Oil and Gas Production Analysis

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MATH 1103 - BIG Problems, Dept. of Mathematics, University of Pittsburgh

Introduction

This project aims to and analyze the oil and natural gas production trends for the state of Pennsylvania over the last six years (2015-2020). Using the data of oil and gas production in the state the team would present how the industry has changed over time, especially in the southwestern and northeastern counties of Allegheny, Beaver, Washington, Green, Fayette, Westmoreland, and Tioga, and Bradford, Susquehanna, Lycoming, Sullivan and Wyoming respectively.

Problem Statement

Based on the monthly oil and gas production reports for PA going back six years, the team was tasked with analyzing oil and gas developments across the state, using these predictions to identify changes in productivity and optimal drilling sites.

Methodology

The team accomplished project objectives using various techniques including:

- Data cleaning and visualizations to analyze trends.
- Decline curve models to create equations that can best describe the wells.
- Machine learning algorithms to predict optimal well locations.

Data Cleaning

From 722,290 rows of data of raw data provided by the Department of Environmental Protection (DEP) of Pennsylvania, the team condensed the number of data points into 76,197 rows of monthly data. Further, the team narrowed the set to 1,572 "good" well IDs, which have consistent production starting during or after 2015.

Time Data Visualization

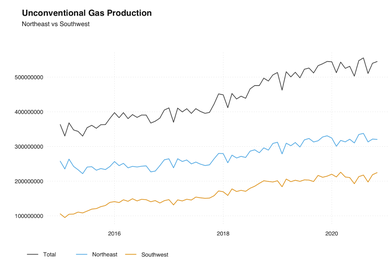


Figure 1:Unconventional Gas Production: Time series representation of unconventional wells from 2015 to 2020.

Geographical Representation

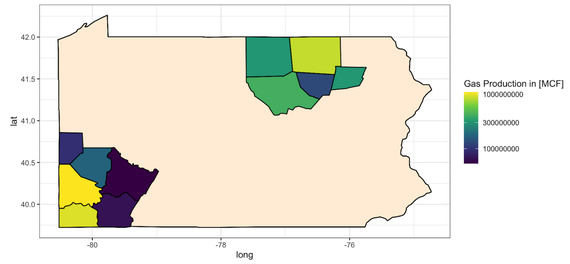
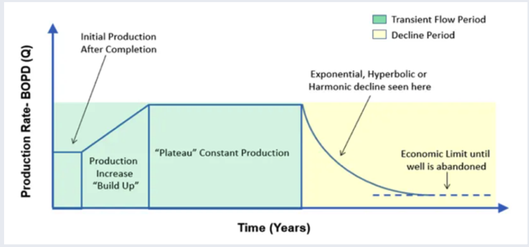


Figure 2:Heat Map: Geographical representation of the amount of gas [MCF] produced in each desired county.

Current Industry Standard

Decline Curve Analysis

Oil and Gas production can be split into three phases: the linear increase of production, a plateau of peak performance, and a decline phase that lasts the majority of the well's lifetime. In oil and gas industry, the decline curve portion is utilized to determine the economic limit of a well, or when a well is no longer a good financial investment.



Regression Modeling

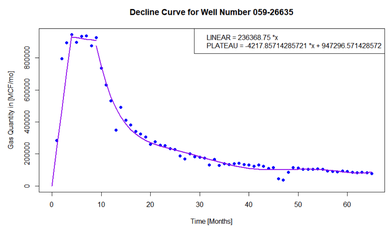


Figure 3:Decline Curve Report: Piecewise analysis that includes a decline curve described continuously by a sixth degree polynomial regression.

Machine Learning

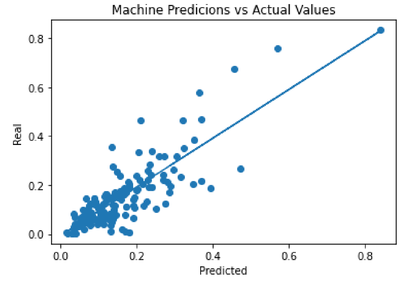


Figure 4:Optimal Well Location: Machine Learning algorithm that can predict well location to an RMSE of 0.003.

Contributions to Industry

- Automated process of analysis to increase efficiency.
- Increased frequency of analysis from yearly to monthly.
- Produce continuous functions to allow for more accurate analysis of change over time, using sixth degree polynomials rather than industry standard piece-wise equations of exponential, harmonic, and hyperbolic parts.

Deliverables

- R Code to Handle Lengthy Data
- Python Machine Learning Algorithms to Model Future of Well Production
- User-friendly app that compiles all visualization efforts

Recommendations

- Optimize R code to handle wells with little or no plateau region
- Users to continue uploading new data to app to get a more holistic view

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