Data Compression – Comparing Haar's Algorithms

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1. project goal:

Analyze and compare different algorithms presented in the paper "New Compression Schemes for Natural Number Sequences" , that use the Haar transform for data compression.

2. Introduction:

Data compression is the process of encoding, restructuring, or otherwise modifying data in order to reduce its size.
In our Data compression research, we specified the Haar wavelet transform, which is a simple discrete transform.
We compare the compression performance of two main Haar algorithms applied for lossless compression of integer sequences.
Haar Integer and *Haar New Transform*.

3. Methods and Selected Approach :

The method to compare the efficiency of the algorithms was to measure the bit size compressed message.

Algorithms:	compression algorithms :
Haar integer Haar New Transform	*Elias code $C\delta$ * binary coding * unary coding.

All the implementations were made in C++

4. *Haar Integer and Haar New Transform pseudo codes:*

Algorithm 1: *Integer-Haar*

INTEGER-HAAR$(k, a_1, \ldots, a_{2^k})$
for $i \leftarrow 1$ to 2^{k-1} do
  $b_{i+2^{k-1}} \leftarrow (a_{2i-1} - a_{2i}) \bmod 2$
  $h_{i+2^{k-1}} \leftarrow \lfloor \frac{1}{2}(a_{2i-1} - a_{2i}) \rfloor$
  $z_i \leftarrow \lfloor \frac{1}{2}(a_{2i-1} + a_{2i}) \rfloor$
if $k = 1$ then
  return $(z_1, (b_1)\, h_1)$
else
  $(y_1, \ldots, y_{2^{k-1}}) \leftarrow$ INTEGER-HAAR$(k-1, z_1, \ldots, z_{2^{k-1}})$
  return $(y_1, \ldots, y_{2^{k-1}}, (b_{1+2^{k-1}})\, h_{1+2^{k-1}}, \ldots, (b_{2^k})\, h_{2^k})$

Algorithm 3: *New-Transform*

NEW-TRANSFORM$(k, a_1, \ldots, a_{2^k})$
for $i \leftarrow 1$ to 2^{k-1} do
  $d_i \leftarrow \lfloor \frac{1}{2}(a_{2i-1} - a_{2i}) \rfloor$
  $z_i \leftarrow a_{2i-1} + a_{2i}$
if $k = 1$ then
  return (z_1, d_1)
else
  $(y_1, \ldots, y_{2^{k-1}}) \leftarrow$ NEW-TRANSFORM$(k-1, z_1, \ldots, z_{2^{k-1}})$
  return $(y_1, \ldots, y_{2^{k-1}}, d_1, \ldots, d_{2^{k-1}})$

5. Solution Description:

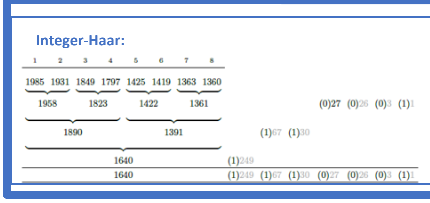
(1) Is a example of an array ,**(2)** is the changes that each haar algorithm performs on the array variables, **(3)** a table contain the size of the compressed massage for each algorithm ,**(4)** contain the result of the better Haar algorithm for each compression in a 100k random arrays

(1)-Array example:

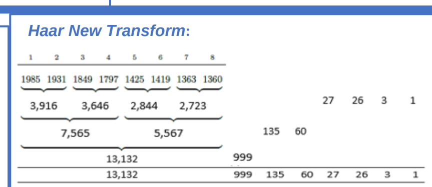
1985 1931 1849 1797 1425 1419 1363 1360

(2)-Haar algorithms :

Integer-Haar:



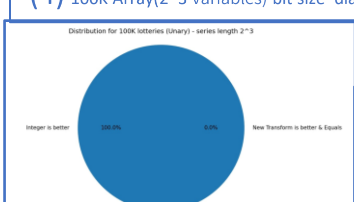
Haar New Transform:

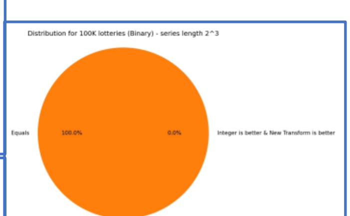


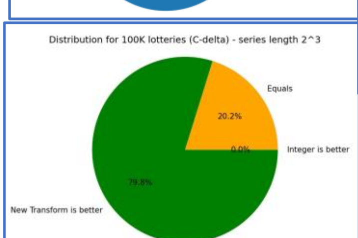
(3)-bit size result table

Compression algorithm / Haar algorithm	Elias code $C\delta$	binary coding	unary coding
Haar integer: bit size	97	51	2,062
Haar New Transform: bit size	87	51	14,386

(4)-100K Array(2^3 variables) bit size diagrams







- Haar Integer
- Equals
- Haar New Transform

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