

VEDLEGG 1 - OPPDRAGSBESKRIVELSE: "OG21-STUDY ON MACHINE LEARNING IN THE NORWEGIAN PETROLEUM INDUSTRY".

VERSION: FEB.13, 2020

1 BACKGROUND

Based on its mandate from the Norwegian Ministry of Petroleum and Energy, OG21 develops and maintains the technology strategy for the Norwegian petroleum industry.

The OG21 strategy illustrates the large value potential in efficient use of technologies. OG21 therefore encourages the development and implementation of technologies that maximize resource utilization, reduce environmental impact, reduce costs and improve productivity on the NCS.

The OG21-study in 2019, "Technologies for cost and energy efficiency", illustrated the importance of digital technologies to create value on the Norwegian Continental Shelf (NCS), for instance as enabling technologies for unmanned platforms, condition-based maintenance and field model optimization.

This study will examine how the petroleum industry in Norway could leverage the potential in machine learning (ML) both short term (0-5 years) and in the longer run (>5 years).

2 PROJECT OBJECTIVE

Machine learning is widely applied in various industries and in the society. ML is increasingly becoming an important element also in the petroleum industry. Some key questions arise:

1. How big is the opportunity related to ML on the NCS in terms of increased volumes, reduced costs and reduced environmental footprint?
2. To which extent is the Norwegian petroleum industry currently capable of developing and deploying ML to improve value?
3. How could ML be developed and adopted faster on the NCS?

The study aims at answering these questions. The main objective is: ***Describe how Machine Learning could improve value creation and reduce emissions on the Norwegian Continental Shelf.***

OG21 intends to use the results for:

- Demonstrate to NCS stakeholders the value and importance of ML to maintain competitiveness.
- Identify areas where ML is of particular high importance to improving the NCS competitiveness.
- Stimulate increased collaboration on the development and use of ML.

3 ORGANIZATION

OG21 has established a project team consisting of members from OG21's four technology groups (TTAs), and a steering committee with members from OG21's board.

Other members from the TTAs and from industry stakeholders will be consulted during the course of the project and engaged through TTA-specific workshops and a cross-functional workshop.

The successful consultancy company (Consultant) will assist the OG21 project team with achieving the project objective.

4 CONSULTANT'S SCOPE OF WORK

4.1 General

The Consultant will gather data, conduct analyses, provide pre-reads for workshops, participate in workshops and provide data driven advice for the OG21 project team.

The study shall address the project objective described in Section 2. The Consultant will in its proposal describe the approach and methodology to be used in the study.

Project analyses, conclusions and recommendations should be linked to OG21's strategic objectives as described in the OG21-strategy (2016).

The Consultant's study should at least include the elements listed in the sections below. The Consultant's proposal should identify and describe any additional elements that the Consultant deems necessary to achieve the project objective.

Analyses and recommendations shall be based on reliable and high-quality data. The proposal should demonstrate the Consultant's access to and understanding of data sources needed to successfully execute the study.

OG21 has gathered data and conducted several relevant and potentially overlapping studies over the last 5 years. Other organizations have also published studies on similar topics recently. The Consultant should in the proposal demonstrate its overview and understanding of published relevant information, and convincingly describe how available data and analyses will be used efficiently.

OG21 believes that the quality of the study will benefit from a close collaboration with OG21's resources and network (project team, technology groups – TTAs, and board). OG21 plans for TTA-workshops and a cross-disciplinary workshop as part of this project. The Consultant should describe in the proposal how they intend to involve and engage OG21-resources as well as other industry resources in a time-efficient and constructive manner.

4.2 Discuss Machine Learning terms

Discuss and define relevant terms such as Artificial Intelligence, Machine Learning, Deep Learning, Automation and Robotics and how these relate to each other. An illustration of some of the terms is shown below.

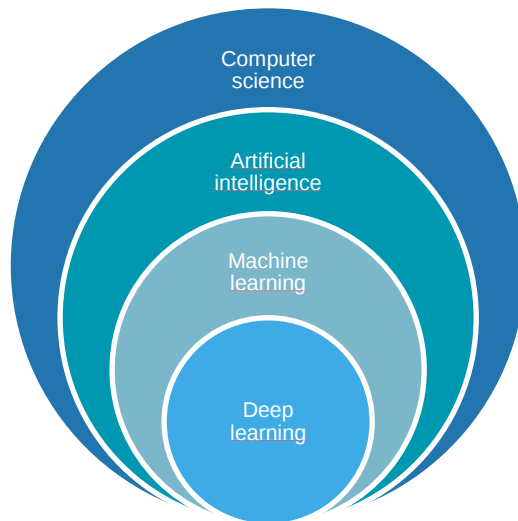


Figure 1 How ML relates to AI and deep learning

Describe types and depths of ML and typical applications of different types of ML, e.g.:

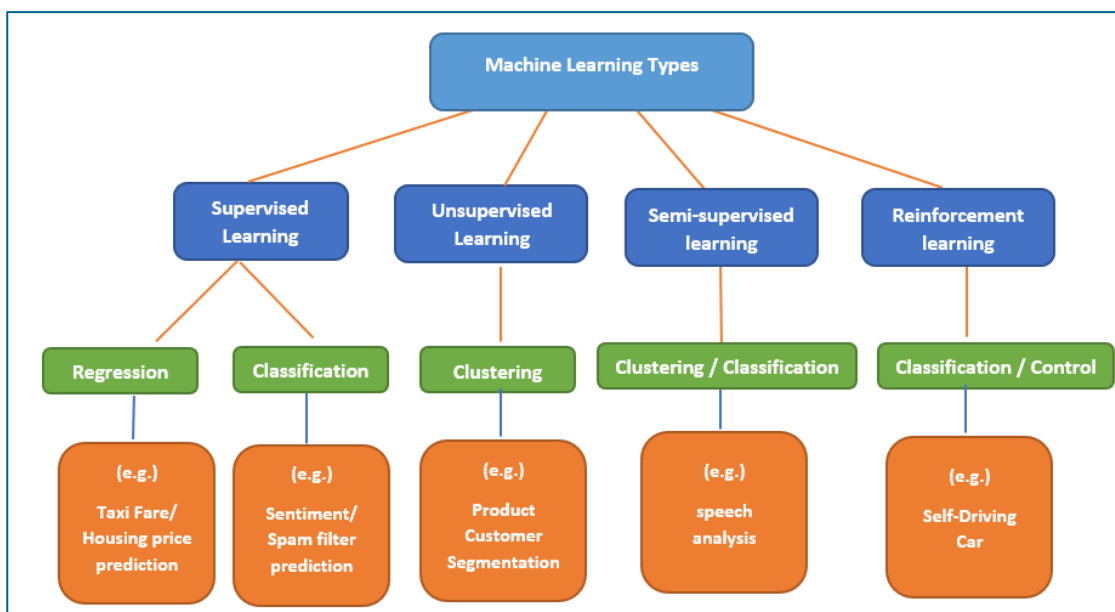


Figure 2 Types of ML (Courtesy: Microsoft TechNet)

Describe competence and capacity needs for different types of ML.

4.3 Identify the ML value potential for the Norwegian petroleum industry

Describe *specific problems* within the Norwegian petroleum industry that ML could be used for solving and what value this represents in terms of increased volumes, accelerated field development and resource production, reduced costs and reduced environmental footprint.

Discuss scale effects of data and computational power, and which type of ML and scale of data and computational power that would be needed or sufficient to solve the identified *specific problems*. The Consultant should describe what they perceive as realistic expectations on ML development and adoption.

Describe how ML could assist the Norwegian petroleum industry to achieve OG21's strategic objectives on environment, resource utilization, costs and productivity, industry development and competence.

Describe ML R&D funding opportunities nationally and in the EU and how these opportunities relate to the identified *specific problems*.

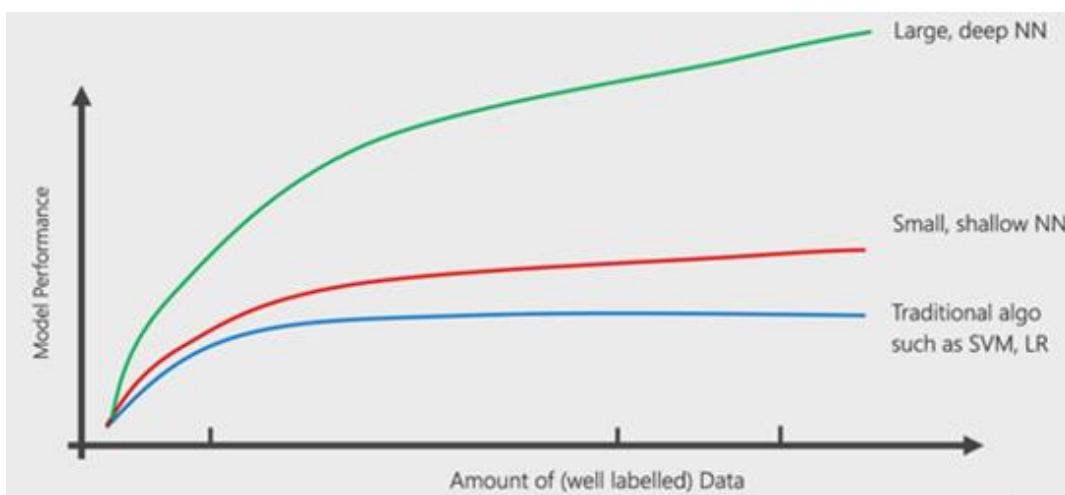


Figure 3 Scale in data and computational power drives ML development and performance (Courtesy: Andrew NG, Stanford)

4.4 Describe the current state

Describe the current status on:

- How ML is applied in the Norwegian petroleum industry ranging from simple to complex problems. Provide case examples.
- ML competence and capacity within the Norwegian petroleum sector and available in the market for the sector. It includes a discussion on how necessary competencies need to be brought together to realize ML opportunities, see figure below.
- Ongoing ML R&D and collaboration efforts in the petroleum sector in Norway and internationally.

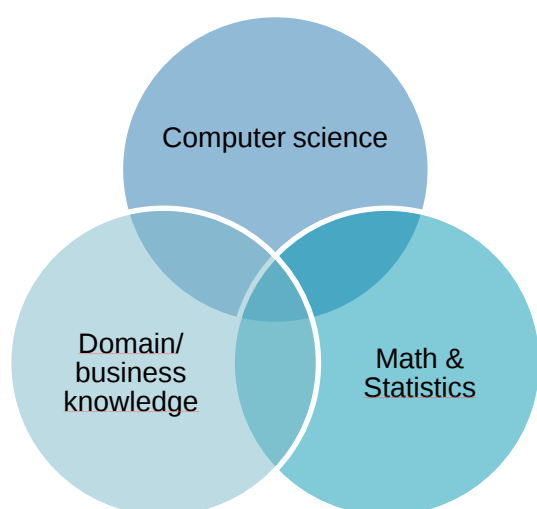


Figure 4 Competencies needed to develop and adopt ML

When describing the current state, the Consultant should leverage already published literature and reports, and gather additional data through interviews and business intelligence. The following is a non-exhaustive list of relevant reports and initiatives that the Consultant should expand on in its proposal:

- Nasjonal strategi for kunstig intelligens, (KMD, 2020).
- Veikart for Norsk Olje og Gass (NOROG, expected March 2020).
- Digitale grep for norsk verdiskaping (Digital21, 2018)
- Konkurranseskraft – norsk sokkel i endring (Konkraft, 2018).
 - Relevant spin-off projects such as "Digital cuttings project", "DataLink", "Digital feltutvikling".
- WE Forum digital transformation, Oil&Gas specific report (WE Forum, 2017).

4.5 Describe challenges and hurdles for ML development and adoption

Describe risks associated with ML, including risks related to safety critical systems and security.

Describe how risks could be mitigated or managed through model development, access to and quality of data, human in the loop, etc.

Describe challenges and hurdles associated with the adoption of ML and with achieving the full potential of ML, e.g. related to technology, training algorithms to work, data structure, data quality, data

protocols and standards, competence, organization, industry structure, regulations, market and dynamics between collaboration and competition.

4.6 Recommend measures

Describe possible measures to stimulate development and adoption of value-adding ML in the Norwegian petroleum industry. Measures could be within technology, competence, business models, collaboration, regulation etc.

4.7 Preparations for and participation in workshops

OG21 plans on running:

- One half-day workshop for each of the four TTAs, in April and May 2020.
- One full-day cross-functional workshop, first half of June, 2020.

The Consultant should suggest how workshops could be organized and how they will participate to obtain maximum benefit for the study. The consultant will assist OG21 in identifying which additional resources outside of the OG21 TTAs that should be invited to the workshops.

The Consultant will provide parts of the pre-read for the workshops. The pre-read for the cross-functional workshop should be an early version of the Consultant's report, which would later be updated based on results from the workshop and additional data collection and analyses.

4.8 Strategic advice to the OG21 project team

The OG21 project team will develop its own report based on the Consultant's report and output from the cross-functional workshop. The Consultant should be available for giving strategic advice to the OG21 project team during this phase.

4.9 Presentation and communication of results

The Consultant shall present its preliminary report at the cross-functional workshop, tentatively scheduled early June, 2020. One week in advance of the workshop, the Consultant will discuss the draft report with the OG21 project team.

The Consultant shall present the major findings and recommendations provided in the final version of the report at the OG21-forum, November 11th, 2020.

The Consultant shall present its report to the OG21 board.

OG21 may want to publish the Consultant's final report at OG21's web site and the consultant should pose no limitations for OG21 to do so.

5 STUDY ASSUMPTIONS AND LIMITATIONS

Study assumptions and limitations:

- Results from previous OG21 studies as well as from other reliable sources should be leveraged.

The Consultant should specify any further assumptions and limitations in its proposal.

6 PRELIMINARY TIME SCHEDULE AND DELIVERABLES

6.1 Time schedule

The time schedule is preliminary and can be altered by OG21 at any time during the project. The time schedule will be discussed and possibly adjusted at the kick-off meeting.

- Invitation: February 14
- Proposal due date: March 6
- Award: March 13
- Kick-off meeting: March 24
- Pre-read for cross-functional workshop (e.g. early version of Consultant's report): Early June
- Participation in cross-functional workshop: Mid June
- Draft of final report: Mid August
- Final report: Sept. 15

6.2 Project deliverables

The Consultant will provide:

- Pre-reads for TTA workshops.
- Early version of the study report as basis for the OG21 cross-functional workshop.
- Draft and final versions of study report.
- Presentation slide deck in ppt-format for final report.
- Bi-weekly progress reports.

OG21 expects the Consultant to possess sufficient technology and business competence and skills to form its own judgement on the topics in scope for this study. The Consultant's study report represents the Consultant's own views and opinions, which do not necessarily align fully with OG21's positions.

6.3 OG21's use of project deliverables

It is a requirement that OG21 may use the Consultant's deliverables from this project as basis for its own analyses, reports and communication material. The Consultant's deliverables will in such cases be referred to.

7 REFERENCES

OG21 (2019). *Technology for cost and energy efficiency*. www.og21.no

Rystad Energy (2019). *Technologies to improve NCS competitiveness*. www.og21.no

Boston Consulting Group (2017). *New business models and contract strategies to improve NCS competitiveness*. www.og21.no

OG21 (2017). *Business models and technology acceleration*. www.og21.no

OG21 (2016). *Strategy document*. www.og21.no