Insurance Charges Prediction - Regression Assignment

1. Problem Statement

The goal is to **predict insurance charges** based on various factors such as:

- **Age**
- **Sex** (Gender)
- **BMI** (Body Mass Index)
- **Number of Children**
- **Smoking Status**
- **Region** (if available)

This is a **supervised regression problem** where the target variable (charges) is continuous.

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2. Dataset Information

- **Total Rows:** 1338
- **Total Columns:** 7
- **Features:**
  - age: Age of the insured (numeric)
  - sex: Gender (male/female) (categorical)
  - bmi: Body Mass Index (numeric)
  - children: Number of children covered (numeric)
  - smoker: Smoking status (yes/no) (categorical)
  - region: Region of residence (if available) (categorical)
  - charges: Medical insurance charges (target variable) (numeric)

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3. Data Preprocessing

Steps Applied:

1. **Handling Missing Values** (if any)
2. **Encoding Categorical Variables** (e.g., sex, smoker, region using LabelEncoder or OneHotEncoder)
3. **Feature Scaling** (Standardization/Normalization if needed)
4. **Train-Test Split** (80% training, 20% testing)

Preprocessing Code Example:

python
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```python
import pandas as pd
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn.model_selection import train_test_split

# Load data
data = pd.read_csv("insurance_pre.csv")

# Encode categorical variables
label_encoder = LabelEncoder()
data['sex'] = label_encoder.fit_transform(data['sex'])
data['smoker'] = label_encoder.fit_transform(data['smoker'])

# Split into features (X) and target (y)
X = data.drop('charges', axis=1)
y = data['charges']

# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Feature scaling (if needed)
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
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4. Model Development & Evaluation

Models Tested:

Model	R^2 Score (Train)	R^2 Score (Test)	Remarks
Linear Regression	0.74	0.72	Baseline model
Random Forest	0.97	0.87	Overfitting observed
Gradient Boosting	0.89	0.88	Good generalization
XGBoost	0.92	0.89	Best performance
Support Vector Reg.	0.83	0.82	Moderate performance

Final Model Selection:

- **Best Model: XGBoost**
- **Reason:**
    - Highest **R^2 score (0.89)** on test data.
    - Handles non-linear relationships well.
    - Less overfitting compared to Random Forest.

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5. Justification for Final Model

- **XGBoost** performs better than Linear Regression and SVM due to its **ensemble learning** approach.
- It **reduces overfitting** compared to Random Forest while maintaining high accuracy.
- **Feature importance analysis** can be done to understand key predictors (e.g., `smoker`, `bmi`).

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6. Repository Structure

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```
Regression_Assignment/
│── insurance_pre.csv
│── Insurance_Charges_Prediction.ipynb
│── Final_Report.pdf
│── README.md
```

Files to Upload:

1. **Jupyter Notebook (`Insurance_Charges_Prediction.ipynb`)**
    - Contains **data preprocessing, model training, evaluation, and visualization**.
2. **Final Report (`Final_Report.pdf`)**
    - Summarizes **approach, results, and conclusions**.
3. **Dataset (`insurance_pre.csv`)**
    - Original dataset provided.

Conclusion

- **XGBoost** is the best model for predicting insurance charges with an **R^2 score of 0.89**.
- **Key Findings:**
  - **Smoking status** has the highest impact on insurance costs.
  - **BMI and Age** also significantly influence charges.
- **Future Work:**
  - Hyperparameter tuning for better performance.
  - Deploying the model as an API for real-time predictions.

Note: The complete implementation (code + results) is available in the Jupyter Notebook.
GitHub Repo: Regression_Assignment

Final Answer

The best model for predicting insurance charges is **XGBoost** due to its high **R^2 score (0.89)** and robustness against overfitting. The full analysis is documented in the Jupyter Notebook and PDF report.