Winter School on Data Assimilation and its application in reservoir engineering
Closed loop reservoir management

Remus Hanea, Arnold Heemink and Brenny van Groesen

Data assimilation (DA) aims at determining as accurately as possible the state of a dynamical system by combining heterogeneous sources of information in an optimal way. The mathematical methods of DA describe algorithms for forming optimal combinations of observations of a system, a numerical model that describes its evolution, and appropriate prior information. DA has a long history of application to high-dimensional geophysical systems dating back to the 60s, with application to estimation of initial conditions for weather forecasts. It has now become an intensive field of research, with applications in oceanography and atmospheric chemistry, and extensions to other geophysical sciences. DA is now a key issue in most numerical forecasting systems in geophysics. Because of the high dimensionality of these systems (usually in the order of $10^6 - 10^7$) the mathematics employed should be relatively simple. However, it has been proven in operational meteorology that the use of advanced methods such as optimal control theory could improve data assimilation systems significantly. Since then, the DA community has contributed to both the applications on very high-dimensional and possibly operational systems, and at the same time to methodology.

In this context, this 1 1/2 -week summer school will be focused on methodology by starting with an introduction in the basics and fundamental concepts of data assimilation followed by a more detailed view on the state of the art methodologies of filtering and optimization. However it will not ignore the applications' side since applications motivate and specify the kind of methodology is needed. As we already mentioned the field of data assimilation flourished in the area of weather prediction and oceanography, but it extends rapidly to other geophysical sciences. One of the most important

fields of application where data assimilation gain a lot of attention is the reservoir engineering world, more precisely the closed loop reservoir management.

Closed-loop reservoir management is a combination of model-based optimization and data assimilation (computer-assisted history matching), also referred to as 'real-time reservoir management', 'smart reservoir management' or 'closed-loop optimization'. The aim is to maximize reservoir performance, in terms of recovery or financial measures, over the life of the reservoir by changing reservoir management from a periodic to a near-continuous process.

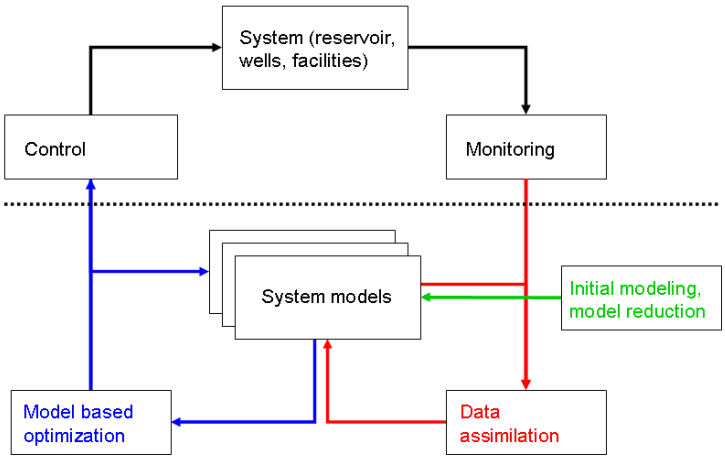

Figure 1: Key elements of the closed-loop reservoir management process.

The two essential elements in the closed-loop reservoir management concept are the model-based optimization and decision making (blue loop), and model updating through data assimilation (red loop). Both of them will be explain in details throughout the lecturers and validated through out applications in syntectic as well as real field cases .

1 Goal

The goal is to get together experts in the field of data assimilation and reservoir engineering and to make use of their knowledge by

- educating graduate students, young and senior researchers
- exposing these new ideas and applications to the Indonesian academia and researchers
- having extensive discussions and exchanging ideas

2 Location and period

- Location: LabMath, Lawangwangi, Art&Science building, Bandung, Indonesia.
- Period: 4^{th} - 13^{th} January 2012

3 Speakers and topics

The one week and a half will cover the basics of inverse modeling/data assimilation and its application in reservoir engineering.

- Introduction course on data assimilation and inverse modeling (4^{th} - 6^{th} January 2012):
  - **Remus Hanea(TNO/TU Delft)**- From classical (traditional) statistic inversion methods(OI, krriging, ...) towards the state-of-art new data assimilation algorithms - Theoretical concepts. (confirmed)
  - **Cristian Maris (TU Delft**- EnKF - Matlab project (TNO Utrecht) (confirmed)
- Closed-loop reservoir management (9^{th} - 13^{th} January 2012)
  - **Geir Evensen** - Ensemble Kalman Filter (EnKF) for history matching (HM) (Statoil, Norway) (confirmed)

- **Jan Dirk Jansen**- Short and long term optimization in reservoir management (TU Delft, The Netherlands) (confirmed)
- **Arnold Heemink** - Adjoint based (Representer method) and adjoint free history matching (Model reduction) (TU Delft, The Netherlands)(confirmed)
- **Remus Hanea(TNO/TU Delft)**- Towards geological realistic estimation via different parameterizations.(confirmed)
- **Tudor Popa**- Link between a commercial simulator (Eclipse) and the OpenDA software (open source data assimilation framework) (Ph.D. student, TU Delft, The Netherlands). (not yet confirmed)
- **Two Indonesian specialists in this domain (seismic interpretation)**

4 Participants

- graduate students
- researchers
- Academia

5 Registration fee

The registration fees, for participants, will cover participation to the Summer School and weekdays lunch.

- The young Indonesian Ph.D student and PostDocs, as well as the Academia are participating free of charge
- The international Ph.D. students and Post Doc students - 400 Euros
- The non-students participants (consultancy companies, oil and gas companies, international University staff, etc.) - 800 Euros

To apply for the event please send an email where you can show your interest for this event and consequently, when the web-site will be up and running, you will need to fill in a registration form with details about your background, present position, an up to date CV and for students a letter of recommendation.

6 Accommodation

- Students - hotels/guest houses in the neighborhood of the Institute.
- Lecturers - hotels closed by to the Institute