ON BITSTREAM FEATURES BASED PERCEPTUAL QUALITY ESTIMATION OF HEVC CODED VIDEOS
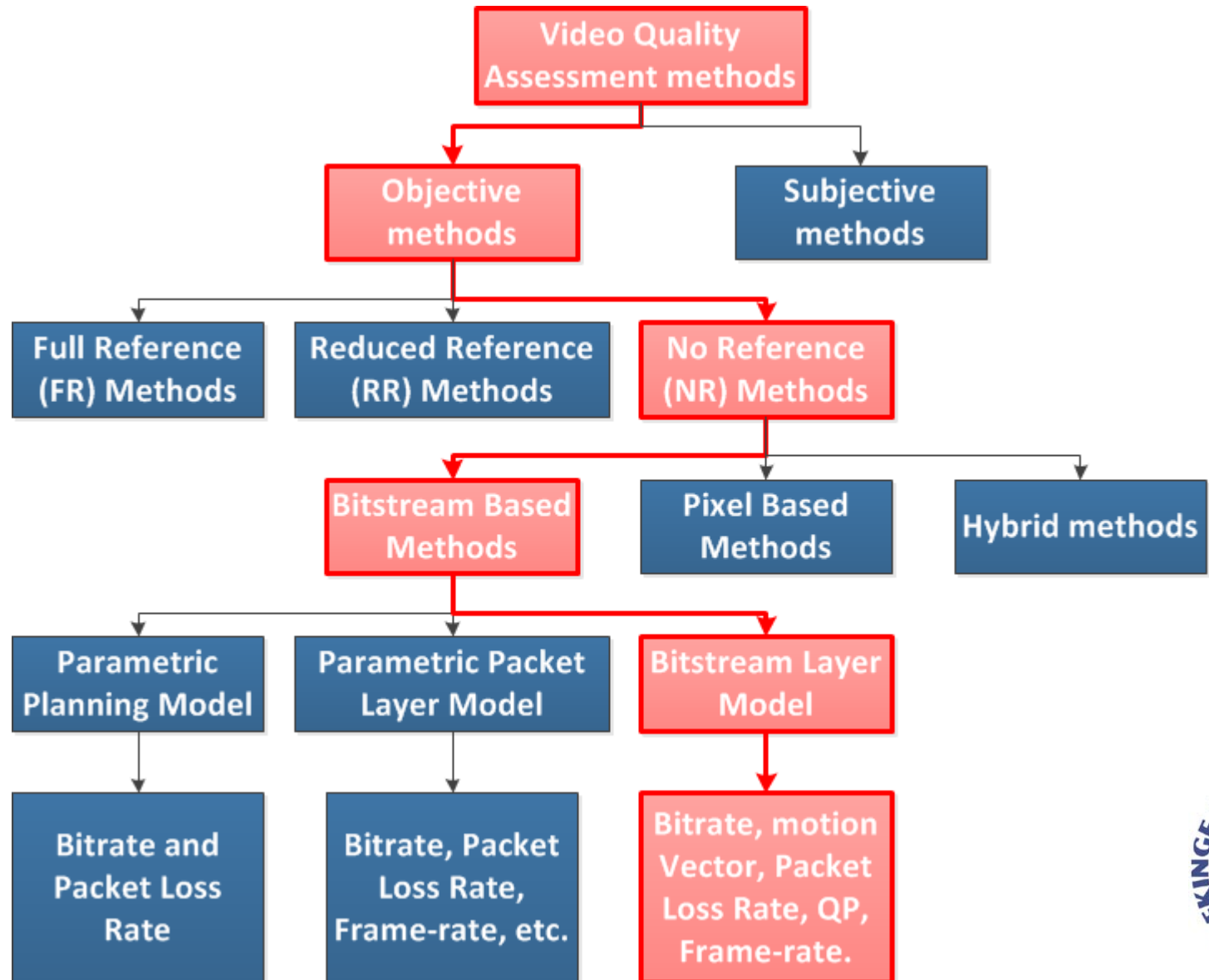
PRESENTER:

Muhammad Shahid

Collaborators: Marcus Barkowsky and Glen Van Wallendael

Video Quality Assessment

Project Outline

1. Deliberations on potential bitstream based features.

2. Extraction of the features from HEVC coded videos.

3. Designing ANN for quality prediction.

4. Analysis of the results.

SRCs

src01	*src02*	*src03*	*src04*	*src05*
- animation - zooming camera	- basketball match - still camera	- basketball training - moving camera	- walking animal - motion tracking camera	- lying animal - three zoom camera position
src06	*src07*	*src08*	*src09*	*src10*
- scene of toys - rotating camera	- people in laboratory - still camera (changing light)	- landscape scene - zooming camera	- 4 different scenes of animals in a zoo, separate videos - still camera	-scene of an escalator at the subway station - amateur video (shaking camera)

Test Stimuli

- **Encoded using HEVC (HM11.1), producing 59520 test videos**
- **560 considered for this pilot investigation**

Bitrate	500kbps, 1Mbps, 2Mbps, 4Mbps, 8Mbps, 16Mbps
Rate control	Picture adaptive, CU adaptive
QP	26, 32, 38, 46
GOP	1, 2, 4, 8
Intra period	8, 16, 32, 64
Random access	IDR (closed-GOP intra), CDR (open-GOP intra)
Resolution	1920x1080, 1280x720, 960x544
Slices	0, 2, 4, 1500byte

Video Quality Assessment Methods

In the project were used following VQA methods:

1. PVQM – *Perceptual Video Quality Metric*

2. VQM – *Video Quality Metric*

3. SSIM – *Single Scale Structural Similarity*

4. PSNR – *Peak Signal to Noise Ratio*

5. VIFP - *Visual Information Fidelity in Pixel Doma...*

Number	Feature	Remarks
1	number_of_Cus	The number of CUs a slice is divided into
2	INTRA[%]	Percentage of blocks coded as INTRA in a slice
3	2Nx2N_I[%]	Percentage of INTRA coded with partition 2Nx2N in a slice
4	NxN_I[%]	Percentage of INTRA coded with partition NxN in a slice
5	INTER_P[%]	Percentage of blocks coded as INTER P prediction in a slice
6	INTER_B[%]	Percentage of blocks coded as INTER B prediction in a slice
7	2Nx2N_P[%]	Percentage of INTER coded with partition 2Nx2N in a slice
8	2NxN_P[%]	Percentage of INTER coded with partition 2NxN in a slice
9	Nx2N_P[%]	Percentage of INTER coded with partition Nx2N in a slice
10	NxN_P[%]	Percentage of INTER coded with partition NxN in a slice
11	2NxnU_P[%]	Percentage of INTER coded with partition 2NxnU in a slice
12	2NxnD_P[%]	Percentage of INTER coded with partition 2NxnD in a slice
13	nLx2N_P[%]	Percentage of INTER coded with partition nLx2N in a slice
14	nRx2N_P[%]	Percentage of INTER coded with partition nRx2N in a slice
15	2Nx2N_B[%]	Percentage of INTER (B) coded with partition 2Nx2N in a slice
16	2NxN_B[%]	Percentage of INTER (B) coded with partition 2NxN in a slice
17	Nx2N_B[%]	Percentage of INTER (B) coded with partition Nx2N in a slice
18	NxN_B[%]	Percentage of INTER (B) coded with partition NxN in a slice
19	2NxnU_B[%]	Percentage of INTER (B) coded with partition 2NxnU in a slice
20	2NxnD_B[%]	Percentage of INTER (B) coded with partition 2NxnD in a slice
21	nLx2N_B[%]	Percentage of INTER (B) coded with partition nLx2N in a slice
22	nRx2N_B[%]	Percentage of INTER (B) coded with partition nRx2N in a slice
23	SKIP[%]	Percentage of blocks coded as SKIP in a slice

| 24	AvgMVx	Average value of MV in direction x in a slice
25	AvgMVy	Average value of MV in direction y in a slice
26	stdDevMVx	Standacrd Deviation of MVx in a slice
27	stdDevMVy	Standacrd Deviation of Mvy in a slice
28	VarMVx	Variance of MVx in a slice
29	VarMVY	Variance of MVy in a slice
30	AvgQP	Average value of QP in a slice
31	DevQP	Standacrd Deviation of QP in a slice
32	VarQP	Variance of QP in a slice
33	max_CU_size (8x8-64x64)	The maximum size of CU used in a slice (if the encoder evaluates only 16x16, probably a bad compression job is done)
34	min_CU_size (8x8-64x64)	The minimum CU size used in a slice
35	is_bipredictive	A binary value if a bipredictive coding is used or not in a slice
36	AvgQP_i	Average value of QP in an INTRA slice
37	DevQP_i	Standacrd Deviation of QP in an INTRA slice
38	VarQP_i	Variance of QP in an INTRA slice
39	AvgQP_p	Average value of QP in an inter (P or B) slice
40	DevQP_p	Standard Deviation of QP in an inter (P or B) slice
41	VarQP_p	Variance of QP in an inter (P or B) slice
42	AvgMVx_small_cu	Average value of MV in direction x in a slice for CUs of size equal or less than 16x16
43	AvgMVy_small_cu	Average value of MV in direction y in a slice for CUs of size equal or less than 16x16
44	stdDevMVx_small_cu	Standard Deviation of MVx in a slice for CUs of size equal or less than 16x16
45	stdDevMVy_small_cu	Standard Deviation of Mvy in a slice for CUs of size equal or less than 16x16
46	VarMVx_small_cu	Variance of MVx in a slice for CUs of size equal or less than 16x16
47	VarMVY_small_cu	Variance of MVy in a slice for CUs of size equal or less than 16x16

48	Slice/frame	Number of slices per frame (more slices decrease compression performance)
49	nr_ref_frames_used	number of reference frames actually used in a frame (an encoder capable of using more reference frames is probably better at compressing)
50	avg_QP	Average QP in a frame
51	avg_QP_Reference	Average value of the QPs of the frames used as reference picture
52	max_avg_QP_Reference	Maximum Average QP of the frames used as reference picture

Cross Validation

- 560 videos from 10 SRCs:

    - Test videos of 8 SRCs - training,

    - Test videos of 1 SRCs - validation,

    - Test videos of 1 SRCs - testing

- 10 combinations of training, testing and validation samples in ANN model,

Video Quality Prediction
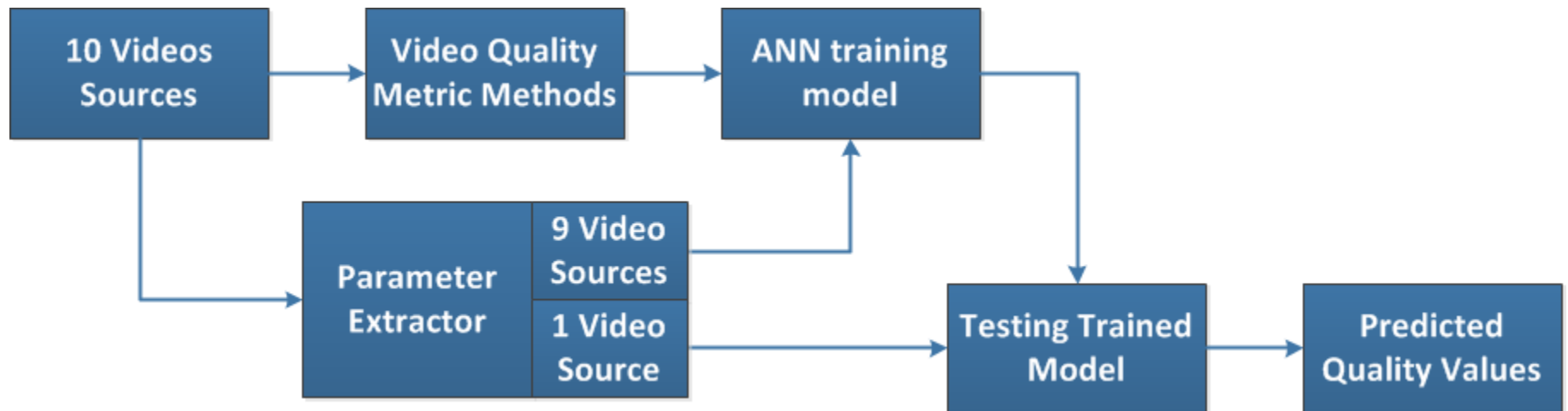
Artificial Neural Network Model

- Inputs: 52 fetaures of the input Videos

- Hidden layers –35 sigmoid hidden neurons,

- Output layer– one linear output neuron,

- Output – estimated quality values.

Results (Pearson Correlation)

Input	Average					Minkowski Summation				
Quality Metric	PSNR	PVQM	VQM	SSIM	VIFP	PSNR	PVQM	VQM	SSIM	VIFP
Test 1	0,981	0,911	0,977	0,954	0,976	0,987	0,968	0,982	0,980	0,989
Test 2	0,989	0,955	0,970	0,969	0,993	0,982	0,985	0,984	0,983	0,993
Test 3	0,992	0,968	0,979	0,973	0,988	0,991	0,964	0,982	0,972	0,992
Test 4	0,983	0,977	0,982	0,974	0,990	0,990	0,985	0,984	0,977	0,992
Test 5	0,995	0,972	0,974	0,961	0,993	0,990	0,974	0,971	0,989	0,993
Average	0,988	0,957	0,977	0,966	0,988	0,988	0,975	0,981	0,980	0,992
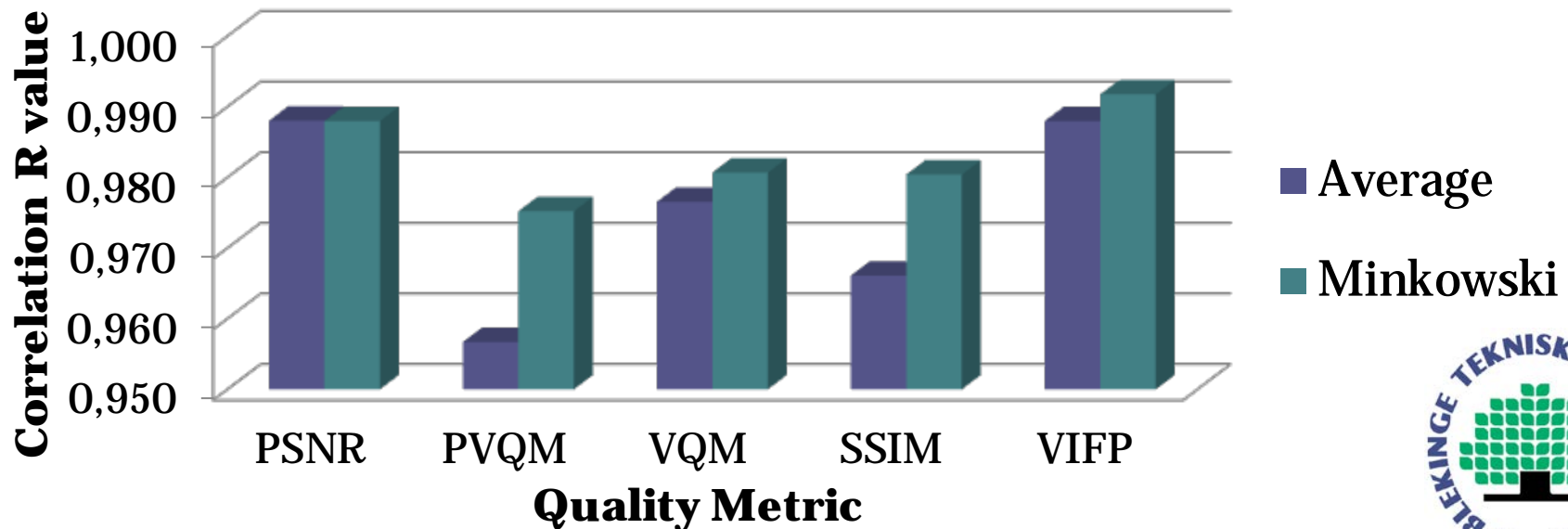
Reflections

▫ **Feature selection?**

▫ **Fetaures are computed on Coding Unit (CU) level and then ultimately averaged to Video sequence level…too much of approximation?**

▫ **More?**