*Editorial*

# Preface of the 42nd International Workshop on Bayesian Inference and Maximum Entropy Methods in Science and Engineering—MaxEnt 2023

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## 1. Introduction

The forty-second International Conference on Bayesian Inference and Maximum Entropy Methods in Science and Engineering (42nd MaxEnt'23) was held at the Max Planck Institute for Plasmaphysics (IPP) in Garching, Germany, from 3rd to 7th of July 2023 (https://www.ipp.mpg.de/maxent2023) (Figure 1). This conference continued a long series of MaxEnt workshops which started in the late 1970s centered on ill-conditioned data analysis tasks, thus making this workshop series one of the oldest (if not the oldest) conferences focusing on areas which are now commonly (but not always correctly) denoted as ML/AI.

**Figure 1.** Conference photo.

The MaxEnt event at the IPP provided an opportunity for scientists, researchers, academics, and professionals to meet and to exchange and discuss the latest ideas and approaches in the areas of Bayesian inference and maximum entropy methods in data analysis, information processing, and inverse problems from a broad range of diverse disciplines, including astronomy and astrophysics, geophysics, medical imaging, acoustics, molecular imaging and genomics, non-destructive evaluation, particle and quantum physics, physical and chemical measurement techniques, economics, econometrics, and robust estimation.

In particular, topics of interest also included new approaches to strong AI, physics-inspired neural networks (PINNs), and the development of efficient closed-loop Bayesian experimental design approaches.

The following list of talks given at the workshop illustrates the wide range of topics addressed.

## 2. 32 Talks

- Danielle Hodgkinson: A Bayesian Data Analysis Method for an Experiment to Measure the Gravitational Acceleration of Antihydrogen.
- Fabian Sigler: Second Order Theory of Mind a Sociophysical Model.
- David Iagaru: Uncertainty Quantification for Super-Resolution.
- Zahra Amini Farsani: Advanced Maximum Entropy Algorithms for Bioimaging Issues.
- Nhan Le: An Iterative Bayesian Algorithm for 3D Image Reconstruction Using Multi-View Compton Data.
- Peter Dieterich: Bayesian inference of anomalous dynamics and tempering memory of migrating cells.
- Yannis Kalaidzidis: Off-target level estimation for siRNA mediated downregulation of gene expression.
- Chang Sub Kim: Bayesian Inversion in the Brain.
- Robert Köberl: Magnetohydrodynamic Equilibrium Reconstruction with Consistent Uncertainties.
- Robert Niven: Construction of Dimensionless Groups by Entropic Similarity.
- Gerd Verdoolaege: Geodesic Least Squares Robust Regression Using Information Geometry.
- Theo Grente: Analysis of Ecological Networks and Information Theory Tools.
- Richard Grumitt: Flow Annealed Kalman Filters.
- Nick Candau: Machine Learning Using Maximum Entropy and Bayesian Inference.
- Sascha Ranftl: Physics-consistent infinite neural networks.
- Ali Mohammad-Djafari: Deep Learning with Bayesian Principles and Inverse Problems.
- Tiago Silva: Data Fusion and Information Content in Self-consistent Processing of Ion Beam Analysis Data.
- Louis Duval: Study of B-like ions X-ray Emission Spectra in an Electron-Cyclotron Resonance Ion Source plasma.
- Ning Chu: A fast-rotating sound localization method based on modal composition beamforming under Bayesian framework.
- Minas Karamanis: Preconditioned Monte Carlo.
- Cesar Godinho: Bayesian Analysis of Strong Field QED Tests for He-Like Ions Using the Nested Sampling Algorithm.
- Nico Unglert: Exploration of Materials Configuration Spaces using Neural Network Force Fields and Nested Sampling.
- Anthony Garrett: Improved Derivation of the Laws of Probability.
- Romke Bontekoe: Kangaroos in Cambridge.
- Stefan Behringer: Value of Information in Zero-Sum Games.
- Kevin Knuth: Using Nested Sampling to Simulate the Characteristics of Extra-Terrestrial Civilizations that Encounter Earth.
- Andrew Fowlie: Origins of Parameters in Adimensional Models.
- Vishal Johnson: Quantum Measurement and Objective Classical Reality.
- Alexander Vosseler: BHAD: Explainable anomaly detection using Bayesian histograms.
- Margret Westerkamp: Inferring Evidence from Nested Sampling Data via Information Field Theory.
- Oliver Schulz: BAT.jl, the Bayesian Analysis Toolkit in Julia.
- John Skilling: Arithmetic and Quantum Theory.

### 3. Nested Sampling Workshop

As the innovative idea of the Nested Sampling algorithm was initially presented by John Skilling at the MaxEnt workshop back in 2004 at the IPP in Garching (i.e., at the same site), it appeared appropriate to include a special session specifically dedicated to Nested Sampling. Though initially considered with some reservation, the ideas underlying Nested Sampling have been proven to be very fruitful and have meanwhile become widely adopted. This can be seen from the range of topics covered in this 1.5-day special session:

- Johannes Buchner, Will Handley: Welcome, goals of the workshop, overview.
- John Skilling: Nested Sampling—The idea.
- Johannes Buchner: Sampling strategies: ideas from the past and current frontiers.
- Josh Speagle: Musings on dynesty, Dynamic Nested Sampling, and Challenges with Practical Implementations of Nested Sampling Algorithms.
- Leah South (remote, 18:30 local time): Unbiased and Consistent Nested Sampling via Sequential Monte Carlo.
- Doris Schneider: Plateaus and rare event estimation.
- Nicolas Chopin: Waste-free Sequential Monte Carlo, and its connection to NS.
- Michael Habeck: Adaptive Ensemble Annealing.
- Discussion: Open issues on statistical foundations, synergies with work on related algorithms (bridge/path sampling, SMC, rare event simulation).
- Jack O'Brien: Probabilistic Inference of Type Ia Supernova Abundances.
- Pablo Lemos: Gradient-based Nested Sampling.
- Xi Chen: Bayesian posterior repartitioning for nested sampling.
- Aleksandr Petrosyan: Stress testing SuperNest.
- Michael J. Williams: Importance NS with normalizing flows.
- Johannes Lange: Boosting importance nested sampling with deep learning.
- Lukas Hergt: Post-Processing Tools for Nested Sampling.
- Discussion: The relation between machine learning and NS.
- Livia Bartok-Partay: Nested sampling of atomic potential energy surfaces.
- George Marchant: Nested sampling of magnetic materials.
- Omar Adesida: NS as a tool for exploring the thermodynamic behaviour of hard sphere dimers.
- Ning Xiang: Nested sampling for detection, enumeration, and localization of multiple sound sources using a spherical microphone array.
- Mingrui Yang: Surface Phase Diagrams from Nested Sampling.
- Jason McEwen: Proximal nested sampling for high-dimensional Bayesian model selection.
- Andrew Fowlie: Opening up nested sampling.
- Brendon Brewer: Computing entropies with NS.
- Will Handley: The scaling frontier of nested sampling.
- Will Handley: workshop summary talk: Frontiers of nested sampling.

As this Editorial exemplifies, the intersections between Bayesian inference, ML/AI, and data science will become increasingly interconnected in the future. As such, it is our hope that these conference proceedings will serve as a valuable source of inspiration for future endeavors in this field.

**Conflicts of Interest:** The authors declare no conflict of interest.