# TREE BASED SEARCH ALGORITHM FOR BINARY IMAGE COMPRESSION

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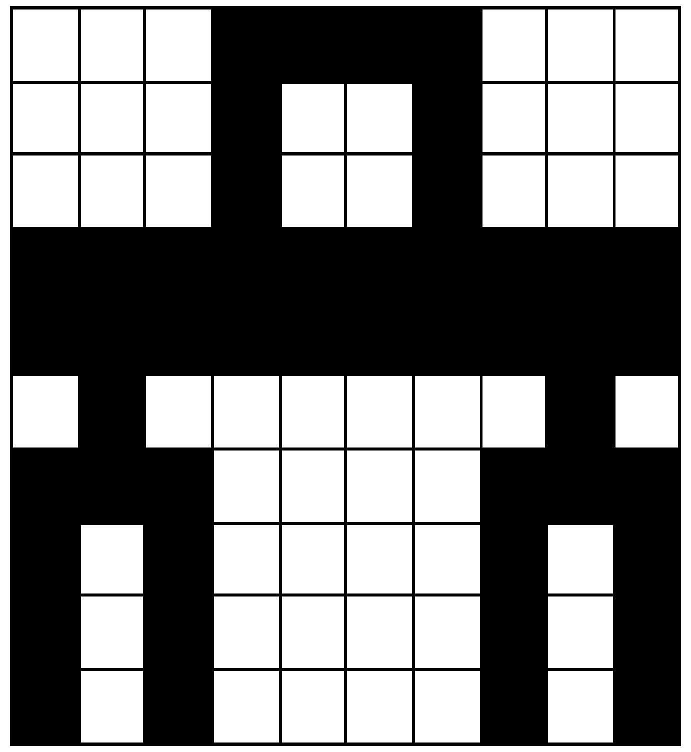
# Outline

- Introduction
- Background
- Tree Based Search Algorithm
- Simulation Results
- Conclusion

# INTRODUCTION

- Images contribute to huge part of data and information.
- Storage and retrieval of data is challenging.
- This work focuses on **Lossless Compression of Binary Images.**
- Tree-based search algorithm : Searches for best grid structure for adaptively partitioning the image into blocks of varying sizes.
- Binary image: either "0" or "1".



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

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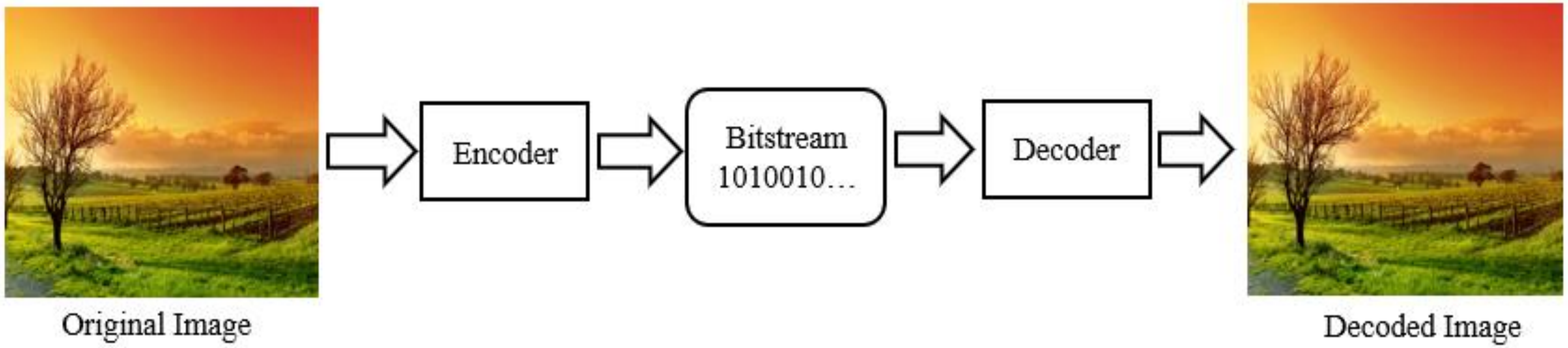
# APPROACHES

- Insufficient storage and demand for higher transmission rates.
- The images found on the web are compressed in some or other formats.
- The compression techniques can be classified as:

  Lossless Compression.

  Lossy Compression.
- A basic image compression algorithm:

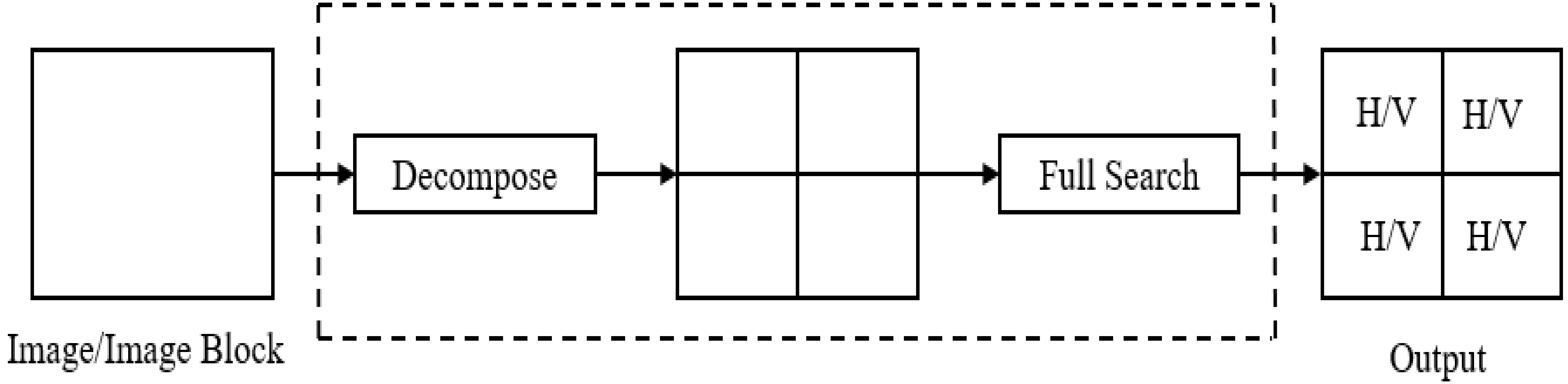


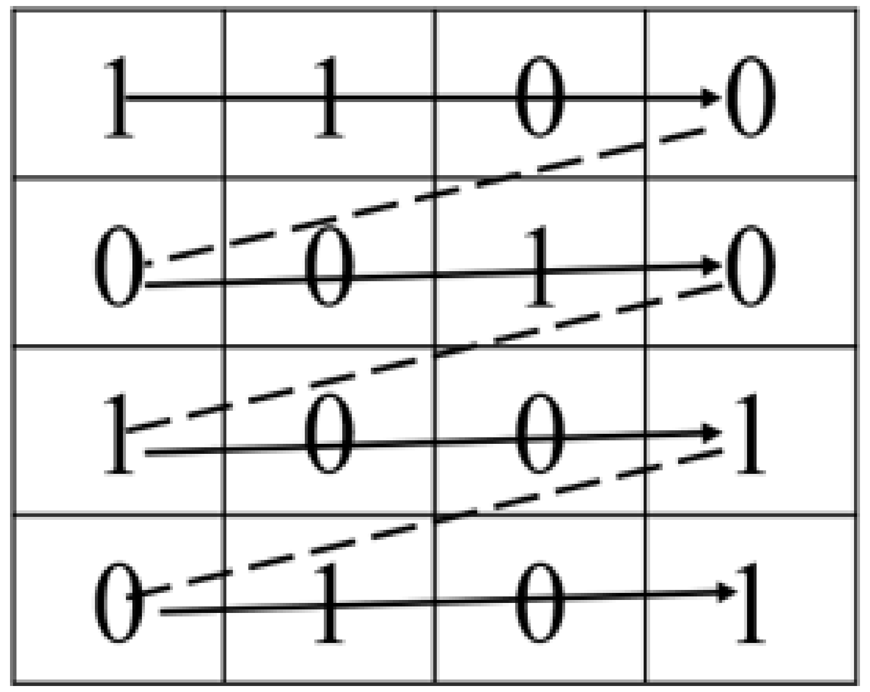
# TREE BASED SEARCH ALGORITHM

- Several regions of an image are less compressible than other regions.
- Changing statistics of an image.
- Exploiting the smoothness in portion of an image.
- Portions dominated by change : retained as smaller blocks.
- Smooth segments : chosen not to be divided further.
- Tree based algorithm steps:

  a. Full search of image sub-blocks.
  b. Optimal tree structure.
  c. Two-level splitting of the original image.

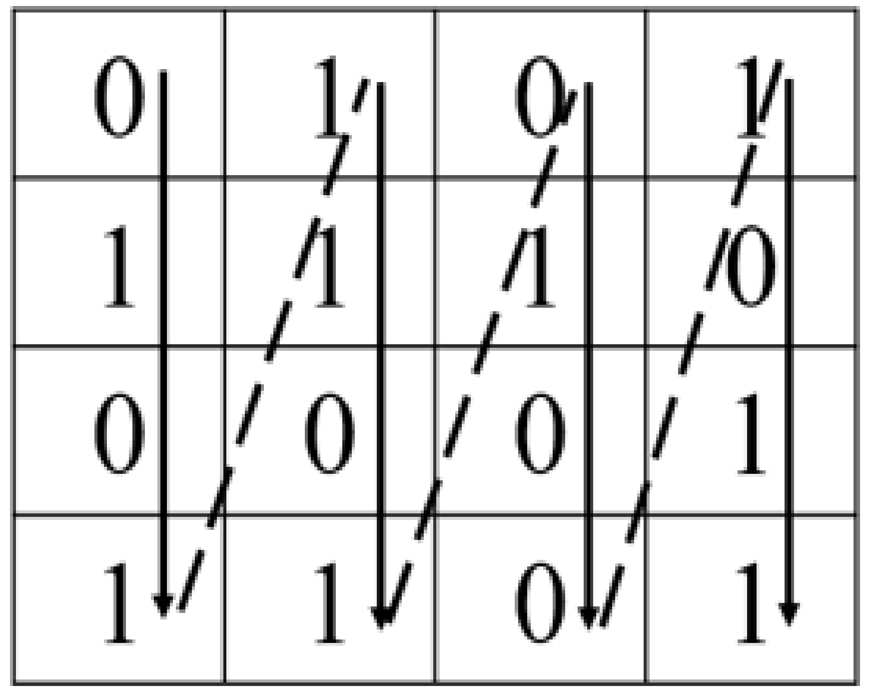
# FULL SEARCH OF IMAGE SUB-BLOCK




Horizontal Scan

Interval sequence : [ 1 1 5 2 3 2 2 ].




Vertical Scan

Interval sequence : [ 2 2 1 1 2 2 3 2 1 ].

- Divide the image into 4 equally sized blocks
- Find the best combination of scanning patterns.

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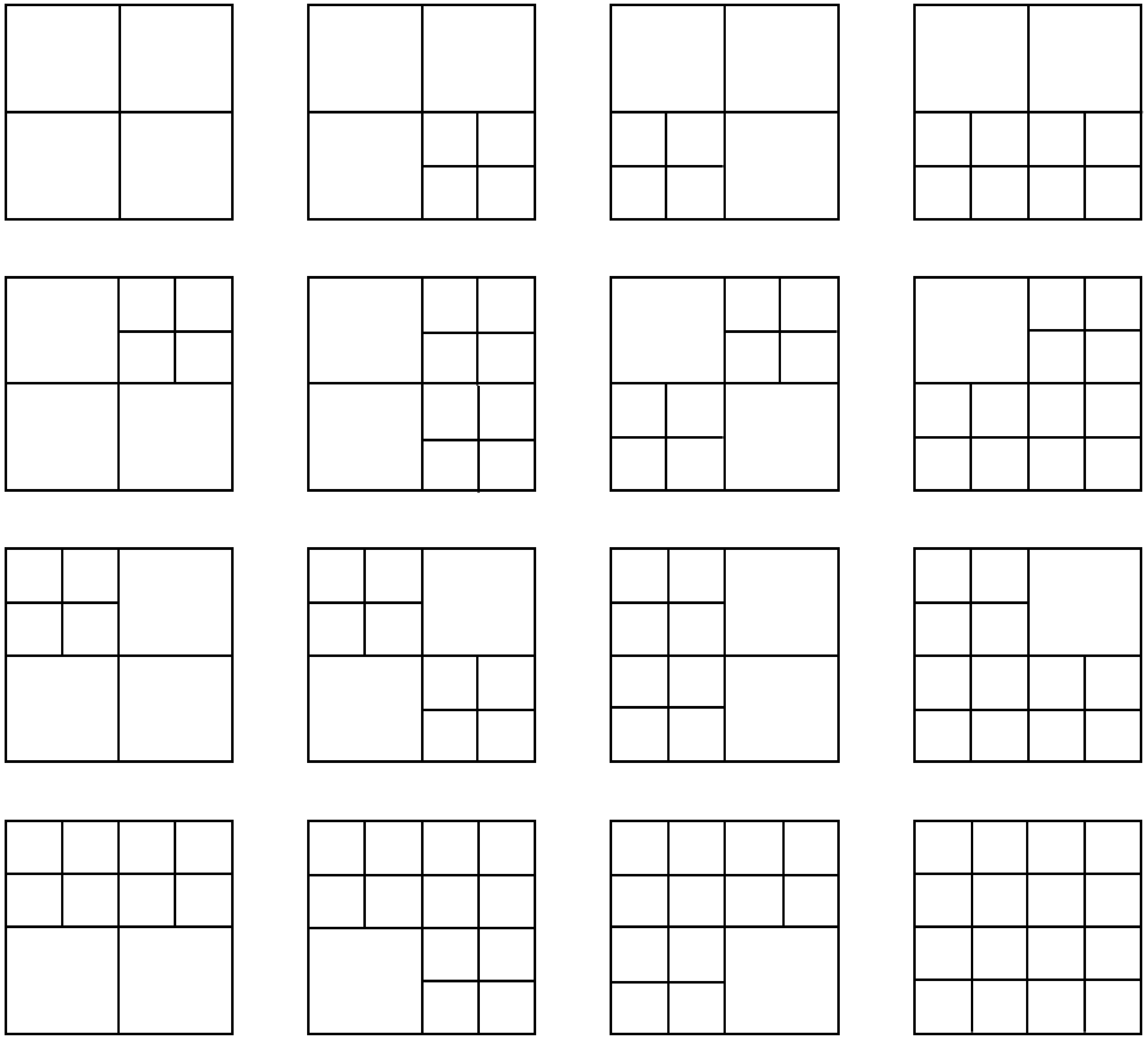
# ADAPTIVE GRID STRUCTURE



- Content of an image → regions contained in the image.
- larger blocks for smooth regions
- Smaller blocks for regions with largely varying content.
- Binary decisions : full search performed on the sub-blocks.
- Non-uniform areas: isolated from the remaining parts of the image.

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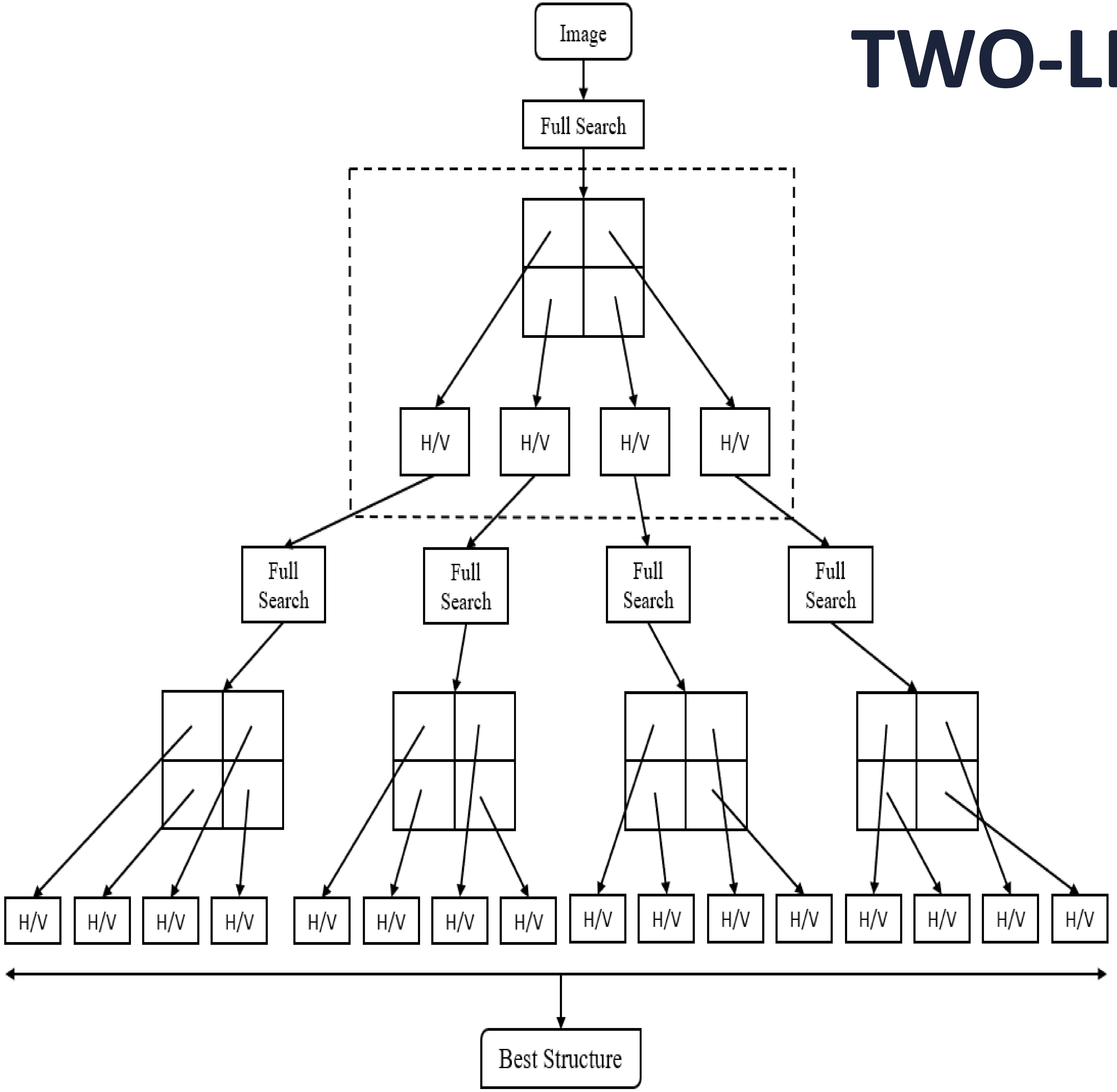


# TWO-LEVEL RECURSIVE SPLITTING

- Image : “original tree” (root node).
- Image can be represented by a tree structure.
- Segmentation:
    - Performed iteratively.
    - Controlled at each step.
- Split parent block → child node.
- Tree structure is designated by series of bits that indicate termination.

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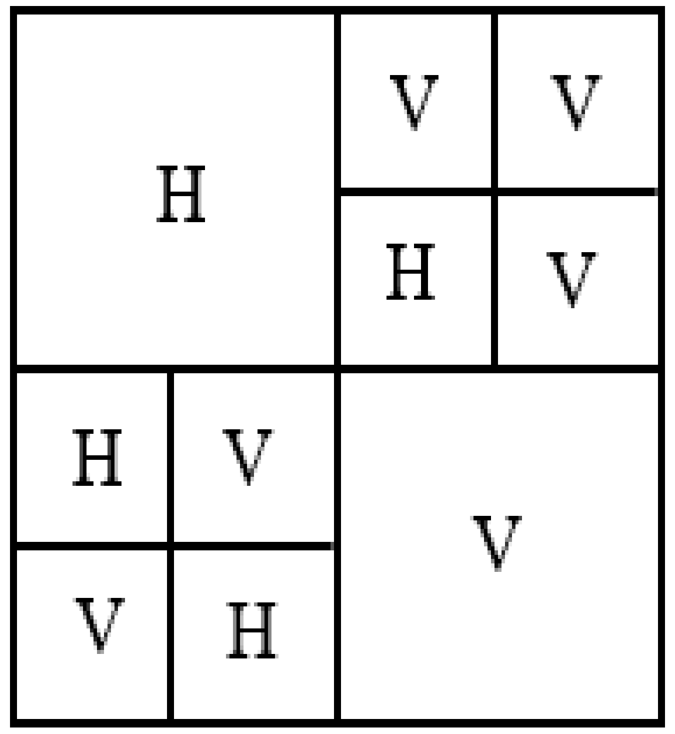
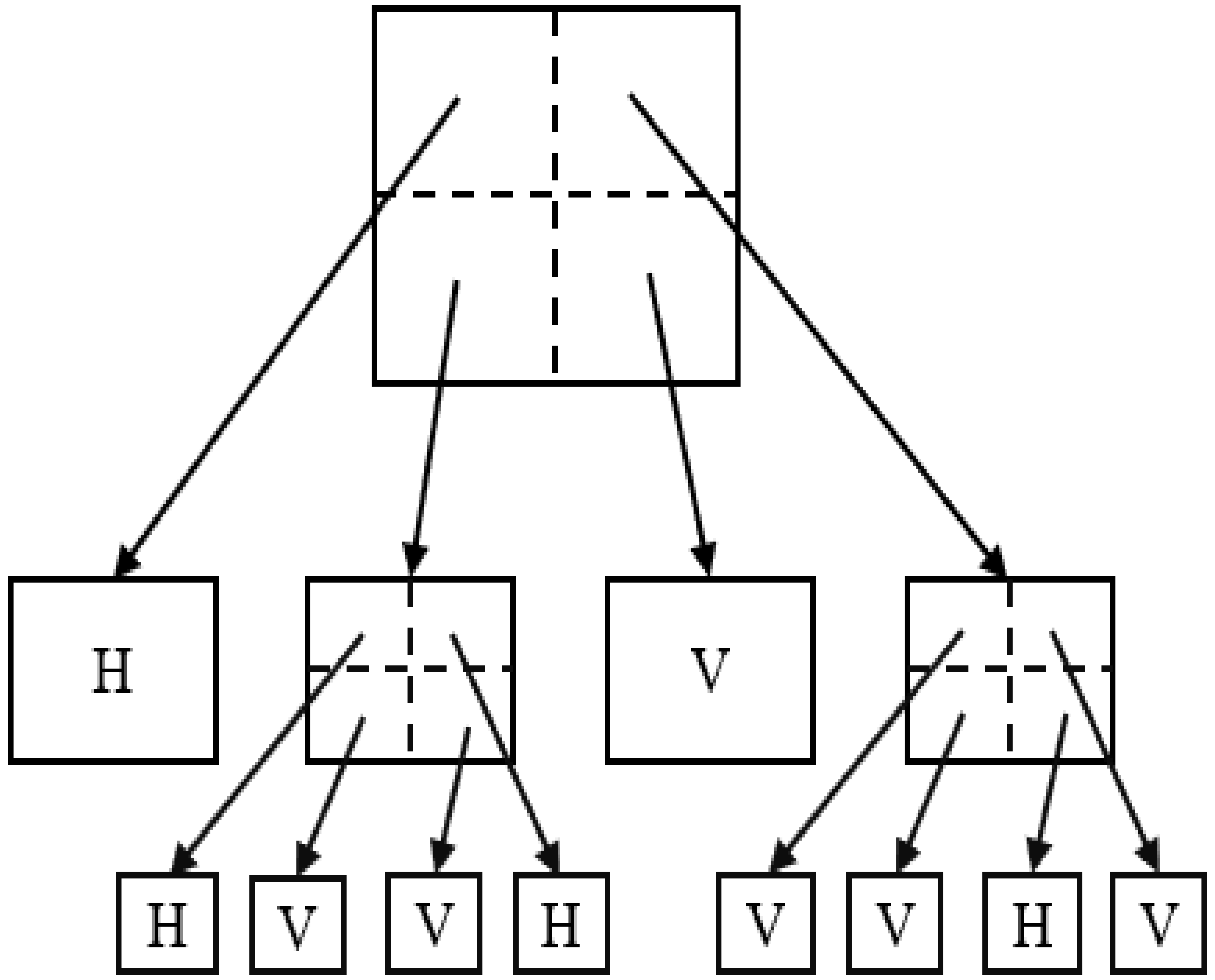
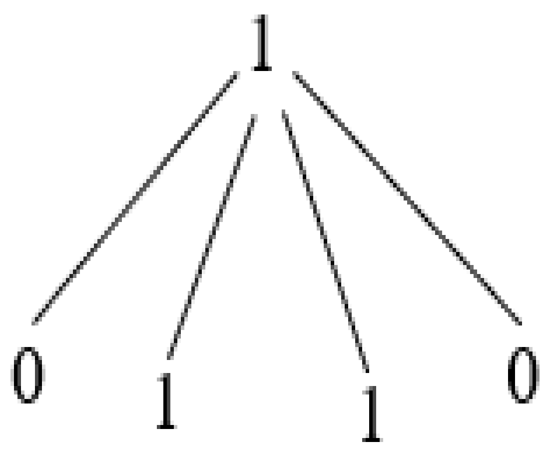
# FINAL STRUCTURE




(a) Optimal Tree Structure




(b) Optimal Tree Path




(c) Decision Bits

- Direction bits : represents division.
- Each node has either no offspring or four offsprings.
- If the block is divided :
  - Binary decision for selection of scanning direction.
- The procedure terminates after two-level recursive splitting.
- Data file : Tree structure and sequence of intervals, header.
- Final step: Data compression utility.
- Lossless check.

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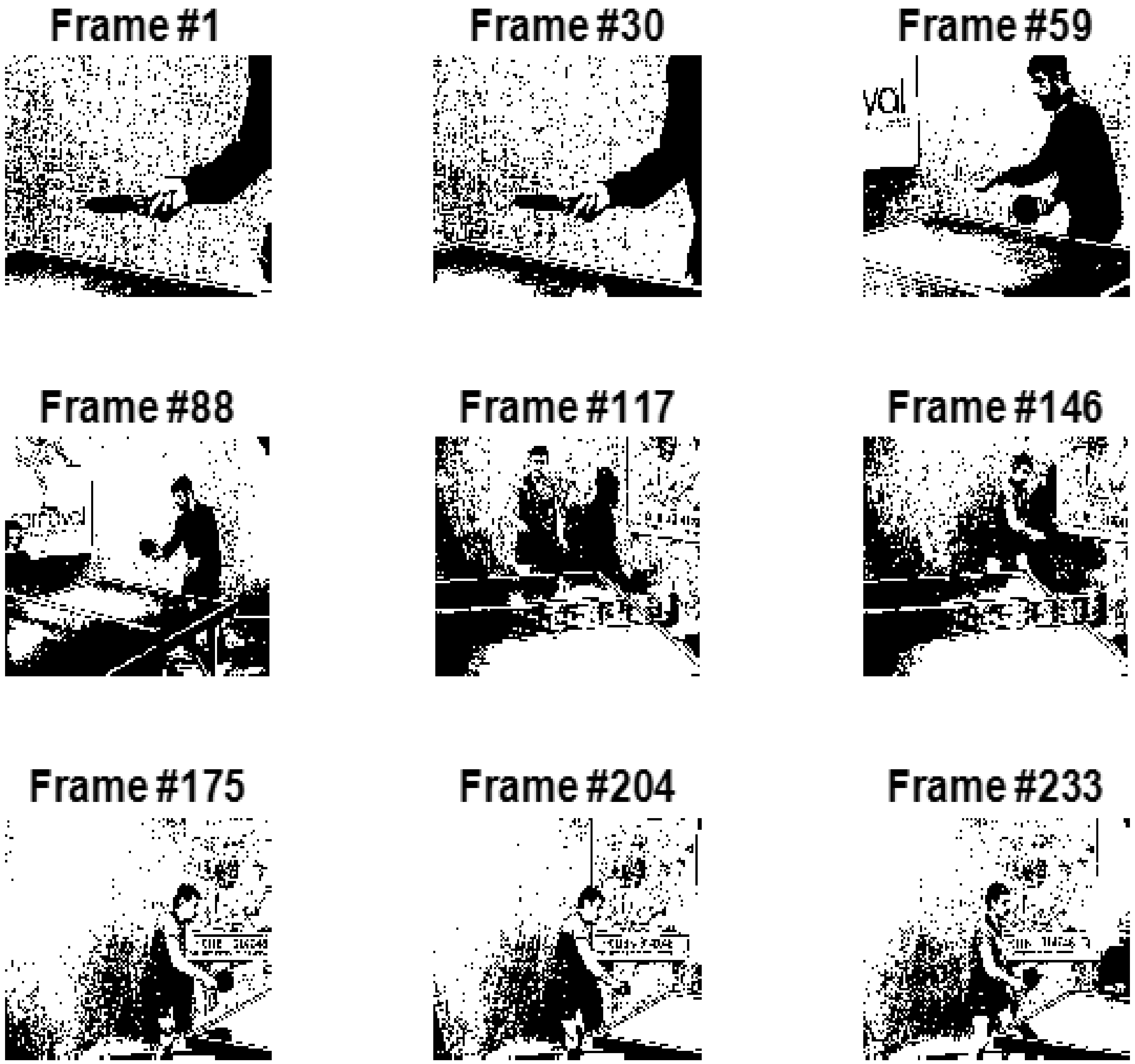
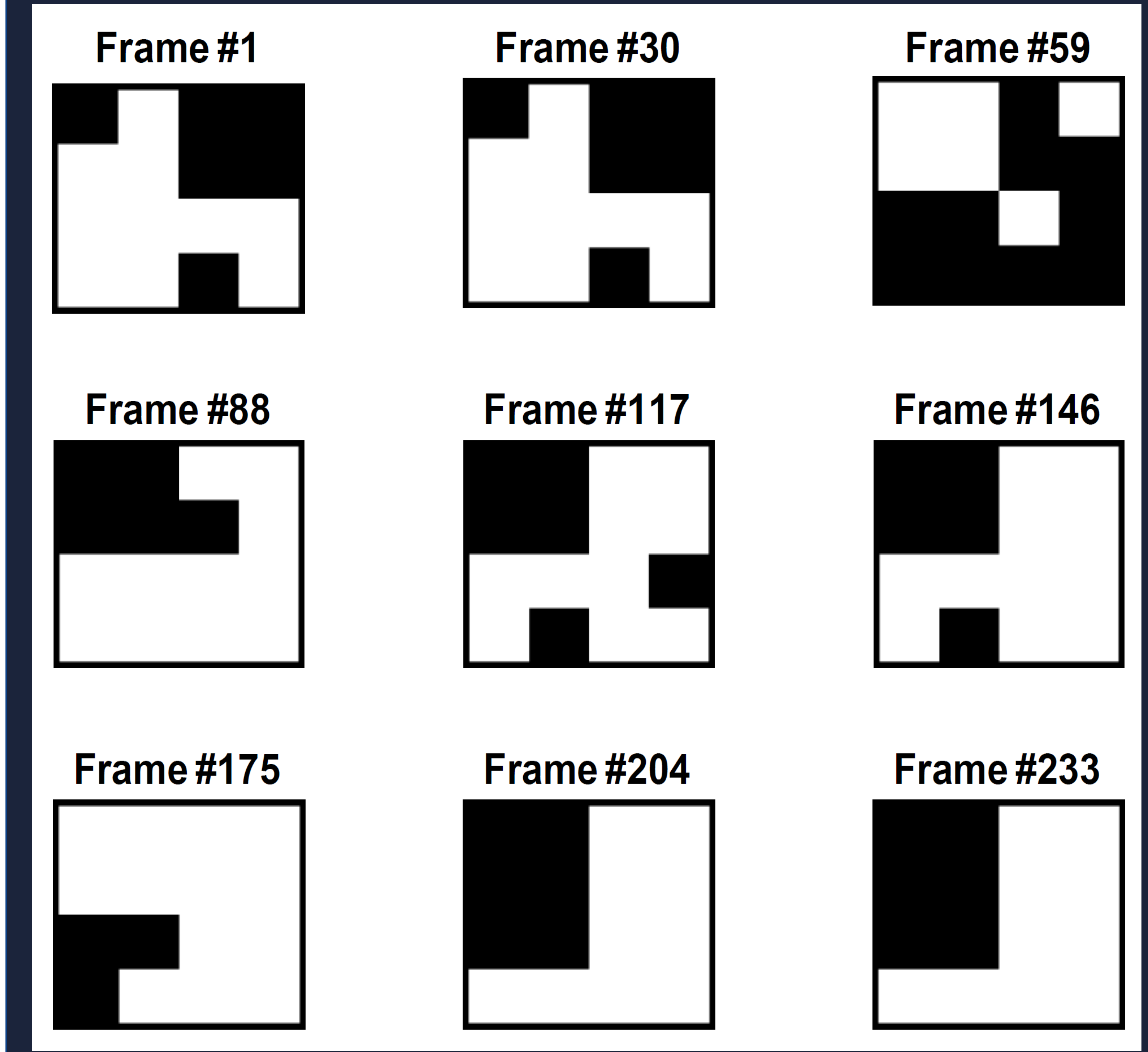
# SIMULATION RESULTS

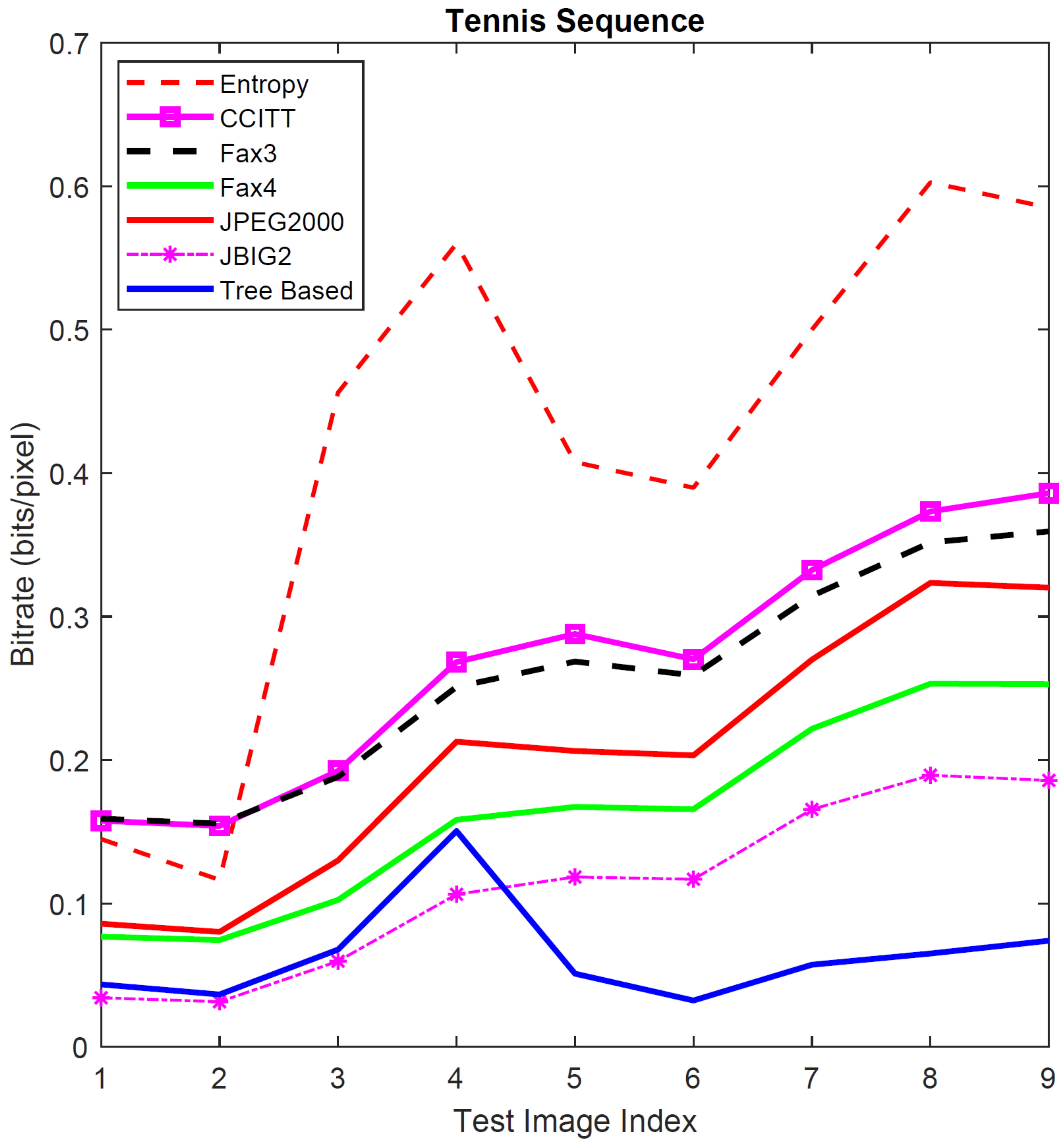



**Binary images obtained by thresholding greyscale images from a video sequence**




**Bitmaps using Tree-based algorithm**

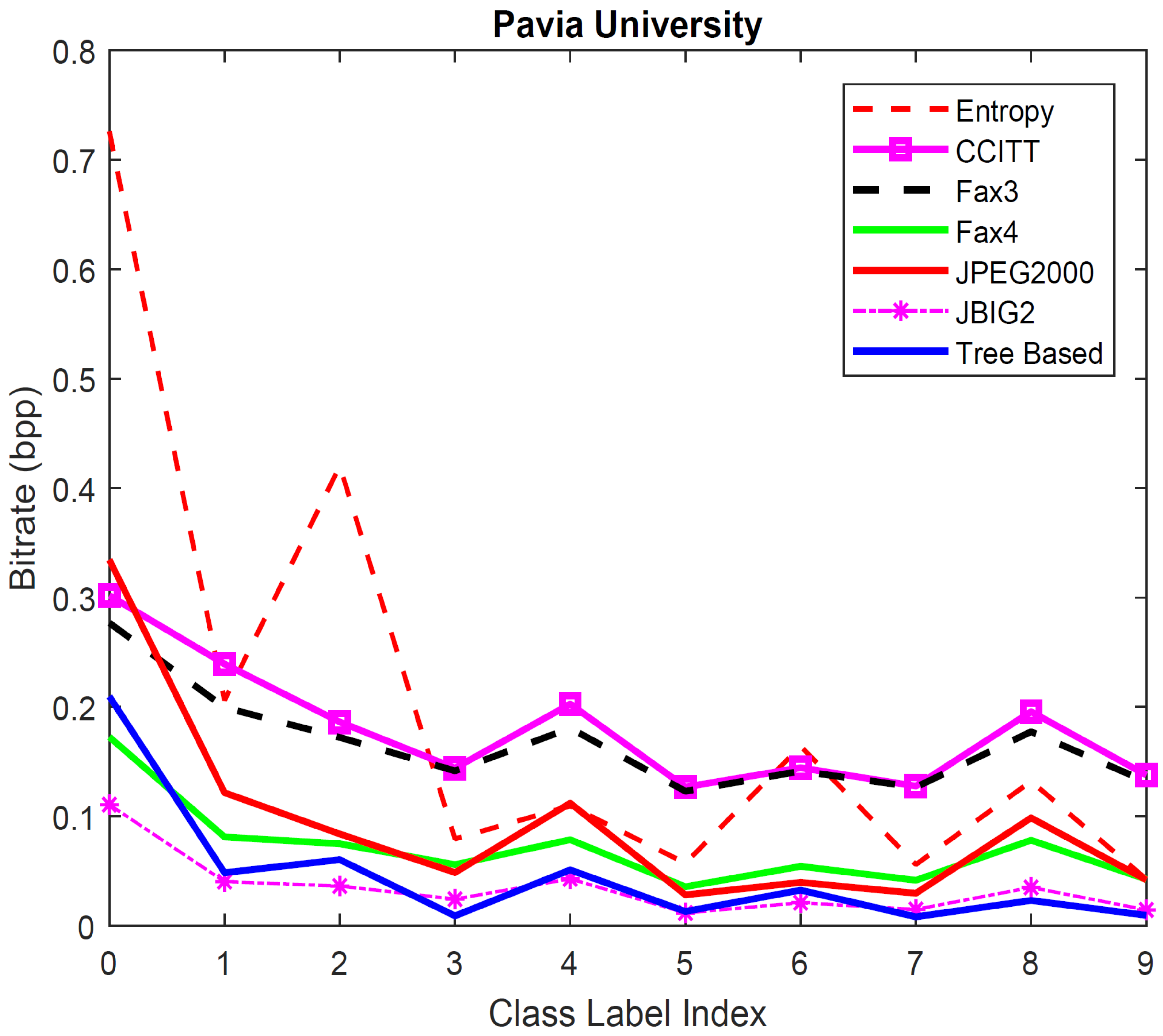
# COMPARISON OF PROPOSED ALGORITHM WITH OTHER TECHNIQUES



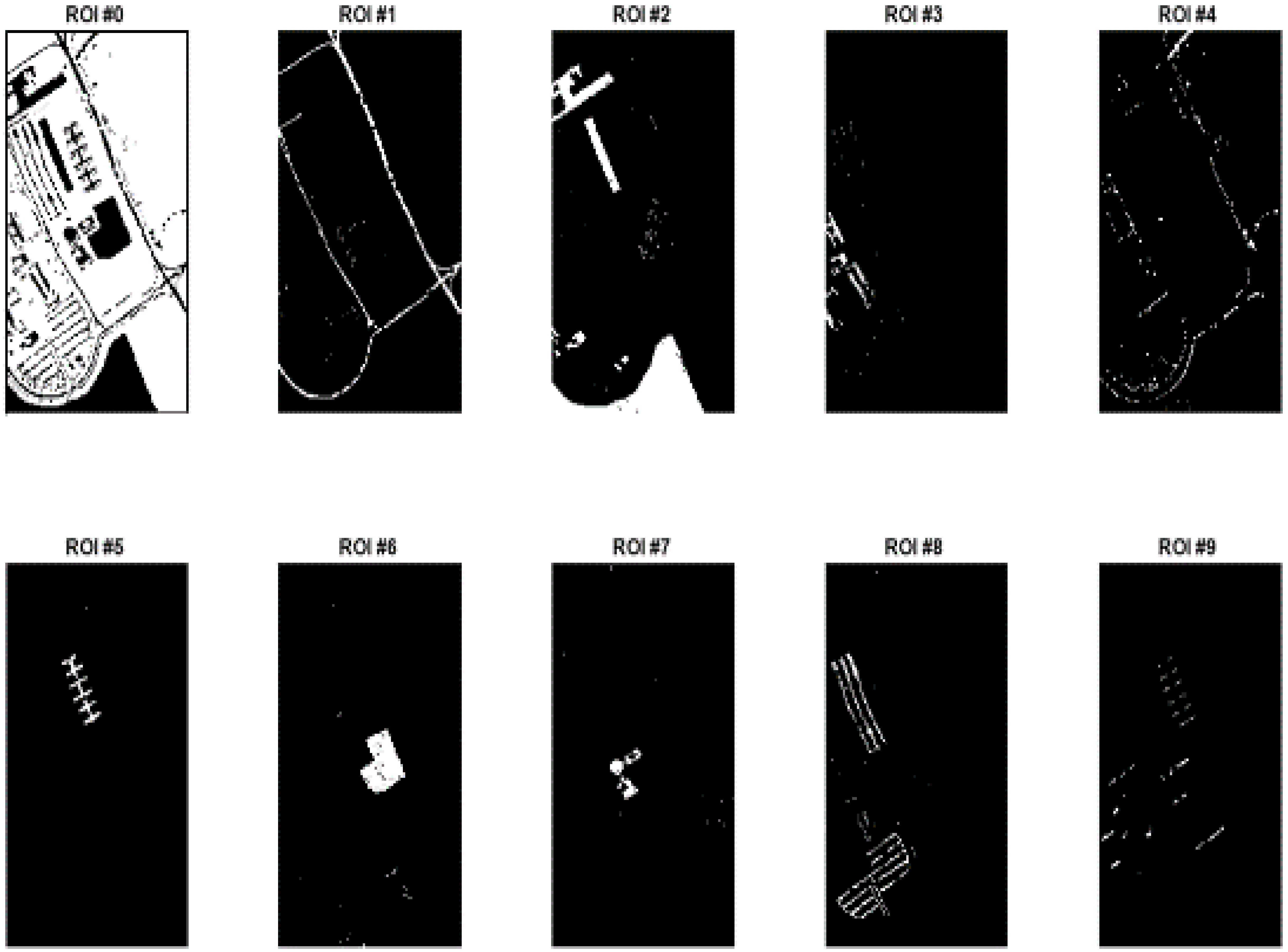

**Compression results for the "Tennis" sequence**

- Test image index 1, 2, 3, 4, 5, 6, 7, 8, and 9 refers to frame 1, 30, 59, 88, 117, 146, 175, 204, 233 in sequence, respectively.
- Tree based search algorithm provides significantly higher compression than other methods.
- Proposed method has lower compression than JBIG2 standard method on average.
- Tree-based search algorithm achieves highest compression for frame 5 to 9.

# "PAVIA UNIVERSITY" DATASET




**Compression results of bi-level PU ROI maps.**




**"Pavia University (PU)" hyperspectral image dataset**

# CONCLUSION

- We proposed Tree based search method for lossless compression of binary images.
- The algorithm explores different search paths to reach the most optimal one.
- It also examines various grid structures employing blocks of varying sizes.
- Non-uniform block size exploits different regions of the image based on its intrinsic nature.
- Extensive simulations showed that we can achieve higher compression on average.

# Thank You!

Any questions?