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Novel Learning-based Pattern-Data-Driven Forecast Approach for Predicting Future Well Responses

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Accurately predicting future well response is crucial for making investment decisions in developing subsurface reservoir resources. Future well responses have been forecasted using history-matching methods, but traditional history-matching methods often incur high computational costs in calibration steps and have difficulties in maintaining geological constraints. Recently, data-driven forecast methods like data-space inversion (DSI) and learning-based data-driven forecast approach (LDFA) have been introduced to mitigate the computation cost and geological constraint issues of history-matching methods. However, DSI and LDFA have extrapolation, conditioning, and prediction variance issues. In this study, we propose two simple approaches, a learning-based pattern-data-driven forecast approach (LPFA) and an ensemble conditioning step (ECS), to resolve the issues associated with DSI and LDFA. For the extrapolation issue, LPFA provides accurate predictions by scaling prior data using observed data, even when the observed data are outside the prior data range. ECS resolves the conditioning and variance issues of LDFA and LPFA by selecting the predictions of ensemble learning that honor the observed data. The prediction performances of DSI, LDFA, LPFA, and ECS are compared using two well-known benchmark models (Brugge and Olympus models). All the forecast approaches showed reliable performance in predicting future well responses, achieving an average median relative error of 2~3% under a 2% noise level of the observed data. However, LPFA was the only approach that provided the most accurate predictions for future well responses when the prior data did not contain data close to the observed data. ECS improved the prediction performances of LDFA and LPFA in both the Brugge and Olympus models as it selects only the predictions from multiple learning models honoring the observed data.

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