Neural Network Precision Tuning Using Stochastic Arithmetic

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Introduction

IEEE754 Standard types

Format	Name	Length	Sign	Mantissa Length	Exponent Length
binary16	Half	16 bits	1 bit	11 bits	5 bits
binary32	Single	32 bits	1 bit	24 bits	8 bits
binary64	Double	64 bits	1 bit	53 bits	11 bits

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- Shorter execution time ☺
- Less volume of results exchanged (less memory used) ☺
- Less energy consumption ☺
- Less accurate results - rounding errors ☹

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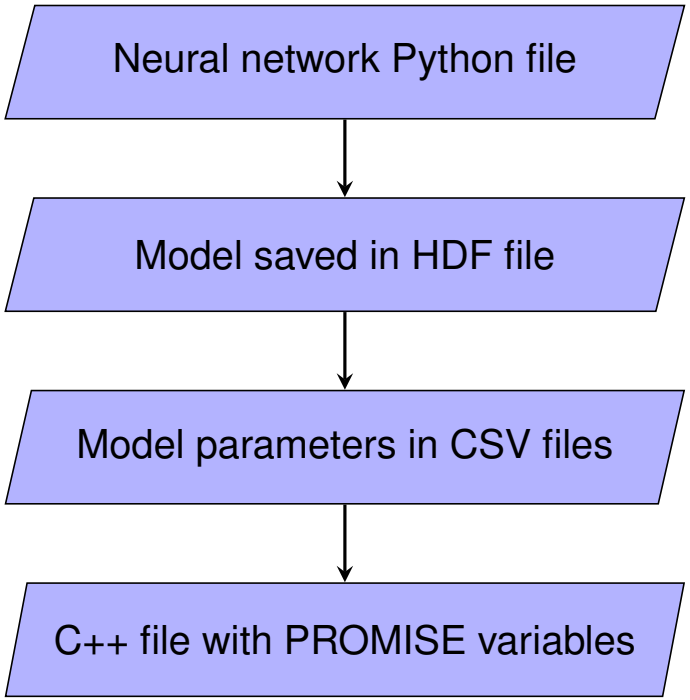
Numerical validation:

- Stochastic arithmetic enables one to estimate rounding errors in numerical programs
- PROMISE: based on stochastic arithmetic, performs precision auto-tuning taking into account an accuracy requirement

Methodology



- One type per neuron
- One type per layer

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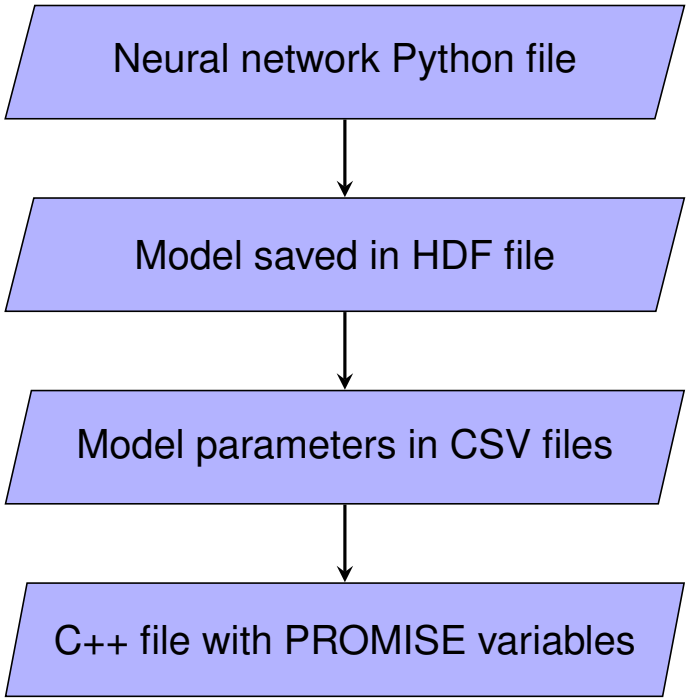

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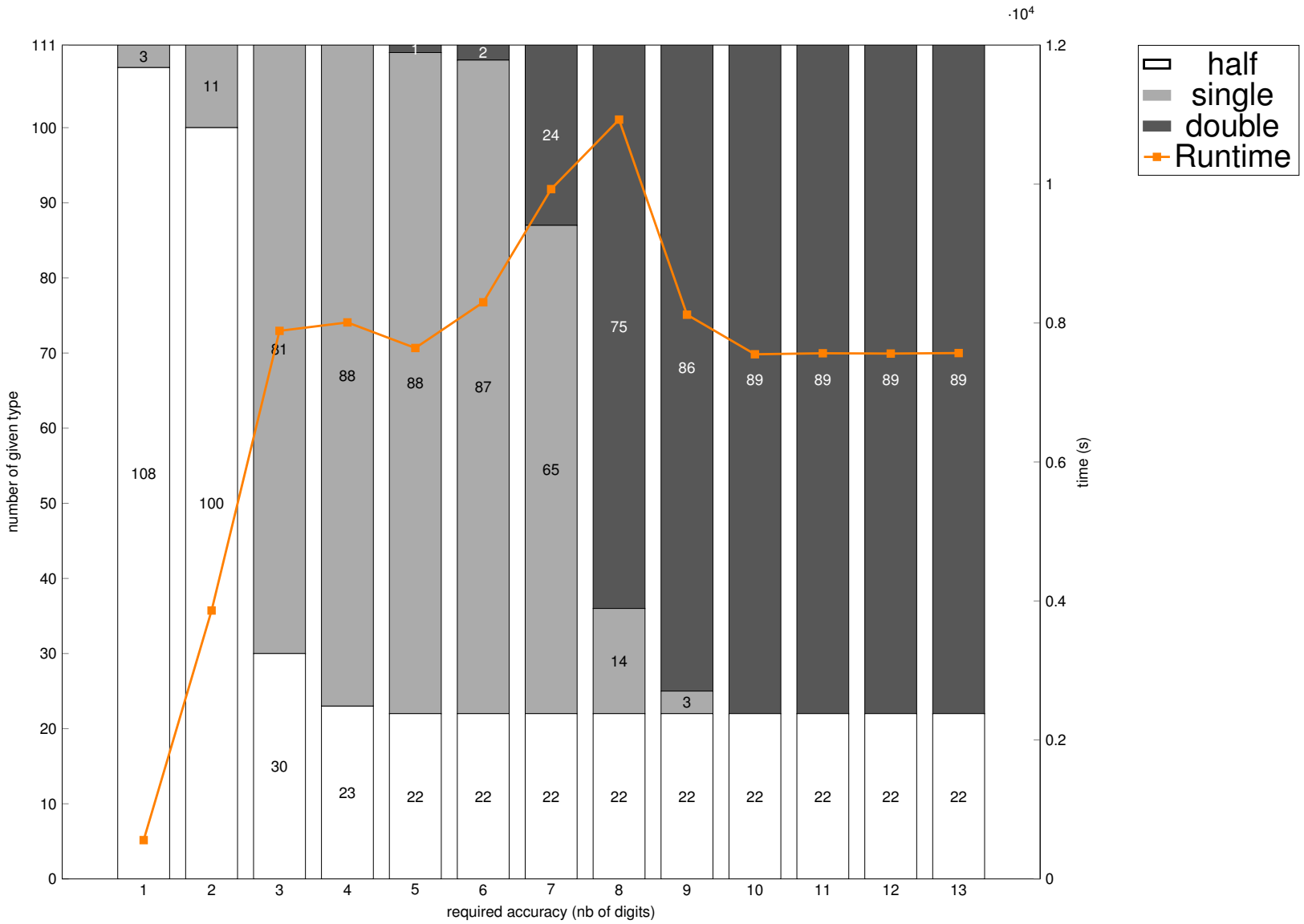
4 Neural Networks:

- Sine NN: approximation of sine function
- Inverted Pendulum: computation of a Lyapunov function [Chang et al., 2020]
- MNIST NN: classification of handwritten digits
- CIFAR NN: classification of pictures among 10 classes (dogs, cats, deer, car, boat...)

Results with CIFAR NN



Thank you for your attention !

Feel free to come see the poster and ask questions