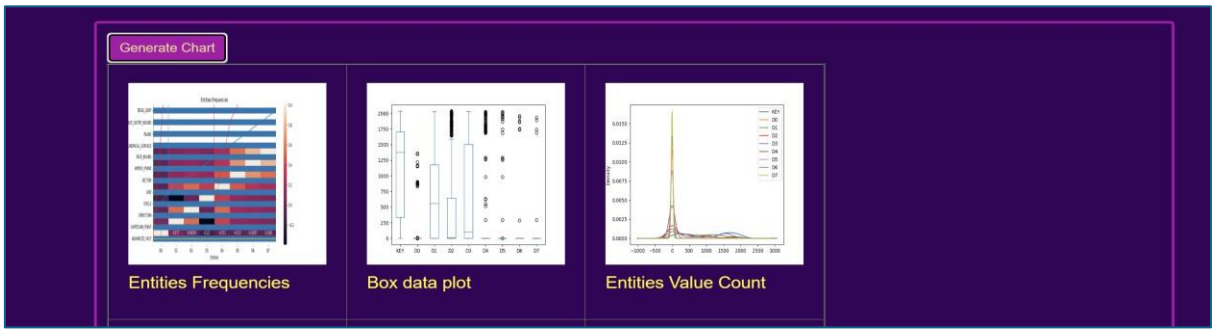
Volume	Center of Mass	Inertia Matrix	Surface Area	Number of Faces	Number of Solids	Number of planes	Number of cylinder
76615.50864724086	(2.91444233198831 8, -3.4739588333497657, 26.815249660078138)	[[42810477.086416915, 3572053.588912038, -493513566945241 8], [3572053.588912038, 37408446.957851, -801419.2423244929], [-493513566945241 8, -801419.2423244929, 41357857.946387134]]	22800.125579702941	1	0	1	

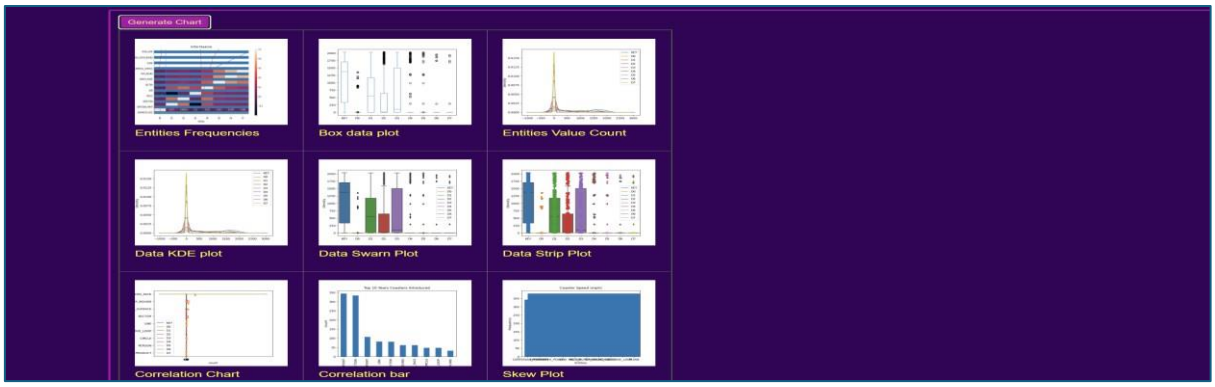
Face	Area
1	110.58 square units
2	363.89 square units
3	110.58 square units
4	363.89 square units
5	78.54 square units
6	26.39 square units
7	8.08 square units
8	78.54 square units
9	26.39 square units
10	8.08 square units
11	75.34 square units
12	75.34 square units
13	77.71 square units
14	880.00 square units
15	84.82 square units

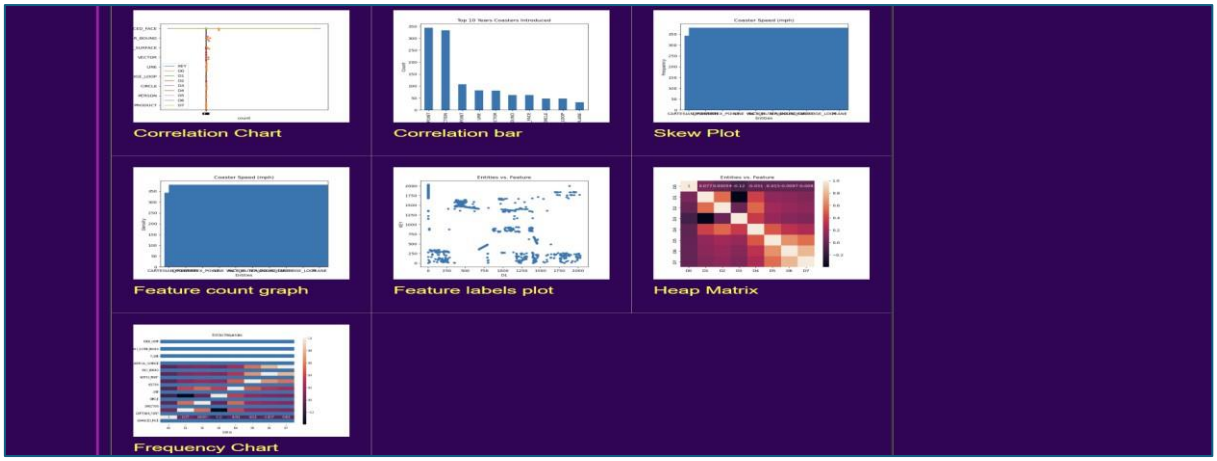
Step 12:

Charts and graphical representations of the dataset are generated, offering multiple perspectives on the extracted data.

This data visualization dashboard displays 13 analytical charts for comprehensive dataset exploration. The top "Generate Chart" section includes Entities Frequencies (horizontal bar chart), Box data plot (statistical distribution), and Entities Value Count (distribution curve). The second row features Data KDE plot (density estimation), Data Swarm Plot (categorical scatter), and Data Strip Plot (vertical point distribution). The third row contains Correlation Chart, Correlation bar (vertical bars showing relationships), and Skew Plot (blue matrix). The fourth row presents Feature count graph, Feature labels plot (scatter with numerical labels), and Heatmap Matrix (pink-purple gradient grid). At the bottom, a Frequency Chart mirrors the top entities visualization. Together, these charts provide statistical analysis including frequency distributions, correlations, data spread, and feature relationships across the dataset.


Generate Chart
Entities Frequencies
Box data plot
Entities Value Count


Generate Chart
Entities Frequencies
Box data plot
Entities Value Count
Data KDE plot
Data Swarn Plot
Data Strip Plot
Correlation Chart
Correlation bar
Skew Plot



Step 13:

A variety of ML algorithms including classification models run on the dataset. Processing duration varies with dataset size (approximately 5–10 minutes). The system returns accuracy, F1 scores, weights, and error metrics.

The table presents a performance comparison of several machine-learning algorithms using key classification quantifiers. These metrics help evaluate how well each model identifies the correct classes and how many mistakes it makes. From the results, algorithms like Random Forest, SVM, and CNN show stronger overall performance with higher accuracy and lower error rates, indicating they are more reliable for this dataset. In contrast, models such as Decision Tree and Naive Bayes perform less effectively, with lower precision and recall. Overall, the table helps identify the most suitable algorithm by highlighting which models deliver the best balance of accuracy and consistency.

Algorithms	precission	recall	f1-score	support	weighted	accuracy	error
Random Forest	0.64	0.45	4 0.23	0.18	0.17	406	0.4354
Logistic Regression	0.47	0.73	1 0.45	0.55	0.12	432	0.5344
Decission Tree	0.23	0.63	5 0.64	0.61	0.21	124	0.8419
Naive Bayes	0.87	0.76	3 0.17	0.34	0.28	675	0.4675
SVM	0.49	0.96	4 0.63	0.65	0.15	356	0.7664
KNN	0.25	0.56	2 0.74	0.32	0.19	754	0.8654
CNN (Convolutional Neural Network)	0.62	0.43	8 0.49	0.11	0.22	345	0.4554

Reference Links:

Source Code:
https://github.com/zunaira-sohail12/zuna_thesis.git

Demonstration Video:

https://www.loom.com/share/26c8b993aecd4d9984347c142244237c

Machine-Learning Notebook:

Naive Bayes:
https://colab.research.google.com/drive/1xECEkKxhtBI6hRnv7arqjw1xTgMPyt2t?authuser=1 - scrollTo=vGiGJQYsqHC1

SVM:
https://colab.research.google.com/drive/1g5577swU2hvlq8L_KyOQAGlbI9WZfsWe?authuser=1 - scrollTo=HCKwIjsAy23z

Exploratory Data Analysis EDA:
https://colab.research.google.com/drive/19PMzjWIn_KnopsAXDe9VEwOqYQydr2ll?authuser=1 - scrollTo=HH59UmZKjGMZ

Decision Tree:
https://colab.research.google.com/drive/1_EaYpEu0rOvuzrPun3rFxIxj1hXaFqeb?authuser=1 - scrollTo=_Az61zEzsNvs

Random Forest:
https://colab.research.google.com/drive/104mFNE3-NumY_ooM2VWaHeEWaYNpd6E4?authuser=1 - scrollTo=hgyk8mjX2CJU

Logistic Regression:
https://colab.research.google.com/drive/12W3FZFPjvPA9ruFQN6h55vwy1lioE5G4?authuser=1 - scrollTo=Yw_tc91iRhro

KNN:
https://colab.research.google.com/drive/1Vef_WtGI8v3ACZ5b4iq3xoC5MQCM3BU4?authuser=1 - scrollTo=8v79-t0rje8-

Convolutional Neural Network CNN:
https://colab.research.google.com/drive/1tupsKYX3mAjh1lQjncqgUiAZH5XqdDyg?authuser=1 - scrollTo=yaW9ybwFQzBi

STEP Dataset Creation:
https://colab.research.google.com/drive/1UIPWxEdid2UPd3yNE0nlH8MoayEe5z-1?authuser=1