



Scene Completion Using Millions of Photographs

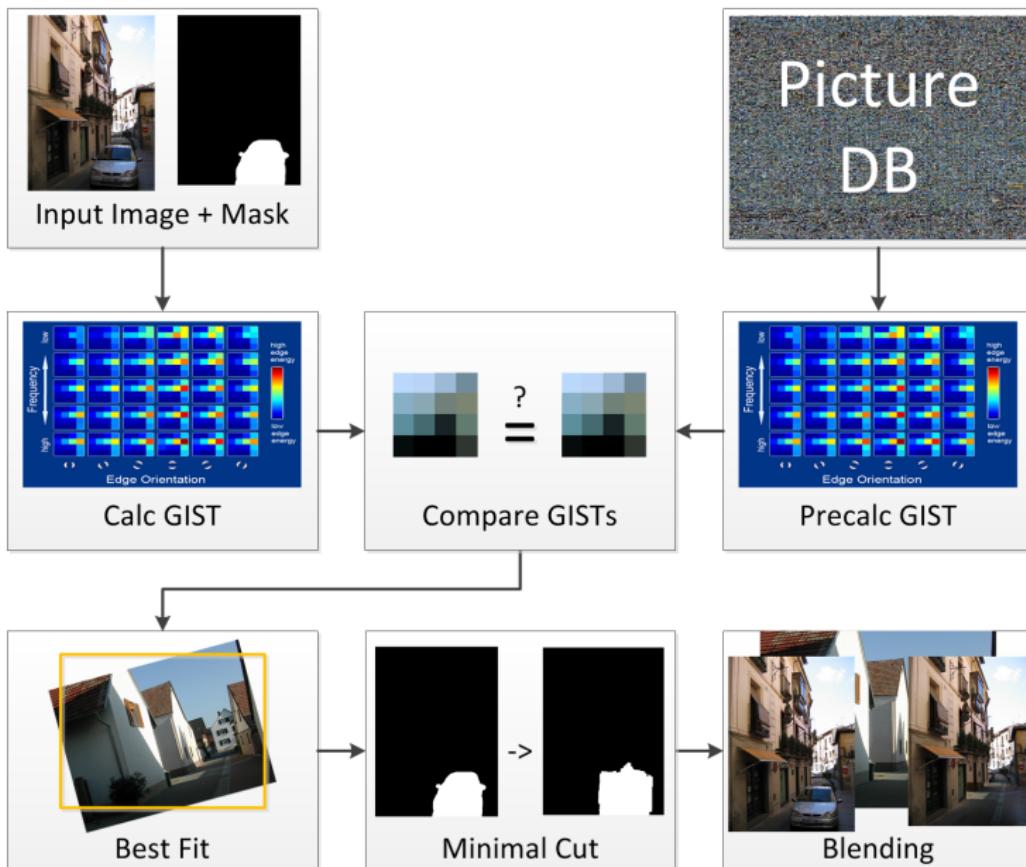
February 7th, 2012

Processing Digital Camera Images Seminar
TU-Berlin
Christian Thurow & Christopher Leiste

oooooooooooo

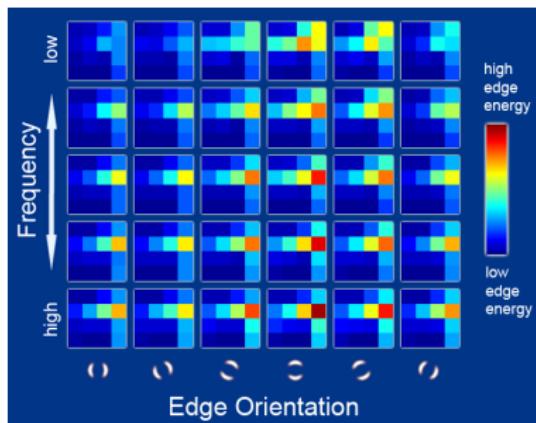
oooooooooooooooooooooooooooo





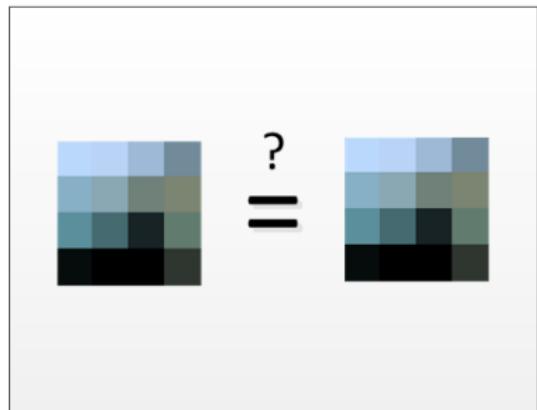
Step 0: Precalculations

- precalc GIST of all images in DB
 - mean/variance
 - gist-script: 48h on intel core i5
 - one time effort, reduce search time



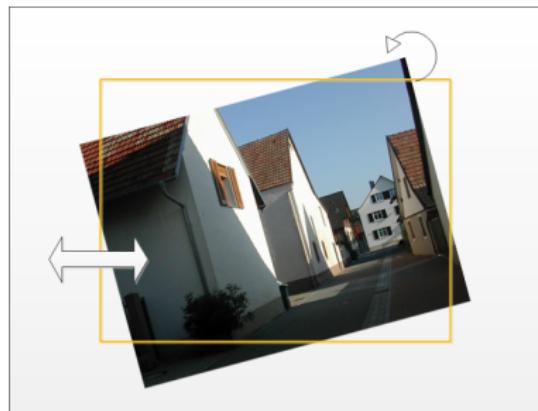
Step 1: Evaluating Images

- calc GIST of input image
 - compare GIST, weighting function
 - store x best



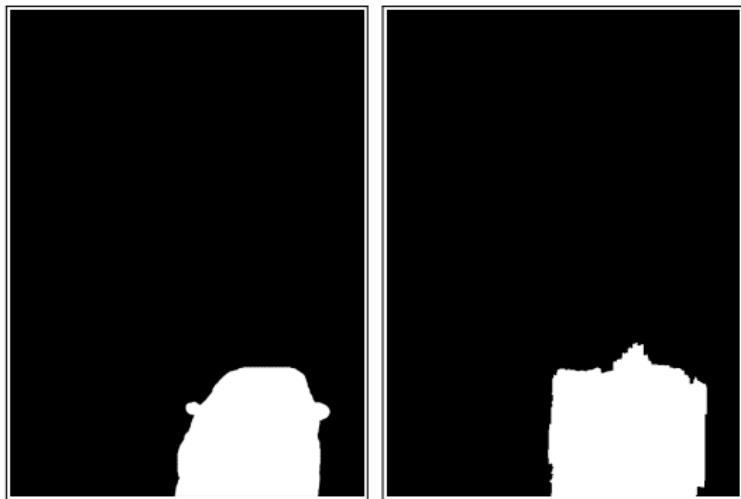
Step 2: Finding Best Fit

- translate found image over mask
 - save best fit according to LAB



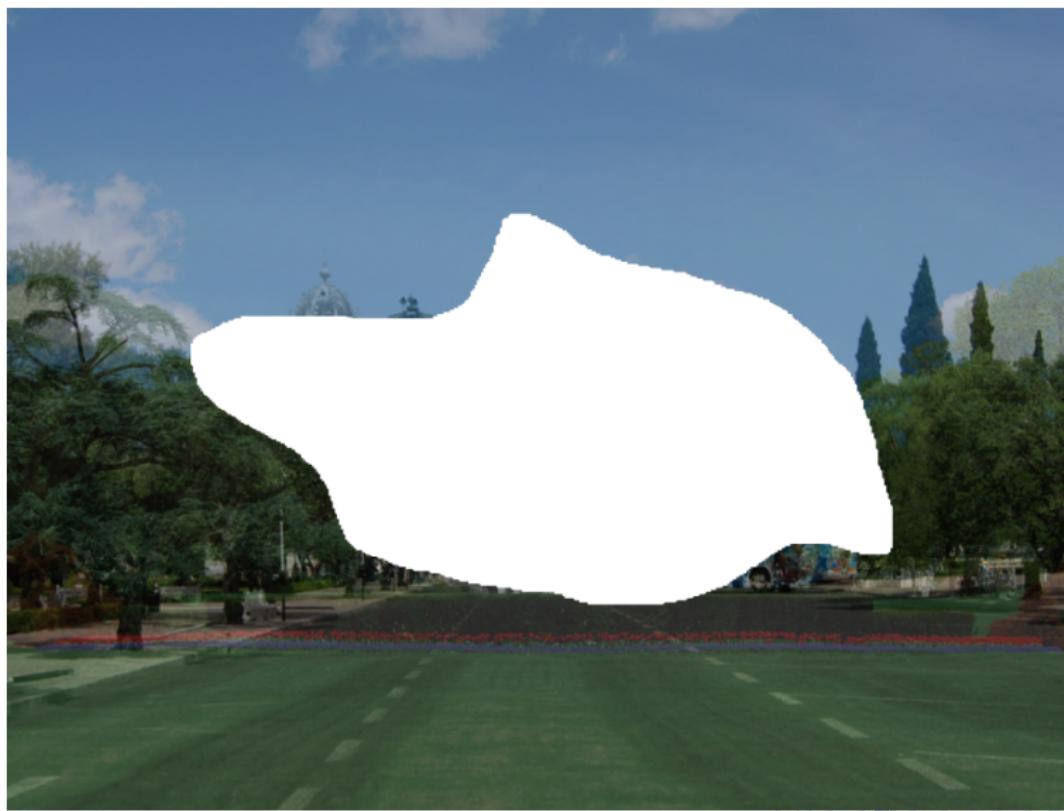
Step 3: Refine the Mask

- read x best images
- for each good image
 - calc graph cut
 - weighting with input mask and gradients

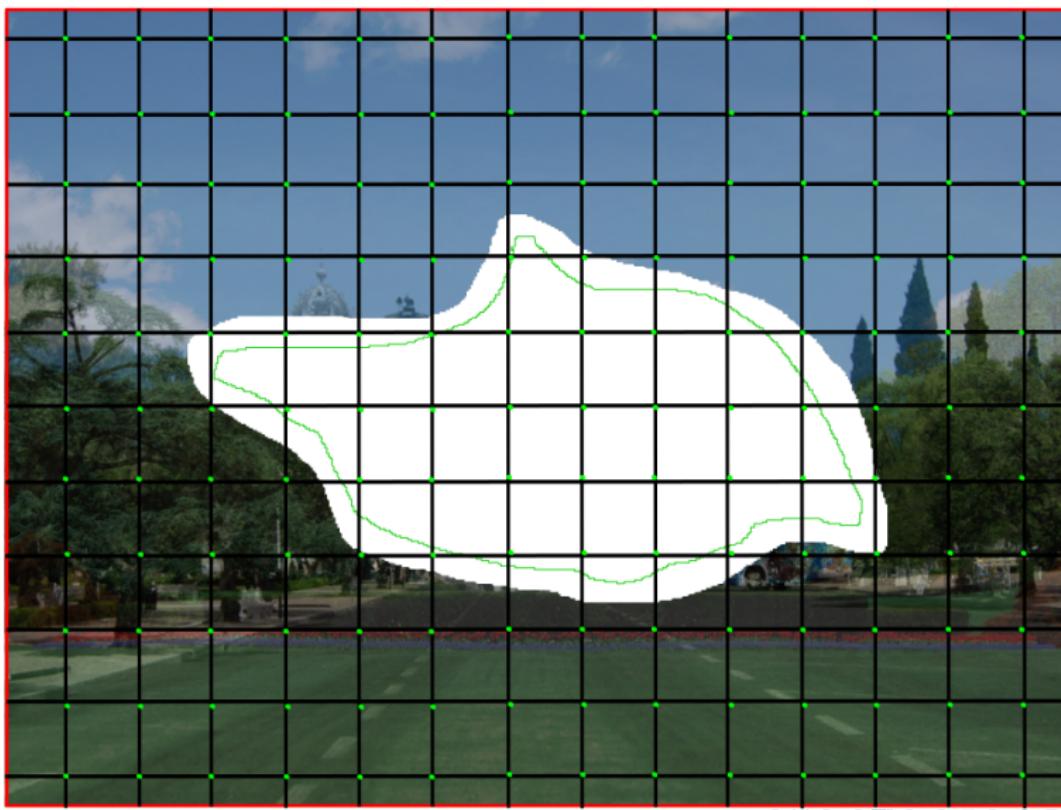




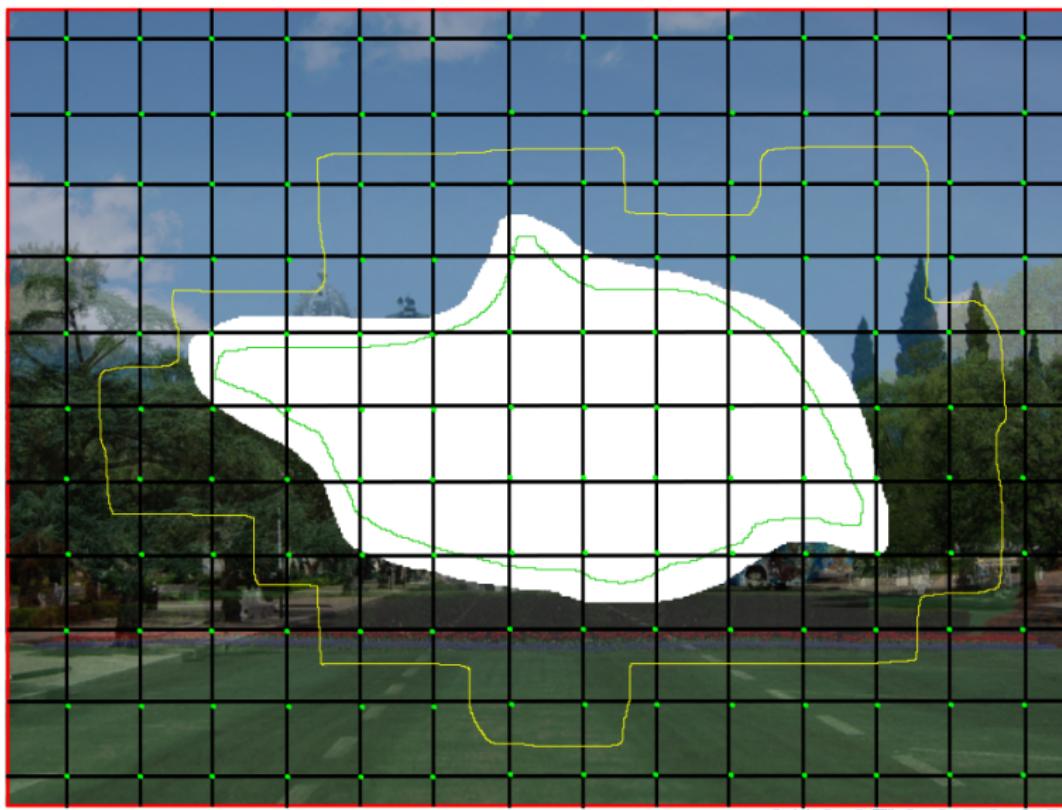
Step 3: Refine the Mask (2)



Step 3: Refine the Mask (3)



Step 3: Refine the Mask (4)



Step 4: Blending Images

- blend images with poisson
- input: images + refined mask



What didn't go so well..

- poisson blending buggy
- finding good weights for graph cut
- where to put sink and source?
- speed optimisations
- compiling libraries

Good Results (1) Input



Good Results (1) Output





Good Results (1) Output



Good Results (1) Output



Good Results (1) Output



Good Results (2) Input



Good Results (2) Output



Good Results (3) Output



Good Results (4) Output



Good Results (4) Output 2



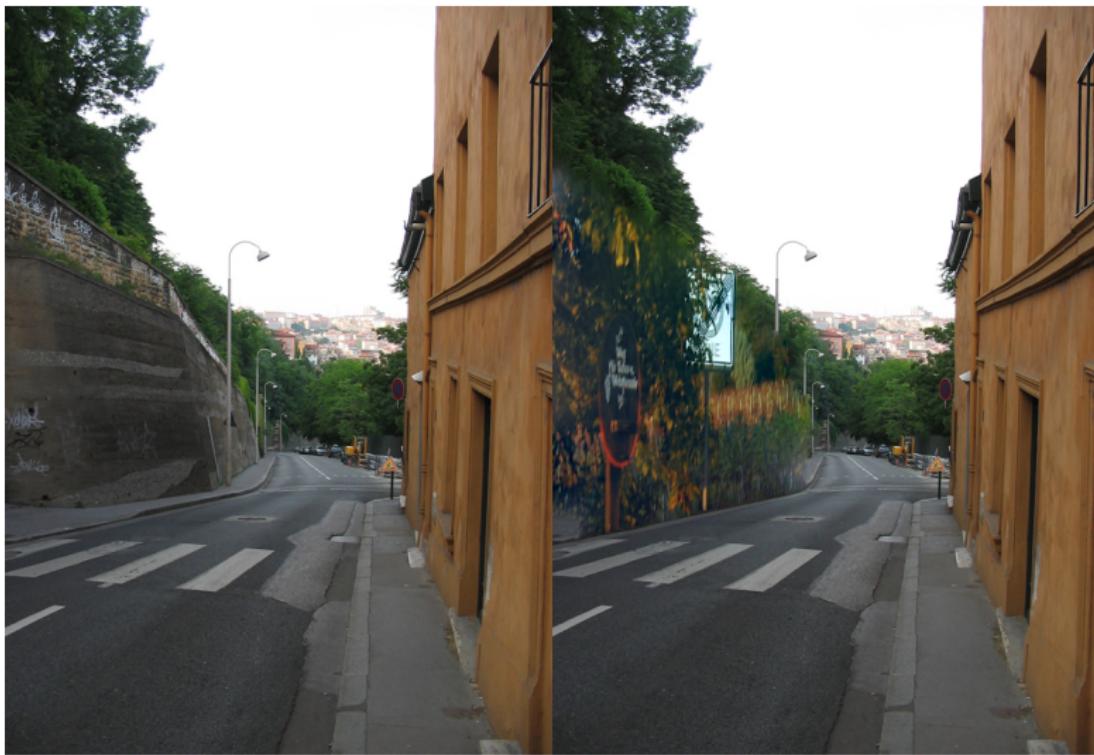
Good Results (5) Output



Good Results (6) Output



Good Results (7) Input + Output



Good Results (8) Input + Output



Good Results (9) Output



Good Results (10) Output 1



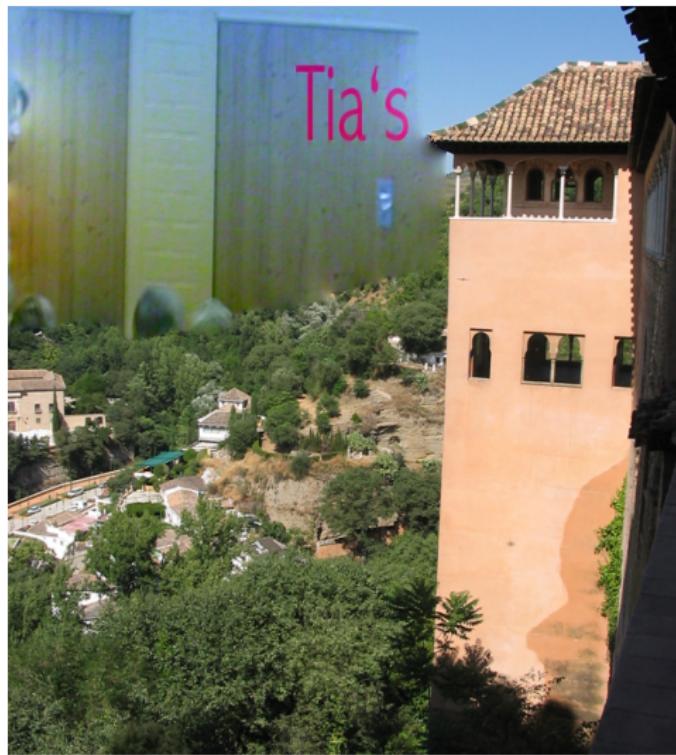
Good Results (10) Output 2



Good Results (10) Output 3



Bad Results (1) Output



Bad Results (2) Output



Bad Results (3) Output



Bad Results (4) Output



Complexity

Program Log

START

Loading and Preprocessing Input

=====

0.92 seconds passed since program start

Search for Similar Images in DB

Read 1457716 images from DB

=====

443.526 seconds passed since program

start

Calc Best Cuts

Calculating Best Cut for Mask: 15 of 15

=====

521.683 seconds passed since program

start

Poisson Blend Images

Blending Image: 15 of 15

=====

1573.02 seconds passed since program

start

END

Complexity in \mathcal{O} -Notation

ALGORITHM	COMPLEXITY
Computing GIST	$f(p) \in \mathcal{O}(p)$
Searching image DB	$f(i) \in \mathcal{O}(i)$
Graph Cut	$f(m, n) \in \mathcal{O}(m \cdot n^2)$ $n = p, m = 2 \cdot p$ $\rightarrow f(p) \in \mathcal{O}(2 \cdot p^3)$
Poisson Blending (Gaussian elimination)	$f(x) \in \mathcal{O}(x^3)$ our matrix: $3 \cdot (\text{mask pixels})$ $\rightarrow f(p) \in \mathcal{O}(3 \cdot c \cdot p^3)$

p: pixels in image

i: number of images

n: nodes in graph

m: edges in graph

x: matrix dimension

c: (mask pixels) / (image pixels)

Limitations

- Hays Method based on large DB
- limitations of this method: no perspective check, no semantic check
- other works:
 - Criminisi et al. - only implicit information, no sanity checks either
 - MS Smart Erase - only implicit information, no sanity checks either
 - Wilczkowiak et al. - small annotated DB and implicit information, no sanity checks either

Related Work - Criminisi et al.



Related Work - Microsoft Smart Erase(Digital Image Pro)



Related Work - Wilczkowiak et al.

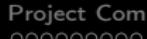


Related Work - Hays (reference paper)



Our Implementation of Hays' Method





- Poisson: border pixel from input or output? -> adaptively!
- changed graph cut weighting inside mask
- suggestion: weighting the GISTs differently
- GIST on color
- only GIST near mask
- distributed implementation



Questions?

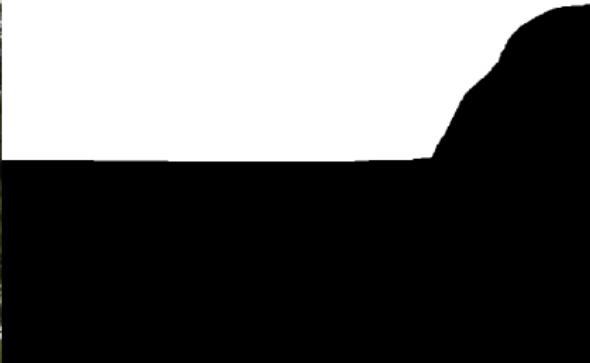
References

-  *paper* "Scene Completion Using Millions of Photographs",
James Hays and Alexei A Efros, ACM Transactions on Graphics (SIGGRAPH 2007)
-  *website* "Poisson Blending in OpenCV", <http://opencv.jp/opencv2-x-samples/poisson-blending>
-  *paper*
"An Experimental Comparison of Min-Cut/Max-Flow Algorithms for Energy Minimization in Vision."
Yuri Boykov and Vladimir Kolmogorov, IEEE Transactions on Pattern Analysis and Machine Intelligence (P)
-  *library* "OpenCV.org"

Minimal Cut Weighting

- $\text{grad} = |\text{A}(t)-\text{B}(t)| - |\text{A}(s)-\text{B}(s)|$, s = curr, t = neighbor, A = image1, B = image2
- distance: get L2 distance to nearest pixel on mask border
- k = 0.01, paper: 0.002
- if inside mask either weighting = 999999999; or
 $\text{pow}((k*10)*(-\text{distance}), 3)$
- outside mask; weighting = $\text{pow}(k*\text{distance}, 3)$
- weight = grad * weighting

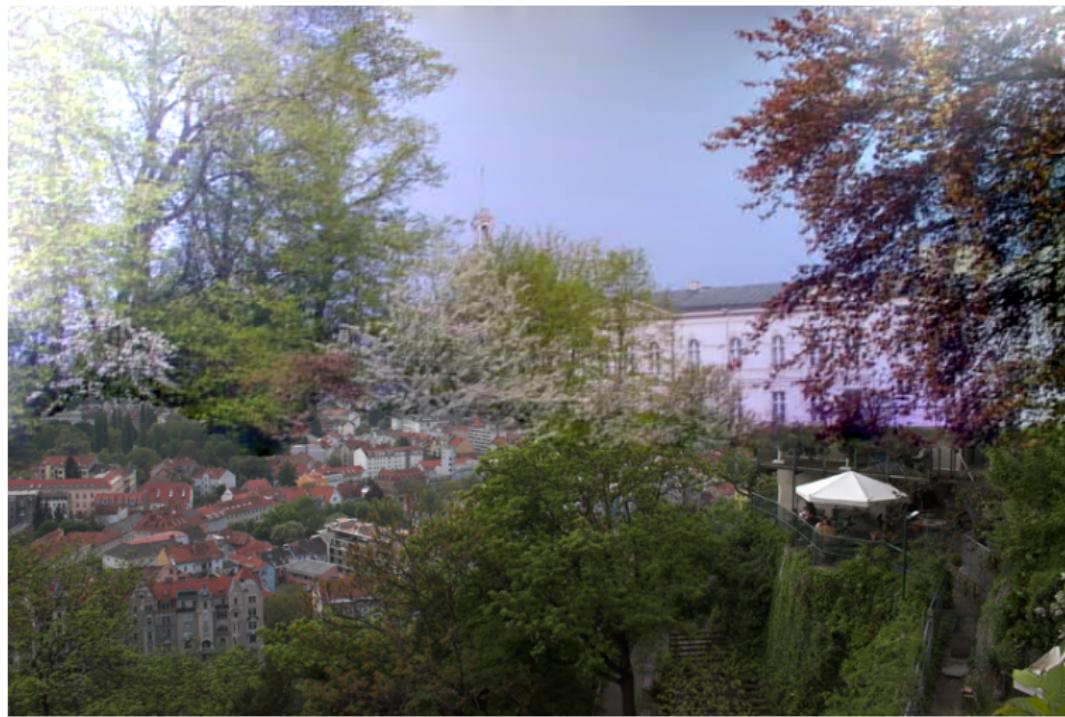
Complete Set Input Image + Mask



Complete Set Output Image 1/15



Complete Set Output Image 2/15



Complete Set Output Image 3/15



Complete Set Output Image 4/15



Complete Set Output Image 5/15



Complete Set Output Image 6/15



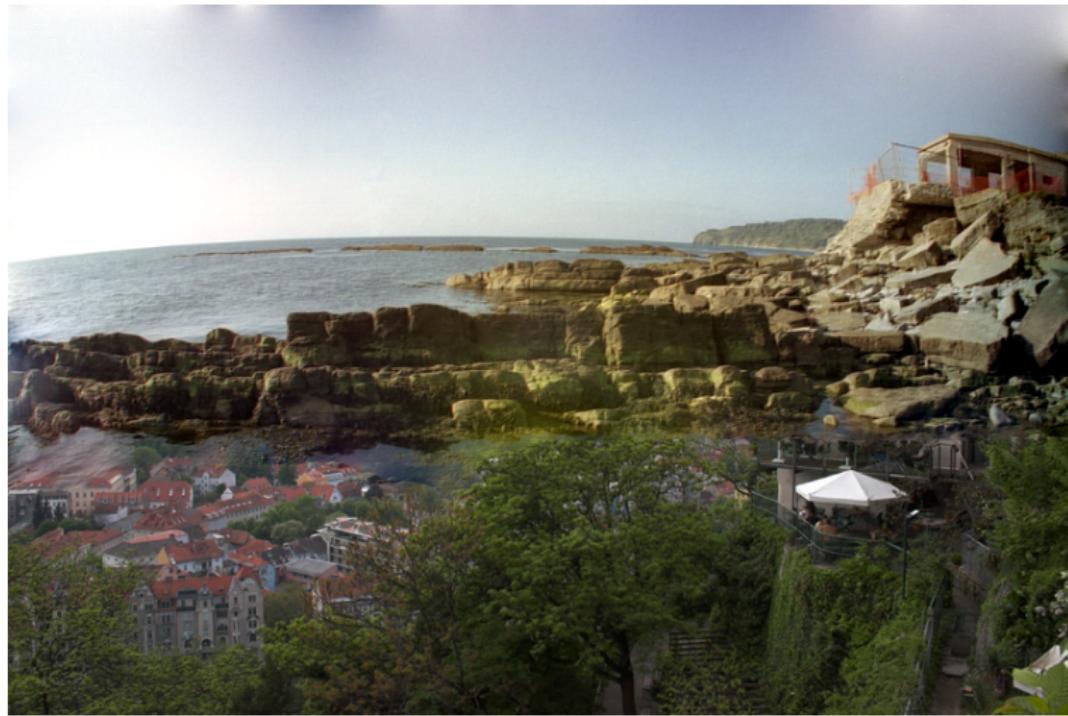
Complete Set Output Image 7/15



Complete Set Output Image 8/15



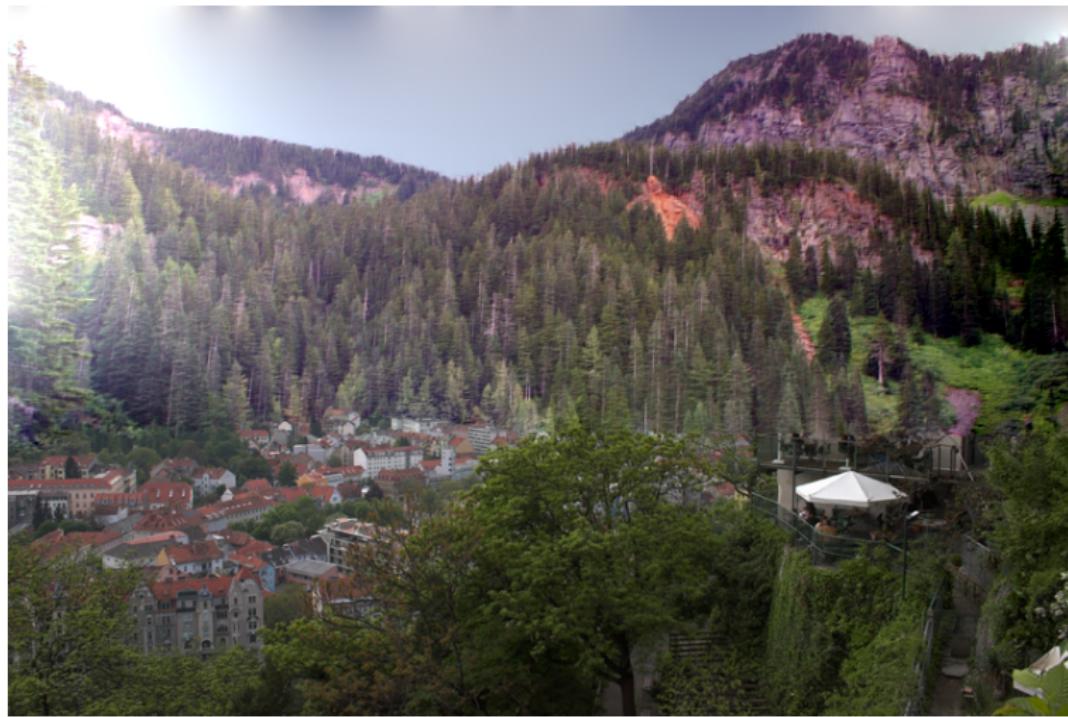
Complete Set Output Image 10/15



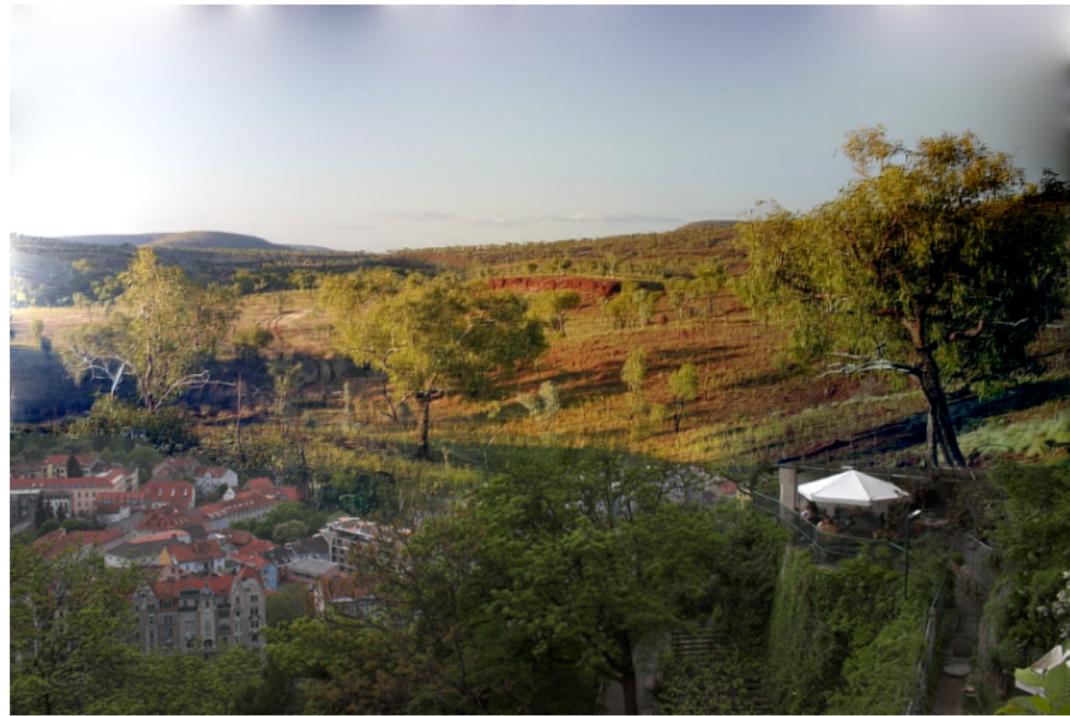
Complete Set Output Image 11/15



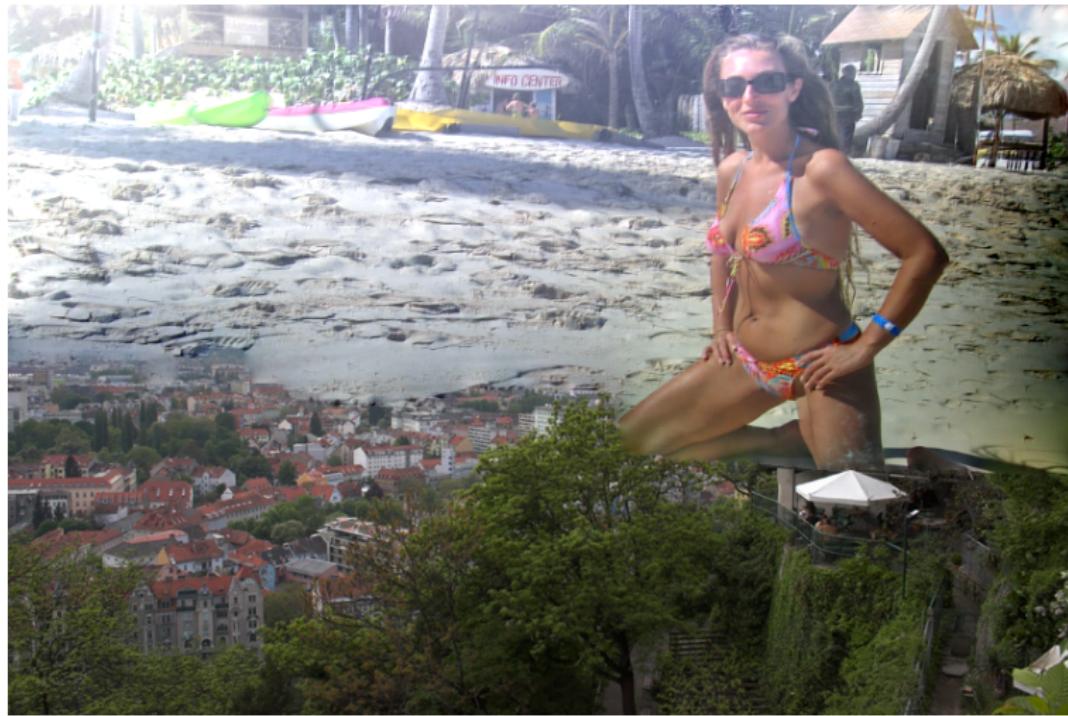
Complete Set Output Image 12/15



Complete Set Output Image 13/15



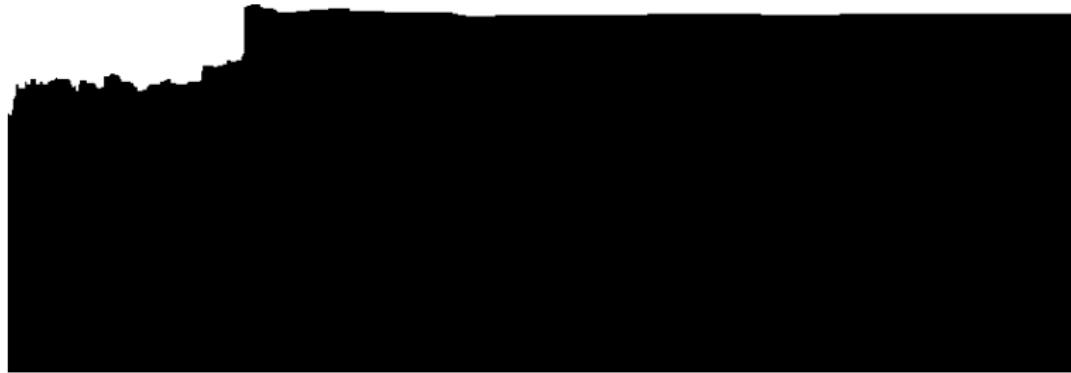
Complete Set Output Image 14/15



Complete Set Output Image 15/15



Complete Set Refined Mask 1/15



Complete Set Refined Mask 2/15

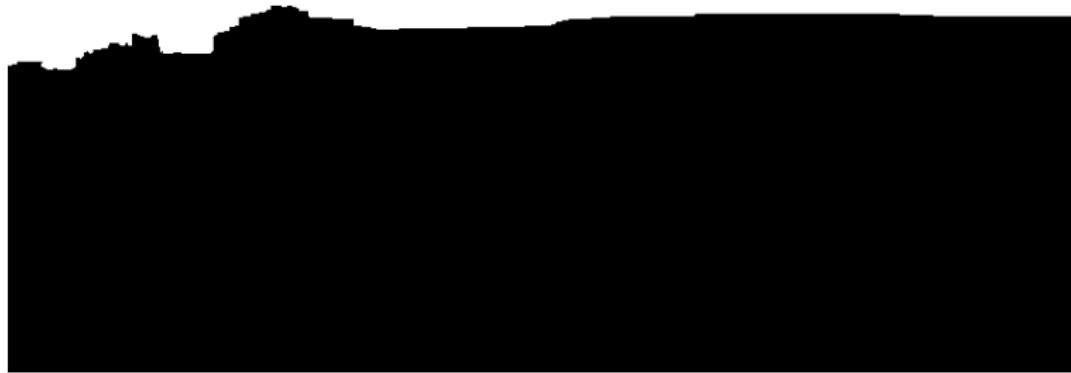


Complete Set Refined Mask 3/15





Complete Set Refined Mask 4/15



Complete Set Refined Mask 5/15





Complete Set Refined Mask 6/15



Complete Set Refined Mask 7/15

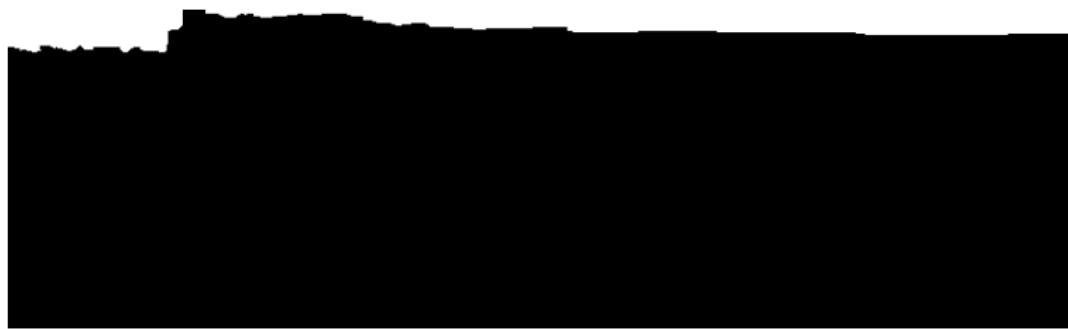


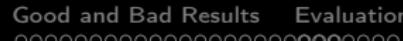
Complete Set Refined Mask 8/15





Complete Set Refined Mask 9/15

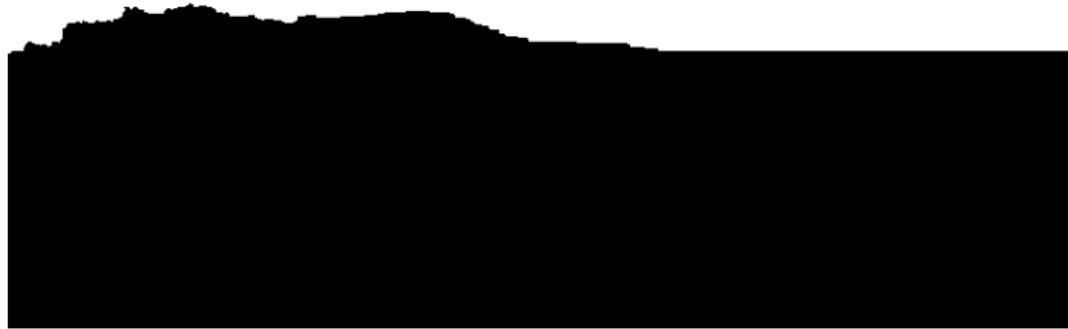




Complete Set Refined Mask 10/15



Complete Set Refined Mask 11/15



Complete Set Refined Mask 12/15



Complete Set Refined Mask 13/15





Complete Set Refined Mask 14/15



Complete Set Refined Mask 15/15



Complete Set 2 Output Image 1/15



Complete Set 2 Output Image 2/15



ref 2010, Tom.Grydelund@gu

Complete Set 2 Output Image 3/15



Complete Set 2 Output Image 4/15



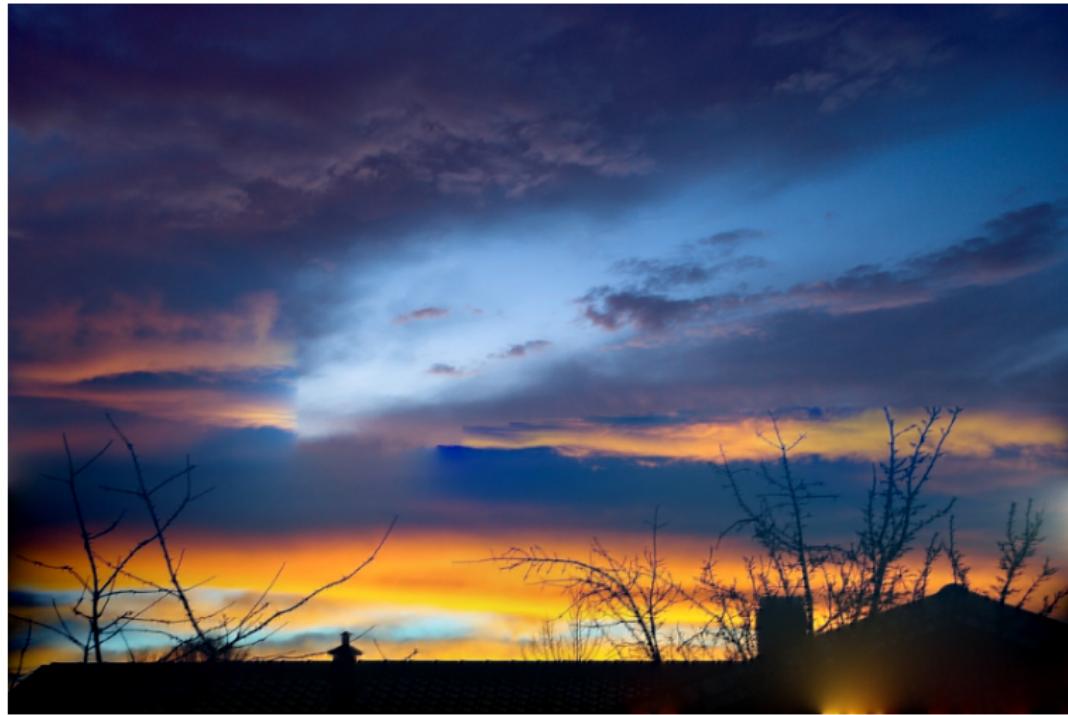
Complete Set 2 Output Image 5/15



Complete Set 2 Output Image 6/15



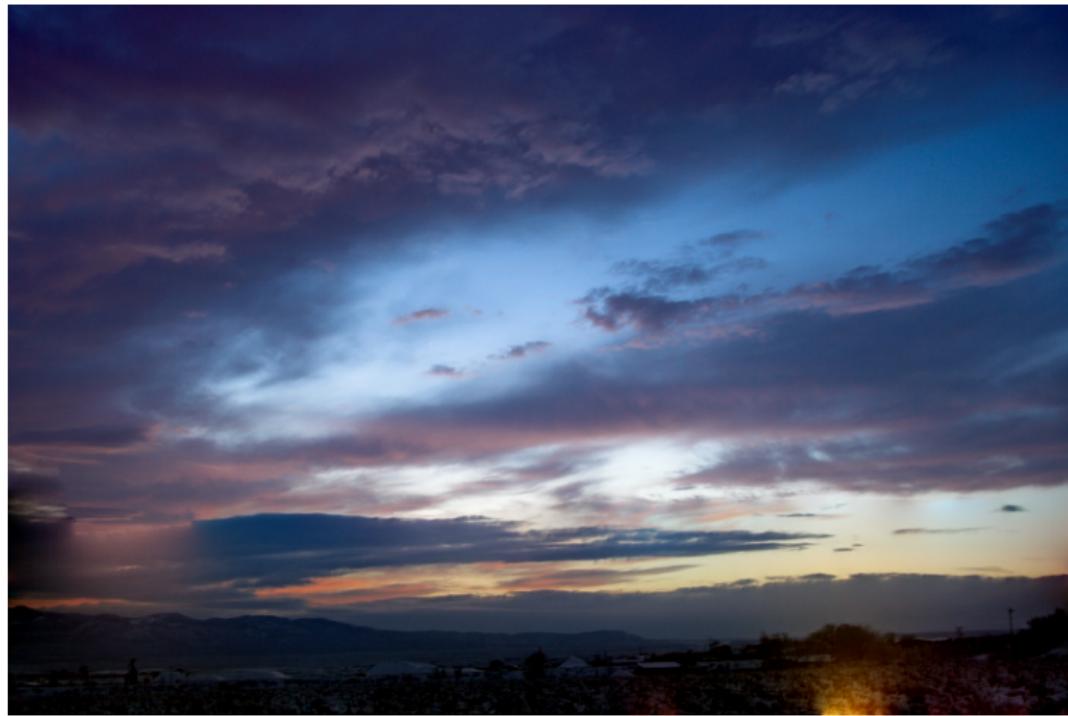
Complete Set 2 Output Image 7/15



Complete Set 2 Output Image 8/15



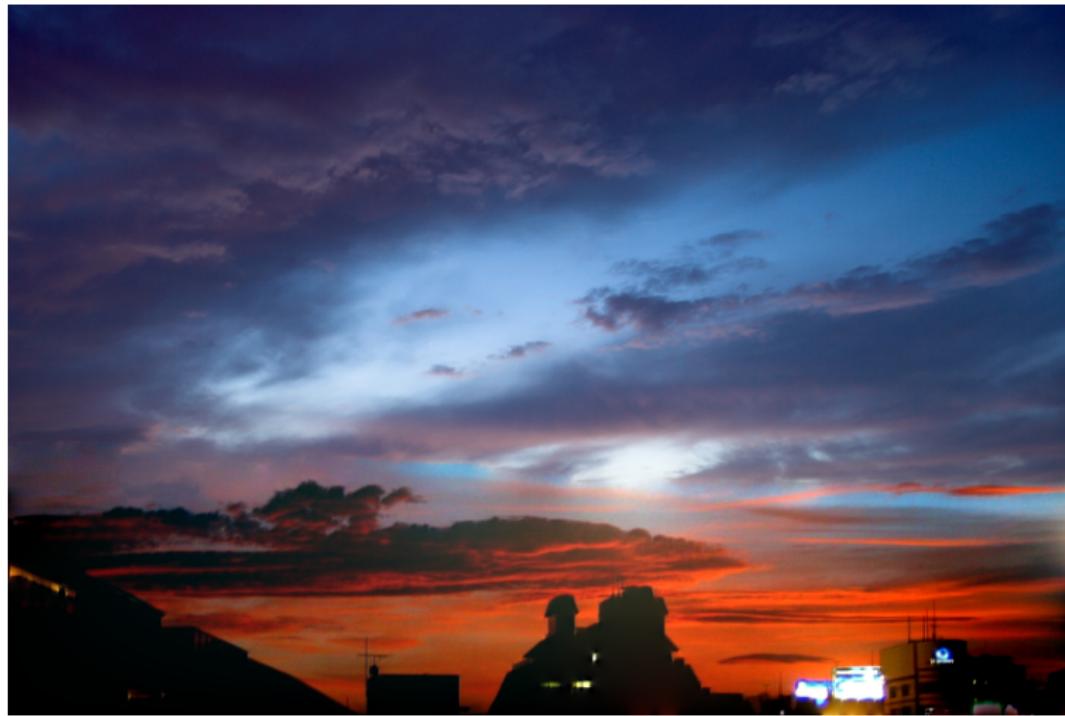
Complete Set 2 Output Image 10/15



Complete Set 2 Output Image 11/15



Complete Set 2 Output Image 12/15



Complete Set 2 Output Image 13/15



Complete Set 2 Output Image 14/15



Complete Set 2 Output Image 15/15

