

# root\_numpy: The interface between ROOT and NumPy

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## Software

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## Summary

root\_numpy interfaces NumPy (Walt, Colbert, and Varoquaux 2011) with CERN's ROOT (Antcheva et al. 2009) software framework, providing the ability to analyse ROOT data within the broad ecosystem of scientific Python packages.

At its core are functions for converting between ROOT TTrees and structured NumPy arrays. root\_numpy can convert TTree branches (columns) of fundamental types and strings, as well as variable-length and fixed-length multidimensional arrays and (nested) std::vectors. root\_numpy can also create columns in the output NumPy array from mathematical expressions like ROOT's TTree::Draw(). root\_numpy's internals are written in Cython (Behnel et al. 2011), installed as compiled C++ extensions, and can handle data with comparable speed to ROOT as shown in the figure below. root\_numpy can also convert between ROOT histograms and NumPy arrays, and sample or evaluate ROOT functions as NumPy arrays.

root\_numpy interfaces NumPy with TMVA (Speckmayer et al. 2010), ROOT's machine learning toolkit, but naturally allows ROOT users to take advantage of scikit-learn (Pedregosa et al. 2011) and TensorFlow (Abadi et al. 2015).

## References

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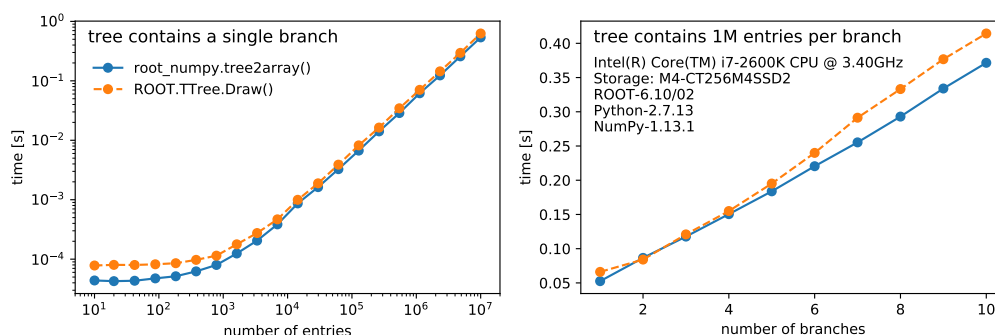


Figure 1: Benchmarking root\_numpy's tree2array() function against ROOT's TTree::Draw()

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