Image Compression and Reconstruction using SVD

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http://www.csm.ornl.gov/Internships/abstracts/WilliamWells.pdf

Singular Value Decomposition (SVD) is an algorithm with the potential of decreasing transfer bandwidth and storage space for images on the Internet. It is one method that mathematicians and computer scientists are inventing for reducing the amount of data processed and stored. The image compression and feature extraction process consists of three key steps.

Image Compression Process:

- **Decomposing an image matrix**
- **Truncating small singular values and vectors**
- **Reconstructing the reduced image matrix**

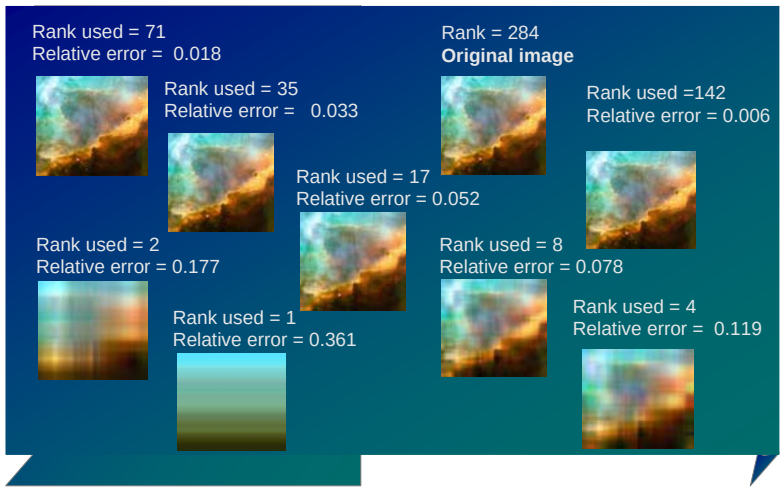
```
[[ 36 37 39 41 43 41 40 39 42 34 41 37 42 50 42 47]
 [ 36 37 39 40 41 40 39 38 39 34 45 39 39 47 43 52]
 [ 37 38 39 40 39 38 36 35 34 32 44 37 35 42 39 51]
 [ 36 37 37 37 37 36 35 34 30 25 36 33 34 41 34 42]
 [ 34 35 35 35 34 34 32 32 29 22 32 33 39 47 32 32]
 [ 33 31 32 33 32 33 32 31 33 24 33 34 43 52 35 32]
 [ 31 30 31 30 31 33 32 32 35 25 34 32 39 49 38 40]
 [ 29 29 30 31 31 33 33 32 35 26 33 29 32 43 38 45]
 [ 32 31 32 31 31 32 31 30 37 24 30 37 58 74 49 35]
 [ 33 33 32 33 33 31 31 31 27 25 29 53 148 223 156 47]
 [ 35 35 33 33 33 32 32 30 21 31 32 34 125 218 156 39]
 [ 36 36 34 34 33 32 32 30 26 33 34 17 43 87 64 24]
 [ 37 36 35 34 33 34 33 33 31 26 39 38 38 41 28 30]
 [ 36 36 34 34 34 35 36 35 34 30 47 48 47 47 34 38]
 [ 35 35 34 35 36 36 38 36 39 37 47 38 34 41 34 39]
 [ 34 34 34 34 36 38 38 40 44 31 39 39 47 53 40 42]]
```

Compressing and Representing Images

Singular value decomposition extracts features, reduces image data for analysis and storage, and reproduces a fairly accurate image (example: 25 vectors can be used, rank=25, to represent an original image of rank 100; similarly, 64 vectors can be used to represent features of an image with a rank of 256).

"Mirroring a Sea Storm" image taken by the Hubble telescope

Image as Pixel Values



Single value decomposition reduces images to essential content to the user requested accuracy

- **Used to store, reconstruct and transfer lossy images fast on the internet**
- **Reduces to dominate features**
- **Good for searching coarse features in images**
- **Less data required for transfer = faster transfer to the user**

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