Modeling Hydrocarbons Flow From Earth Using Deep Learning

1. Context/Purpose:

Recently, the need for and dependency on energy has been inevitable to run all the technologies we have. Therefore, there has been a demand to shift all the energy consumption to renewable energy instead of depending on non-renewable one, and there has been a trend and discoveries supporting this demand. Although this trend has been going on for decades, it's not yet effective in many tools/machines used today. Therefore, the need to depend and utilize non-renewable energy in the most efficient way possible is the way to go to save time and environment resources until renewable energy can fully replace it.

This work is intended mainly to understand how hydrocarbon flows out of the earth given certain geological and engineering conditions; furthermore, It introduces a new time-series problem to the machine learning community with publicly available data.

This paper presents data-driven models using machine/deep learning techniques to model oil and gas production until the end of a well's life (30-40 years) for unconventional horizontal wells. The main motive for this project is the desire to make more accurate production forecasting and to utilize best locations to drill. The approach used here is intended to forecast production for both producing locations (PLs) and non-producing locations (NPLs).

2. Methods:

The developed models utilize different data sources to combine a large set of features for more than 38000 unconventional horizontal wells. Then different state of the art machine learning algorithms is trained on these data/features to create the model. Some of the key features used in model training are location, reservoir properties, drilling and completion, and production (if applicable). For the production features, only 1 month of production data is needed to provide the model with relevant features.

3. Results:

Studying the model by conducting extensive experimentations helped in drawing conclusions about the most useful factors attributing to our accuracy. These factors include, but not limited to, adding features about drilling and completion, including production features in different formats, including both oil and gas production features, choosing a suitable filtering criteria to select our training set, including data from multiple basins, and definitely tuning our model parameters. We used several interpretability methods such as Shap values to help us gain these insights.

4. Interpretation:

For the purpose of evaluating the performance of our model compared to the classic Arps Decline Curve Analysis (DCA) equation, that is currently used by engineers to forecast production, a set of distribution of errors on year cumulative were created. Our approach has shown an 8% improvement on the median of the distribution of the 5-year cumulative compared to the old approach and a 40% improvement over the distribution of the first 3 months cum.

5. Conclusion:

Understanding the geology of the earth is a very challenging task, but machine learning/deep learning has shown great contribution to this. This work has shown a very good performance when modeling hydrocarbon's flow given geological conditions.