CNN Quadtree Depth Decision Prediction for Block Partitioning in HEVC Intra-Mode

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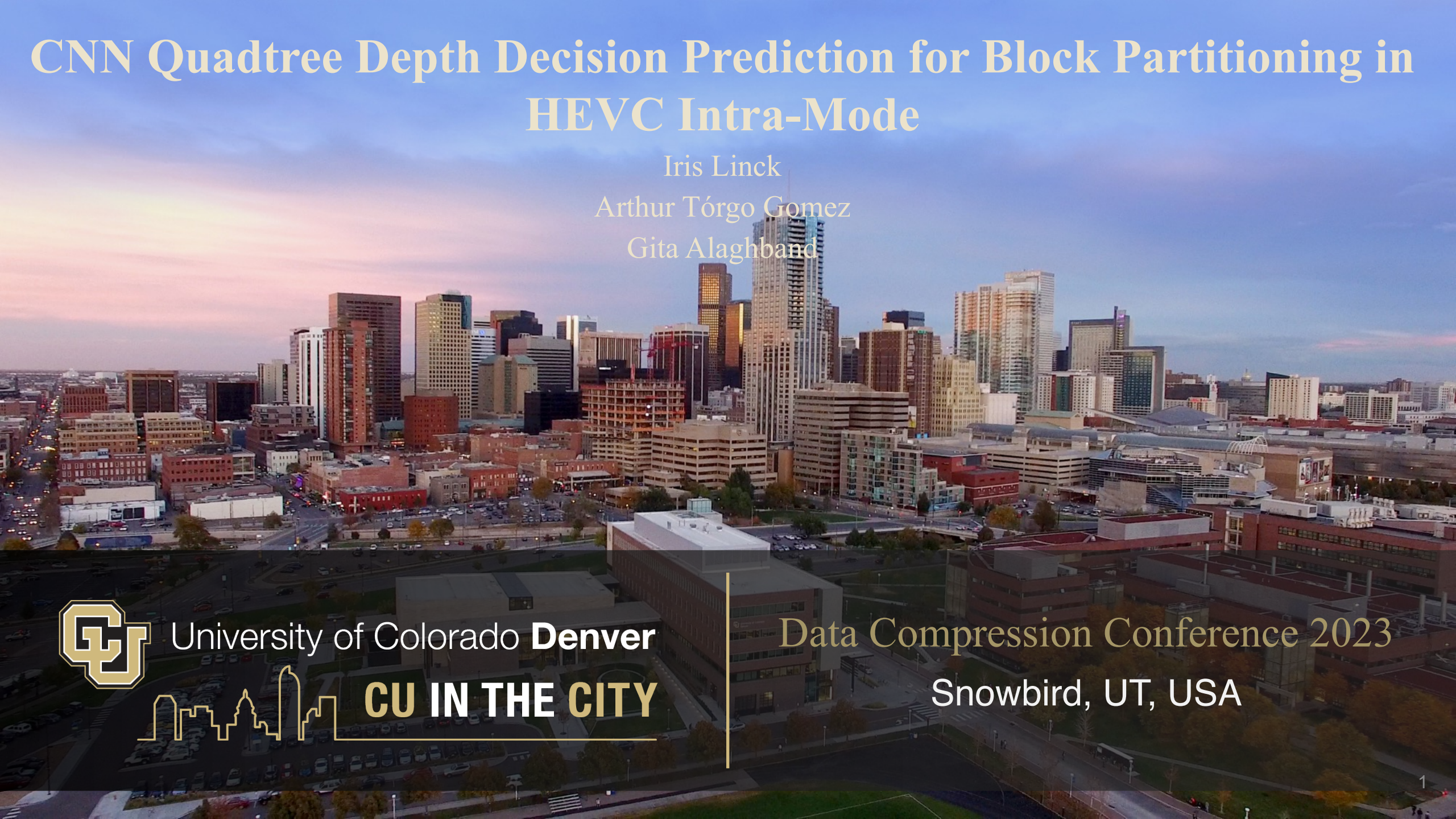

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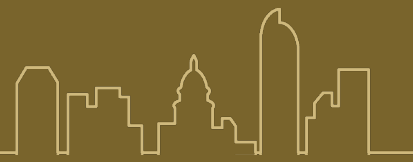
Agenda



- Introduction
- Motivation
- CNN architecture based on VGGNet
- Results
- Conclusion

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Introduction

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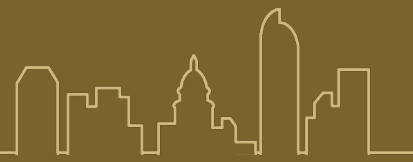

- High Efficient Video coding (HEVC/H265) [1] improved compression rate around 40-50% bit rate reduction in comparison to its antecessor H.264/AVC.
- The high compression improvement of HEVC is mostly due to the new quad-tree partitioning of coding tree unit (CTU) at the expense of increasing coding complexity.
- We propose three CNNs based on VGGNet to predict quadtree levels for CTUs in Intra-Mode to reduce code complexity in HEVC.

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MOTIVATION

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- Quad-tree seems to be a tendency in the next generations of video coding, and it was introduced for the first time in HEVC.
- An example of this tendency is showed in the new standard and a successor to HEVC, called Versatile Video Coding (VVC) [2] finalized in 2020, which inherits the Quadtree (QT) partitioning structure from HEVC.
- In this scenario, algorithms to improve quadtree partition structure will benefit the next generations of video coding.

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CNN architecture based on VGGN

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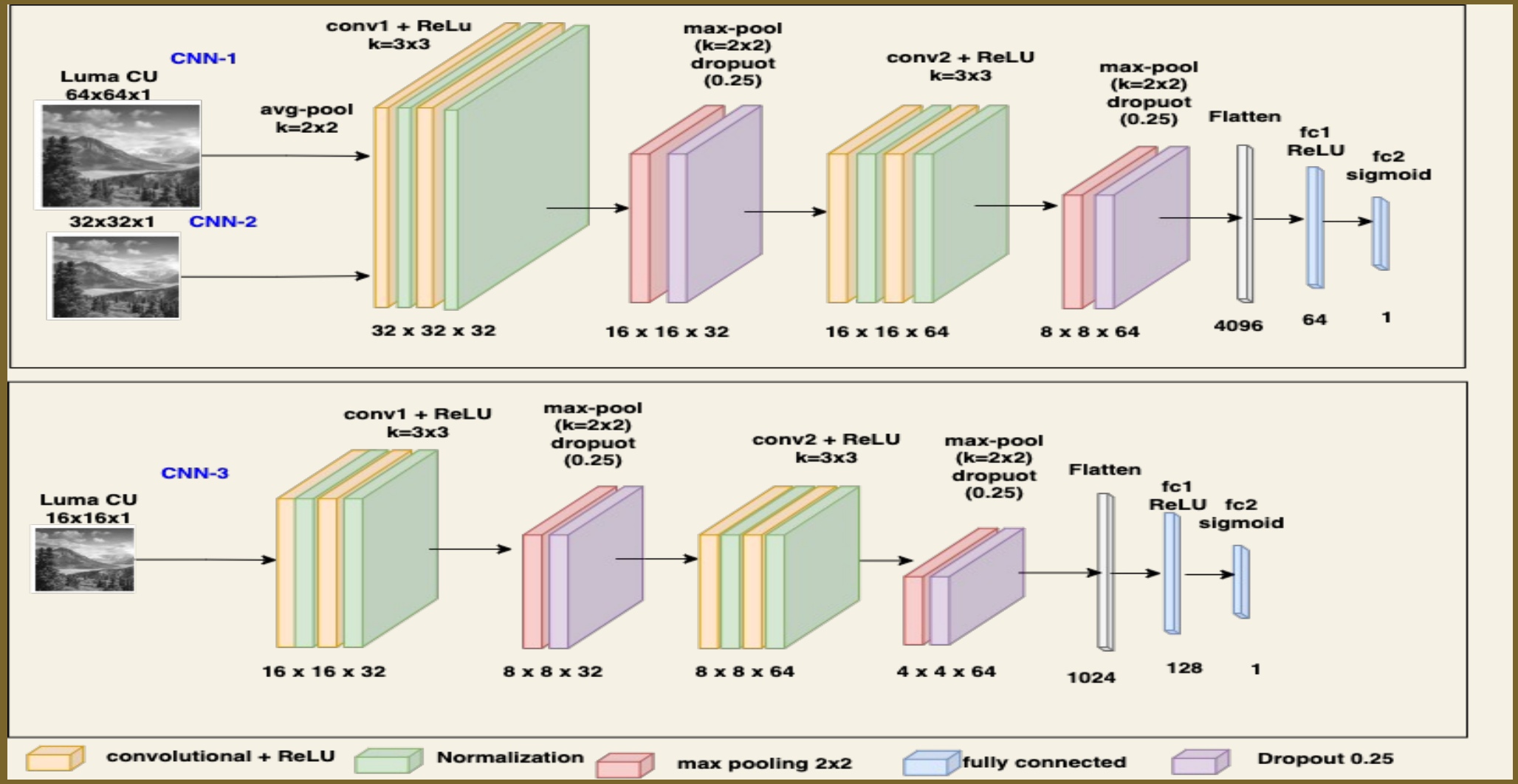
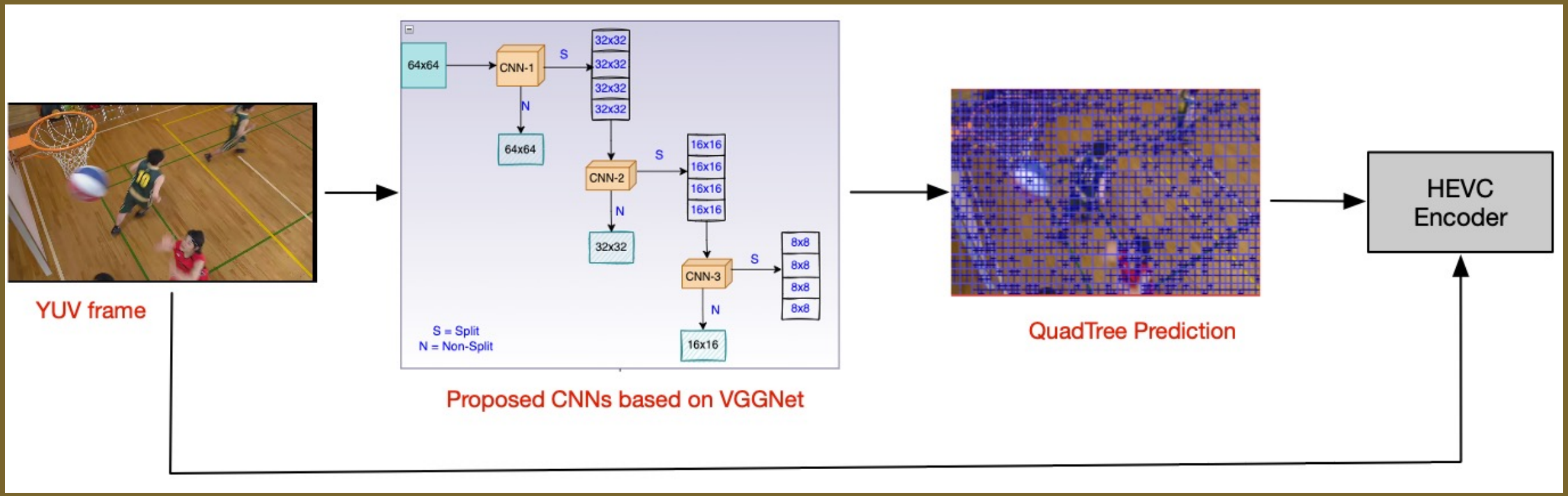


Architecture

- Dataset:
  - Each CNN has its own CU dataset with a specific size encoded with a specific QP.
  - Each dataset is composed by CU blocks from frames of videos with different resolutions.
- CNN Model:
  - CNN-1 applies avg pool to the input CU_{64x64}
  - The models use binary cross entropy with Adam optimizer.
  - The conv layers use ReLU
  - The output layer is activated with sigmoid function

CNN prediction integrated to HEVC



Configuration:

- HM-16.5, which uses all-intra main configuration with QP value set to 32 and applied to videos of classes B, C and E.
- The complete quadtree prediction for each frame is generated and sent to HEVC as a text file.
- A threshold of 0.5 is applied to decide if a block may or may not split.

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Results

Results

Test Sequence		Ref. [7]		Ref.[8]		Ref. [5]		Proposed	
		BD-rate (%)	TS (%)	BD-rate (%)	TS (%)	BD-rate (%)	TS (%)	BD-rate (%)	TS (%)
Class B 1920 x 1080	Kimono	1.73	78.40	1.93	69.20	1.49	59.53	0.95	84.67
	ParkScene	1.70	64.80	2.06	58.90	1.47	63.25	0.09	80.08
	Cactus	1.90	63.80	2.18	59.40	2.07	61.56	-1.22	77.69
	BQTerrace	1.90	57.20	1.48	63.30	1.09	67.97	1.21	72.42
	BaskballDrive	2.82	68.70	3.58	65.10	2.26	60.18	1.04	81.41
Class C 832x480	BaskballDrill	2.41	53.30	2.35	59.60	2.80	62.11	1.35	66.65
	BQMall	1.65	54.00	1.15	55.00	2.09	54.50	0.54	66.44
	RaceHorses	1.52	56.20	1.43	61.00	1.97	48.65	1.54	63.66
	PartyScene	0.49	41.40	1.07	57.20	1.01	49.00	-0.38	50.75
Class E 1280 x 720	FourPeople	2.71	65.00	3.51	65.70	1.83	67.89	0.89	78.49
	Johnny	3.16	72.20	3.42	66.30	1.69	71.34	4.71	83.56
	Kristen&Sara	2.68	71.4	2.91	69.5	1.55	72.19	2.49	78.52
Classes B, C, E Average		**2.06**	**62.20**	**2.26**	**62.52**	**1.78**	**61.51**	**1.10**	**73.69**

Conclusion

Conclusion

- Our method reduces the encoding time by 73.69% on average at the cost of 1.10% BD-rate increase and no significant loss in PSNR compared with HM16.5 reference software.
- On average, our proposed method outperformed the results presented by current machine learning approaches [3], [4] and [5], in terms of BD-BR and encoding time.

References

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