



Image Segmentation for Improved Lossless Screen Content Compression

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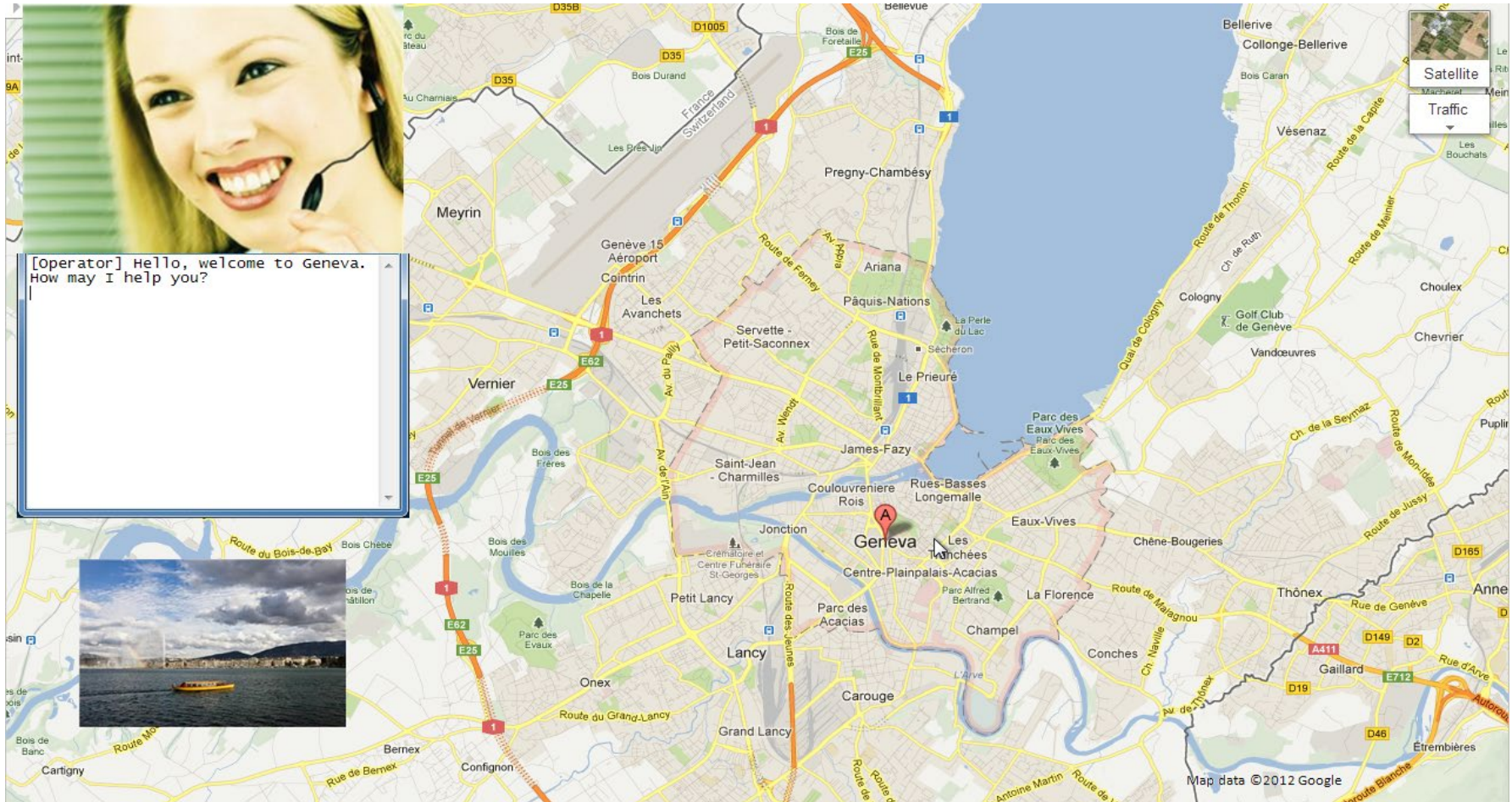
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Introduction

- What are SCI's?
- SCIs comprise of synthetic and natural content (Compound)
- Synthetic – limited colours and repeating patterns
- Natural – many colours and random patterns
- Segmentation algorithm that identifies natural regions
- Two step processing of modelling and coding is performed

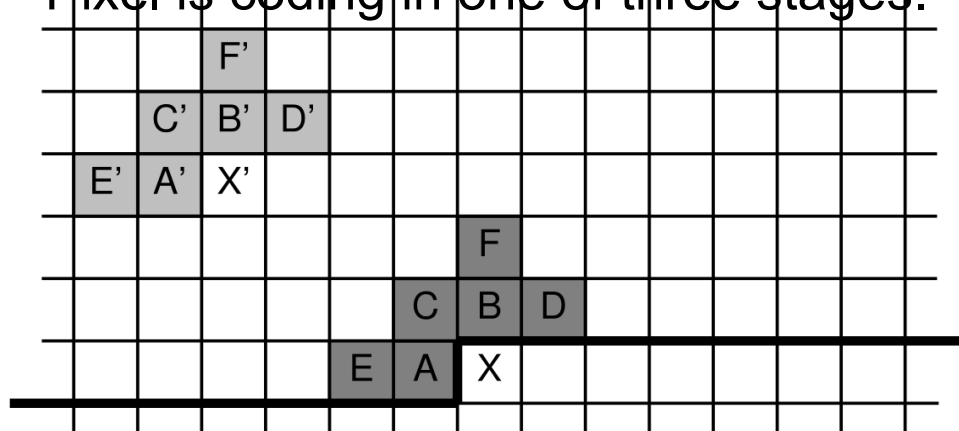
Introduction



Screen Content Image [6]

Soft Context Formation (SCF)

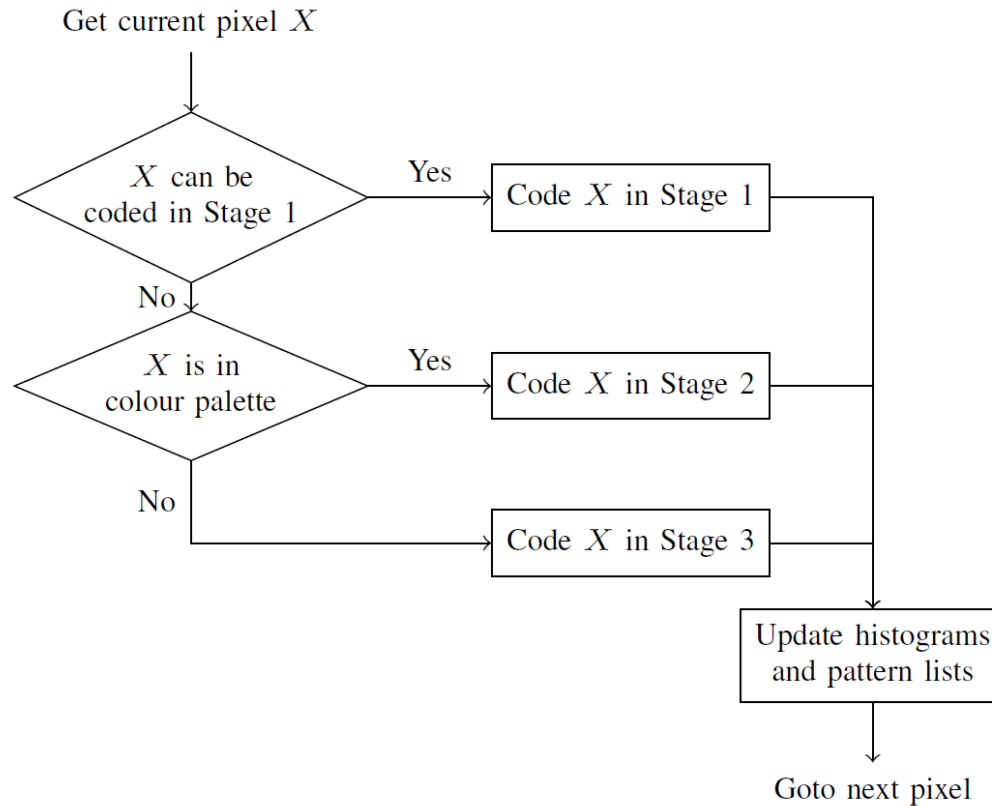
- SCF is the most recent and successful approach for lossless coding of SCI
- Probability distribution model, fully adaptive arithmetic coding
- Pattern list (6 neighbours) and global colour palette.
- A pattern comprises a template with the colours of the closest six causal neighbours with respect to the current pixel position.
- Global colour palette contains all seen colours and their counts.
- Pixel is coding in one of three stages.



X – Current pixel to encode
 X' – already encoded pixel

A, B, C,
 D, E, F – Neighbours

Soft Context Formation (SCF)

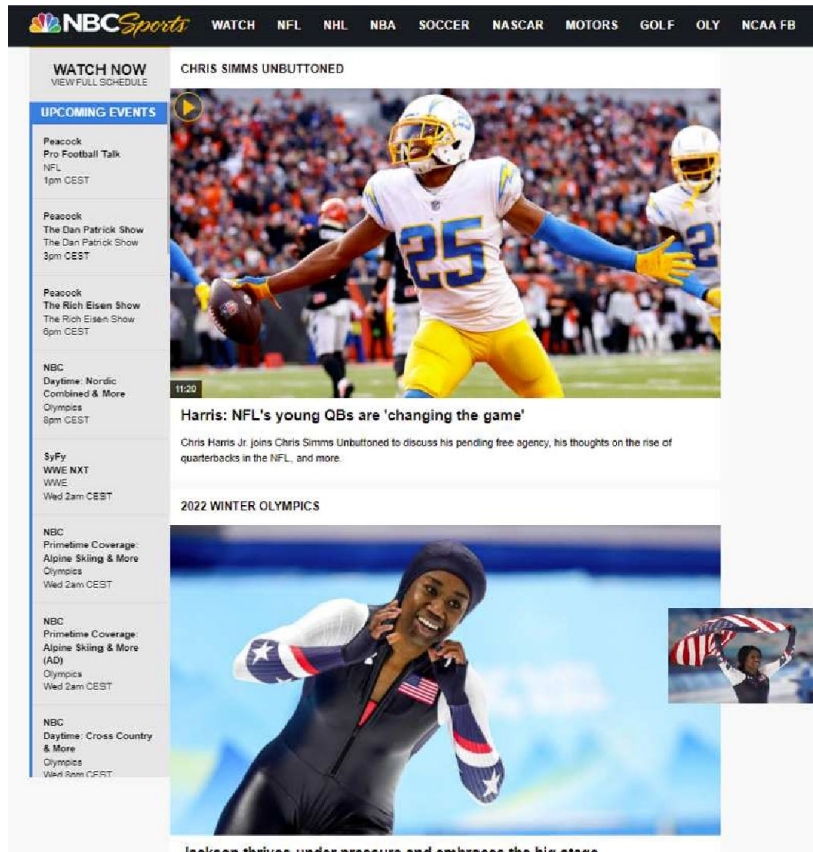


Coding Stages [3][4]

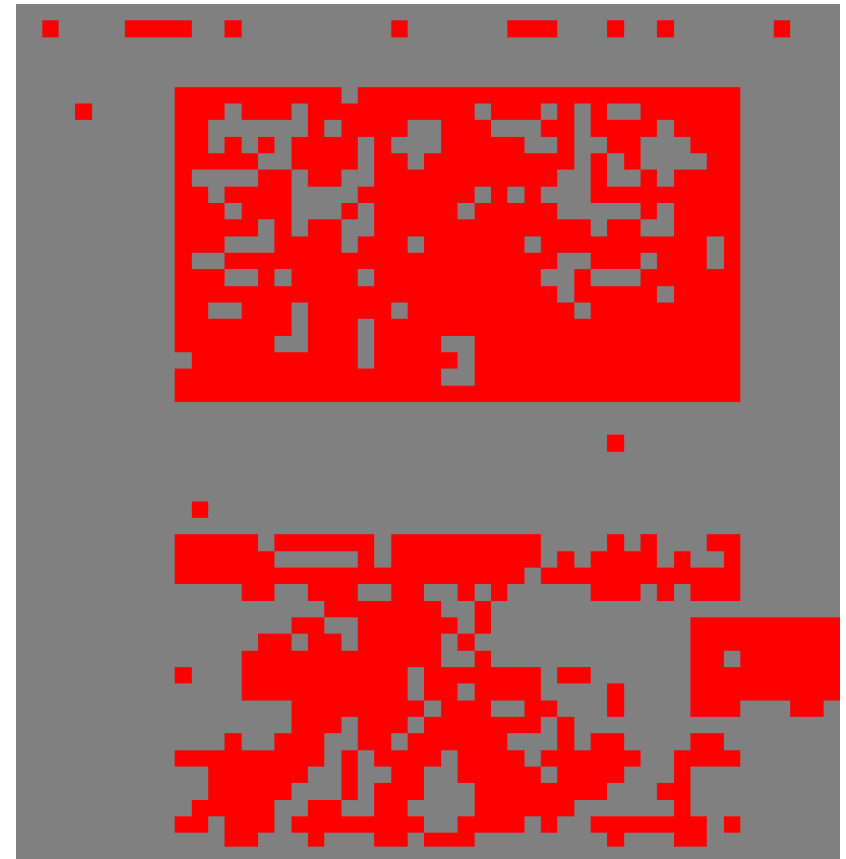
Segmentation – Introduction

- Compound SCIs make estimation of proper distributions difficult.
- Segmentation algorithm to detect and extract natural regions.
- Synthetic background and natural segments are coded separately.

Segmentation – Block Classification

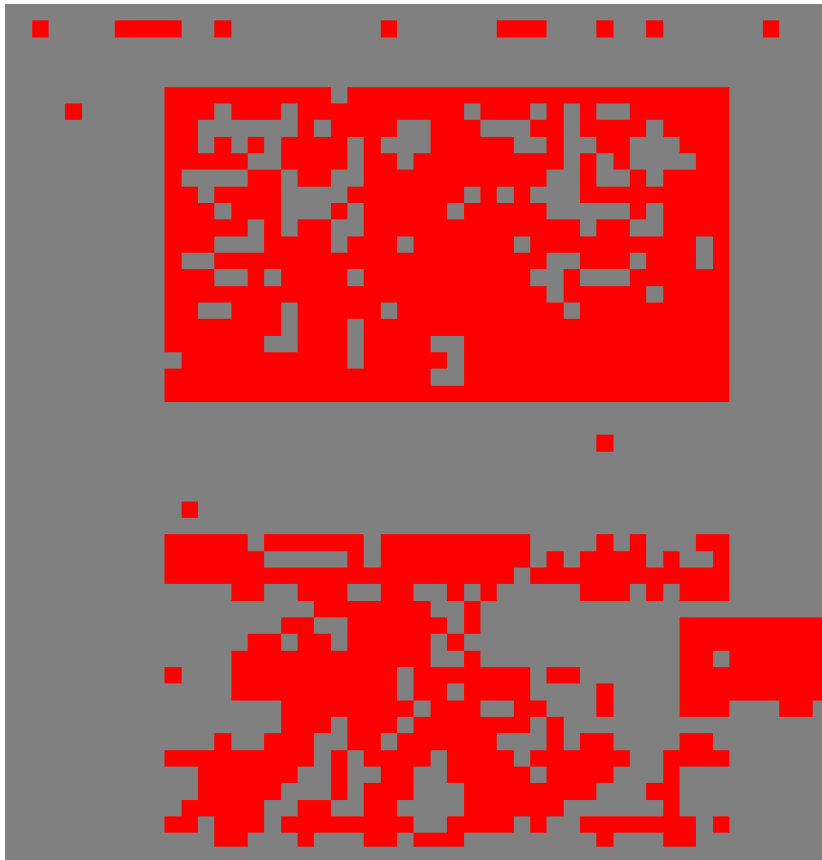


(I) Original image

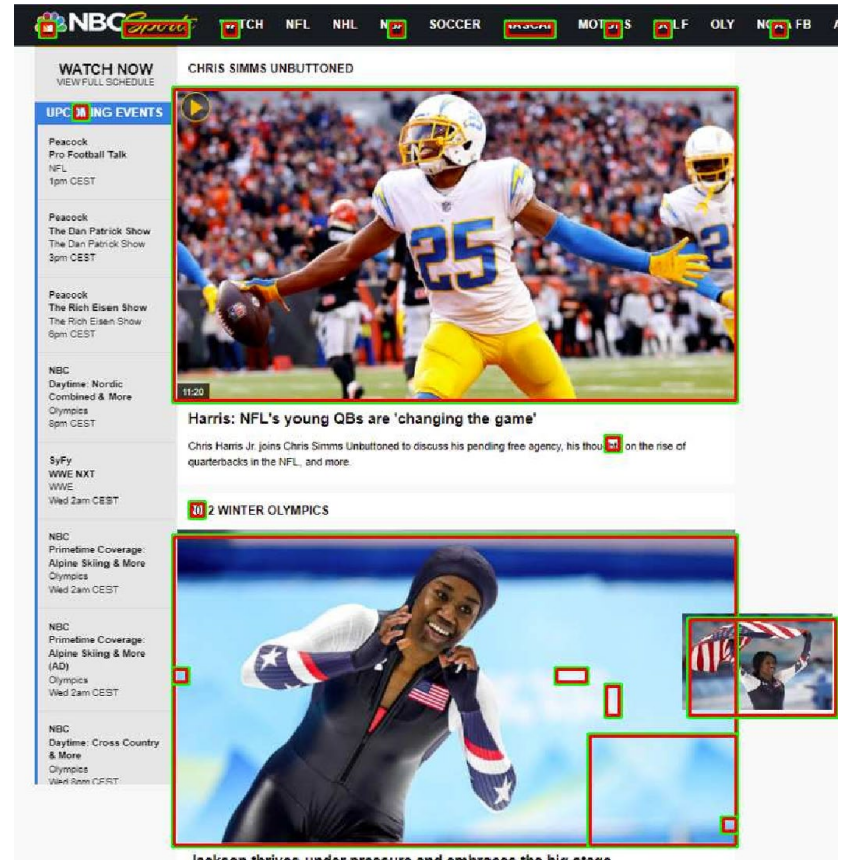


(II) Block classification

Segmentation – Initial bounding boxes



Block classification



Initial bounding boxes

Segmentation – Area threshold

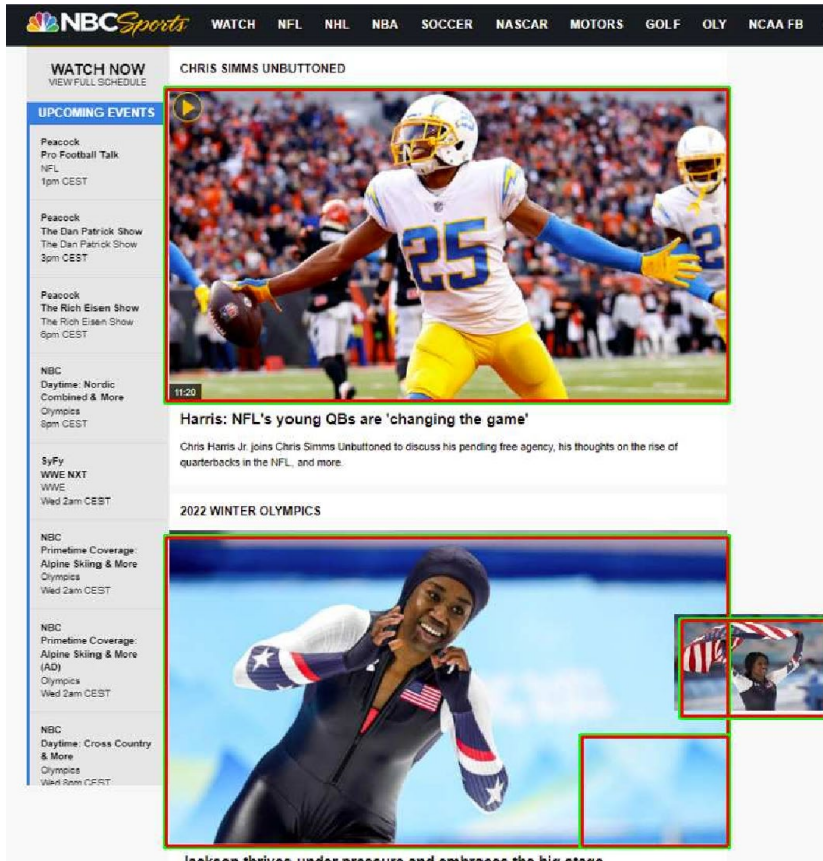
The screenshot shows the NBC Sports website interface. The main content area features a large image of a football player (Chris Harris Jr.) in a white jersey with the number 25, holding a football. Below this image is a headline: "Harris: NFL's young QBs are 'changing the game'" and a sub-headline: "Chris Harris Jr. joins Chris Simms Unbuttoned to discuss his pending free agency, his thoughts on the rise of quarterbacks in the NFL, and more." Below the main image is a smaller image of a female athlete (Lindsey Jackon) in a blue and white winter sports suit, with a small inset image of her waving an American flag. The website layout is segmented into several distinct blocks: a top navigation bar, a "WATCH NOW" section, a "UPCOMING EVENTS" sidebar, a main content area with a large image and text, a "2022 WINTER OLYMPICS" section, and a bottom image with text. The segmentation is performed using a block classification method, where the entire page is divided into rectangular regions based on content type.

(II) Block classification

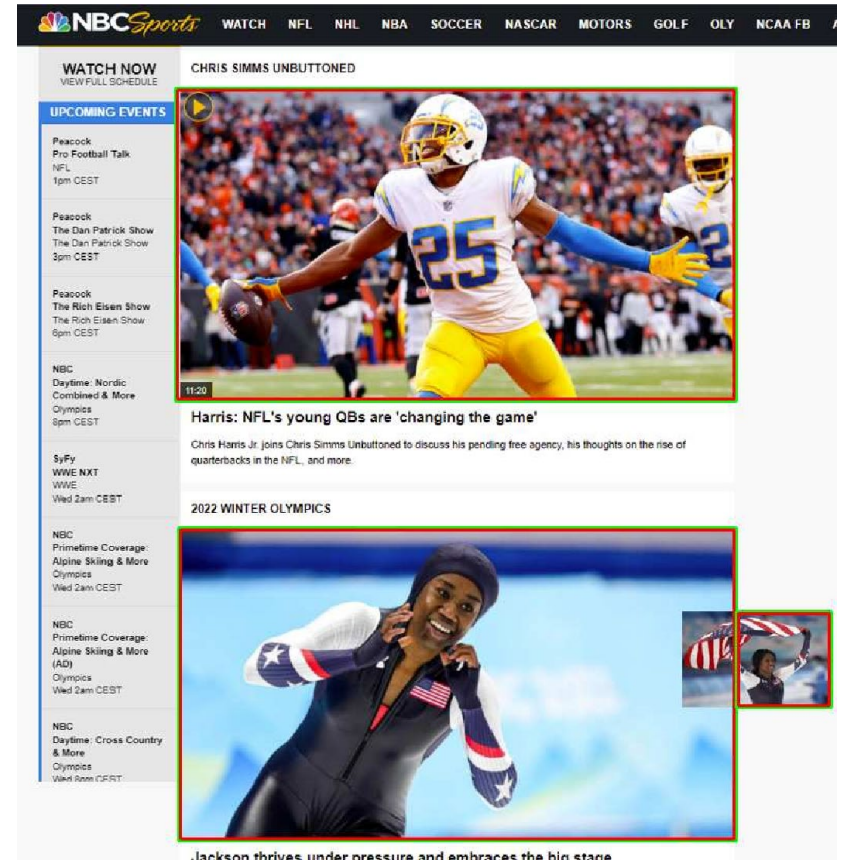
The screenshot shows the same NBC Sports website interface as in the previous image. However, the segmentation is performed using an area threshold method. This results in a different set of rectangular regions. The main content area (the football player image and text) is segmented into a single large block. The sidebar and navigation elements are segmented into smaller, more irregular blocks. The bottom image and text are also segmented into a single block. The area threshold method focuses on identifying large, contiguous regions of similar content, resulting in fewer and more irregular segments compared to block classification.

(III) Area threshold

Segmentation – Bounding box refinements (Overlap)

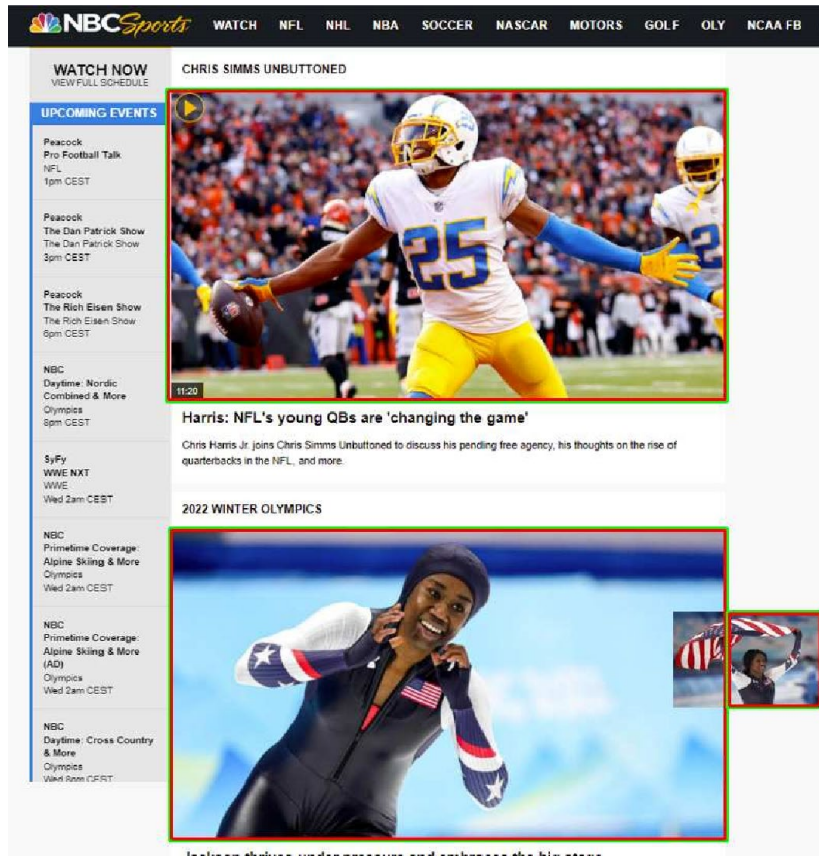


(III) Area threshold



(IVa) Remove overlap

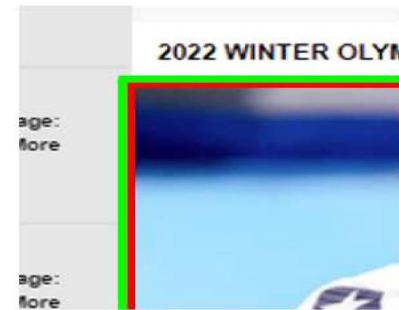
Segmentation – Bounding box refinements



(IVb) Border refinement



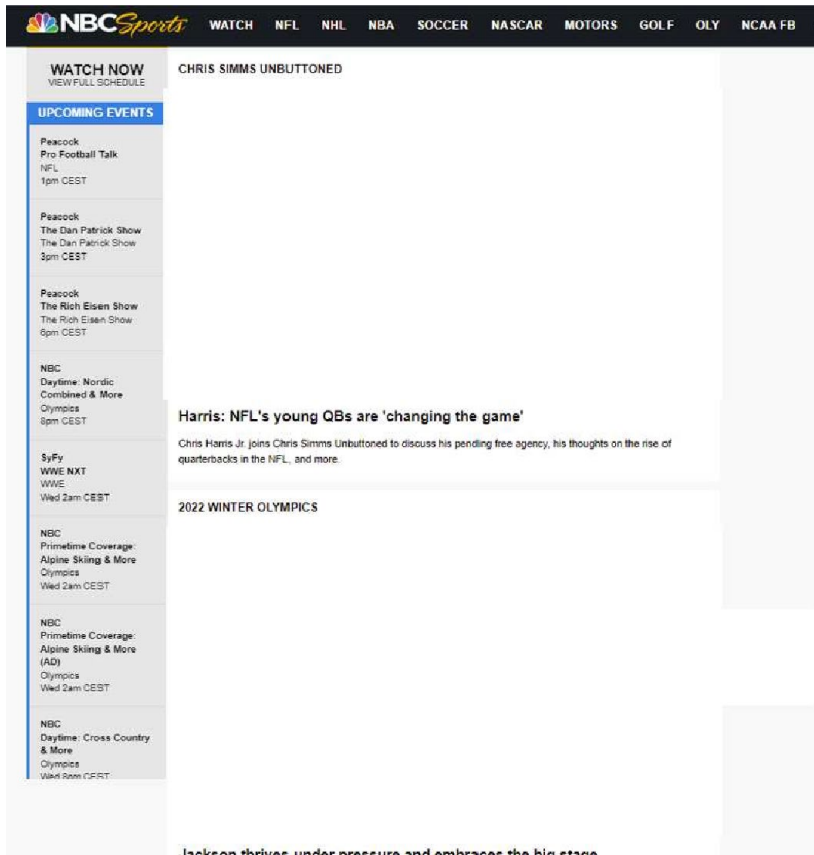
Before



After

(IVc) Enlarged parts

Segmentation – Synthetic and Natural Regions



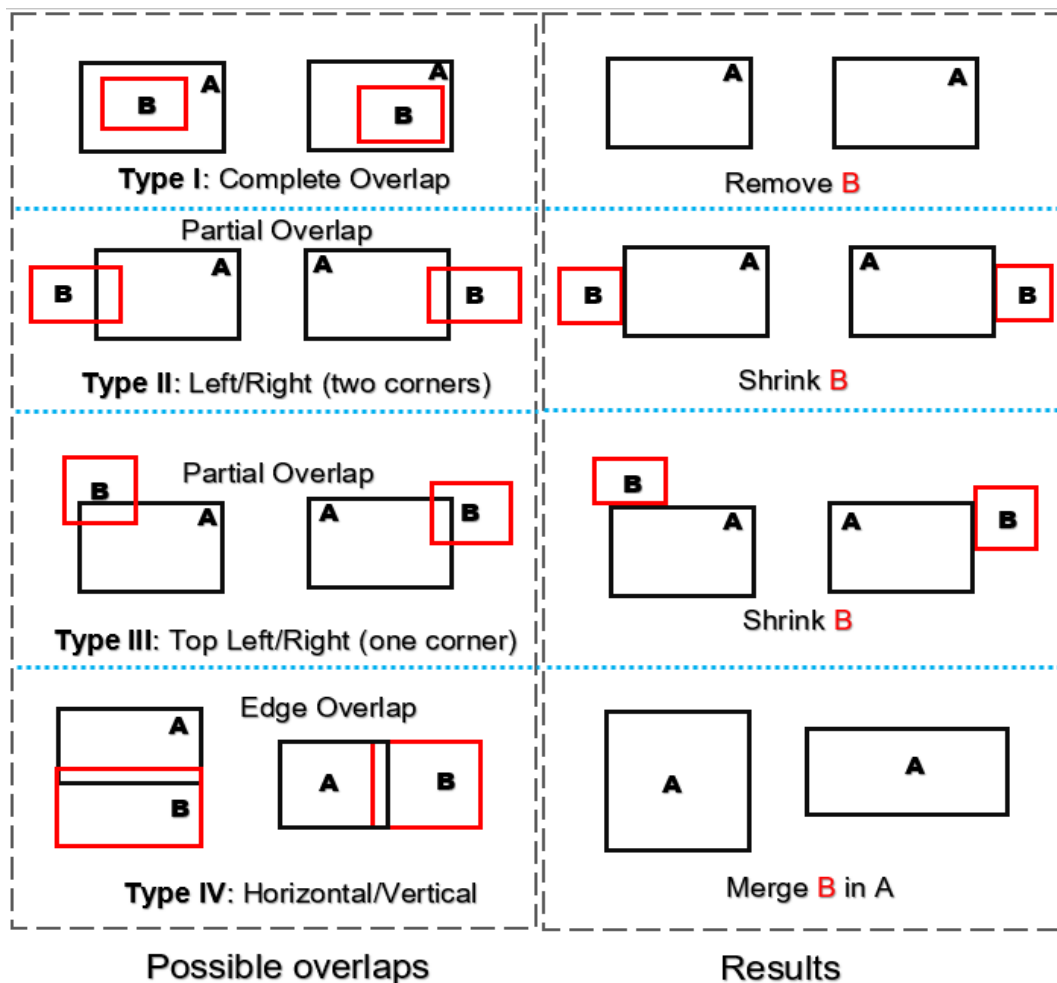
(V) Background image
(Synthetic)



(V) Segment image
(Natural)

Segmentation – Overlap removal

- Always retains the larger bounding box.
- Remove “**B**” in case of complete overlap.
- Shrink “**B**” in case of partial overlap.
- Merge “**B**” in case of edge overlap.
- Avoid unnecessary transmission of bounding boxes.



Segmentation – Encoding/Decoding

- Two step processing of modelling and coding is performed.
- At least one natural segment should be found.
- The decoder is made aware of the following:
 - **Segmentation flag is signalled (1 bit)**
 - **Bounding box co-ordinates are transmitted (40 bits\bounding box)**
 - **Top colour is transmitted (26 bits)**
- Background image and segment image are encoded/decoded separately.
- After decoding, the natural segments are stitched back into the background image.

Evaluation

- Proposed SCF version is compared to HEVC and previous version of SCF.
- Investigated a collection of 306 (6 testsets) SCI's.
- The proposed version identifies 76 images with synthetic background and at least one natural segments
- The other images are fully natural or fully synthetic or natural background images with synthetic segments
- Compared to HEVC, previous SCF version achieves 11% bit-rate savings on average
- Segmentation approach marginally improves (0.4%) w.r.t previous SCF version
- Test sets are available at [5],[6],[7],[8],[9] and [10]

Evaluation

	No. of Images	HM-16.21 SCM-8.8 [1][2]	Previous SCF [3]	Proposed SCF
Entire set Percentage	306	45966722 bytes 111.01%	41486484 bytes 100.19%	41408200 bytes 100.00%
Sub-set Percentage	76	20872931 bytes 107.03%	19583094 bytes 100.42%	19500950 bytes 100%

Comparison of the compression performances of proposed method (SCF) with HEVC (HM-16.21+SCM-8.8) and previous version of SCF.

Conclusion

- Coding synthetic and natural regions separately helps in better estimation of probability models
- Segmentation approach - Proof of concept
- The current version only detects natural segments within synthetic background images
- In future work, we would like to extend our approach to segment synthetic regions from natural background images
- At least a third class should be considered representing rendered images that are computer generated but still contain a very high number of colours
- Extend the segmentation algorithm to deal with other shapes than rectangles\squares

References

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Thank you
Questions?

