Energy-aware paradigm for designing compact data structures

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"P.O. FEDER: Unha maneira de facer Europa"

Brief presentation – Susana Ladra (University of A Coruña)

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Data Compression ; Algorithms and Data Structures

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Energy-aware paradigm for designing compact data structures

Introduction: Compact Data Structures

Data Structures:

Pre-process input data so as to answer (long) series of retrieval or update operations

Want to minimize:

1. Query time
2. Space usage of data structure
3. Time of pre-processing
4. Space for pre-processing

Slide from: https://materials.dagstuhl.de/files/18/18281/18281.RajeevRaman1.Slides.pdf

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Introduction: Compact Data Structures

Data Structures:

Answering queries on data requires an index in addition to the data

Index may be larger than the data

Space usage = “space for data” + “space for index”

redundancy

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Introduction: Compact Data Structures

Compact Data Structures:

Space usage = “space for data” + “space for index”

low-order term

and perform operations **directly** on it

→for static data structures, often get O(1) time operations

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Introduction: Compact Data Structures

Examples of compact Data Structures:

Trees: 2 bits per node, allowing navigation (child, parent, subtree…)

Sequences: $n \log \sigma + o(n \log \sigma)$ bits, allowing rank/select/access

Texts: $O(H_k(T)$ + lower order), allowing counting in $O(|P| \log \sigma)$ time

→ Full-text index occupying 20-30% of the text (**self-indexing**)

Web graphs: 1-2 bits per edge

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Motivation of the project

Big Data / IoT → compact data structures

Compact data structures → space/time trade-off

What about energy?

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Current status

Green Computing → traditionally focuses on hardware

Green Software → gaining importance

Software Quality, Software Design, Software Requirements…

Insufficiently studied from the algorithmic point of view

Not studied at all for compact data structures

Ferragina (2010) made some reflections on the state of the art

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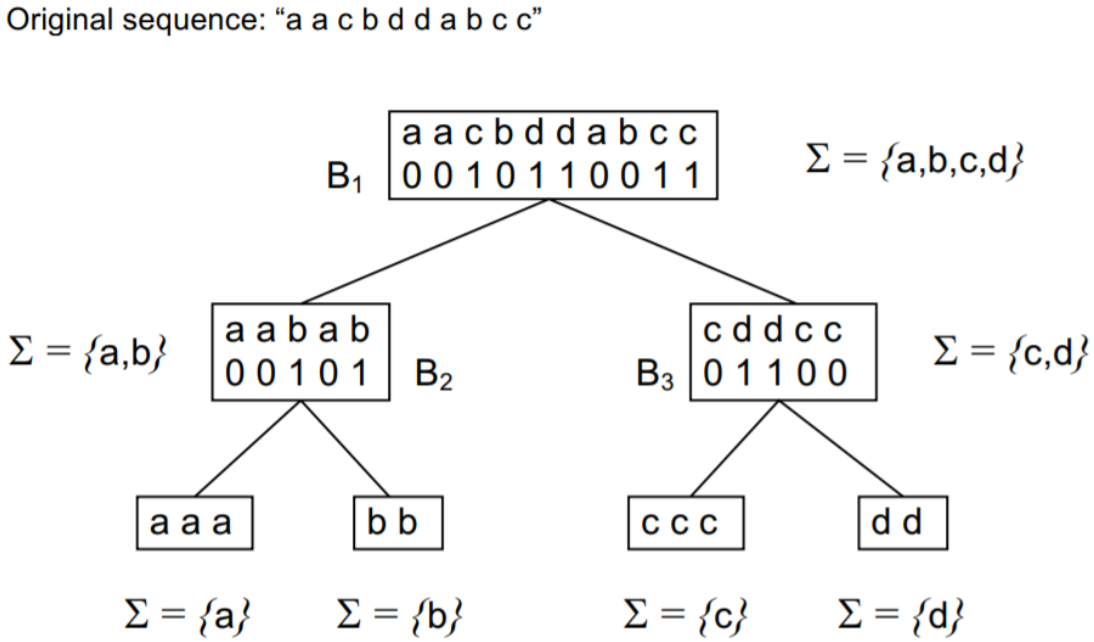
Energy complexity?



Complex memory patterns (not energy-efficient?)

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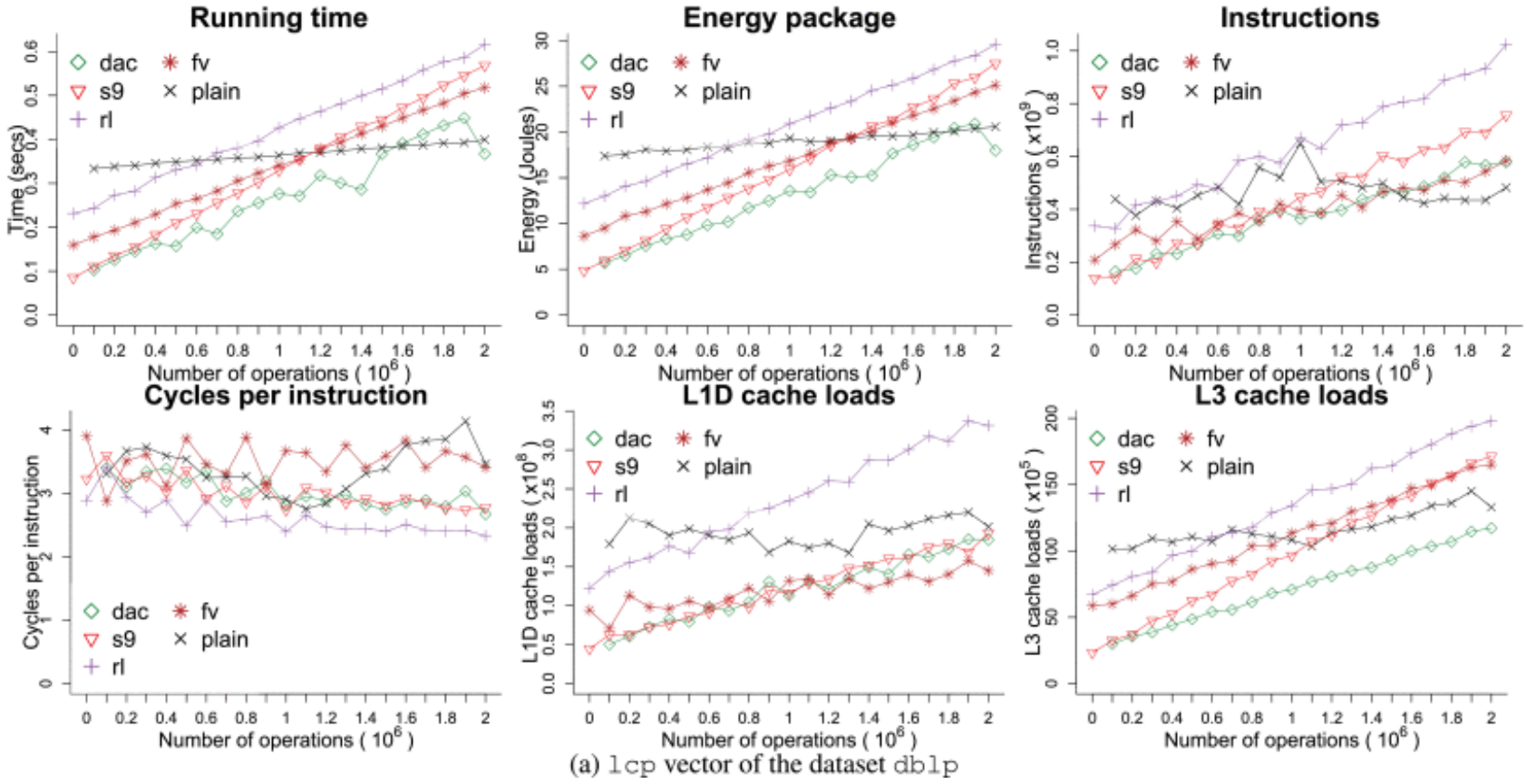
Preliminary studies



(a) `lcp` vector of the dataset `dblp`

https://doi.org/10.1109/ACCESS.2019.2949655

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Challenges

→ Better characterize all the factors that impact on the energy consumption

- How to accurately measure the energy consumption?

→ Energy labelling for algorithms and data structures?

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