HPI clean-IT Initiative for Sustainable Technologies

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International Community Recognizes Growing Energy Consumption of Digital Technologies

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But Green IT is not enough!

Focus on:

- Renewable energy sources for IT infrastructures
- Digital sobriety
- Sustainable production of digital technologies (hardware, recycling, etc.)

What is missing?

- Algorithmic efficiency
- Sustainability by Design

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HPI clean-IT Initiative – What it is About ?

Digital technologies as a driver of sustainable development according to the UN Global Compact and the SDGs

Facets of clean-IT:

- Raising awareness of the digital carbon footprint
- Algorithmic efficiency
- Sustainability by Design

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HPI clean-IT Initiative – Sustainability by Design

Major Challenge in Digital Engineering:

Optimizing the energy efficiency of algorithms, programs and IT systems

- Algorithms solving the same problem can vary in their energy efficiency
- Programs implementing the same algorithm can vary in their energy efficiency
- Trade-off between accuracy/ speed/ memory size and energy efficiency

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HPI clean-IT Initiative – Sustainability by Design

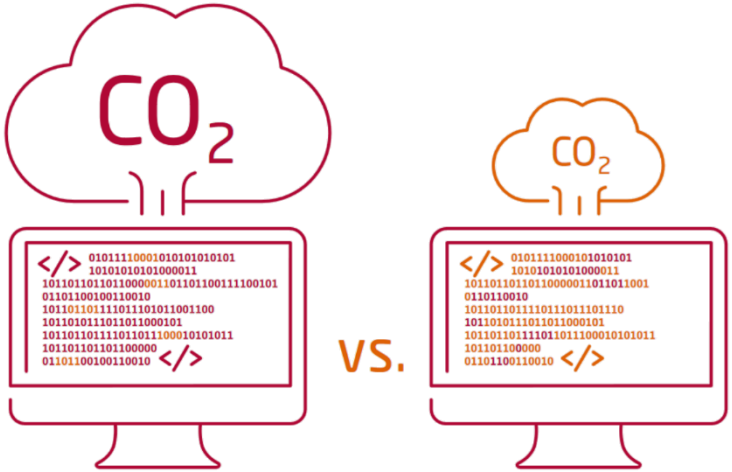
Not sobriety, but better technology!

- Incentivizing research to take the trade-off between energy-consumption and performance into account
  - **algorithmic efficiency**
- Focus on developing energy-efficient computer systems from the start
  - **sustainability by design**
- Establishing international standards on developing sustainable computer systems and implementation of such systems and products

HPI clean-IT Initiative – Some Examples: Heuristic Algorithms

Heuristic Algorithms

- Algorithms that aim at solving complex problems with 100% precision may run into run time excesses
- New class of algorithms that takes trade-off between precision and runtime into account
- Heuristic algorithms produce results with less precision but gaining reductions of runtime / energy consumption by orders of magnitude 100-10.000
  - **Example:** HPI Algorithm Engineering group gave an example that heuristic algorithms are fit to solve submodular functions **300-times** faster and reducing energy consumption to **0,35%**



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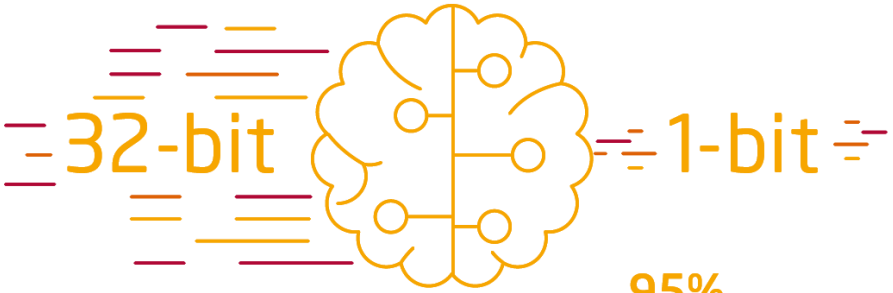
HPI clean-IT Initiative – Some Examples: Efficient AI Computation with Binary Neural Networks

Binary neural networks

- State of the art deep neural networks are trained and operate on 32-bit models
- Training of deep neural networks on binary-level (1-bit) is possible
  - **Example:** HPI Internet Technologies and Systems group showed that training a deep neural network on a binary-level saves **64-times** of computing operations and therefore about **95 % energy** by sacrificing currently only 5 % precision.



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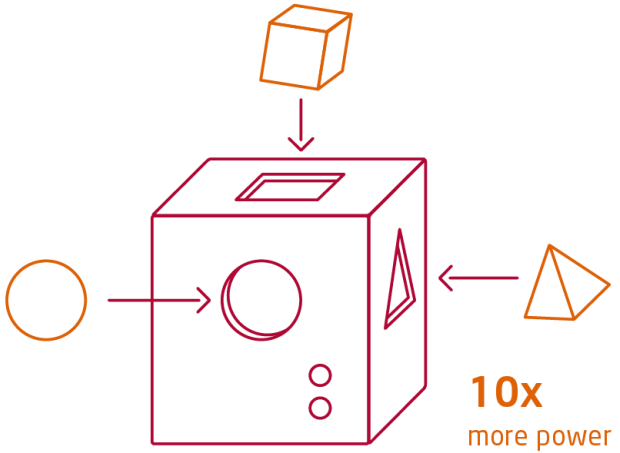
HPI clean-IT Initiative – Some Examples: Energy-Aware Heterogeneous Computing

Energy-Aware Computing

- Current data centers mostly use homogenous hardware for computing tasks
- Not every computing task is performed optimally by each hardware component
- Next-Gen data centers host heterogenous hardware architectures, chips, GPUs …
- Energy-aware computing software routes specific tasks to the optimal chip
  - **Example:** HPI Operating and Middleware group showed that a weather model simulation can be carried out with **10 times** less energy, by using FPGA accelerators instead of general purpose processors



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HPI clean-IT Initiative – Some Examples: Clean Data Profiling

Clean Data Profiling

- Major task in data engineering is to prepare large heterogeneous datasets in a meaningful way by structuring, normalizing, cleaning data
- Important aspect of data profiling is the discovery of Unique Column Combinations
- Current approaches can only find UCCs on mid-sized datasets with quite some runtime effort
  - **Example:** HPI Information Systems group developed the "HPIValid" algorithm which reduces the runtime of UCC discovery by **5-100-times** on mid-sized datasets **saving 20-99%** of energy and makes it possible for large datasets.

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This is Just the Beginning – What´s the Next Steps?

Next-Gen Data Storage Algorithms in Data Centers and Cloud

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Next-Gen Streaming Algorithms

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Next-Gen Blockchain Cryptography

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Next-Gen …

…many more

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HPI clean-IT Initiative
Cooperating for a Sustainable Future

Partners and Supporters

Cooperation of all societal actors required to shape the future of sustainable digital transformation:

- International Organizations
- Politics
- Industry
- Academia
- NGOs
- …

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THE GLOBAL COMPACT

THE GLOBAL GOALS
For Sustainable Development

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Enjoy Watching Our clean-IT Activities and Join the clean-IT Initiative!

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