

# Transient Attributes for High-Level Understanding and Editing of Outdoor Scenes



more “warm”



more “moist”



more “winter”

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The appearance of an outdoor scene changes over time



*Cracow four  
seasons timelapse  
by Piotr Wancerz -  
[www.timelapsemedia.pl](http://www.timelapsemedia.pl)*

# Our goals

- Recognize high-level properties of an outdoor scene



{ during autumn  
sunny  
some clouds  
no snow  
daylight  
...

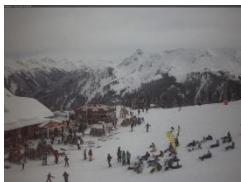
# Our goals

- Recognize high-level properties of an outdoor scene
- Edit scene properties in outdoor photographs



“more autumn”

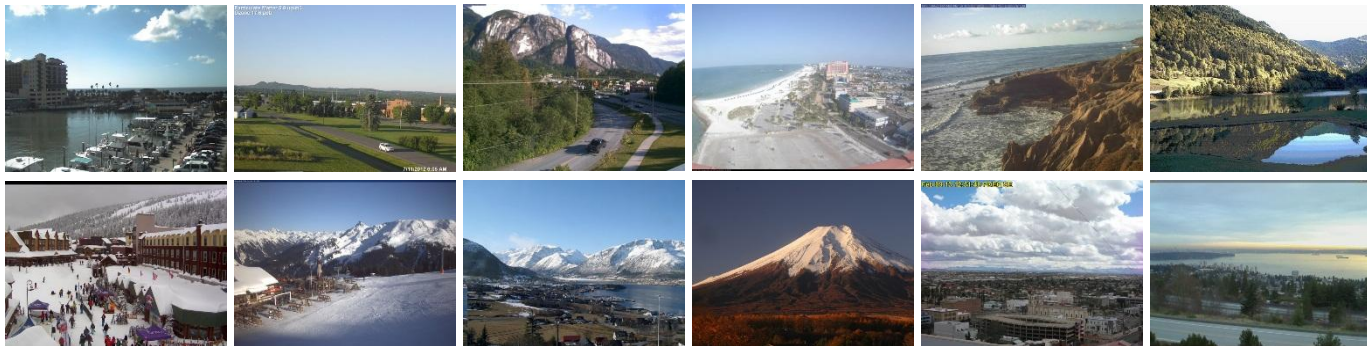






# Our webcam database

- Images from **static webcams** over **several months** from AMOS and Webcam Clipart datasets [Jacobs07,Lalonde09]
- 8571 images from 101 webcams



# Transient scene attributes

- High-level nameable properties [Patterson12,Kovashka12]
- Describe **variations within a scene** over time

# Transient scene attributes

- High-level nameable properties [Patterson12,Kovashka12]
- Describe **variations within a scene** over time
- 40 transient attributes
  - **Lighting**
  - Weather
  - Season
  - ...



Sunrise/sunset



Dawn/dusk



# Transient scene attributes

- High-level nameable properties [Patterson12,Kovashka12]
- Describe **variations within a scene** over time
- 40 transient attributes
  - Lighting
  - **Weather**
  - Season
  - ...



Rain



Sunny

# Transient scene attributes

- High-level nameable properties [Patterson12,Kovashka12]
- Describe **variations within a scene** over time
- 40 transient attributes
  - Lighting
  - Weather
  - **Season**
  - ...



Autumn



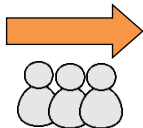
Winter

# Collecting attribute labels

- Gather crowdsourced labels for all images & attributes
- Combine annotations from multiple reliable workers



Annotation



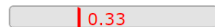
**sunrise/sunset**



**sunny/direct sun**



**clouds/overcast**



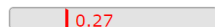
**summer**



**winter**



**glowing/radiant**



**dry**



**gloomy/depressing**



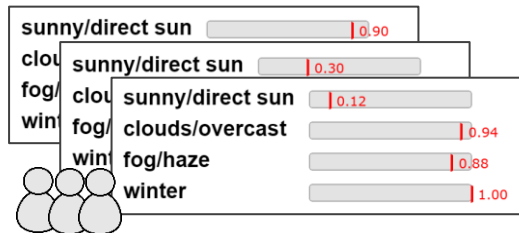
...

# **Recognizing transient attributes in new images**

# Training attribute regressors



Training images



Training annotations

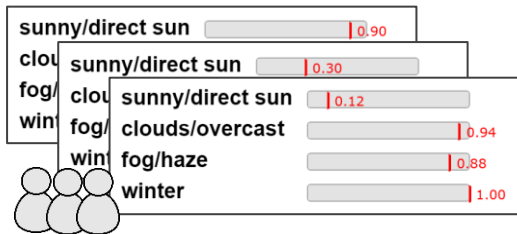
# Training attribute regressors



Training images



Image feature extraction  
[Xiao10, Patterson12]



Training annotations



# Training attribute regressors



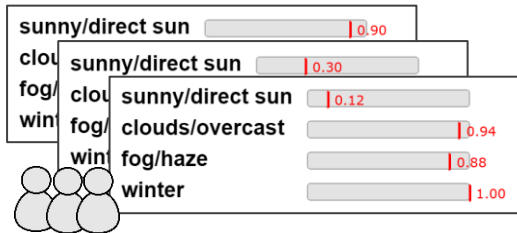
Training images



Image feature extraction  
[Xiao10, Patterson12]



Fisher Vector encoding  
[Perronnin10]

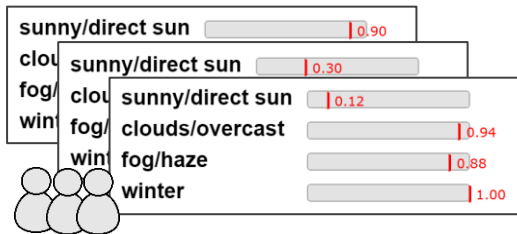


Training annotations

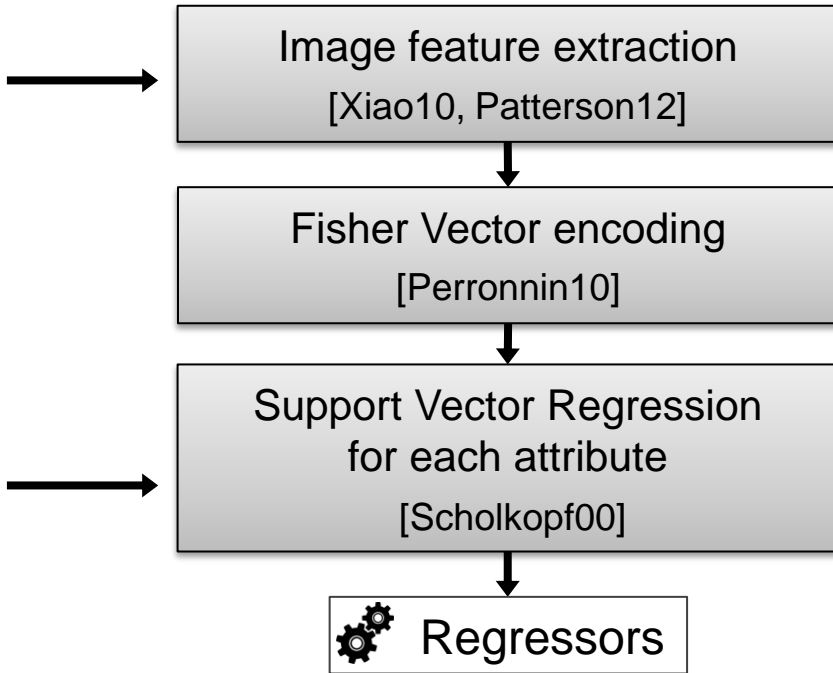
# Training attribute regressors



Training images



Training annotations



# Recognizing attributes in a new image



Input image

# Recognizing attributes in a new image



Input image



Image feature extraction  
[Xiao10, Patterson12]



Fisher Vector encoding  
[Perronnin10]

# Recognizing attributes in a new image



Input image

Image feature extraction  
[Xiao10, Patterson12]

Fisher Vector encoding  
[Perronnin10]

Attribute prediction



Regressors

sunny/direct sun	<div><div></div></div> 0.85
clouds/overcast	<div><div></div></div> 0.19
fog/haze	<div><div></div></div> 0.22
winter	<div><div></div></div> 0.01

Predicted attributes

with



Collection contains 582 images



more images (582) ▼



# **Attribute-based image editing**

# Attribute-based image editing

Input:



more



# Related work: high-level image editing

- Content-adaptive macros

[Berthouzoz11]



“Snow”  
macro



# Related work: high-level image editing

- Content-adaptive macros
- Example-based color transfer

[Berthouzoz11]

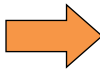
[Reinhard01, Pitie05]



Input image



Example image

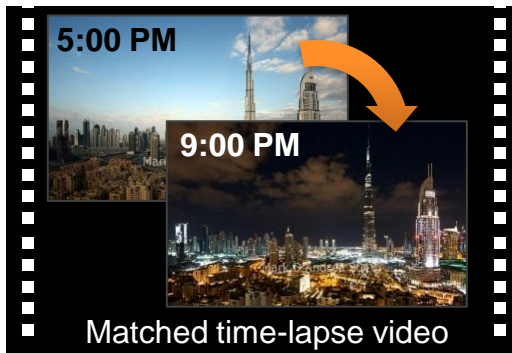


# Related work: high-level image editing

- Content-adaptive macros [Berthouzoz11]
- Example-based color transfer [Reinhard01, Pitie05]
- Data-driven manipulation of time of day [Shih13]



Input image



Matched time-lapse video



Output at 9pm

# Appearance changes observed in database



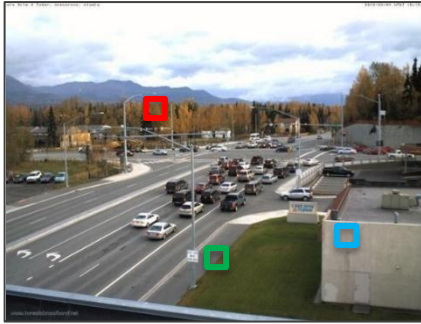
# Appearance changes observed in database



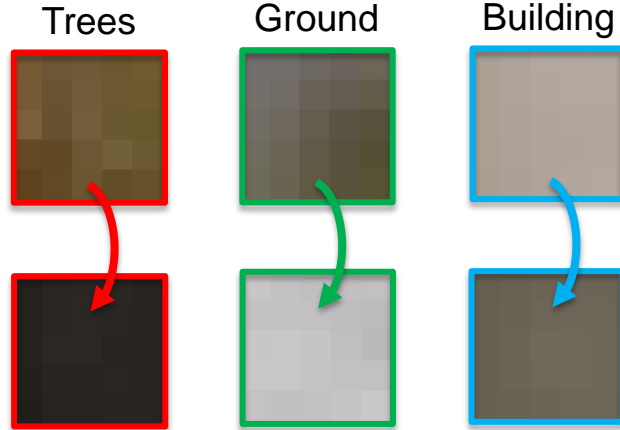
↓ “more winter”



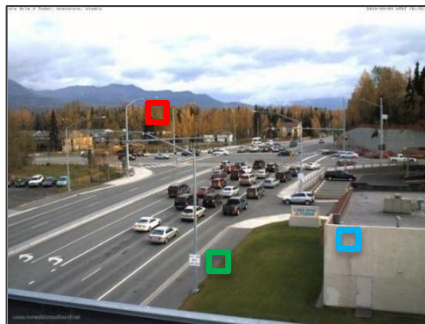
# Appearance changes observed in database



↓ “more winter”



# Appearance changes observed in database



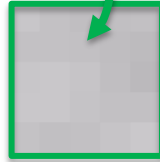
↓ “more winter”



Trees



Ground

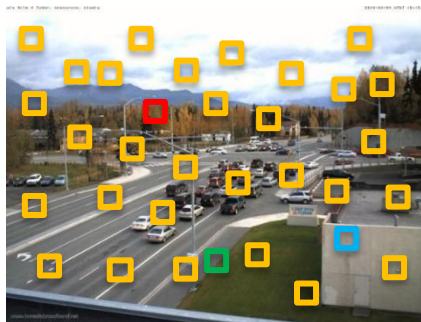


Building

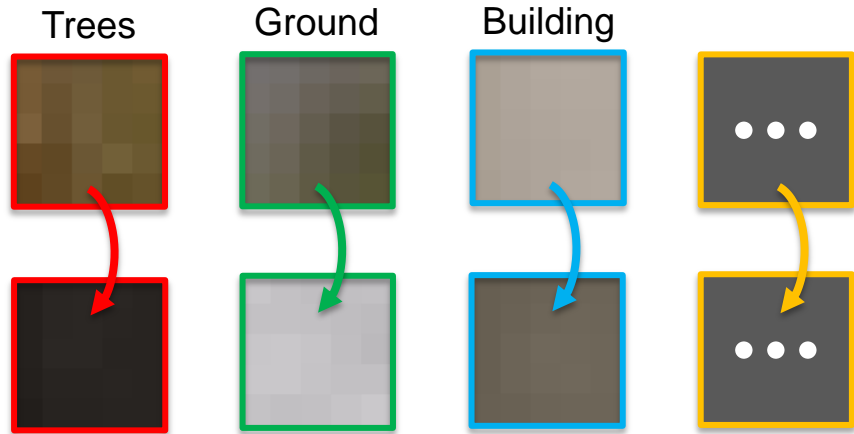
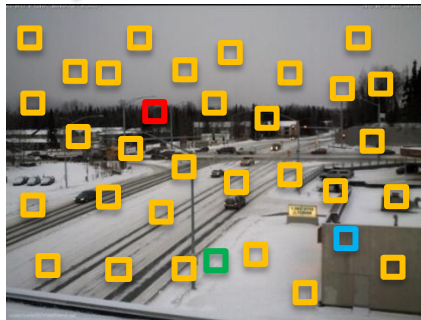


⇒ Learn local, region-dependent color transformations

# Appearance changes observed in database



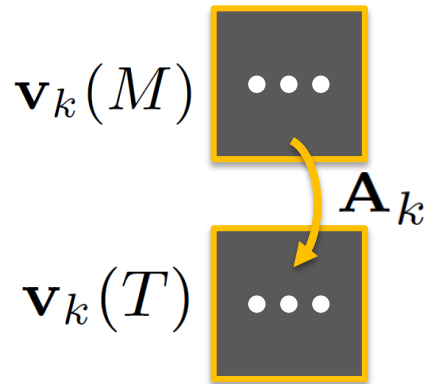
↓ “more winter”



⇒ Learn local, region-dependent color transformations

# Appearance changes observed in database

$$\operatorname{argmin}_{\mathbf{A}_k} \left\| \underbrace{\mathbf{v}_k(T)}_{\substack{3 \times N \text{ matrices} \\ N = 5 \times 5 \text{ pixels}}} - \mathbf{A}_k \underbrace{\mathbf{v}_k(M)}_{\substack{3 \times 3 \text{ matrix}}} \right\|_F^2$$



⇒ Learn local, region-dependent color transformations

# Appearance changes observed in database



↓ “more winter”



↓ “more cloudy”



↓ “more rain”



# Editing a new image – “more rain”



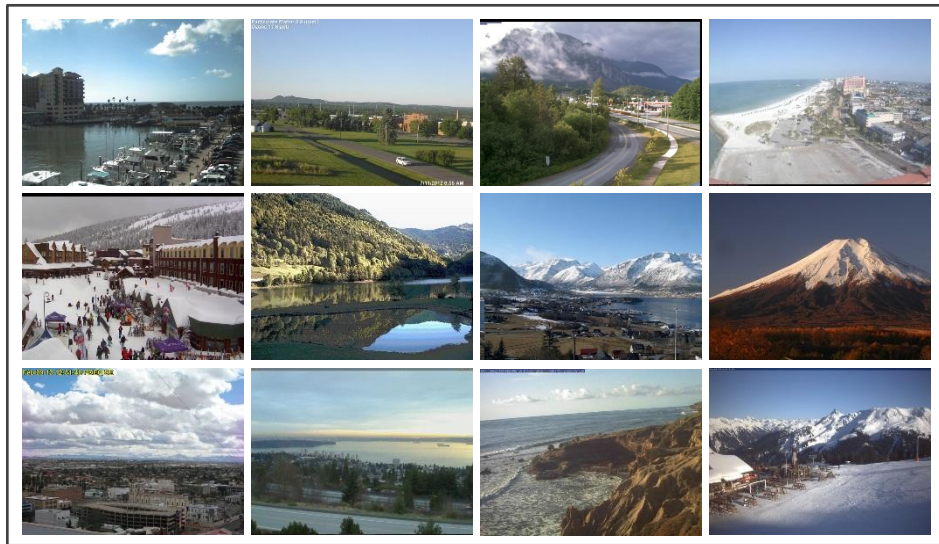
Input image



# Editing a new image – “more rain”



Input image



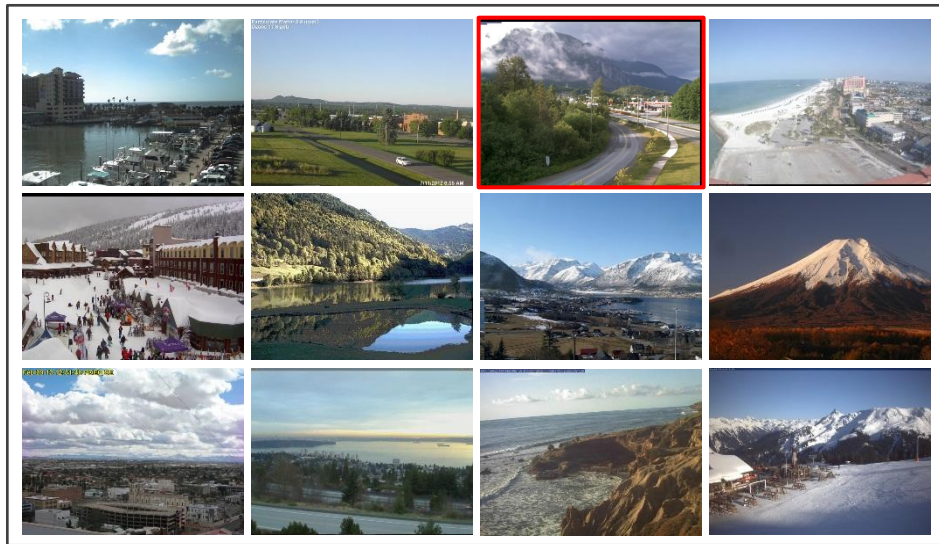
Transient attributes database



# Editing a new image – “more rain”



Input image



Transient attributes database

# Editing a new image – “more rain”



Input image



## Match image

- similar scene as input
- found automatically based on image features

# Editing a new image – “more rain”



Input image

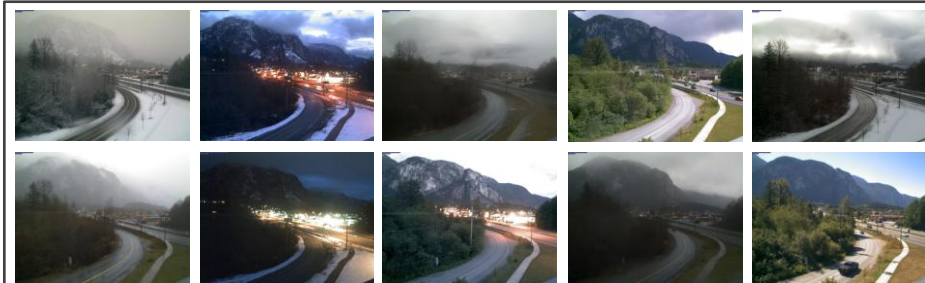


## Match image

- similar scene as input
- found automatically based on image features

rain

0.04



# Editing a new image – “more rain”



Input image



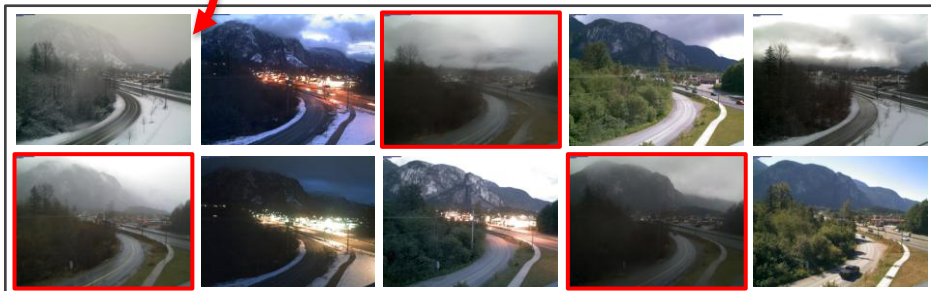
Match image

- similar scene as input
- found automatically based on image features

rain

0.04

“more rain”



# Editing a new image – “more rain”



Input image



## Match image

- similar scene as input
- found automatically based on image features

rain

0.04

“more rain”



## Target image

- from same webcam
- has desired attributes
- can be chosen by user

rain

0.98



# Editing a new image – “more rain”



Input image

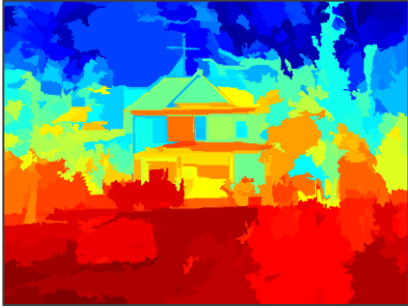


Match image

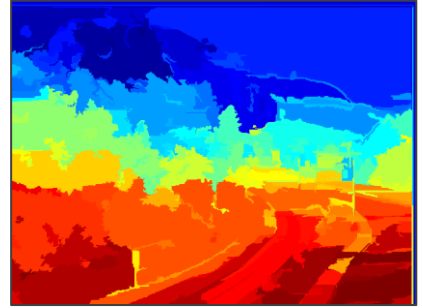


Target image

# Editing a new image – “more rain”



Input image segmentation

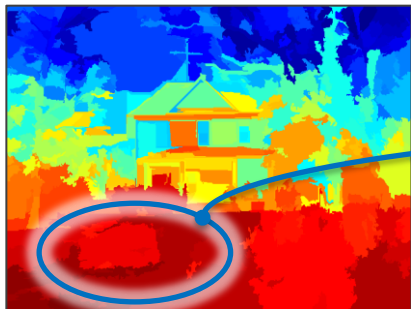


Match image segmentation



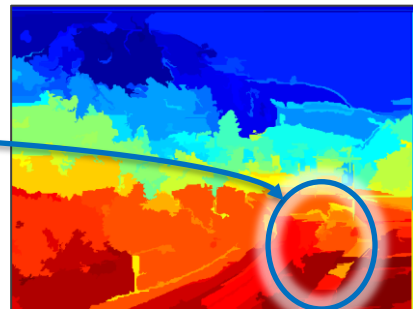
Target image

# Editing a new image – “more rain”



Input image segmentation

Segment correspondence



Match image segmentation



Target image



# Editing a new image – “more rain”

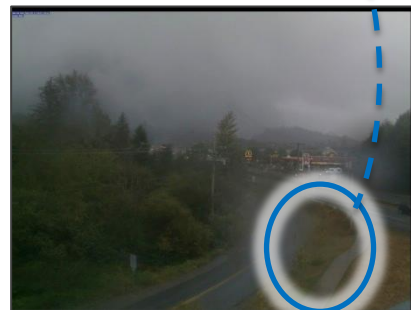


Input image

Segment correspondence



Match image



Target image

# Editing a new image – “more rain”



Input image

Segment correspondence



Match image



Target image

# Editing a new image – “more rain”

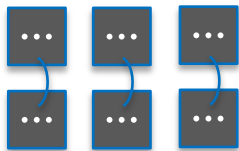


Input image

Segment correspondence



Match image



Local transforms  
in segment

Assign local  
transformations



Target image

# Editing a new image – “more rain”

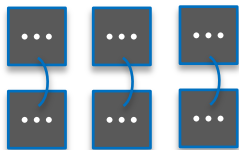


Input image

Segment correspondence

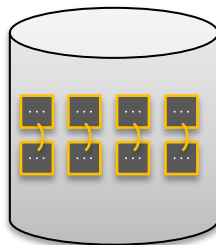


Match image



Local transforms  
in segment

Lookup precomputed  
transforms



Transform  
Library



Target image

# Editing a new image – “more rain”



Input image

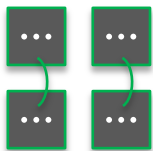
Segment correspondence



Match image

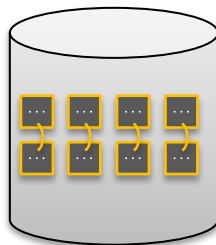


Target image



Local transforms  
in segment

Lookup precomputed  
transforms

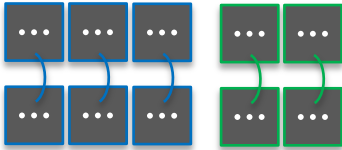


Transform  
Library

# Editing a new image – “more rain”



Input image



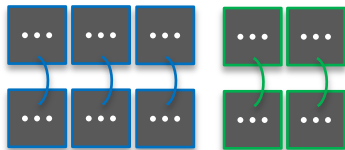
Local transforms  
for all segments



# Editing a new image – “more rain”



Input image



Local transforms  
for all segments



Result after applying per-segment transforms

# Editing a new image – “more rain”



Input image

**Filter color transforms  
spatially**

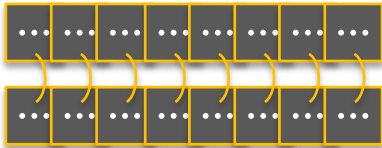
**cross-bilateral filter  
[Chen07]**



# Editing a new image – “more rain”



Input image

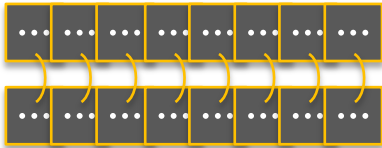


Per-pixel  
filtered transforms

# Editing a new image – “more rain”



Input image



Per-pixel  
filtered transforms



Final output – “more rain”

# Comparison to global color transfer



Input image



Target image



Result of [Reinhard01]



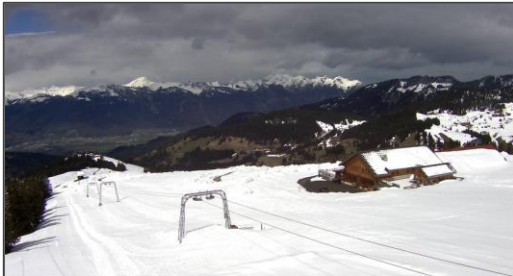
Result of [Pitie05]



Our result

# Limitations

- Data-driven technique: our annotated database currently contains 101 outdoor scenes
- Local color transforms cannot *create* texture or high-frequency details (e.g., winter to summer)





Input image (courtesy minque)



Input image (courtesy Roland Schweizer)



Input image (courtesy sabreguy29)





Input image (courtesy Charlie Dave)





# Conclusion

- *Transient Attributes Database*: outdoor webcam images annotated with attribute labels
- Regressors to recognize attributes in new images
- High-level image editing method guided by user-specified attribute changes
- Data and code available!

<http://transattr.cs.brown.edu>

# Transient Attributes for High-Level Understanding and Editing of Outdoor Scenes



more “warm”



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