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message: "If you use TensorFlow in your research, please cite it using these metadata. Software is available from tensorflow.org."

title: TensorFlow, Large-scale machine learning on heterogeneous systems

abstract: TensorFlow is a machine learning system that operates at large scale and in heterogeneous environments. TensorFlow uses dataflow graphs to represent computation, shared state, and the operations that mutate that state. It maps the nodes of a dataflow graph across many machines in a cluster, and within a machine across multiple computational devices, including multicore CPUs, general purpose GPUs, and custom-designed ASICs known as Tensor Processing Units (TPUs). This architecture gives flexibility to the application developer, whereas in previous “parameter server” designs the management of shared state is built into the system, TensorFlow enables developers to experiment with novel optimizations and training algorithms. TensorFlow supports a variety of applications, with a focus on training and inference on deep neural networks. Several Google services use TensorFlow in production, we have released it as an open-source project, and it has become widely used for machine learning research. In this paper, we describe the TensorFlow dataflow model and demonstrate the compelling performance that TensorFlow achieves for several real-world applications.

authors:

- family-names: Abadi

given-names: Martín

- family-names: Agarwal

given-names: Ashish

- family-names: Barham

given-names: Paul

- family-names: Brevdo

given-names: Eugene

- family-names: Chen

given-names: Zhifeng

- family-names: Citro

given-names: Craig

- family-names: Corrado

given-names: Greg S.

- family-names: Davis

given-names: Andy

- family-names: Dean

given-names: Jeffrey

- family-names: Devin

given-names: Matthieu

- family-names: Ghemawat

given-names: Sanjay

- family-names: Goodfellow

given-names: Ian

- family-names: Harp

given-names: Andrew

- family-names: Irving

given-names: Geoffrey

- family-names: Isard

given-names: Michael

- family-names: Jozefowicz

given-names: Rafal

- family-names: Jia

given-names: Yangqing

- family-names: Kaiser

given-names: Lukasz

- family-names: Kudlur

given-names: Manjunath

- family-names: Levenberg

given-names: Josh

- family-names: Mané

given-names: Dan

- family-names: Schuster

given-names: Mike

- family-names: Monga

given-names: Rajat

- family-names: Moore

given-names: Sherry

- family-names: Murray

given-names: Derek

- family-names: Olah

given-names: Chris

- family-names: Shlens

given-names: Jonathon

- family-names: Steiner

given-names: Benoit

- family-names: Sutskever

given-names: Ilya

- family-names: Talwar

given-names: Kunal

- family-names: Tucker

given-names: Paul

- family-names: Vanhoucke

given-names: Vincent

- family-names: Vasudevan

given-names: Vijay

- family-names: Viégas

given-names: Fernanda

- family-names: Vinyals

given-names: Oriol

- family-names: Warden

given-names: Pete

- family-names: Wattenberg

given-names: Martin

- family-names: Wicke

given-names: Martin

- family-names: Yu

given-names: Yuan

- family-names: Zheng

given-names: Xiaoqiang

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