# Generating Natural Images with Direct Patch Distributions Matching

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Code & Live demo

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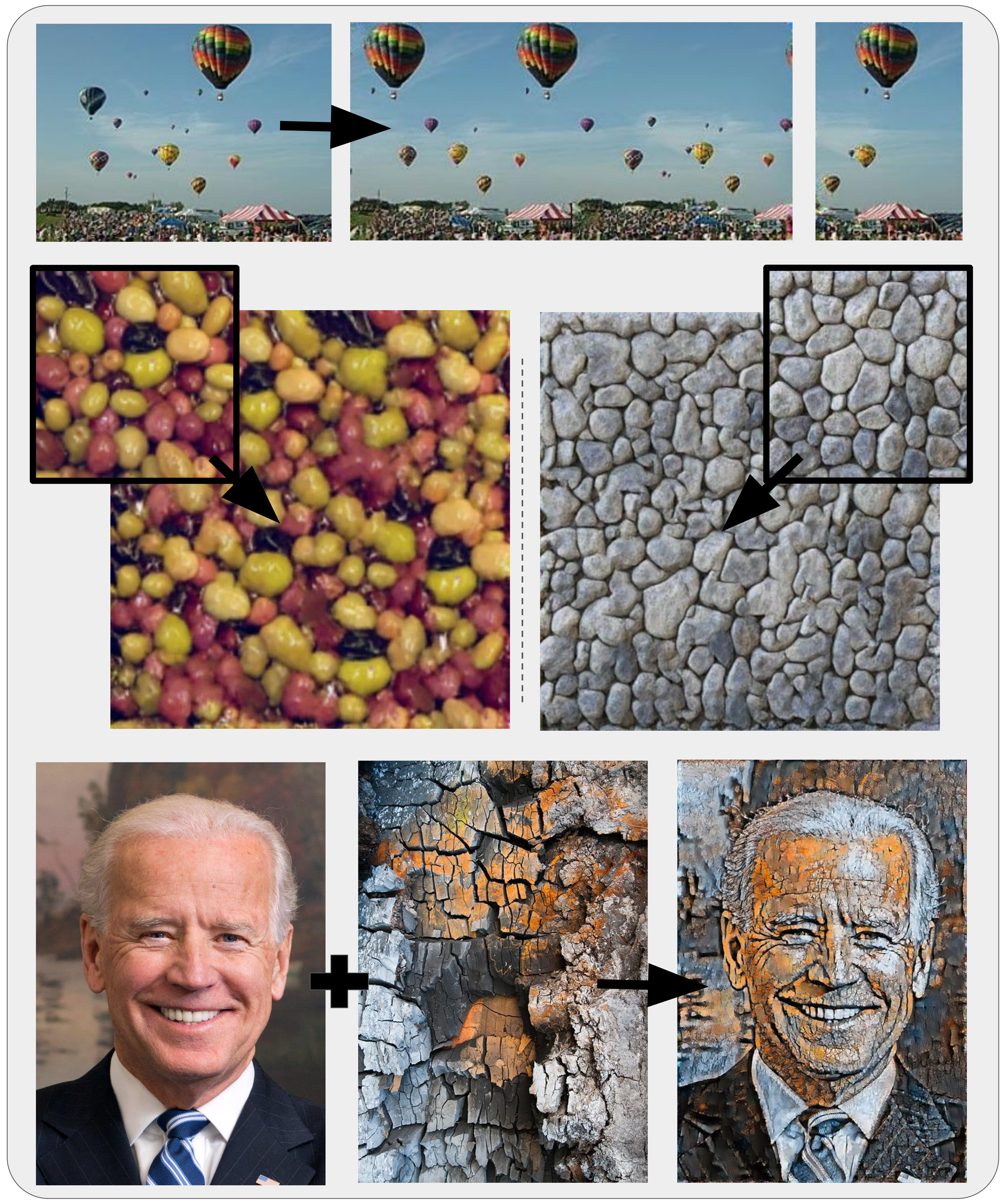
## Overview


### Abstract

By efficiently matching the distribution of patches between images we can solve a broad spectrum of single-image generative tasks without training a per-image GAN or computing patch nearest neighbors.


### Single image generative models

In a wide variety of tasks a model needs to capture the statistics of a single reference image in order to resample or manipulate it.



## Method

### Patch distribution matching:

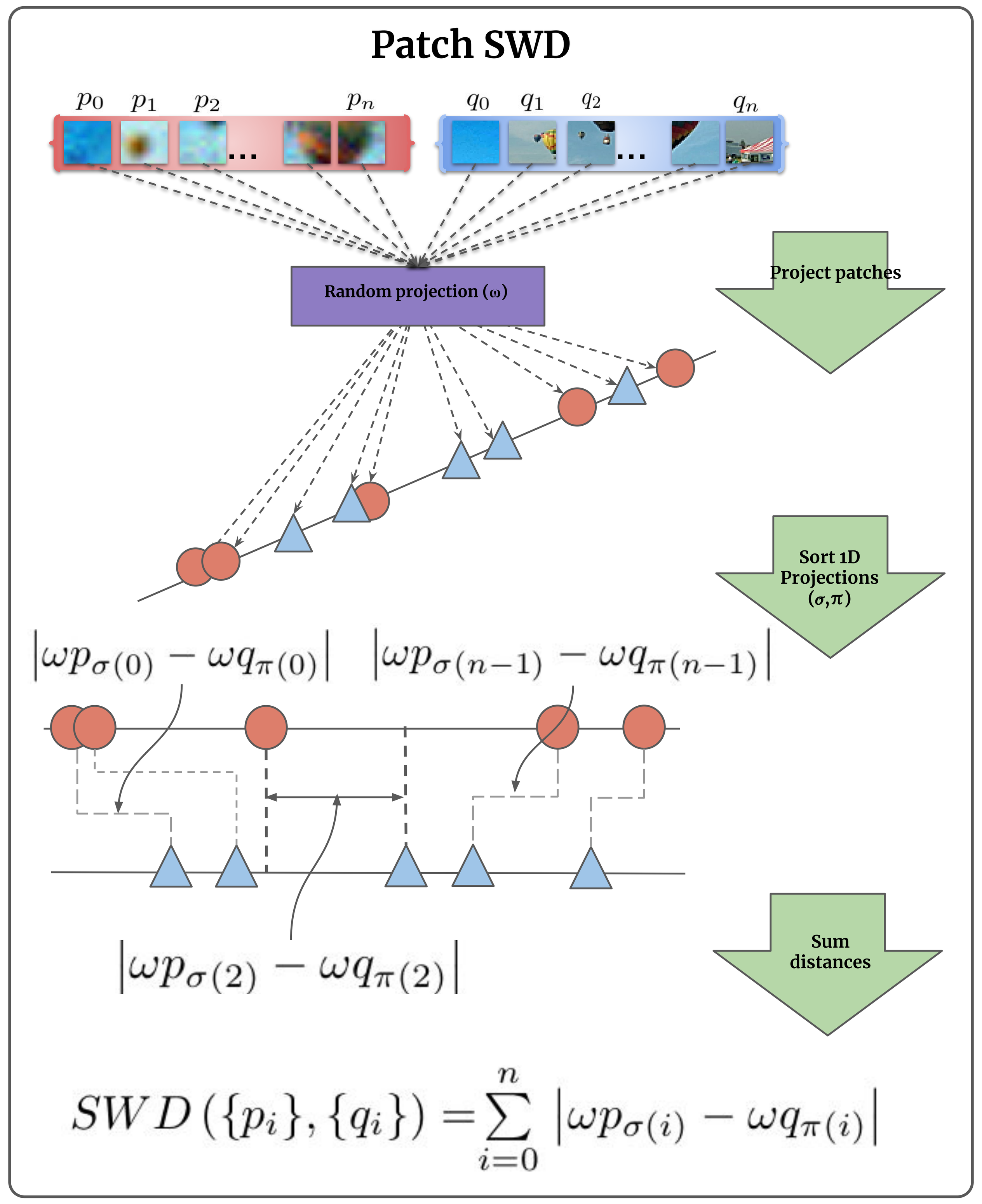
Many single image generative models try to match the patch distribution of a reference image using objectives like the Bidirectional similarity or patch-discriminators.

We use efficiently compute the SWD between patches using 2d convolutions:

**Algorithm 1** GPDM.

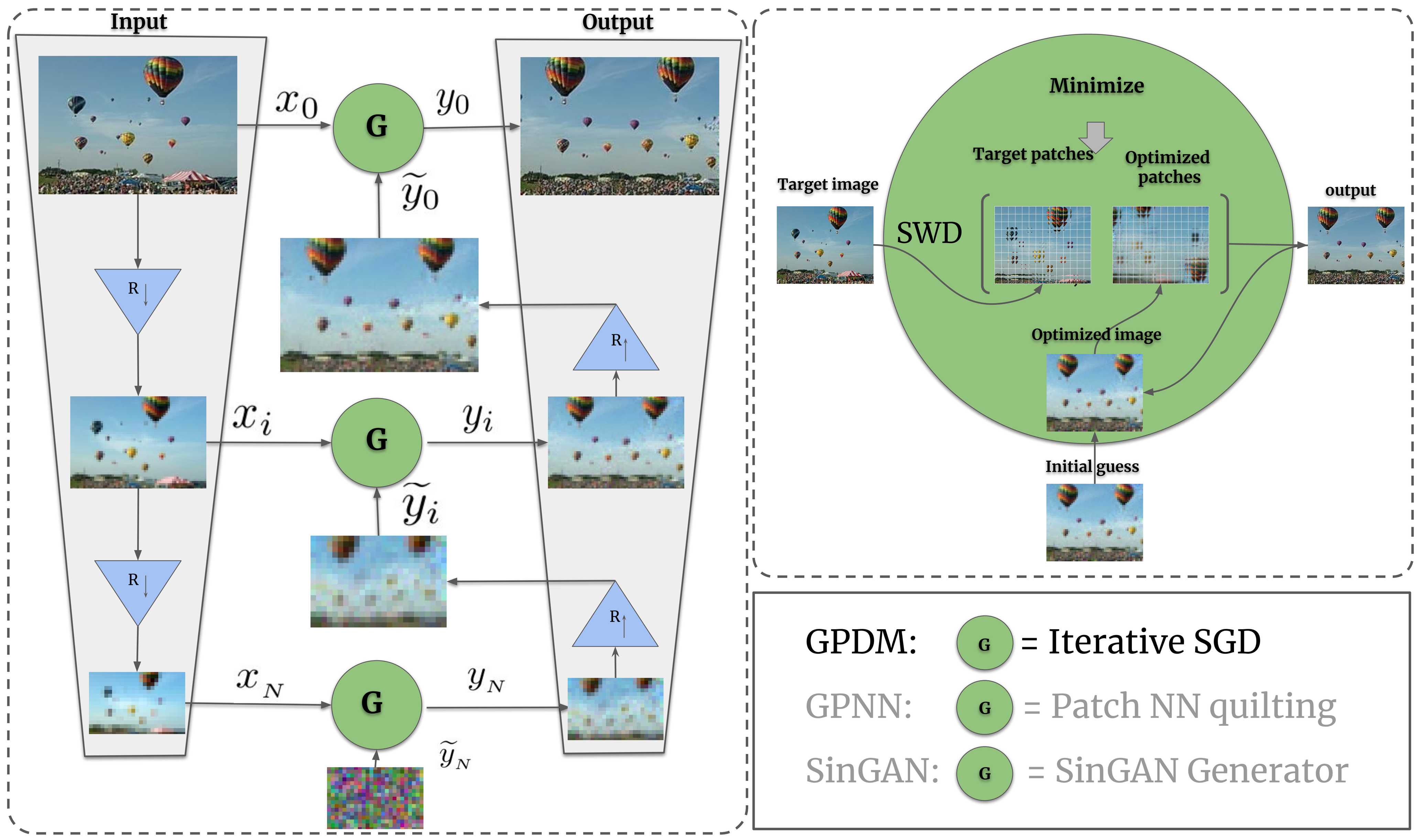
**Input**: Target image x, initial guess $\tilde{y}$, learning rate $\beta$
**Output**: Optimized image y

$y \leftarrow \tilde{y}$
**while** not converged **do**
  $L \leftarrow 0$
  **for** i=1,k **do**
    $\omega \sim N(0, \sigma I)$
    $\omega \leftarrow unflat(\frac{\omega}{\|\omega\|})$
    $p \leftarrow flat(conv2d(x, \omega))$
    $q \leftarrow flat(conv2d(y, \omega))$
    $L \leftarrow L + \frac{1}{k}|sort(p) - sort(q)|$
  **end for**
  $y \leftarrow y - \beta \nabla_y L$
**end while**




### Synthesis proces:

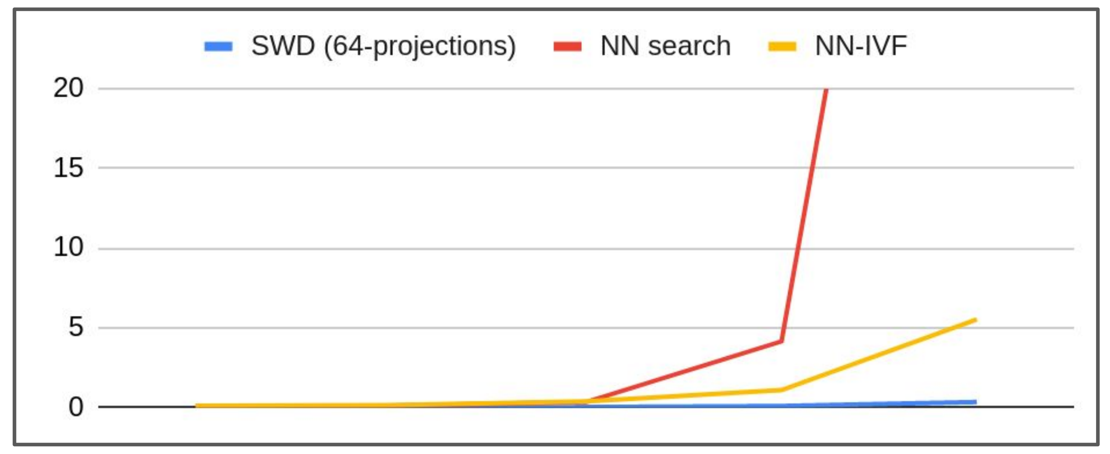
We syntesis an image in a multi-scale manner: at each level an initial guess is optimize to match the patch distribution of the scaled reference imag.




## Results

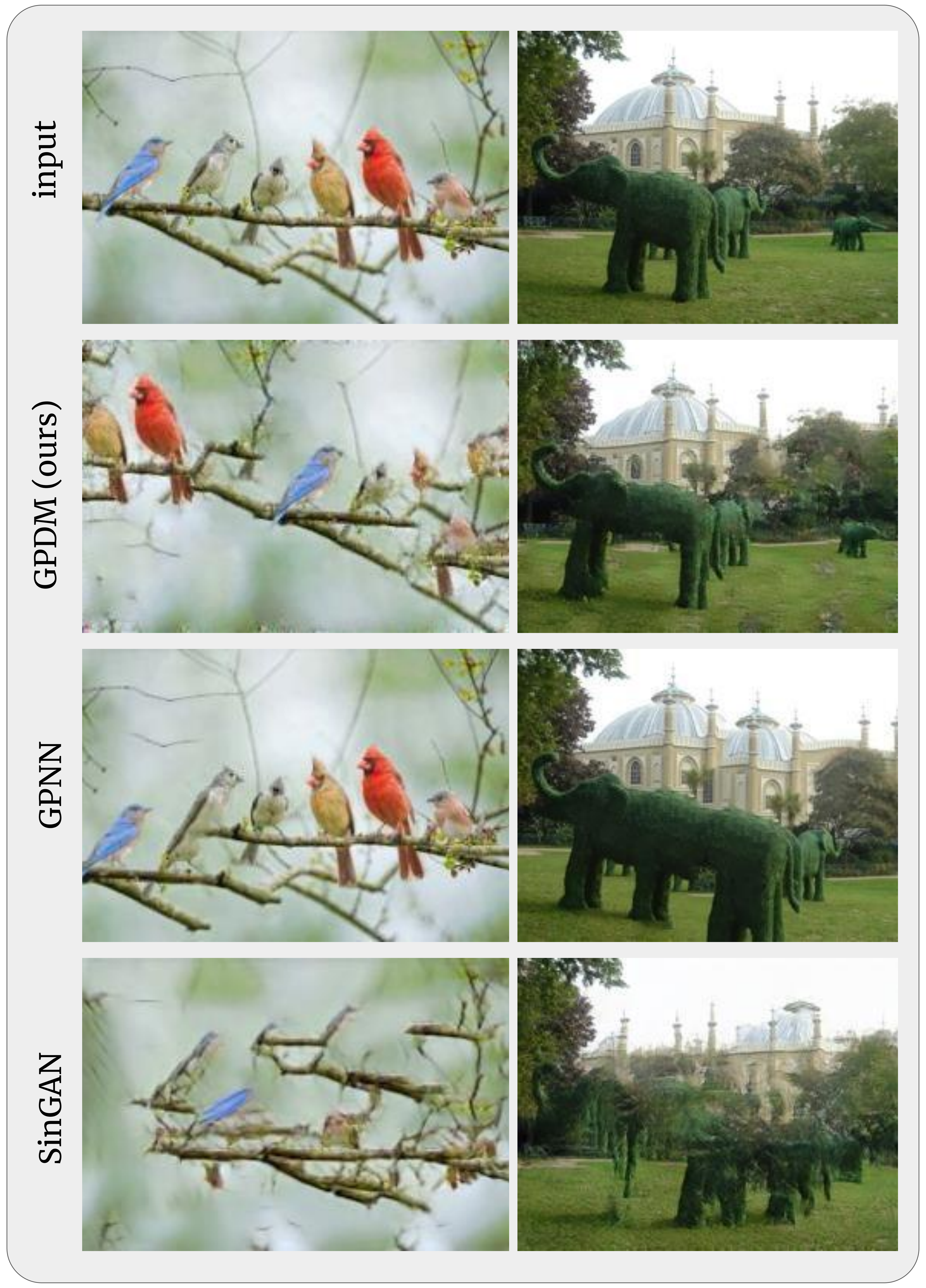
### Computation efficiency

Our method scales more efficiently with the size of the image.Computing SWD is $O(nlog(n))$ while nearest-neighbor based approaches scale quadratically




### Comparison to other methods:

We visually and quantitatively compare our to other method. GPDM compares to GPNN outperforms SinGAN.




## References


1. Simakov, Denis, et al. "Summarizing visual data using bidirectional similarity." *2008 IEEE Conference on Computer Vision and Pattern Recognition*. IEEE, 2008.
2. Shaham, Tamar Rott, Tali Dekel, and Tomer Michaeli. "Singan: Learning a generative model from a single natural image." *Proceedings of the IEEE/CVF International Conference on Computer Vision*. 2019.
3. Granot, Niv, et al. "Drop the gan: In defense of patches nearest neighbors as single image generative models." *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern 1. Recognition*. 2022.