Online Video SEEDS

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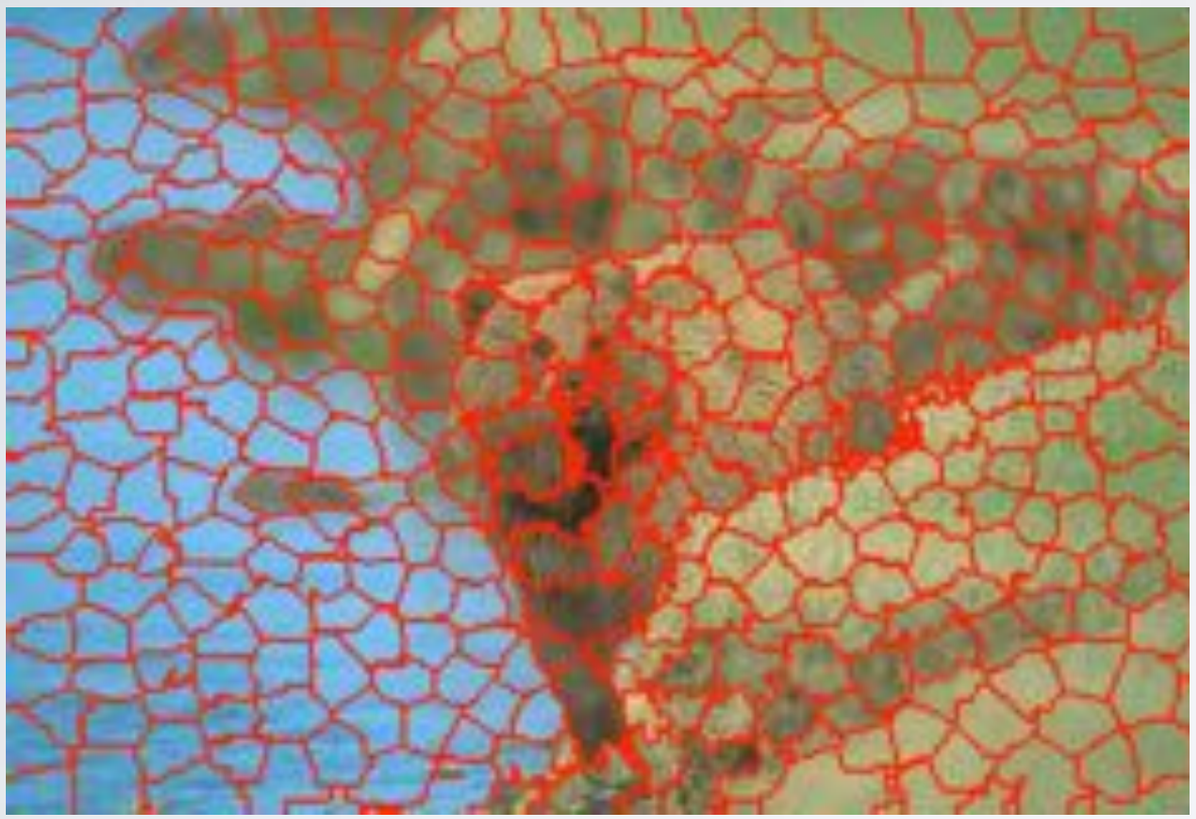
Superpixels Extracted via

SEEDS

Energy-Driven Sampling

ECCV 2012

What are superpixels?



- grouping pixels based on similarity (color)
- speeds up segmentation
- objects are made up of a small number of superpixels

Existing superpixel methods

gradual addition of cuts

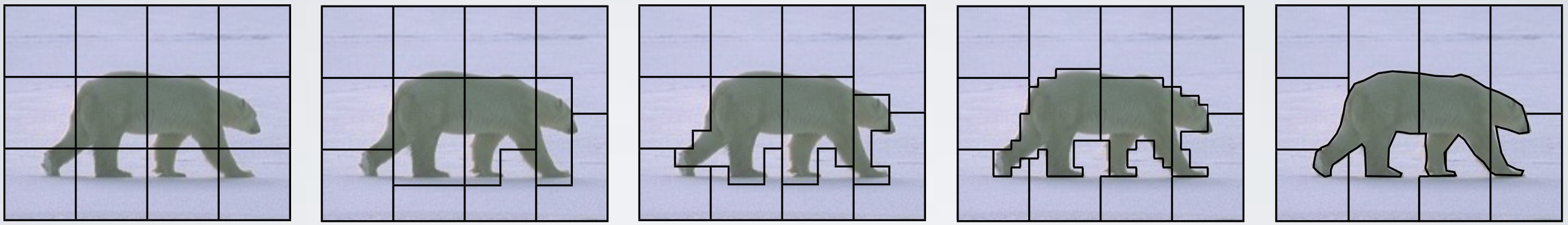
- high accuracy
- very slow (contradictory)
- *e.g.* Entropy Rate Superpixels (Liu *et al.*)

Existing superpixel methods

growing from centers

- faster
- reduced accuracy (local minima + stray labels)
- still not fast enough
- *e.g.* SLIC Superpixels (Achanta *et al.*)

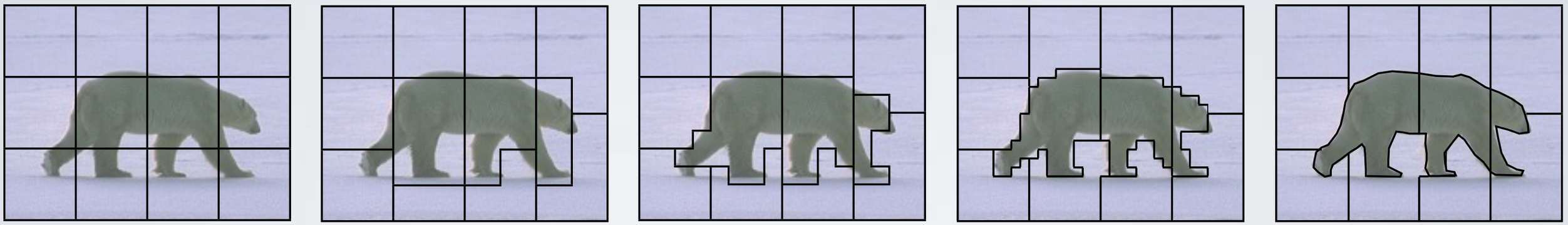
new approach: SEEDS Superpixels



initalization | largest block update | medium block update | smallest block update | pixel-level update

- initialize with rectangular boundaries
- gradually refine boundaries
- **SEEDS: Superpixels Extracted via Energy-driven Sampling** - ECCV 2012

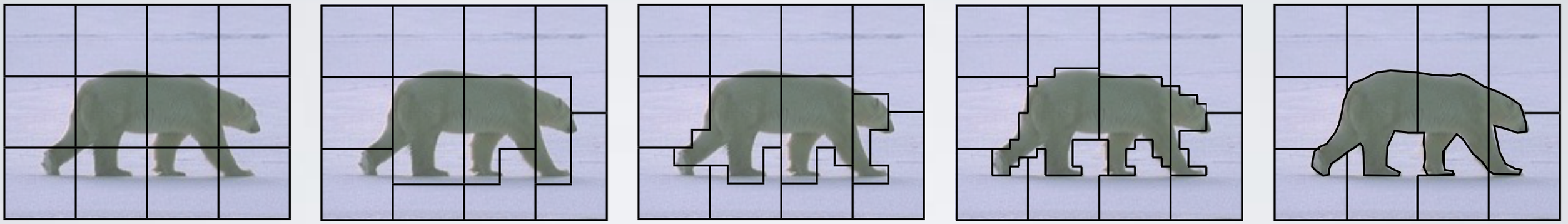
Advantages of SEEDS



initalization | largest block update | medium block update | smallest block update | pixel-level update

- faster than growing centers
  - only needs to evaluate at the boundaries
  - highly efficient evaluation using color histograms (1 memory lookup)

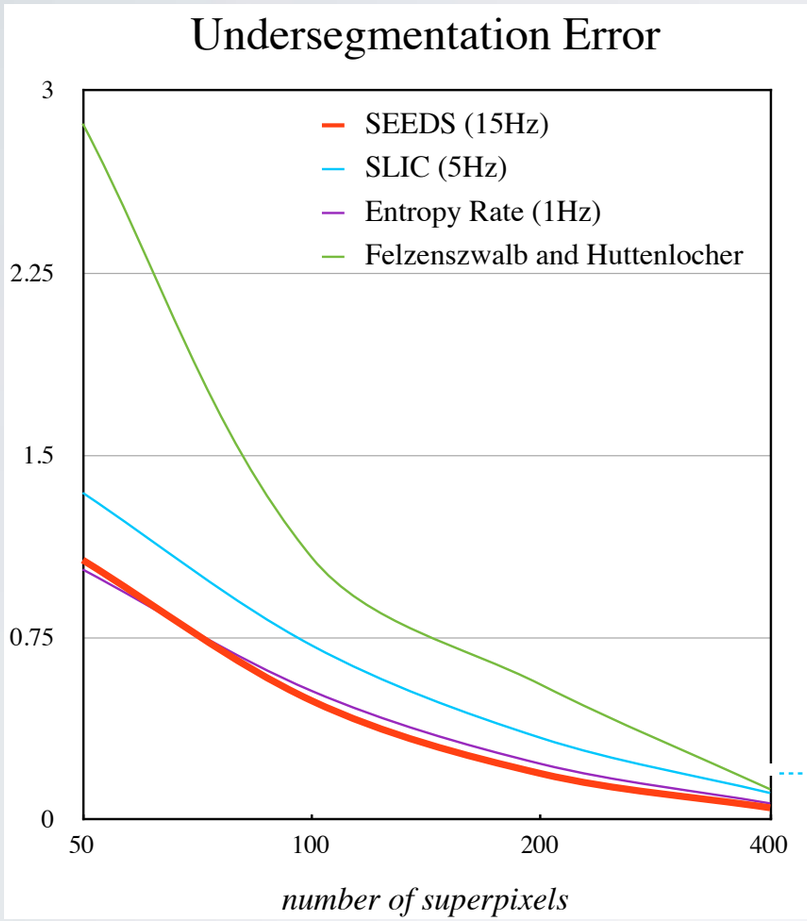
Advantages of SEEDS

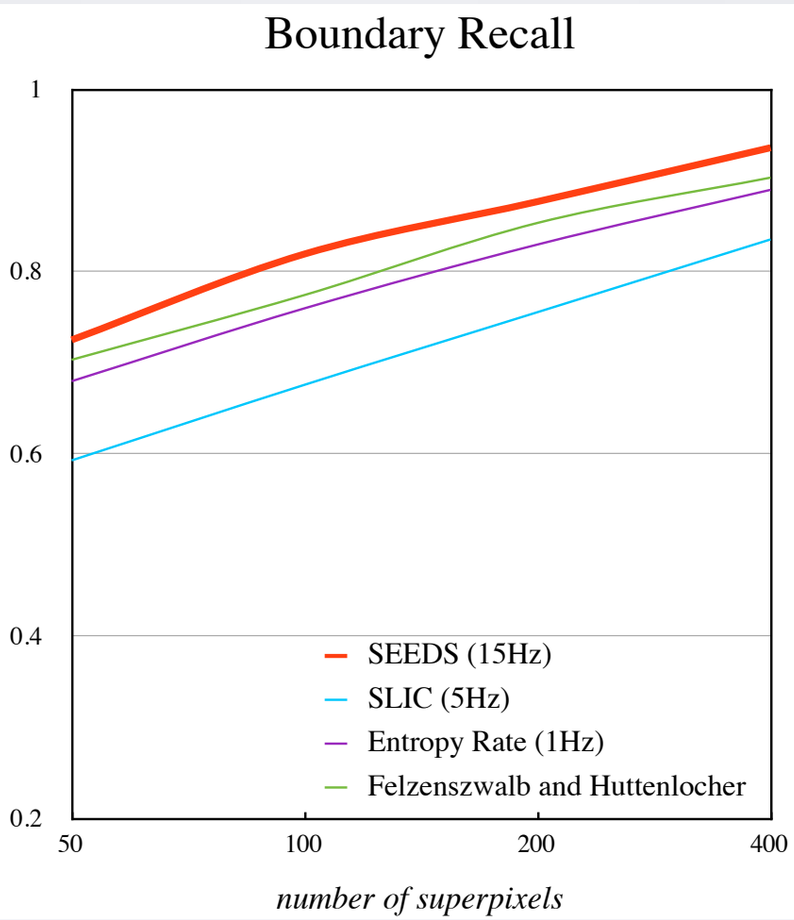


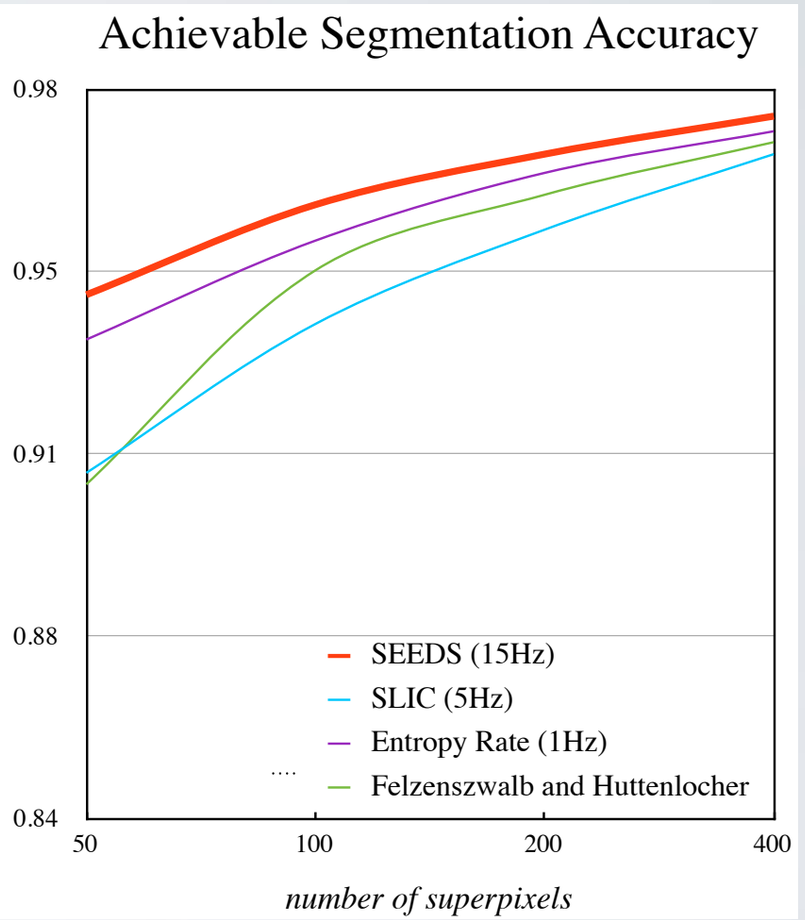
initalization | largest block update | medium block update | smallest block update | pixel-level update

- faster than growing centers
  - only needs to evaluate at the boundaries
  - highly efficient evaluation using color histograms
- accuracy matches or exceeds state-of-the-art
  - avoids local minima
  - optimization only evaluates valid partitionings

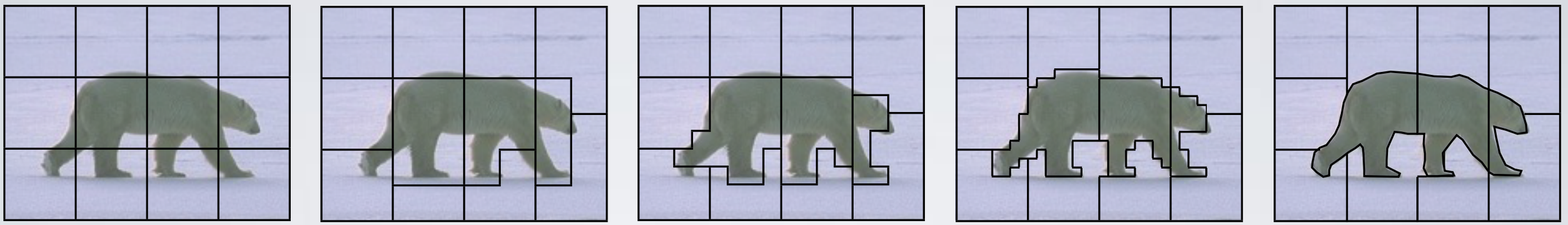
Advantages of SEEDS







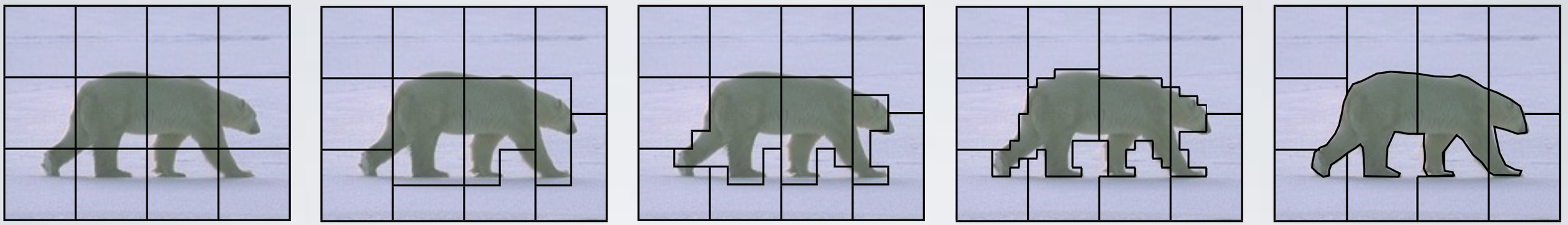
Advantages of SEEDS



initalization | largest block update | medium block update | smallest block update | pixel-level update

- faster than state-of-the-art
- accuracy matches or exceeds state-of-the-art

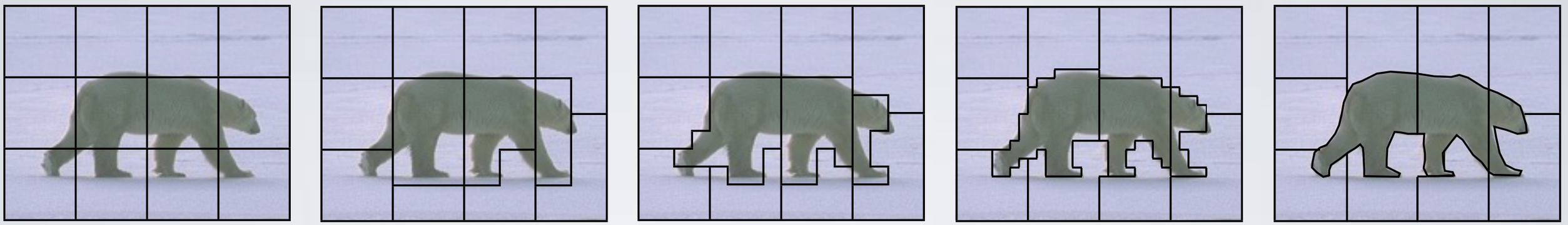
Advantages of SEEDS



initalization | largest block update | medium block update | smallest block update | pixel-level update

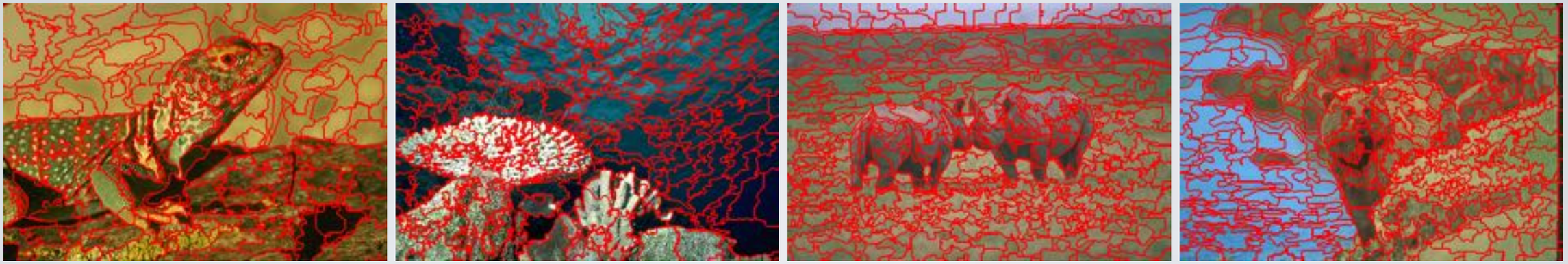
- faster than state-of-the-art
- accuracy matches or exceeds state-of-the-art
- control over run-time
  - whenever the algorithm is stopped, a valid partitioning is available
  - state-of-the-art accuracy at 30 Hz (single core)

Advantages of SEEDS

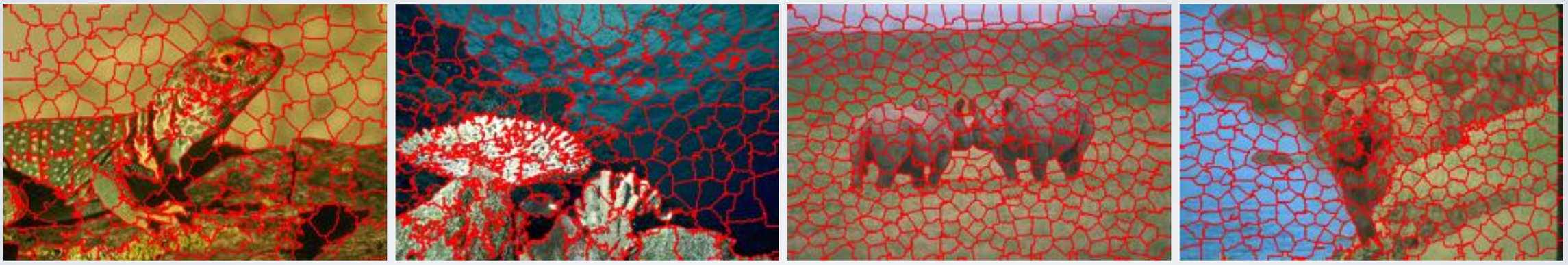


initalization | largest block update | medium block update | smallest block update | pixel-level update

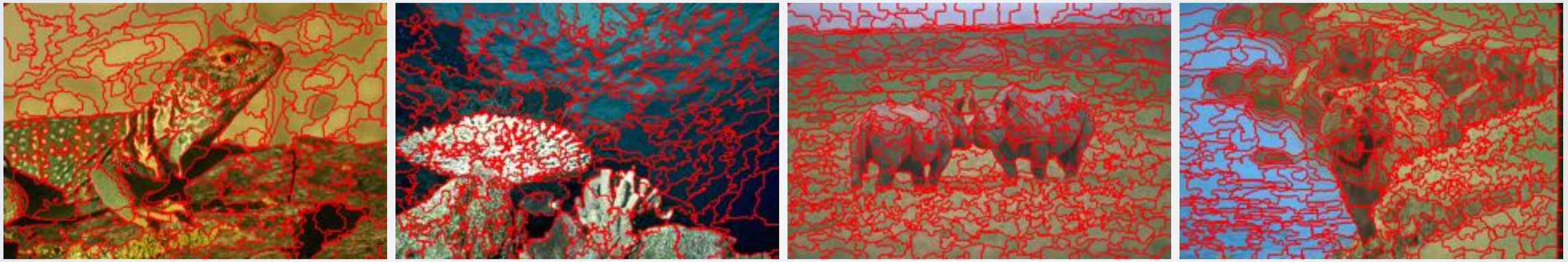
- faster than state-of-the-art
- accuracy matches or exceeds state-of-the-art
- control over run-time
  - whenever the algorithm is stopped, a valid partitioning is available
  - state-of-the-art accuracy at 30 Hz (single core)
- control over superpixel shape
  - one or more priors can be applied during boundary updating



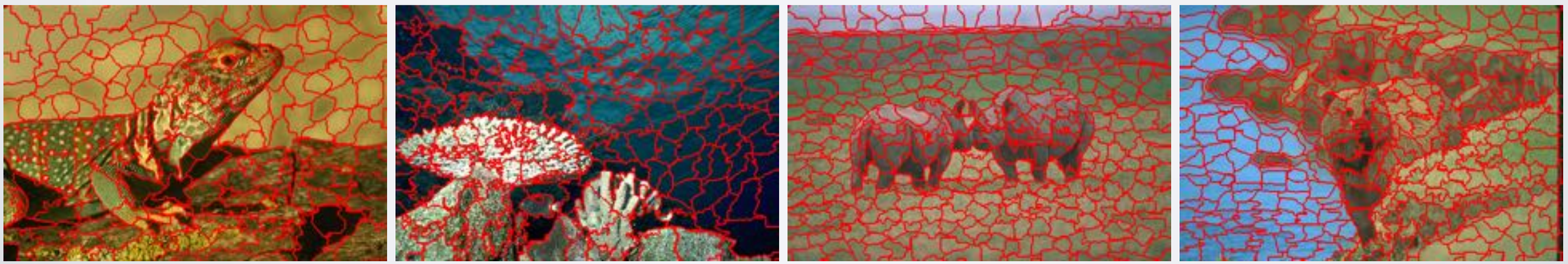
(b) SEEDS with 3×3 smoothing prior



(b) SEEDS with compactness prior



(b) SEEDS with edge prior (snap to edges)

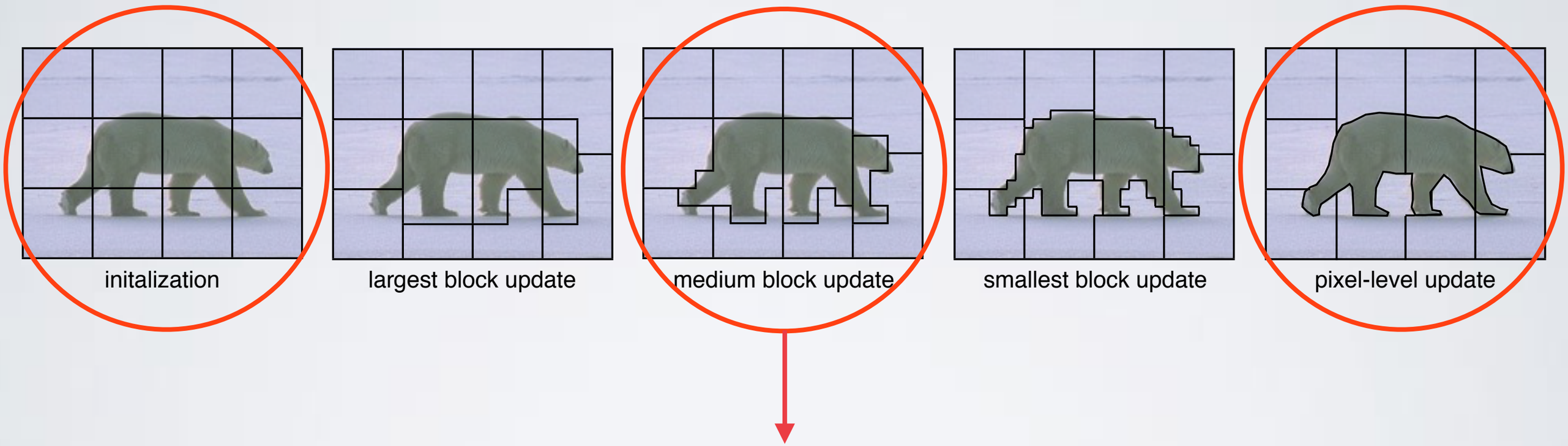


(b) SEEDS with combined prior (3×3 smoothing + compactness + snap to edges)

Advantages of SEEDS

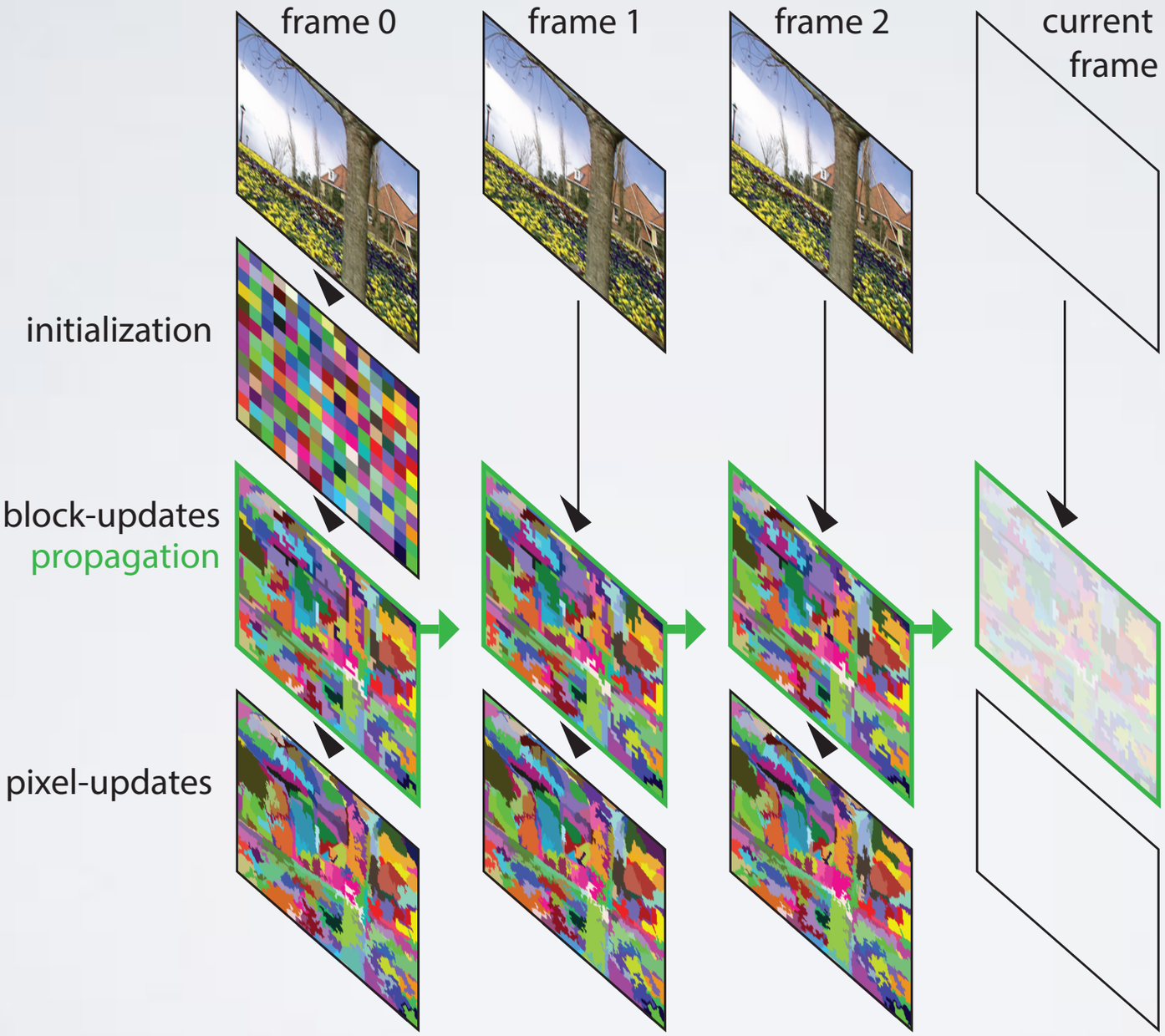
- faster
- more accurate
- control over run-time
- control over shape
- temporal

Advantages of SEEDS

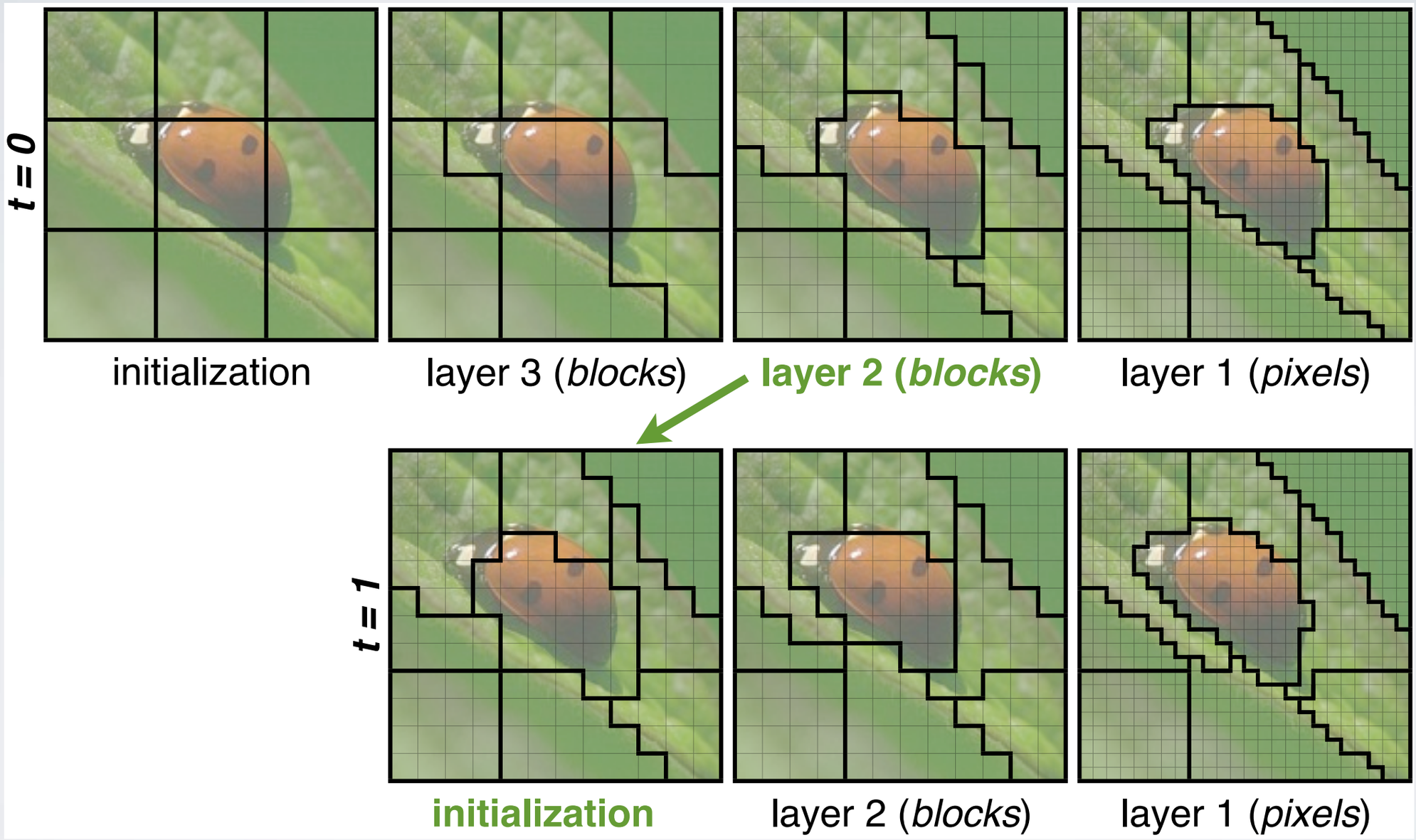


Online Video SEEDS

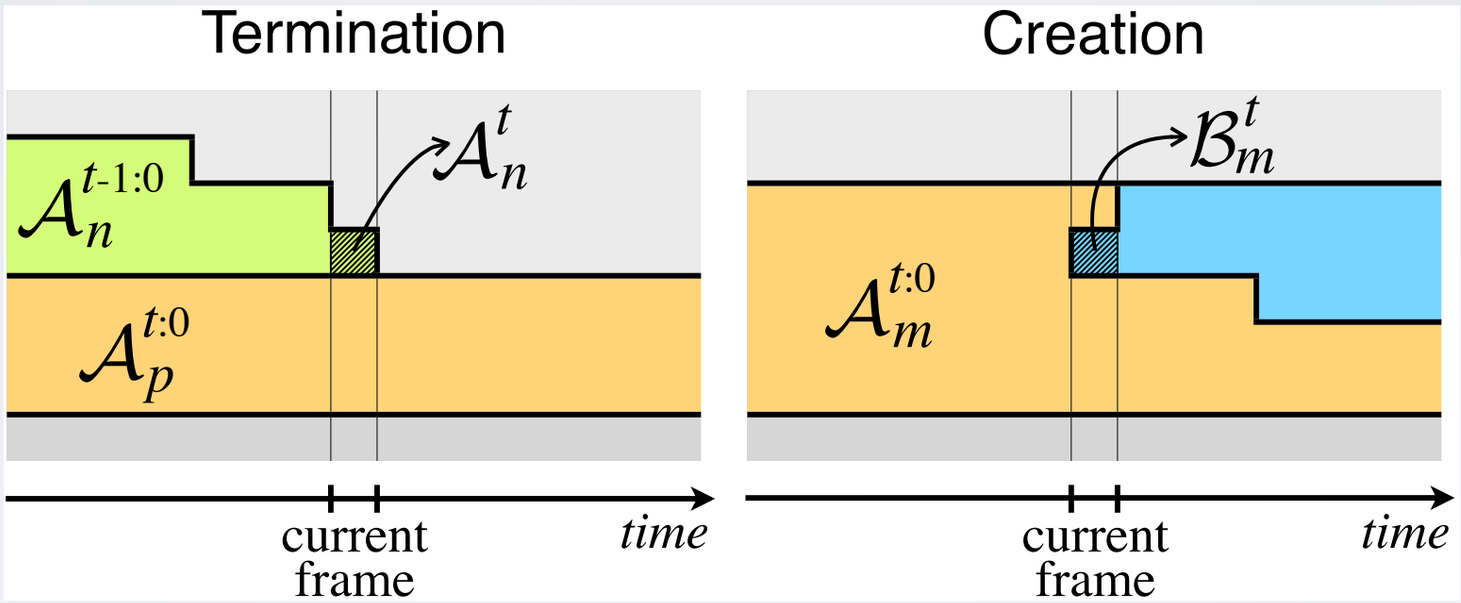
Video SEEDS


frame 0
frame 1
frame 2
current frame
initialization
block-updates propagation
pixel-updates

Video SEEDS

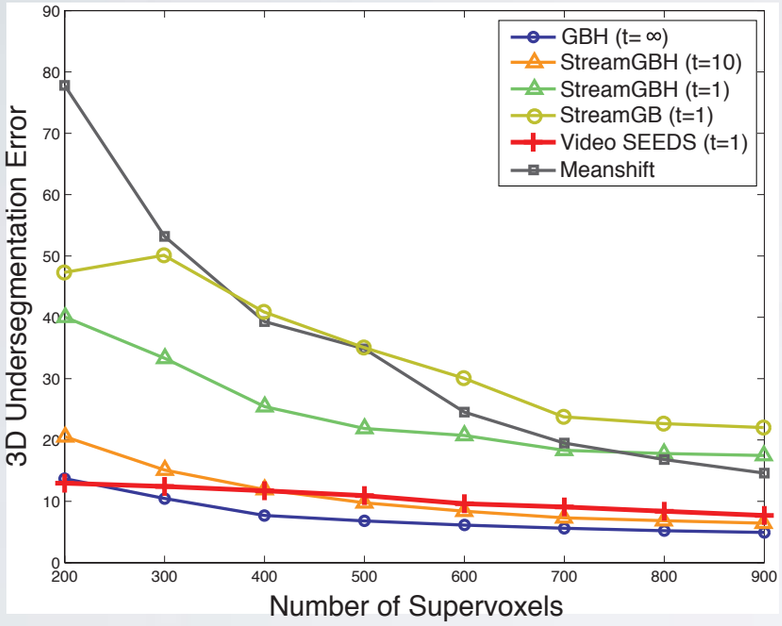

t = 0
initialization
layer 3 (*blocks*)
layer 2 (*blocks*)
layer 1 (*pixels*)
t = 1
initialization
layer 2 (*blocks*)
layer 1 (*pixels*)

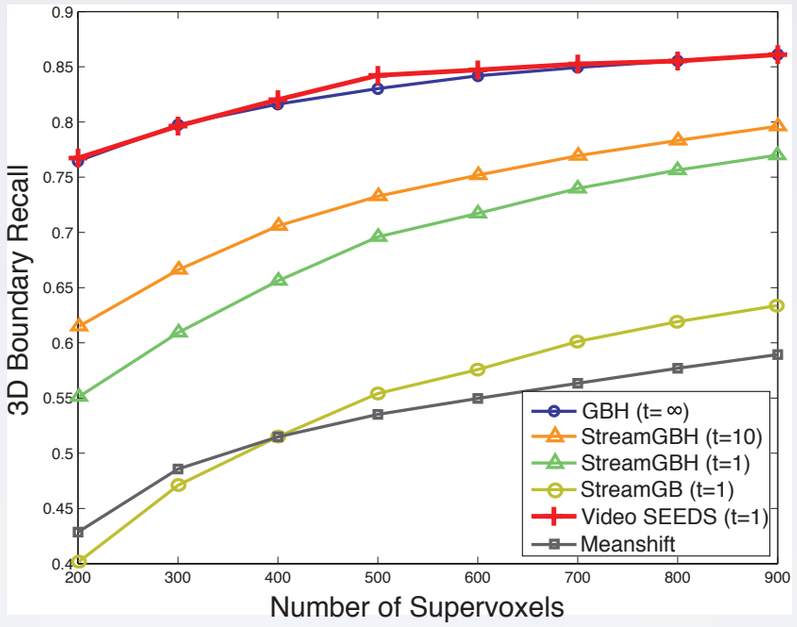
Video SEEDS

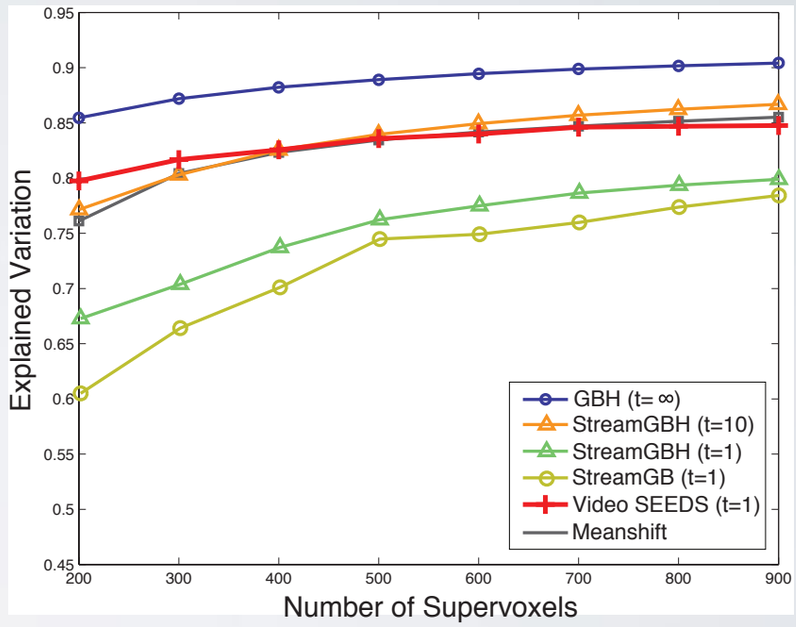


- superpixels per frame
- superpixel rate (time)

Video SEEDS







- Chen Xiph.org benchmark
- **t=∞** means the entire video is analyzed
- **t=1** means it is online (not streaming)
- we are at 30Hz, they are at 0.25 Hz

SEEDS in OpenCV

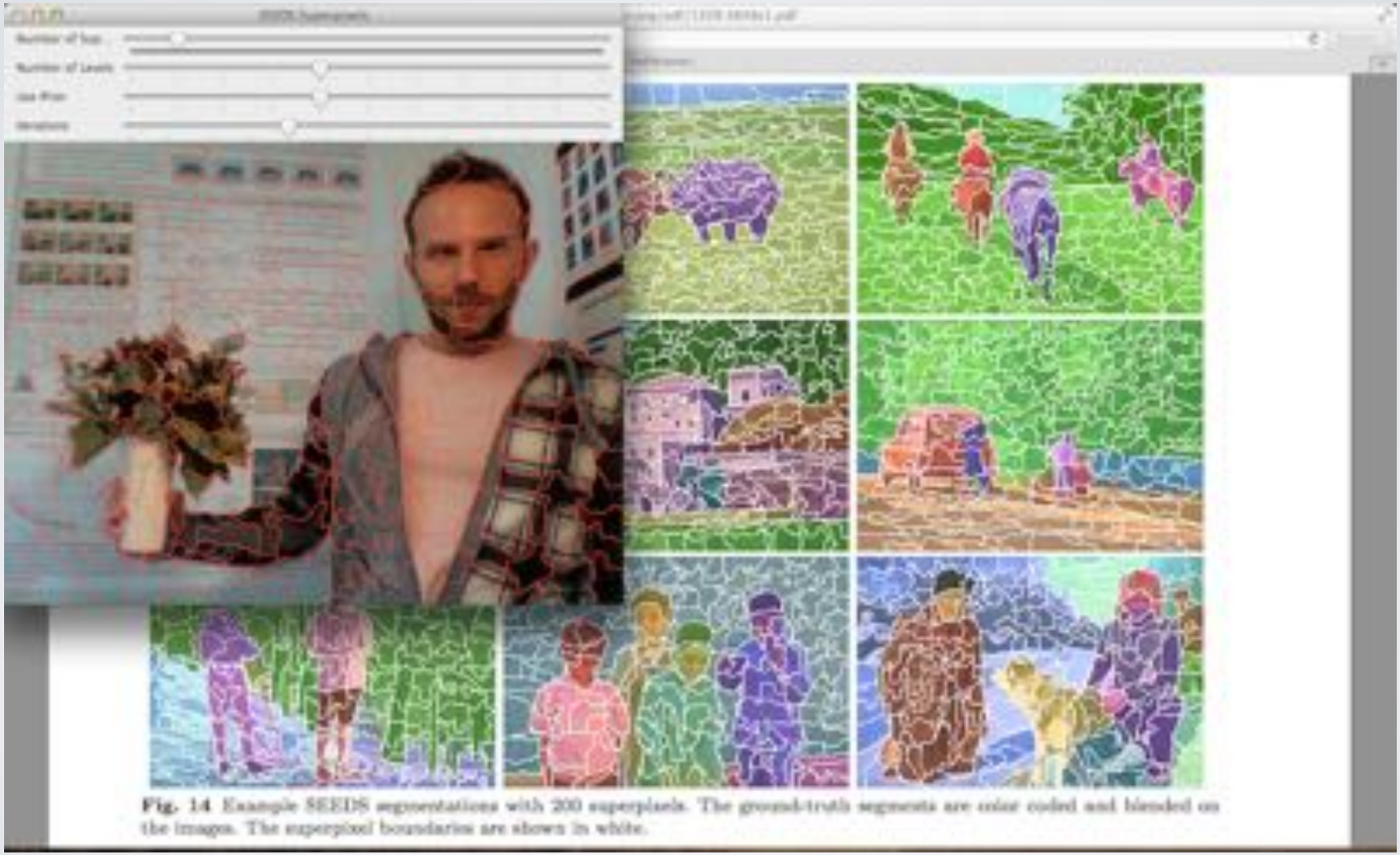
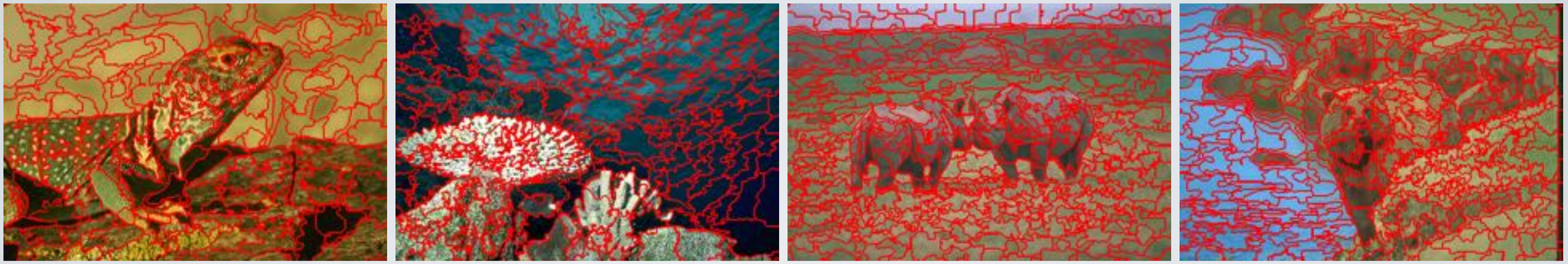
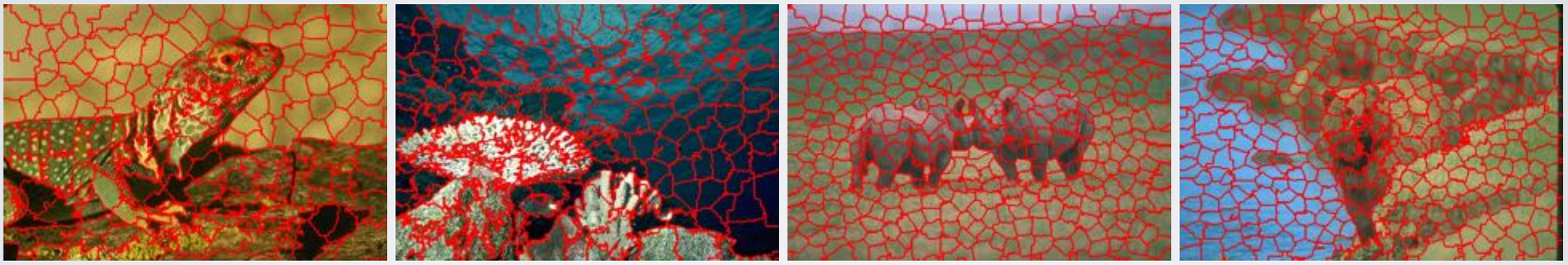


Fig. 14 Example SEEDS segmentations with 200 superpixels. The ground-truth segments are color coded and blended on the images. The superpixel boundaries are shown in white.

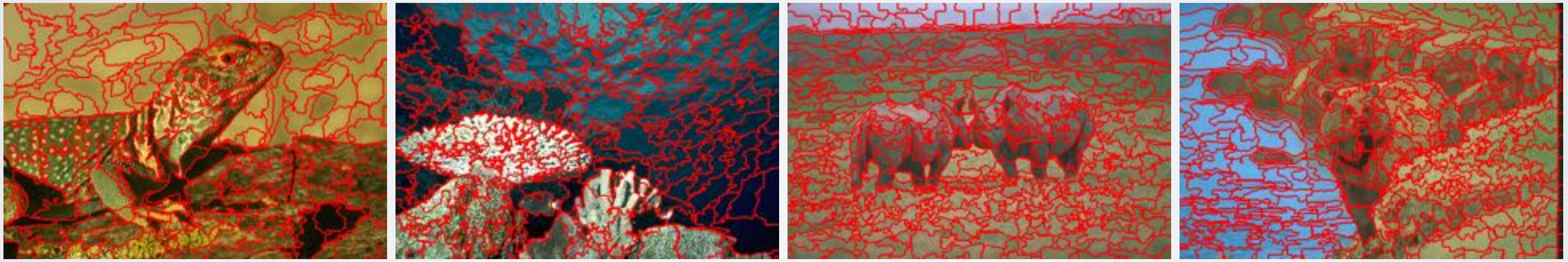
Randomized SEEDS



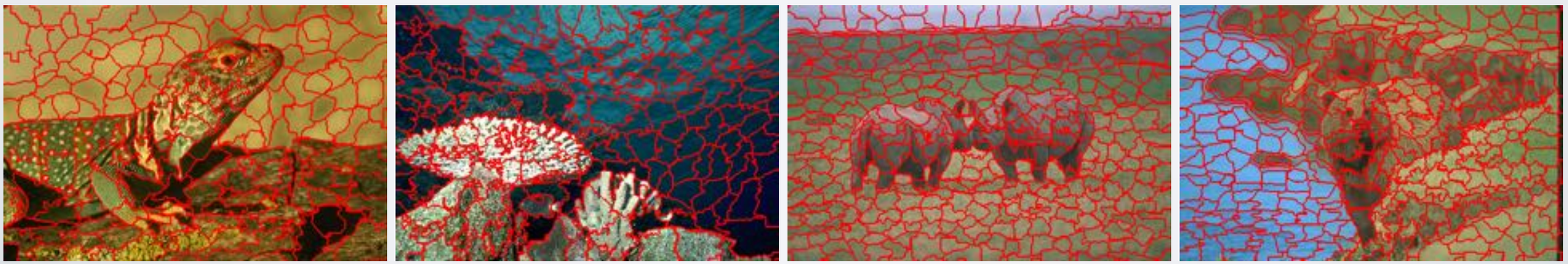
(b) SEEDS with 3×3 smoothing prior



(b) SEEDS with compactness prior



(b) SEEDS with edge prior (snap to edges)



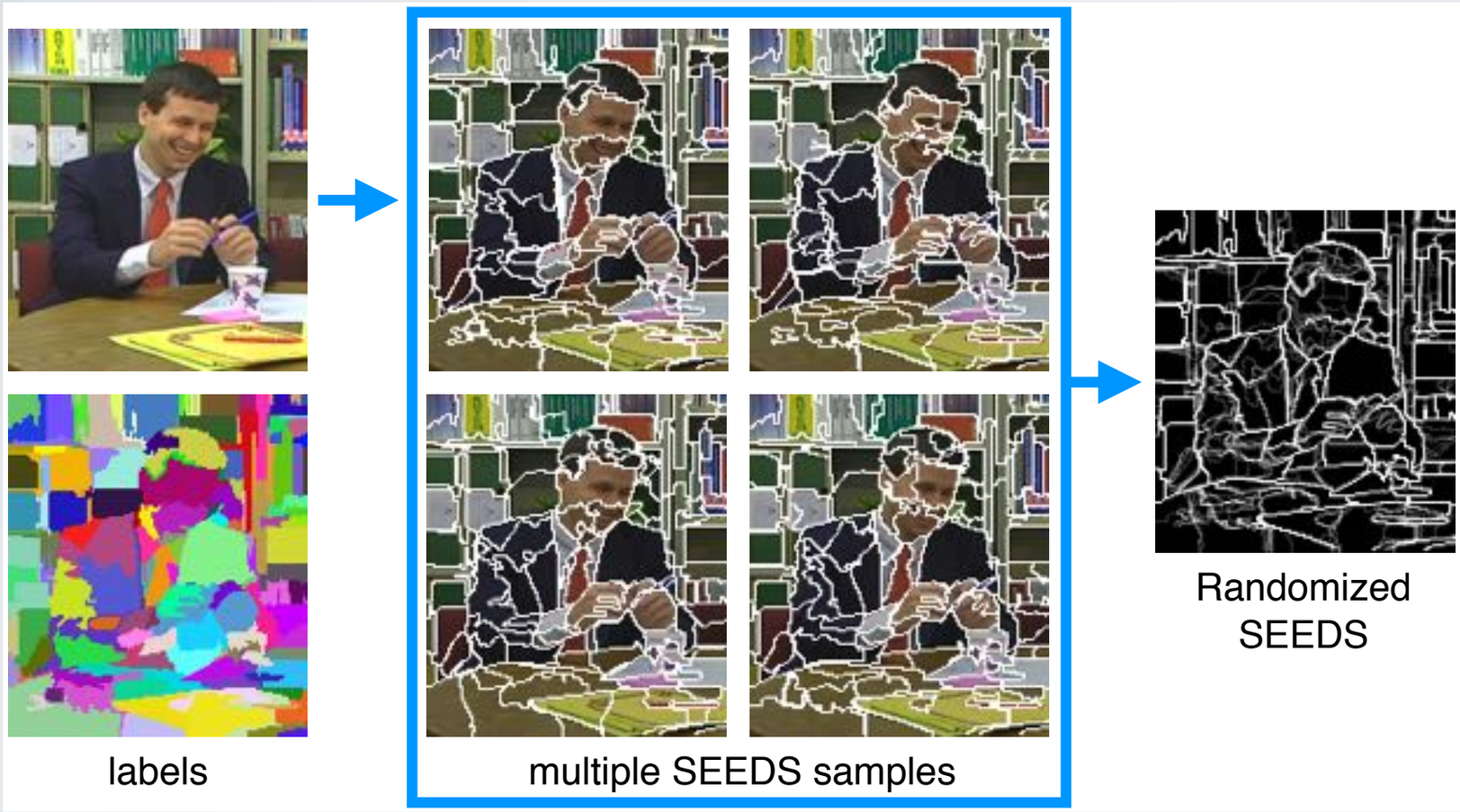
(b) SEEDS with combined prior (3×3 smoothing + compactness + snap to edges)

Randomness Injection

labels

multiple SEEDS samples

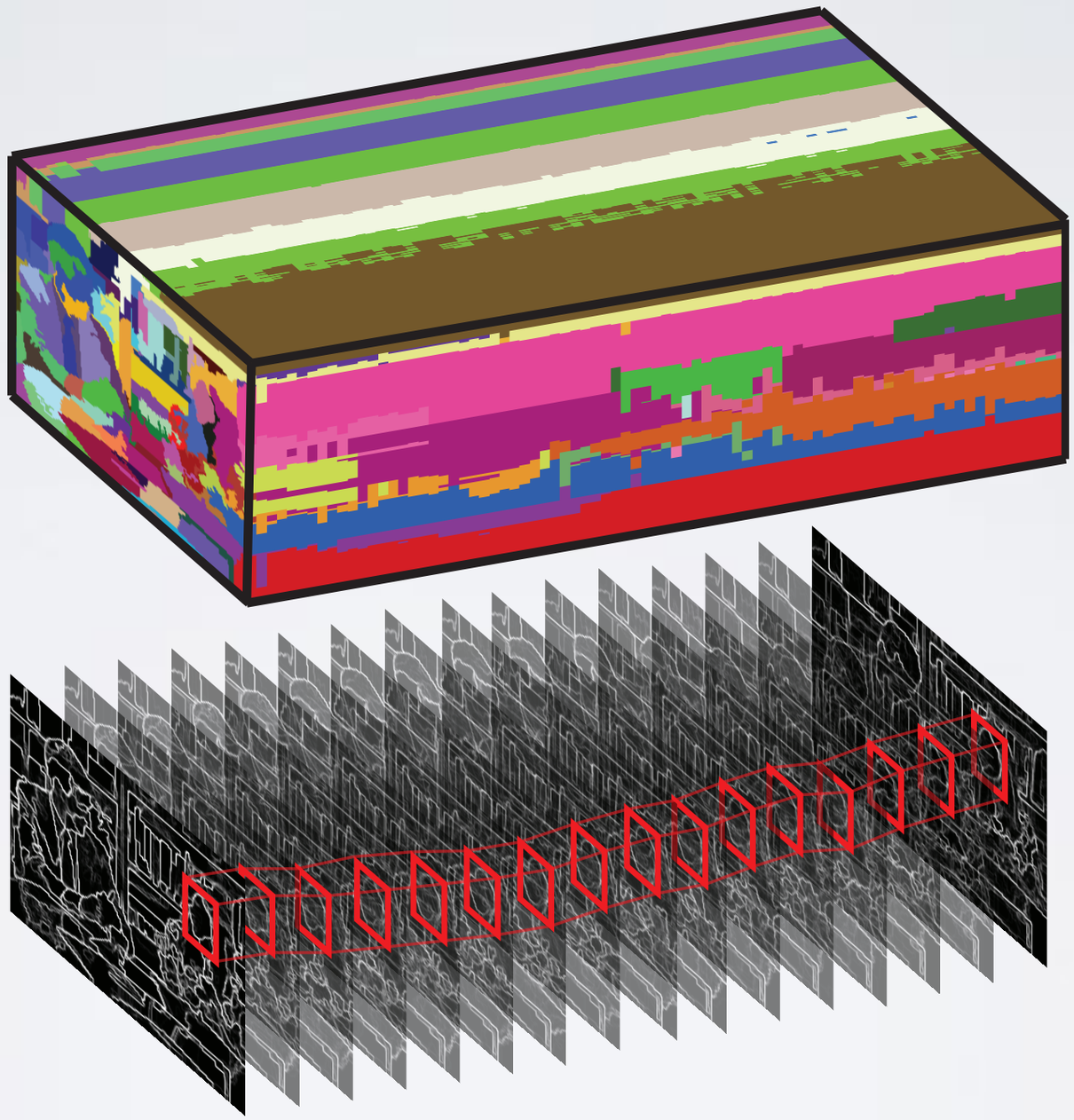
Randomized SEEDS



Temporal Video Objectness

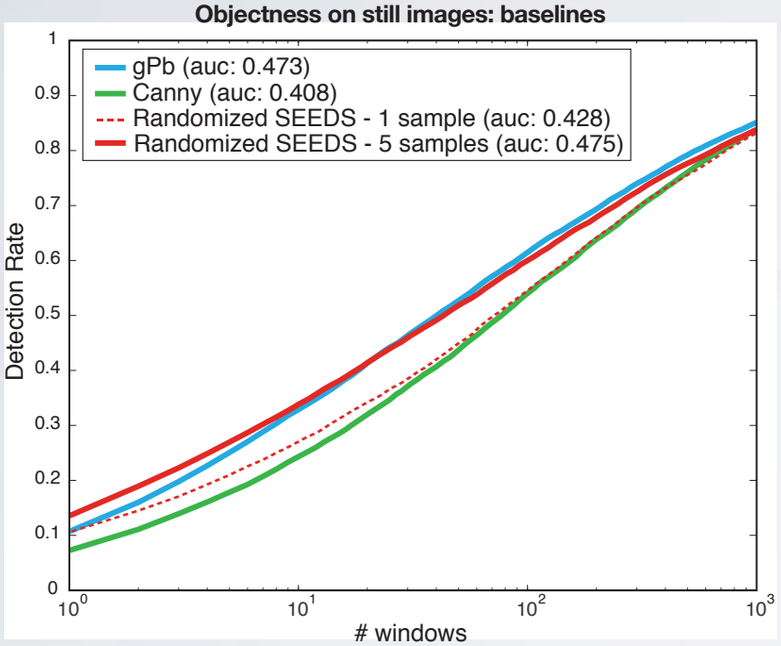
Temporal Video Objectness

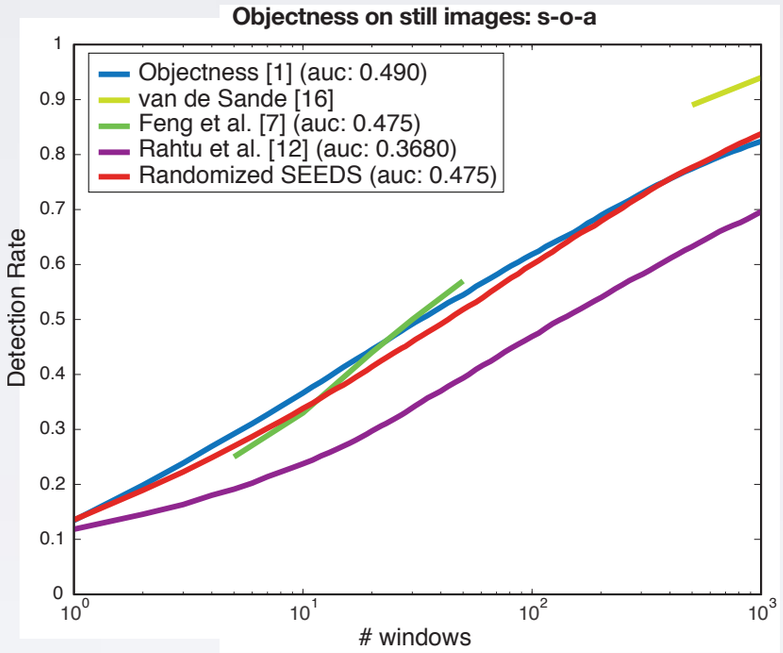
Tubes of Bounding Boxes

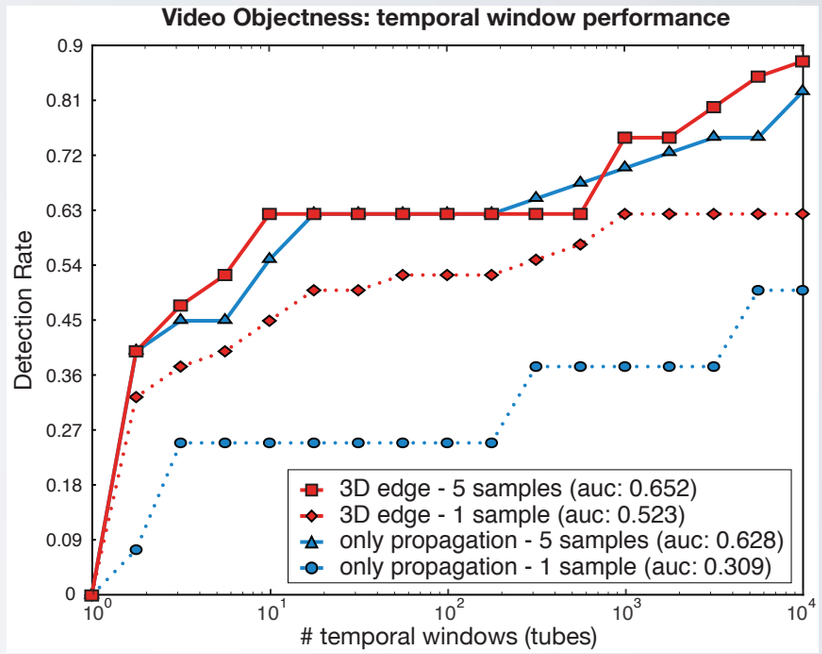


Tubes of Bounding Boxes

Temporal Video Objectness (SEEDS)







Thank You.