AUTODESK UNIVERSITY

Integrating AI-ML with Autodesk Fusion360 and Autodesk PLM360

Deepali Pulate
SQA Engineer

Suraj Meshram
Research Scholar

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Learning Objectives

What will you learn today?

Learning Objectives

- Apply automation techniques to your designs and daily workflows to save time and effort, Learning New techniques
- AI/ML, adopt efficient ways to work on complex assemblies and data, Data management, New or efficient Technologies
- Cost and time effective Design, optimizing existing business services, Increasing revenue
- Increasing customer satisfaction, offering differentiated digital services, Automating business operations

Content

- Introduction
- Why?
- Now
- Future
- Summary

Speaker

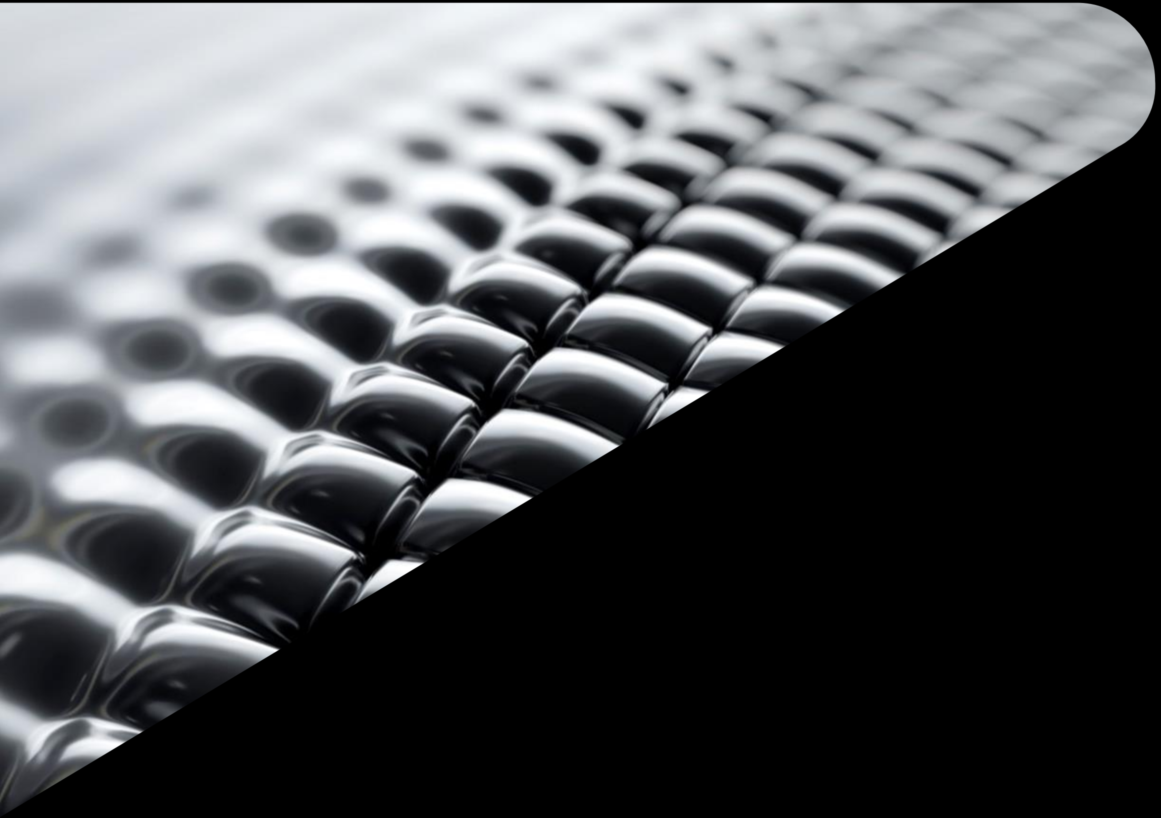
Deepali Pulate

- SQA Engineer with 6+ years of experience in CAD Domain.
- Started my Testing career with Dassault Systems in 2016, and currently working with Autodesk from Sept 2021.
- Education : Mechanical Engineer, PG Diploma in CAD.
- Worked on Different Cad Software like AutoCad, Inventor, SolidWorks, SolidEdge, Fusion360, SmarTeam, Enovia, 3DExperience, Catia, AutoVue, UG-NX, etc.
- Passionate about Innovation and Acro Contemporary Dance Form.

Speaker

Suraj Meshram

- Suraj Meshram is a Research Scholar in the Centre of Excellence in Artificial Intelligence at IIT Kharagpur.
- He has done his master's from IIT Delhi in Mechanical Design.
- He has hands-on experience in Modeling software such as Autodesk Inventor, SolidWorks and Catia.
- He is currently working on optimization techniques and the deployment of Deep Reinforcement learning models for the balancing of Assembly lines in Flexible Manufacturing Systems.



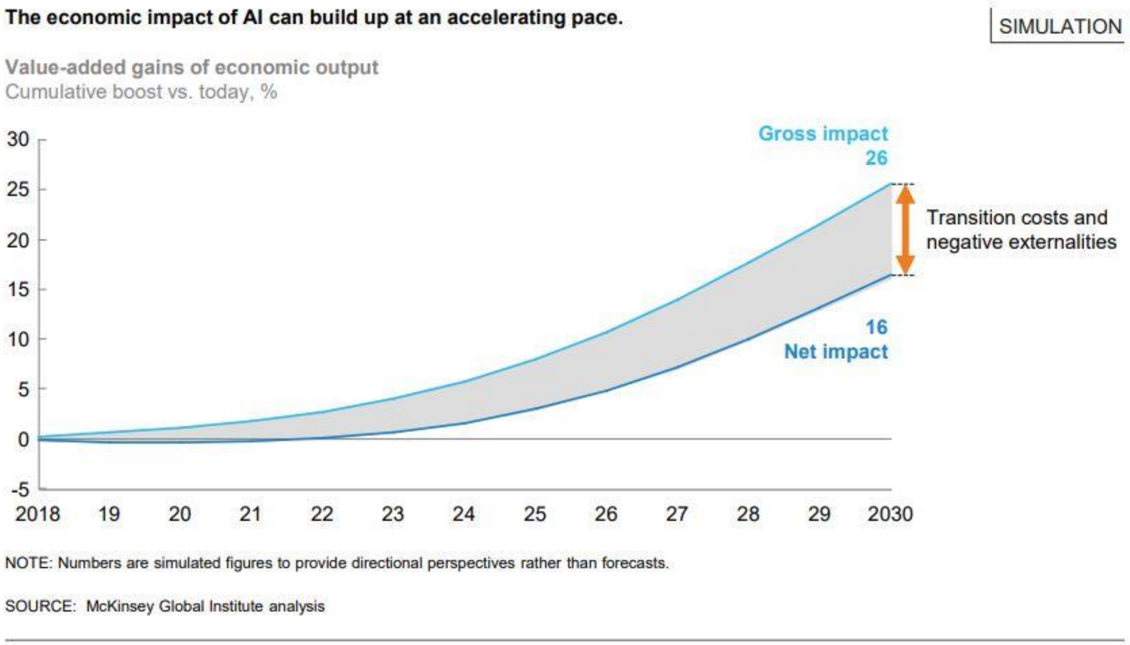
Why?

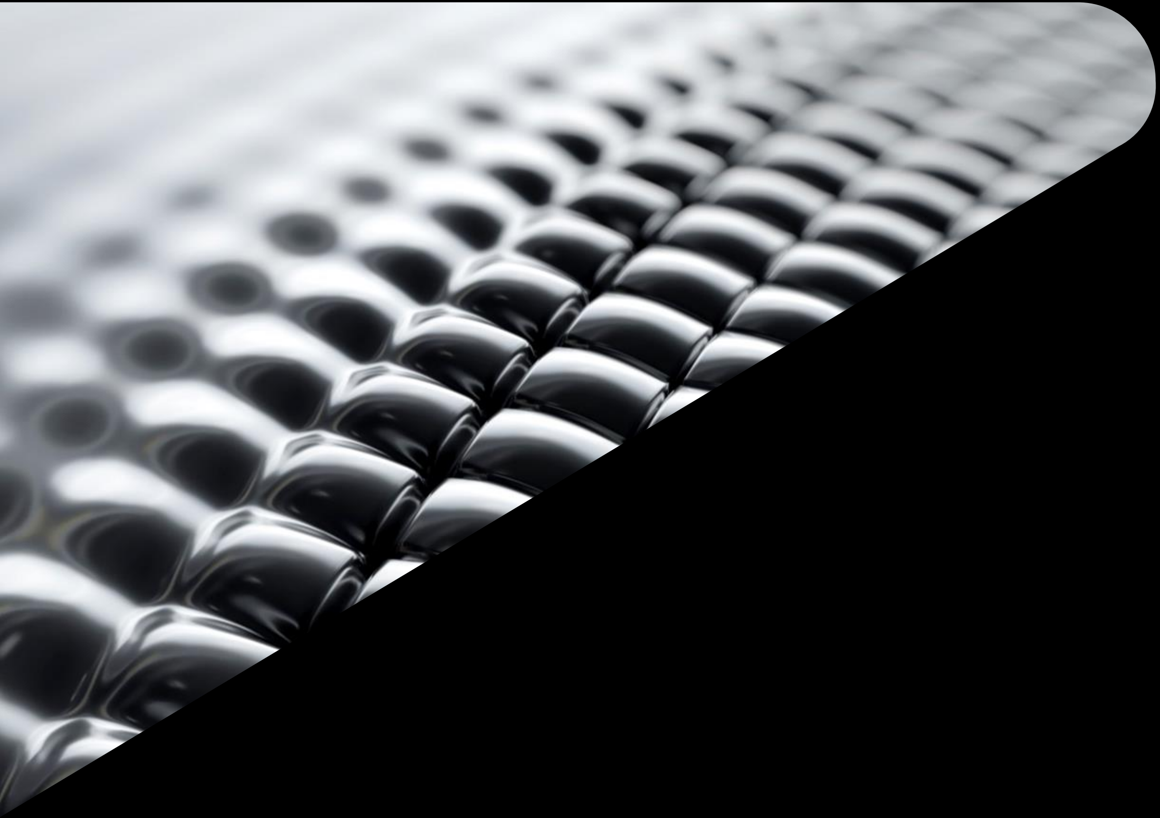
Why need of an AI?

- Outdated Design Processes
- Time
- Money
- Resources
- Energy
- Data

Artificial intelligence meets project management

- Decision-making
- Predictions
- Project kickoff
- Meeting notes and analysis





Now

Product Phases

Product requirements

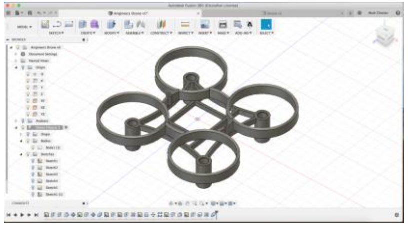
- Identification of Need

Modelling

- Model the Product on Modelling Software

Design

- Checking for the safety
- Traditional Designing



Manufacturing

- Production and Development

Credits: Google Images

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Product Phases

Product requirements — Identification of Need

Design — Checking for the safety

Modelling — Model the Product on Modelling Software

Can we skip this? →

- An iterative process
- Material Selection
- Selecting the design parameters (Dimensions)
- Checking safety against the stresses induce in the component
- Selection of Standard Components

→ **AI/ML**

Reduce cost

Reduce time and efforts

Bolt Design

Product requirements — Bolt required for Foundation with capacity of 250kN

Design — Checking for the safety

Modelling — Model the Product on Modelling Software

Can we skip this?

- An iterative process
- Material for Bolt
- Selecting the design parameters – such as number of bolts, factor of safety, Tensile stress areas
- Checking safety against the stresses induce in the component
- Selection of Standard Metric thread

AI/ML

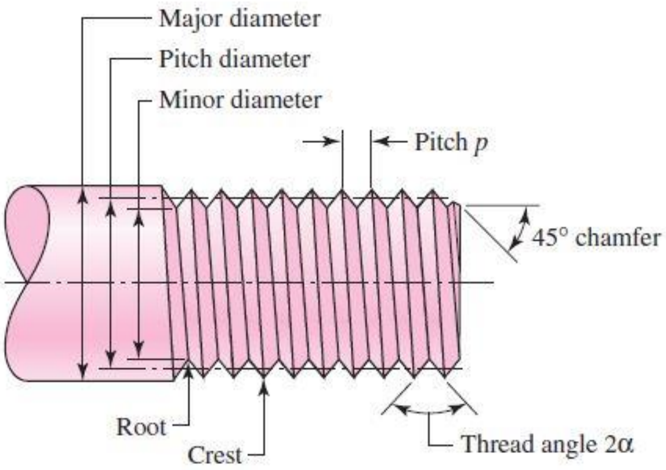
Reduce cost

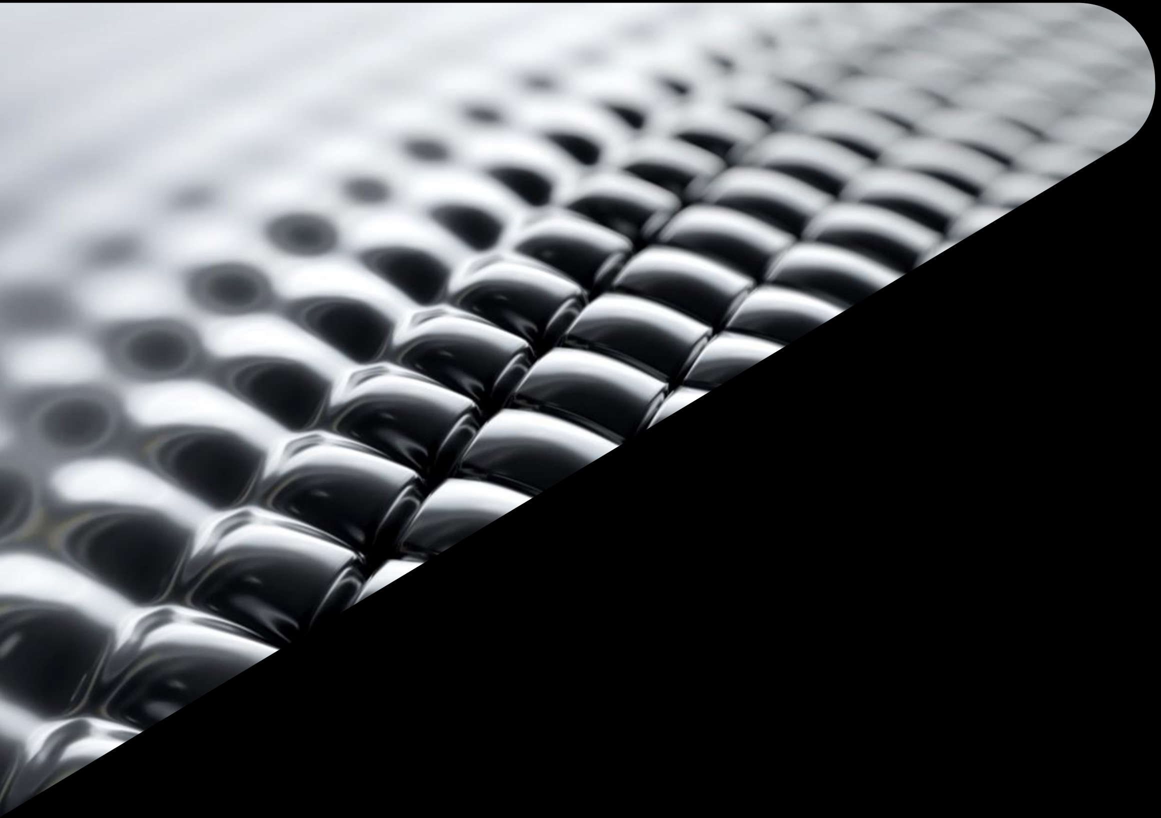
Reduce time and efforts

Bolt Design

- A bolt is a type of threaded hardware fastener that is used to position two workpieces in specific relation to each other

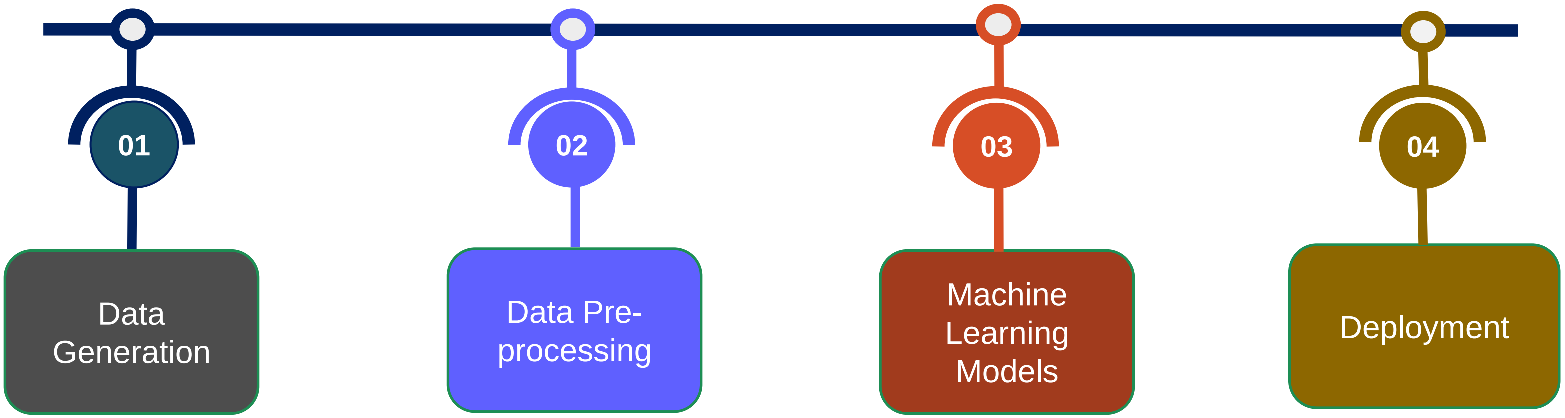
- **Standards:**
- The American National (Unified) thread standard defines basic thread geometry for uniformity and interchangeability





Future

Machine Learning Model Deployment Process



Data generated using the design procedure for bolts

Data was preprocessed using Normalization techniques

Machine Learning Models such as Logistic Regression, Naïve Bayes and Decision

Streamlit for the deployment in Web UI

Machine Learning Model Deployment Process

01

Data Generation

Data generated using the design procedure for bolts

Design Tensile capacity of bolt is given by this equation:

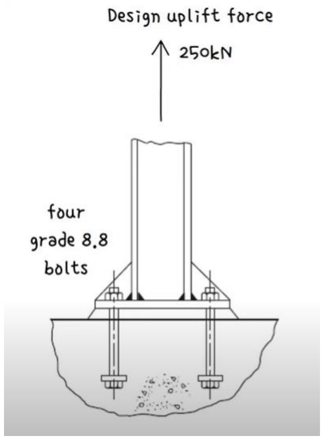
Material Property

Thread Property

Application

$$F_{t,Rd} = \frac{0.9 \times f_{ub} \times A_s}{\gamma_{M2}}$$

Safety



where:

- $f_{ub} = Ultimate\ tensile\ strength\ of\ a\ bolt$
- $A_s = Tensile\ Stress\ Area, mm^2$
- $\gamma_{M2} = Partial\ Safety\ factor$

Machine Learning Model Deployment Process

01

Data Generation

Data generated using the design procedure for bolts

Design Tensile capacity of bolt is given by this equation:

$$F_{t,Rd} = \frac{0.9 \times f_{ub} \times A_s}{\gamma_{M2}}$$

$$62500 = \frac{0.9 \times 800 \times A_s}{1.25}$$

$$A_s = 109\,mm^2$$

Nominal Major Diameter d mm	Coarse-Pitch Series: Pitch p mm	Coarse-Pitch Series: Tensile-Stress Area A_t mm²	Coarse-Pitch Series: Minor-Diameter Area A_r mm²	Fine-Pitch Series: Pitch p mm	Fine-Pitch Series: Tensile-Stress Area A_t mm²	Fine-Pitch Series: Minor-Diameter Area A_r mm²
1.6	0.35	1.27	1.07			
2	0.40	2.07	1.79			
2.5	0.45	3.39	2.98			
3	0.5	5.03	4.47			
3.5	0.6	6.78	6.00			
4	0.7	8.78	7.75			
5	0.8	14.2	12.7			
6	1	20.1	17.9			
8	1.25	36.6	32.8	1	39.2	36.0
10	1.5	58.0	52.3	1.25	61.2	56.3
12	1.75	84.3	76.3	1.25	92.1	86.0
14	2	115	104	1.5	125	116
16	2	157	144	1.5	167	157
20	2.5	245	225	1.5	272	259
24	3	353	324	2	384	365
30	3.5	561	519	2	621	596
36	4	817	759	2	915	884
42	4.5	1120	1050	2	1260	1230
48	5	1470	1380	2	1670	1630
56	5.5	2030	1910	2	2300	2250
64	6	2680	2520	2	3030	2980
72	6	3460	3280	2	3860	3800
80	6	4340	4140	1.5	4850	4800
90	6	5590	5360	2	6100	6020
100	6	6990	6740	2	7560	7470
110				2	9180	9080

*The equations and data used to develop this table have been obtained from ANSI B1.1-1974 and B18.3.1-1978. The minor diameter was found from the equation $d_r = d - 1.226\,869p$, and the pitch diameter from $d_p = d - 0.649\,519p$. The mean of the pitch diameter and the minor diameter was used to compute the tensile-stress area.

Machine Learning Model Deployment Process

01

Data Generation

Data generated using the design procedure for bolts

Input Features

Design Uplift Force	No of bolts	Ultimate Tensile Strength of bolt	Partial Factor of safety = γm2	Tensile Stress Area
250000	4	800	1.25	108.51
500000	4	800	1.25	217.01
500000	6	400	1.1	254.63
60300	1	800	1.25	104.69

Output Features → M14 * 2.0

56 lakhs rows were created, and 1000 datasets were selected randomly for each classes.

Machine Learning Model Deployment Process

02

Data Pre-processing

Data was preprocessed using Normalization techniques

Input Features

Design Uplift Force	No of bolts	Ultimate Tensile Strength of bolt	Partial Factor of safety = γm2	Tensile Stress Area
0.5	0.5	1.0	1.0	0.425
1.0	0.5	1.0	1.0	0.854
1.0	0.75	0.5	0.88	1.0
0.1206	0.1	1.0	1.0	0.409

Training and Test Dataset = 0.75

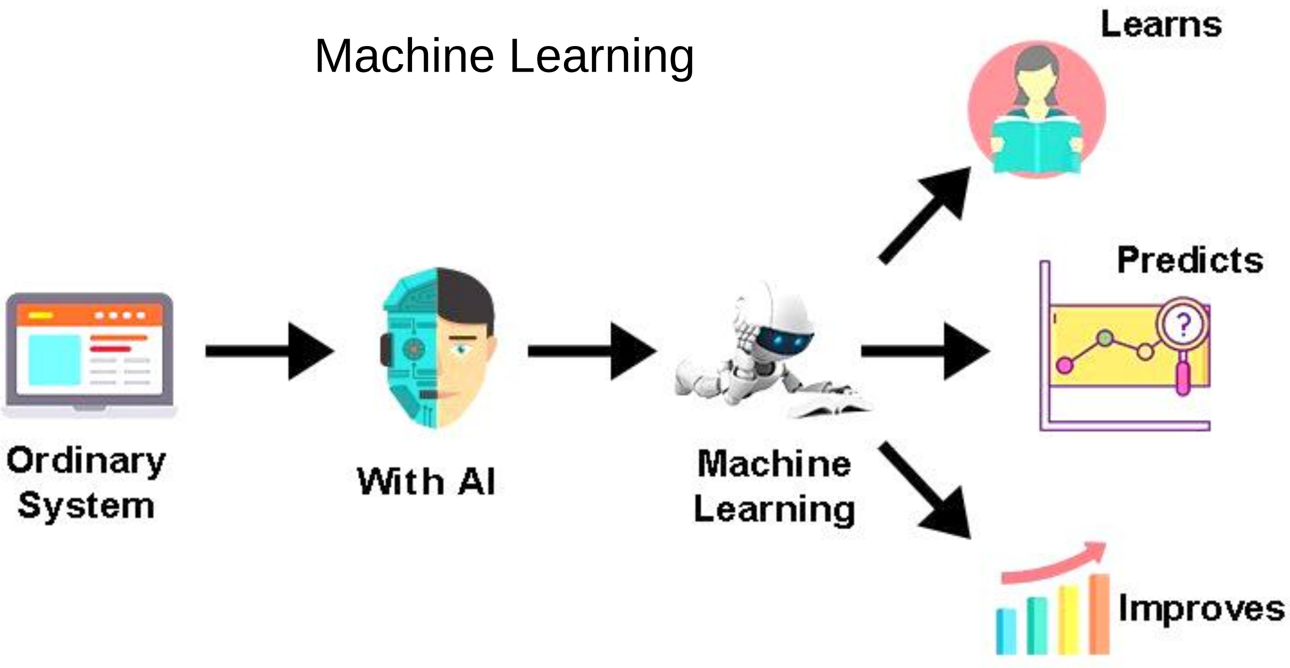
Machine Learning Model Deployment Process

03

Machine Learning Models

Machine Learning models were used to recommend the selected design

Machine Learning



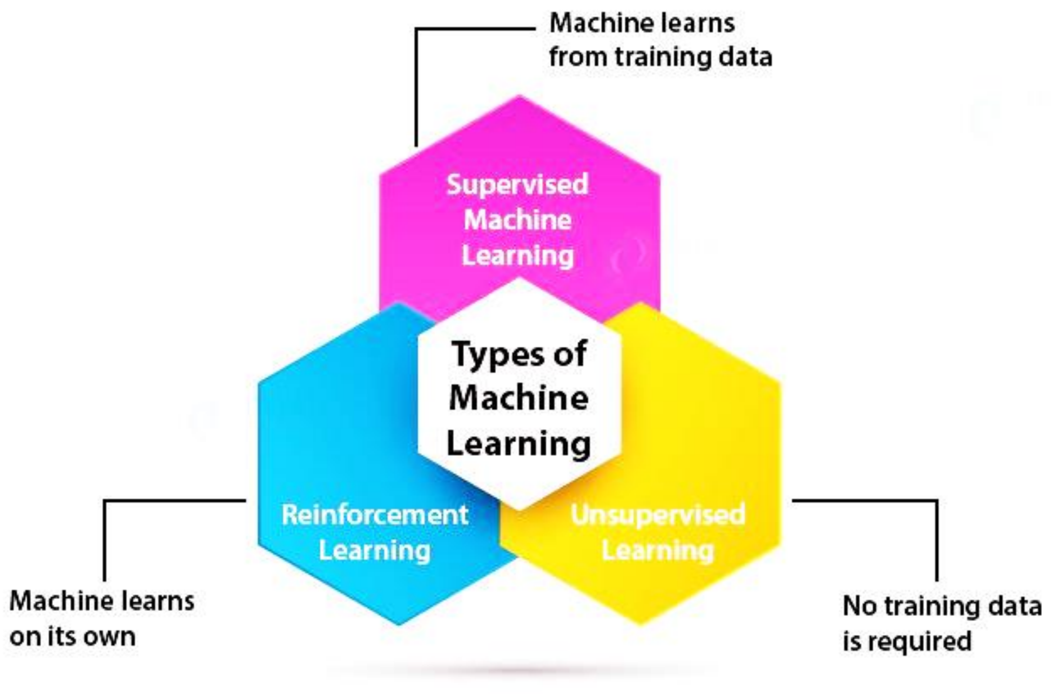
Credits: DataFlare

Machine Learning Model Deployment Process

03

Machine Learning Models

Machine Learning models were used to recommend the selected design



Credits: DataFlare

Machine Learning Model Deployment Process

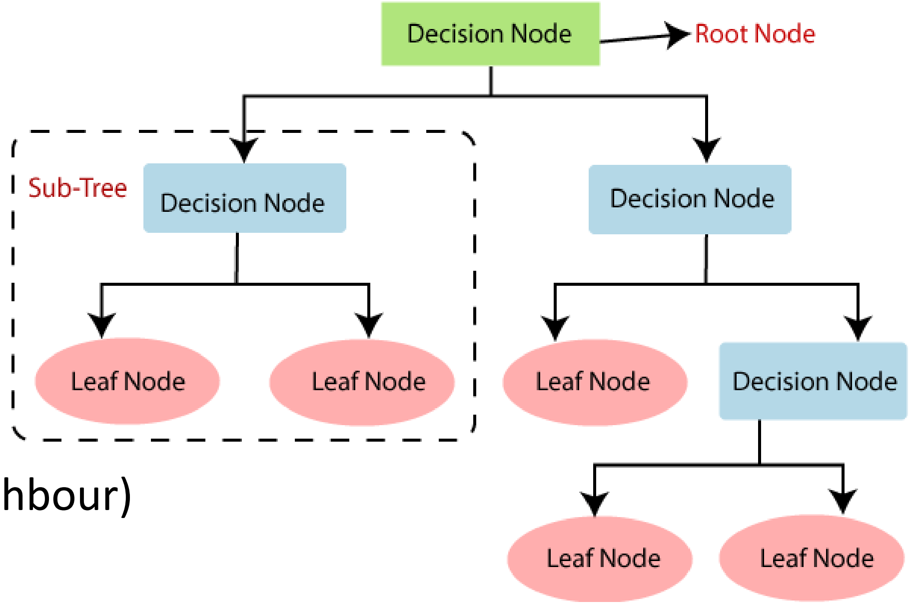
03

Machine Learning Models

Machine Learning models were used to recommend the selected design

Classification Models

- Logistic Regression
- Naive Bayes
- **Decision Trees**
- KNN (K Nearest Neighbour)



Machine Learning Model Deployment Process

03

Machine Learning Models

Machine Learning models were used to recommend the selected design

Training and Testing Accuracy

Machine Learning Model	Training Accuracy	Testing Accuracy
Logistic Regression	28 %	26 %
Naïve Bayes	83%	84 %
Decision Trees	**100 %**	**100 %**
KNN (K-Nearest-Neighbor)	98 %	96 %

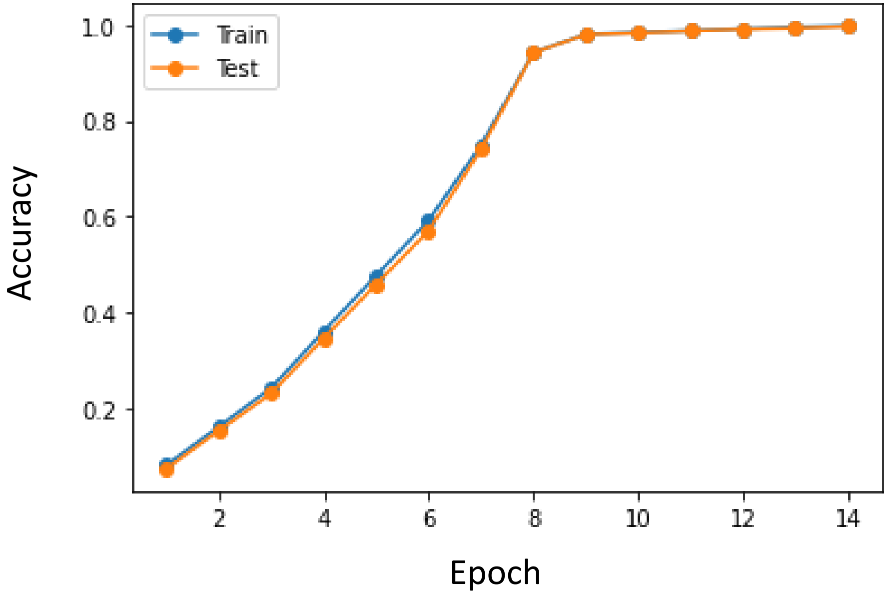
Machine Learning Model Deployment Process

03

Machine Learning Models

Machine Learning models were used to recommend the selected design

Training and Testing Accuracy

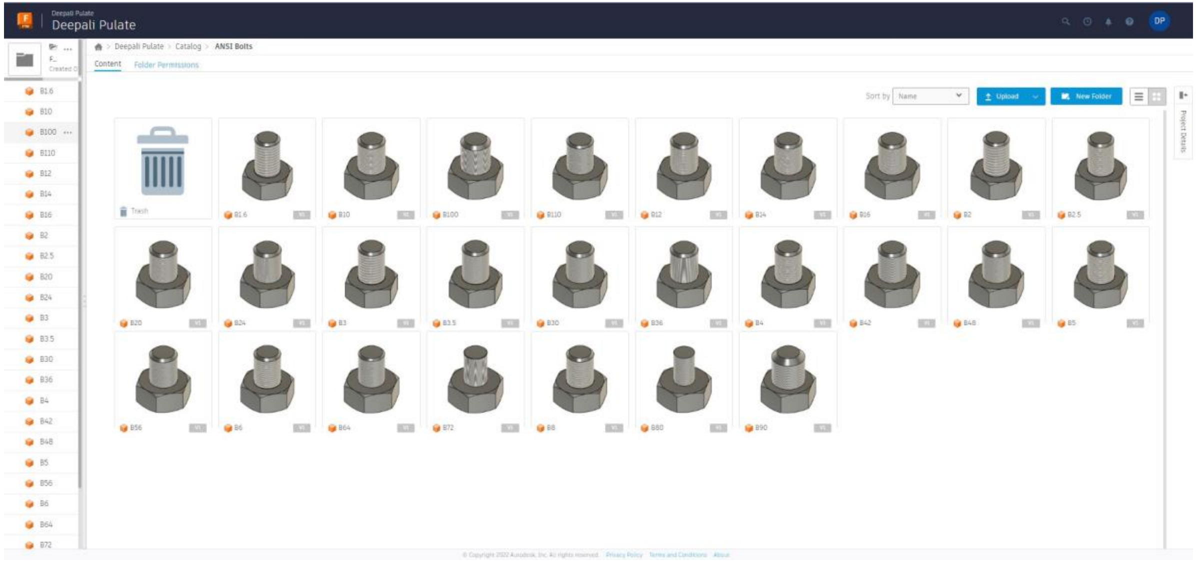


Machine Learning Model Deployment Process

04

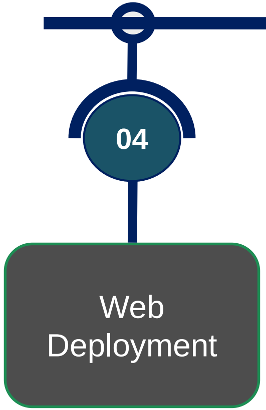
Web Deployment

Already existing Standards created in Dataset Library of Fusion 360

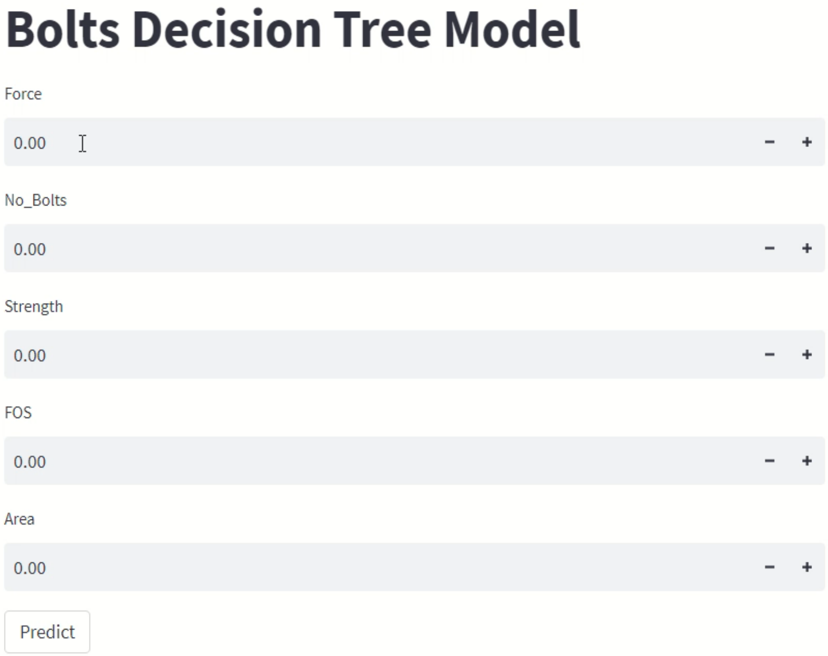


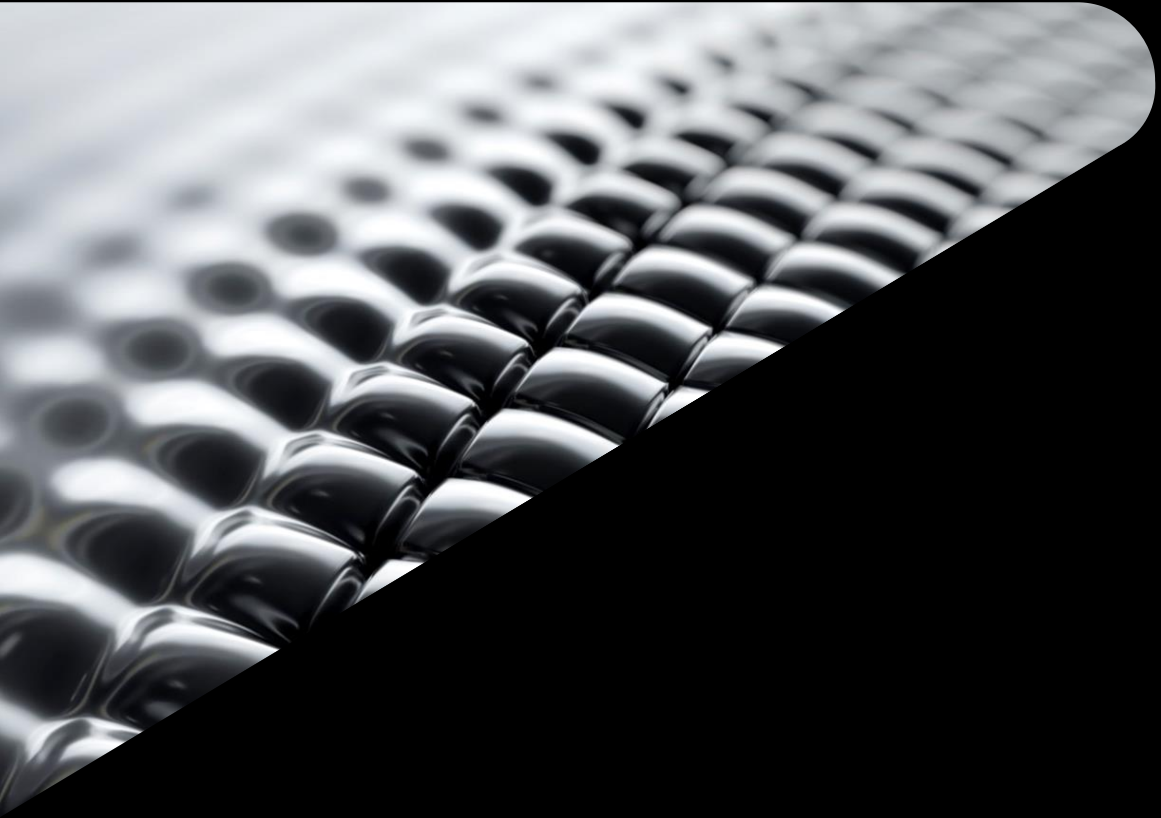
Web Deployment using Streamlit

Machine Learning Model Deployment Process



Web Deployment using Streamlit





Conclusion

Future Work

- Implementation of the Model on the actual Fusion 360 platform
- Modelling of on the fly Machine parts.
- ***We can train the Machine Learning Model to create parts by itself.***