**JouleSort: A Balanced Energy-Efficiency Benchmark**

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Reviewer: Wei Li

**Summary**

This paper proposed and motivated a fair external sort benchmark whose name is “JouleSort” for evaluating the energy efficiency of various computer systems including mobile, desktop and server.

At first, the authors estimated and compared the energy efficiency of past sort benchmark winners and concluded that this year’s winner PennySort system cannot satisfy their need to promote development of the most energy-efficient sorting systems.

In the second part, the authors described the detailed criteria and challenges in designing the JouleSort benchmark. They chose some type of I/O-centric tasks as their workload, fixed the number of records sorted and used total energy as the metric to minimize. In this part, they also listed the issues and guidelines for proper energy measurement in three areas. Finally, they summarized the JouleSort benchmark.

Then the authors measured the energy consumption of unbalanced and balanced systems and concluded that the I/O subsystem is a significant part of total power.

Finally they did some experiments to provide an in-depth study of their 100GB JouleSort system using NSort and showed that the best configuration is when the sort if CPU-bound and both the choice of filesystem and in-memory sorting algorithm affect energy efficiency. Additionally, they discussed some related work and presented some limitations and future works.

**Contributions**

Compared with previous related works, this paper makes the following contributions.

Previous benchmarks for energy efficiency improvement put most concern on processor energy efficiency but not the I/O subsystem which plays a significant role in total system power consumption. JouleSort is an I/O-centric benchmark that is quite different from those. And it is a complete benchmark including a workload, metric and guidelines, to gauge the efficacy of energy optimizations from a whole-system perspective.

This paper clearly described pitfalls surrounding the creation of a fair energy-efficiency benchmark and justified their fairest formulation which includs three scale factors that are corresponding to three dominant classes of systems existed today: mobile, desktop and server. So except charting past trends, their JouleSort also gains insight into future trends in energy efficiency.

And their winning 100GB JouleSort system balances a low-power, mobile processor with numerous laptop disks connected via server-class PCI-e I/O cards and uses a commercial common sort. This configuration is unprecedented. It is over 3.5 times more efficient than the past winners.

Their approach can optimize both power-consumption and performance which are both important concerns for current computer systems.

In general, the authors stated clearly their motivation, analyzed the past trends, described their design in detail, and took enough experiments on different systems, and presented limitations and future directions. They summarized some sentences at the end of mostly each part. This is really convenient for reader to grab their main idea.

**Weaknesses**

There are several weaknesses in this paper.

1. In this paper, authors summarized the JouleSort benchmark twice and the sentences they used for them are almost the same. From my view, the first appeared summarization in the introduction part can be removed away as a redundancy. Except this point, I can find other similar cases within the whole paper.
2. In historical trends part, table 1 just showed the estimated yearly growth in pure performance, price-performance and energy efficiency of past winners, except their JouleSort. Even though their current JouleSort winner can reach 11300 SRec/J which is 3x the last year’s PennySort winner at 3200 SRec/J, the growth rate of JouleSort might not be greater than that of PennySort. So I can bravely imagine that the energy efficiency of PennySort can exceed JouleSort at some future time. This is one reason that I conclude that their approach is not fully history-proof.
3. Though they adopted three scales to represent the three main classes of computer system, scales can be added or obsoleted as technology improves and comparison across scales is misleading. These are other evidences that their approach is not fully history-proof.
4. The authors adopted three scales including 10GB, 100GB and 1TB. But in fact, because of the hardware limitations and market availability, they could not scale the system to the 1TB class.