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# Representation of Dense Volume Datasets Using Pointerless Sparse Voxel Octrees With Variable and Fixed-Length Encoding

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# Content

- Contribution of the paper
- Proposed Data Structure
- Test Results
- Conclusions

# Contribution of the paper(1)

- Design of the hierarchical data structure,
  - based on the pointerless sparse voxel octrees,
  - carving out of subtrees homogenously filled by any value from the set of values,
  - fixed-length and variable-length (Huffman) encoding of subtrees,
  - fixed-length and variable-length (Huffman) encoding of voxel values.

# Proposed hierarchical data structure(1)

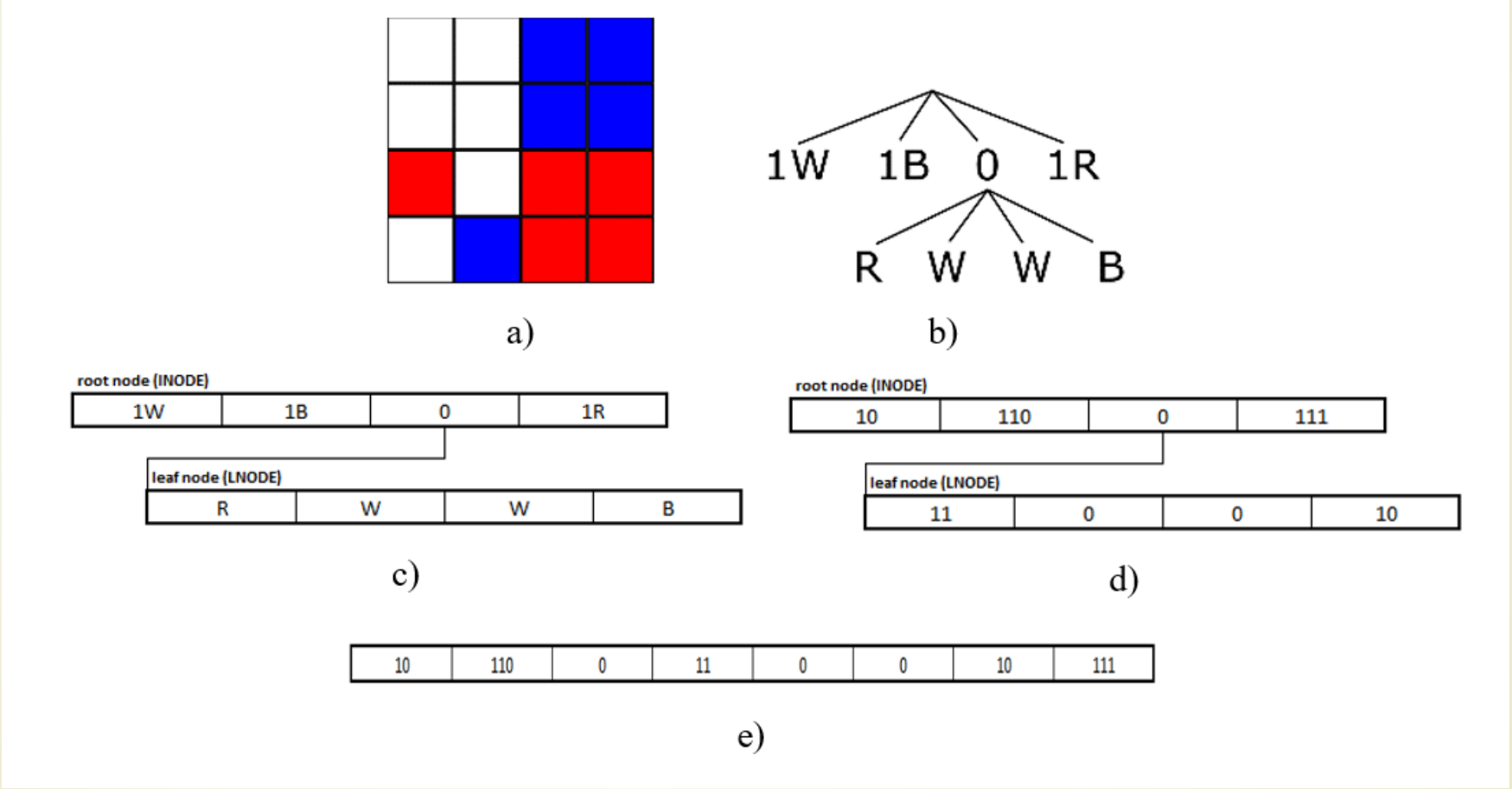
- Formal description of the proposed hierarchical data structure using Backus-Naur Form (BNF)

  - **PSVO** ::= <**INODE**> | <**LNODE**>
  - **INODE** ::= <**CHNM**>
  - **CHNM** ::= (8)<**HT**>
  - **HT** ::= “0“ <**INODE**> | “0“ <**LNODE**> | “1“ <**SYMB**>
  - **LNODE** ::= (8) <**SYMB**>
  - **SYMB** ::= (n)<**BIT**>
  - **BIT** ::= “0” | “1”

*where:*

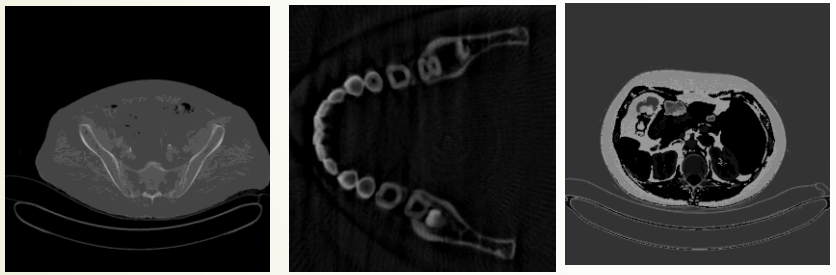
*<SYM> - mandatory non-terminal symbol SYM,*
*“sym“ – terminal symbol sym,*
*(n) <SYM> - symbol SYM, concatenated n times,*
*| - alternative,*
*Juxtaposition – concatenation*

# Proposed hierarchical data structure(2)



# Test results(1)

a) b) c)



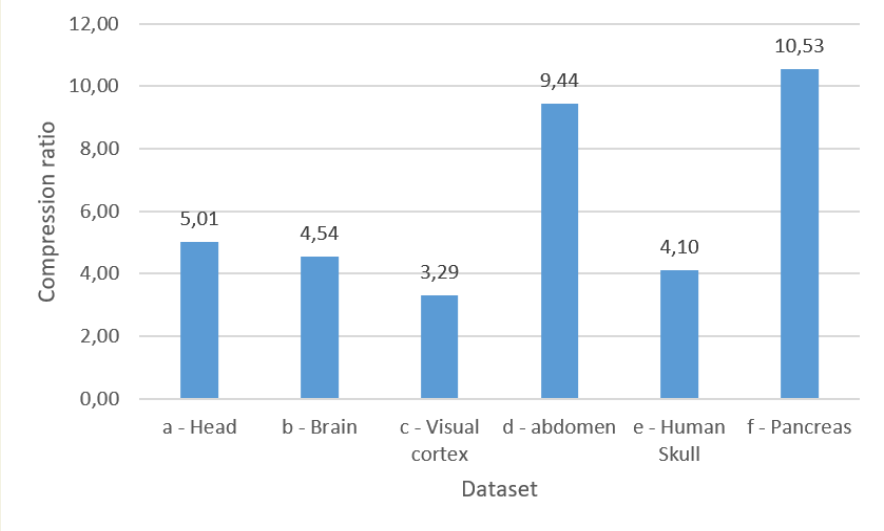
d) e) f)

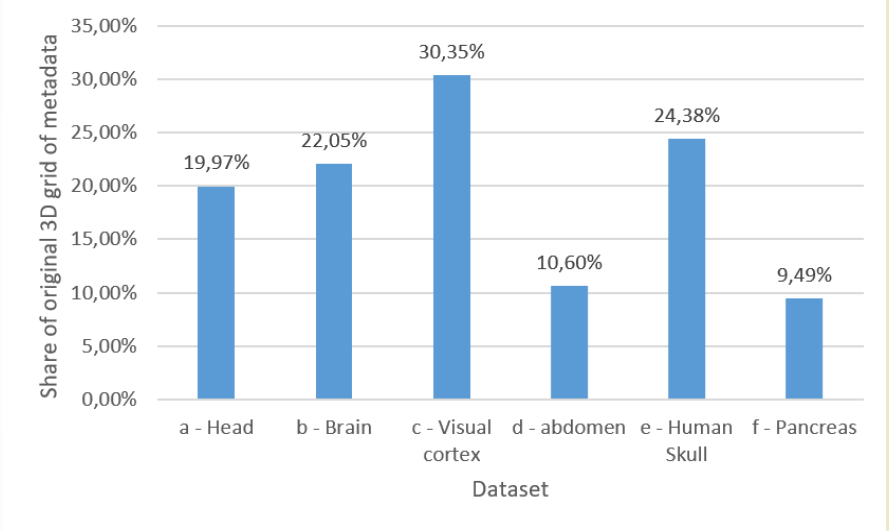
| | Volume dataset | Volume dimensions | Voxels [M] | b/vox | Size [MB] |
|---|---|---|---|---|---|
| A | Head | 256 × 256 × 113 | 7.4 | 16 | 14.1 |
| B | Brain | 256 × 256 × 109 | 7.1 | 16 | 13.6 |
| C | Visual Cortex | 1024 × 1024 × 314 | 329.3 | 8 | 314.0 |
| D | Abdomen | 512 × 512 × 174 | 45.6 | 16 | 87.0 |
| E | Human skull | 256 × 256 × 256 | 16.8 | 8 | 16.0 |
| F | Pancreas | 240 × 512 × 512 | 62.9 | 16 | 120.0 |

# Test results(2)

| | Metadata details | | | Proposed hierarchical data structure details | | | | | | Compression | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Threshold | | Original | $HT_0$ | $HT_1$ | $S_0$ | $S_1$ | $S_2$ | Size | | | |
| | $\tau_1$ | $\tau_2$ | [KB] | [$\times 10^3$] | [$\times 10^3$] | [$\times 10^3$] | [$\times 10^3$] | [$\times 10^3$] | [KB] | [%] | Ratio | b/vox |
| a - Head | 200 | 400 | 1 808 | 395 | 99 | 546 | 467 | 458 | 361 | 19.97% | 5.01 | 0.40 |
| b - Brain | 1 150 | 1 350 | 1 744 | 315 | 150 | 636 | 495 | 492 | 385 | 22.05% | 4.54 | 0.44 |
| c - Visual cortex | 25 | 50 | 80 384 | 8 744 | 9 003 | 41 416 | 34 534 | 33 474 | 24 397 | 30.35% | 3.29 | 0.61 |
| d - Abdomen | 200 | 400 | 11 136 | 3 007 | 237 | 1 327 | 1 175 | 1 260 | 1 180 | 10.60% | 9.44 | 0.21 |
| e - Human Skull | 25 | 50 | 4 096 | 466 | 377 | 1 679 | 1 389 | 1 345 | 999 | 24.38% | 4.10 | 0.49 |
| f - Pancreas | 225 | 425 | 15 360 | 7 761 | 75 | 745 | 787 | 776 | 1 458 | 9.49% | 10.53 | 0.19 |

# Test results(3)



# Conclusions(1)

- Proposed hierarchical data structure allowed
  - lossless compression,
  - significant reduction of the size of metadata ,
  - from 9.49% to 30.35% share in comparison to original metadata size,
  - compression ratio in the range from 3.29 to 10.53.

# References(1)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*Thank you*