

# How to measure the relevance of a retargeting approach?

ECCV'10, Greece, 10 September 2010



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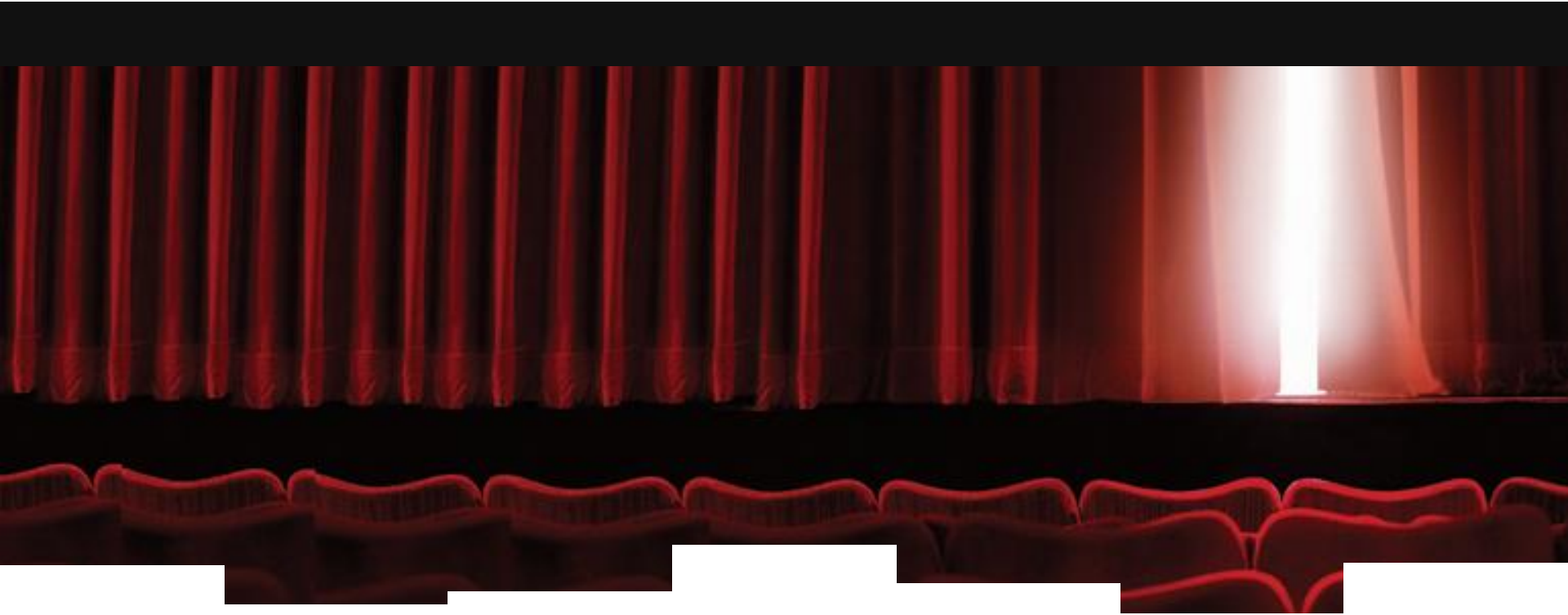
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# Content

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- Introduction
- Retargeting relevant factors
- Proposed metric
- Validation
- Conclusion & Perspectives

# Introduction



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# Context

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## Retargeting for small screen devices in mobile/broadcast applications



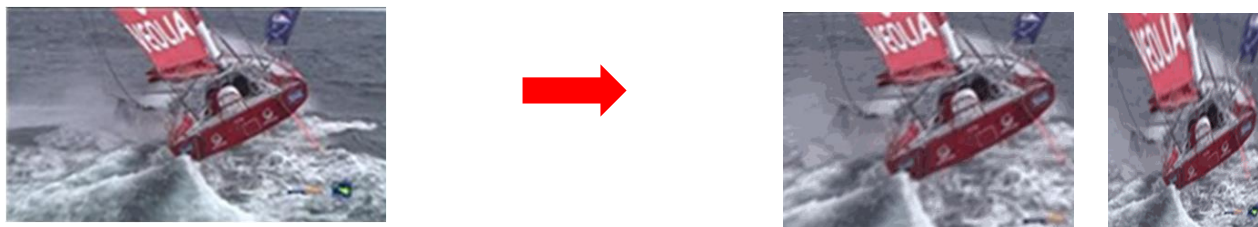
# State of the Art: Uniform Transform

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Linear transform: Sub-sampling, pillar-box, letter-box

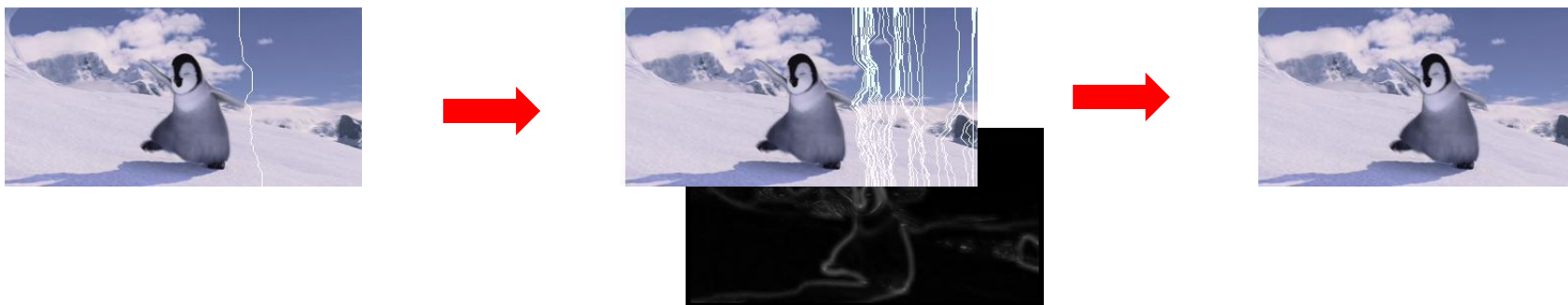


Non-linear transform: Scaling, Warping, Anamorphic

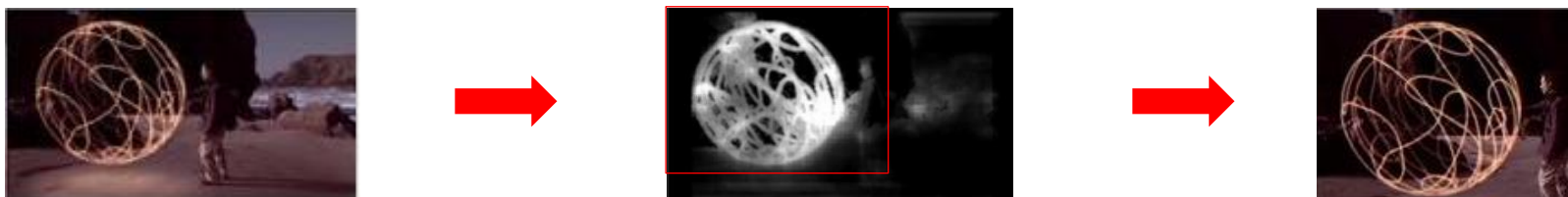


# State of the Art: Content Aware Reframing

## Seam Carving



## Adaptive Cropping



## Constrained Approaches

- Shape/Structure preserving approaches
- Energy based deformations
- Region-based adaptive warping/sampling

## Mixed

- Crop, scaling and warp/seam carving approaches

# Some examples (Images)

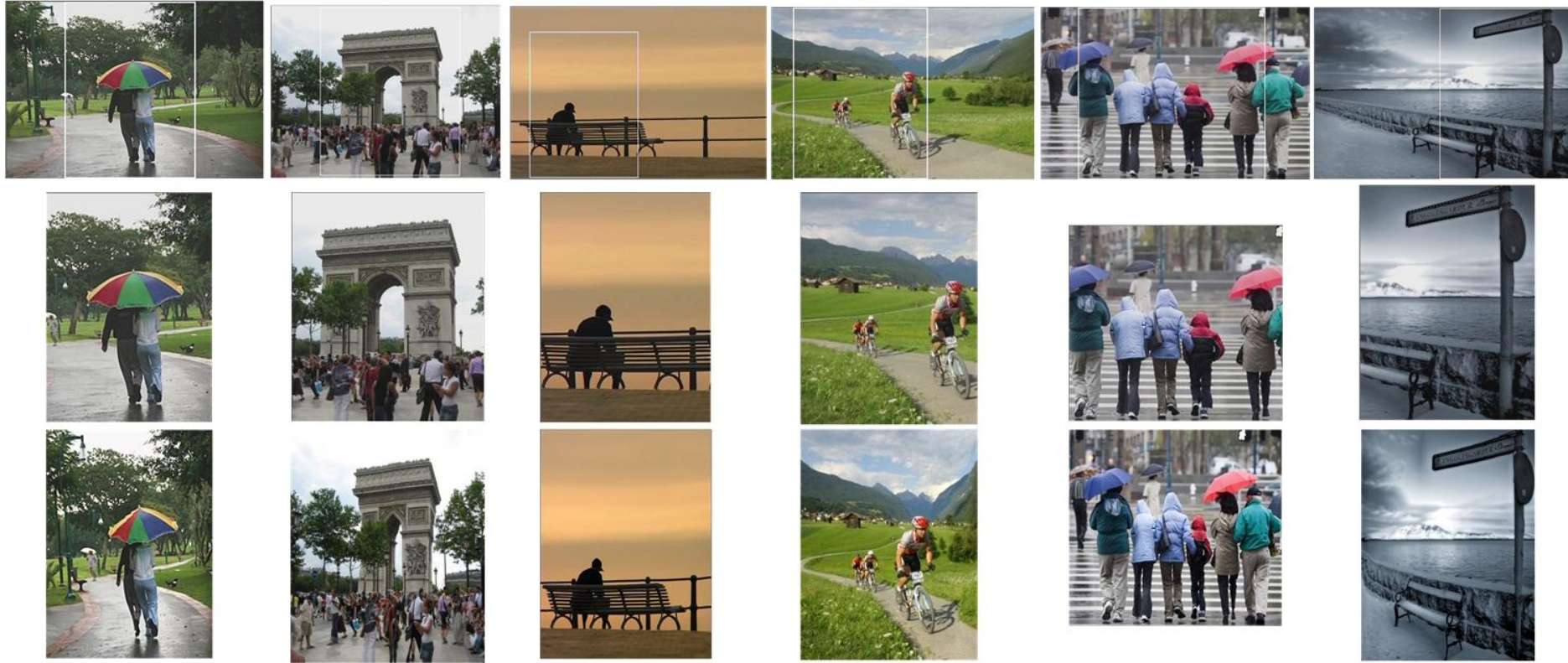
Original + window

Adaptive  
Cropping

Seam  
Carving

Adaptive Cropping (Chamaret C., Le Meur O., ICPR 2008)

Seam Carving (Avidan S., Shamir A., SIGGRAPH 2007)



# Some examples (Video)

Original + window

Down-sampling

Reframing

Linear Transform (Sub-sampling)

Adaptive Cropping (Chamaret C., Le Meur O., ICPR 2008)



# Factors Impacting the Reframing Efficiency

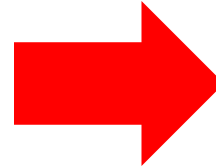


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# Scene consistency

- Objects shape
- Distance between objects
- Aspect ratio
- Image Distortion



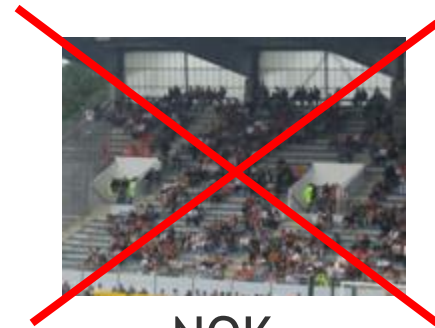
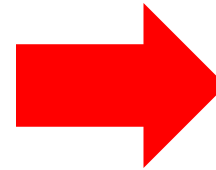
NOK



OK

# Spatial consistency

- Keep relevant information in the final image
- But zooming for improved comfort



NOK



OK

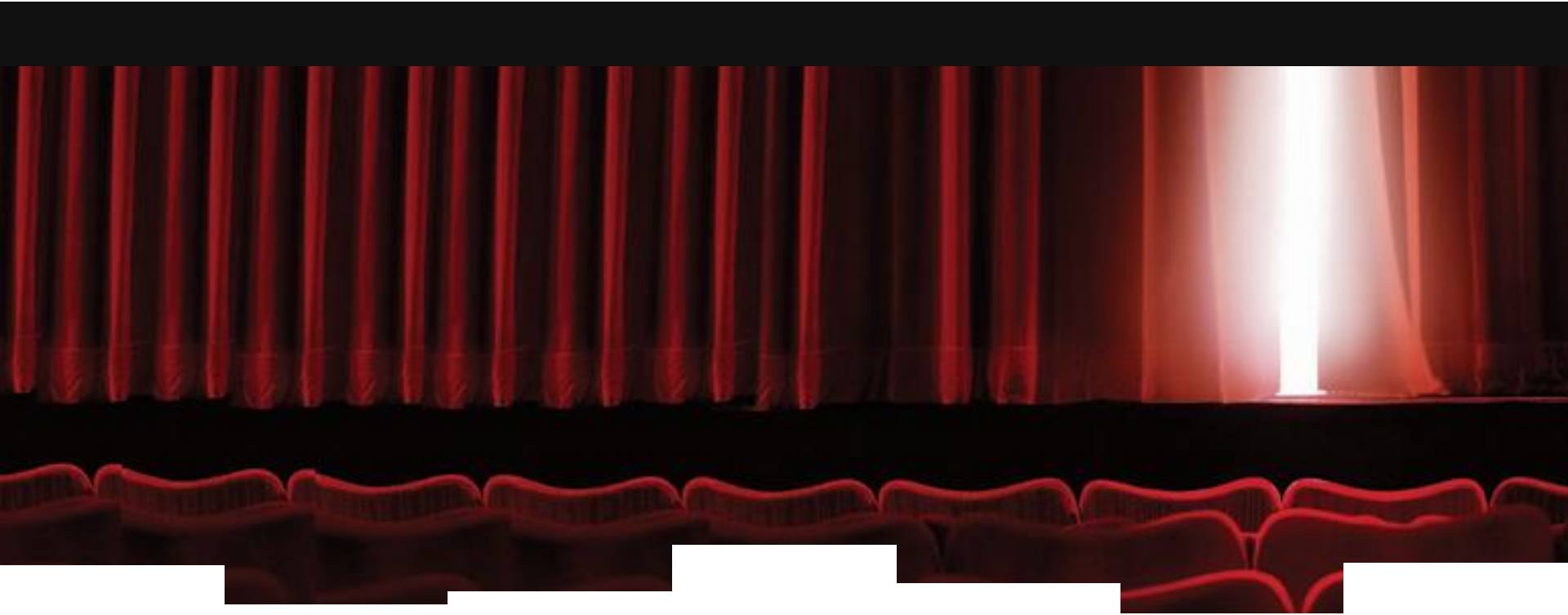
# Temporal consistency & stability

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- Temporal consistency between frames to prevent visual annoyances
  - Consistent for frame to frame
  - Simulate shooting & camera motion
  - Manage scene cuts



# Proposed Assessment Metric



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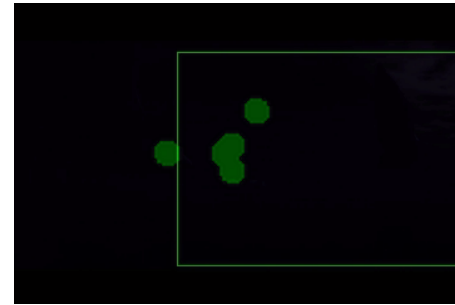


# Definition

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Based on the use of eye-tracking data

- Real users, content dependent
- Compare computed cropping window (CW or BB) to observers fixation points (FP)



Taking into account...

- Scene consistency
- Spatial consistency
- Temporal consistency and stability (natural motion)
- Comfort (Zoom)

# Definition

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## Quality computation

$$Q = f \left( p_f(t) \times \frac{100}{100 + coh_c(t)^\gamma} \times \frac{100}{100 + coh_z(t)^\beta} \times \frac{100}{100 + g(z(t), z_{opt}(t))^\alpha} \right)$$

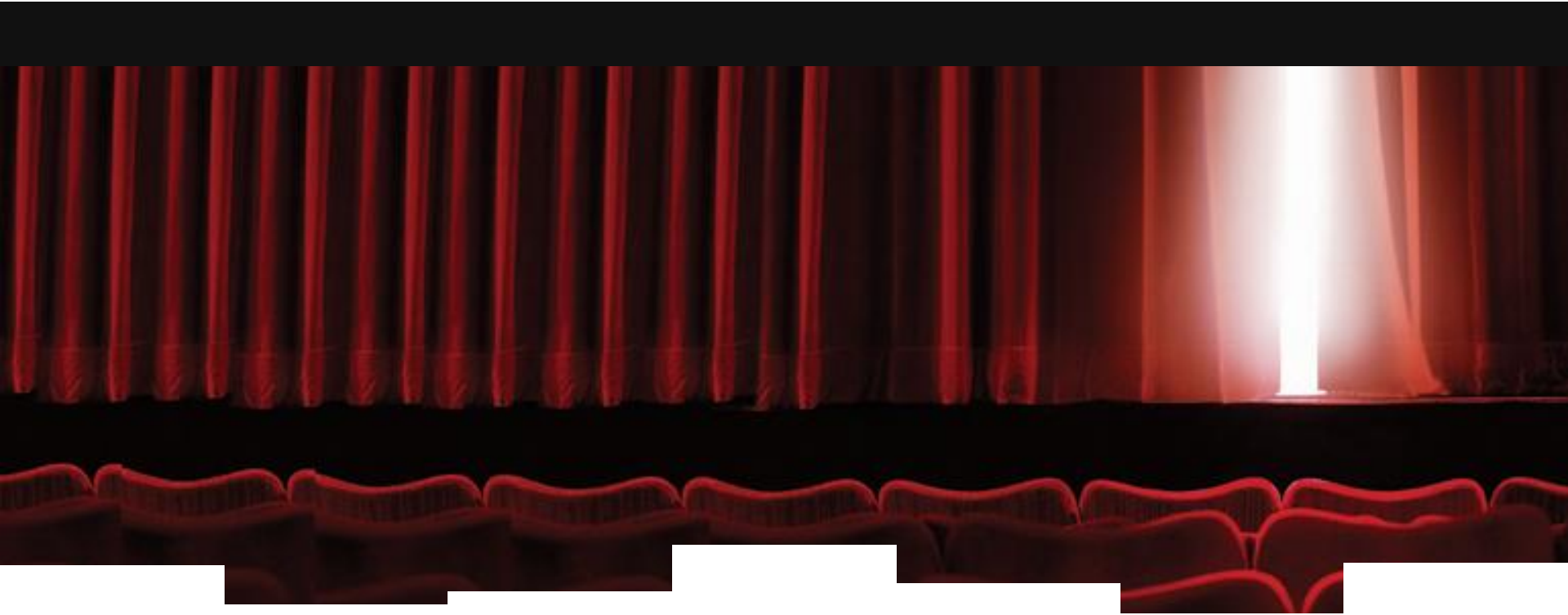
- $P_f$ : preservation of visually important areas (% of FP inside BB)
- $Coh_c$ : temporal variations of the reframing (bounding box)
- $Coh_z$ : temporal variations of the coverage ratio (zoom)
- $g$ .: distance between current coverage ( $z$ ) and optimal coverage ratio ( $z_{opt}$ )
- $f$ .: pooling function
- $a, B, \gamma$ : coefficients

# Limitations

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- Image distortions are not taken into account
  - *could be done through  $P_f$*
- The position of the window compared to the scene content is not taken into account
- $Z_{opt}$  is fixed
- The different factors functions are probably too simple

# Validation



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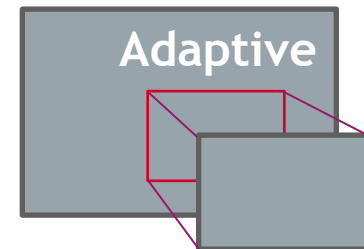
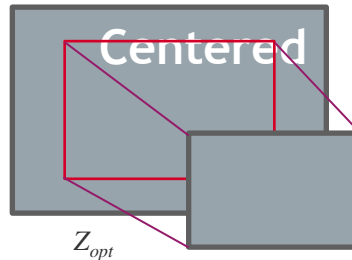
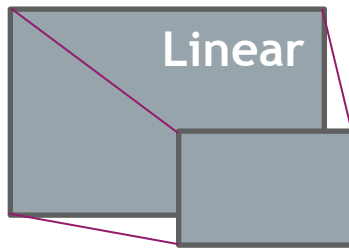


# Context (1/3)

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## Retargeting Algorithms

- Linear distortion
- Centered cropping
- Adaptive reframing based on RoI (Chamaret C., Le Meur O., ICPR 2008)
  - *With and without temporal stability processing*



*with and w/o temporal filtering*

# Context (2/3)

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## Video Sequences

- Format: IN: 720x480 OUT: 360x240
- 4 sequences: Movie, Cartoon1, Cartoon2, Sports



Clip	Number of observers	Spatial resolution	Length (frames)	Type
Movie	16	720 × 480	1000	Trailer (action)
Cartoon1	16	720 × 480	1200	Trailer (cartoon)
Cartoon2	16	720 × 480	2000	Trailer (cartoon)
Sports	16	720 × 480	2000	basketball, soccer, cycling...

# Context (3/3)

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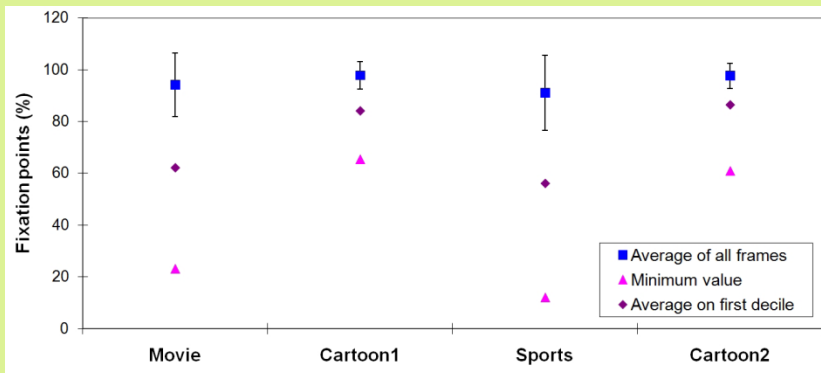
## Metric

<i>Algo</i>	<i>Pf</i>	$coh_c$	$coh_z$	$Z-Z_{opt}$
Linear	Distortion factor (1)	0	0	0.5/0.35
Centered	FP in BB	0	0	0
Adaptive	FP in BB	$\frac{\partial}{\partial t}$ BB position	$\frac{\partial}{\partial t}$ zoom	f(zoom)

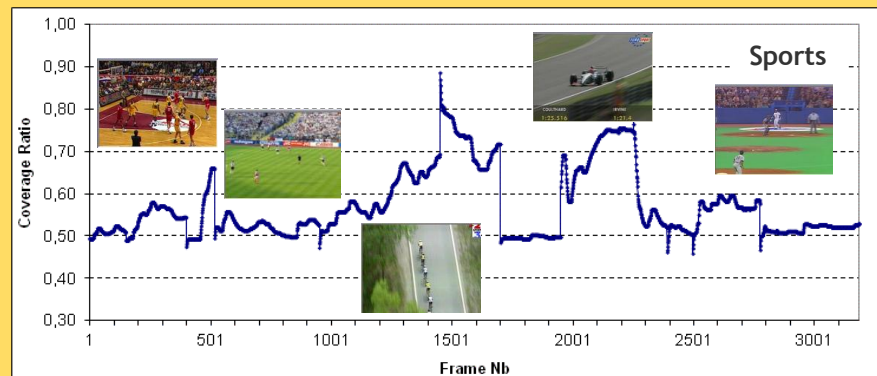
$Z_{opt} = 0.5$  or  $0.65$  (16:9 movie)

# Results on the individual functions

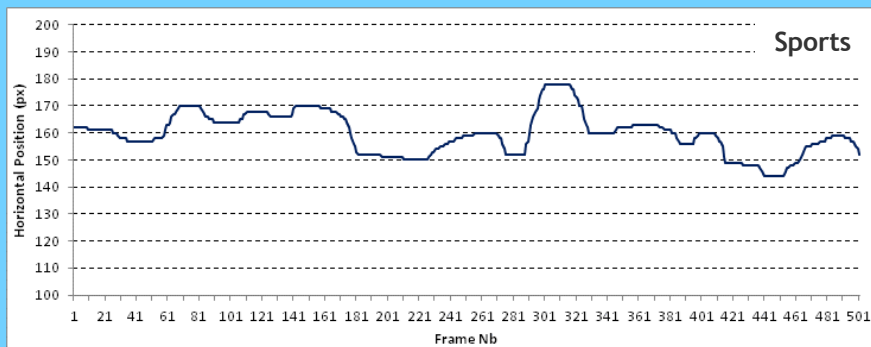
*P<sub>f</sub>*: preservation of visually important areas



*Coh<sub>z</sub>*: temporal variations of the coverage ratio (zoom)



*Coh<sub>c</sub>*: temporal variations of the cropping window center



# Quality Metrics: Global Results

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## Global Results Q [x100]

- $Z_{opt}=0.5/0.65$  (Movie);  $f$ .: average;  $a=\beta=1$ ,  $\gamma=3$

$$Q = f \left( p_f(t) \times \frac{100}{100 + coh_c(t)^\gamma} \times \frac{100}{100 + coh_z(t)^\beta} \times \frac{100}{100 + g(z(t), z_{opt}(t))^\alpha} \right)$$

<i>Algo</i>	<i>Min</i>	<i>Max</i>	<i>average</i>
Linear	66.67	74.1	72.84
Centered	56.78	100.00	96.92
Adaptive (w/o temp)	33.22	100.00	51.08
Adaptive (with temp)	35.49	99.77	86.47

# Quality Metrics: Results per sequences

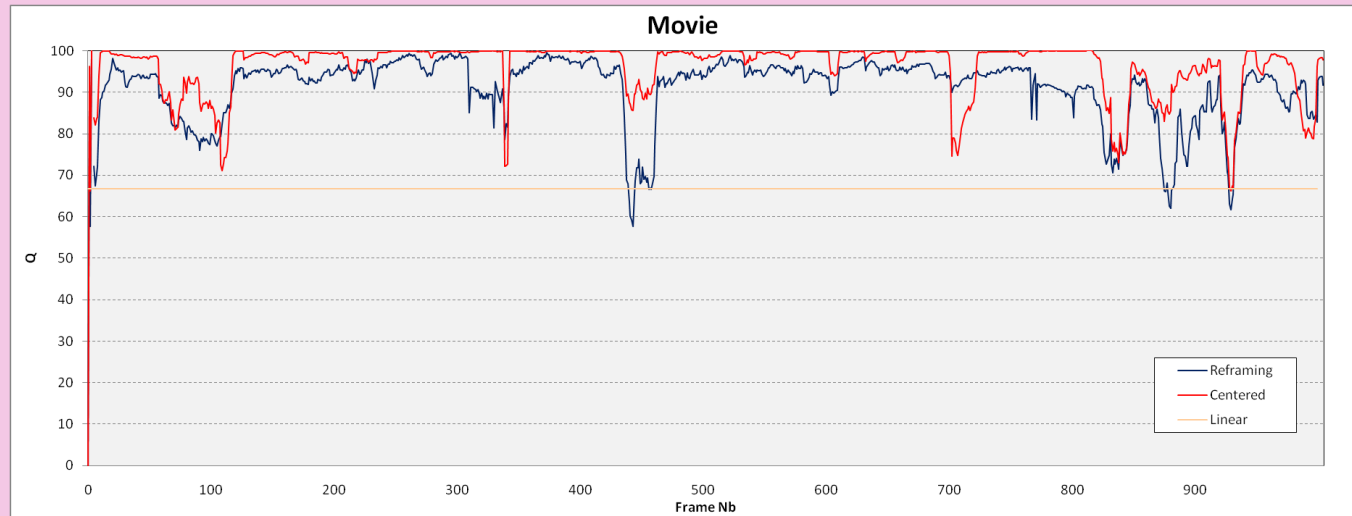
## Results Q [x100]

- $Z_{opt}=0.5/0.65$  (Movie);  $f$ .: average;  $a=\beta=1$ ,  $\gamma=3$

$$Q = f \left( p_f(t) \times \frac{100}{100 + coh_c(t)^\gamma} \times \frac{100}{100 + coh_z(t)^\beta} \times \frac{100}{100 + g(z(t), z_{opt}(t))^\alpha} \right)$$

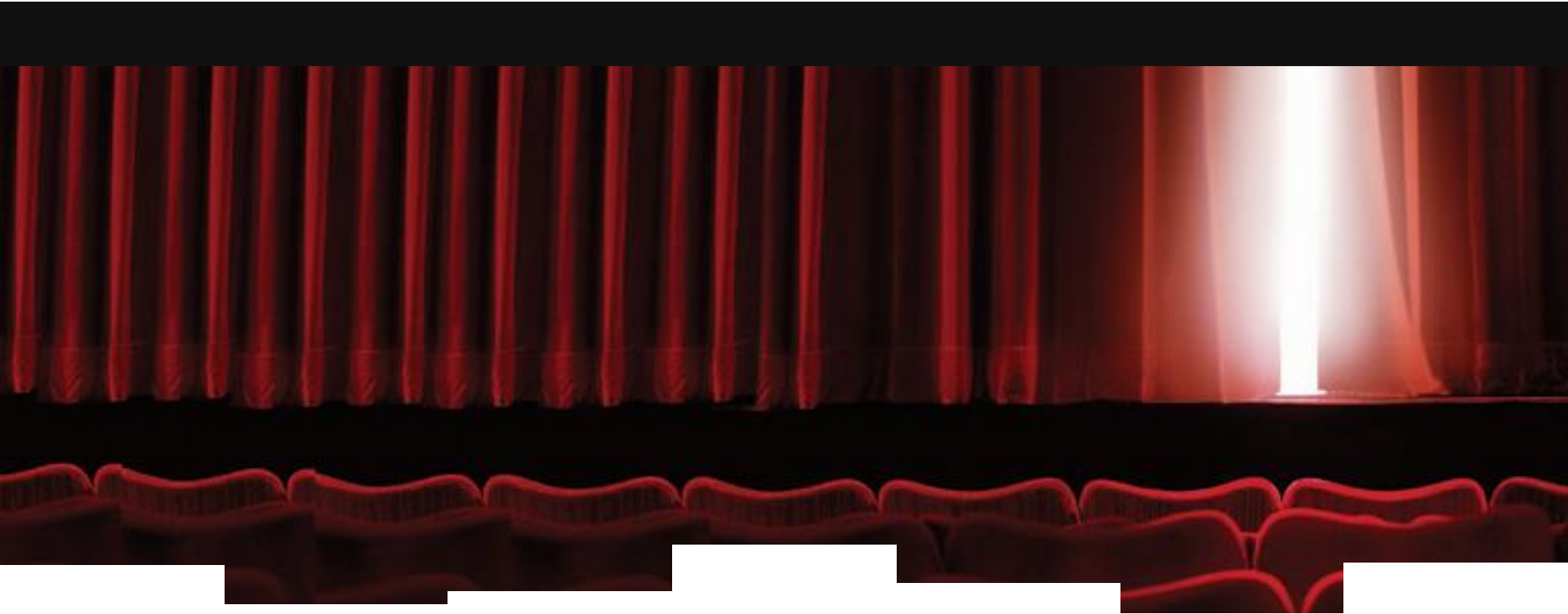
<i>Algo</i>	<i>Movie</i>	<i>Cartoon1</i>	<i>Cartoon2</i>	<i>Sports</i>
Linear	66.67	74.07	74.07	74.07
Centered	96.16	98.98	98.90	94.24
Adaptive (w/o temp)	60.31	66.99	66.34	64.69
Adaptive (with temp)	91.22	91.34	99.77	98.65

# Quality Metric: Results for *Movie*



Movie	$Q$	$P_f$	$coh_c$	$coh_z$	$z-z_{opt}$
Linear	66.67	100.00	0	0	50
Centered	96.16	96.16	0	0	0
Adaptive	91.22	95.49	[0-4]	[0-7]	[0-12]

# Conclusion



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# Conclusions & Perspectives

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## Metric

- Takes into account accuracy and stability in both spatial and temporal dimensions
- Includes “Comfort” metric (zoom)
- Applied to different reframing schemes

## Improvements

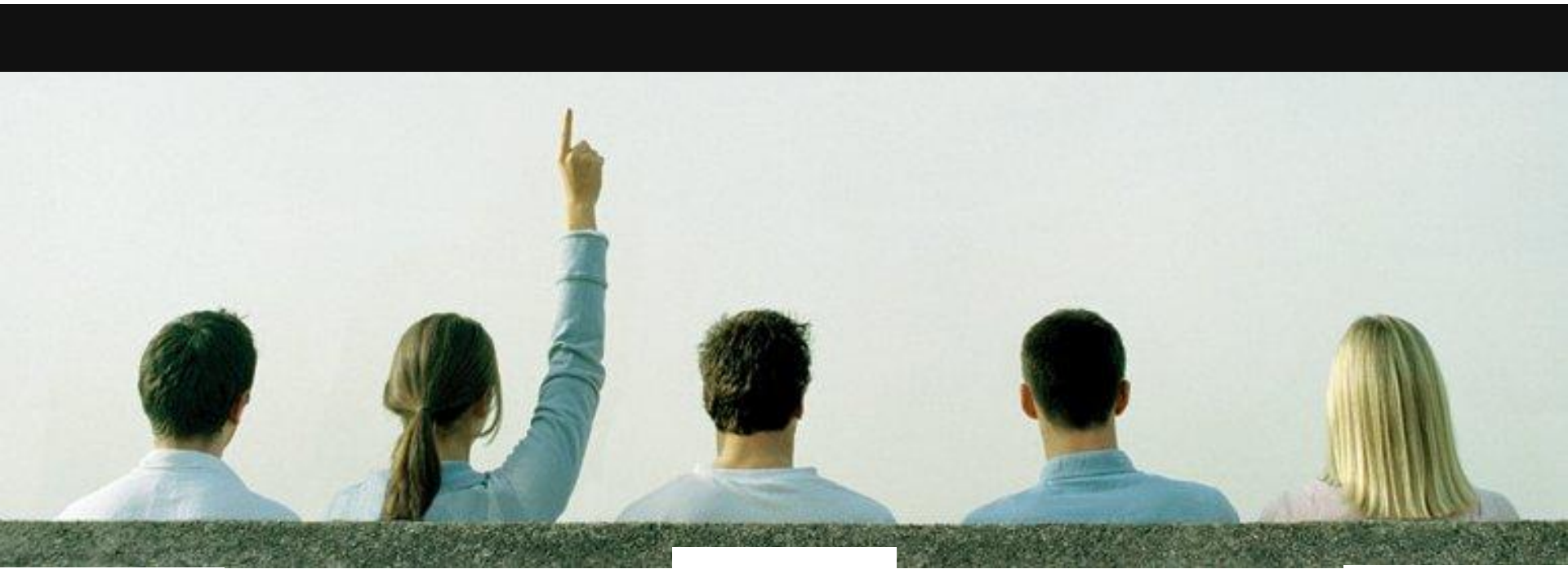
- Inc. Specific distortion factor
- Inc. Quality factor for the positioning of the window
- Take into account scenes cuts for the two *coh* factors
- Compute metric on other reframing schemes to complete validation
- Perform subjective tests to validate the metric

## Supplemental materials

- Video: <http://www.thlab.net/~guillotelp/publications/ECCV10-Reframing.avi>

# Thank you

*Special thanks to Fabrice Urban for the computation of the results*



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# Annex

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