**Measure Energy Consumption**

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**1**.Introduction:

Computer architecture researchers have been investigating energy consumption for decades, especially to be able to deliver state-of-the-art energy efficient processors. Machine learning researchers, on the other hand, have been mainly focused on producing high accurate models without considering energy consumption as an important factor. This is the case for deep learning, where the goal has been to produce deeper and more accurate model without any constraints in terms of computation. These models have grown in computation (typically in the GigaFlops) and memory requirements (typically in the millions of parameters or weights). These algorithms require high levels of computing power during training as they have to be trained on large amounts of the data while during deployment they may be used multiple times. Some awareness in energy consumption is starting to arise, originating from a few machine learning research groups and challenges such as The Low Power Image Recognition Challenge (LPIRC). Thus, we believe that efforts towards estimating energy consumption and developing tools for researchers to advance their research in energy consumption are necessary for a more scalable and sustainable future.

## 2.Background:

## This section explains the main concepts and terminology used throughout the rest of the paper. Energy, measured in joules (J), is the total power consumed during an interval of time. Power, i.e., the rate at which energy is consumed, is the sum of static and dynamic power. Static power, also known as leakage power, is the power consumed when there is no circuit activity. Dynamic power is the power consumed by the circuit, from charging and discharging the capacitance load in the circuit.

## 3.Taxonomy of power estimation models:

## • Software level: The developers of the model at this level are interested in the energy consumption of the application or software implementation and explore optimization techniques that include designing efficient algorithms or better software implementation of the algorithm.

• Hardware-level: The developers of the model at this level are interested in the energy consumption of specific hardware components. They are interested in identifying the hardware components (processor, memory and IO peripherals) that are strongly correlated to the power of the application, also referred to as Functional-level power analysis (FLPA) in. These power models are valuable for the machine learning researchers interested in building specific chips for machine learning computations.

## 4.Conclusion:

## Machine learning algorithms consume significant amounts of energy. However, the lack of evaluations based on energy consumption of these algorithms can be attributed to the lack of appropriate tools to measure and build power models in existing machine learning suites, and because estimating energy consumption is a challenging task.