
The Beauty of Machine Learning
A Journey Through IBM—Machine Learning Professional Certificate by Salah

The Big Picture

- One of humanity's most potent tools is mathematics. It enables us to easily conduct our daily activities, such as purchasing and selling. Even when we reached the moon and beyond, these achievements depended entirely on mathematics. Systematic thinking in mathematics allows us to classify objects, predict the future, understand patterns in data, and more. These systematic methods are known as algorithms, which use logic to reach answers. Yet, a significant challenge in some of these algorithms is that they are incredibly lengthy and sometimes impossible to do by hand.
- Therefore, we use computers to make them do calculations for us. Since computers are much faster than us in logic and arithmetic, their capability to apply algorithms to find solutions is remarkable. “It seems probable that once the machine thinking method had started, it would not take long to outstrip our feeble powers” Alan Turing, 1951.

Machine Learning Algorithms

- In short, machine learning algorithms are mathematical approaches to solving problems related to forecasting, classification, clustering, dimensionality reduction, natural language processing, and other applications. Despite the situation, machine learning provides solutions without being explicitly programmed. This beautiful nature of machine learning makes it a great asset in technological advancements.

- In these capstone projects, I used Scikit-Learn framework to build the machine learning models and Keras for the deep learning models. Moreover, these projects cover four sectors: health, green energy, agriculture, and online content. The complexity increases as we move forward from project A to project F.

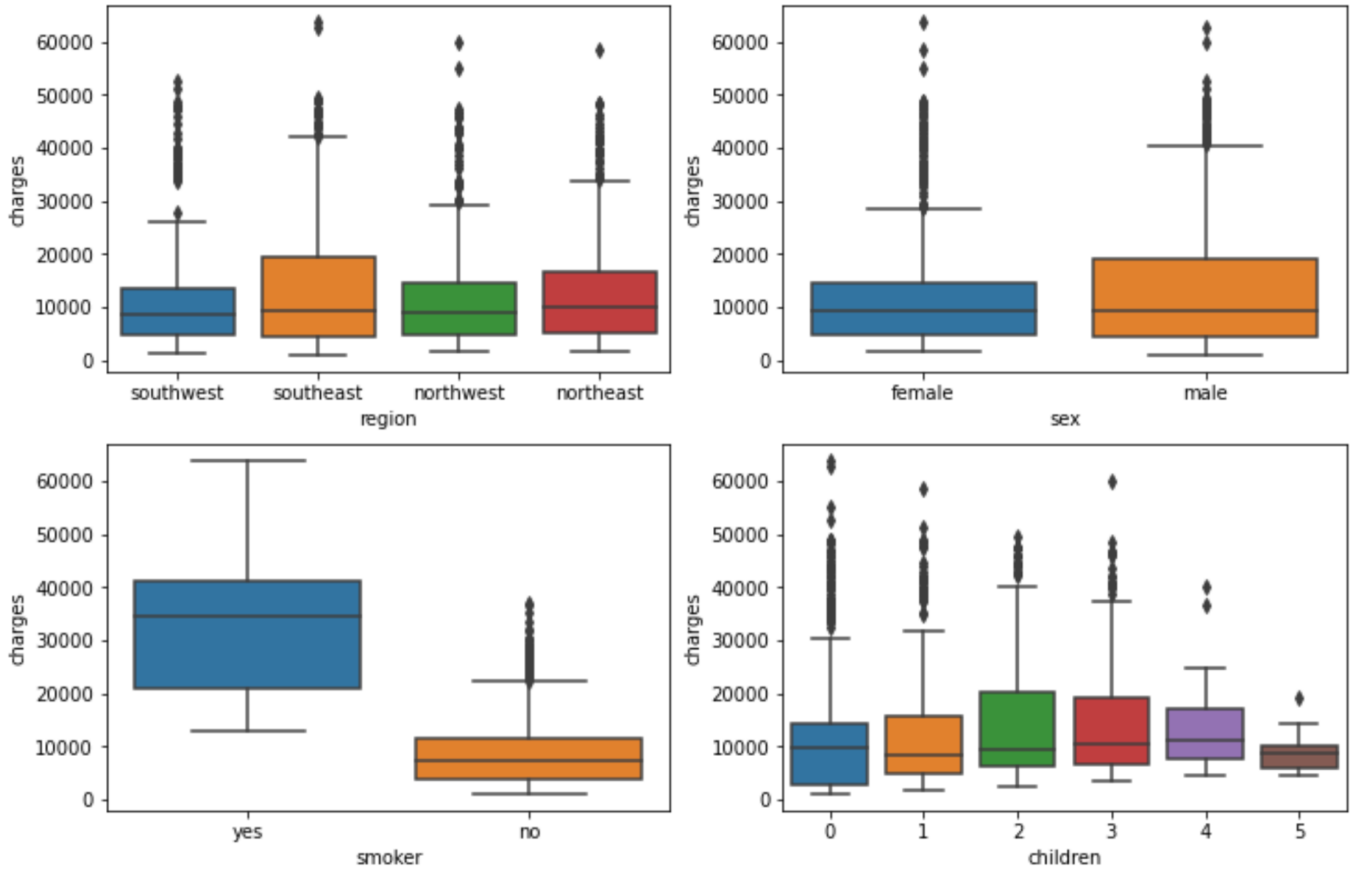
Project A — Treatment Costs per Person - Exploratory & Predictive Analysis

- Aim: predict the cost of medical treatments based on six features, namely, age, sex, BMI, children, smoking status, and region.

- Procedure: In-depth EDA via pair, bar, box, violin, and regression plots to see the effect of smoking on charges. Hypothesis testing on the relationship between treatment costs and smoking status.

- Findings: The test indicates that a person with a 35K$ charge or more is likely a smoker with a p-value = 0.023 and a confidence level = 0.977.

- [Project GitHub Notebook]



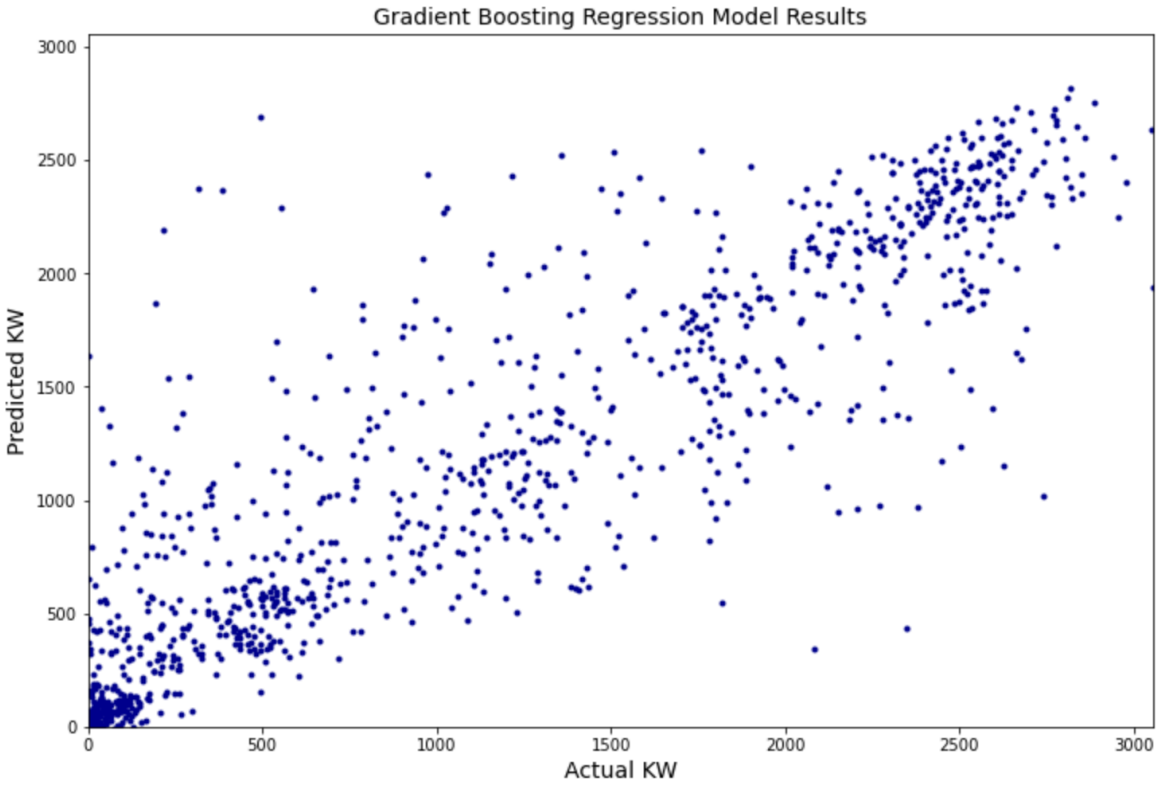
Project B — Forecasting Photovoltaic Generated Power - Regression Analysis

- Aim: create a regression model that predicts the generated power by PV panels to facilitate energy management in power plants.

- Procedure: Deploy a pipeline encompassing polynomial transformation, standard scaling, and regressor models. Then, apply GridSearchCV, hyper-parameters tuning and benchmarking of Regular, Lasso, Ridge, Elastic Net & Gradient Boosting Regressors.

- Findings: The winner is the Gradient Boosting Regressor model with an R2 score of ~ 0.79.

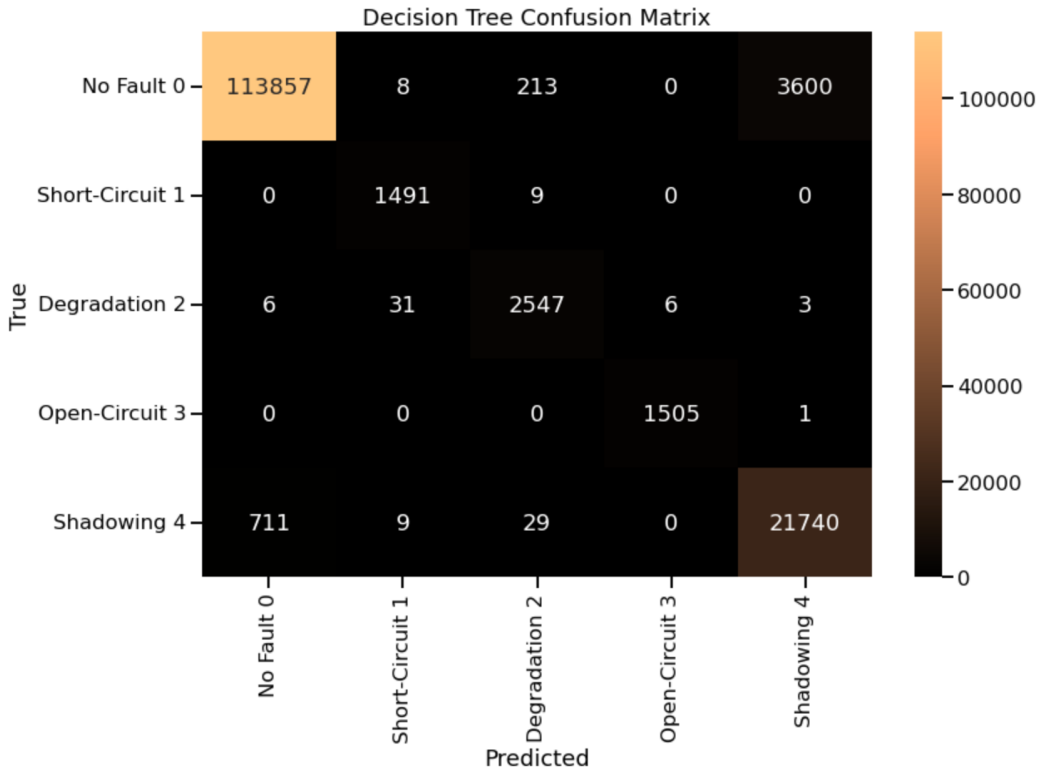
- Project GitHub Notebook



	RMSE	R2
Linear Regression	518.185763	0.693086
Lasso	472.603033	0.744707
Ridge	522.369032	0.688110
ElasticNet	491.545238	0.723832
Gradient Boosting Reg	425.442963	0.793115

Project C — Fault Classification in Photovoltaic Plants - Multi-Class Classification Analysis

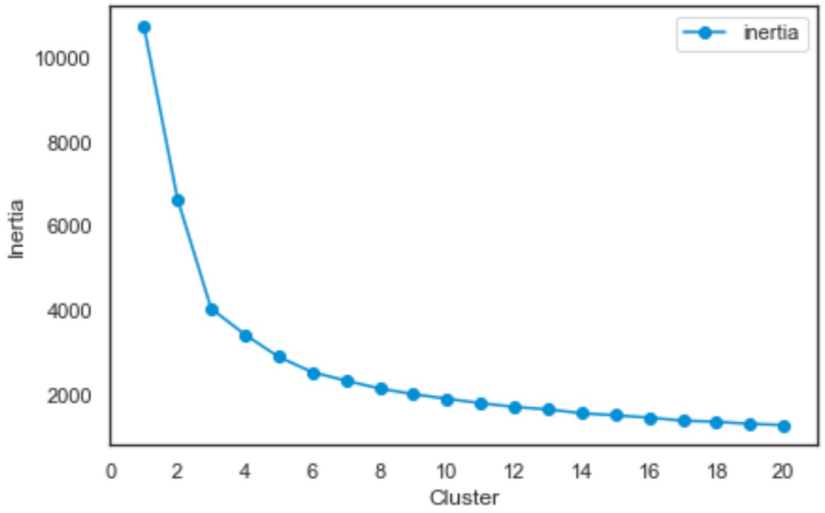
- Aim: Classify the faults that might occur in photovoltaic panels, namely, Short-Circuit, Open-Circuit, Degradation, and Shadowing.
- Procedure: Data stratified split, features scaling, and re-weighting the imbalanced classes. Then, apply a GridSearchCV, hyper-parameters tuning and benchmarking of Logistic Regression, Decision Tree, and Random Forrest.
- Findings: The winner is the Decision Tree algorithm with an accuracy and a weighted F1-score of ~ 97%.
- [Project GitHub Notebook]

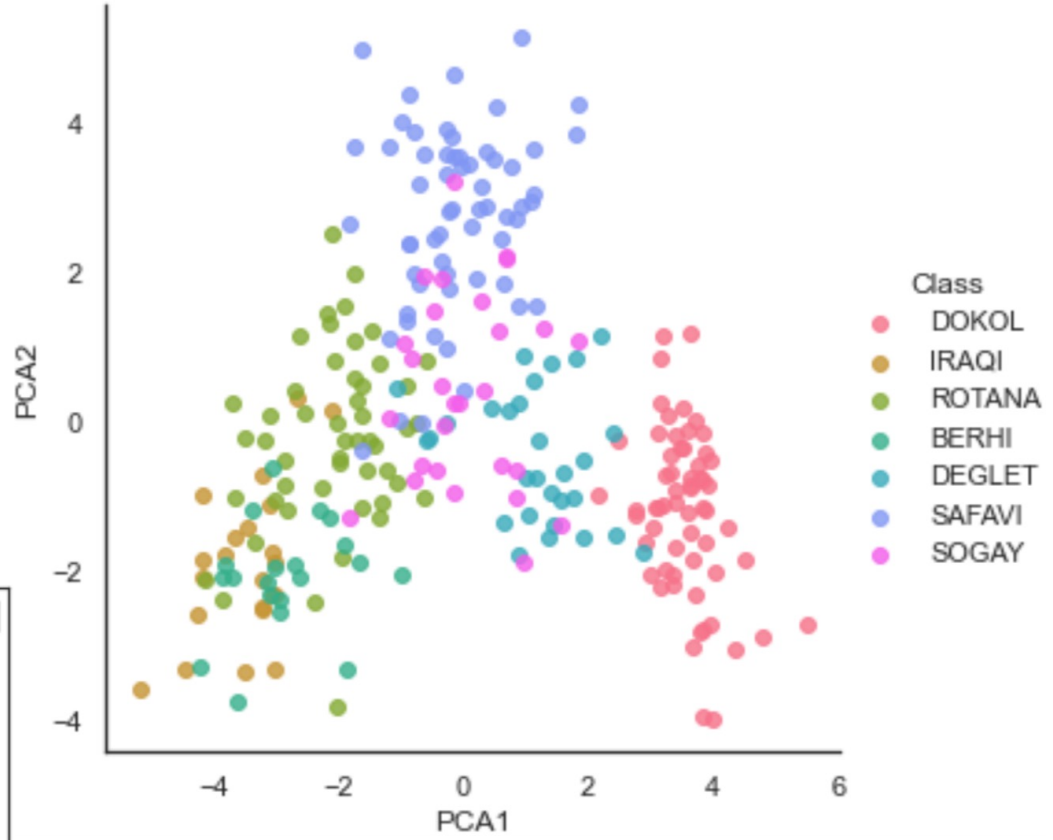


Metric	Logistic Regression	Decision Tree	Random Forest
Accuracy	0.924619	0.968264	0.949000
Weighted Precision	0.921286	0.971051	0.956368
Weighted Recall	0.924619	0.968264	0.949000
Weighted F1score	0.919966	0.968989	0.950931

Project D — Date Fruit Segmentation & Dimensionality Reduction via PCA - Unsupervised Analysis

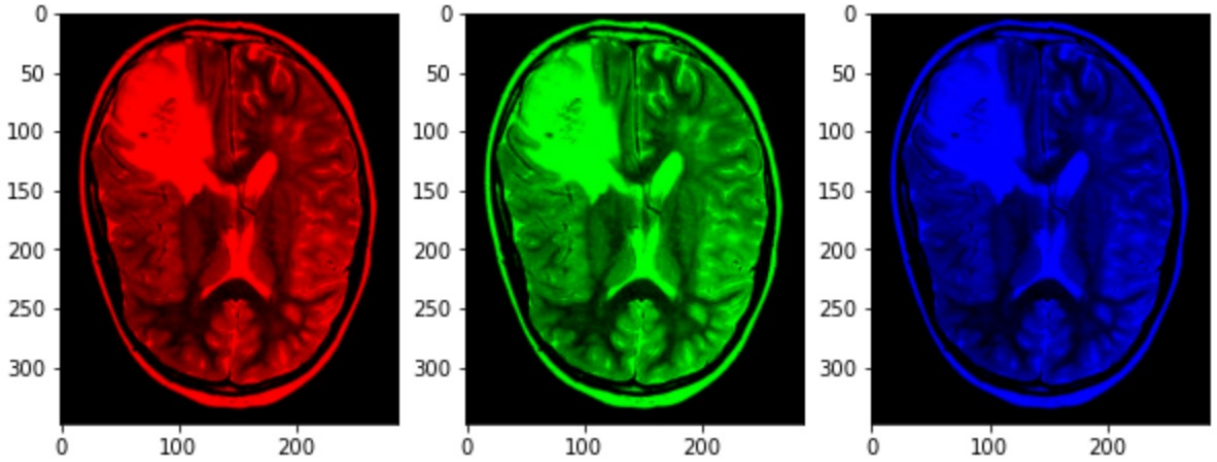
- Aim: Cluster date fruits based on their physical features.
- Procedure: Check multicollinearity, scale data, and reduce the number of features via PCA. Then, apply a comparative analysis between K-means, Agglomerative, Mean Shift & DBSCAN clustering.
- Findings: The winner is the k-means++ technique. Also, an accuracy of 76% was scored with only two PCAs.
- [Project GitHub Notebook]

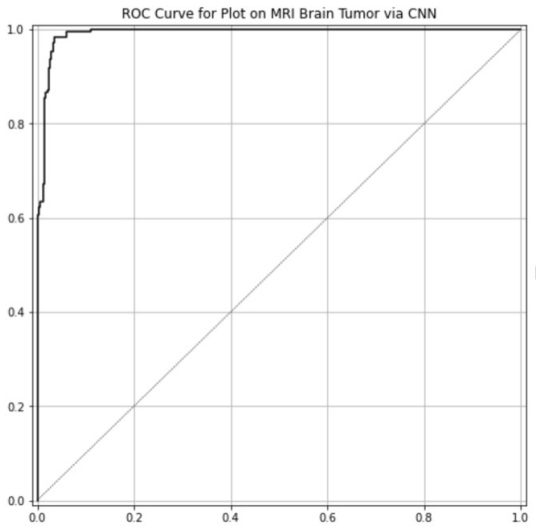


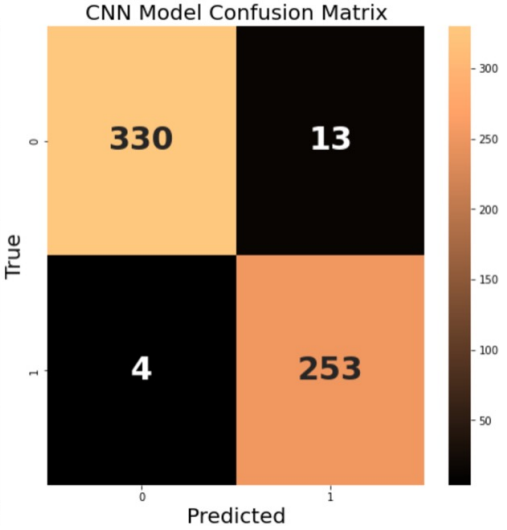


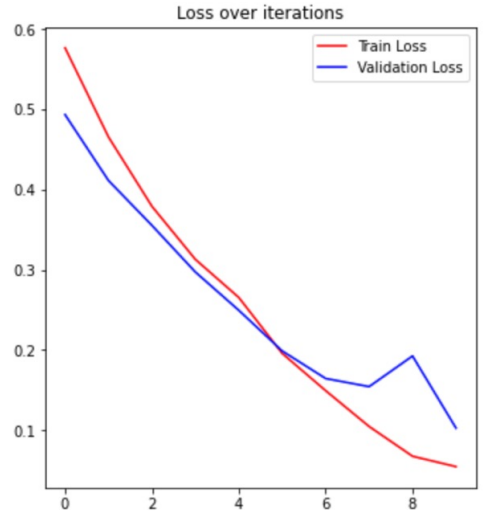
Project E — MRI Brain Tumor Classification via CNN - Deep Learning Analysis

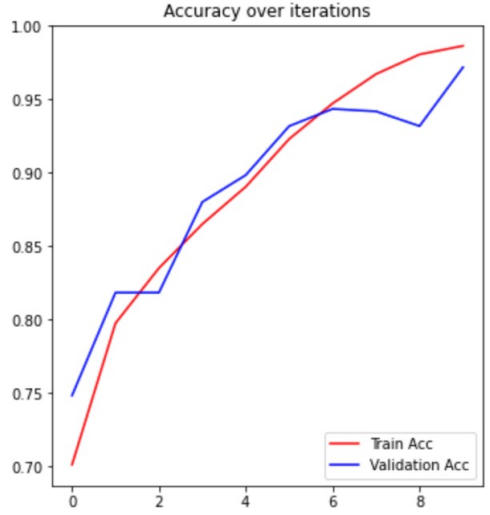
- Aim: Detect whether a patient has a brain tumor or not.
- Procedure: Convert images to a NumPy array and scale them. Build a convolutional network and train the CNN model to classify brain tumors. Then, deploy the deep learning model using Flask app.
- Findings: The CNN model accuracy is 97%.
- [Project GitHub Notebook]



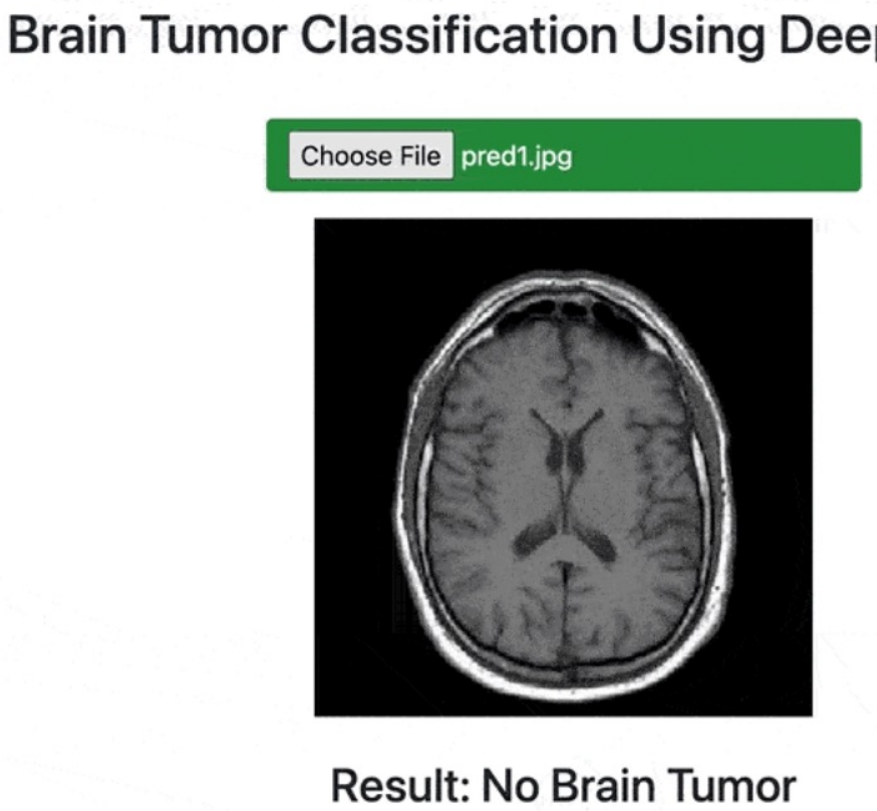


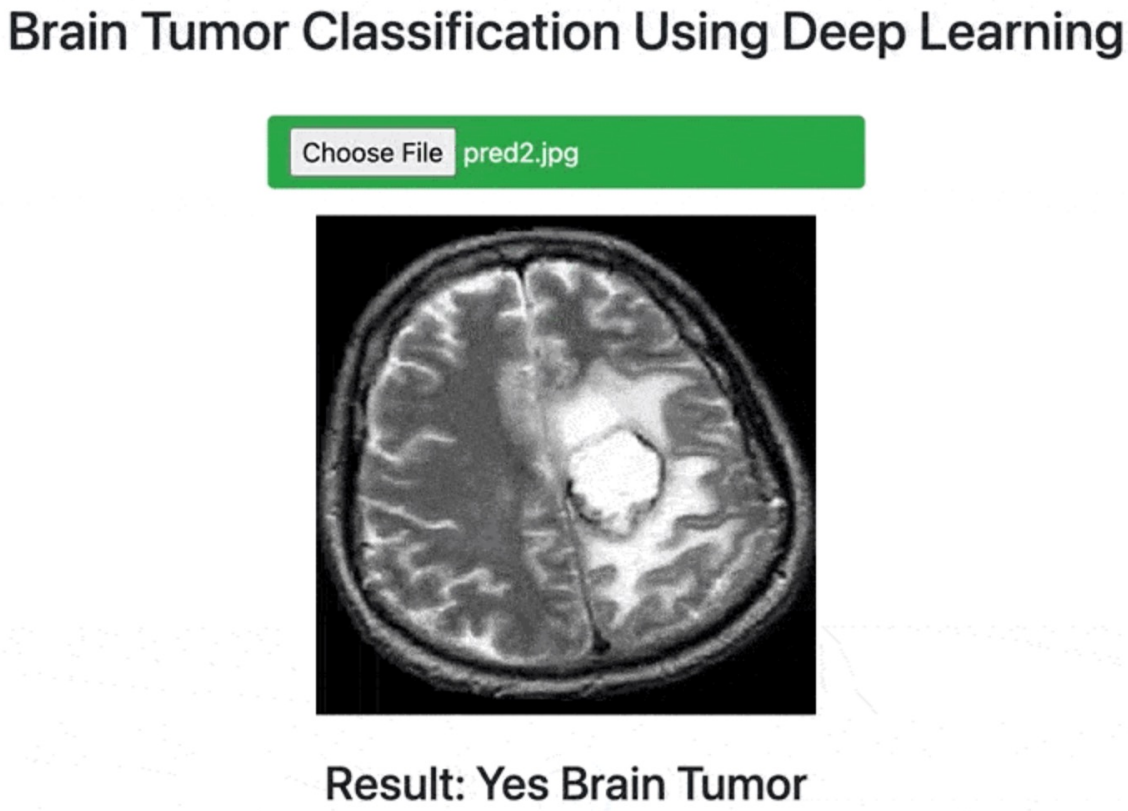






Project E — MRI Brain Tumor Classification via CNN - Dashboard





The dashboard is created using Flask framework. First, it prompts the user to select an MRI image. Then, it uses the convolutional neural network model to classify whether there is a brain tumor or not. The two figures demonstrate the outcomes of the model.

Project F – IBM Capstone Project — Personalized Course Recommendation System for Data Science Learners

- **Aim: To build a recommendation system that recommends the most suitable courses for learners on educational platforms.**
- **Procedure: As listed in the findings, several techniques are used to build the recommendation system.**
- **Findings: The recommender system is created via eight approaches. Firstly, the content-based approaches.**

Approach 1 - Content-Based Recommender Using User Profile and Course Genres.

Approach 2 - Content-Based Recommender Using Course Similarities.

Approach 3 - Content-Based Recommender Using PCA Clustering.

USER	COURSE_ID	SCORE
37465	RP0105EN	27.0
37465	GPXX06RFEN	12.0
37465	CC0271EN	15.0
37465	BD0145EN	24.0
37465	DE0205EN	15.0
...	...	...
2087663	excourse88	15.0
2087663	excourse89	15.0
2087663	excourse90	15.0
2087663	excourse92	15.0
2087663	excourse93	15.0

Approach 1

USER	COURSE_ID	SCORE
37465	[DS0110EN, excourse67, excourse63, excourse72,...	[0.7329409123199365, 0.7082138557765277, 0.694...
50348	[CB0101EN, DS0110EN, CL0101EN, excourse67, exc...	[0.9233805168766388, 0.7329409123199365, 0.732...
52091	[ML0120ENv3, CB0101EN, excourse24, excourse36,...	[1.0, 0.9233805168766388, 0.7526312050490548, ...
70434	[excourse67, excourse72, excourse74, excourse68]	[0.7082138557765277, 0.7036476305124202, 0.650...
85625	[TMP0101EN, excourse72, TA0105EN, BD0151EN, BD...	[0.8894991799933215, 0.7036476305124202, 0.659...
...	...	...
2061096	[DS0110EN, excourse67, excourse63, excourse72,...	[0.7329409123199365, 0.7082138557765277, 0.694...
2074313	[excourse36, excourse23, DS0110EN, DV0151EN, e...	[0.7397041774816828, 0.7397041774816828, 0.732...
2074462	[CL0101EN, excourse22, excourse62, excourse24]	[0.7327907262791404, 0.6475015976638527, 0.647...
2082818	[DV0151EN, ML0115EN, ML0122EN]	[0.7235359517703827, 0.7071067811865475, 0.681...
2087663	[CB0103EN, excourse24, DS0110EN, CL0101EN, exc...	[0.9233805168766388, 0.7526312050490548, 0.732...

Approach 2

user	cluster	Recommended_Unseen_Courses
1502801	4	[DS0101EN, PY0101EN, SC0101EN, BD0121EN, DS010...
1609720	5	[PY0101EN, DS0103EN, BD0101EN, DS0105EN, ML011...
1347188	3	[CO0101EN, CC0101EN, CC0201EN, DS0101EN, BD010...
755067	4	[BD0111EN, BD0211EN, BD0115EN, BD0141EN, BD013...
538595	4	[BD0211EN, BD0131EN, DS0101EN, PY0101EN, SC010...
...	...	...
481658	4	[BD0211EN, BD0115EN, BD0131EN, DS0101EN, PY010...
1341273	3	[CC0101EN, BC0101EN, CO0301EN, CC0103EN, DS010...
884271	1	[DS0101EN, PY0101EN, DS0103EN, DS0105EN, ML011...
1868084	2	[LB0101ENv1, LB0107ENv1, BC0101EN]
630511	1	[DS0101EN, BD0101EN, DS0103EN, DS0105EN, BC010...

Approach 3

Project F — IBM Capstone Project — Personalized Course Recommendation System for Data Science Learners

• Findings: The remaining five approaches are collaborative-based. The comparison between them is based on RMSE.

Approach 4 - Collaborative-Filtering Recommender Using K Nearest Neighbor

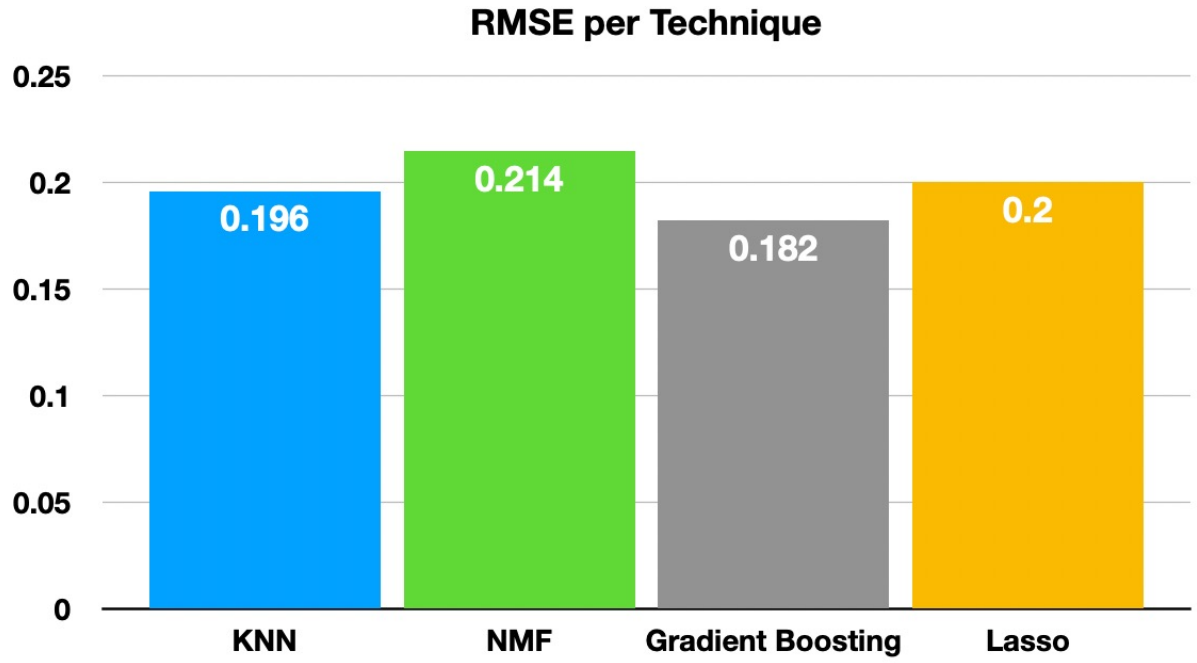
Approach 5 - Collaborative-Filtering Recommender Using Non-negative Matrix Factorization

Approach 6 - Collaborative-Filtering Recommender Using Neural Networks

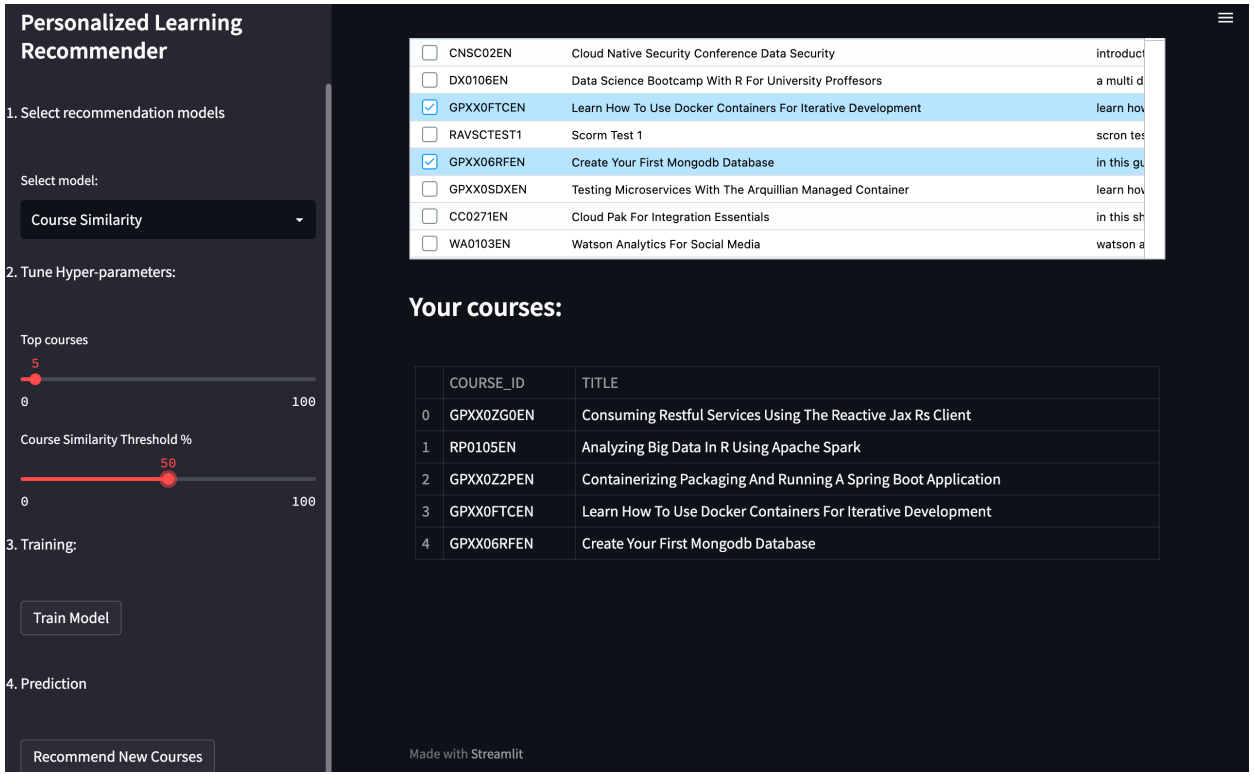
Approach 7 - Collaborative-Filtering Recommender Using Embedding Features Regression

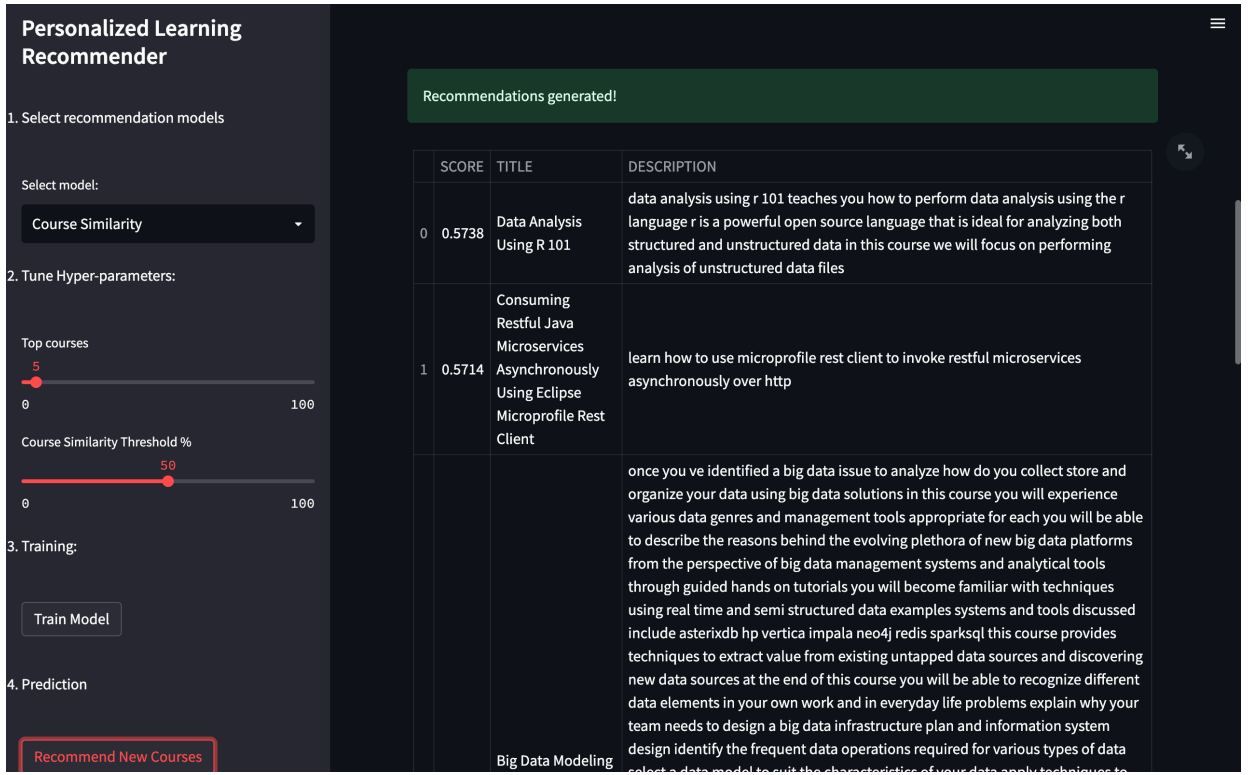
Approach 8 - Collaborative-Filtering Recommender using Embedding Features

• Approaches Notebooks



Project F — IBM Capstone Project — Personalized Course Recommendation System for Data Science Learners Dashboard





- The dashboard is created using Streamlit framework. The backend and frontend are created by IBM.

6 Courses

Exploratory Data Analysis for Machine Learning

Supervised Machine Learning: Regression

Supervised Machine Learning: Classification

Unsupervised Machine Learning

Deep Learning and Reinforcement Learning

Machine Learning Capstone

Aug 26, 2022

SALAH ALDDEEN YACOUB A. AL KAFRAWI

has successfully completed the online, non-credit Professional Certificate

IBM Machine Learning

Machine Learning is one of the most in-demand skills for jobs related to modern AI applications, a field in which hiring has grown 74% annually for the last four years (LinkedIn). This Professional Certificate from IBM provides evidence that the above named individual developed skills in Machine Learning: Unsupervised Learning, Supervised Learning, Deep Learning, and Reinforcement Learning; including Time Series Analysis and Survival Analysis. This program consisted of 6 courses providing a solid theoretical understanding and considerable practice of the main algorithms, uses, and best practices related to Machine Learning.

Joseph Santarcangelo
Senior Data Scientist
IBM

Mark J Grover
Digital Content Delivery Lead
IBM Data & AI Learning

Miguel Maldonado
Machine Learning Curriculum Developer
Data and AI Learning

Yan Luo
Ph.D., Data Scientist and Developer

Svitlana Kramar
Data Science Content Developer
Skills Network

The online specialization named in this certificate may draw on material from courses taught on-campus, but the included courses are not equivalent to on-campus courses. Participation in this online specialization does not constitute enrollment at this university. This certificate does not confer a University grade, course credit or degree, and it does not verify the identity of the learner.

Verify this certificate at:
https://coursera.org/verify/professional-cert/3P4L22THWW33