# Predicting the Distribution of Subsurface Sedimentary Facies Using Deep Convolutional Progressive Generative Adversarial Network (Progressive GAN)

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9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

## Abstract

Predicting the distribution of favorable subsurface sedimentary facies is of great significance for petroleum exploration and production. It involves integrating three different types of data: prior depositional pattern knowledge, seismically-produced facies probability maps (soft data) and well facies data (hard data). Many approaches have been proposed trying to deal with this problem, with varying results; the most difficult part is the integration of prior geologic knowledge. Deep Convolutional Neural Network (CNN) has shown great potential to generate complex patterns, and thus have been successively applied in many fields. We built a CNN architecture which takes expected global features (e.g., channel proportions, width and sinuosity of channels, etc.), facies probability maps and well facies data as inputs and outputs possible distributions of sedimentary facies. A large synthetic dataset was constructed to train the network, which includes 35,640 channel images with global features marked, 285,120 probability maps and well facies distribution images. The basic ideas of the training include: 1) an improved Progressive Generative Adversarial Network (Progressive GAN) strategy to ensure pattern realism and computational efficiency; and 2) special terms added in the loss function to strengthen the conditioning of the results to probability image, global features and well facies data. After training, the network learnt the sedimentary patterns of the training dataset and was able to integrate different types of soft and hard data. The trained CNN network is being applied in synthetic and

practical cases. The generated results have geologic realism and are conditioned to probability, well facies and global features data. Additionally, the network can produce thousands of simulations in seconds, which allows very quick uncertainty analyses of the subsurface sedimentary facies.