Karlsruhe Institute of Technology

Compression IOI

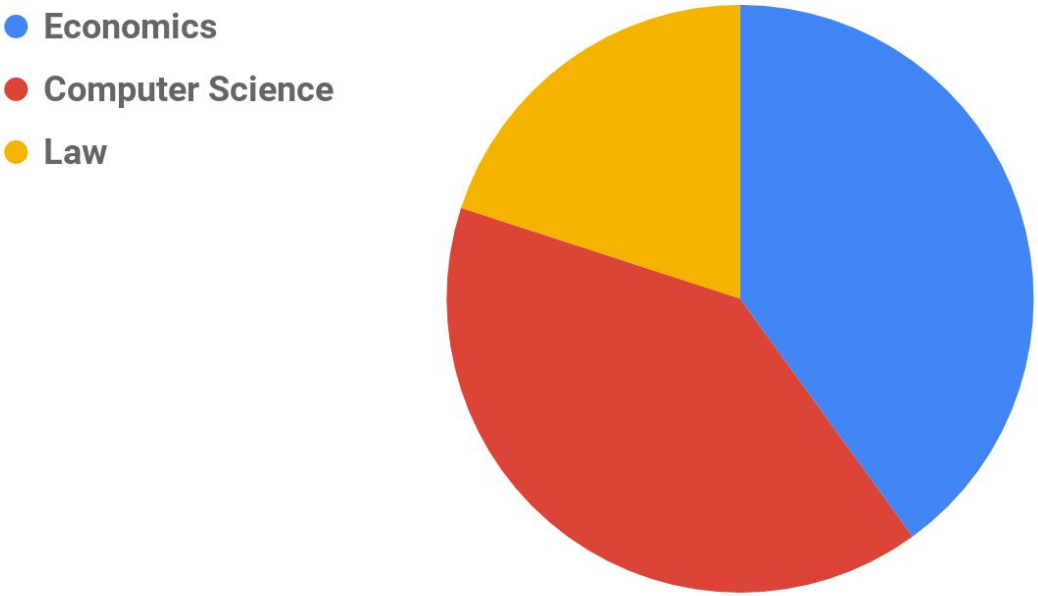
by Uğur Çayoğlu

13. February 2020

STEINBUCH CENTRE FOR COMPUTING (SCC) &
INSTITUTE FOR METEOROLOGY AND CLIMATE RESEARCH (IMK-ASF)

Me, myself and I

- Studied Information Management and Engineering @ KIT



Me, myself and I

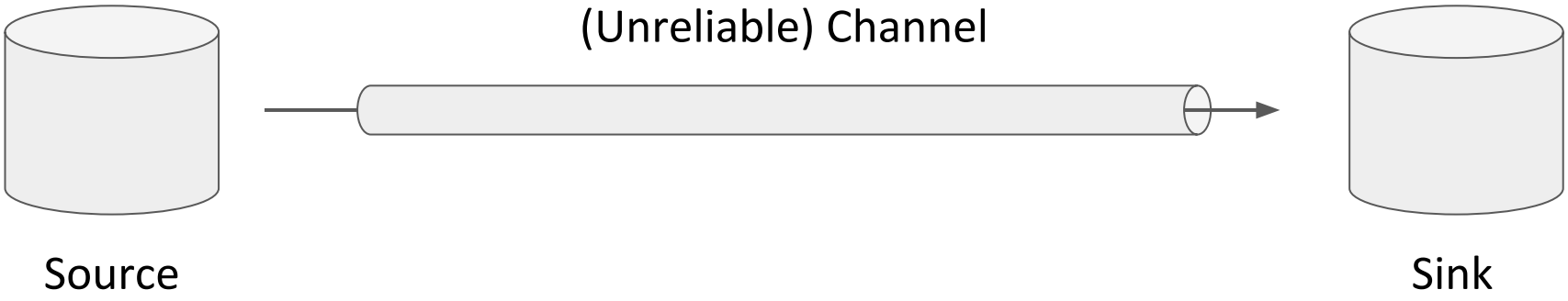
- Studied Information Management and Engineering @ KIT
- Bachelor thesis:
  - *Improve Collaboration Between **Marketing and Sales** and Analyze the Impact on the Quality of **Customer Data** in the Enterprise*

Me, myself and I

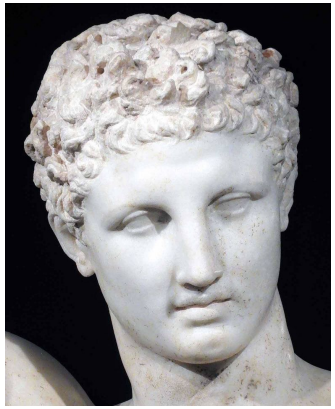
- Master thesis:
  - *Conceptualization and Prototypical Implementation of a Tool to Determine the Optimal **XML Similarity Measurement***
- Doctoral thesis:
  - ***Compression Methods** for Structured Floating Point Data and their Application in Climate Research*

History

- Compression has its origin in communication technology
- Hence compression == source coding

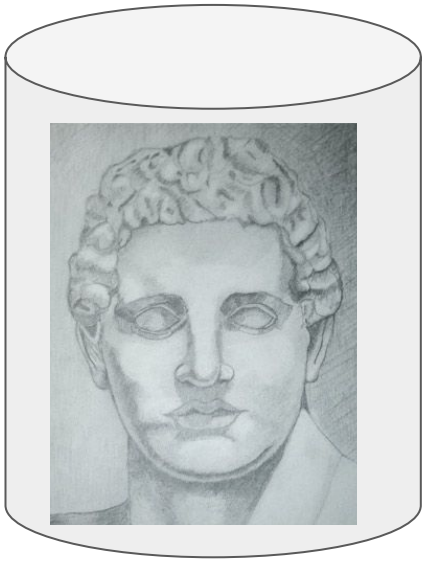


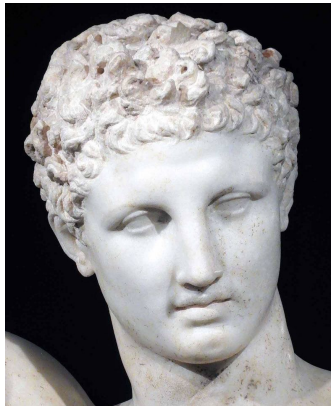
Compression IOI



Source [A]

Compression IOI





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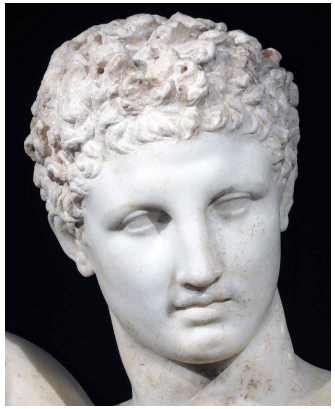
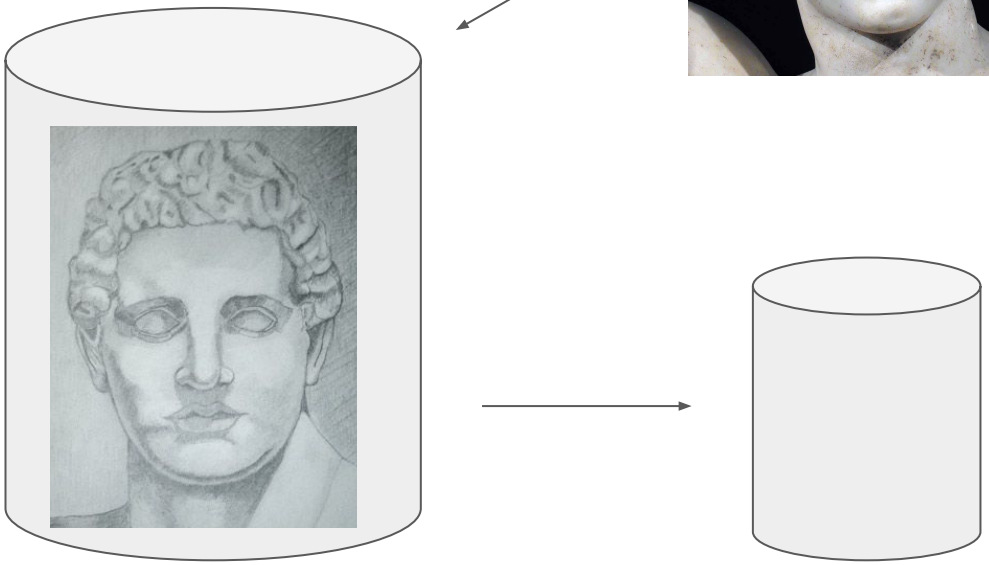
Compression IOI





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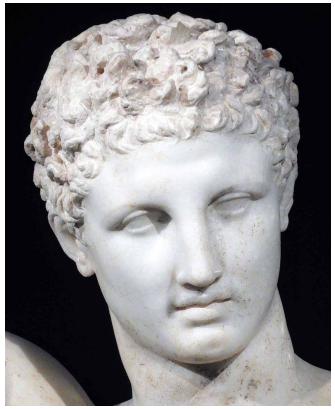

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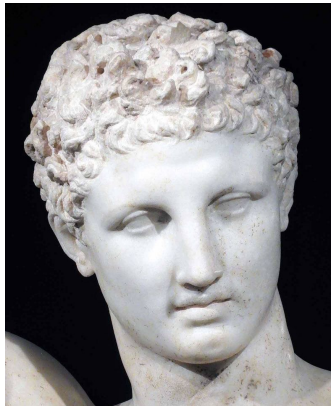

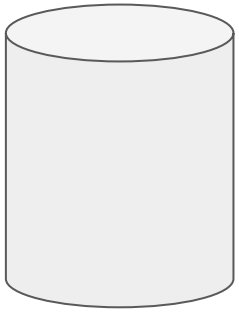

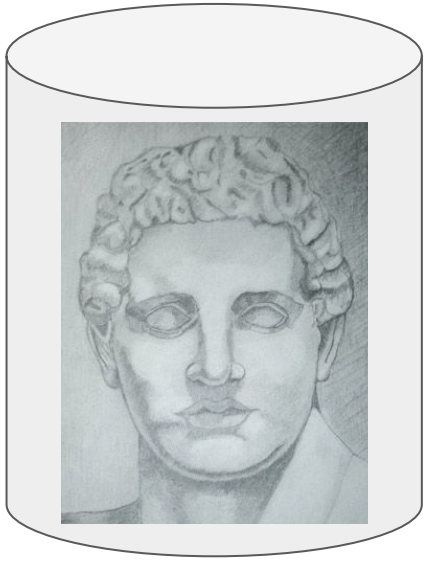

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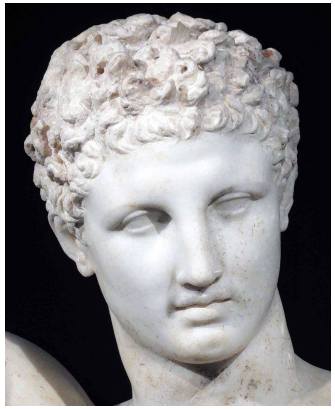

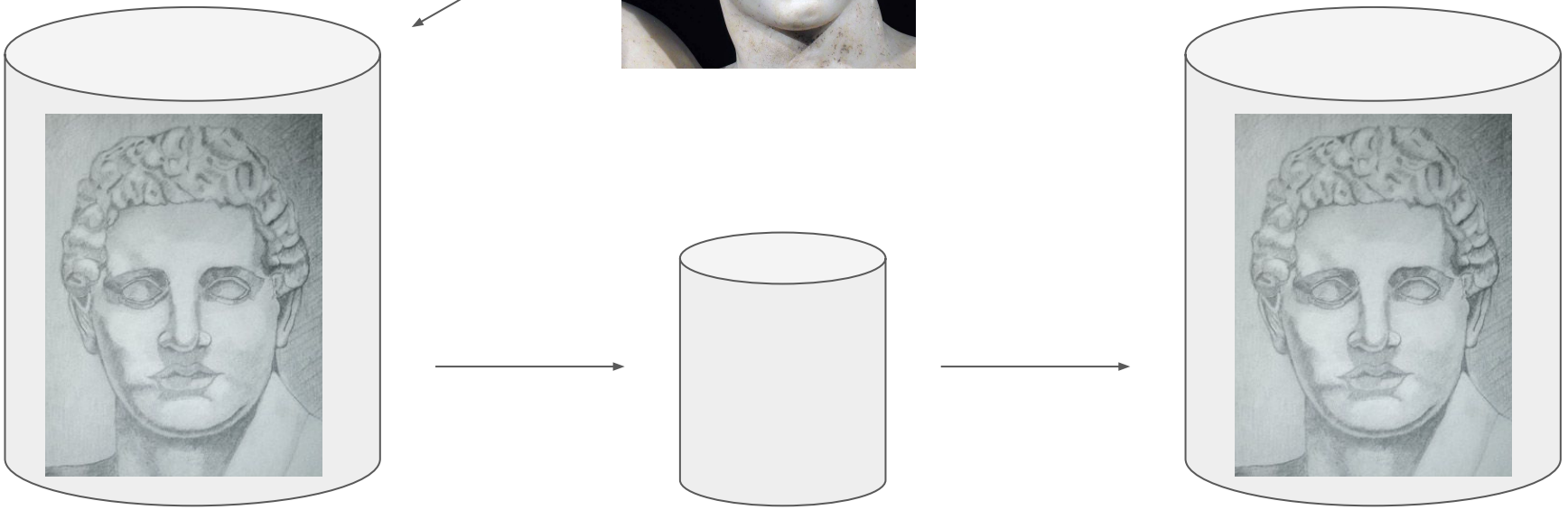

Lossless compression

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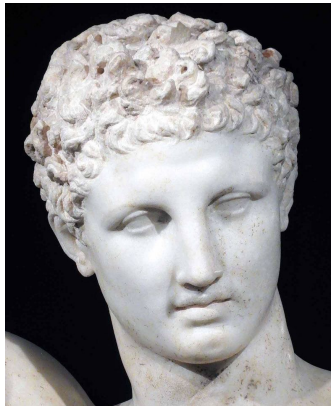
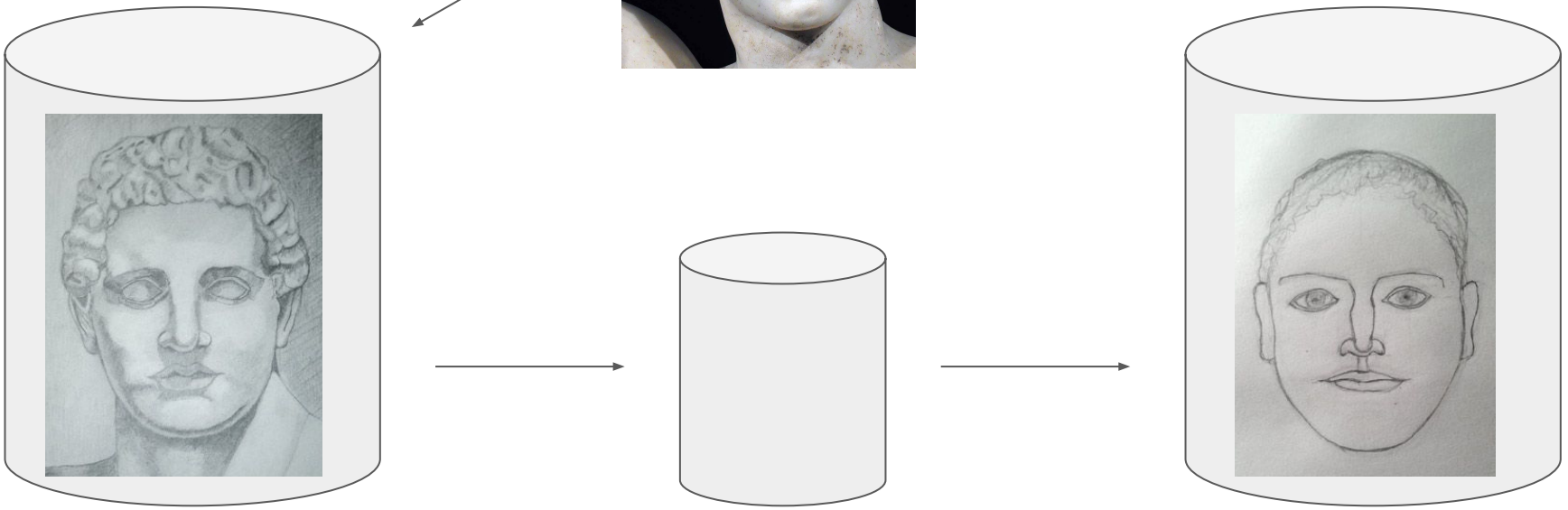
Compression IOI

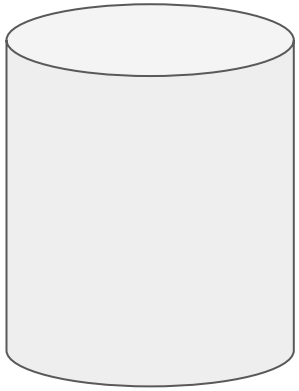




Lossy compression

Source [B]

Nomenclature



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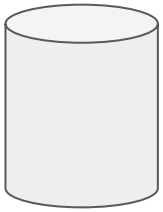

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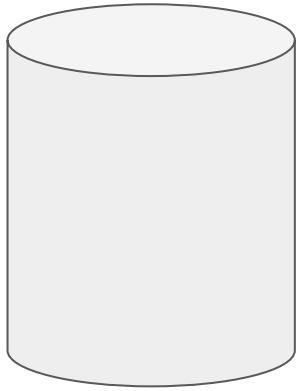

Decoded data

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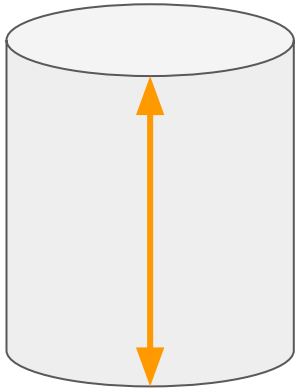
Nomenclature

Size of original data



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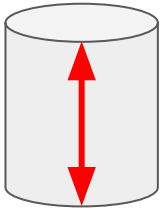

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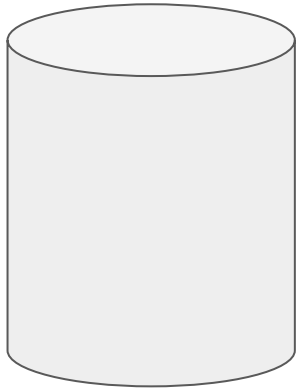

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Nomenclature

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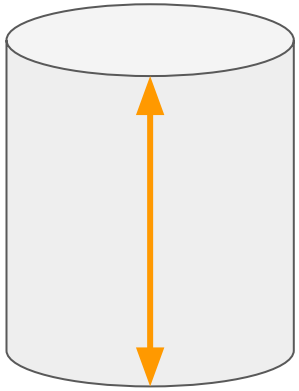

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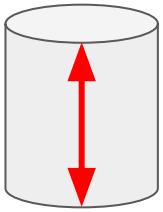

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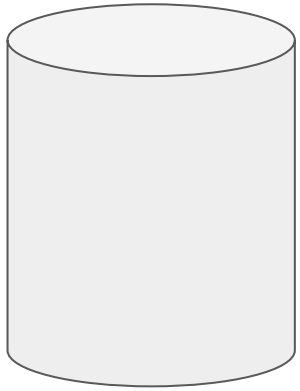


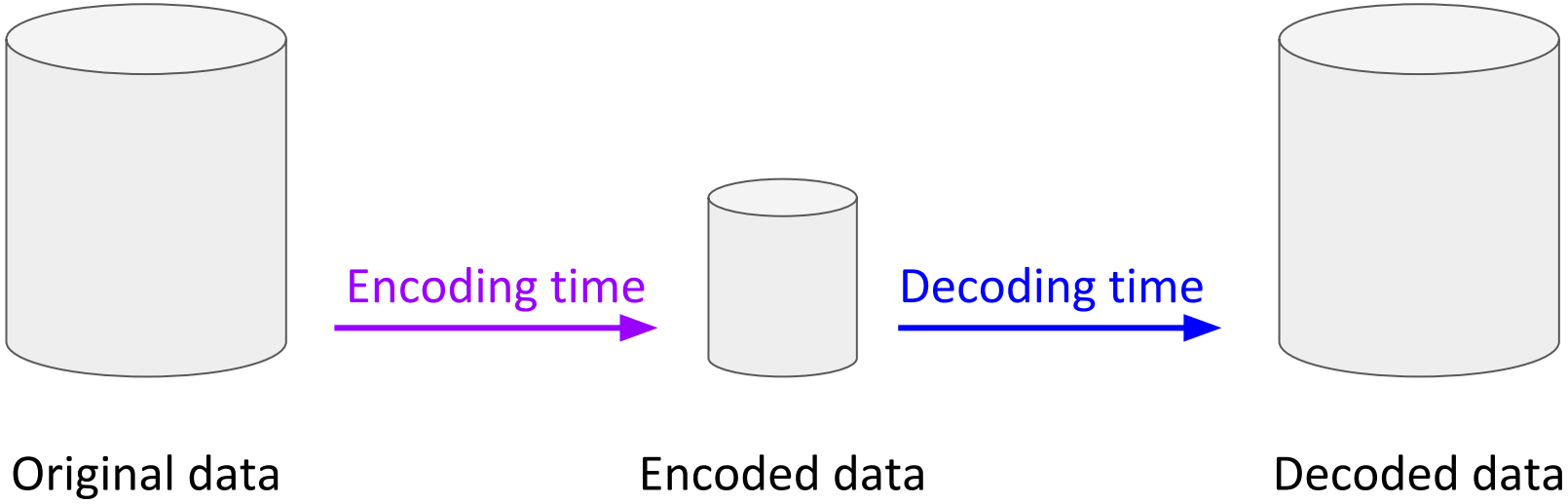
Decoded data

$$\frac{\text{Size of encoded data}}{\text{Size of original data}}$$

Compression Factor [no dimension]

STEINBUCH CENTRE FOR COMPUTING (SCC)
INSTITUTE FOR METEOROLOGY AND CLIMATE RESEARCH (IMK-ASF)

Nomenclature



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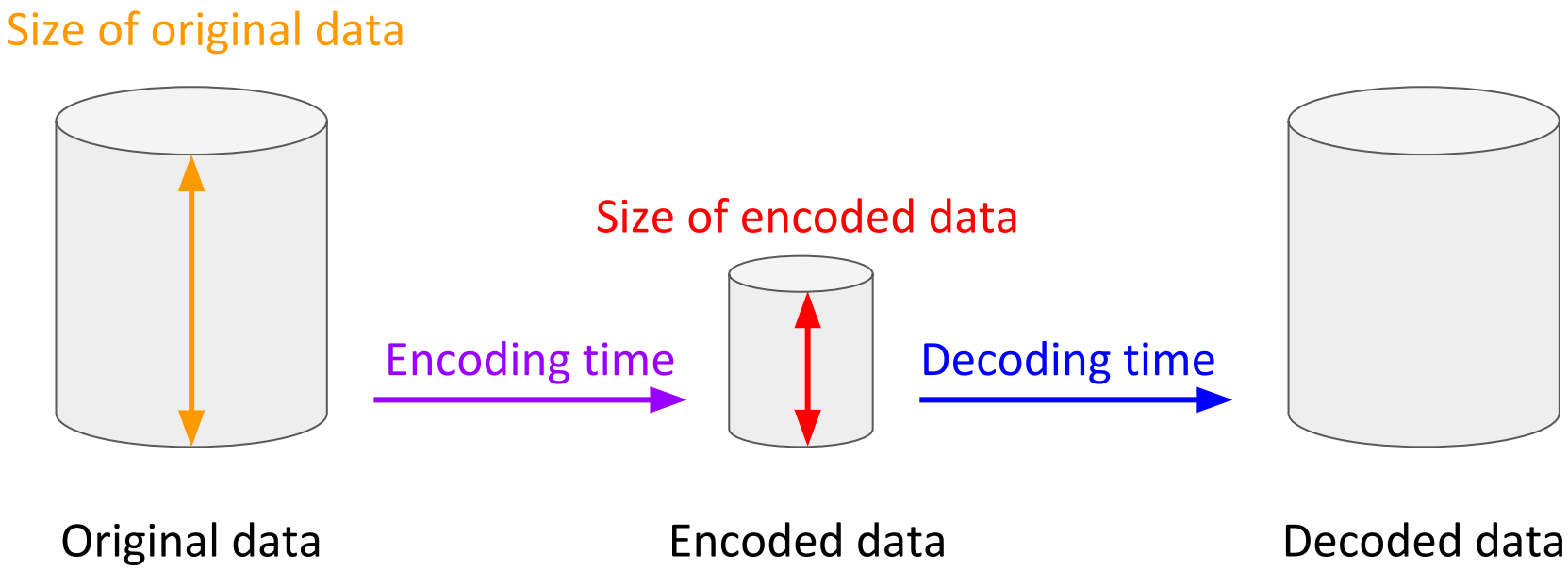
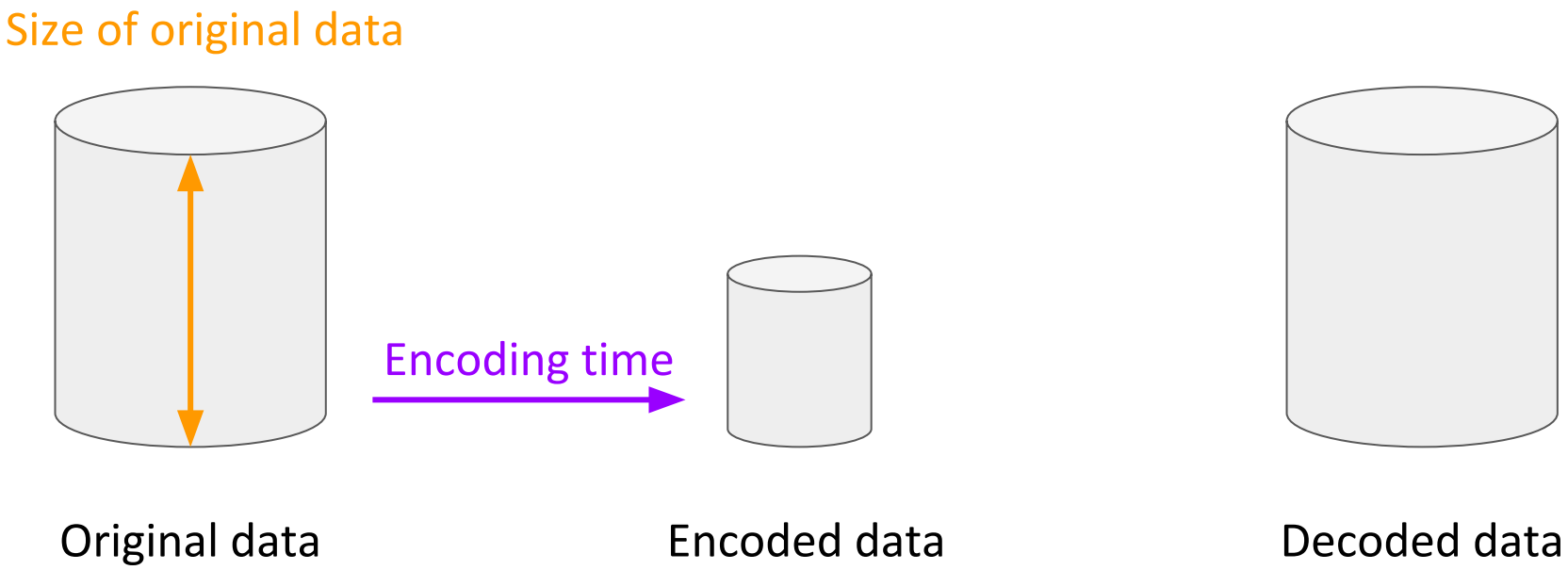
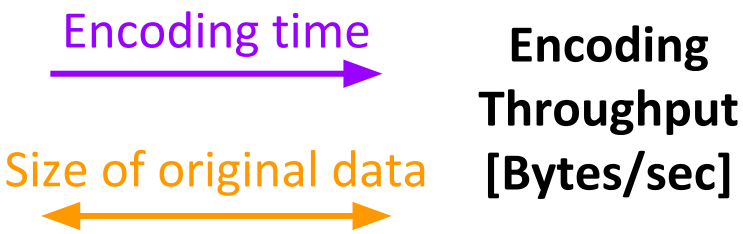


Encoding time / Size of original data → **Encoding Throughput [Bytes/sec]**

Decoding time / Size of encoded data → **Decoding Throughput [Bytes/sec]**

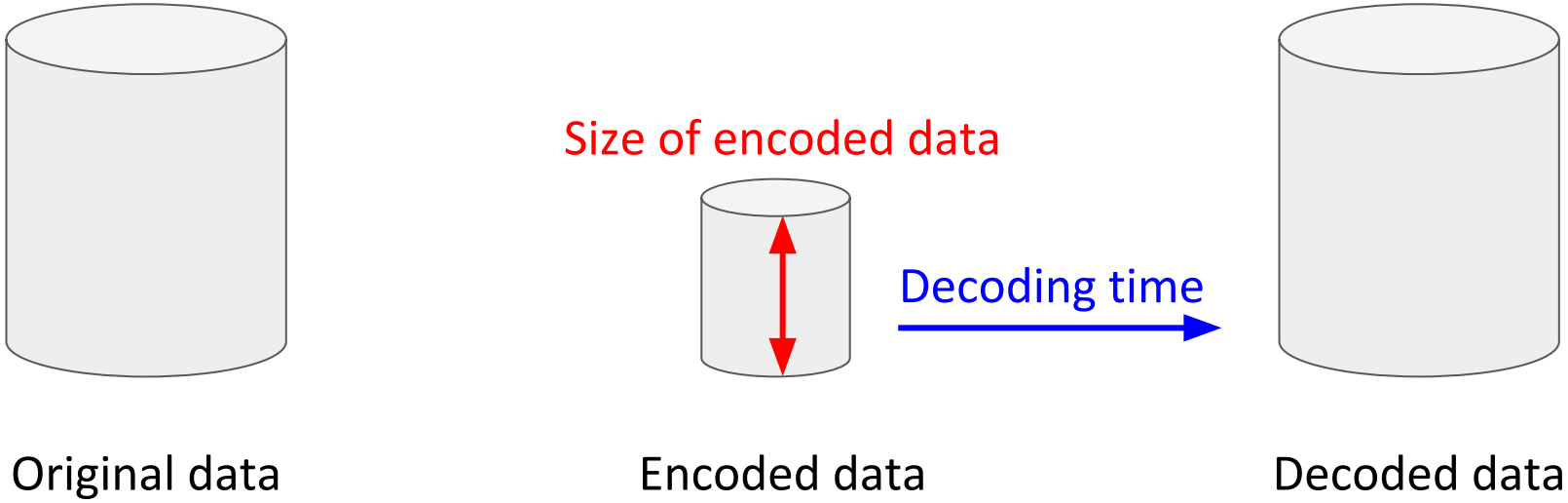
Nomenclature

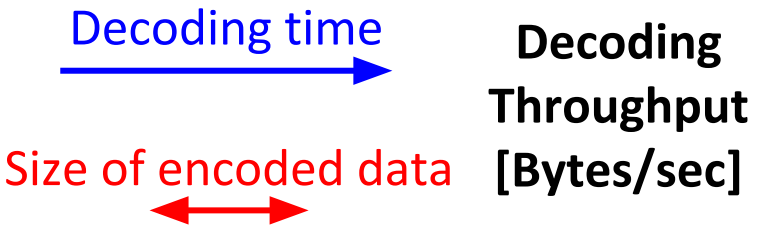




Encoding Throughput [Bytes/sec]

Nomenclature





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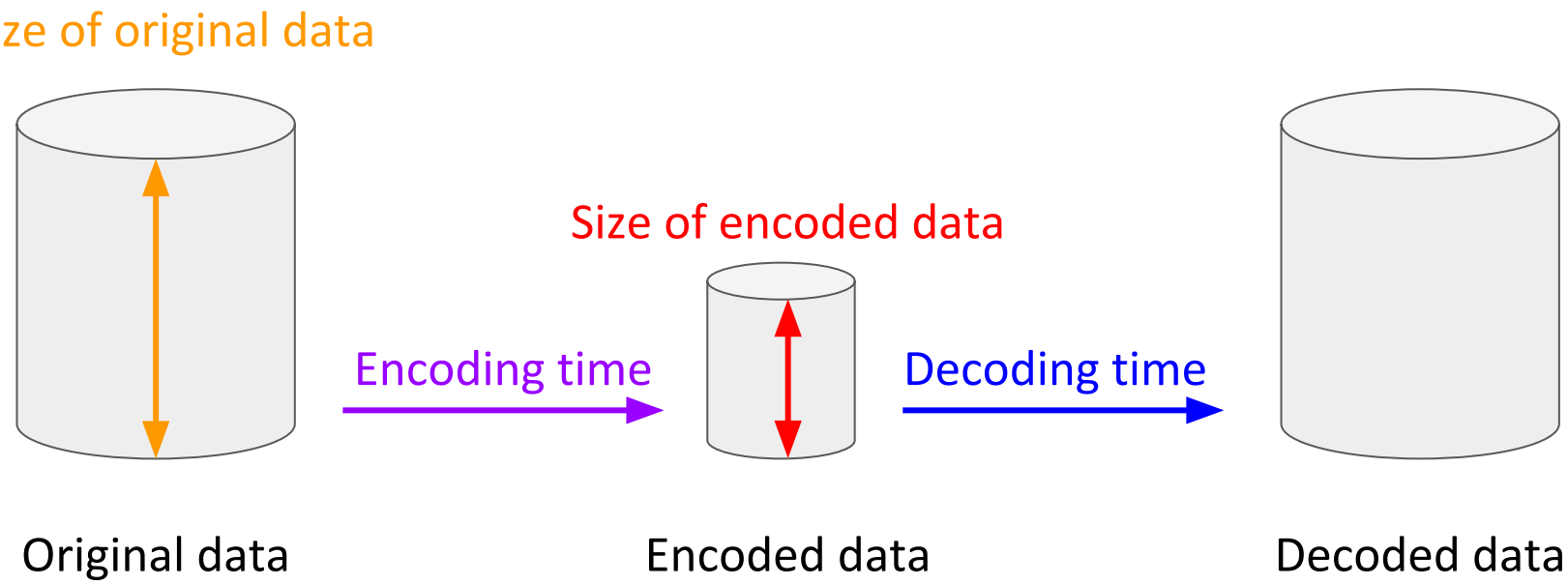
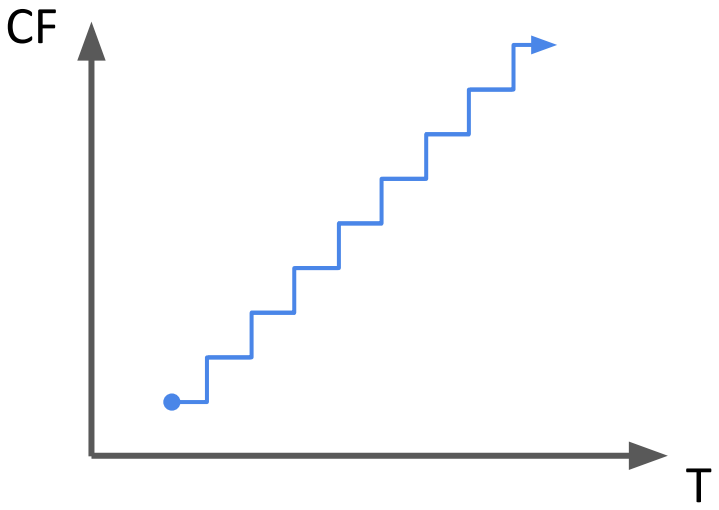


Compression Factor (CF)
[no dimension]

Throughput (T)
[Bytes/sec]

Iterative Process



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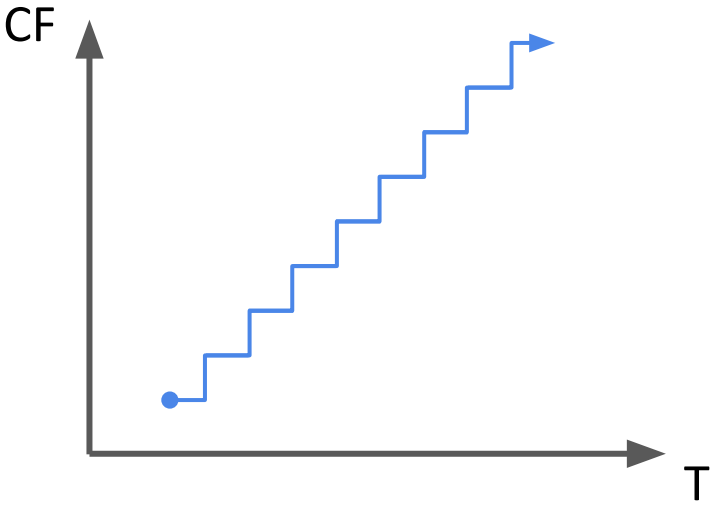
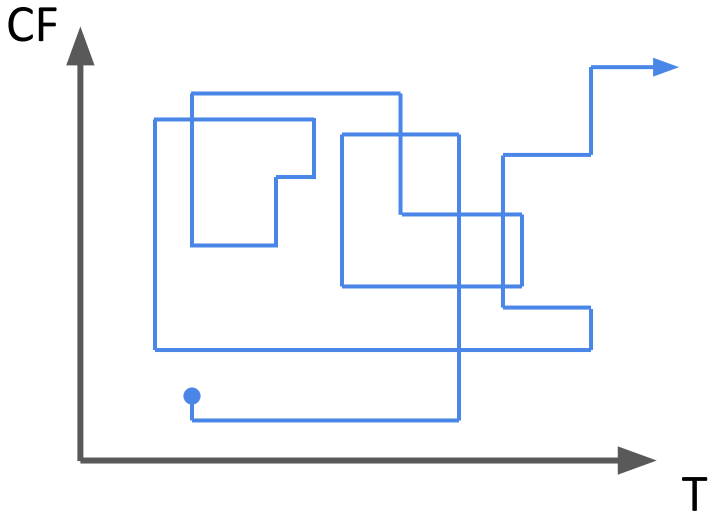
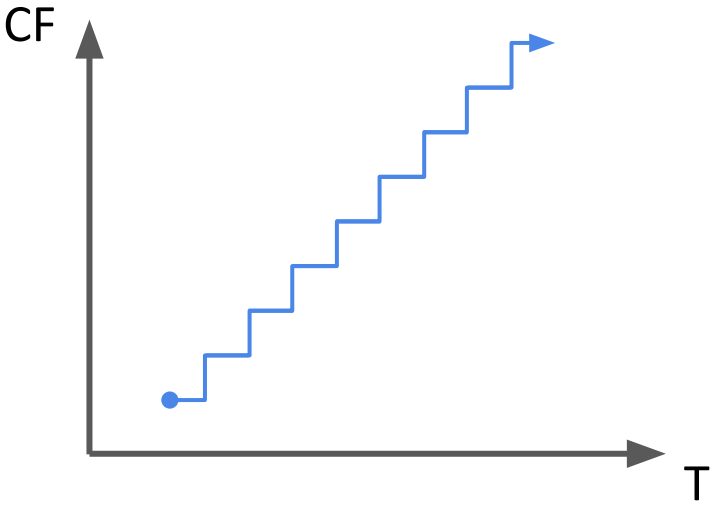
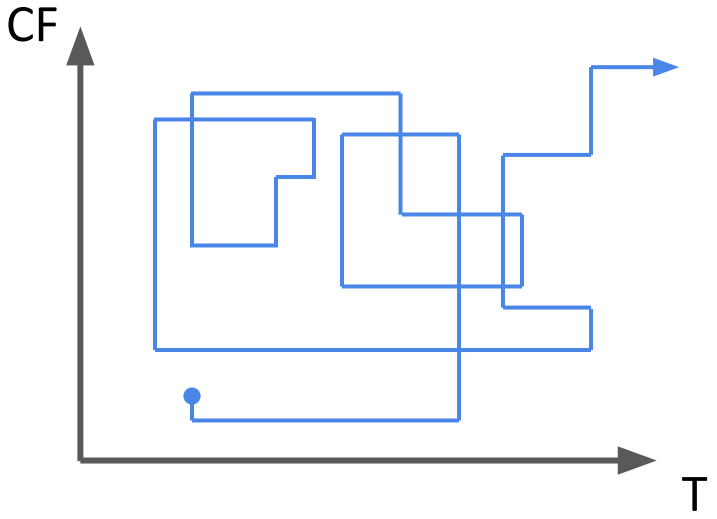
Iterative Process



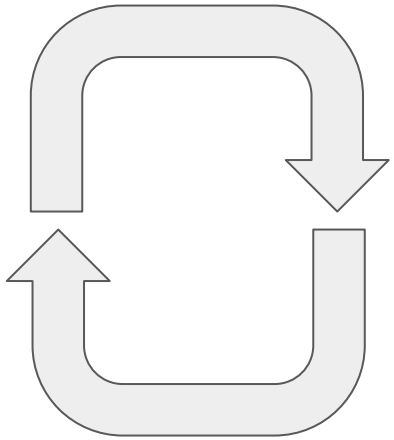


Iterative Process





Compression Factor (CF)
[no dimension]



Throughput (T)
[Bytes/sec]

Timeline

Past	Present	Future	Far Future
Compression Factor	Throughput	Compression Factor	Throughput
Understanding the information and intrinsic structure of the data	Research of data structures and algorithms	AI/ML methods for understanding of interdependencies	…
Custom scientific field	Applied computer science	Custom + related scientific field	…

Timeline

Past	Present	Future	Far Future
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Understanding the information and intrinsic structure of the data	Research of data structures and algorithms	AI/ML methods for understanding of interdependencies	…
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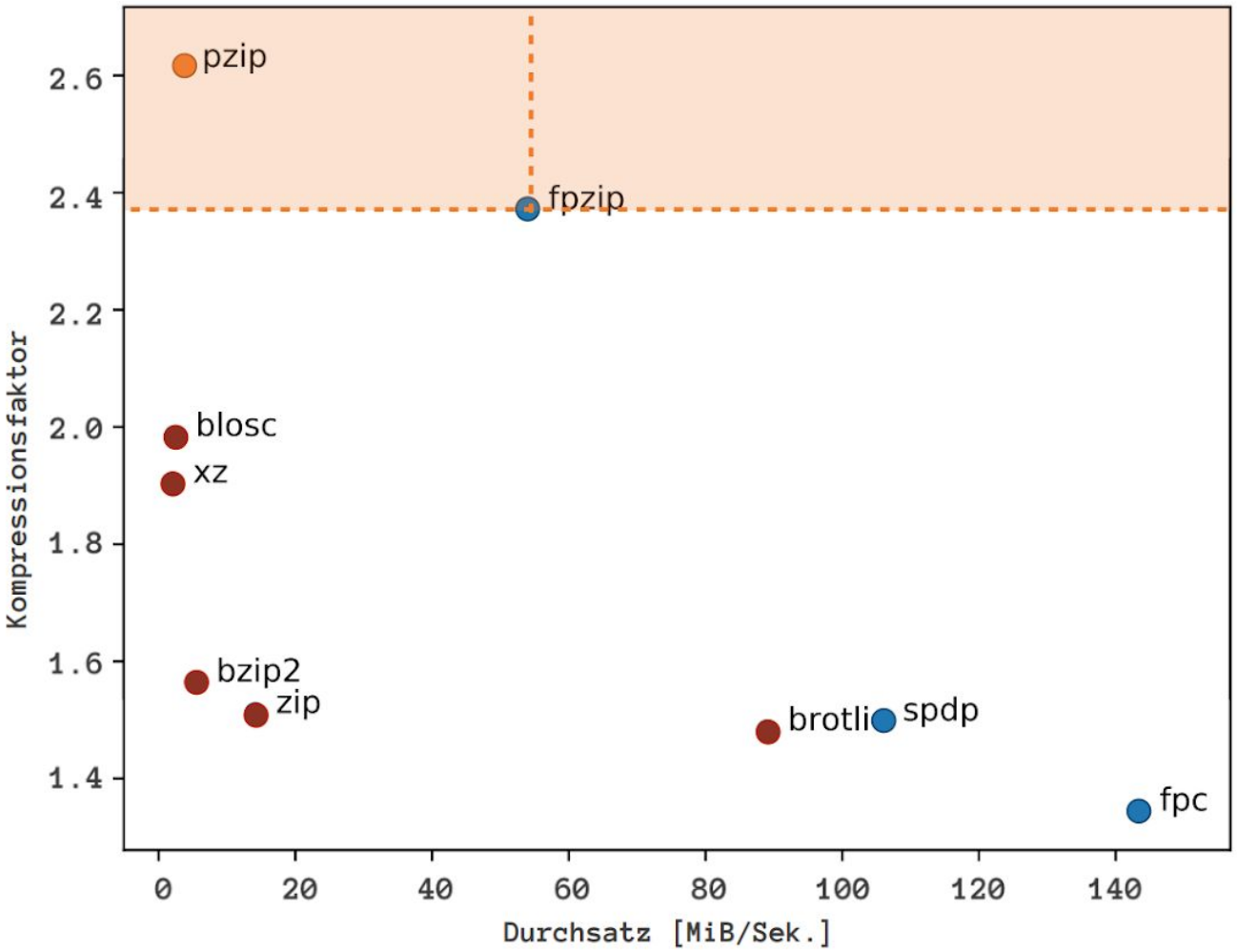
Timeline

Past

Compression Factor

Understanding the information and intrinsic structure of the data

Domain knowledge



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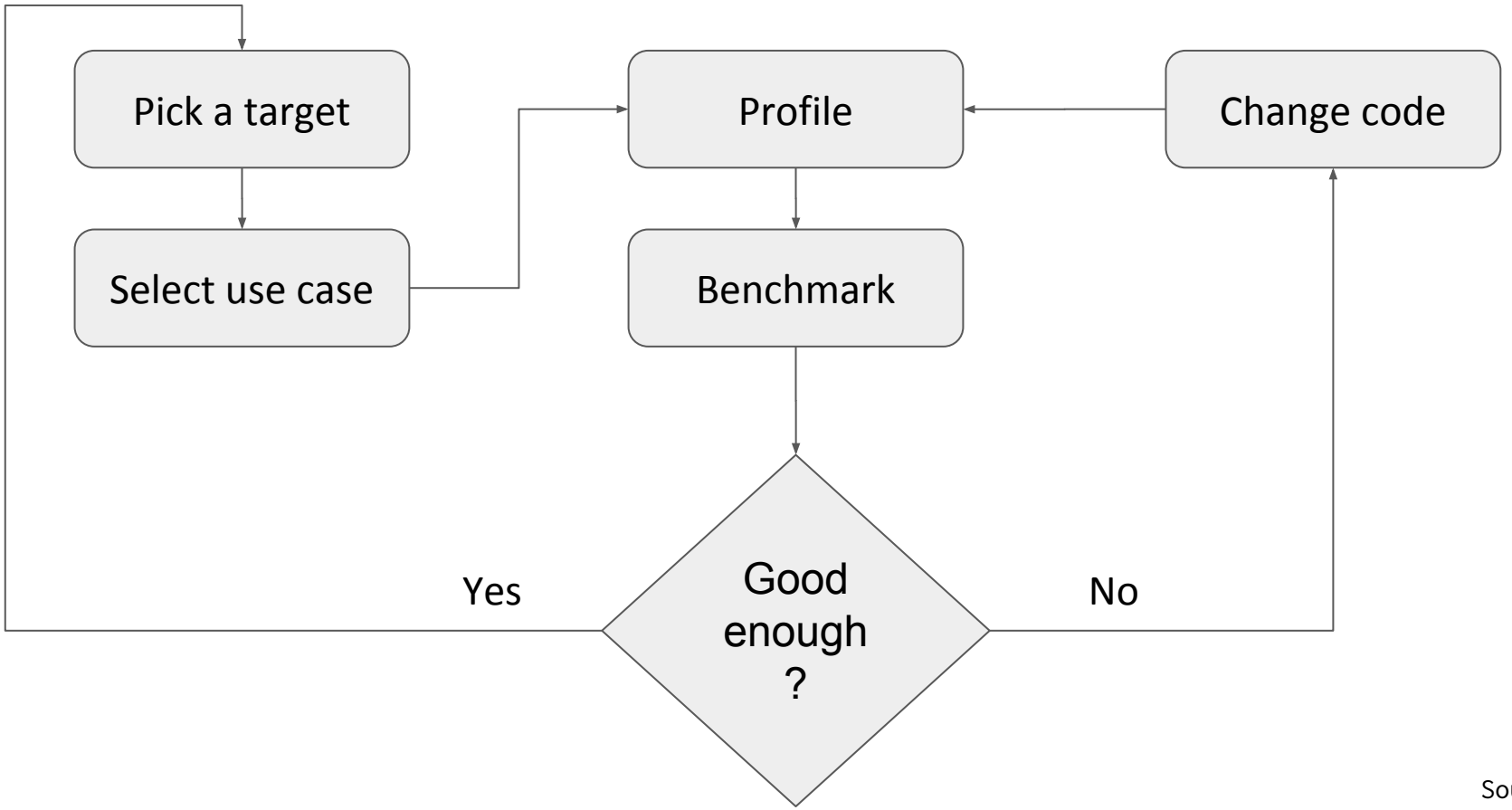
Workflow for optimizing throughput or compression factor



Source [C]

Profiling and Benchmarking in this context

Karlsruhe Institute of Technology

- Profiling: Analysis of the **program as a whole** (might be split down to function level)
- Benchmarking: Comparison of **evolutions/versions** of functions

Profiling and Benchmarking in this context

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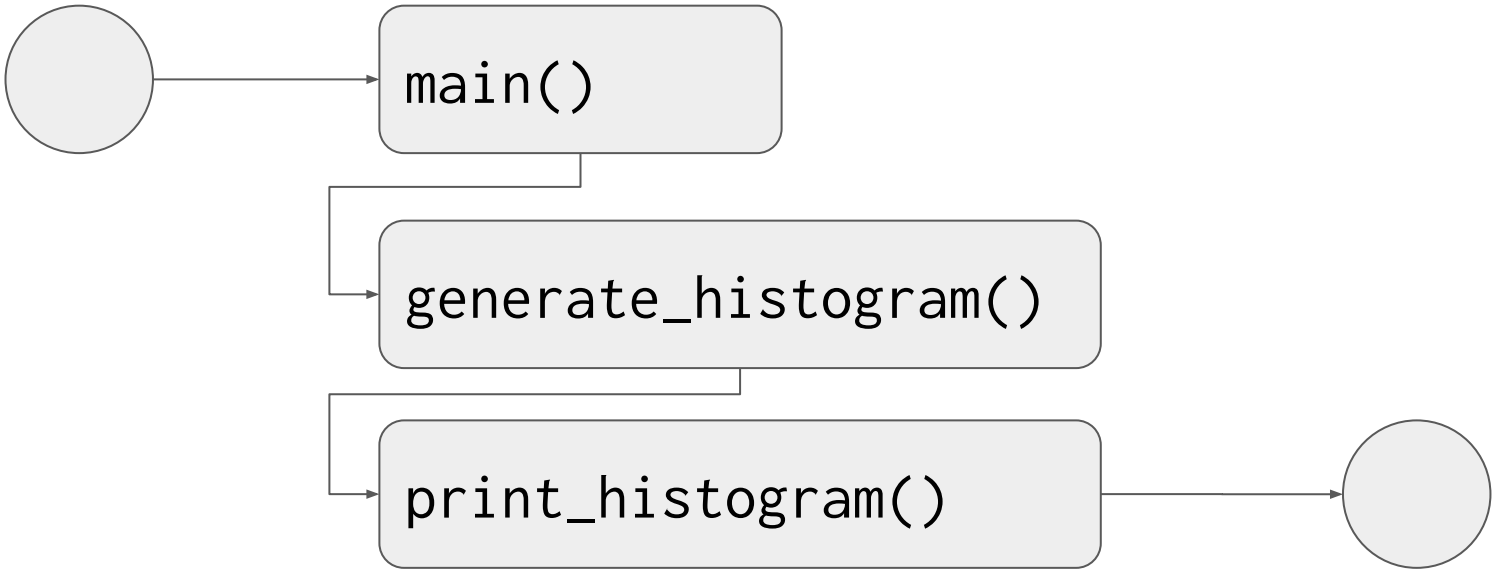
- Benchmarking: Comparison of **evolutions/versions** of functions



Profiling and Benchmarking in this context

- Profiling: Analysis of the **program as a whole** (might be split down to function level)
- Benchmarking: Comparison of **evolutions/versions** of functions

```
generate_histogram()
```

```
fast_histogram()
```

```
instant_histogram()
```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Profiling and Benchmarking in this context

Karlsruhe Institute of Technology

- Profiling: Analysis of the **program as a whole** (might be split down to function level)
  - `hyperfine` (time)
  - `valgrind` (time + memory)
  - `gnu time` (time + memory)
- Definitely worth looking into …
  - `flamegraph`
  - `perf`
  - `*not-perf`
  - `*cargo-instruments`

based on [C]

Profiling and Benchmarking in this context

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- Benchmarking: Comparison of **evolutions/versions** of functions
  - Very specific for each programming language
  - No general recommendation possible
  - Rust: `criterion`

Demo time

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- Profile I/O of my laptop
- First generate some random data
- Copy this data from a to b
- Profile different copy commands
  - cp
  - dd
  - rsync
- Applications we will use
  - hyperfine (**time**)
  - valgrind (time + **memory**)
  - gnu time (time + **memory**)

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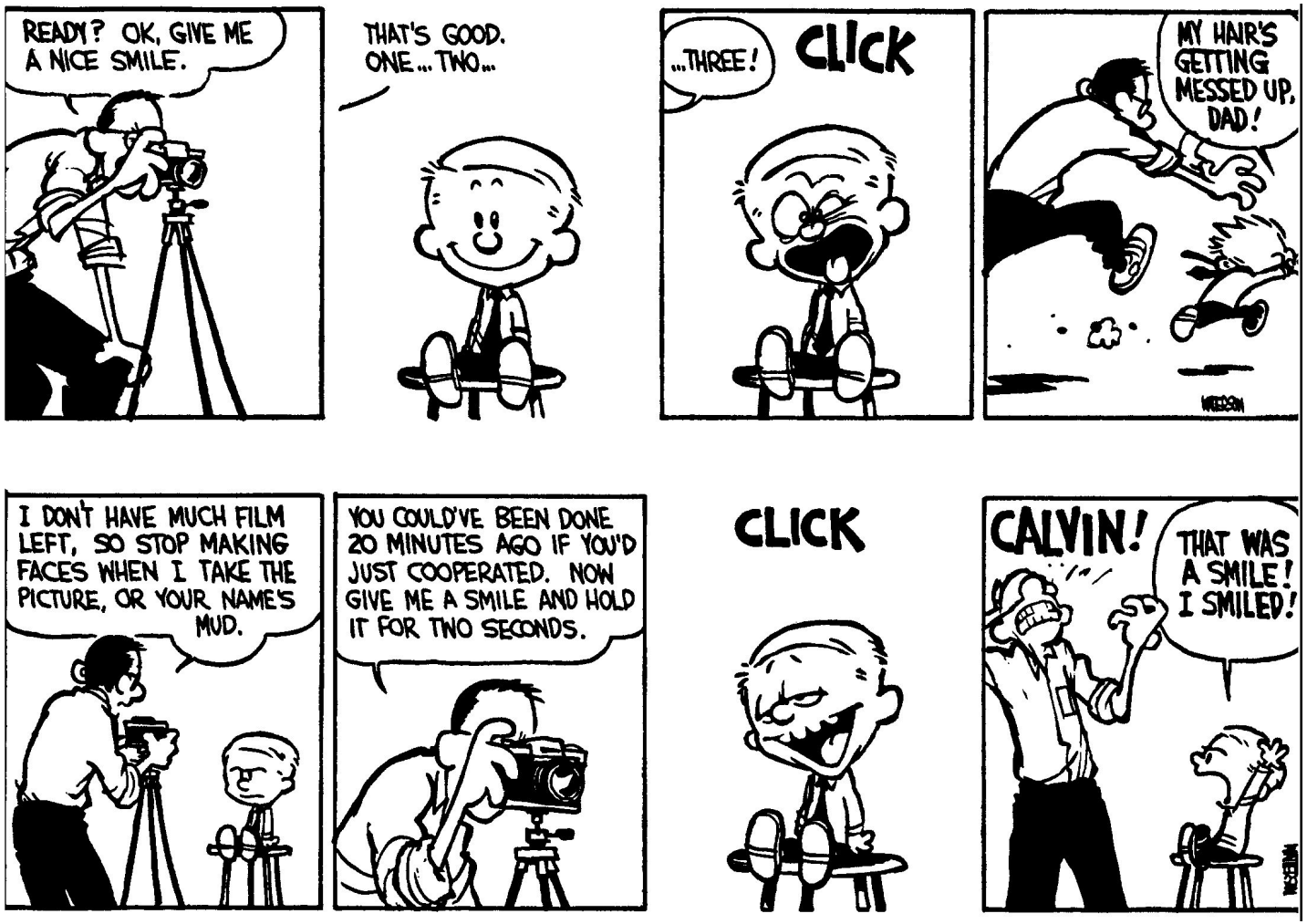
That’s all folks



Source [Z]

Sources

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[Z] Calvin Photoshoot
[A] Greece Olympia Marble Statue
[B] https://drawingacademy.com/drawing-progress
[C] https://fosdem.org/2020/schedule/event/rust_optimizing_rav1e/