# Machine Learning on Real Time Data for Oil&Gas

Application to Goliat, the first oil field in the Barents Sea

Cristina Bottani
ICT Digital Field Applications
Eni SpA
S.Donato Milanese (MI) Italy
cristina.bottani@eni.com

Gabriella Esposito
Tech. Comp. for Geosciences
Eni SpA
S.Donato Milanese (MI) Italy
gabriella.esposito@eni.com

Paola Stolfi
Ist. Applic. Calc. M.Picone
CNR
Rome Italy
stolfi.p@gmail.com

## ABSTRACT

Goliat is an offshore production field that spans from the subsea wells up to a complete process plant installed on the largest and most sophisticated cylindrical floating production storage and offloading vessel (FPSO) in the world. Due to the comprehensive instrumentation installed on the plant designed to cope with the Arctic conditions of the Barents Sea, the Asset is the perfect case study to test an innovative agent based software architecture able to support production management.

A project named MASTER (**M**achine learning **A**gents to **S**upport **E**fficien**T** p**R**oduction management) has been carried out to implement machine learning algorithms on real time data coming from the Goliat Asset.

MASTER provides support to users in their decisions aimed to maximize oil production while ensuring optimal plant and energy efficiency management, taking into account the needs of the single functional unit together with the needs of the whole system. The modularity and the scalability provided by the agent based architecture guarantees the applicability of the method to any part of the plant. Each agent is in charge of supervising a specific or a group of equipment and is fed by the real-time data coming from the field. These data are then analyzed through Machine Learning and Deep Learning algorithms that are incorporated within the agents. In particular, three agents will be described:

- the "Well" agent exploits a Random Forest algorithm to classify the operating status of each well, in order to identify the set of KPI that can be computed coherently with the status;
- the "Flowline" agent is based on a combination of a Decision Tree and Ridge regressors in order to estimate the pressure variations on the flowline corresponding to variations in the well valve openings;
- the "Compressor" agent exploits a transformation of time series trends into images using the "Gramian Angular Field" algorithm; images can then be classified using Convolutional Neural Networks. The classifier can therefore identify trends on the time series, such as "increasing", "peak", "constant", and provide essential information to the operators for the correct management of the plant.

The machine learning algorithms estimate the current state of the equipment and provide a set of KPIs (Key Performance Indicators) in order to understand both the production efficiency and the health status of the machines. Furthermore, learning from the observations of the state transition paths that happened in the past, the agents are capable of predicting the most likely future state. The latter capability is fundamental to match the highest Safety and Environment standards and to optimize the maintenance plans. Based on the estimated current state, each agent can also provide a list of actions targeted to maximize the efficiency from an "equipment" point of view.

The actions coming from all the agents can then be collected and negotiated in order to maximize the production from the plant point of view. The negotiating algorithms are implemented in a super-agent that can support a human operator in the day-by-day management tasks of the plant.

## CCS CONCEPTS

• Real-time systems • Machine Learning

## KEYWORDS

Agent-based Model, Multi-agent System, Agent-based Negotiation.

## ACKNOWLEDGMENTS

We would like to express our deepest gratitude to all those who have collaborated in this project and have invested full effort in achieving the goal: Marco Piantanida, Alfonso Amendola, Davide Floriello, Stefano Carminati, Eni S.p.A. Daniele Vanzan, Massimo Zampato, Eniprogetti S.p.A. Sture Lygren, Stefano Nappi, Vår Energy AS. Davide Vergni, Filippo Castiglione, Cesar Nieto Coria, IAC CNR.

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