Texture Optimization for Example-based Synthesis

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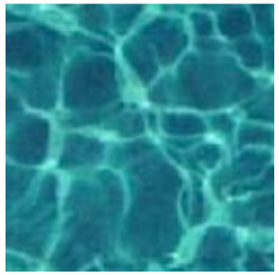
Overview

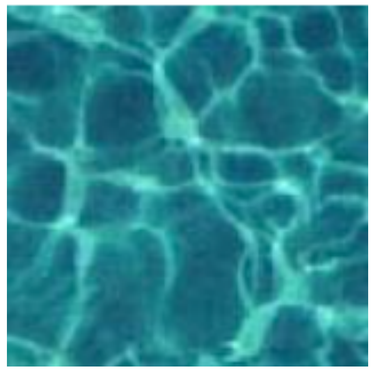
- Markov Random Field (MRF) energy defines the similarity between a pair of images
- When MRF energy is minimized, output image will be similar to input image



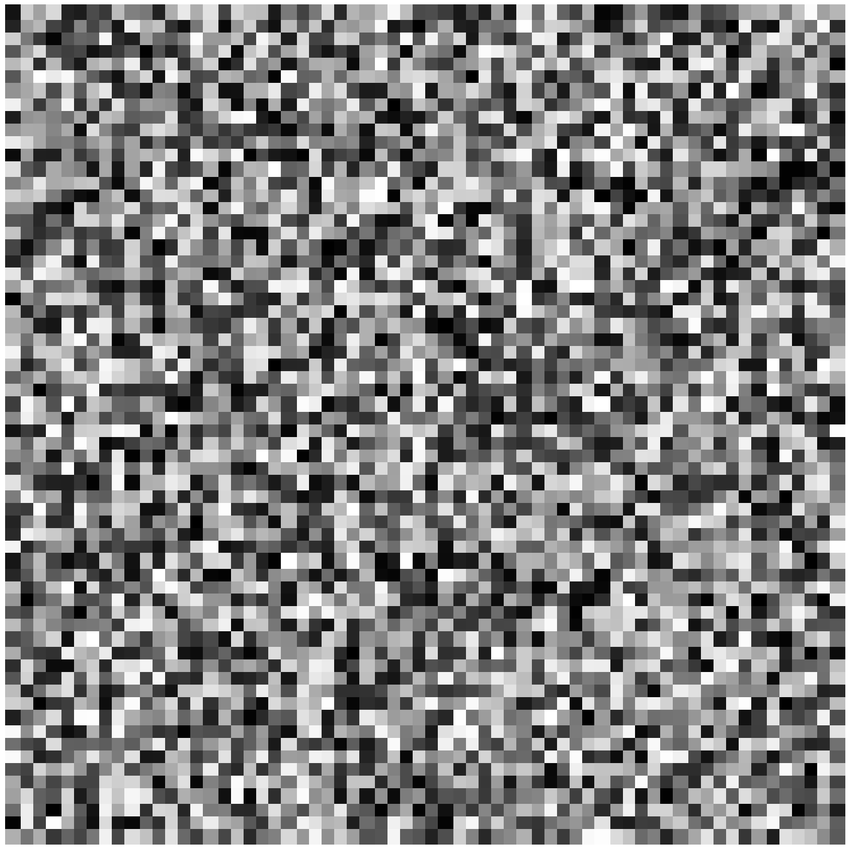
Input

Output

MRF Energy for a Single Patch



Input

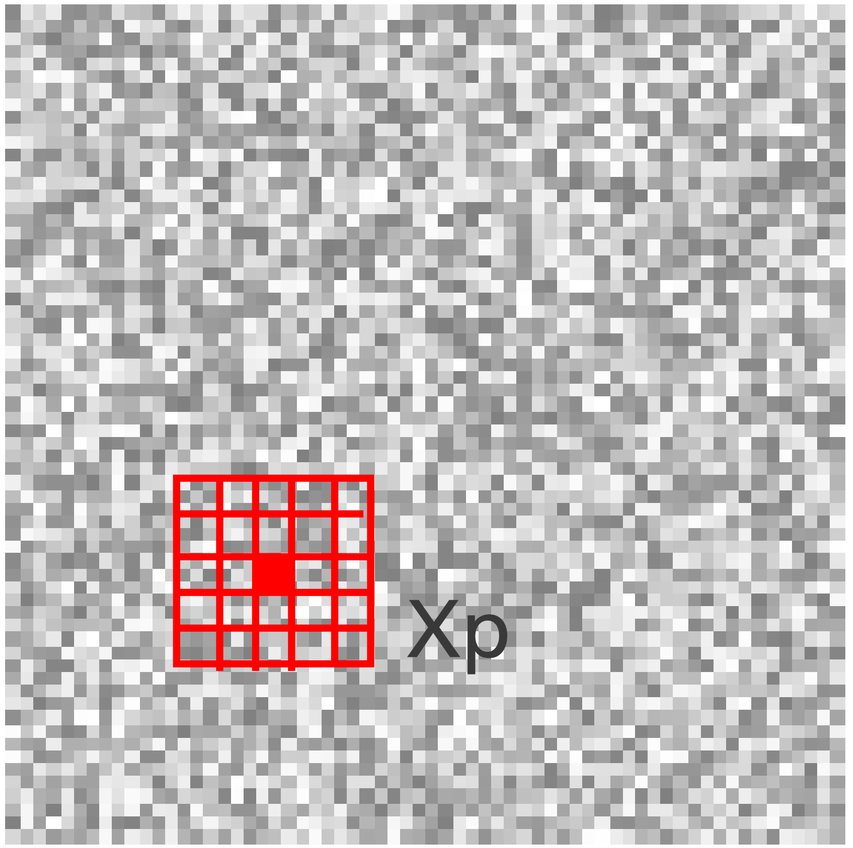


Output

MRF Energy for a Single Patch

Given a patch, Xp, in output image

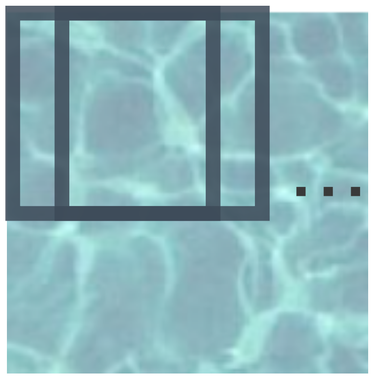
Input



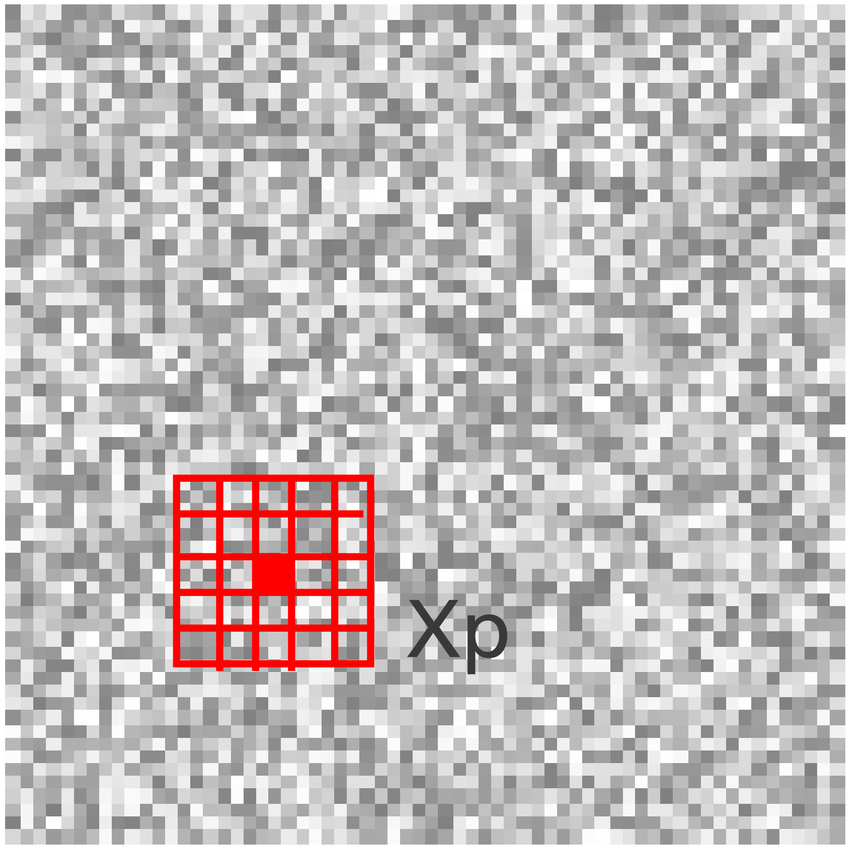
Output

MRF Energy for a Single Patch

Search Xp's closest patch in input image



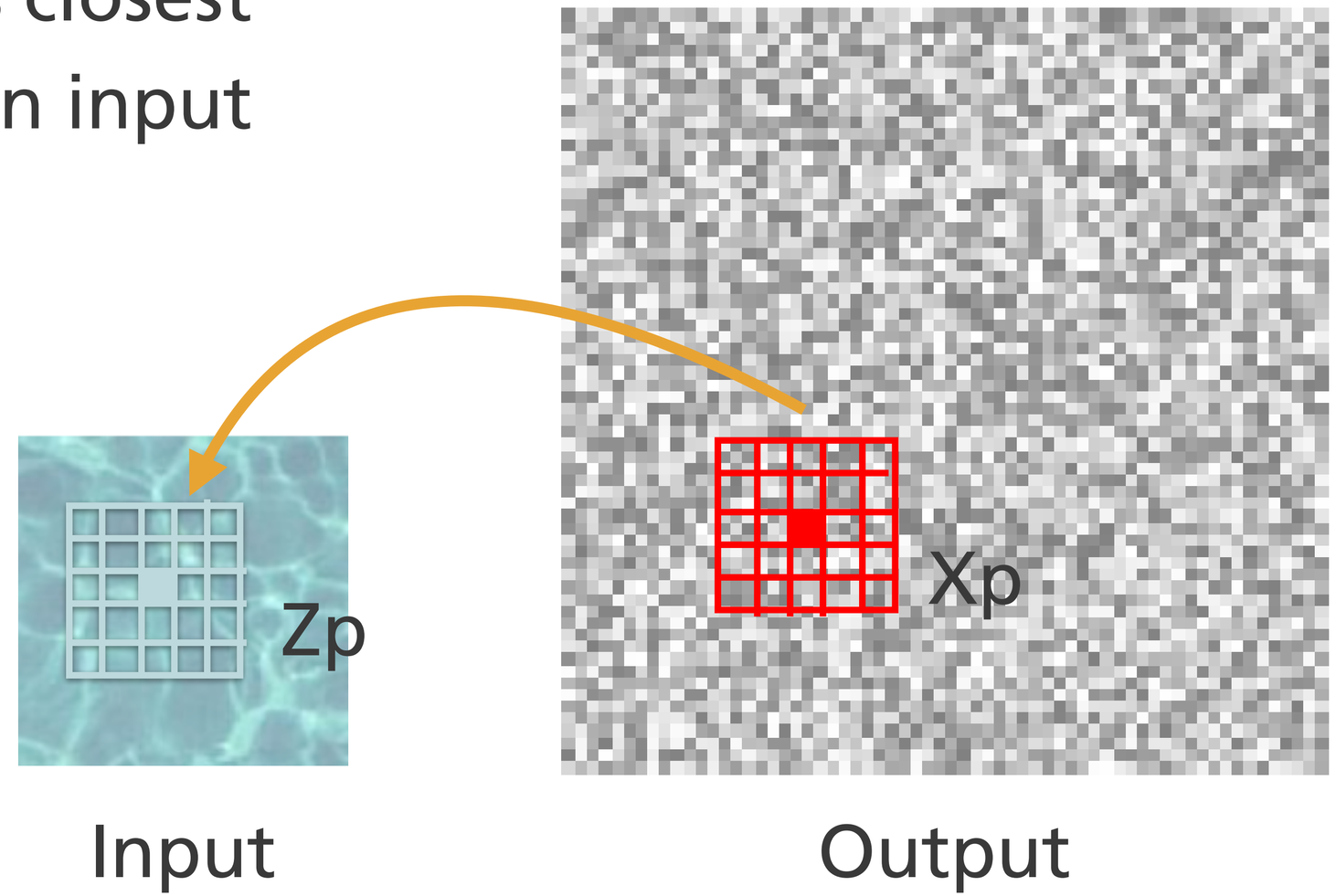
Input



Output

MRF Energy for a Single Patch

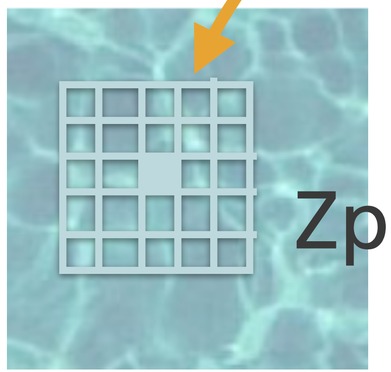
Search Xp's closest patch, Zp, in input image



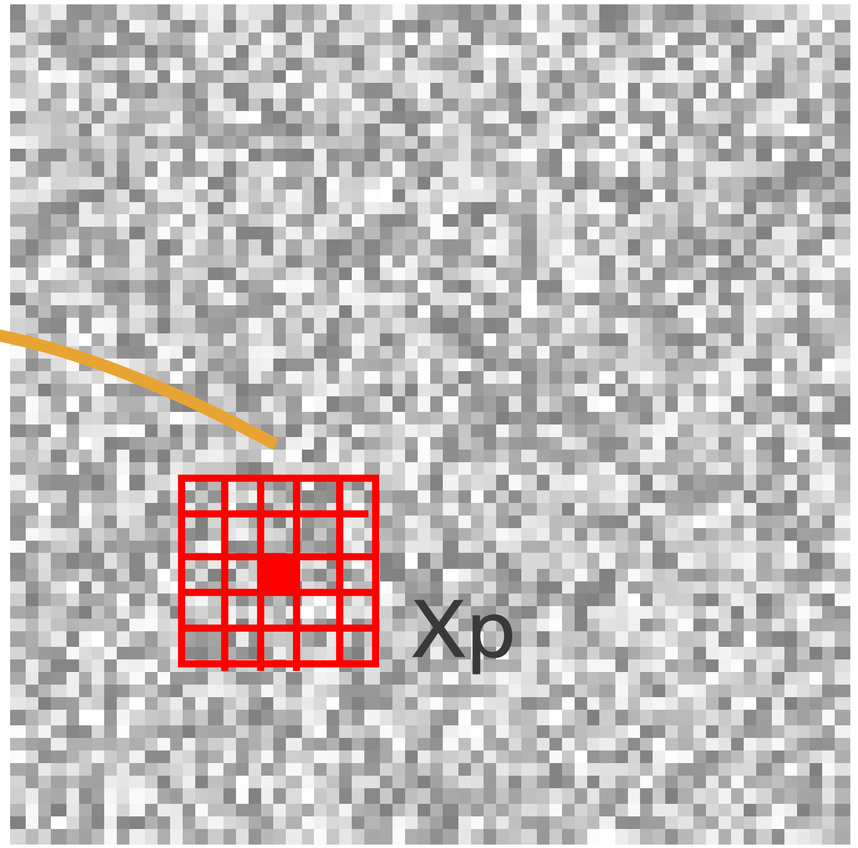
MRF Energy for a Single Patch

MRF energy is the square pixel difference between Xp, Zp

$$E_{MRF}^{(p)} = (\mathbf{X_p} - \mathbf{Z_p})^2$$



Input



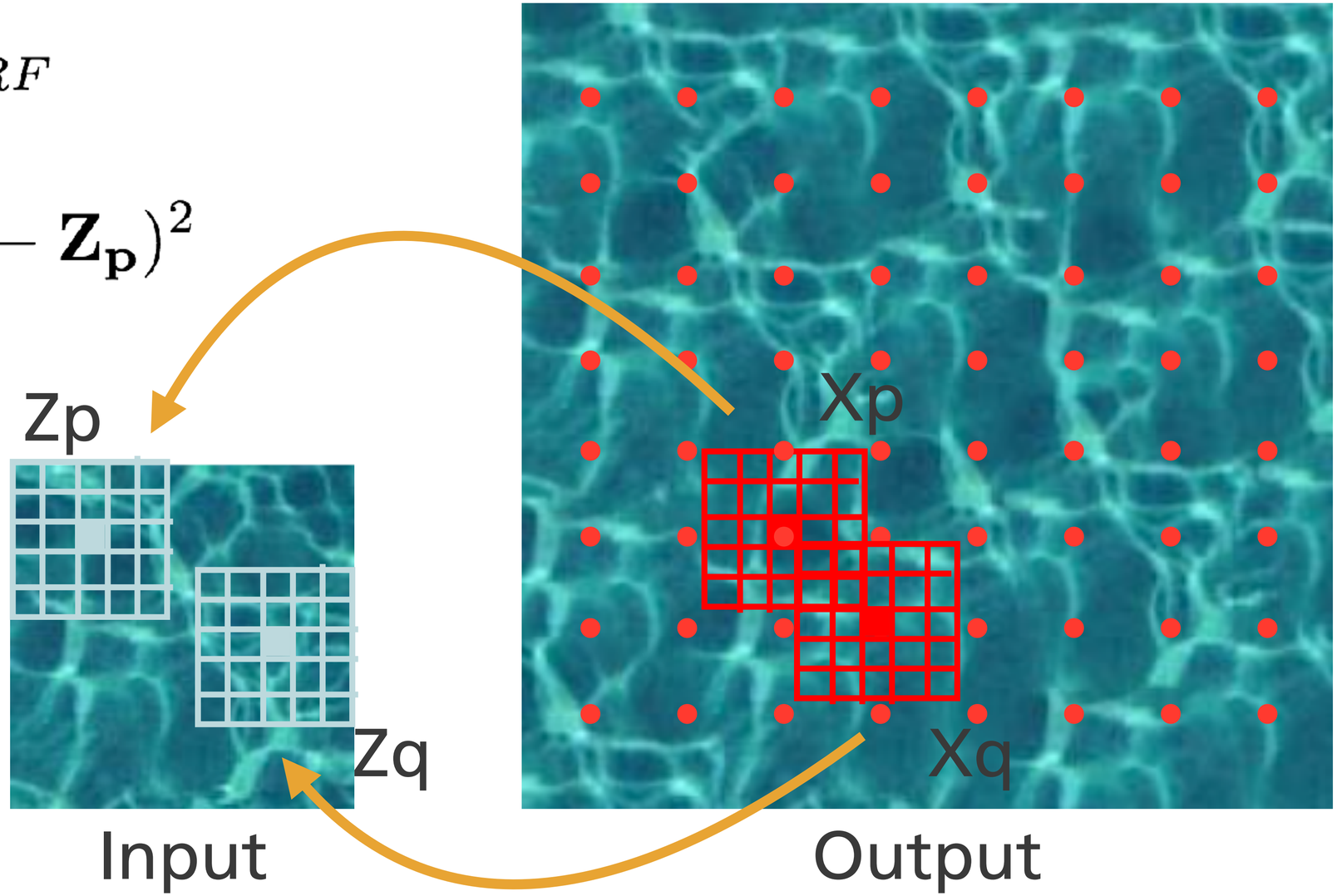
Output

MRF Energy for an Entire Image

$$E_{MRF} = \sum_p E_{MRF}^{(p)}$$

$$= \sum_p (\mathbf{X_p} - \mathbf{Z_p})^2$$

all the sampled patches in the output image

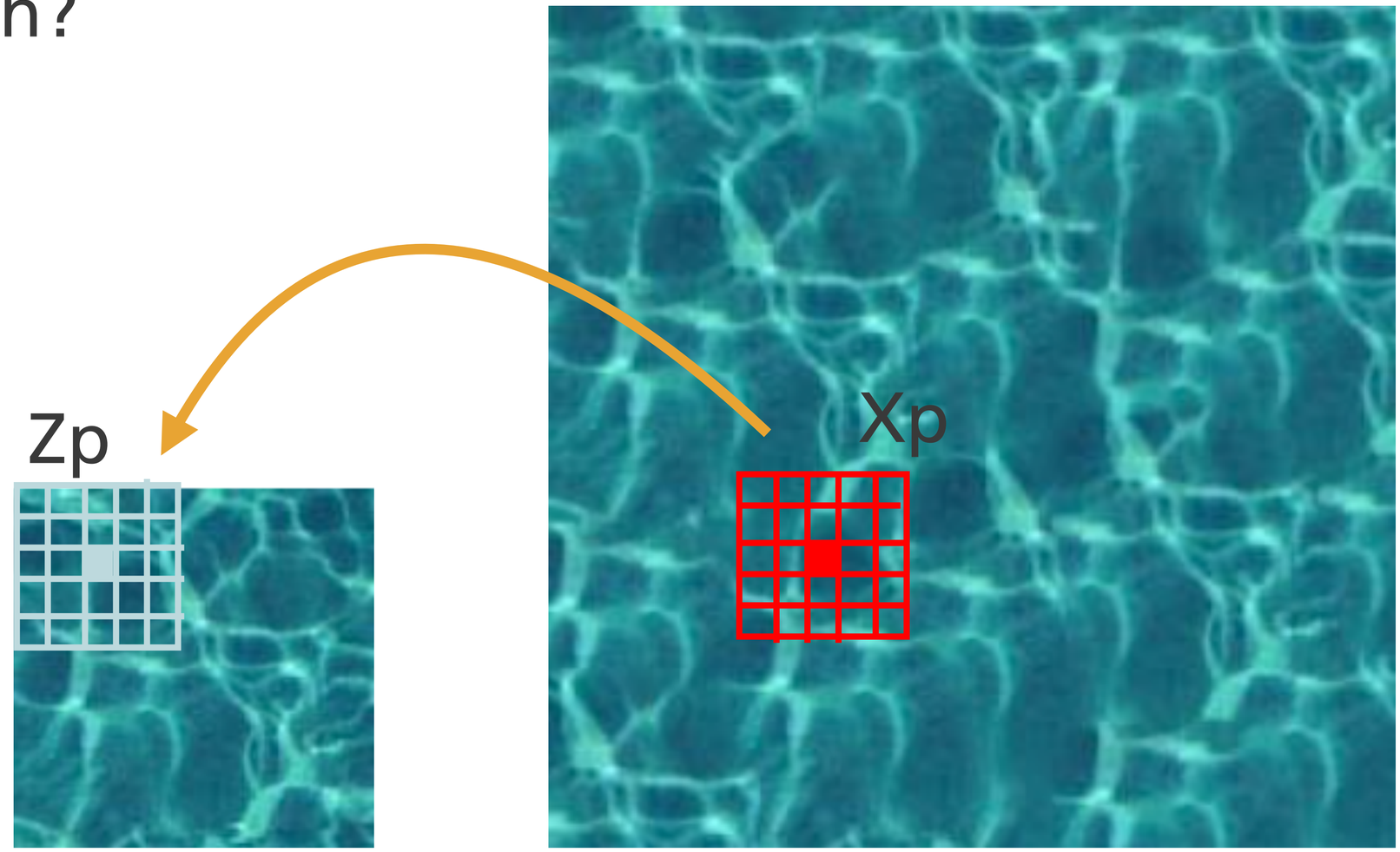


Minimizing MRF Energy

$$E_{MRF}^{(p)} = (\mathbf{X_p} - \mathbf{Z_p})^2$$

For a single patch?

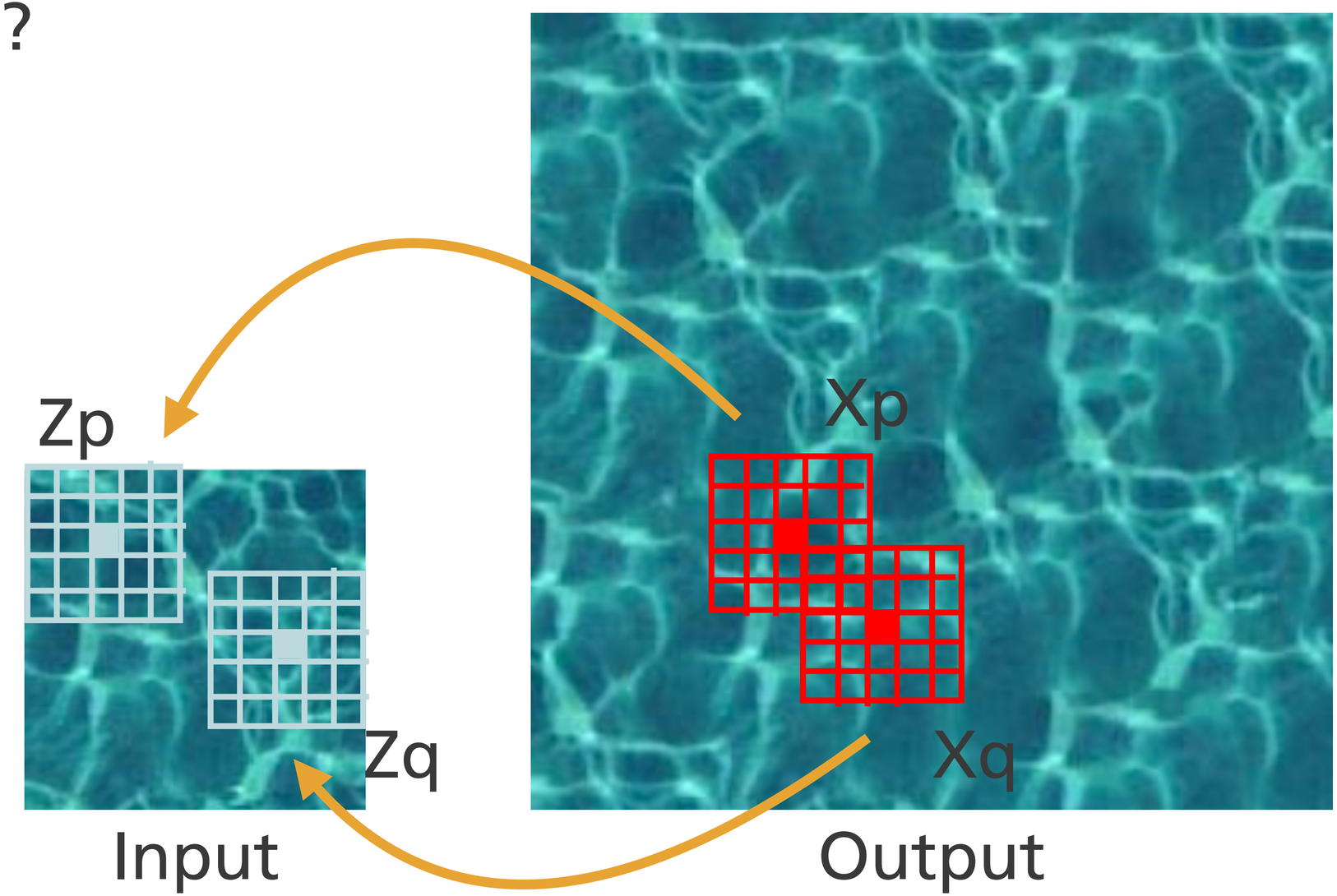
Xp = Zp



Minimizing MRF Energy

$$E_{MRF} = \sum_p E_{MRF}^{(p)}$$
$$= \sum_p (\mathbf{X_p} - \mathbf{Z_p})^2$$

For two patches?



Minimizing MRF Energy

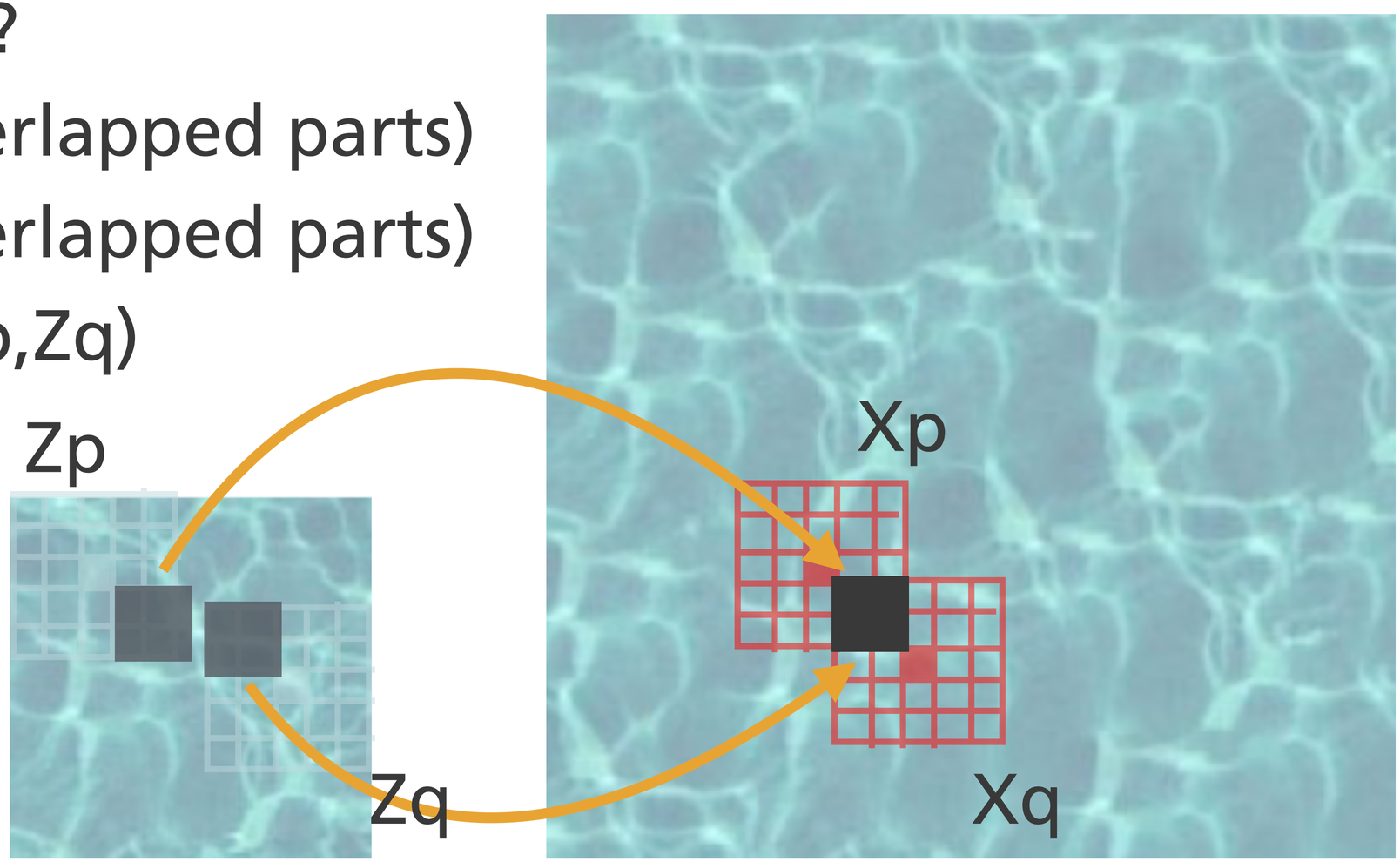
$$E_{MRF} = \sum_p E_{MRF}^{(p)}$$
$$= \sum_p (\mathbf{X_p} - \mathbf{Z_p})^2$$

For two patches?

Xp = Zp (not overlapped parts)

Xq = Zq (not overlapped parts)

overlap = avg(Zp,Zq)



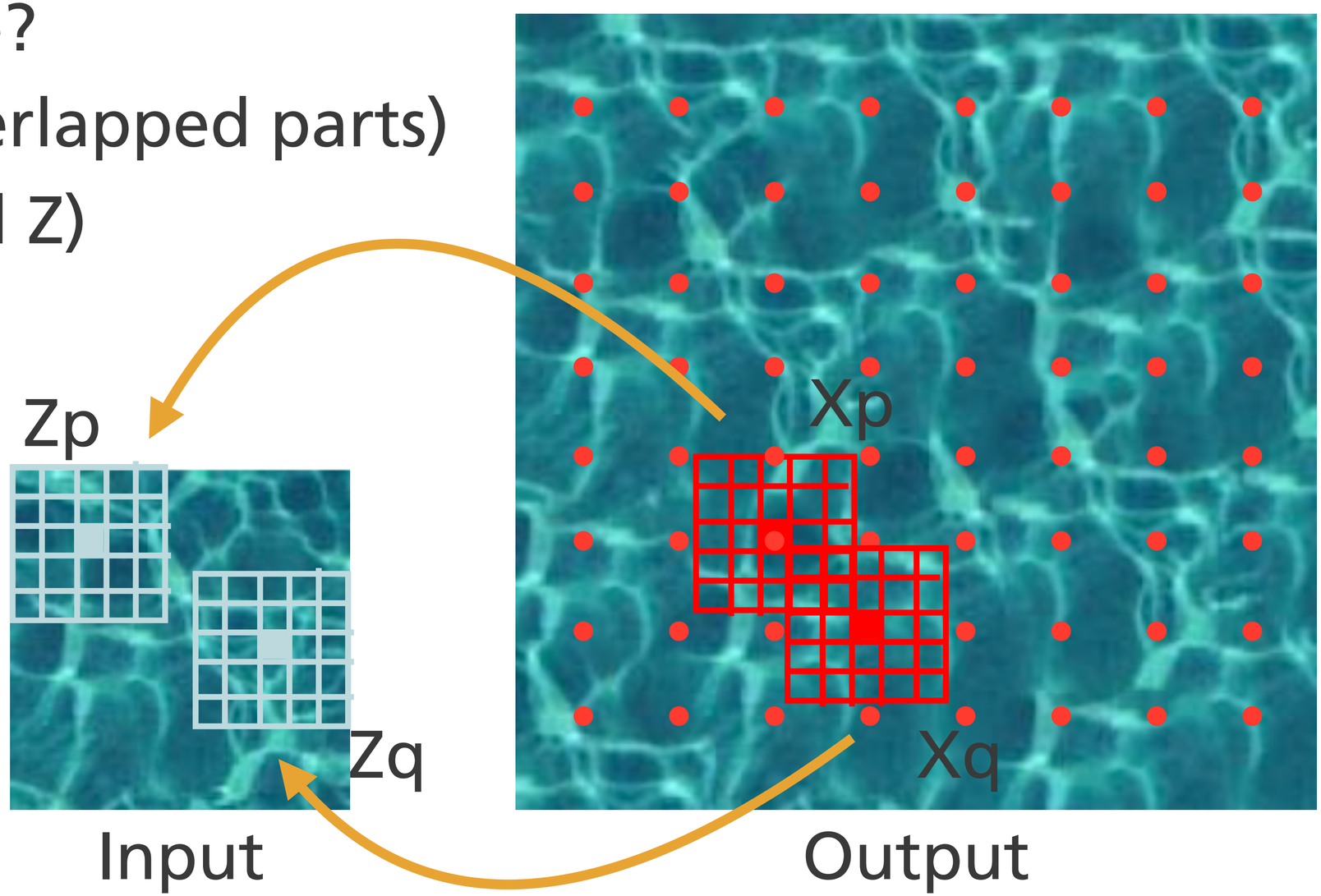
Minimizing MRF Energy

$$E_{MRF} = \sum_p E_{MRF}^{(p)}$$
$$= \sum_p (\mathbf{X_p} - \mathbf{Z_p})^2$$

For entire image?

Xp = Zp (not overlapped parts)

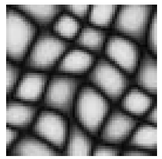
overlap = avg(all Z)



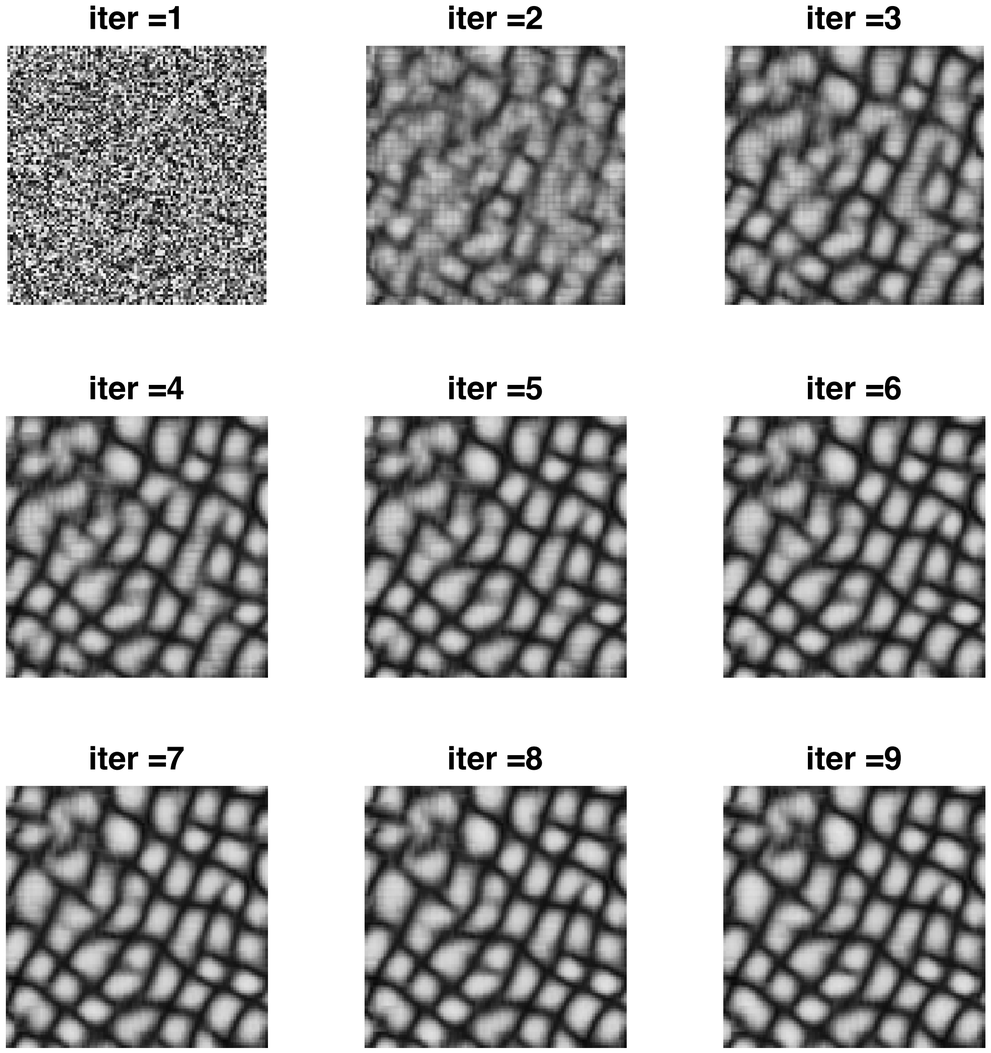
Optimizing MRF Energy Algorithm

1. Random initialize output, X, Zp
2. for iteration = 1:maxIter do
3. **Xnew** = minimize MRF Energy wrt X, given Zp
4. Update nearest neighbor field, **Zpnew**
5. if Zpnew == Zp
6. break
7. X = Xnew, Zp = Zpnew

Demo



input (64x64)



output (100x100)