FFSM - Flip-Flop Split & Merge:
An efficient Split & Merge algorithm for embedded systems

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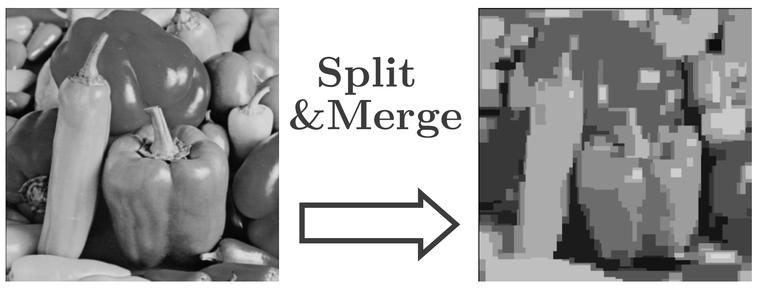
CONTEXT

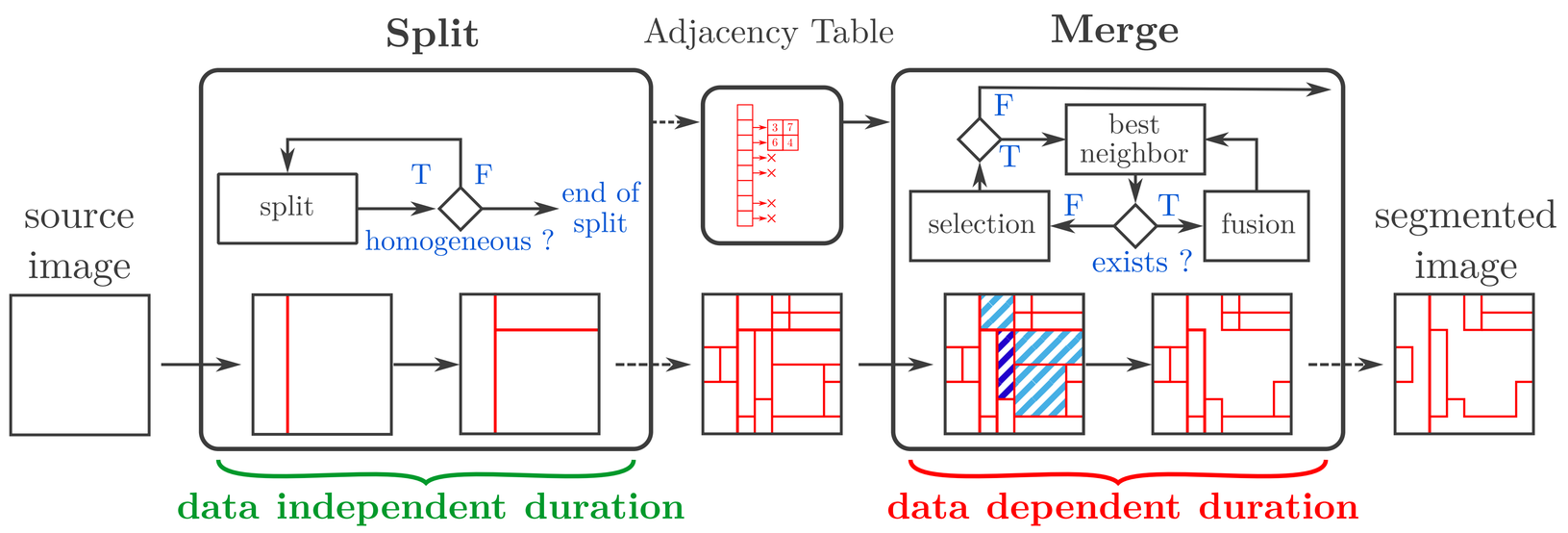
Split & Merge [1]: a pre-processing algorithm

It is made out of two steps:

1. **Split step:** recursively divide image into homogeneous squares
2. **Merge step:** iteratively merge adjacent regions if similar enough



SPLIT & MERGE: PROCESSING CHAIN

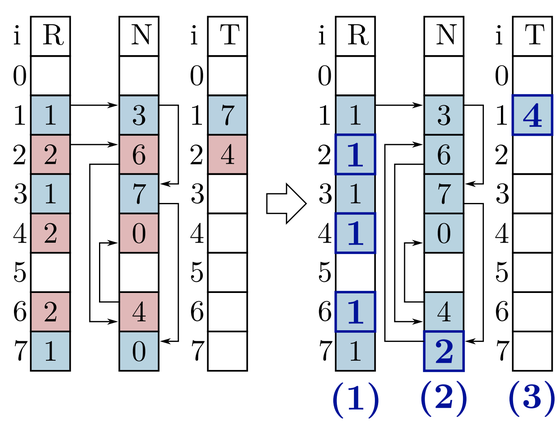


Current limits
- Execution time too high for real-time embedded system applications
- Execution time sensitive to segmentation parameters

A NEW MERGE ALGORITHM: 3 MECHANISMS TO FIGHT 3 BOTTLENECKS

1 Problem: dynamic memory reallocations & memory fragmentation

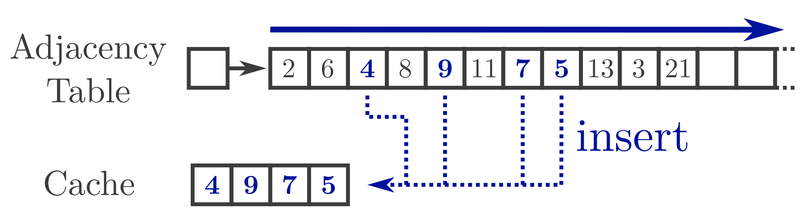
Solution: With a TTA data structure [2], regions can be merged in-place (no memory reallocation needed)



2 Problem: high cost of best neighbor search in TTA (random jumps)

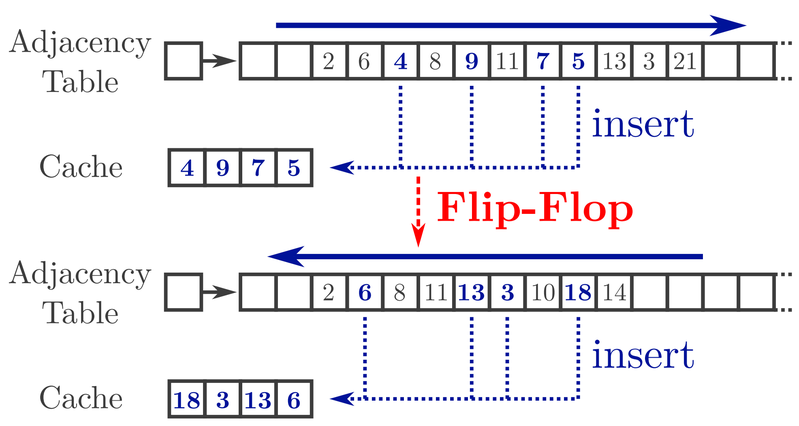
Solution: cache of *good* neighbors

1. Insert good neighbors into cache
2. Iterate over cache to find best neighbors



3 Problem: finding good neighbors requires 2 iterations & is sensitive to direction

Solution: aggregate neighbors in a single pass by relaxing constraints and use a *flip-flop* mechanism to avoid worst cases



EXPERIMENTAL SETUP

CAMVID dataset [4, 5]:
street images (**960** × **720**)

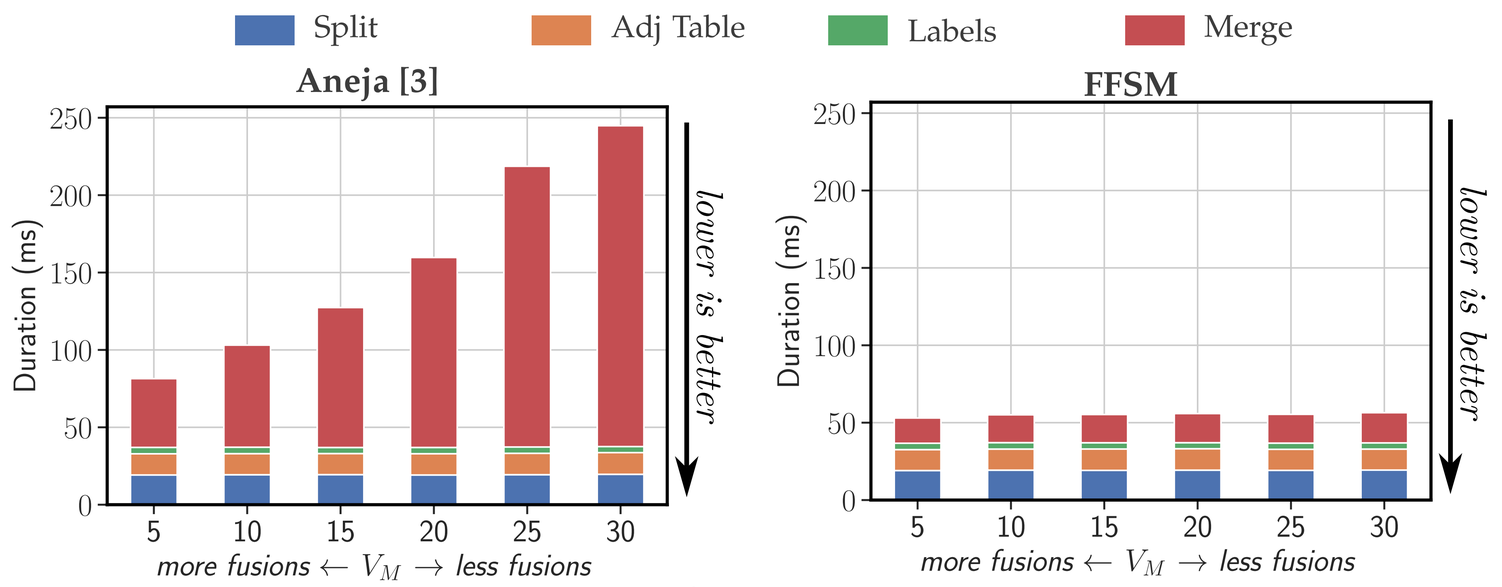
Nvidia Jetson Xavier NX
ARMv8.2-A | 15 Watts

COMPARABLE QUALITY

V_M : homogeneity criterion for merge

Comparable qualitative results

GOOD PERFORMANCE FOR ALL MERGE CRITERIONS



FFSM improves the execution time of
- The *merge* step by a factor of **×3.6 to ×10.6**
- The total execution time by a factor of **×1.5 to ×4.3**

REFERENCES

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[3] Kanur Aneja, Florence Laguzet, Lionel Lacassagne, and Alain Merigot. Video-rate image segmentation by means of region splitting and merging. In 2009 IEEE International Conference on Signal and Image Processing Applications, pages 437–442, Kuala Lumpur, Malaysia, 2009. IEEE.

[4] Gabriel J. Brostow, Jamie Shotton, Julien Fauqueur, and Roberto Cipolla. Segmentation and Recognition Using Structure from Motion Point Clouds. In David Forsyth, Philip Torr, and Andrew Zisserman, editors, Computer Vision – ECCV 2008, volume 5302, pages 44–57, Berlin, Heidelberg, 2008. Springer Berlin Heidelberg.

[5] Gabriel J. Brostow, Julien Fauqueur, and Roberto Cipolla. Semantic object classes in video: A high-definition ground truth database. Pattern Recognition Letters, 30(2):88–97, January 2009.

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