Internship proposal: Conditioning MPS simulation with additional information: a Constraint Satisfaction Approach

Project supervisor

Mohammad Shahraeeni (mohammad.shahraeeni@total.com)

Aim

Application of Constraint Satisfaction Problem framework to condition Multiple Point Statistics simulation with additional sources of information such as local proportions, connectivity between two points, and seismic data.

Description

Models of distribution of geological facies, i.e. discrete variables that describe a body of rocks, within a hydrocarbon reservoir can be generated using Multiple Point Statistics (MPS) simulation. MPS information is extracted from a training image and during simulation a model with similar MPS properties is generated. In many cases, in addition to MPS information other sources of uncertain information about some properties of facies are available; examples include: local proportions, which measure proportion of a facies in a given neighbourhood of each point in the model, connectivity between two points, which shows that two points in the reservoir model must be connected with a given type of facies, and seismic data, which is a linear function of elastic properties of facies. MPS statistics and other available information can be considered as constraints that are needed to be imposed on a set of variables, which represent a reservoir model. Therefore, conditioning MPS simulation with different sources of information to generate a reservoir model is an instance of Constraint Satisfaction Problem (CSP). Several algorithms for solving CSPs, such as conflict-directed back jumping, forward checking, dynamic backtracking, partial constraint satisfaction, and local search are available. The choice of one algorithm or a hybrid of different algorithms to solve a given problem depends on the nature of the problem, the constraints, and the required precision of the solution. Furthermore, several specialized algorithm have been developed that are efficient in solving particular classes of constraints. Therefore, a proper selection of algorithms is necessary for solving a CSP efficiently. The purpose of this internship is to select the most efficient algorithms for conditioning MPS simulation with aforementioned sources of information, namely local proportions, connectivity data, and seismic information.

Objectives

1) To identify suitable algorithms and implement them within an existing MPS simulation when either of local proportions, connectivity, or seismic data is available.
2) To demonstrate the efficiency of the algorithm on a 2D example.
3) To demonstrate the algorithm on a 3D example for at least seismic data.

Timeline and location

4.5 months at TOTAL's Geoscience Research Centre in Aberdeen, UK

Candidate

Candidate must be literate in the field of CSP. A PhD student in applied computer science, with a thesis topic related to CSP is ideal. Knowledge of and interest in Geoscience would be appreciated.