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taurex-emcee: a TauREx 3.1 plugin for the emcee sampler

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Summary

taurex-emcee is a plugin for the TauREx 3.1 atmospheric retrieval framework (A. F. Al-Refaie et al., 2021) that extends the choice of sampling methods available to the user. The plugin provides an interface to the emcee sampler (Foreman-Mackey et al., 2013), a popular affine-invariant ensemble sampler widely used in the astronomy community. Running the sampler to convergence is automated through the autoemcee package, which also supports parallelization with MPI. Thus, the taurex-emcee plugin allows users to easily launch parallelized retrievals of atmospheric spectra with emcee. This enables reliable, efficient, and fast retrievals, especially when coupled with TauREx's GPU-accelerated forward models (A. Al-Refaie et al., 2020).

taurex-emcee is released under the BSD 3-Clause license and is available on GitHub. The plugin can be installed from the source code or from PyPI, so it can be installed as `pip install taurex-emcee`. The documentation is available on readthedocs, including a quick-start guide, a tutorial, a description of the software functionalities, and guidelines for developers. The documentation is continuously updated and is versioned to match the software releases.

Benchmark

Emcee vs MultiNest

Statement of need

Optimized sampling methods are a key component of any retrieval code. Nested samplers (F. Feroz et al., 2009; Farhan Feroz et al., 2019) are a powerful and robust sampling method, successfully applied to the retrieval of exoplanet atmospheric spectra (Barstow et al., 2020; Bocchieri et al., 2023; Changeat et al., 2020). TauREx 3.1 natively implements a suite of nested samplers, including the MultiNest sampler, or makes them available as plugins, such as the UltraNest sampler. The primary target of nested samplers is the efficient calculation of the Bayesian `evidence`, whilst the inference of the `posterior` is a by-product. This is regarded as a key advantage of nested samplers, as the `evidence` can be readily used for model selection. However, the `evidence` is not always required, and the interpretation of the `posterior` from nested samplers necessitates some care. Additionally, algorithmic assumptions of nested samplers may require to tailor the priors to explore the parameter space thoroughly.

Where the inference of the Bayesian `posterior` is the primary target, a well-established alternative to nested samplers are a family of Markov chain Monte Carlo methods known as affine-invariant ensemble samplers (Goodman & Weare, 2010). The implementation in emcee (Foreman-Mackey et al., 2013) is a popular choice in the astronomy community, as it takes care of the heavy lifting of the sampling process, is well documented, and is straightforward to utilize. To date, the `emcee` sampler is not natively implemented in the TauREx 3.1 retrieval framework, nor elsewhere in other retrieval codes, to the knowledge of the authors. To fill this gap, we developed the `taurex-emcee` plugin, which interfaces the `emcee` sampler to TauREx.

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