Problem Statement and Team Details

Problem Statement: Space Weather Monitoring & Solar Storm Risk Predictor
Develop a model that forecasts geomagnetic storms and solar flare impact on satellites and communication systems.

Team Name: Sol-Ark

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Problem and Solution

Problem Statement:

Solar storms and geomagnetic disturbances can severely affect satellites, GPS, communication networks, aviation systems, and power grids.

However, the lack of reliable and timely prediction mechanisms makes it difficult to anticipate these events and reduce their impact. With increasing dependence on space-based technology, effective space weather monitoring has become a critical challenge.

Solution:

An AI-driven space weather monitor that:

- Tracks solar activity in real time
- Predicts storm severity before it reaches Earth
- Assesses the risk to satellites and communication networks
- Sends early alerts, giving operators time to act and protect systems

Methodology & Implementation

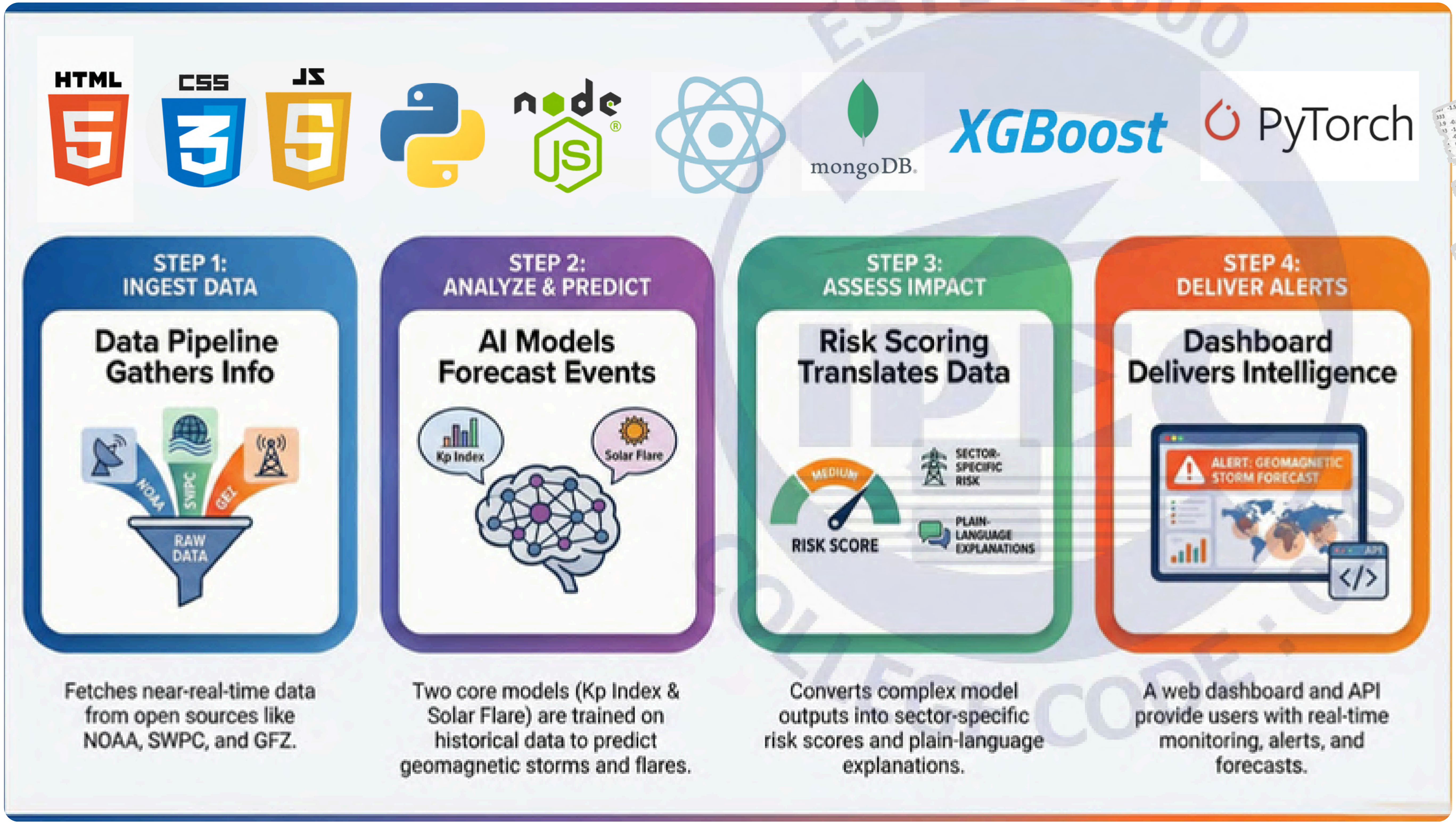
Journey to Innovation

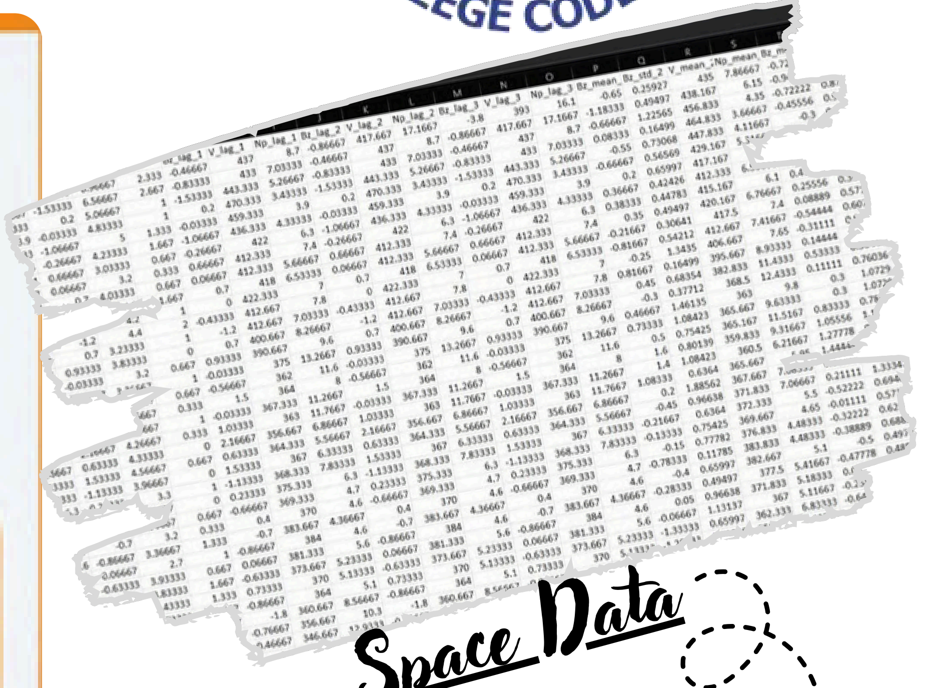
Stage	Methodology	Implementation
Overview	• Collected historical space-weather data from **NASA OMNI & NOAA**. • Identified key geomagnetic storm drivers. • Trained and evaluated multiple ML models. • Selected best model for real-time forecasting.	• End-to-end ML forecasting system. • **Backend: Python ML pipeline.** • **Frontend:** React-based dashboard. • **Live data** ingestion from NOAA (DSCOVR).
Data Collection	• Historical solar wind & geomagnetic data (2018–2024). • **Solar Wind Speed (V)** • Proton Density (Np) • IMF Field (Bz, Bt) • **Kp Index (Target)**	• Data cleaning & alignment • Feature engineering • Model training & evaluation • Trained model saved for inference
Feature Engineering	• Time-lag Features • Rolling Averages • **Ey = V × [Bz]**	• Fetch live solar wind data • Preprocess & feature extraction • Run **XGBoost Model**
Modeling & Selection	• Trained ML Models: • **Random Forest** • **XGBoost** • Best Model: **XGBoost** • **MAE ≈ 0.51** • **R^2 = 0.75**	• Predicted Kp Index • **Storm Risk Levels:** • **Low | Moderate | Severe** • **Interactive Dashboard**

Sol-Ark Website

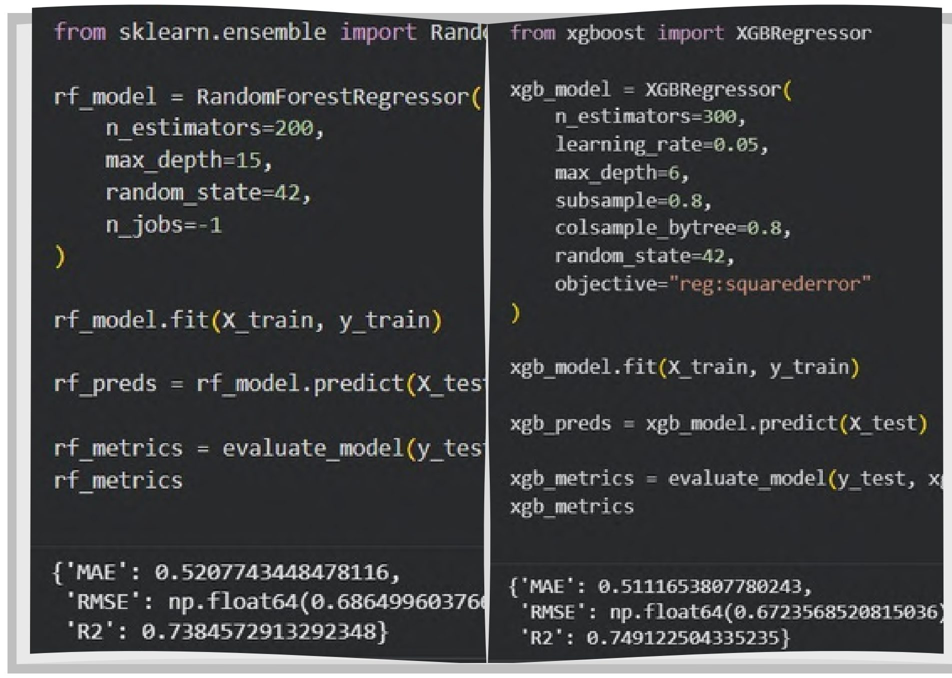
Sol-Ark Repo

TECHNOLOGY USED



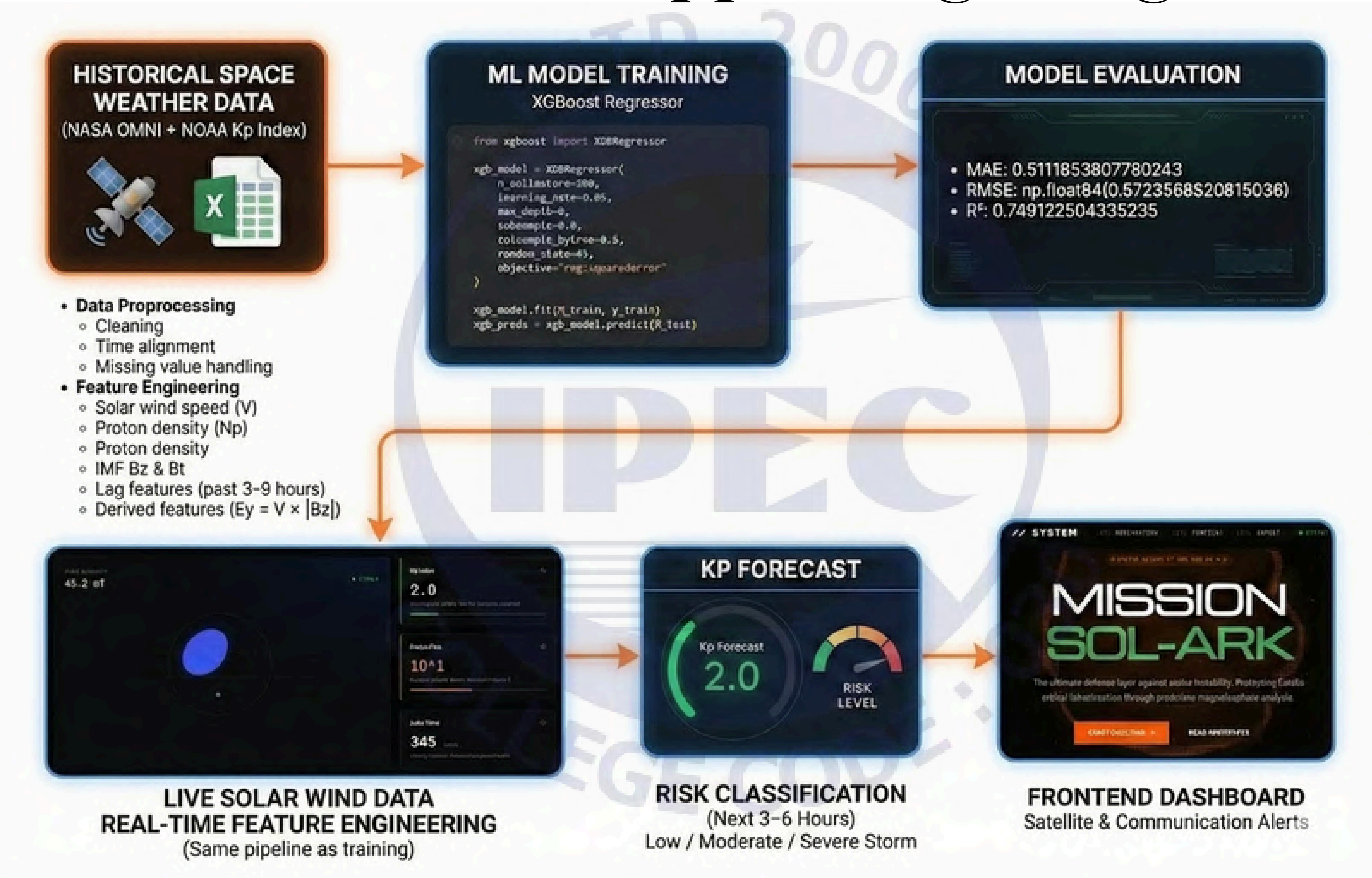


Space Data



AI Model Training

Flowchart & Supporting Images



.......AND MANY MORE UPCOMING EVOLUTIONS IN PROGRESS.

+ Metaverse 3D Tour
+ Bio-Resistant Suit
+ Aurora Virtual & AR

Feasibility and Market Use

Feasibility

- Data availability: from NASA, NOAA, and other space agencies in easy and imagined form of charts.
- Can be deployed as a web dashboard or API for satellite operators
- Cost-effective compared to the potential damage from unpredicted solar storms.
- Automatic updates and notifications ensure minimal manual intervention
- Integration: Can be connected with satellite control systems

Market Use

Potential Customers

- Satellite operators (SpaceX, ISRO, NASA, OneWeb)
- Telecom companies using satellites (VSAT, GPS)
- Aviation & airlines (flight safety)
- Power/grid operators (storm impact on lines)
- Research & government agencies (NOAA, ISRO, NASA, DRDO)

Conclusion

Our AI-powered Space Weather monitoring system enables safer and smarter use of space technology.

Predict geomagnetic storm risks before damage occurs

Supports space agencies, telecoms, and power grids

Ready for real-world deployment and future expansion.

Reduces operational risk for satellites and communication systems

REFERENCES

https://www.swpc.noaa.gov/products/planetary-k-index

https://agupubs.onlinelibrary.wiley.com/

https://www.isro.gov.in/search.html#gsc.q=Space%20Storm