Compression of Sheet Music

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Outline

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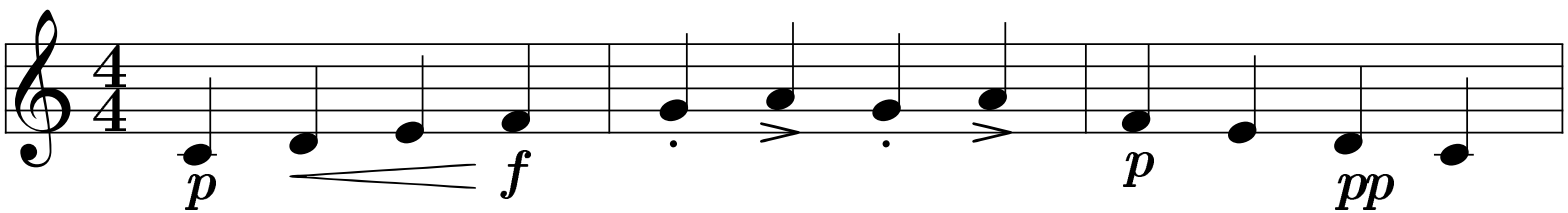
Music

"Music is primarily something to which one listens, so it is one of many forms of art, art of audition. Music is also a universal language and language of the emotions." [1]

Music

We can only describe a subset of all attributes:

- pitch,
- duration,
- loudness,
- articulation.



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The ExCom Library

Main features of the Extensible Compression library[1]:

- C++ language,
- GNU LGPL version 3 license,
- common interface,
- unified access to data,
- pipelining,
- extensibility.

[1] `http://www.stringology.org/projects/ExCom/`

Types of Compression Methods

- Statistical methods (arithmetic coding, Huffman)
- Dictionary methods (LZ family – LZ77, LZ78, LZSS, LZW)
- Context methods (PPM, ACB)
- Block size integer coding
- Variable length integer coding

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Methods for Integer Compression

- Elias codes
  - α code
  - β, β' code
  - γ, γ' code
  - δ, δ' code
  - ω, ω' code
- Golomb and Rice codes
- Fibonacci codes
- Other codes
  - Unary code
  - Block code
  - Ternary comma code

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Musical Compositions

- Plenty of different software means plenty of formats:
  1. MIDI,
  2. MusiXTeX,
  3. Lilypond,
  4. CSound,
  5. MuseScore,
  6. MusicXML.
- Some are standardized.

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CSound score file

```
;;  Inst  Time     Dur      Pitch    Vely
    i0    0        1        8.00     100
    i0    1        1        8.02     100
    i0    2        1        8.04     100
```

Figure: A CSound score file fragment

The Optimal Method

	Length of code word for an integer		
	10	1 000	n
ternary code	8	16	$2\left(\lfloor log_3\left(n-1\right)\rfloor+2\right)$
α-code	10	1 000	n
β-code	4	10	$\lfloor log_2\left(n\right)\rfloor+1$
γ-code	7	19	$2\lfloor log_2\left(n\right)\rfloor+1$
δ-code	8	16	$\lfloor log_2\left(n\right)\rfloor+2\lfloor log_2\left(log_2\left(n\right)+1\right)\rfloor+1$
ω-code	7	16	$\leq \frac{5}{2}\lfloor log_2\left(n\right)\rfloor+1$
Fibonacci c.	6	16	$\leq \lfloor log_\phi\left(\sqrt{5}n\right)\rfloor+1,\ \phi=\frac{1+\sqrt{5}}{2}$

Table: Comparison of lengths of code words for some methods

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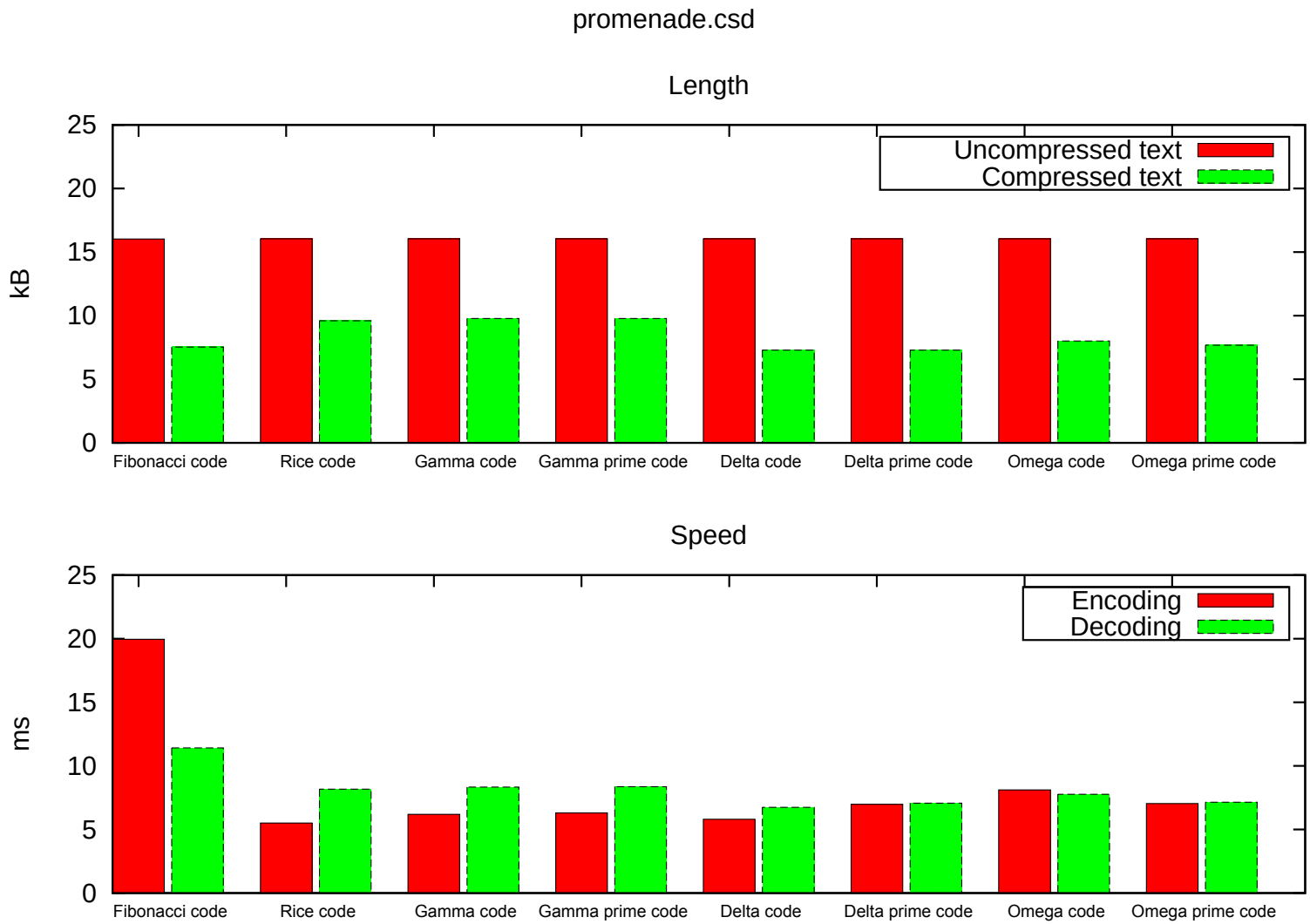
Comparison of Used Codes



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Comparison of Used Codes

rank	method	score
1.	Delta code	1.00
2.	Rice code	1.06
3.	Delta prime code	1.15
4.	Gamma code	1.17
5.	Gamma prime code	1.20
6.	Omega prime code	1.25
7.	Omega code	1.30
8.	Fibonacci code	2.53

Table: Methods according to the encoding and decoding speed

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Dictionary and Statistical Methods

These methods should be used if

- the entropy of the input is low,
- the variance of the symbols is low.

The disadvantages of these methods are

- lower encoding speed,
- a lack of streaming encoding capabilities,
- high dependency on the entropy.

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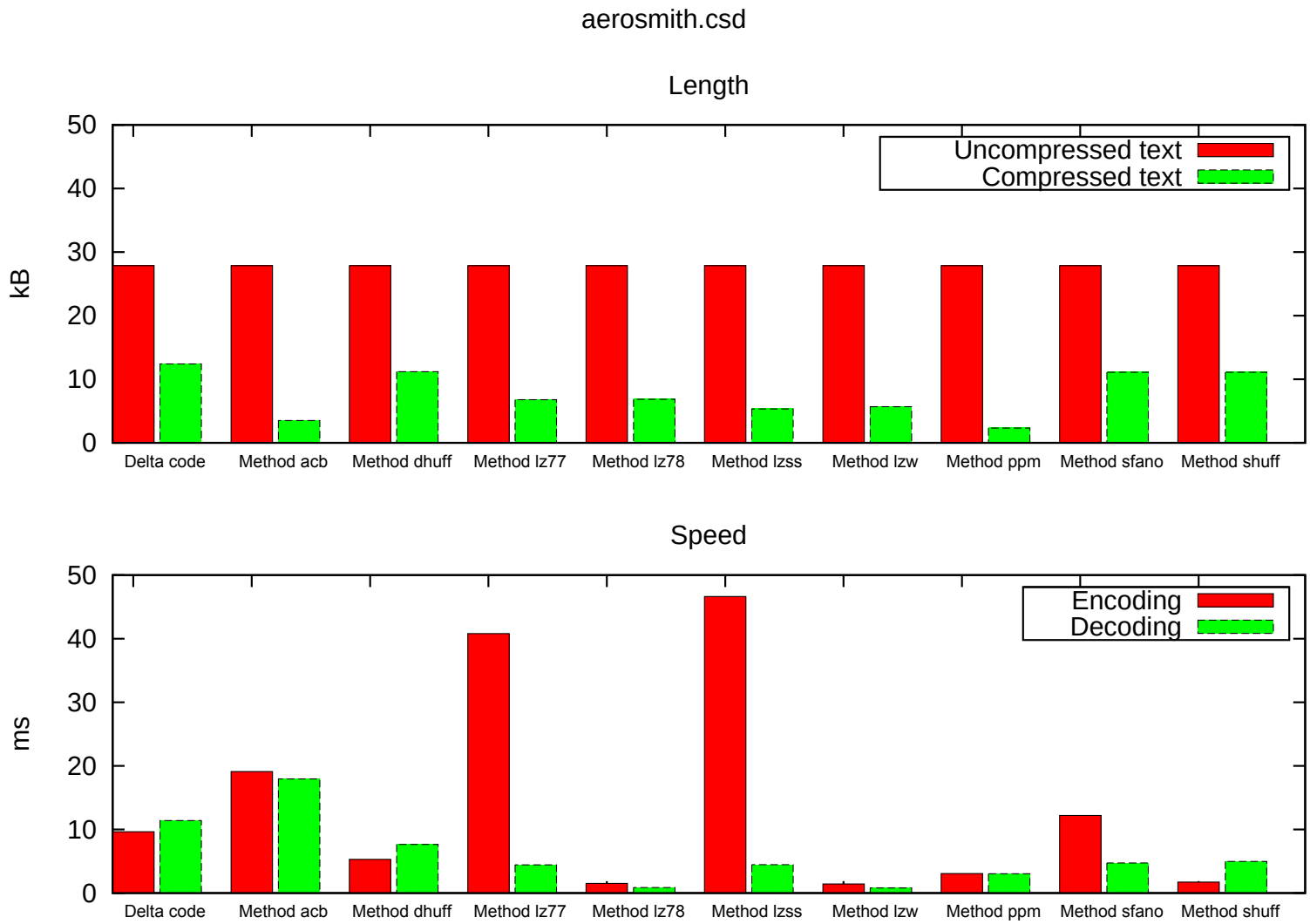
Dictionary and Statistical Methods



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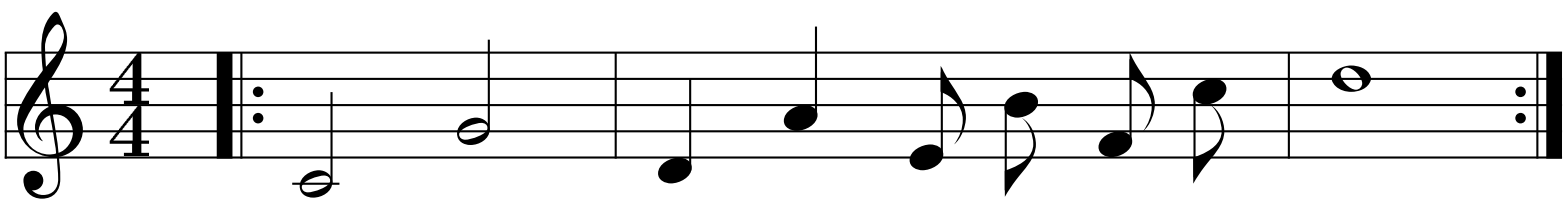

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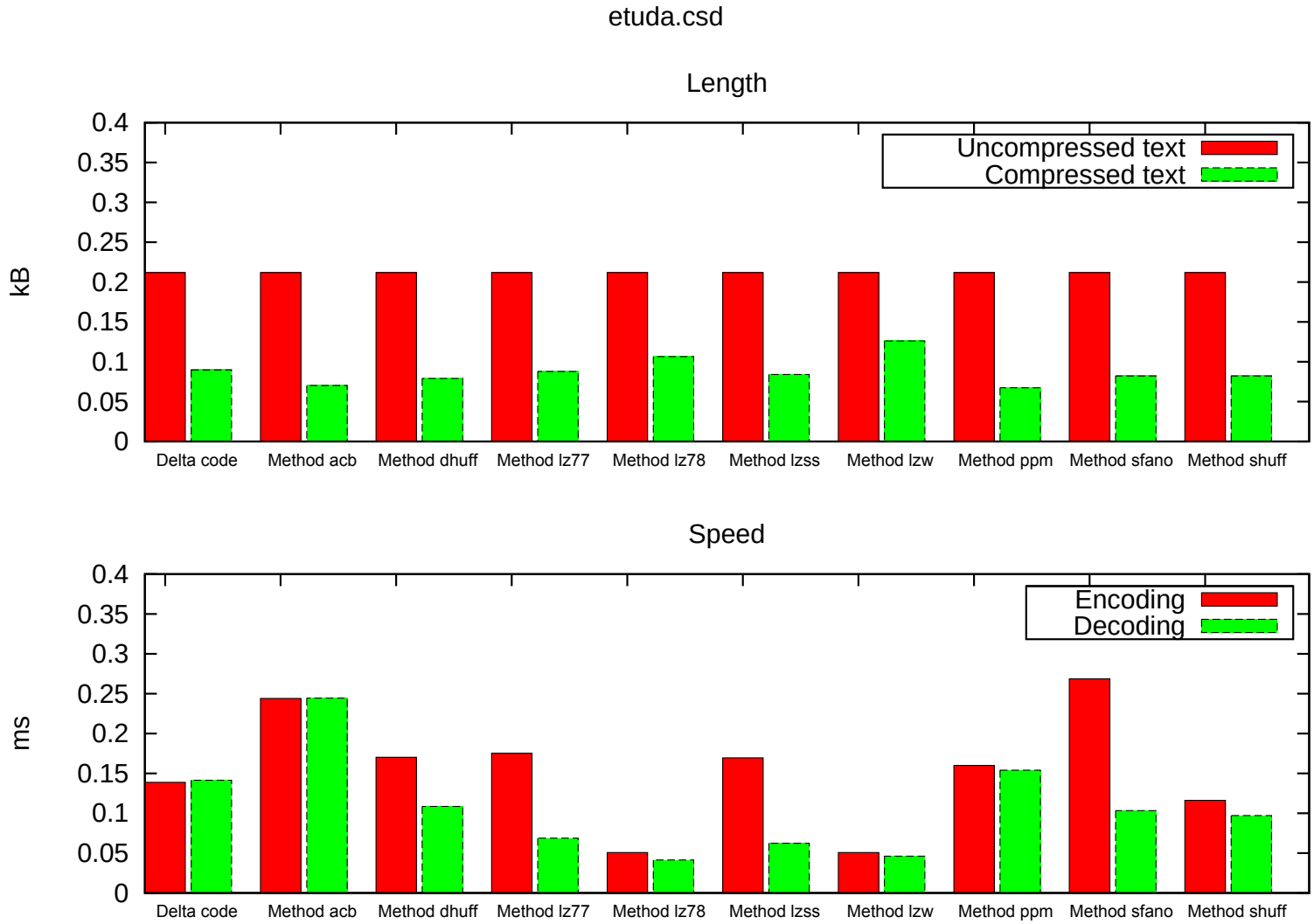
Dictionary and Statistical Methods



Final thoughts

- Variable length integer coding can be used.
- There is no optimal method but we can have a heuristic.
- Is it genre-dependent?
- Can we find a pattern?

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Reference


Alperson, P.: *What is music?: an introduction to the philosophy of music*. Pennsylvania State University Press, 1987, ISBN 9780271013183.

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