הבינתחומי הרצליה

Images Processing Resizing

Ariel Shamir

Resizing Definition

- Scaling up and down while preserving aspect ratio

- Changing aspect ratio = retargeting

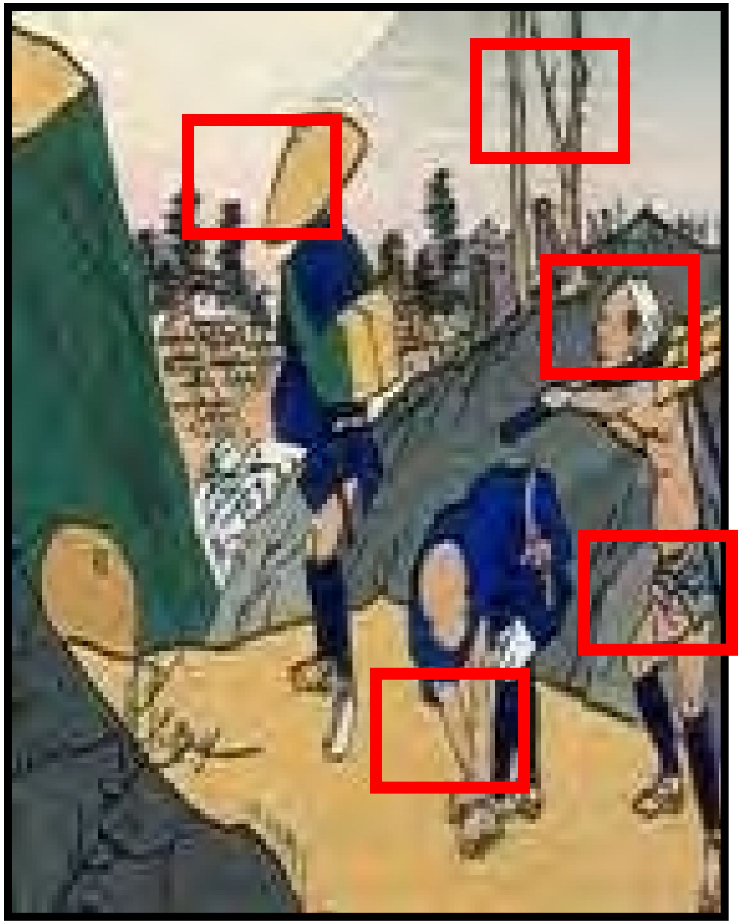
Resizing Using Scaling

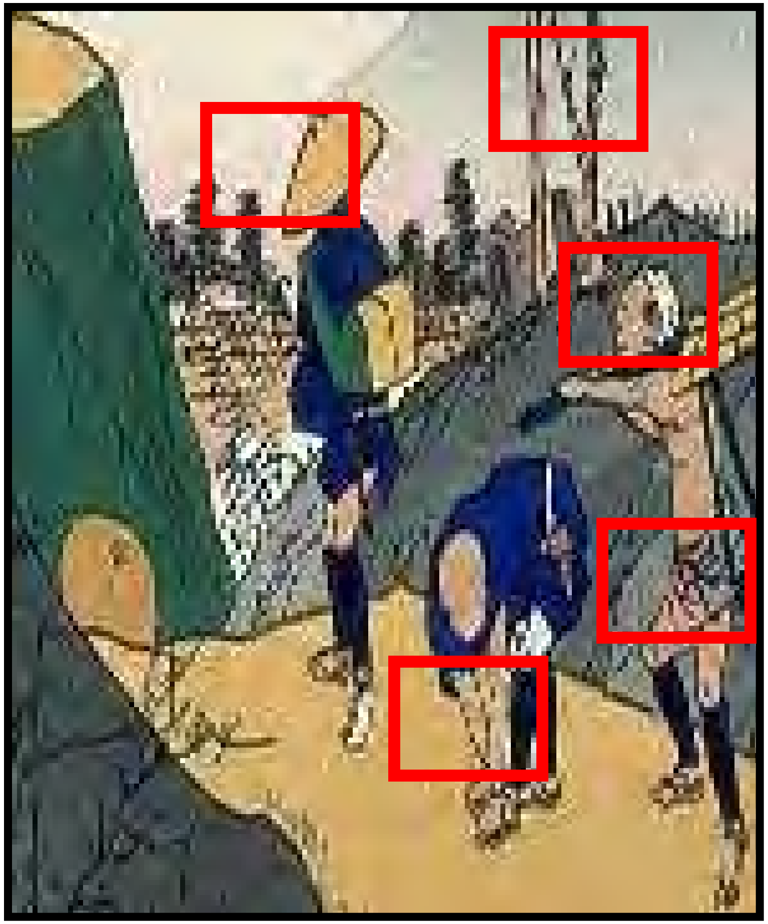
- How can scaling be done gracefully?
  - Scaling up
  - Scaling down
  - Scaling non-uniformly
- All share the same problems: **aliasing** (since they are similar to sampling)

Non Uniform Resizing

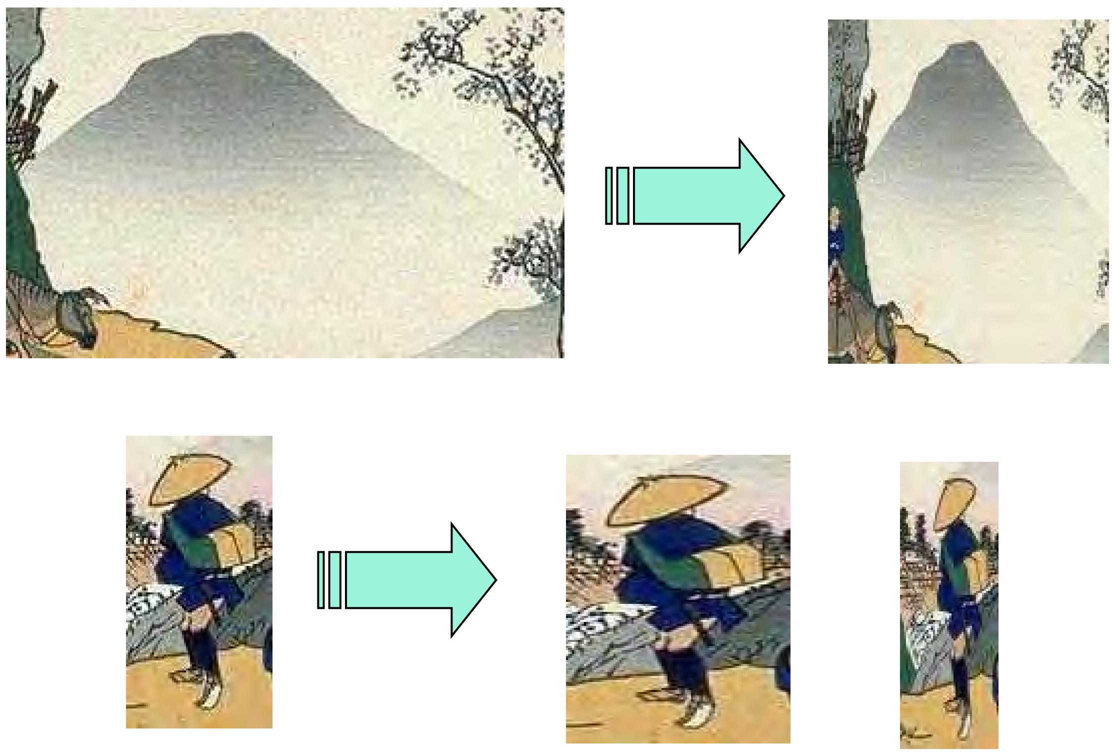
Sampling Vs. Reconstruction

Comparison





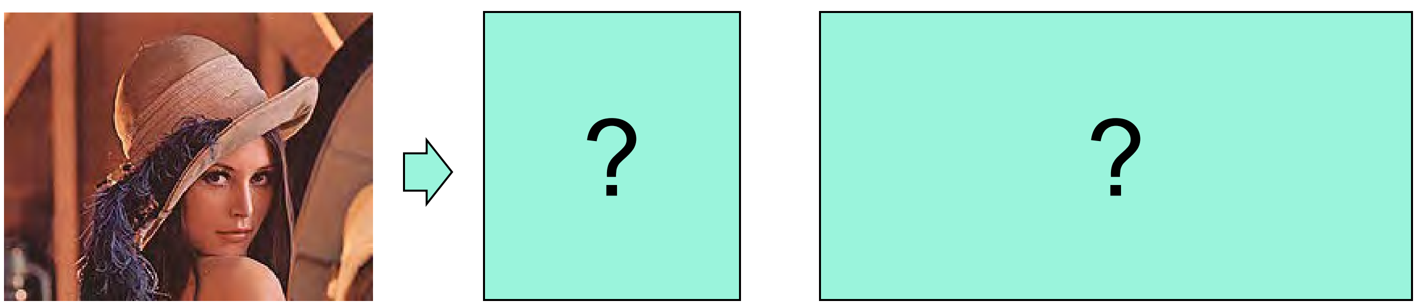
Still, non-uniform artifacts!



Retargeting

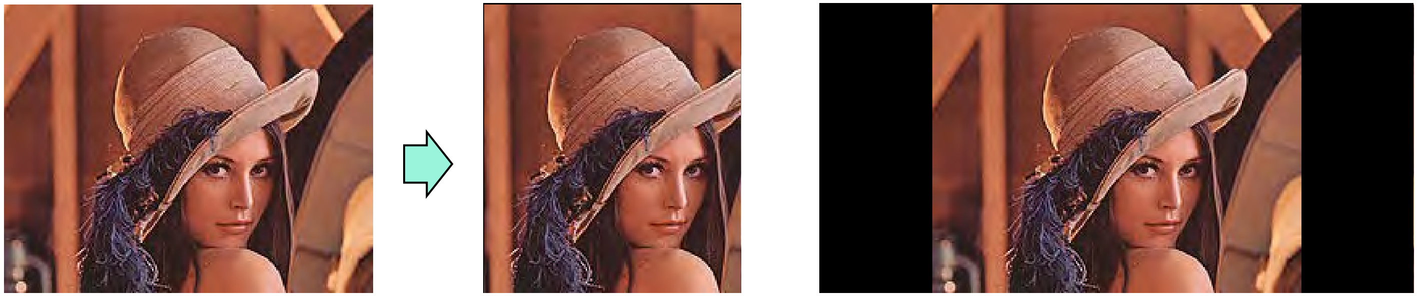
- Changing the aspect ratio!
- Given the original media in size mxn resize it to size m’xn’

  where m’ ≠ m or n’ ≠ n or both.



Retargeting

- Simple scaling creates artifacts
- Simple cropping looses information at the edges, and cannot support enlarging an image:



Cropping?

Enlarging?

Seam Carving

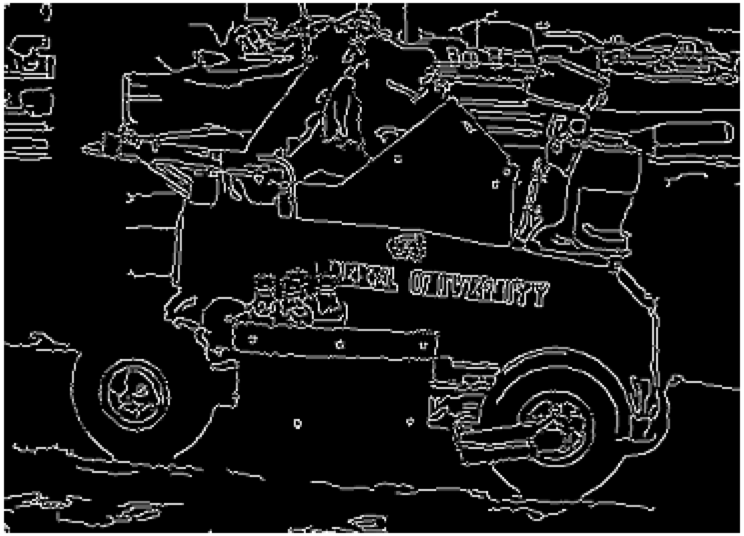
Key Idea: Content Aware

- Remove (or Insert) “less important” parts and preserve more important ones
- In effect this means we are creating ... ***content aware*** resizing

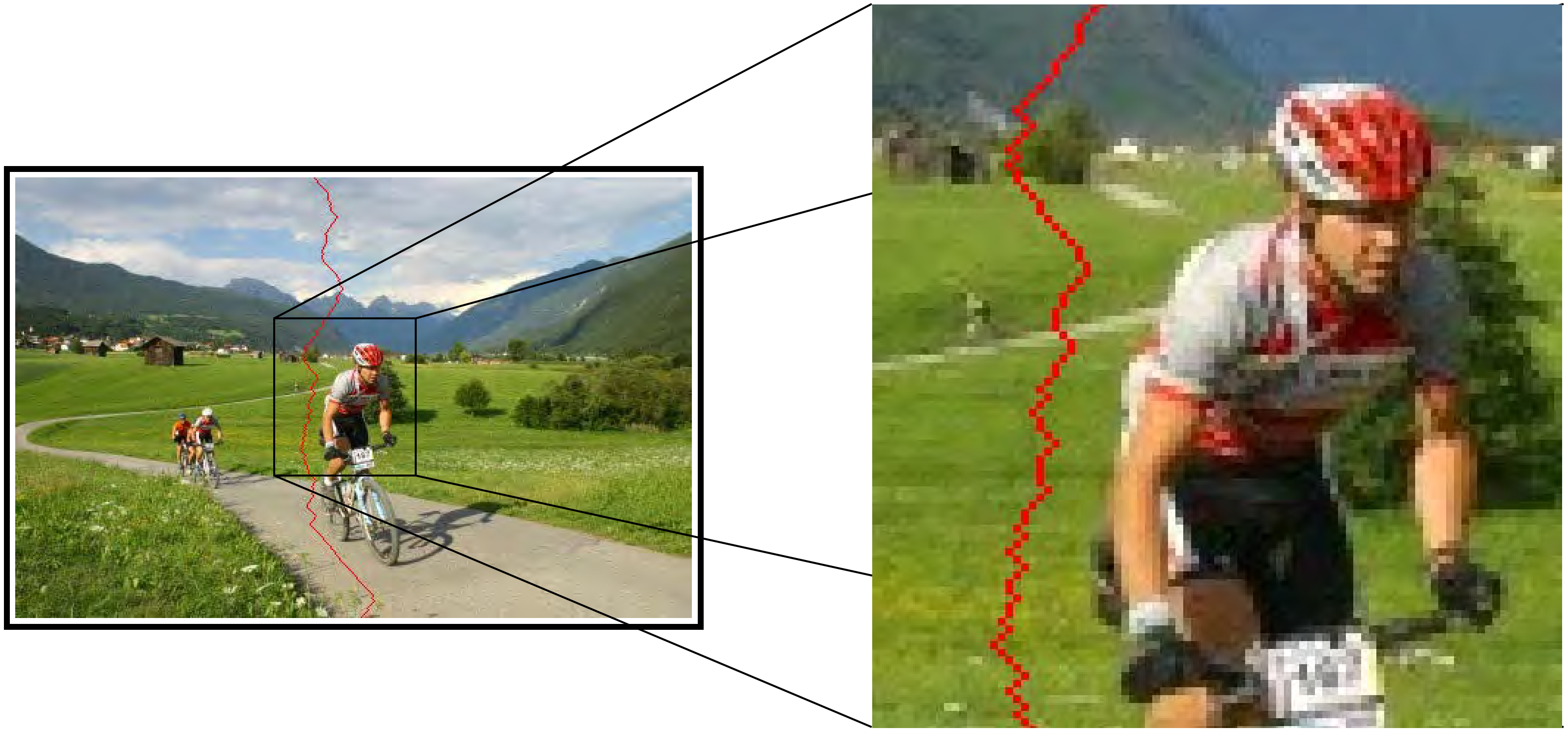
- **Key questions: what is important?**
  - **Edges are important**

What Is Important?

- Edges Carry most information in the scene:



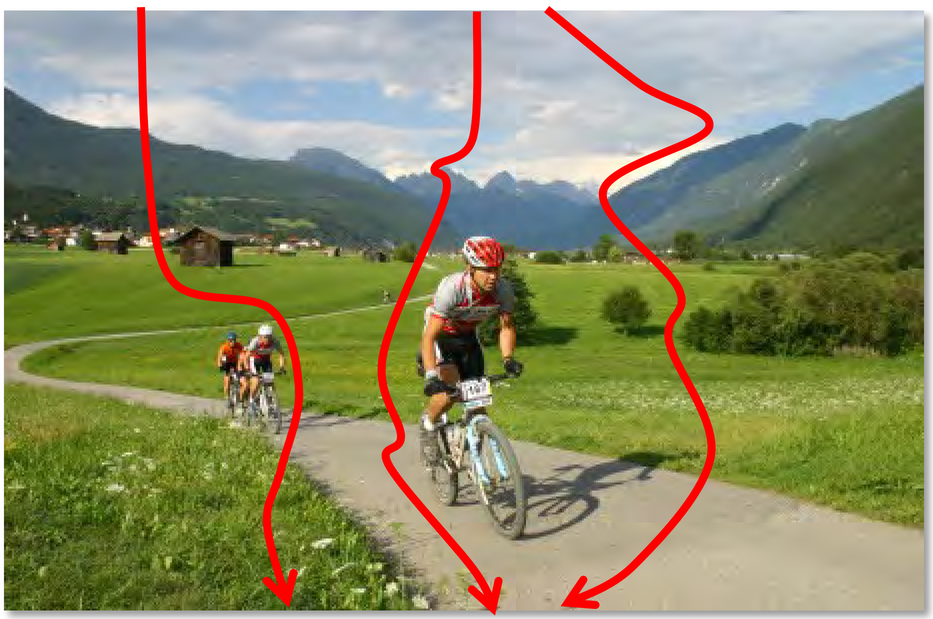
A Seam



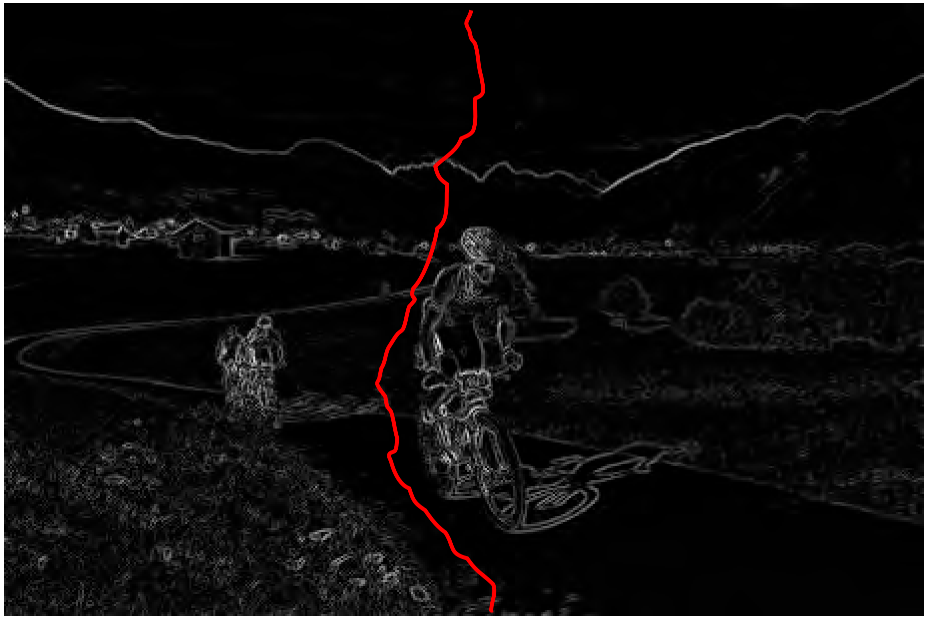
Seam Carving

A Local Operator!

Finding the Seam?



The Optimal Seam



$$E(\mathbf{I}) = \left|\frac{\partial}{\partial x}\mathbf{I}\right| + \left|\frac{\partial}{\partial y}\mathbf{I}\right| \quad \Rightarrow \quad s^* = \arg\min_{s} E(s)$$

How Many Seams?

- An image has n columns and m rows
- Start from any pixel at top row (n)
- For each one choose between 3 possible pixels in the next row
- For each one of those, choose between 3 in the next row…
- $n*3^{m-1}$ = exponential! ☹

Pixel Attribute → Dynamic Programming

$$M(i, j) = e(i, j) + \min(M(i-1, j-1), M(i-1, j), M(i-1, j+1))$$

5	8	12	3
9	2	3	9
7	3	4	2
5	4	7	8

Dynamic Programming

$$M(i, j) = e(i, j) + \min(M(i-1, j-1), M(i-1, j), M(i-1, j+1))$$

5	8	12	3
9	2+5	3	9
7	3	4	2
5	4	7	8

Dynamic Programming

$$M(i, j) = e(i, j) + \min(M(i-1, j-1), M(i-1, j), M(i-1, j+1))$$

5	8	12	3
9	7	3+3	9
7	3	4	2
5	4	7	8

Dynamic Programming

$$M(i, j) = e(i, j) + \min(M(i-1, j-1), M(i-1, j), M(i-1, j+1))$$

5	8	12	3
9	7	6	12
14	9	10	8
14	13	15	8+8

Searching for Minimum

$$M(i, j) = e(i, j) + \min(M(i-1, j-1), M(i-1, j), M(i-1, j+1))$$

5	8	12	3
9	7	6	12
14	9	10	8
14	13	15	16

Backtracking the Seam

$$M(i, j) = e(i, j) + \min(M(i-1, j-1), M(i-1, j), M(i-1, j+1))$$

5	8	12	3
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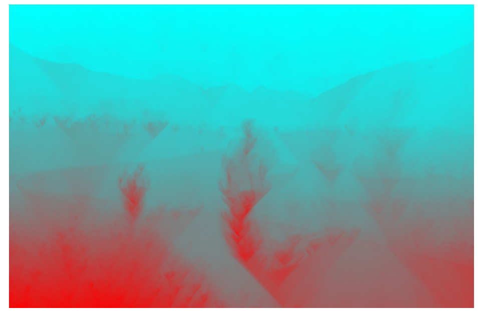
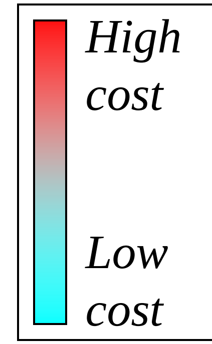
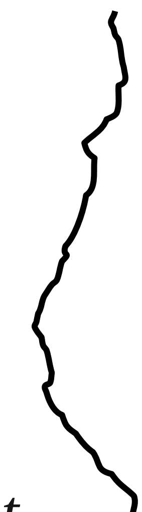
H & V Cost Maps



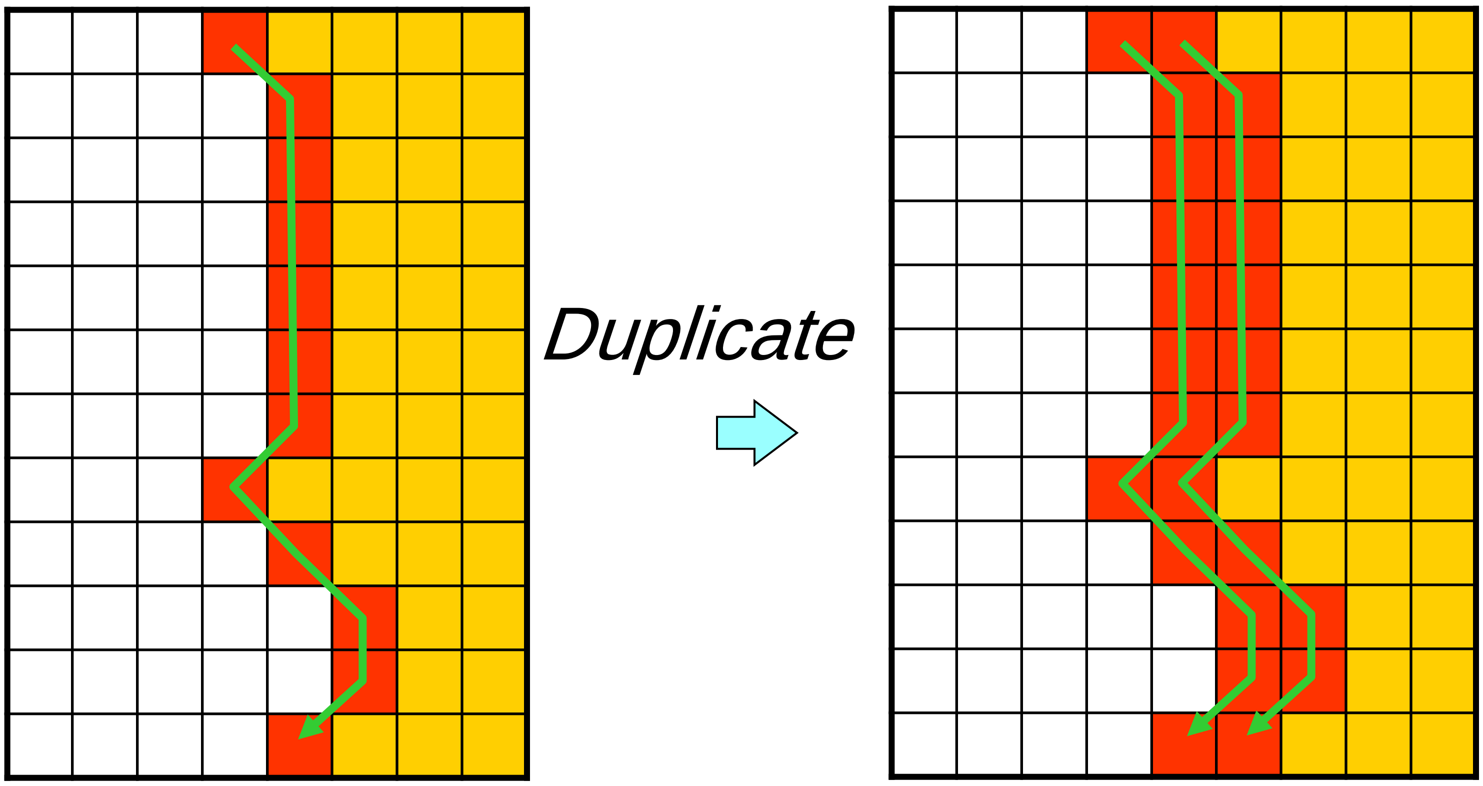


Horizontal Cost



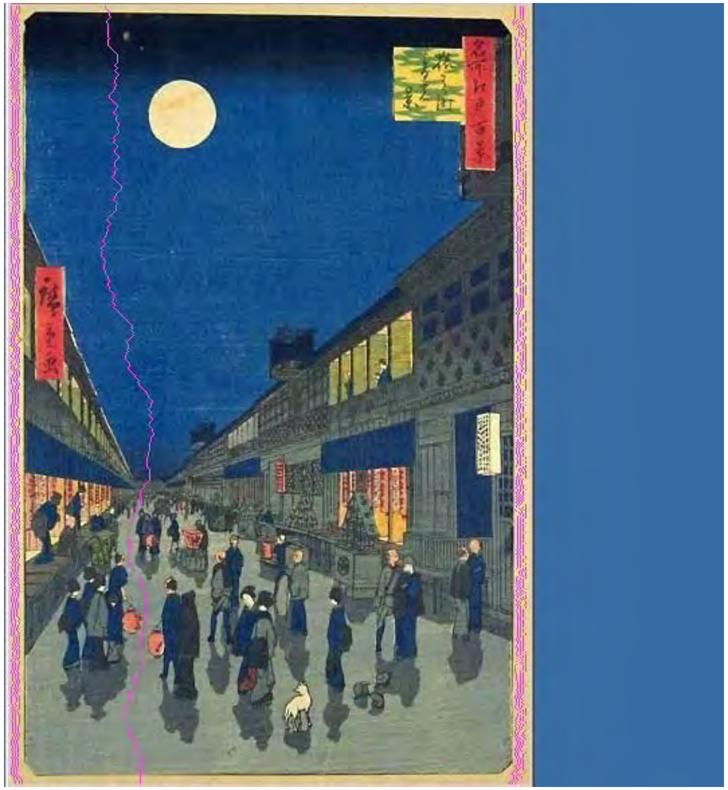
Vertical Cost

Inserting a Seam



Enlarging by Seam Insertion?

Duplicate Seams in Order



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Duplicate Seams in Order

Enlarged or Reduced?

Not Always a Success

Image: Yehudit Garinkol

Find the Missing Shoe!

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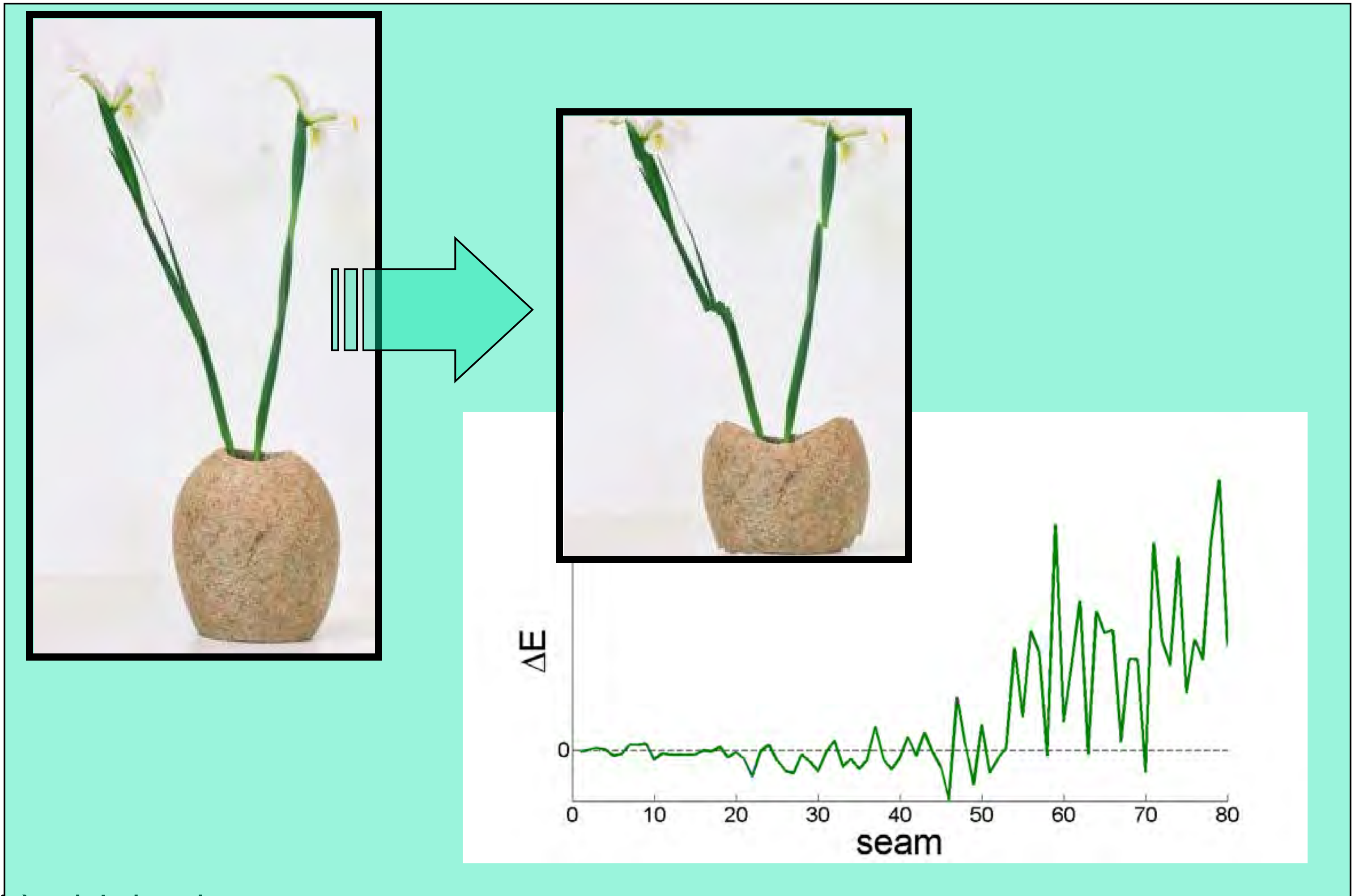
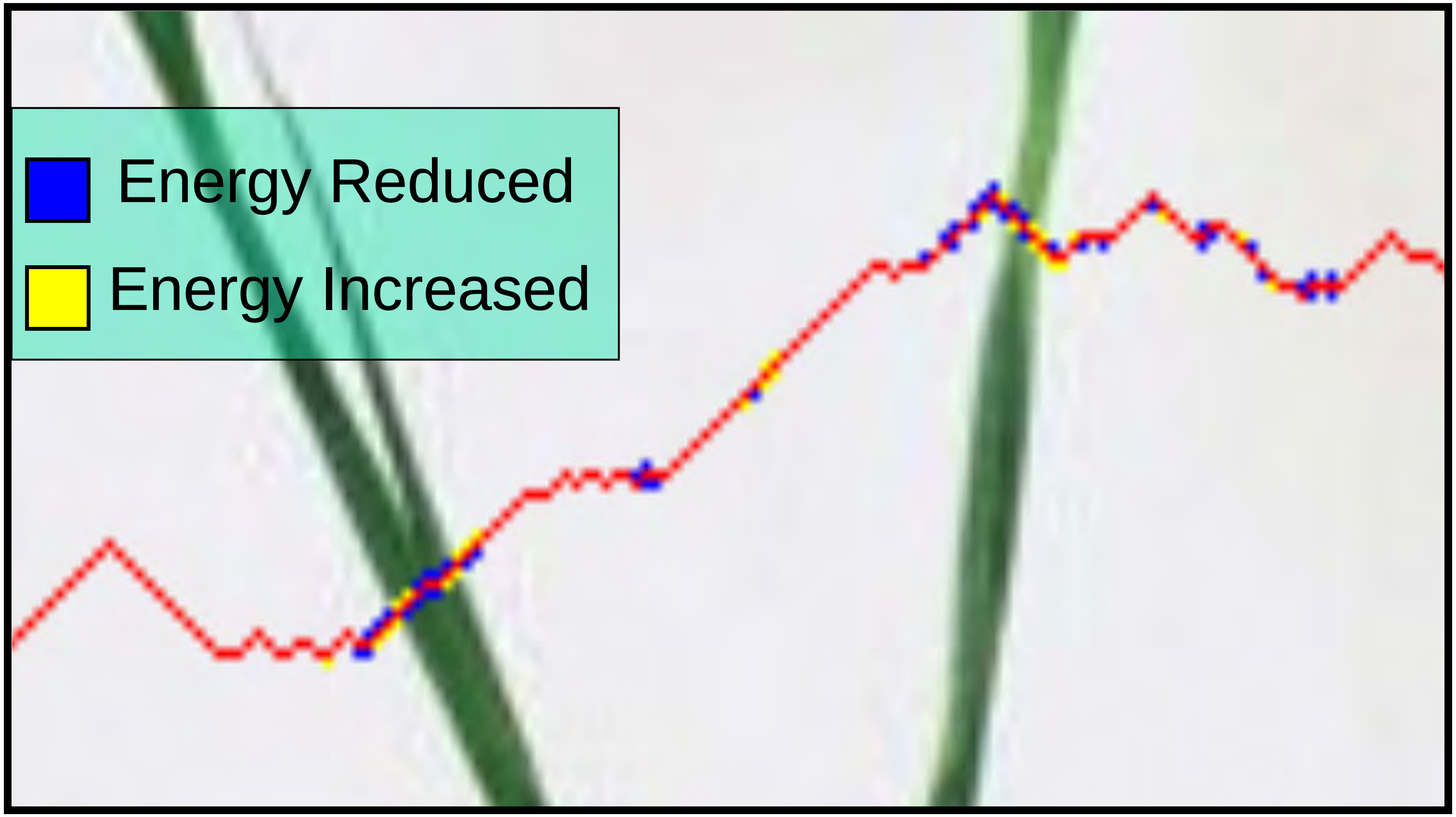
Solution

Changes in Energy

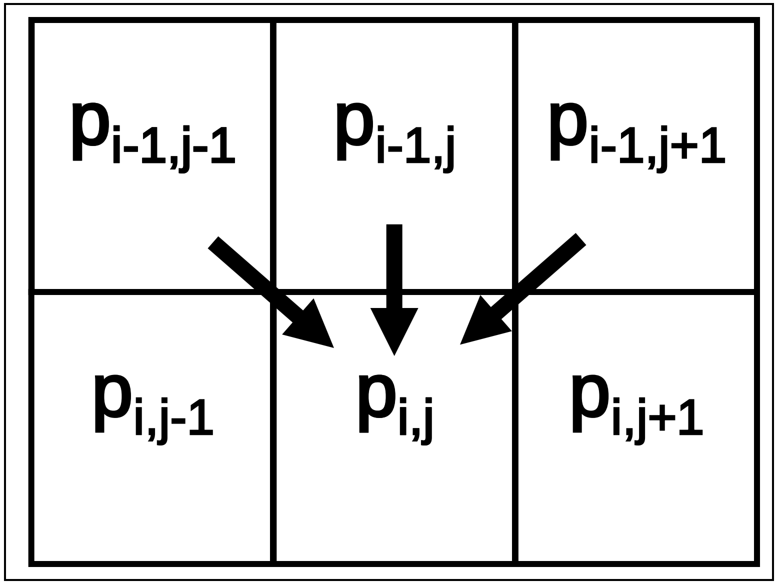


Changes in Energy

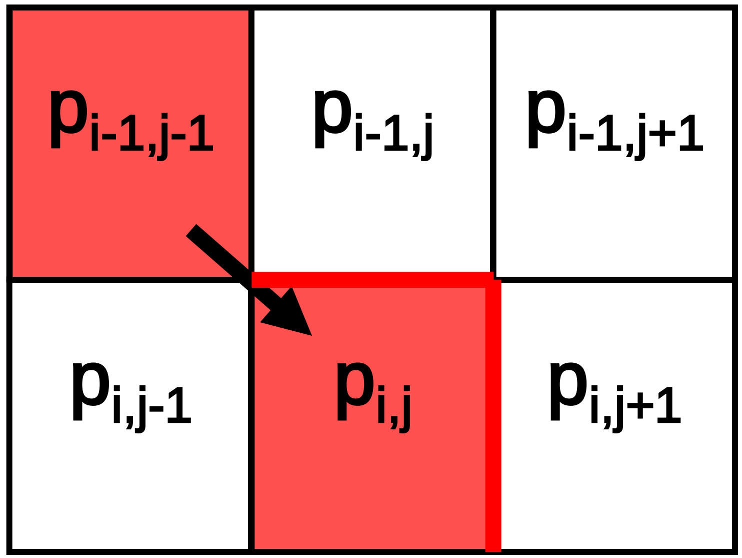


Tracking Inserted Energy

- Three possibilities When Removing Pixel $P_{i,j}$:

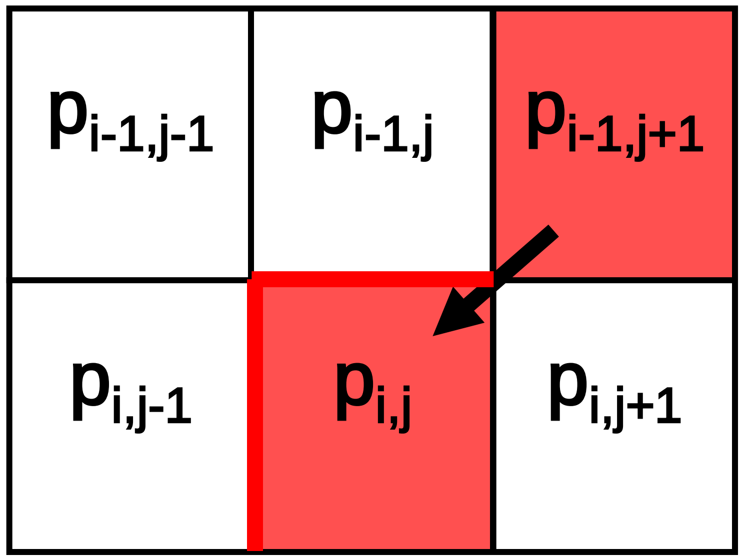


Pixel $P_{i,j}$: Left Seam



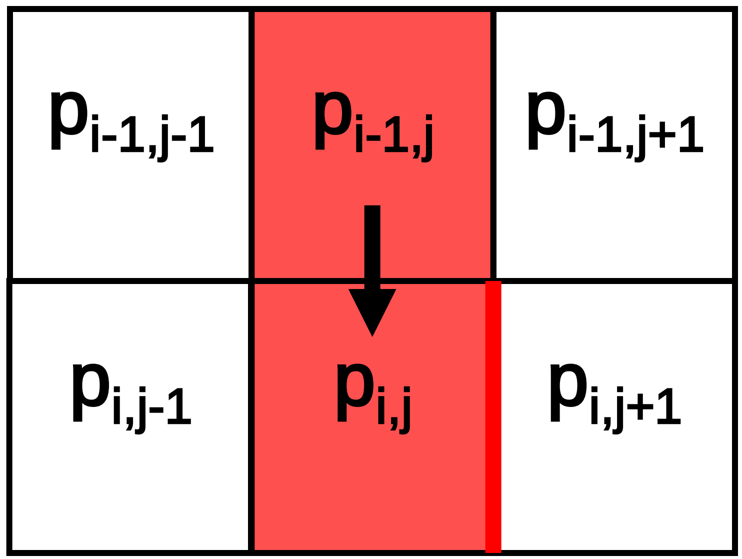
$$C_L(i,j) = |I(i,j+1) - I(i,j-1)| + |I(i-1,j) - I(i,j-1)|$$

Pixel $P_{i,j}$: Right Seam



$$C_R(i,j) = |I(i,j+1) - I(i,j-1)| + |I(i-1,j) - I(i,j+1)|$$

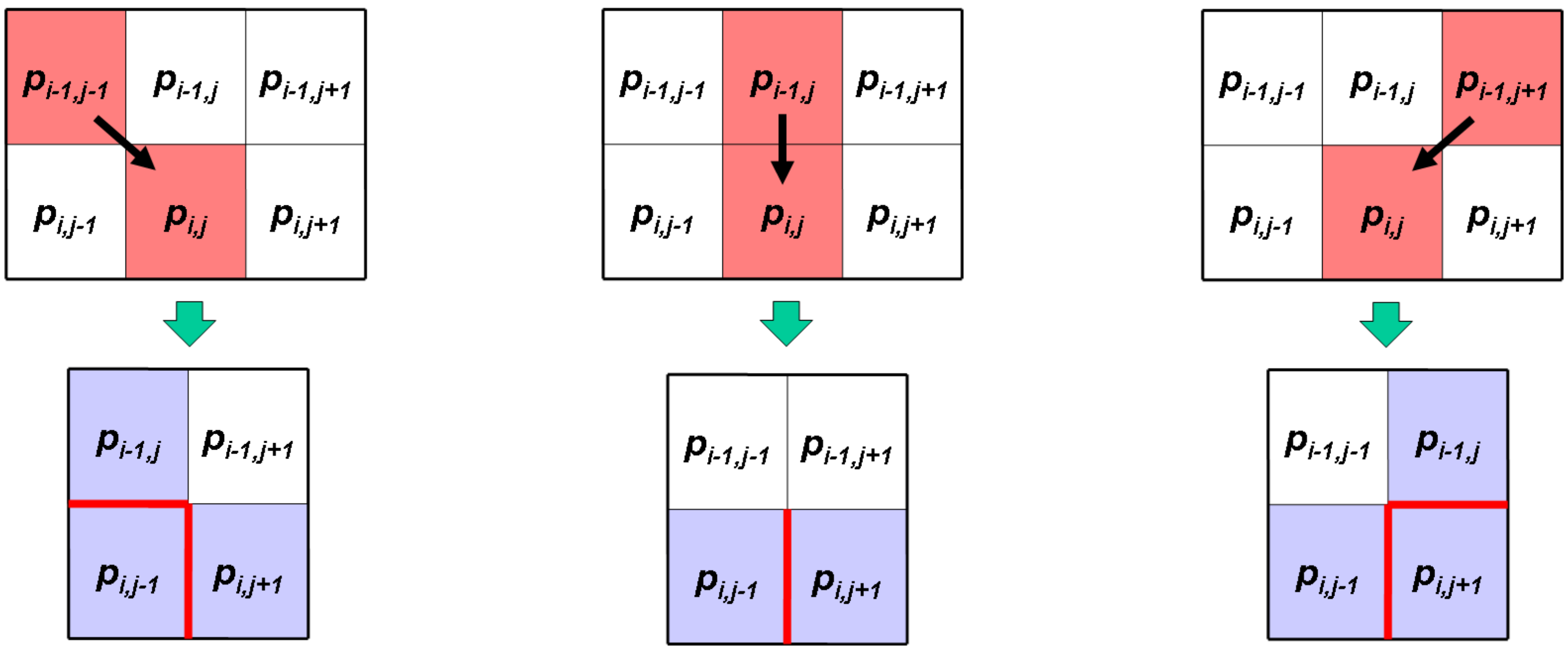
Pixel $P_{i,j}$: Vertical Seam



$$C_V(i,j) = |I(i,j+1) - I(i,j-1)|$$

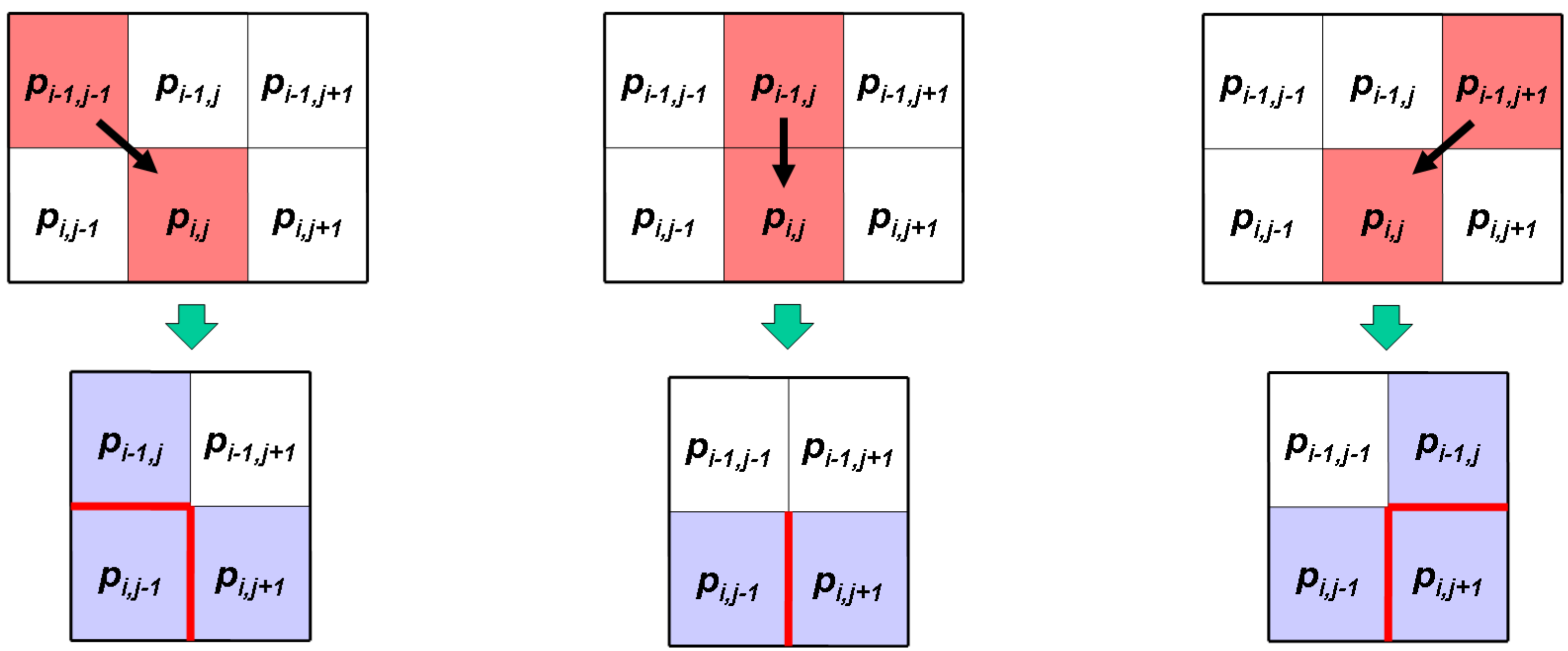
New Forward Looking Energy Function

$$M(i,j) = E(i,j) + \min \begin{cases} M(i-1,j-1) \\ M(i-1,j) \\ M(i-1,j+1) \end{cases}$$

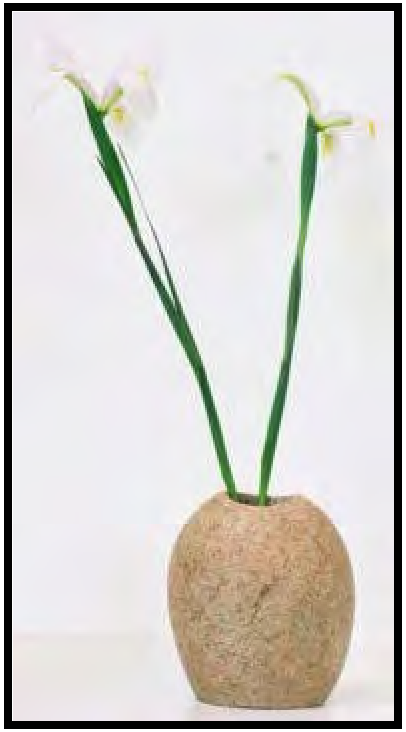


New Forward Looking Energy Function

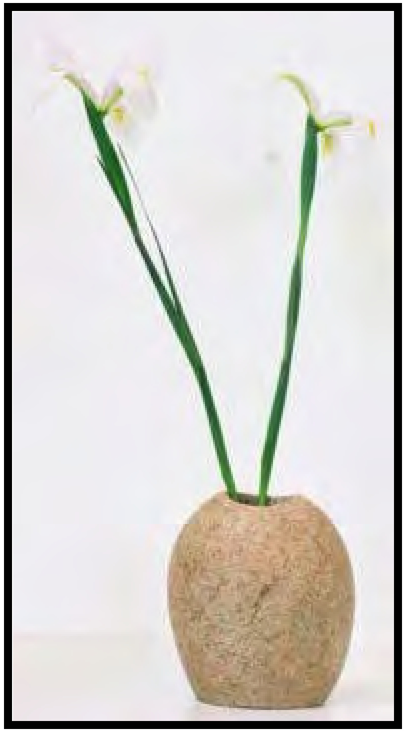
$$M(i,j) = \min \begin{cases} M(i-1,j-1) \\ M(i-1,j) \\ M(i-1,j+1) \end{cases}$$

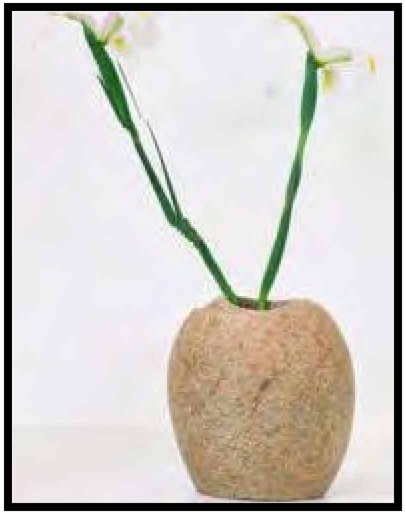


Backward (SIG 07)



Forward (SIG 08)





Backward

Forward

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Backward

Forward

Expand

Expand