Summary of ISC6 Workshop

Inverse problems

"Parameter identification, model validation, real-time systems"

– Professor Tom Schanz memory workshop –

Organizer: ISSMGE HNC

Date: 10h30 to 13h October 1 2021

Location: Hungarian Academy of Sciences

Maria Datcheva chair

Prof. Kornél Kovács co-chair

Secretaries: Nadaprapha Binsaaeteh, Emoke Imre

TOPICS

The evaluation of tests usually needs the identification of parameters. The model validation, model calibration or model building entails the fit of 'measured' and computed data. These problems are commonly referred as the solution of an inverse problem. In the linear case automatic solutions are available. The non-linear inverse problems is either solved with local minimisation combined with a trial and error procedure. The parameter error, the goodness of fit (and uniqueness of the solution in the non-linear case). Alternatively, learning algorithms are used.

This workshop aims to promote research dissemination of earlier and current research related to the non-linear inverse problem solution including methods like neural network and AI.

- model fitting methods related to various physical, biological, technical problems
- reliability testing methods (parameter error estimation, uniqueness, goodness of fit)
- real-time test evaluation
- modeling an immun reactions

PROGRAM

Opening on behalf of the Hungarian Academy of Sciences:

Prof. János Józsa

(a few words on Professor Schanz)

isc6 1001 01 - YouTube

https://www.youtube.com/watch?v=kshPcrAy9qo

Opening of Maria Datcheva chair

isc6 1001 02 - YouTube

https://www.youtube.com/watch?v=v1G-uJAhy4A

Peter Berzi: Secant method in multidimension

isc6 1001 03 - YouTube
https://drive.google.com/file/d/137tuy-q4nS2u13qJv0F3qc4bDAksKfPd/view?usp=sharing
www.youtube.com/watch?v=rr2FyNOux1A
In the secant method trial solutions for n+1 parameter vectors and the related residual or error vector are used to compute a new parameter vector. In the suggested method, from the new vector – using its coordinate components : n+1 parameter new vectors are formed. The convergence is better than the one of the Newton – Raphson method.

Sai Sri Harsha Vallurupalli, M.Sc. RUBochum: Optimizing the design of retaining wall systems using multiobjective optimization strategies.

isc6 1001 04 - YouTube
https://www.youtube.com/watch?v=JoRyN56V1Yo
As increase in the constructions that are associated with the retaining wall systems, the need of maintaining the system economic within the permissible deflections and safety factor is significant.

➢ This can be efficiently done by applying the optimization strategies (Genetic algorithms) to the wall design considering the wall deflections (mm), cost per linear meter (€/m) and safety factor as the objectives that are minimized and/or maximized accordingly.

➢ Regression models have been developed in order to make the numerical calculations more flexible and to economize the computation effort & time.

➢ Besides, the adaptive design optimization has been implemented in which the optimization can be associated with back-analysis which makes the procedure adaptable for the practical scenario."

Chenyang Zhao : A hybrid model for mechanized tunnel excavation,

isc6 1001 05 - YouTube
https://www.youtube.com/watch?v=iYXb7ZBu0Zw

To provide realistic predictions of mechanized tunnel excavation-induced ground movements, this research develops an innovative simulation technique called hybrid modeling that combines a detailed process-oriented finite element simulation (submodel) with the computational efficiency of metamodel (or surrogate model). This hybrid modeling approach has three levels to consider the uncertainty in soil properties and tunneling process parameters. The results show the capability of the proposed approach to provide reliable model responses in the near field around the tunnel with reduced computational costs

Elham Mahmoudi (Kavan Khaledi co-authors) :Reliability-based Robust Design Optimization of a Rock Salt Cavern

isc6 1001 06 - YouTube
https://www.youtube.com/watch?v=DFift3nD3BI

The fluctuating nature of renewable energy sources can be managed by storing the surplus of electrical energy in an appropriate reservoir. The excess electricity available during off-peak periods of consumption may be used to compress air or electrolyse Hydrogen. Afterwards, the pressurised gas is stored in the rock salt cavities and discharged to compensate for the energy shortage when required. The validation of rock salt caverns' short and long-term integrity and stability is a prerequisite in their design process. Because of the significant levels of uncertainties involved in the design procedure of such structures, a reliable design can be achieved by employing probabilistic approaches. Therefore, the numerical calculation is extended by statistical tools such as sensitivity analysis, probabilistic analysis, random field discretisation and reliability-based design to evaluate design parameters of the paramount need for practice.

Erick Baziw and Gerald Verbeek: Inverse Theory – Concepts and Examples

isc6 1001 07 - YouTube
https://www.youtube.com/watch?v=fF3zteBHOuc

This presentation outlines the general concepts of inverse theory with a focus on iterative forward modelling (IFM) and applied seismology. Comparisons are made to Bayesian recursive estimation where a posterior probability distribution is required. A downhole seismic testing example is provided where arrival times are inverted so that estimates of the interval velocities are obtained. Finally, the challenging problem of blind time variant seismic deconvolution is outlined and the necessity of IFM is demonstrated.

Arash Lavasan: Optimized model validation based on monitoring data in mechanized tunneling: application to Milan Metro line 5

isc6 1001 08 - YouTube
https://www.youtube.com/watch?v=qLx975GAfik

The concept of optimal experimental design (OED) enables determination of the most relevant monitoring set up among various strategies in order to allow an efficient parameter identification through an inverse analysis. In
this frame, optimum monitoring set up is defined based on spatial and temporal sensitivity analyses to investigate the relevant zones in the domain and time scales to measure a certain item in the system. To validate the numerical model and to justify the applicability of this concept to a real case, the measured settlements in a shallow founded building that is induced by new double tube Milan metro line 5 is investigated.

Maria Datcheva: Epilogue on Professor Schanz

https://drive.google.com/file/d/1pj8Gqnlz0pWA1SumF8CK2mp3bu-D2Ou0/view?usp=sharing

isc6 1001 09 - YouTube

www.youtube.com/watch?v=GRtglFZPA8Y

Péter Bakucz: Traffic and automated car development

isc6 1001 10 - YouTube
https://www.youtube.com/watch?v=DUmbBD3KJFE
In the chassis control engineering practice, it is often necessary to create a system that is fully demonstrable or provable. In addition to provability, the completeness of the system is also important.
The system provability and completeness is necessarily for release processes.
Therefore, in this work to be introduced a method, being defined the fully-provable and complete dynamical system for a traffic node based on the Euler-Lagrange equations.
The fully provable means for a traffic node, that the geometry, the traffic dynamics, the boundaries and the mathematical, algorithmical detection of the node are analyzed and quantified using Lagrangian densities.
The dynamics of a transport node is determined by discretizing the node and recording the movements of each transport participant in a "state - next state" system.
For product owners in chassis control software engineering and system engineering, the procedure may be important to be able to design a system where completeness and provability is ensured from the outset.
Full-provability means that the system is built using lagrange-densities in such a way that the combination of dynamic traffic correlations with boundary conditions and detection algorithmical know-how reaches an extremum.
The extremum is achieved by applying the principles of variation, aka the solution of the Euler-Lagrange partial differential equations with the system lagrangians based on the kinetical-, potential energies, boundary conditions and algorithmical detectability issues.

CV-s

Sai Sri Harsha Vallurupalli, M.Sc. RUBochum: Optimizing the design of retaining wall systems using multi-objective optimization strategies.

Name: Sai Sri Harsha Vallurupalli

Age: 25 years

Education: Master’s in Computational Engineering (RUB, Germany)

Bachelor’s in civil engineering (VFSTR University, India)

Current position: PhD student in the chair of Soil mechanics, Foundation Engineering &

- Environmental geotechnics, RUB.
Current research: Mechanized tunneling in natural structured clay considering to the -
- influence of the construction procedure on long-term behavior.

Chenyang Zhao: A hybrid model for mechanized tunnel excavation
Dr. Chenyang Zhao obtained his Ph.D. degree at Ruhr-University Bochum, Germany under the supervision of Prof. Tom Schanz in 2018. He continued working as a Postdoctoral research associate at the same institute before returning to China in August 2019. Now he is an assistant professor at Sun Yat-sen University, China.

Elham Mahmoudi: Reliability-based Robust Design Optimization of a Rock Salt Cavern
Elham Mahmoudi is an associate researcher in the chair of Computing in Engineering at Ruhr-University Bochum, Germany. Previously, she was an assistant researcher in the chair of Soil Mechanics and Foundation engineering led by Prof Tom Schanz. She obtained her Ph.D. in Geotechnical Engineering under his supervision in 2017. Her research interests include simulation-based optimization, machine learning, uncertainty quantification in computational geotechnics.

Péter Bakucz: Testing the completeness of the autonomous driving
He is a hydraulic engineer, mathematician, associate professor at Obuda University.

Arash Lavasan:
Dr. Arash Lavasan is a research associate and group leader at the chair of Soil Mechanics, Foundation Engineering, and Environmental Geotechnics at the Ruhr University Bochum since 2012. His research mainly focuses on the assessment of Thermo-Hydro-Mechanical behavior of geomaterials and numerical simulation of multi-phase systems in Geomechanics including the development of advanced constitutive models. After finishing his Ph.D. in 2010, he received the Alexander von Humboldt Foundation award for Post-doctoral research at Ruhr University Bochum. Currently, he serves as Project Leader in the collaborative research center 837 and as junior principal in the research department Subsurface Modeling & Engineering.