# Well Production Rate Prediction

**🔹 Objective:**

Predict **future oil or gas production rates** for a well based on reservoir, well, and operational parameters.

**🔍 Use Case Summary**

| **Element** | **Description** |
| --- | --- |
| **Problem Type** | Regression (continuous prediction) |
| **Industry Area** | Production / Petroleum Engineering |
| **Goal** | Forecast production to support planning, optimization, and investment decisions |

**🧾 Example Features (Input Data)**

| **Category** | **Feature** |
| --- | --- |
| **Reservoir Properties** | Porosity, permeability, formation pressure, temperature |
| **Well Design** | Lateral length, number of stages, wellbore diameter |
| **Operational Data** | Artificial lift type, pump speed, choke size, fluid rate |
| **Historical Production** | Cumulative oil produced, initial production (IP), decline rate |
| **Stimulation Info** | Proppant volume, fluid volume, frac pressure |

**🎯 Label (Target Variable)**

* Production\_Rate: Measured in BOPD (barrels of oil per day), MSCFD (thousand standard cubic feet per day), etc.

**🧠 Suitable ML Models**

* **Linear Regression** (baseline)
* **Random Forest Regressor**
* **XGBoost / LightGBM Regressors**
* **Neural Networks** (for large, complex datasets)

**📊 Key Metrics**

* **Mean Absolute Error (MAE)**
* **Root Mean Squared Error (RMSE)**
* **R² Score (Coefficient of Determination)**

**💡 Example Applications**

* Field development planning
* Production allocation
* Artificial lift optimization
* Economic modeling for reserves estimation

# Anomaly Detection in Well Production Rates

**Objective:**

Automatically identify **wells with abnormal production behavior** (potential underperformers or mechanical failures) by clustering production data — **no labels or prior definitions needed**.

**🧾 Use Case Summary**

| **Element** | **Description** |
| --- | --- |
| **Problem Type** | Unsupervised Learning – Clustering (Anomaly Detection) |
| **Goal** | Detect wells with unexpected production trends early |
| **Industry Area** | Production Engineering / Field Operations |

**🔧 Input Features (Daily/Monthly Well Data)**

| **Feature** | **Description** |
| --- | --- |
| BOPD | Daily oil production |
| WCT | Water Cut (%) |
| GOR | Gas-Oil Ratio |
| Choke Size | Wellhead choke setting |
| Tubing Pressure | Downhole pressure reading |

**🎯 Output**

* **Clusters of wells**:
  + **Cluster A**: Normal production pattern
  + **Cluster B**: High WCT and GOR — possible water breakthrough
  + **Cluster C**: Sudden drop in BOPD — potential equipment failure

These clusters are like “soft classifications” that help identify **wells needing attention**, without being told in advance what’s good or bad.

**🧠 Algorithm Choices**

* **K-Means** (simple and fast)
* **DBSCAN** (good for finding outliers)
* **Isolation Forest** (for direct anomaly scoring)

**📈 Business Value**

* Early detection of well underperformance
* Lower deferred production
* Proactive maintenance
* Scalable monitoring for large fields