Shale Gas Production Decline Prediction Using Machine Learning Algorithms

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Method

• Locally Weighted Linear Regression
  In order to make predictions for a specific well, find several wells in the training set that are ‘close’ to the target, using functional regression.

• Principal Component Analysis
  Since the component of the data is too large (about 100 dimensions), we compress the into 5 dimensions and then make prediction.

• PCA after K-means
  We separate the wells in to High-Productivity Cluster and Low-Productivity Cluster using K-means, then use PCA in each cluster.

Results

<table>
<thead>
<tr>
<th>Well</th>
<th>LWLR</th>
<th>PCA</th>
<th>K-means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well 47</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
</tr>
<tr>
<td>Well 1557</td>
<td><img src="image4" alt="Graph" /></td>
<td><img src="image5" alt="Graph" /></td>
<td><img src="image6" alt="Graph" /></td>
</tr>
<tr>
<td>Well 20</td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
<td><img src="image9" alt="Graph" /></td>
</tr>
<tr>
<td>Well 555</td>
<td><img src="image10" alt="Graph" /></td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
</tr>
</tbody>
</table>

Cross-Validation

Leave-one-out cross-validation is adopted. We define a threshold to remove the extreme errors which are caused by irregular manipulation on the wells (such as shutting down by engineers).

Discussion

LWLR has the lowest error because there is no information loss due to dimension reduction.

PCA for prediction can be improved by using high and low productivity clusters respectively. Prediction will be unprecise if the irregular activities (such as shutting down or re-stimulating) dominate in the true production history.

We want to substitute PCA by Principal Curve in the future to see if it can make more accurate prediction.