Data Compression Conference

中国科学技术大学
University of Science and Technology of China

Compressing the Tree of Canonical Binary AIFV Coding

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CONTENTS

binary AIFV coding

definition

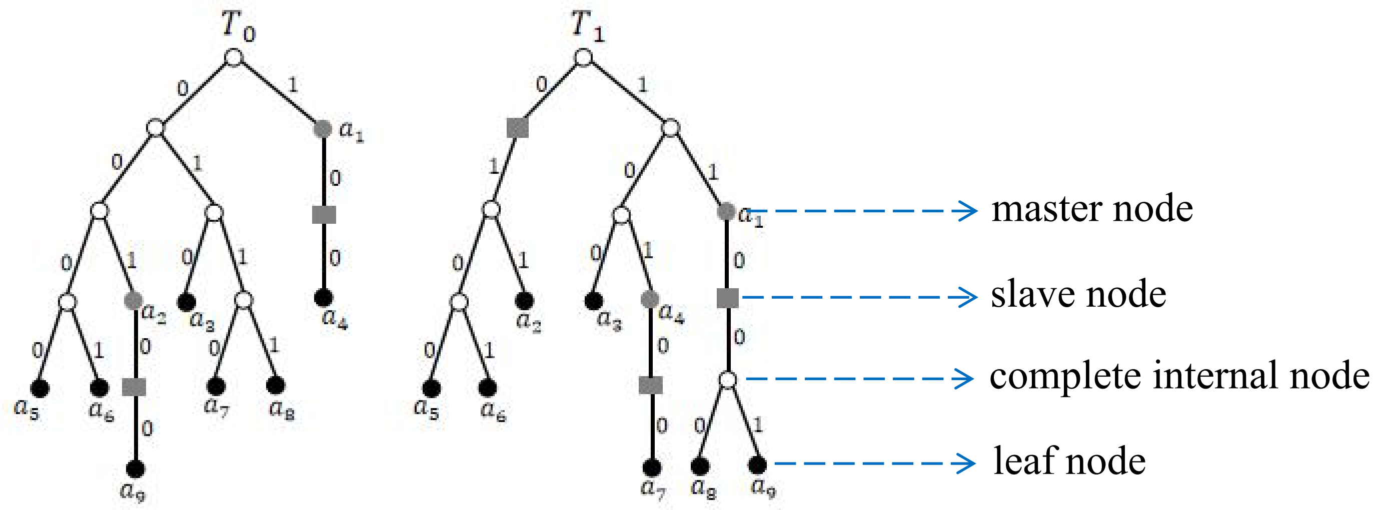
binary AIFV codes contain two trees T_0 and T_1, which satisfy the following requirements

- There are **four** types of nodes, termed as leaf node, complete internal node, master node and slave node. Each complete internal node has two children, where the left edge corresponds to "0" and the right edge corresponds to "1", respectively. The master node has only one child, termed slave node, that corresponds to "0". In addition, the slave node also has only one child corresponding to "0".
- The root of T_1 has two children corresponding to "0" and "1", respectively. The left child is a slave node, and the root **cannot have a grandchild corresponds to "00"**.
- All source symbols are assigned to **leaf nodes** and **master nodes**, respectively.

binary AIFV coding

- **an example**

source symbols: $\{a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9\}$



binary AIFV coding

- **some properties**

N:the size of alphabet; d_j: the height of T_j; $n_{j,i}$, $m_{j,i}$, $b_{j,i}$:the number of leaf nodes, master nodes, complete internal nodes.

- $\sum_{i=0}^{d_j} (n_{j,i} + m_{j,i}) = N$
- $m_{j,d_j-1} = m_{j,d_j} = b_{j,d_j-1} = 0$
- $m_{0,0} + b_{0,0} = 1,\ b_{1,0} = 1, m_{1,0} = 0$
- $n_{0,i} + m_{0,i} + b_{0,i} = m_{0,i-2} + 2b_{0,i-1},\ \forall 1 \le i \le d_0$
- $n_{1,i} + m_{1,i} + b_{1,i} = \begin{cases} 1, & if\ i = 1, \\ 1 + 2b_{1,1}, & if\ i = 2, \\ m_{1,i-2} + 2b_{1,i-1}, & if\ i \ge 3. \end{cases}$

canonical AIFV coding

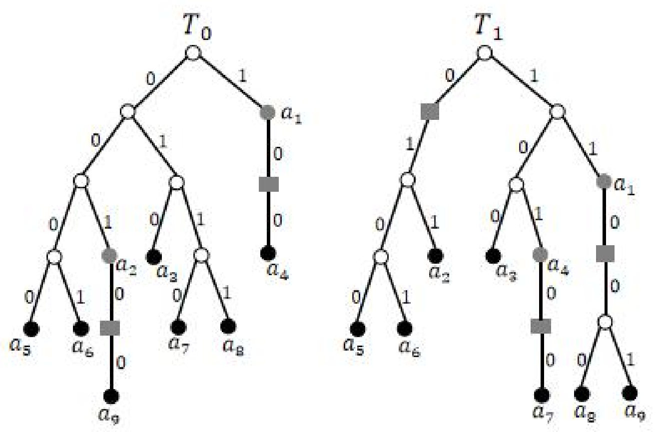
- **definition**

  the canonical binary AIFV code is the AIFV code, whose code tree meets the following requirements

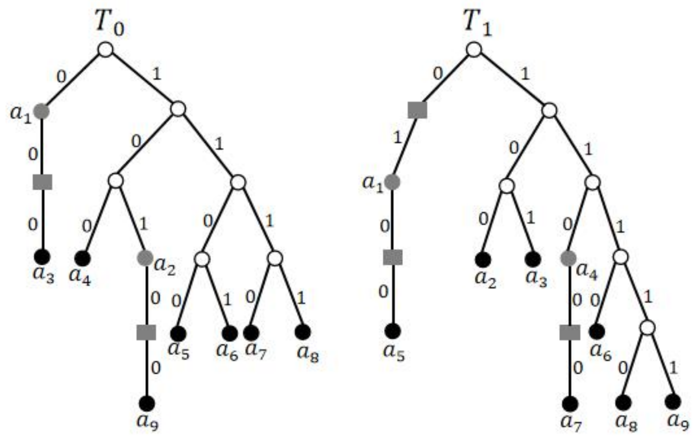
  - all master nodes are located on the right of the leaf nodes in each layer
  - all complete internal nodes are located on the right of the master nodes in each layer

canonical AIFV coding

- **an example**



AIFV code trees



canonical AIFV code trees

the proposed method

- **idea**

encode the numbers of master nodes, the complete nodes and leaf nodes of each layer

method :encode the combination $(m_{0,i}, b_{0,i,} n_{0,i})$ instead of respetively encoding $m_{0,i}$, $b_{0,i}$, $n_{0,i}$

1. encode $\boldsymbol{b_{0,0}}$, then use $m_{0,0}+b_{0,0}=1$ to obtain $\boldsymbol{m_{0,0}}$

2. use $n_{0,i} + m_{0,i} + b_{0,i}=m_{0,i-2} + 2b_{0,i-1}$ to obtain the sum $m_{0,i-2} + 2b_{0,i-1}$

3. sort the combination $(m_{0,i}, b_{0,i,} n_{0,i})$ in lexicographical order, then encode the order value

the proposed method

- **algorithm**

Algorithm 1 Decode the string Y into $m_{0,i}$, $b_{0,i}$ and $n_{0,i}$ from $i = 0$ to $i = d_0$

Input: The string Y, d_0.

Output: $m_{0,i}, b_{0,i}$ and $n_{0,i}$ for $0 \le i \le d_0$.

Let y'_k denote the string of first k bits in Y, $y'_k = y_{k-1}y_{k-2}\cdots y_0$, and denote $Y - y'_k$ as the rest string deleting y'_k from the front of Y.

if $d_0 == 0$ **then**

  $(m_{0,0}, b_{0,0}, n_{0,0}) \leftarrow (0, 0, 1)$

else

  $(m_0, m_{0,-1}, b_{0,0}, n_{0,0}, Y) \leftarrow (y'_1, 0, 1 - m_{0,0}, 0, Y - y'_1)$

  for $i \leftarrow 1$ **to** d **do**

    $z_{i-1} \leftarrow m_{0,i-2} + 2b_{0,i-1}$, $k \leftarrow \lceil \log_2 \frac{(z_{i-1}+2)(z_{i-1}+1)}{2} \rceil$, $Y \leftarrow Y - y'_k$,

    $K \leftarrow \sum_{j=0}^{k-1} y_j \times 2^j + 1$, $m_{0,i} \leftarrow \lceil \frac{2z_{i-1}+1-\sqrt{(2z_{i-1}+3)^2-8K}}{2} \rceil$,

    $b_{0,i} \leftarrow K - \frac{(2z_{i-1}+3-m_{0,i})m_{0,i}}{2} - 1$, $n_{0,i} \leftarrow z_{i-1} - m_{0,i} - b_{0,i}$

  end for

end if

return

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Thank you !

For more details, please refer to our paper:
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That is all my presentation

reporter：Qi Cheng