LOST BETWEEN TWO SHORES

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THE NETHERLANDS (HOLLAND)

Known for:
1. Beer (Heineken, Amstel)
2. Soccer (Cruijff, Sneijder)
3. Cheese (Gouda, Edam)
4. Beauty of its capital (??)
5. Flowers
6. Non-interesting geology
ALMA MATER: UNIVERSITY OF AMSTERDAM

CAMPUS AREA

LOTS OF BIKES
TRANSITION TO THE WORLD
NOW UC - IRVINE

CAMPUS AREA

NEWPORT BEACH
WHAT DO I ACTUALLY DO?
TUNING THE PARAMETERS SO THAT CLOSEST FIT TO THE OBSERVED SYSTEM RESPONSE IS OBTAINED
CLASSICAL ESTIMATION: A SINGLE SOLUTION
MODELING FRAMEWORK WITH UNCERTAINTY

System invariants (Parameters)

Forcing (Input Variables)

State (Prognostic Variables)

Output (Diagnostic Variables)

Observations

Update Rule
I. Pareto optimization
Multi-objective optimization

AMALGAM optimization

II. Stochastic Optimization
Markov Chain Monte Carlo sampling

DREAM - MCMC
III. Sequential Data Assimilation

Combined Parameter & State Estimation

\[ X = \text{measurement} = \text{model} \]

\[ t \rightarrow t+1 \]

Other Model - Data Synthesis Methods

IV. Model Averaging

Bayesian / Mallows Model Averaging

- \( \bigcirc \) = model 1
- \( \square \) = model 2
- \( \blacklozenge \) = model 3
- \( X \) = measurement

P-PREAM: Differential Evolution Particle Filter
Sequential Monte Carlo + MCMC with DREAM

Quantile Regression
PDF sharper than BMA
Maintains Detailed Balance and is Ergodic
Handles Multimodality Efficiently
High-dimensionality

DREAM: Continuously Updates the Scale
and Orientation of the Proposal Distribution

Vrugt et al., WRR, (2008); Vrugt et al., IJNSNS, (2009)

DREAM: Continuously Updates the Scale
Maintains Detailed Balance and is Ergodic
Handles Multimodality Efficiently
High-dimensionality

ESPECIALLY DESIGNED FOR PARALLEL COMPUTING

ACCELERATING MARKOV CHAIN MONTE CARLO SIMULATION BY SELF-ADAPTIVE DIFFERENTIAL EVOLUTION WITH RANDOMIZED SUBSPACE SAMPLING
NEVADA TEST SITE

241 parameters

Keating et al., *WRR* (2010)
MT-DREAM$_{zs}$: CALIBRATION RESULTS

(a) DREAM$_{zs}$: $AR = 4.0\%$

(b) MT-DREAM$_{zs}$: $AR = 14.3\%$

Laloy and Vrugt, WRR (2011)
Software

MATLAB Packages

**DREAM:** Differential Evolution Adaptive Metropolis (DREAM) Markov Chain Monte Carlo (MCMC) sampling of the posterior probability density function. This code runs multiple different chains simultaneously for global exploration, and automatically tunes the scale and orientation of the proposal distribution using differential evolution. The algorithm maintains detailed balance and ergodicity and is generally superior to other adaptive MCMC sampling approaches, especially in the presence of high-dimensionality and multimodality. This algorithm is a follow up on the SCEx-UA global optimization algorithm (which can be obtained upon request) and is especially designed to take full advantage of the power of distributed computer networks.

**DREAM**$	ext{235}$: Differential Evolution Adaptive Metropolis (DREAM) Markov Chain Monte Carlo (MCMC) of the posterior probability density function. DREAM$	ext{235}$ is based on the original DREAM algorithm, but uses sampling from an archive of past states to generate candidate points in each individual chain. Sampling from the past circumvents the need for a large number of parallel chains, designed to accelerate convergence for high-dimensional state spaces.

Request Software Packages

It's easy - just fill out this form.

What software packages are you interested in?
Please choose your package(s) below.

MATLAB Packages

- DREAM
- DREAM$	ext{(Z5)}$
- DREAM$	ext{(D)}$
- AMALGAM
- AMALGAM-SO
- SODA
- BMA
- None - I want something else

Other Packages

- R Packages
- Python Packages
- C Packages
- Parallel Computation
- Other Languages

About

How are you planning on using this software?

How did you hear about this software?
WHAT AM I PLANNING TO DO?
LEAST SQUARES REVISITED

\[ \min_{\theta \in \Theta} F(\theta) = \sum_{t=1}^{n} e_t(\theta)^2 \]

IS THIS REALLY THE WAY TO GO?

ARTIFICIALLY INTRODUCES EQUIFINALITY
TREMENDOUS INFORMATION LOSS OF DATA
COMPLICATES FINDING BEST SOLUTIONS
NEW RULES - AFTER BILL MAHER

• TRY TO BE THE FIRST TO PUBLISH ON A NEW SUBJECT - LESS IMPORTANT TO BE RIGHT

• DON’T READ TOO MUCH LITERATURE; IT WILL KILL YOUR CREATIVITY AND ABILITY TO THINK OUTSIDE THE BOX

• A GOOD PROFESSOR CAN EXPLAIN A CONCEPT TO A 15 YEAR OLD KID. I CAN’T.

• ALWAYS QUESTION CONVENTIONAL WISDOM. DO NOT TAKE PROFESSORS TOO SERIOUSLY

• HIRING IS EASY, BUT HOME GROWN EXCELLENCE IS THE ULTIMATE STAMP OF A GOOD PROGRAM

• OPEN SOURCE DATA, MODELS, CODES. MANY PEOPLE BENEFIT FROM THIS