

MSU Video-Codec Comparison 2019

Video Set Description



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http://www.compression.ru/video/codec_comparison/index_en.html
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A. SEQUENCES

A.1. African Village

Sequence title	African Village
Resolution	1920×1080
Number of frames	1524
Color space	YV12
Frames per second	24
Source	https://vimeo.com/252911280#t=166
Source resolution	FullHD
Bitrate	160.26

A part of a music clip with red sparkles, grain and double exposure effects.



Figure 1: African Village sequence, frame 100

A.2. Airport Interview

Sequence title	Airport Interview
Resolution	1920×1080
Number of frames	1016
Color space	YV12
Frames per second	24
Source	https://vimeo.com/143774318#t=42
Source resolution	FullHD
Bitrate	102.23

Different people give interviews at the airport.



Figure 2: Airport Interview sequence, frame 30

A.3. Animation Clip

Sequence title	Animation Clip
Resolution	1920×1080
Number of frames	5450
Color space	YV12
Frames per second	30
Source	https://vimeo.com/239189580#t=62
Source resolution	FullHD
Bitrate	104.58

2D animation advertising clip drawn in bright colors.



Figure 3: Animation Clip sequence, frame 62

A.4. Ariadnes Thread

Sequence title	Ariadnes Thread
Resolution	1920×1080
Number of frames	902
Color space	YV12
Frames per second	30
Source	https://vimeo.com/234495532#t=71
Source resolution	FullHD
Bitrate	209.05

A woman is dancing then another woman appears. Objects are highly textured and video contains flickering effects.



Figure 4: Ariadnes Thread sequence, frame 650

A.5. Bad Sleep

Sequence title	Bad Sleep
Resolution	1920×1080
Number of frames	1075
Color space	YV12
Frames per second	24
Source	https://vimeo.com/121936092#t=85
Source resolution	FullHD
Bitrate	98.75

A man sees a dream of a conversation with a girl, then wakes up in his room. A moment with a dream contains grain effect.



Figure 5: Bad Sleep sequence, frame 40

A.6. Bagpipes

Sequence title	Bagpipes
Resolution	1920×1080
Number of frames	1008
Color space	YV12
Frames per second	24
Source	https://vimeo.com/305804367#t=0
Source resolution	4K
Bitrate	126.41

A clip about preparation for the wedding contains scenes of a party with a fiance and morning makeup for fiancee.



Figure 6: Bagpipes sequence, frame 75

A.7. Carnival

Sequence title	Carnival
Resolution	1920×1080
Number of frames	1314
Color space	YV12
Frames per second	24
Source	https://vimeo.com/143088742#t=85
Source resolution	FullHD
Bitrate	78.33

People in Brazilian carnival costumes walk on the street. A clip is filmed with a handheld camera, contains bright-coloured costumes and colour effects.



Figure 7: Carnival sequence, frame 10

A.8. Carpets

Sequence title	Carpets
Resolution	1920×1080
Number of frames	801
Color space	YV12
Frames per second	25
Source	https://vimeo.com/193845705#t=0
Source resolution	FullHD
Bitrate	105.48

Shortchanging scenes of people, children and animals acting on different carpets. Filmed from one angle.



Figure 8: Carpets sequence, frame 400

A.9. Castle

Sequence title	Castle
Resolution	1920×1080
Number of frames	324
Color space	YV12
Frames per second	24
Source	https://vimeo.com/161938766#t=0
Source resolution	4K
Bitrate	91.87

A single view of the Tower of London, filmed with a handheld camera.



Figure 9: Castle sequence, frame 0

A.10. CG Figures

Sequence title	CG Figures
Resolution	1920×1080
Number of frames	1201
Color space	YV12
Frames per second	30
Source	https://vimeo.com/234318232#t=0
Source resolution	FullHD
Bitrate	244.26

The camera moves through rendered water drops and other plain geometric figures in a space.

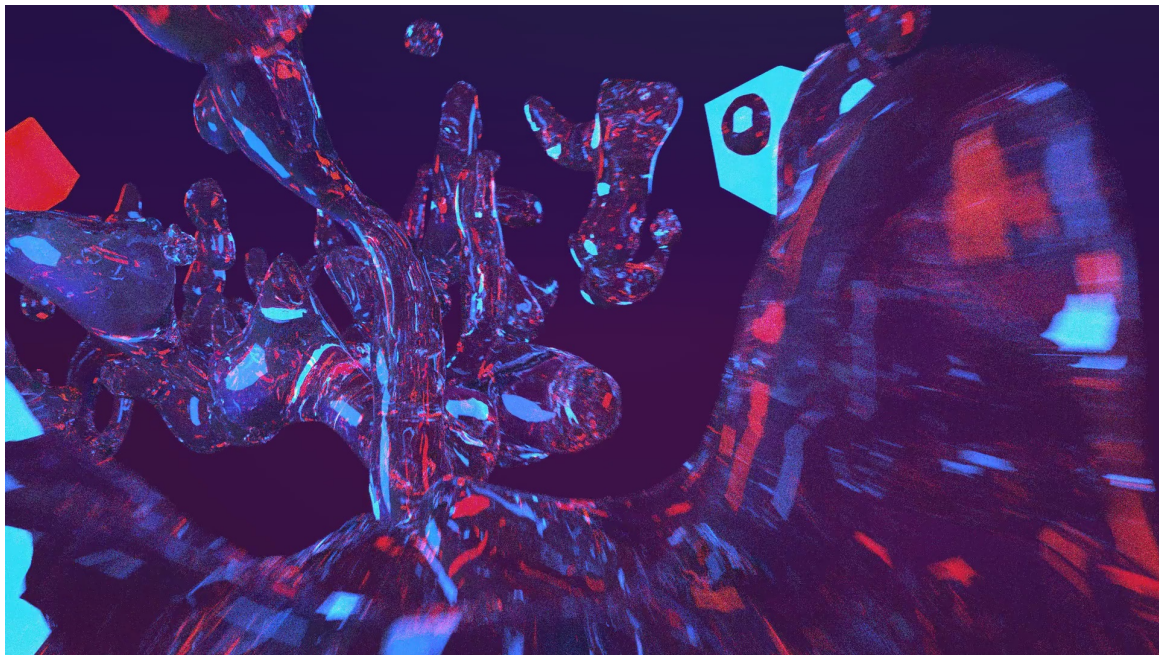


Figure 10: CG Figures sequence, frame 475

A.11. Cherry Up

Sequence title	Cherry Up
Resolution	1920×1080
Number of frames	877
Color space	YV12
Frames per second	30
Source	https://vimeo.com/226272099#t=0
Source resolution	FullHD
Bitrate	107.41

Two women pose on the camera in different clothes. Filmed outside with bright sun, a promo contains short close-up and general views.



Figure 11: Cherry Up sequence, frame 190

A.12. Christmas Cats

Sequence title	Christmas Cats
Resolution	1920×1080
Number of frames	1500
Color space	YV12
Frames per second	25
Source	https://vimeo.com/192252473#t=0
Source resolution	FullHD
Bitrate	182.23

Concert record with superimposed complicated translucent CG effects.



Figure 12: Christmas Cats sequence, frame 25

A.13. Cion

Sequence title	Cion
Resolution	1920×1080
Number of frames	1540
Color space	YV12
Frames per second	24
Source	https://vimeo.com/162777344#t=0
Source resolution	4K
Bitrate	220.37

Macro shooting of watch dials and cats faces.



Figure 13: Cion sequence, frame 900

A.14. City Panorama

Sequence title	City Panorama
Resolution	1920×1080
Number of frames	751
Color space	YV12
Frames per second	24
Source	https://vimeo.com/135497286#t=46
Source resolution	FullHD
Bitrate	108.13

View of a city filmed from a moving drone in sunny weather.



Figure 14: City Panorama sequence, frame 350

A.15. City Walk

Sequence title	City Walk
Resolution	1920×1080
Number of frames	436
Color space	YV12
Frames per second	25
Source	https://vimeo.com/149197238#t=0
Source resolution	FullHD
Bitrate	58.74

Day and night views of city streets and roads with the operator's feet in the frame. Shot from a hand-held camera.



Figure 15: City Walk sequence, frame 160

A.16. Colliers Wood

Sequence title	Colliers Wood
Resolution	1920×1080
Number of frames	1341
Color space	YV12
Frames per second	25
Source	https://vimeo.com/200655495#t=0
Source resolution	FullHD
Bitrate	174.92

Animated promo of realty agency. Filmed with stop-motion applique in bright colors.



Figure 16: Colliers Wood sequence, frame 200

A.17. Controlled Burn

Sequence title	Controlled Burn
Resolution	1920×1080
Number of frames	570
Color space	YV12
Frames per second	30
Source	https://media.xiph.org/video/derf/
Source resolution	FullHD
Bitrate	948.27

A house in the steppe burnes under the control of firefighters.



Figure 17: Controlled Burn sequence, frame 241

A.18. Cookie Jam

Sequence title	Cookie Jam
Resolution	1920×1080
Number of frames	600
Color space	YV12
Frames per second	30
Source	https://vimeo.com/237182757#t=0
Source resolution	FullHD
Bitrate	130.41

Bright-colored animated promo of a mobile game representing gameplay. Contains close-ups and sparkled effects.



Figure 18: Cookie Jam sequence, frame 230

A.19. Craft Beer

Sequence title	Craft Beer
Resolution	1920×1080
Number of frames	455
Color space	YV12
Frames per second	25
Source	https://vimeo.com/201919671#t=0
Source resolution	FullHD
Bitrate	109.24

A static scene in a bar, a man sits at the bar desk and talks to the camera.



Figure 19: Craft Beer sequence, frame 365

A.20. Crazy Bar

Sequence title	Crazy Bar
Resolution	1920×1080
Number of frames	1116
Color space	YV12
Frames per second	25
Source	https://vimeo.com/157539515#t=240
Source resolution	FullHD
Bitrate	72.63

Friends drink in a bar, then a concert with horses on the stage starts. Close-ups change with general plans of a crowd on a concert with flashes of light.



Figure 20: Crazy Bar sequence, frame 280

A.21. Creek Kooler

Sequence title	Creek Kooler
Resolution	1920×1080
Number of frames	1432
Color space	YV12
Frames per second	30
Source	https://vimeo.com/245462211#t=55
Source resolution	FullHD
Bitrate	132.98

A man ads floating cooler in a studio with another man, and interviews a woman in studio with chroma key. The video contains scenes with a demonstration of a cooler in a river.



Figure 21: Creek Kooler sequence, frame 160

A.22. Crowd Run

Sequence title	Crowd Run
Resolution	1920×1080
Number of frames	500
Color space	YV12
Frames per second	50
Source	https://media.xiph.org/video/derf/
Source resolution	FullHD
Bitrate	1186.52

A crowd of sportsmen run while the camera slowly moves left and right.



Figure 22: Crowd Run sequence, frame 50

A.23. Dancing Party

Sequence title	Dancing Party
Resolution	1920×1080
Number of frames	979
Color space	YV12
Frames per second	24
Source	https://vimeo.com/233300326#t=130
Source resolution	4K
Bitrate	201.13

Bride dance on a stage with bridesmaids and guests dance in a hall. The video contains scenes with a man in a lighting costume a lot of flashes from lights.



Figure 23: Dancing Party sequence, frame 395

A.24. Dancing People

Sequence title	Dancing People
Resolution	1920×1080
Number of frames	1463
Color space	YV12
Frames per second	24
Source	https://vimeo.com/305804367#t=291
Source resolution	4K
Bitrate	126.41

People are dancing in the hall, the bride throws a bouquet. Professional wedding videography.



Figure 24: Dancing People sequence, frame 1225

A.25. Desert

Sequence title	Desert
Resolution	1920×1080
Number of frames	750
Color space	YV12
Frames per second	24
Source	https://vimeo.com/223230094#t=50
Source resolution	FullHD
Bitrate	110.89

Static scenes and handheld shooting in the desert. Moving objects and sand in the air.



Figure 25: Desert sequence, frame 250

A.26. DJ Show

Sequence title	DJ Show
Resolution	1920×1080
Number of frames	993
Color space	YV12
Frames per second	60
Source	https://vimeo.com/307098048#t=16
Source resolution	FullHD
Bitrate	390.97

A concert with very bright flickering spotlights filmed in black and white colors. Scenes with a DJ on the stage and people standing under the stage and filming a concert.



Figure 26: DJ Show sequence, frame 390

A.27. Drakenboot

Sequence title	Drakenboot
Resolution	1920×1080
Number of frames	1010
Color space	YV12
Frames per second	25
Source	https://vimeo.com/278314059#t=79
Source resolution	FullHD
Bitrate	126.89

Scenes of different activities (boating, outdoor games, concerts, barbecue) on a festival.



Figure 27: Drakenboot sequence, frame 780

A.28. Field Milton Academy

Sequence title	Field Milton Academy
Resolution	1920×1080
Number of frames	1080
Color space	YV12
Frames per second	30
Source	https://vimeo.com/242753498#t=0
Source resolution	4K
Bitrate	553.63

View on a town and football fields captured from a drone on a sunny day.



Figure 28: Field Milton Academy sequence, frame 670

A.29. Film

Sequence title	Film
Resolution	1920×1080
Number of frames	916
Color space	YV12
Frames per second	24
Source	https://vimeo.com/189893327#t=173
Source resolution	FullHD
Bitrate	105.22

Scenes from a disaster movie filmed in the evening city. Men fight in a lane, a crowd run from crashing buildings.



Figure 29: Film sequence, frame 695

A.30. Film Promo

Sequence title	Film Promo
Resolution	1920×1080
Number of frames	1042
Color space	YV12
Frames per second	25
Source	https://vimeo.com/238901135#t=0
Source resolution	FullHD
Bitrate	180.48

A trailer of a military film shot in winter. Contains scenes with warriors in a snowy forest and village, burning guns and people inside the houses.



Figure 30: Film Promo sequence, frame 368

A.31. Final Cut Lesson

Sequence title	Final Cut Lesson
Resolution	1920×1080
Number of frames	750
Color space	YV12
Frames per second	25
Source	https://vimeo.com/229485661#t=0
Source resolution	FullHD
Bitrate	181.05

A short video captured from the screen with the interface of a video editing program.

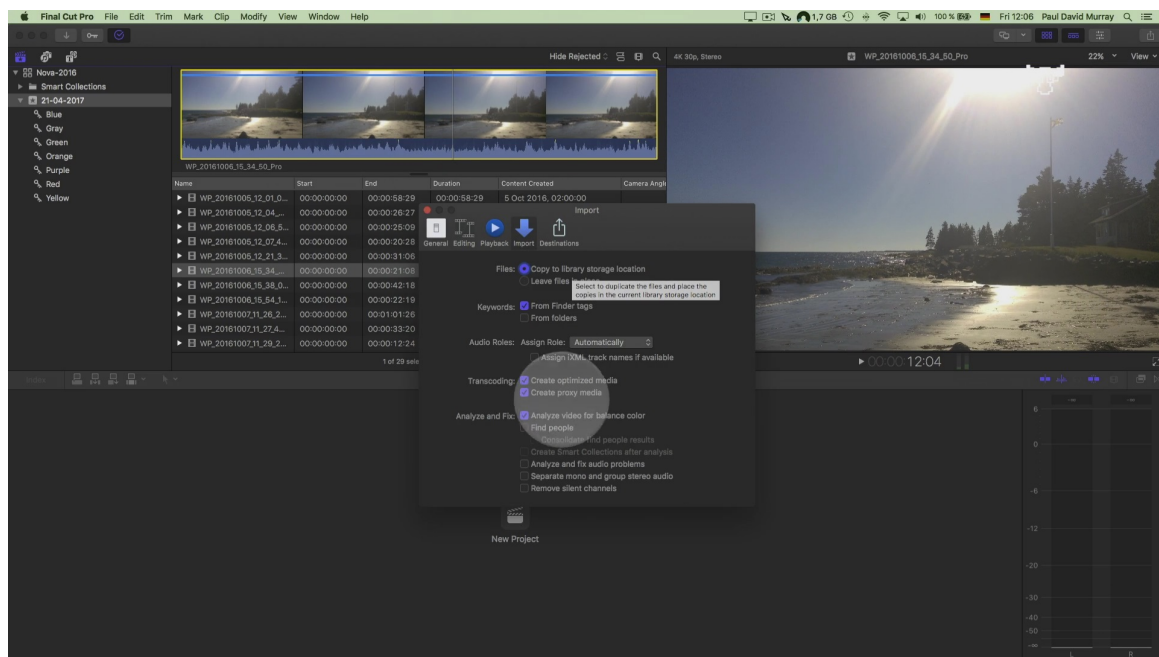


Figure 31: Final Cut Lesson sequence, frame 280

A.32. First Things First

Sequence title	First Things First
Resolution	1920×1080
Number of frames	359
Color space	YV12
Frames per second	30
Source	https://vimeo.com/276961360#t=0
Source resolution	FullHD
Bitrate	138.17

A promo of a talk show, two men and a woman are talking in the table in a studio. Scenes change with a storyboard effect.



Figure 32: First Things First sequence, frame 165

A.33. Flower Shop

Sequence title	Flower Shop
Resolution	1920×1080
Number of frames	749
Color space	YV12
Frames per second	25
Source	https://vimeo.com/315459683#t=0
Source resolution	FullHD
Bitrate	211.25

A man and a woman arrange potted flowers in an open greenhouse.



Figure 33: Flower Shop sequence, frame 620

A.34. Glass Production

Sequence title	Glass Production
Resolution	1920×1080
Number of frames	1126
Color space	YV12
Frames per second	30
Source	https://vimeo.com/240640831#t=66
Source resolution	FullHD
Bitrate	202.79

General view of a workshop and a man working with an oven.



Figure 34: Glass Production sequence, frame 100

A.35. Golden Bear

Sequence title	Golden Bear
Resolution	1920×1080
Number of frames	974
Color space	YV12
Frames per second	30
Source	https://vimeo.com/263194006#t=0
Source resolution	FullHD
Bitrate	108.14

Promo of a sports team, girls from a support group are dancing and a bear talisman and orchestra are walking in a sports hall in front of other students.



Figure 35: Golden Bear sequence, frame 345

A.36. Graduation

Sequence title	Graduation
Resolution	1920×1080
Number of frames	850
Color space	YV12
Frames per second	30
Source	https://vimeo.com/131252475#t=0
Source resolution	FullHD
Bitrate	129.40

View of many students in purple mantles, a president's speech and people rewarding on stage.



Figure 36: Graduation sequence, frame 140

A.37. Greenscreen Talks

Sequence title	Greenscreen Talks
Resolution	1920×1080
Number of frames	978
Color space	YV12
Frames per second	24
Source	https://vimeo.com/290760994#t=303
Source resolution	FullHD
Bitrate	157.59

Scenes filmed with a chroma key of people on a different background.



Figure 37: Greenscreen Talks sequence, frame 211

A.38. GTA5

Sequence title	GTA5
Resolution	1920×1080
Number of frames	3602
Color space	YV12
Frames per second	60
Source	https://media.xiph.org/video/derf/
Source resolution	FullHD
Bitrate	1423.83

Screen-captured process of GTA 5 gaming.



Figure 38: GTA5 sequence, frame 0

A.39. Guitar Show

Sequence title	Guitar Show
Resolution	1920×1080
Number of frames	1013
Color space	YV12
Frames per second	24
Source	https://vimeo.com/185306832#t=130
Source resolution	FullHD
Bitrate	85.06

A man is playing the guitar and singing on a stage in a dark hall.



Figure 39: Guitar Show sequence, frame 210

A.40. Gun Stuff

Sequence title	Gun Stuff
Resolution	1920×1080
Number of frames	1364
Color space	YV12
Frames per second	30
Source	https://vimeo.com/286199156#t=0
Source resolution	FullHD
Bitrate	135.96

A promo of a TV channel followed by an interview in a studio.



Figure 40: Gun Stuff sequence, frame 680

A.41. Gun Stuff Promo

Sequence title	Gun Stuff Promo
Resolution	1920×1080
Number of frames	964
Color space	YV12
Frames per second	30
Source	https://vimeo.com/277990158#t=274
Source resolution	FullHD
Bitrate	128.13

Dynamic slides from a presentation with black background followed by an interview on an expo.

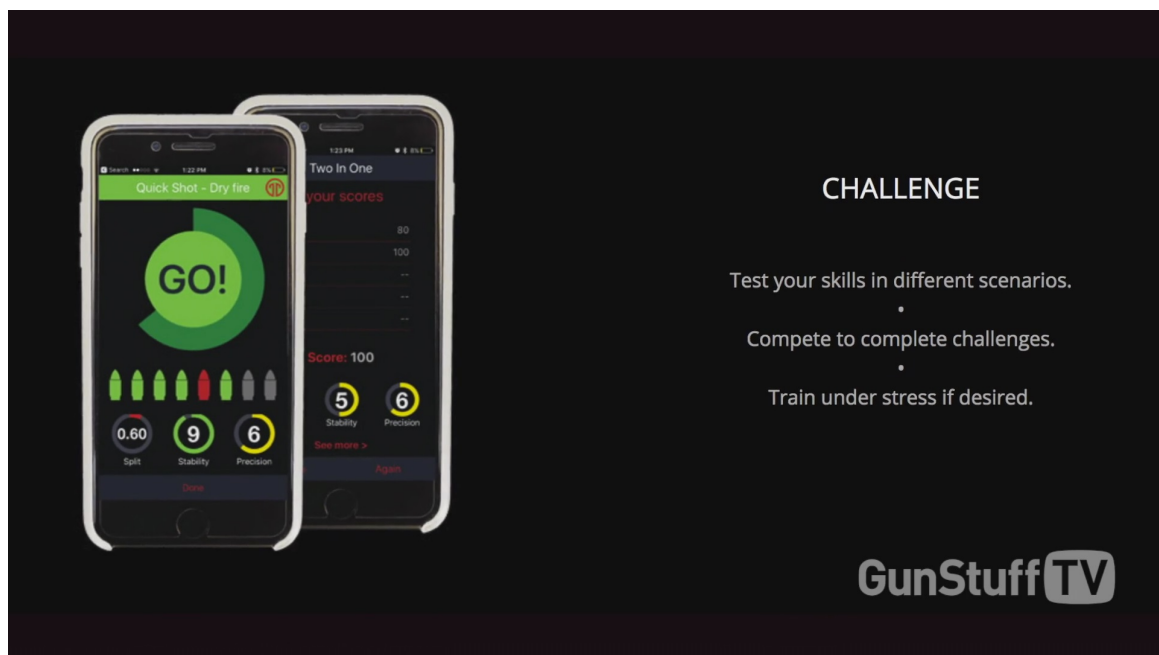


Figure 41: Gun Stuff Promo sequence, frame 280

A.42. Hallelujah

Sequence title	Hallelujah
Resolution	1920×1080
Number of frames	974
Color space	YV12
Frames per second	30
Source	https://vimeo.com/204122382#t=101
Source resolution	FullHD
Bitrate	84.88

A man is praying and singing on the street. A part of a music clip with double exposure effects.



Figure 42: Hallelujah sequence, frame 530

A.43. Historic Mansion

Sequence title	Historic Mansion
Resolution	1920×1080
Number of frames	958
Color space	YV12
Frames per second	30
Source	https://vimeo.com/240540029#t=139
Source resolution	FullHD
Bitrate	202.11

Scenes with men firing from a gun, food from a field kitchen and an interview of a woman.



Figure 43: Historic Mansion sequence, frame 0

A.44. Hotel Advertisement

Sequence title	Hotel Advertisement
Resolution	1920×1080
Number of frames	1434
Color space	YV12
Frames per second	30
Source	https://vimeo.com/171105466#t=206
Source resolution	FullHD
Bitrate	72.36

View of different rooms in a house standing on the seashore (from a balcony, bedroom, sports room, etc.) followed by a general view of the house taken from the drone.



Figure 44: Hotel Advertisement sequence, frame 145

A.45. Infinit

Sequence title	Infinit
Resolution	1920×1080
Number of frames	258
Color space	YV12
Frames per second	25
Source	https://vimeo.com/180708512#t=0
Source resolution	FullHD
Bitrate	262.64

The camera flies through CG buildings and statues, then video shows a picture of man with CG title on it.



Figure 45: Infinit sequence, frame 25

A.46. Interactive Newspaper

Sequence title	Interactive Newspaper
Resolution	1920×1080
Number of frames	1336
Color space	YV12
Frames per second	25
Source	https://vimeo.com/276246440#t=79
Source resolution	FullHD
Bitrate	246.15

The camera moves through newspaper articles with different videos inserted inside articles pictures.



Figure 46: Interactive Newspaper sequence, frame 500

A.47. Interview at the Expo

Sequence title	Interview at the Expo
Resolution	1920×1080
Number of frames	1110
Color space	YV12
Frames per second	24
Source	https://vimeo.com/278075823#t=83
Source resolution	FullHD
Bitrate	104.95

A man takes an interview with two other men inside the expo hall.



Figure 47: Interview at the Expo sequence, frame 45

A.48. Italy History

Sequence title	Italy History
Resolution	1920×1080
Number of frames	989
Color space	YV12
Frames per second	24
Source	https://vimeo.com/207945404#t=292
Source resolution	FullHD
Bitrate	167.11

Views of a city, fields and trees, and a map of a journey. A video contains grain effect and subtitles.



Figure 48: Italy History sequence, frame 200

A.49. Judy Trailer

Sequence title	Judy Trailer
Resolution	1920×1080
Number of frames	754
Color space	YV12
Frames per second	24
Source	https://vimeo.com/316284113#t=37
Source resolution	FullHD
Bitrate	144.31

Very noisy video with women talking on a stage.

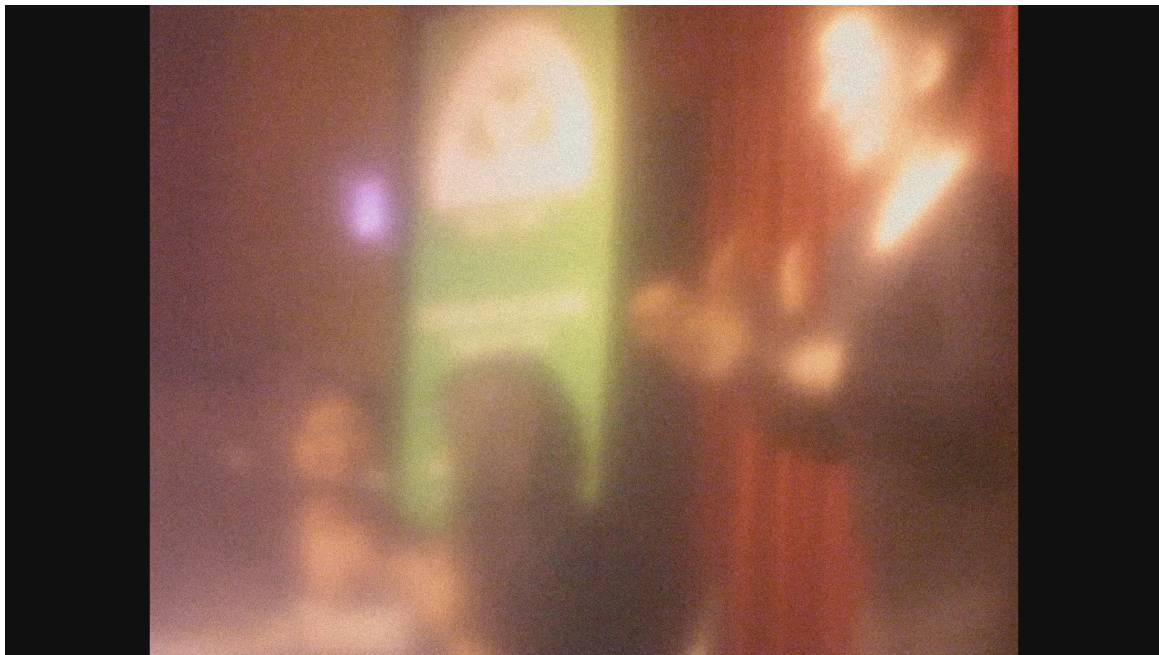


Figure 49: Judy Trailer sequence, frame 330

A.50. Kayak Trip

Sequence title	Kayak Trip
Resolution	1920×1080
Number of frames	1577
Color space	YV12
Frames per second	60
Source	https://vimeo.com/311282786#t=18
Source resolution	4K
Bitrate	117.18

Different people kayak in the sea and lakes. Filmed from a drone, a kayak, and from under water.



Figure 50: Kayak Trip sequence, frame 380

A.51. Keeping Warm

Sequence title	Keeping Warm
Resolution	1920×1080
Number of frames	999
Color space	YV12
Frames per second	30
Source	https://vimeo.com/217915002#t=0
Source resolution	FullHD
Bitrate	186.49

Stop-motion clip with a girl walking in a town and taking photos.



Figure 51: Keeping Warm sequence, frame 530

A.52. Kobe Bryant

Sequence title	Kobe Bryant
Resolution	1920×1080
Number of frames	891
Color space	YV12
Frames per second	25
Source	https://vimeo.com/187892523#t=0
Source resolution	FullHD
Bitrate	100.78

Promo video of sneakers with a lot of CG-effects filmed in black and red colors.



Figure 52: Kobe Bryant sequence, frame 117

A.53. Laser Cutter

Sequence title	Laser Cutter
Resolution	1920×1080
Number of frames	1068
Color space	YV12
Frames per second	24
Source	https://vimeo.com/147556715#t=128
Source resolution	FullHD
Bitrate	154.09

A man is working on the laser cutting machine, contains a scene of closely-captured cutting process.



Figure 53: Laser Cutter sequence, frame 70

A.54. Love Story

Sequence title	Love Story
Resolution	1920×1080
Number of frames	1132
Color space	YV12
Frames per second	50
Source	https://vimeo.com/250664372#t=17
Source resolution	FullHD
Bitrate	208.98

Slide show of videos and photographs of a man and a woman walking on nature.



Figure 54: Love Story sequence, frame 400

A.55. Magazine Advertisement

Sequence title	Magazine Advertisement
Resolution	1920×1080
Number of frames	984
Color space	YV12
Frames per second	60
Source	https://vimeo.com/245381090#t=0
Source resolution	FullHD
Bitrate	379.25

Scenes with changing magazine pages and people sharing a magazine in a car wash and pizzeria.



Figure 55: Magazine Advertisement sequence, frame 560

A.56. Making Alcohol

Sequence title	Making Alcohol
Resolution	1920×1080
Number of frames	1575
Color space	YV12
Frames per second	24
Source	https://vimeo.com/245154516#t=42
Source resolution	FullHD
Bitrate	95.26

People watching after the boiler at the stake in different weather in tropics.



Figure 56: Making Alcohol sequence, frame 400

A.57. Manhattan Bridge Views

Sequence title	Manhattan Bridge Views
Resolution	1920×1080
Number of frames	1484
Color space	YV12
Frames per second	24
Source	https://vimeo.com/209725936#t=43
Source resolution	FullHD
Bitrate	99.83

Views of Manhattan bridge shot from a drone in sunny weather.



Figure 57: Manhattan Bridge Views sequence, frame 300

A.58. Mercedes

Sequence title	Mercedes
Resolution	1920×1080
Number of frames	1016
Color space	YV12
Frames per second	25
Source	https://vimeo.com/286341622#t=40
Source resolution	FullHD
Bitrate	106.70

Scenes with a woman posing while sitting on the hood and a man singing and dancing.



Figure 58: Mercedes sequence, frame 0

A.59. Music Clip

Sequence title	Music Clip
Resolution	1920×1080
Number of frames	989
Color space	YV12
Frames per second	24
Source	https://vimeo.com/234712184#t=0
Source resolution	FullHD
Bitrate	164.78

A clip showing city views and couples; exhibits grain effect, red sparks between changing scenes and superimposed text. A black screen appears in the beginning.



Figure 59: Music Clip sequence, frame 149

A.60. Music Fantasy

Sequence title	Music Fantasy
Resolution	1920×1080
Number of frames	1022
Color space	YV12
Frames per second	25
Source	https://vimeo.com/112617677#t=159
Source resolution	FullHD
Bitrate	106.62

Scenes with a couple in a park and a man playing guitar and drums. Contains CG effects for scenes with a band playing musical instruments.



Figure 60: Music Fantasy sequence, frame 390

A.61. Nancy

Sequence title	Nancy
Resolution	1920×1080
Number of frames	1259
Color space	YV12
Frames per second	25
Source	https://vimeo.com/197980531#t=81
Source resolution	4K
Bitrate	64.56

A woman is walking on the house full of plants searching for something and gathering photography.



Figure 61: Nancy sequence, frame 390

A.62. New York Bakery

Sequence title	New York Bakery
Resolution	1920×1080
Number of frames	429
Color space	YV12
Frames per second	25
Source	https://vimeo.com/251650008#t=0
Source resolution	FullHD
Bitrate	179.32

Views of dawn in a city, an old woman in a bakery serving the visitors.



Figure 62: New York Bakery sequence, frame 240

A.63. Newsy

Sequence title	Newsy
Resolution	1920×1080
Number of frames	1005
Color space	YV12
Frames per second	30
Source	https://vimeo.com/223356403#t=30
Source resolution	FullHD
Bitrate	102.20

Scenes with a man giving an interview in an expo hall and views of an office and reporters at work.



Figure 63: Newsy sequence, frame 290

A.64. Night Pursuit

Sequence title	Night Pursuit
Resolution	1920×1080
Number of frames	1001
Color space	YV12
Frames per second	24
Source	https://vimeo.com/230112973#t=0
Source resolution	FullHD
Bitrate	159.90

A woman runs through a city street at night and walks in a forest in the dawn.



Figure 64: Night Pursuit sequence, frame 350

A.65. Nina Music Video

Sequence title	Nina Music Video
Resolution	1920×1080
Number of frames	1001
Color space	YV12
Frames per second	24
Source	https://vimeo.com/252911280#t=0
Source resolution	FullHD
Bitrate	160.26

A man is dancing on a red carpet in a white hall. Filmed from different angles and contains a grain effect.

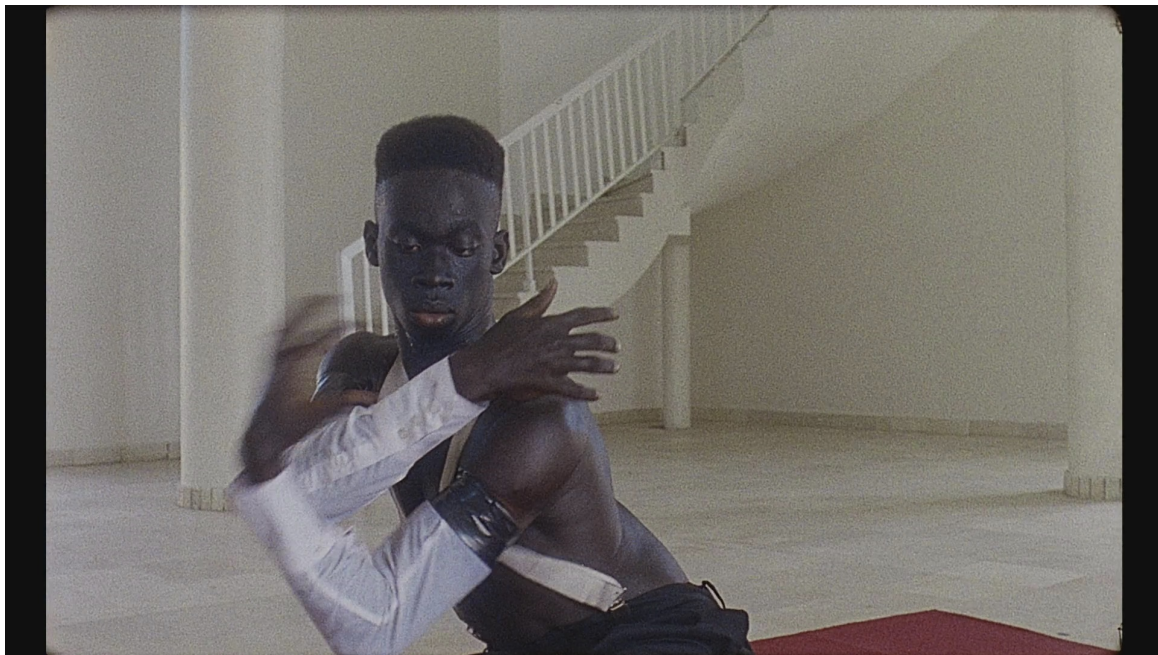


Figure 65: Nina Music Video sequence, frame 460

A.66. Nurse Interview

Sequence title	Nurse Interview
Resolution	1920×1080
Number of frames	1387
Color space	YV12
Frames per second	60
Source	https://vimeo.com/260860774#t=49
Source resolution	4K
Bitrate	110.89

An interview with a nurse with CG text on a screen.



Figure 66: Nurse Interview sequence, frame 803

A.67. Off the Wall

Sequence title	Off the Wall
Resolution	1920×1080
Number of frames	394
Color space	YV12
Frames per second	25
Source	https://vimeo.com/220467033#t=0
Source resolution	FullHD
Bitrate	157.73

Scenes with computer graphics painted on real walls on the streets.



Figure 67: Off the Wall sequence, frame 210

A.68. Old Message

Sequence title	Old Message
Resolution	1920×1080
Number of frames	986
Color space	YV12
Frames per second	24
Source	https://vimeo.com/142207516#t=41
Source resolution	FullHD
Bitrate	150.94

A scared man is writing a message with a pen on a paper, between some pictures are shown. There are flickering effects.

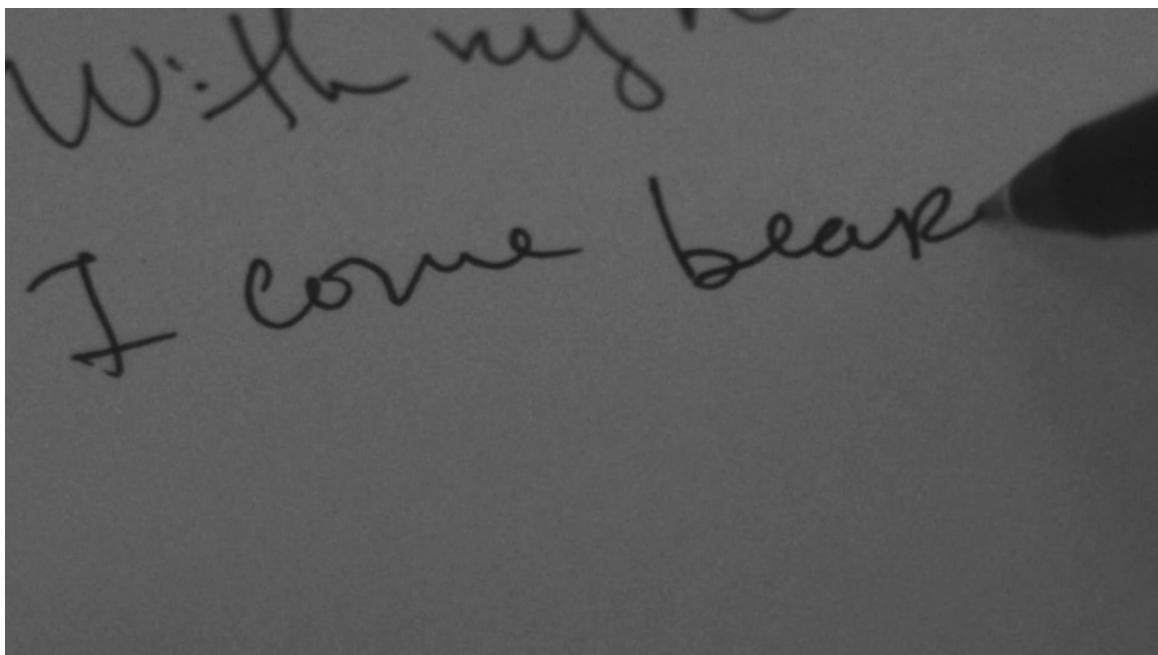


Figure 68: Old Message sequence, frame 222

A.69. Oman Museum

Sequence title	Oman Museum
Resolution	1920×1080
Number of frames	532
Color space	YV12
Frames per second	25
Source	https://vimeo.com/95320600#t=441
Source resolution	FullHD
Bitrate	66.48

A woman is staying, prepares some food and then reads Braille. Static scenes with smooth fading transitions.



Figure 69: Oman Museum sequence, frame 100

A.70. Pebble Beach

Sequence title	Pebble Beach
Resolution	1920×1080
Number of frames	930
Color space	YV12
Frames per second	24
Source	https://vimeo.com/239546249#t=0
Source resolution	FullHD
Bitrate	109.52

Scenes near and inside a nice house with palm trees outside.



Figure 70: Pebble Beach sequence, frame 202

A.71. Pet Photography

Sequence title	Pet Photography
Resolution	1920×1080
Number of frames	925
Color space	YV12
Frames per second	30
Source	https://vimeo.com/240589082#t=211
Source resolution	FullHD
Bitrate	199.26

A woman is sitting with a dog on a chair and giving an interview.



Figure 71: Pet Photography sequence, frame 340

A.72. Preparation for the Celebration

Sequence title	Preparation for the Celebration
Resolution	1920×1080
Number of frames	496
Color space	YV12
Frames per second	24
Source	https://vimeo.com/231500538#t=43
Source resolution	4K
Bitrate	243.57

A woman applies a makeup, a man straightens his tie and laces up his shoes.



Figure 72: Preparation for the Celebration sequence, frame 347

A.73. Prism

Sequence title	Prism
Resolution	1920×1080
Number of frames	180
Color space	YV12
Frames per second	30
Source	https://vimeo.com/301267404#t=0
Source resolution	FullHD
Bitrate	333.64

An animated animal creature is shown through a CG prism.



Figure 73: Prism sequence, frame 168

A.74. Professor

Sequence title	Professor
Resolution	1920×1080
Number of frames	1439
Color space	YV12
Frames per second	24
Source	https://vimeo.com/209917350#t=0
Source resolution	FullHD
Bitrate	165.41

Interview with a professor from a public and international affairs school, some scenes from it with him.



Figure 74: Professor sequence, frame 55

A.75. Psychotherapy

Sequence title	Psychotherapy
Resolution	1920×1080
Number of frames	1010
Color space	YV12
Frames per second	25
Source	https://vimeo.com/213681940#t=0
Source resolution	FullHD
Bitrate	230.58

A woman is talking with her psychotherapist. Then a wall clock is shown.



Figure 75: Psychotherapy sequence, frame 590

A.76. Rugby

Sequence title	Rugby
Resolution	1920×1080
Number of frames	901
Color space	YV12
Frames per second	60
Source	https://vimeo.com/190175685#t=0
Source resolution	FullHD
Bitrate	193.57

A promo video of a rugby championship with CG effects.



Figure 76: Rugby sequence, frame 53

A.77. Rust

Sequence title	Rust
Resolution	1920×1080
Number of frames	3602
Color space	YV12
Frames per second	60
Source	https://media.xiph.org/video/derf/
Source resolution	FullHD
Bitrate	1423.83

A recording of playing a video game Rust.



Figure 77: Rust sequence, frame 3245

A.78. Sad Day

Sequence title	Sad Day
Resolution	1920×1080
Number of frames	1039
Color space	YV12
Frames per second	24
Source	https://vimeo.com/141638222#t=44
Source resolution	4K
Bitrate	92.23

A man plays guitar and then he walks in the rain.



Figure 78: Sad Day sequence, frame 792

A.79. School Promo Video

Sequence title	School Promo Video
Resolution	1920×1080
Number of frames	1006
Color space	YV12
Frames per second	24
Source	https://vimeo.com/251886971#t=0
Source resolution	4K
Bitrate	91.57

A promo video of a religious school. Children are shown to come in it and pray.



Figure 79: School Promo Video sequence, frame 873

A.80. Sea Sunrise

Sequence title	Sea Sunrise
Resolution	1920×1080
Number of frames	1021
Color space	YV12
Frames per second	25
Source	https://vimeo.com/251138827#t=0
Source resolution	FullHD
Bitrate	175.00

Two scenes, the first shows a sea, the second – sunrise.

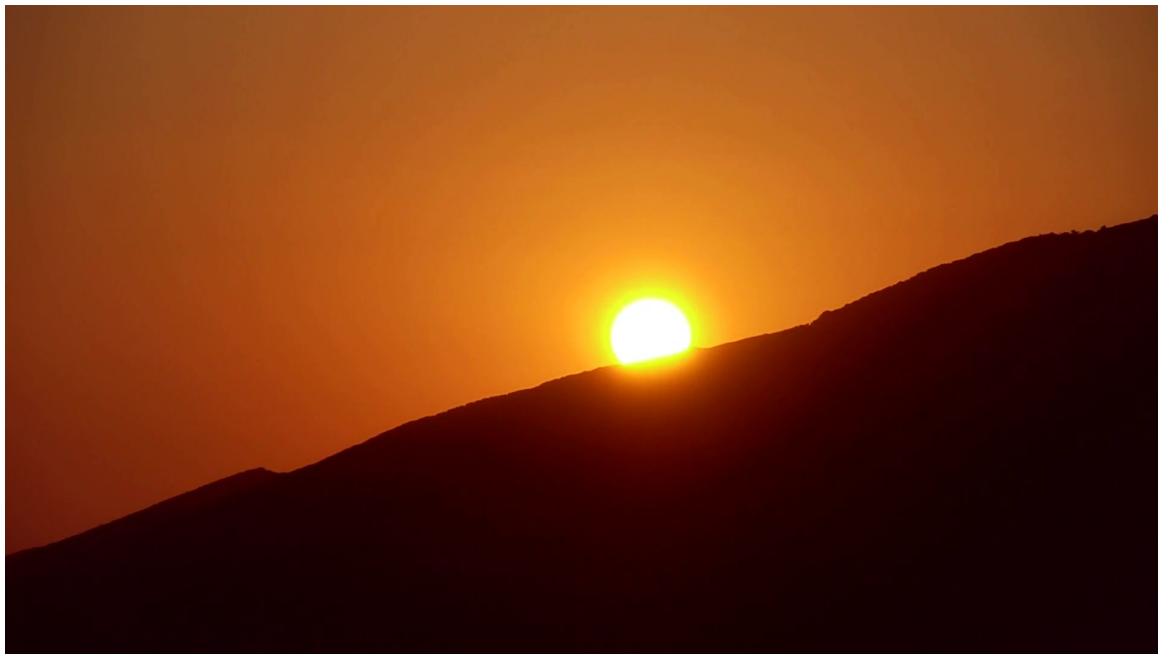


Figure 80: Sea Sunrise sequence, frame 713

A.81. Simple Animation

Sequence title	Simple Animation
Resolution	1920×1080
Number of frames	144
Color space	YV12
Frames per second	24
Source	https://vimeo.com/155922649#t=0
Source resolution	FullHD
Bitrate	143.77

A CG animation of a woman sitting on a couch.

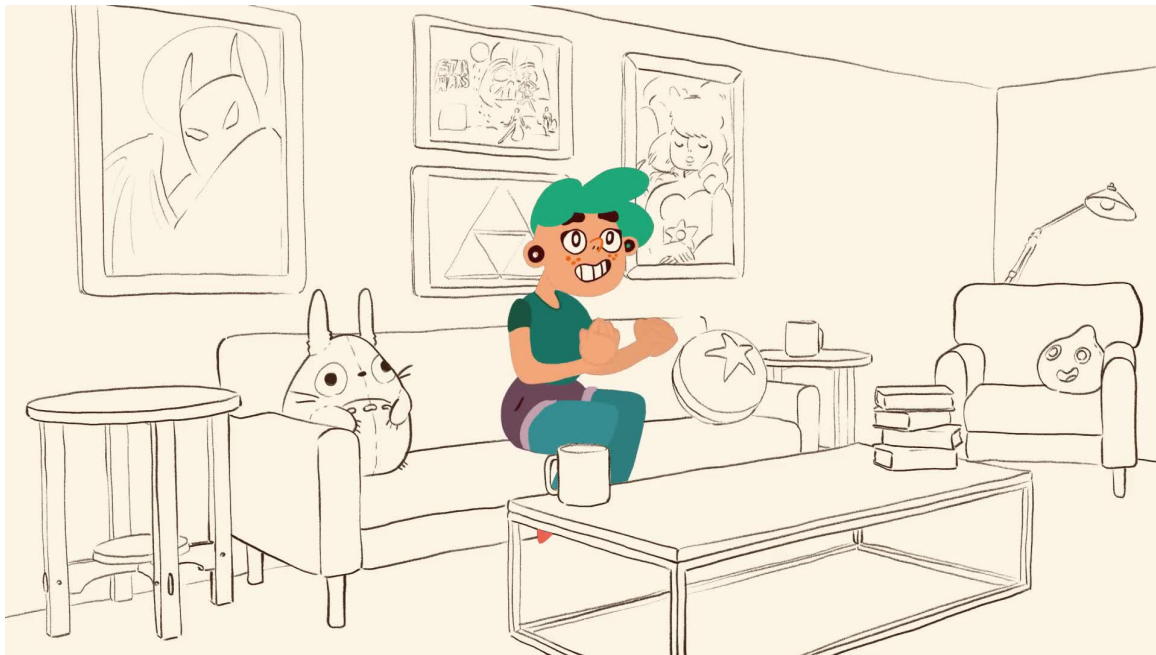


Figure 81: Simple Animation sequence, frame 48

A.82. Skiing Learning

Sequence title	Skiing Learning
Resolution	1920×1080
Number of frames	809
Color space	YV12
Frames per second	24
Source	https://vimeo.com/207867490#t=86
Source resolution	FullHD
Bitrate	107.59

People are being trained to ski in slow motion.



Figure 82: Skiing Learning sequence, frame 246

A.83. Slow Motion Clip

Sequence title	Slow Motion Clip
Resolution	1920×1080
Number of frames	1021
Color space	YV12
Frames per second	24
Source	https://vimeo.com/158004101#t=45
Source resolution	4K
Bitrate	273.05

A woman is walking in a building in slow motion.



Figure 83: Slow Motion Clip sequence, frame 584

A.84. Snow Mount

Sequence title	Snow Mount
Resolution	1920×1080
Number of frames	570
Color space	YV12
Frames per second	30
Source	https://media.xiph.org/video/derf/
Source resolution	FullHD
Bitrate	948.27

Panoramas of snow mountains and trees.

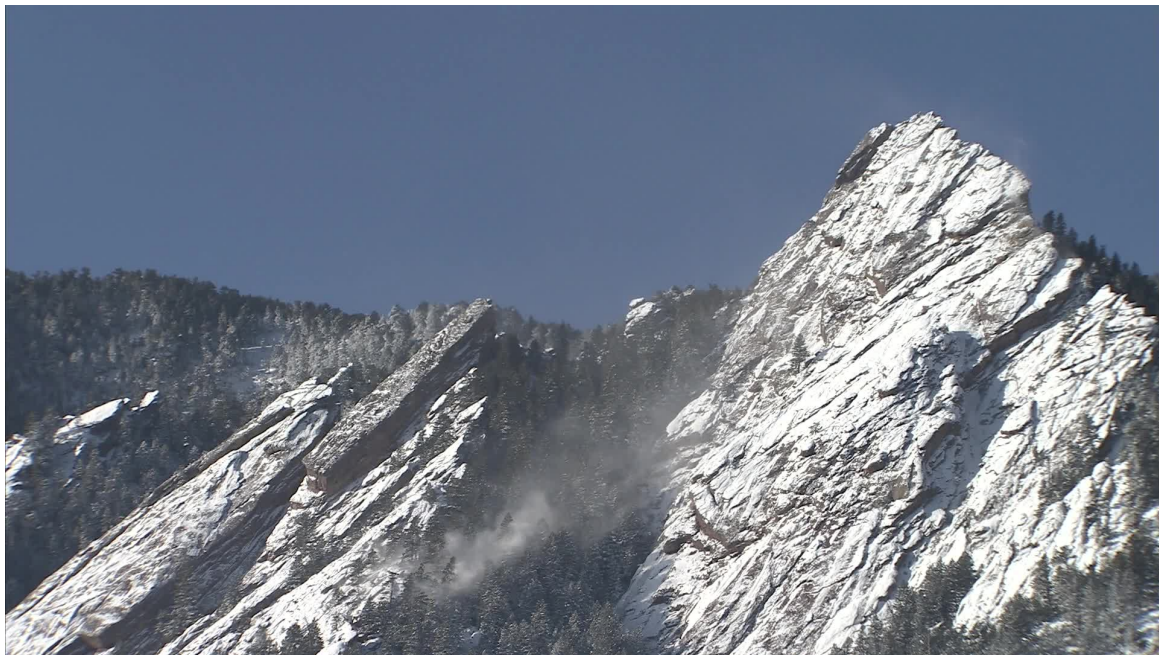


Figure 84: Snow Mount sequence, frame 70

A.85. Sports Team

Sequence title	Sports Team
Resolution	1920×1080
Number of frames	1007
Color space	YV12
Frames per second	25
Source	https://vimeo.com/123907536#t=80
Source resolution	FullHD
Bitrate	103.38

A sports team before and during an important competition. There are some CG effects, double exposure.



Figure 85: Sports Team sequence, frame 732

A.86. Street Show

Sequence title	Street Show
Resolution	1920×1080
Number of frames	1058
Color space	YV12
Frames per second	24
Source	https://vimeo.com/308829951#t=0
Source resolution	4K
Bitrate	108.40

Two men sing, dance and show some acrobatics on a street.



Figure 86: Street Show sequence, frame 862

A.87. Surfing

Sequence title	Surfing
Resolution	1920×1080
Number of frames	1156
Color space	YV12
Frames per second	30
Source	https://vimeo.com/237783771#t=66
Source resolution	4K
Bitrate	220.71

People are surfing on an ocean, also there are houses captured by the drone camera.



Figure 87: Surfing sequence, frame 138

A.88. Terry Cage

Sequence title	Terry Cage
Resolution	1920×1080
Number of frames	947
Color space	YV12
Frames per second	24
Source	https://vimeo.com/39247973#t=88
Source resolution	FullHD
Bitrate	100.28

People are resting near a house, one man is talking on his phone.



Figure 88: Terry Cage sequence, frame 626

A.89. Theater Show

Sequence title	Theater Show
Resolution	1920×1080
Number of frames	1307
Color space	YV12
Frames per second	25
Source	https://vimeo.com/136614597#t=39
Source resolution	FullHD
Bitrate	86.40

An advertisement of a theater show. There are people on the scene, then a picture with the announcement.



Figure 89: Theater Show sequence, frame 829

A.90. Tractor

Sequence title	Tractor
Resolution	1920×1080
Number of frames	690
Color space	YV12
Frames per second	25
Source	https://media.xiph.org/video/derf/
Source resolution	FullHD
Bitrate	593.26

A tractor rides across a field. The camera zooms in, then zooms out.



Figure 90: Tractor sequence, frame 533

A.91. Tribute

Sequence title	Tribute
Resolution	1920×1080
Number of frames	1050
Color space	YV12
Frames per second	30
Source	https://vimeo.com/186264229#t=34
Source resolution	FullHD
Bitrate	122.83

A live recording from a concert of a musical group.



Figure 91: Tribute sequence, frame 920

A.92. Video in Video

Sequence title	Video in Video
Resolution	1920×1080
Number of frames	1537
Color space	YV12
Frames per second	24
Source	https://vimeo.com/240015784#t=173
Source resolution	4K
Bitrate	95.17

A clip of some artist in a beige jacket who sings near the wall with video-in-video effects.

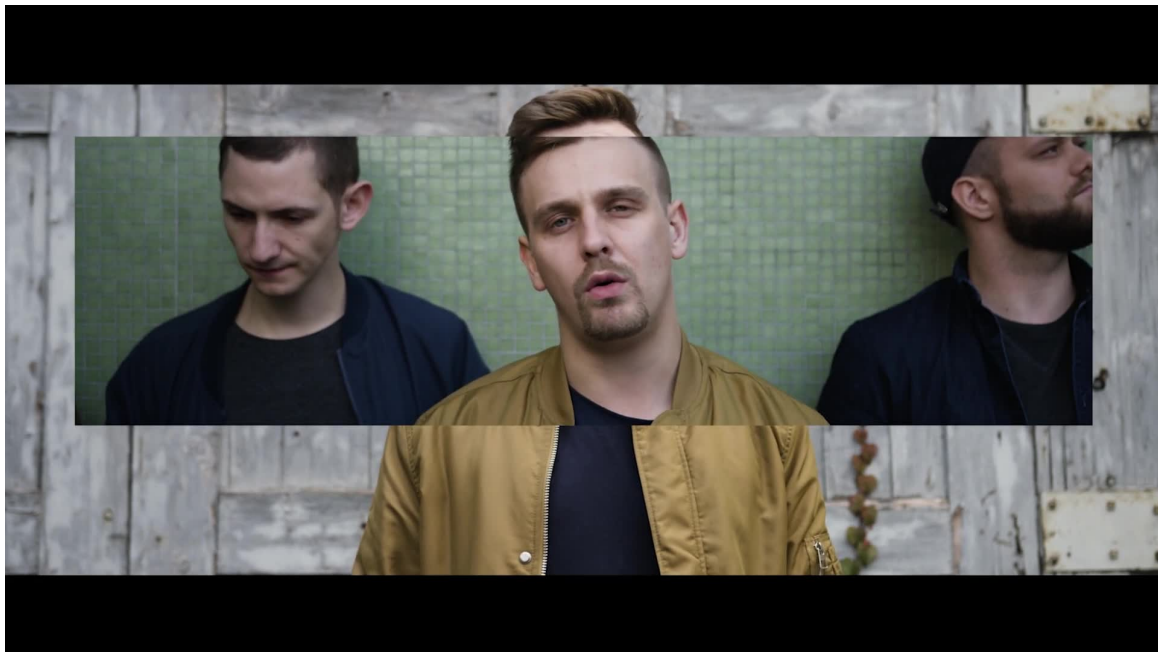


Figure 92: Video in Video sequence, frame 77

A.93. Walk with Children

Sequence title	Walk with Children
Resolution	1920×1080
Number of frames	1032
Color space	YV12
Frames per second	30
Source	https://vimeo.com/219044636#t=0
Source resolution	FullHD
Bitrate	137.26

Two children with their mother walk in a quiet area of a city.



Figure 93: Walk with Children sequence, frame 162

A.94. Wedding Party

Sequence title	Wedding Party
Resolution	1920×1080
Number of frames	808
Color space	YV12
Frames per second	24
Source	https://vimeo.com/280135236#t=347
Source resolution	4K
Bitrate	161.08

A party after a wedding, many guests dance in a dark club.



Figure 94: Wedding Party sequence, frame 552

A.95. Wedding Walk

Sequence title	Wedding Walk
Resolution	1920×1080
Number of frames	1031
Color space	YV12
Frames per second	24
Source	https://vimeo.com/227291200#t=331
Source resolution	4K
Bitrate	123.96

The video shows a newlywed couple, a restaurant in which the celebration takes place, and walk of lovers.



Figure 95: Wedding Walk sequence, frame 245

A.96. Will and Hannah

Sequence title	Will and Hannah
Resolution	1920×1080
Number of frames	965
Color space	YV12
Frames per second	30
Source	https://vimeo.com/176555781#t=0
Source resolution	FullHD
Bitrate	133.49

A couple of people that at first walk, then sit on the couch and talk about something.



Figure 96: Will and Hannah sequence, frame 118

A.97. Work under the Microscope

Sequence title	Work under the Microscope
Resolution	1920×1080
Number of frames	1129
Color space	YV12
Frames per second	25
Source	https://vimeo.com/173390620#t=81
Source resolution	FullHD
Bitrate	174.87

A man makes crafts in an eye of a needle looking through a microscope.



Figure 97: Work under the Microscope sequence, frame 745

A.98. Wuyue

Sequence title	Wuyue
Resolution	1920×1080
Number of frames	1281
Color space	YV12
Frames per second	25
Source	https://vimeo.com/246243901#t=39
Source resolution	FullHD
Bitrate	112.92

A trailer about a life of a Japanese girl, there are CG effects.



Figure 98: Wuyue sequence, frame 759

A.99. Zombie Apocalypse

Sequence title	Zombie Apocalypse
Resolution	1920×1080
Number of frames	900
Color space	YV12
Frames per second	60
Source	https://vimeo.com/119255634#t=0
Source resolution	FullHD
Bitrate	187.99

An advertisement in which a report about the onset of the zombie apocalypse is shown on TV.



Figure 99: Zombie Apocalypse sequence, frame 202

A.100. Zulu International

Sequence title	Zulu International
Resolution	1920×1080
Number of frames	914
Color space	YV12
Frames per second	24
Source	https://vimeo.com/143088742#t=0
Source resolution	FullHD
Bitrate	78.33

Party at the Zulu International festival with CG effects.



Figure 100: Zulu International sequence, frame 627

B. SEQUENCE SELECTION

In “MSU Video Codecs Comparison 2016” we introduced a technique for selecting test video sequences. This technique allows for creating a set containing representative sequences. For this report, we used the same method and updated the video database from which we sample videos.

We analyzed 384,946 videos at Vimeo, looking for 4K and FullHD examples with high bitrates (we chose 50 Mbps as our minimum) and downloaded 145 new 4K videos and 603 new FullHD videos. Figure 101 shows the bitrate distributions for last year data set and for the updated data set. Table 1 shows

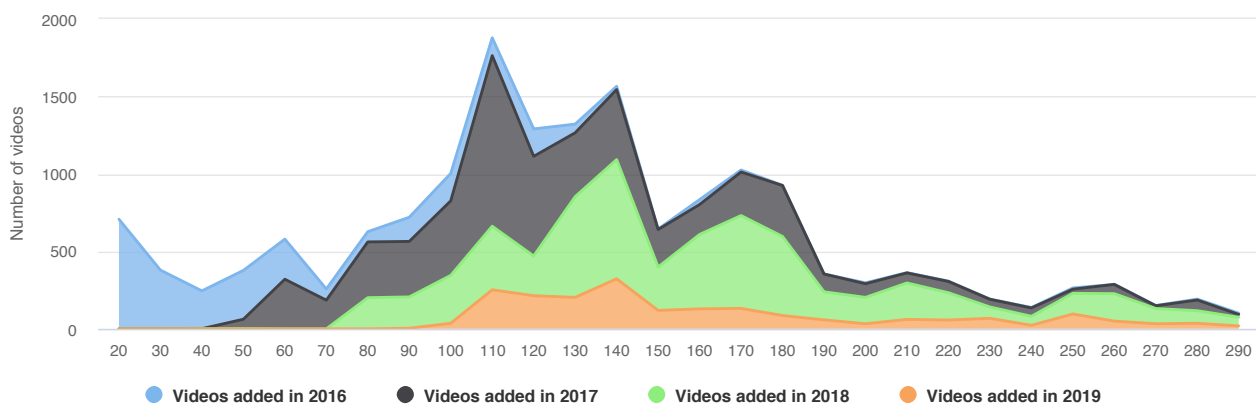


Figure 101: Bitrate distributions for comparison video set.

Year	FullHD videos	FullHD samples	4K videos	4K samples	Total (videos)	Total (samples)
2016	3	7	882	2902	885	2909
2017	1996	4638	1544	4561	3540	9299
2018	4342	10330	1946	5503	6288	15833
2019	4945	12402	2091	6016	7036	18418

Table 1: Number of videos in MSU video collection.

We resized and cropped 4K videos to FullHD resolution in order to avoid compression artefacts, and at scene changes, we cut all videos to samples using an approximate length of 1,000 frames. Besides 2,585 samples from 748 newly downloaded videos, we used 15,833 samples from our collection, which was used in our previous comparisons. Thus, our sample database for this year consisted of 18,418 items.

To evaluate spatial and temporal complexity, we encoded all samples using x264 with a constant quantization parameter (QP). We calculated the temporal and spatial complexity for each scene, defining spatial complexity as the average size of the I-frame normalized to the sample’s uncompressed frame size. Temporal complexity in our definition is the average size of the P-frame divided by the average size of I-frame. ¹ Also, an additional preprocessing step was added to unify chroma subsampling of videos which affects evaluating complexity. All

¹C. Chen et. al., “A Subjective Study for the Design of Multi-resolution ABR Video Streams with the VP9 Codec,” 2016.

videos were converted to YUV 4:2:0 chroma subsample. Distribution of obtained samples compared to samples from previous codec comparisons is shown in Figure 102.

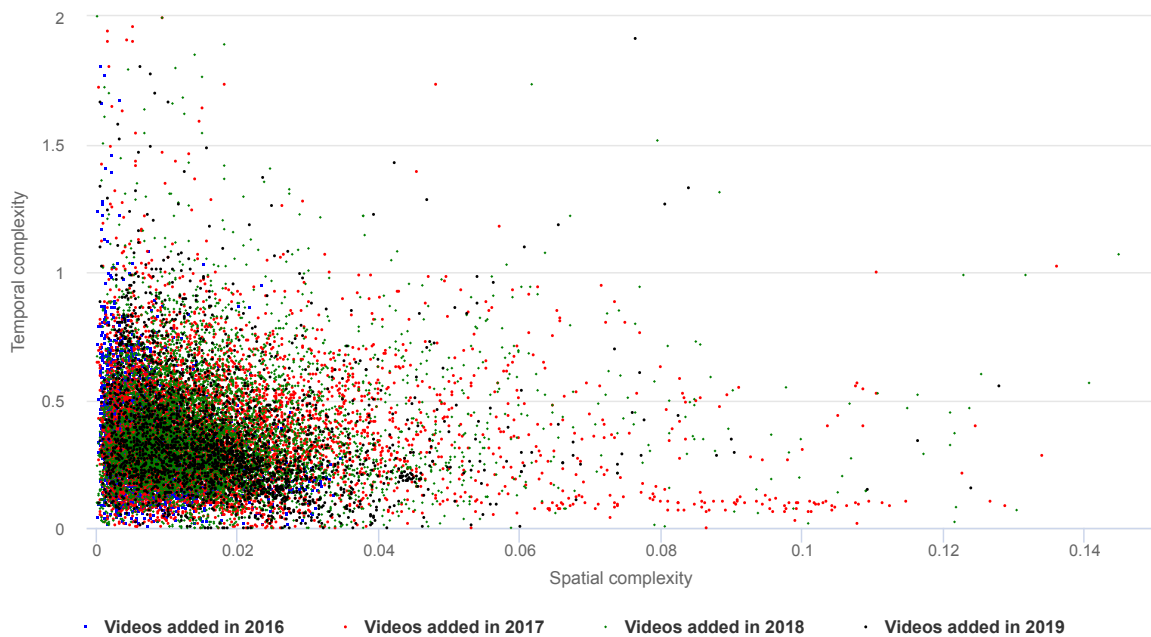


Figure 102: Distribution of obtained samples.

This year, we conducted a voting to choose final set of 100 videos for the comparison. Participation in video selection was optional. We divided the video collection into 100 clusters. For each cluster, we randomly selected from 2 to 6 candidate videos that were close to the cluster centre and that had a license enabling derivatives and commercial use. Figure 103 shows the cluster boundaries and constituent sequences.

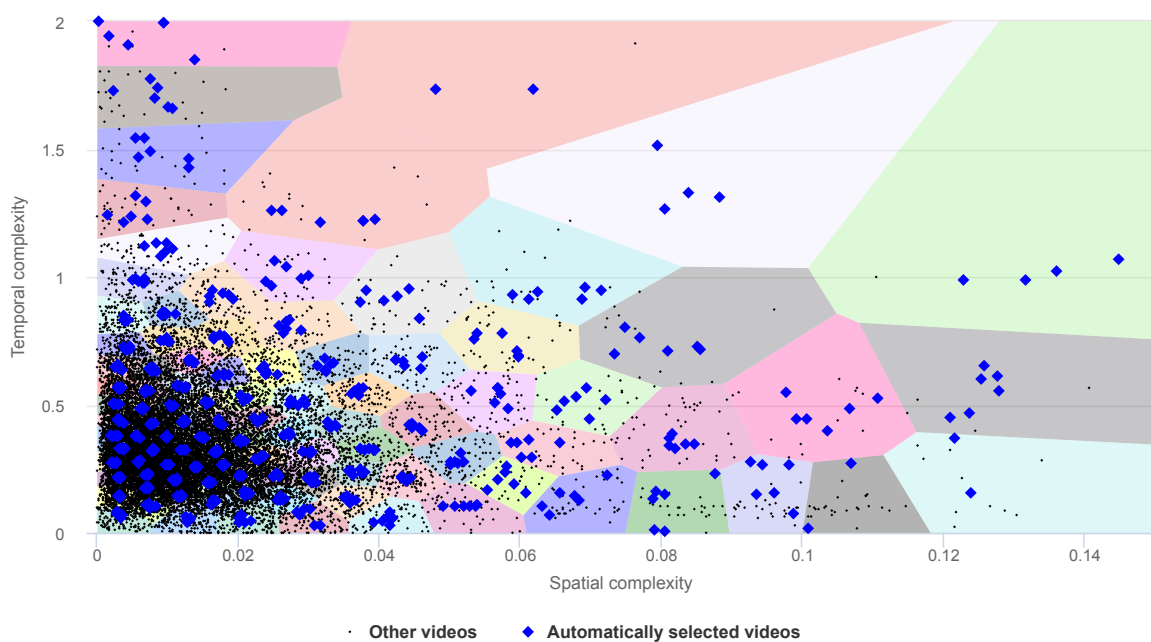


Figure 103: Segmentation of samples.

All comparison participants were invited to participate in video selection, and seven took part in it. Also, two organizers of comparison (Dr Dmitriy Vatolin and Dr Dmitriy Kulikov) and independent industry expert (Jan Ozer <https://streaminglearningcenter.com/about-jan-ozar>) took part in voting for final video set. Table 2 contains information about video selection participants.

Voter	Number of clusters to vote	Number of received votes	Vote weight
Dr. D. Vatolin	100	100	1
Dr. D. Kulikov	100	100	1
Jan Ozer	70	70	2
Participant #1	25	25	1
Participant #2	25	25	1
Participant #3	25	25	1
Participant #4	25	25	1
Participant #5	25	15	1
Participant #6	25	8	1
Participant #7	25	7	1

Table 2: Voted members of video selection.

For every participant, only a subset of clusters is available for voting. Each participant was suggested to choose one video in each of 25 given clusters. These clusters were chosen randomly, overlapped for different voters and equally covered all 100 clusters. A participant could change a vote until the end of voting. Fig. 104 shows the interface of video selection platform.

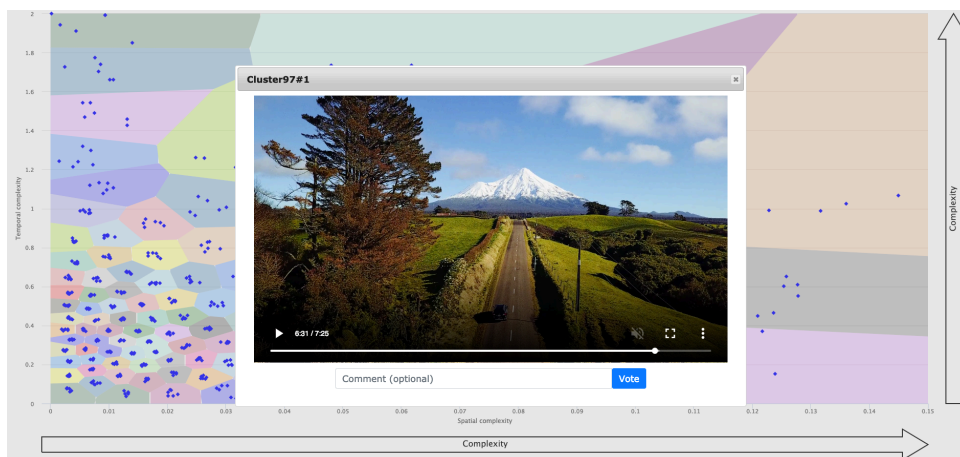


Figure 104: Video selection platform interface.

At the end of voting, videos with the highest number of votes were selected for the final comparison set. List of final videos and votes for them is presented in separate PDF with videos descriptions, and their distribution in SI/TI space among all videos from collection is shown in Fig. 105.

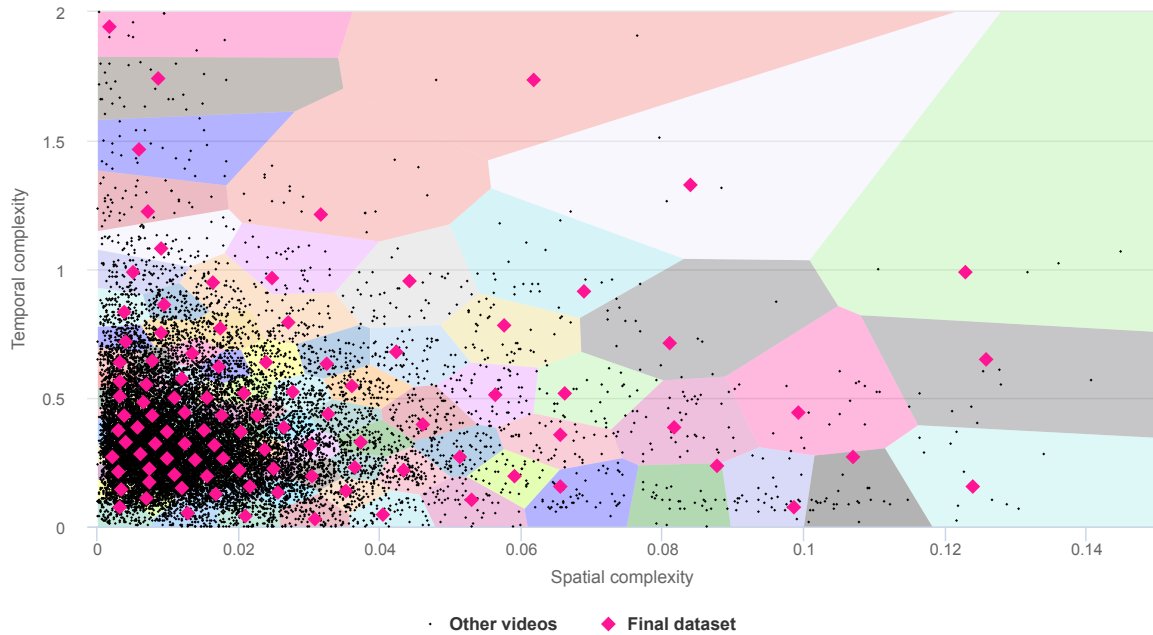


Figure 105: Distribution of sequences in final set.

The new data set consists of 100 sequences: 8 from the old data set and 92 new ones from Vimeo and xiph.org. The average bitrate for all sequences in the final set is 218.9 Mbps, median – 143.2 Mbps. “City walk” (61.5 Mbps), “Nancy” (67.6 Mbps) and “Oman museum” (69.7 Mbps) sequences have minimal bitrates. The complete list of sequences for new data set appears in Appendix A.

We also compared the distribution of videos from xiph.org with clusters obtained from our data set from Vimeo. The result is presented on Figure 106. It shows that most of the videos from xiph.org database have high spatial and temporal complexity with which codecs rarely face in everyday life.

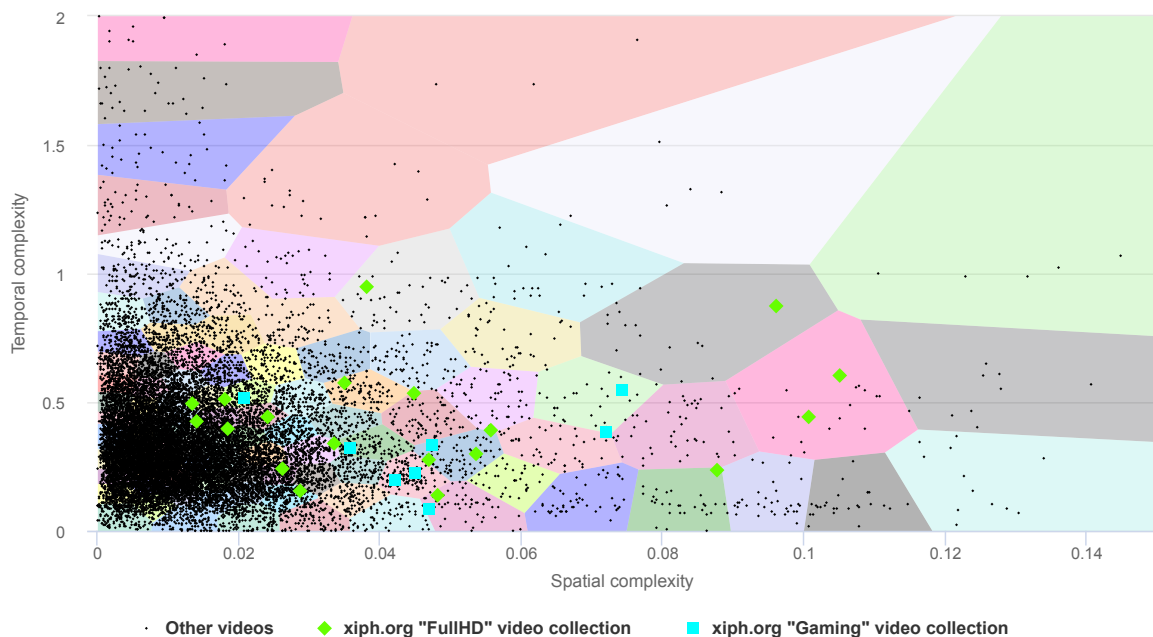


Figure 106: Comparison with xiph.org

C. ABOUT THE GRAPHICS & MEDIA LAB VIDEO GROUP



The Graphics & Media Lab Video Group is part of the Computer Science Department of Lomonosov Moscow State University. The Graphics Group began at the end of 1980's, and the Graphics & Media Lab was officially founded in 1998. The main research avenues of the lab include areas of computer graphics, computer vision and media processing (audio, image and video). A number of patents have been acquired based on the lab's research, and other results have been presented in various publications.

The main research avenues of the Graphics & Media Lab Video Group are video processing (pre- and post-, as well as video analysis filters) and video compression (codec testing and tuning, quality metric research and codec development).

The main achievements of the Video Group in the area of video processing include:

- High-quality industrial filters for format conversion, including high-quality deinterlacing, high-quality frame rate conversion, new, fast practical super resolution and other processing tools.
- Methods for modern television sets, such as a large family of up-sampling methods, smart brightness and contrast control, smart sharpening and more.
- Artifact removal methods, including a family of denoising methods, flicking removal, video stabilization with frame edge restoration, and scratch, spot and drop-out removal.
- Application-specific methods such as subtitle removal, construction of panorama images from video, video to high-quality photo conversion, video watermarking, video segmentation and practical fast video deblur.

The main achievements of the Video Group in the area of video compression include:

- Well-known public comparisons of JPEG, JPEG-2000 and MPEG-2 decoders, as well as MPEG-4 and annual H.264 codec testing; codec testing for weak and strong points, along with bug reports and codec tuning recommendations.
- Video quality metric research; the MSU Video Quality Measurement Tool and MSU Perceptual Video Quality Tool are publicly available.
- Internal research and contracts for modern video compression and publication of MSU Lossless Video Codec and MSU Screen Capture Video Codec; these codecs have one of the highest available compression ratios.

The Video Group has also worked for many years with companies like Intel, Samsung and RealNetworks.

In addition, the Video Group is continually seeking collaboration with other companies in the areas of video processing and video compression.

E-mail: video@graphics.cs.msu.ru



D. SEQUENCES VOITING RESULTS

Video	D. Vatolin	D. Kulikov	J. Ozer	P1	P2	P3	P4	P5	P6	P7
African Village	+	-	+		+	-				-
Airport Interview	+	-					-		+	+
Animation Clip	+	+								
Ariadnes Thread	+	-			+					
Bad Sleep	+	-	+							
Bagpipes	+	+	-		+		-			
Carnival	+	+								
Carpets	+	-	-	+		+			+	
Castle	-	-	+				-			+
Cg Figures	+	+								
Cherry Up	+	-	+							
Christmas Cats	+	+								
Cion	+	+								
City Panorama	+	+								
City Walk	+	-	+				-			
Colliers Wood	+	-	-			+				+
Controlled Burn	+	+	-		+			-		
Cookie Jam	+	-	+				-		+	
Craft Beer	+	+				-				
Crazy Bar	+	-	+							
Creek Kooler	-	+	+					-		-
Crowd Run	+	+				-				
Dancing Party	+	-	+				+		+	-
Dancing People	+	+	-							+
Desert	+	+								
Dj Show	+	+				-				
Drakenboot	+	+	-		+					
Field Milton Academy	-	+	-				+			+
Film	-	+	+							

Film Promo	+	+	+		-		+
Final Cut Lesson	-	+	+				-
First Things First	+	-	+	+	-		-
Flower Shop	+	+					
Glass Production	+	-	+			-	
Golden Bear	+	+	+			+	-
Graduation	+	+					
Greenscreen Talks	-	-	+		+		
Gta5	+	+	+			-	+
Guitar Show	+	-	+			-	
Gun Stuff	-	+	+	+	-		-
Gun Stuff Promo	+	-	+				
Hallelujah	+	-	+			-	
Historic Mansion	+	+	-		+		
Hotel Adword	-	-	+		+		+
Infinif	-	+	+		+		-
Interactive Newspaper	+	-	+			-	
Interview At The Expo	-	+	+		+		-
Italy History	+	+			-		
Judy Trailer	+	-			+		
Kayak Trip	+	+	+			-	
Keeping Warm	-	+	+				-
Kobe Bryant	-	+	+				
Laser Cutter	+	+	-		+		-
Love Story	+	-	+	+	-		-
Magazine Advertisement	+	-	+	+	-		
Making Alcohol	+	-					+
Manhattan Bridge Views	+	-	+	+		-	+
Mercedes	+	-	+				
Music Clip	+	+	-	-			+
Music Fantasy	+	+	-	+		+	
Nancy	+	-	-		+	-	+
New York Bakery	+	+	-	-	+	-	+

Newsy	+	-	+				-
Night Pursuit	+	+					
Nina Music Video	+	-	+				
Nurse Interview	+	-	+				+
Off The Wall	-	+			+	+	-
Old Message	-	+	+				-
Oman Museum	+	+			-		
Pebble Beach	+	-	+		+		-
Pet Photography	+	+	-				+
Preparation For The Celebration	+	+	-		-	+	+
Prism	+	-	+		-		+
Professor	+	+					
Psychotherapy	+	+	+			-	
Rugby	+	-	+				-
Rust	+	+			-		
Sad Day	+	+					
School Promo Video	-	+	+		+	-	-
Sea Sunrise	+	+	-			-	+
Simple Animation	+	+	+			-	-
Skiing Learning	+	-				-	+
Slow Motion Clip	+	+					
Snow Mnt	+	+	+			-	-
Sports Team	+	+	-			+	
Street Show	+	-	+			+	+
Surfing	+	+				-	
Terry Cage	-	+			+		
Theater Show	+	+	+			-	-
Tractor	+	-	+				-
Tribute	+	-	+		-	-	+
Video In Video	+	-	+				-
Walk With Children	+	+					
Wedding Party	+	-	+		+	-	-
Wedding Walk	+	+					

Will And Hannah	-	+	-		+		+
Work Under The Microscope	+	+	-		+		
Wuyue	+	-	+				+
Zombie Apocalypse	+	+			-		
Zulu International	+	-	+	-		+	-

Table 3: List of selected sequences and their votes.