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AnyPyTools: A Python package for reproducible research with the AnyBody Modeling System

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Software

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Summary

The AnyPyTools package provides a Python interface to automate multibody musculoskeletal model simulations in the AnyBody Modeling System. The main advantage of AnyPyTools is that it enables reproducible research for the AnyBody Modeling System, and bridges the gap to the whole ecosystem of open source scientific Python packages.

As musculoskeletal simulations become increasingly important in decision making processes in a range of applications, so does the requirement for model verification and validation (V&V) (M. E. Lund, Zee, Andersen, & Rasmussen, 2012). Successful V&V will often require running large numbers of simulations (batch processing) or investigating parameters systematically (sensitivity or parameter studies). The stand-alone AnyBody Modeling System is not very suited for this kind of meta-analysis. The modeling system is essentially an IDE/compiler for scripting single multibody musculoskeletal models in the AnyScript modeling language.

The AnyPyTools Python package enables batch processing, parallelization of model simulations, model sensitivity studies, and parameter studies, using either Monte-Carlo (random sampling) or Latin hypercube sampling. It makes reproducible research much easier and replaces the tedious process of manually automating the musculoskeletal simulations and aggregating the results.

The AnyPyTools library was developed at Aalborg University to help in the effort to validate musculoskeletal models created within the AnyBody Modeling System (M. E. Lund, Andersen, Zee, & Rasmussen, 2015, M. E. Lund et al. (2012)). In this work AnyPyTools was used to orchestrate large number of model simulations and distribute the load over multiple processors, as well as collect the results directly in Python and investigate the sensitivity of the model predictions. The library has evolved over time to also include a pytest plugin for running unit tests on AnyScript files (`test_*.any`) similar to how unit-tests are used for Python.

The AnyPyTools library is available on both PyPI and conda. It has been downloaded more than 20.000 times from the conda-forge channel and has been used in a large number of scientific publications over the last 5 years (De Pieri et al., 2018, Stensgaard Stoltze, Rasmussen, & Skipper Andersen (2018), Richards, Andersen, Harlaar, & Noort (2018), Theodorakos et al. (2018), Rasmussen2018-nq, Dell'Isola, Smith, Andersen, & Steultjens (2017), Eltoukhy, Kuenze, Andersen, Oh, & Signorile (2017), Skals, Rasmussen, Bendtsen, Yang, & Andersen (2017), Anderson Souza Oliveira, Silva, Lund, Farina, & Kersting (2017), Skipper Andersen, Zee, Damsgaard, Nolte, & Rasmussen (2017), Skals, Jung, Damsgaard, & Andersen (2017), Vanheule et al. (2017), Theodorakos et al. (2016), M. E.

Lund et al. (2015), A. S. C. Oliveira, Silva, Lund, Farina, & Kersting (2014), Anderson Souza Oliveira et al. (2013), A S Oliveira, Silva, Lund, Kersting, & Farina (2013))

The source code for AnyPyTools is available on GitHub and releases are archived to Zenodo with the linked DOI: (M. E. Lund, Andersen, & Rasmussen, 2018)

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