# Image Processing, Retrieval and Analysis

Project 3

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# Task 3.1: Interpolation

Implementation of radial basis function interpolation.

$$y(x_i) = y_i = \sum_{j=1}^{n} w_j \, \varphi\Big(\big\|x_i - x_j\big\|\Big) = \sum_{j=1}^{n} w_j \, \Phi_{ij}$$

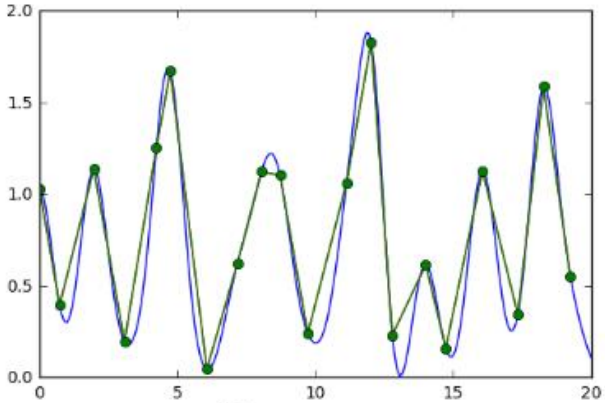
$\boldsymbol{w} = \boldsymbol{\Phi}^{-1}\boldsymbol{y}.$ - the main idea

# The Code

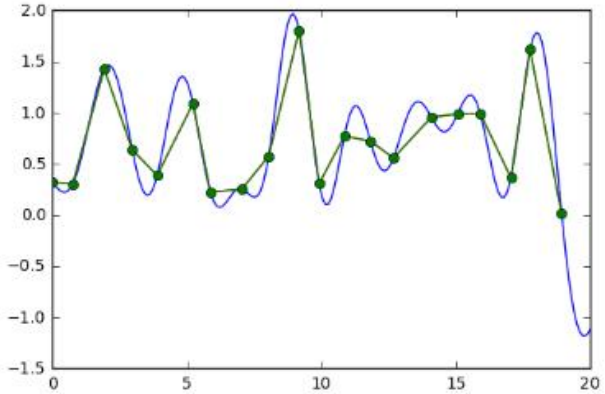
```
# Pseudocode
# phi(pairwise distances)
fill_Phi()

# initialize data set
x = np.arange(n) + np.random.randn(n) * 0.2
y = np.random.rand(n) * 2

# calculating weights
w = np.linalg.inv(Phi).dot(y)

# drawing the results
xs = np.linspace(0, n, 200)
plt.plot(xs, calc_y(xs))
```

# The Results

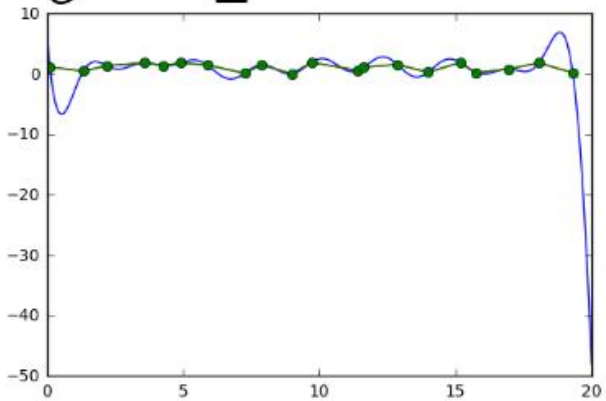
$\sigma = 0.5$



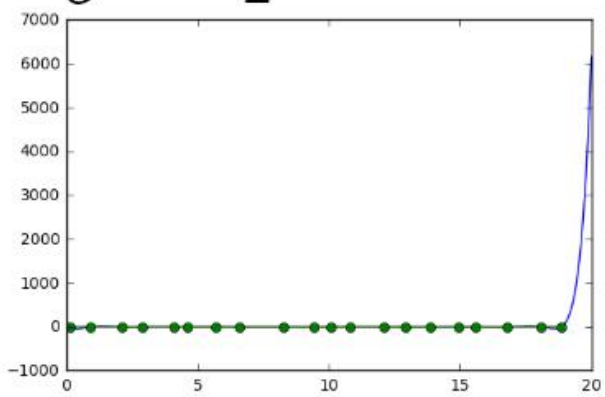

$\sigma = 1$




$\sigma = 2$

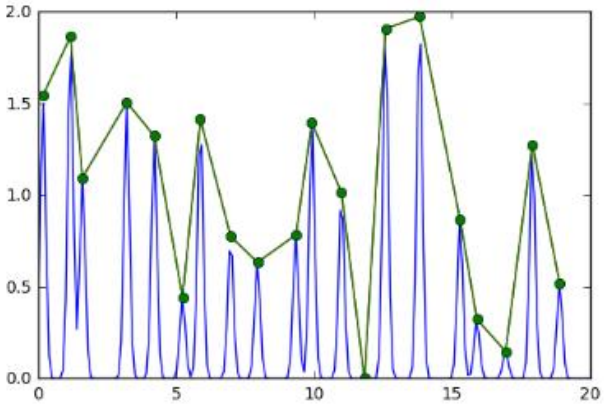



$\sigma = 4$

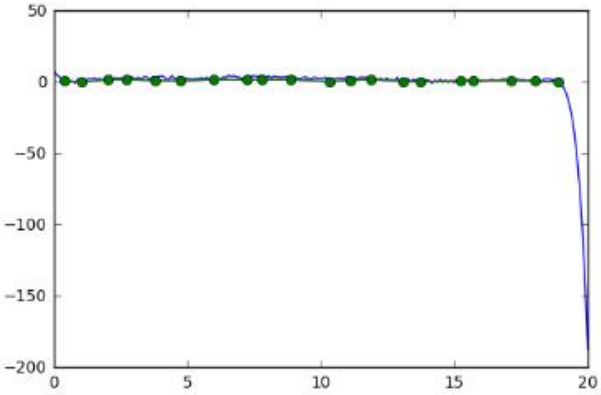


# The Results: bonus

$\sigma = 0.1$




$\sigma = 6$



## Task 3.2: Wave Warps

$$T(x) = x + \alpha \cdot \sin\left(\nu x - \phi\right)$$

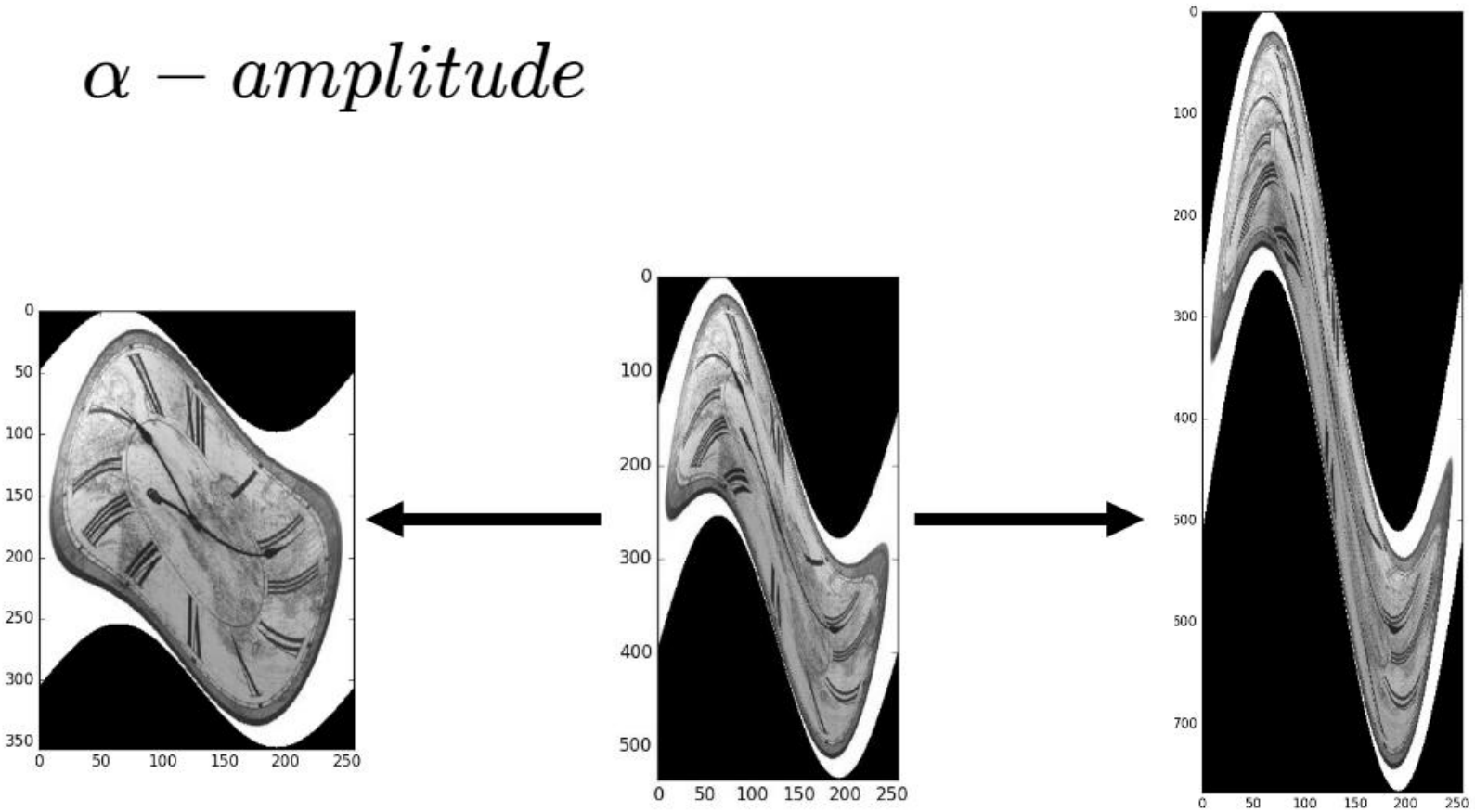
$\alpha - amplitude$

$\nu - frequency$

$\phi - phase$

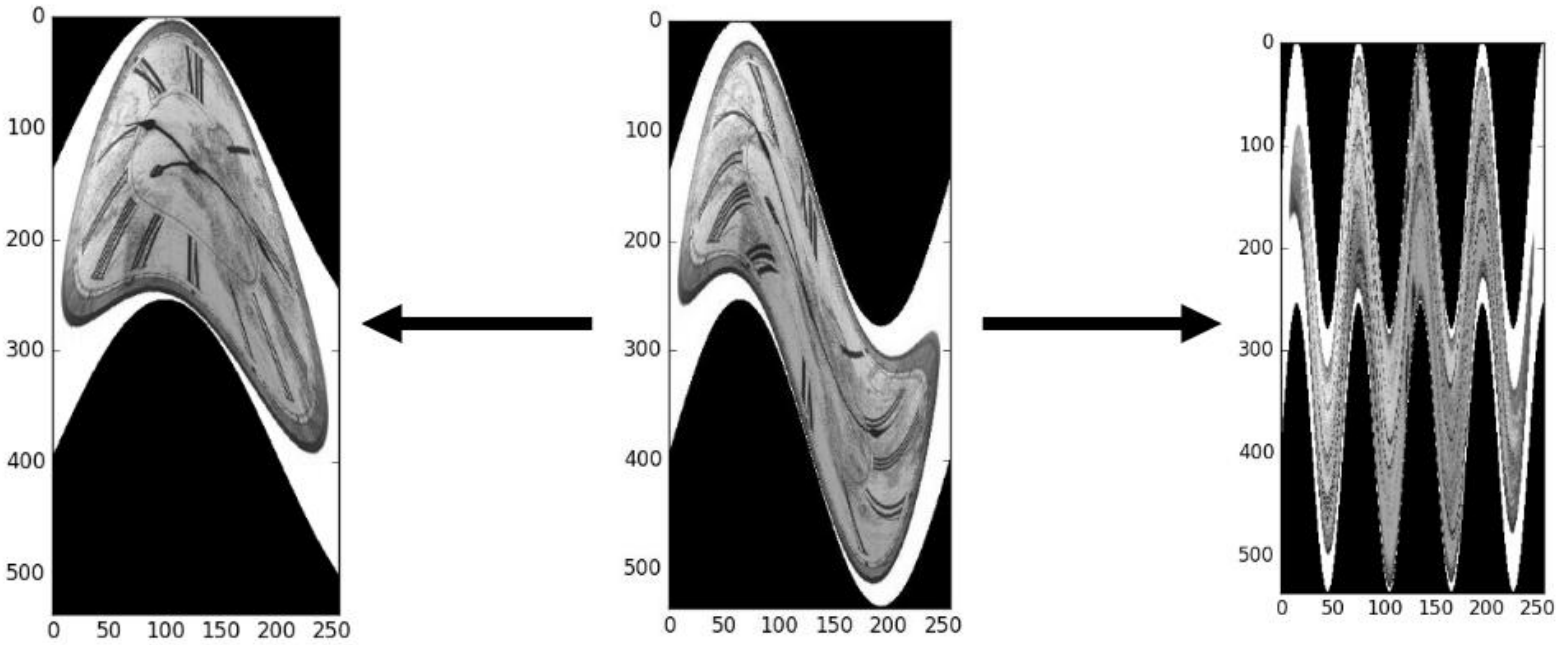
# Task 3.2: Wave Warps

$$\alpha - amplitude$$



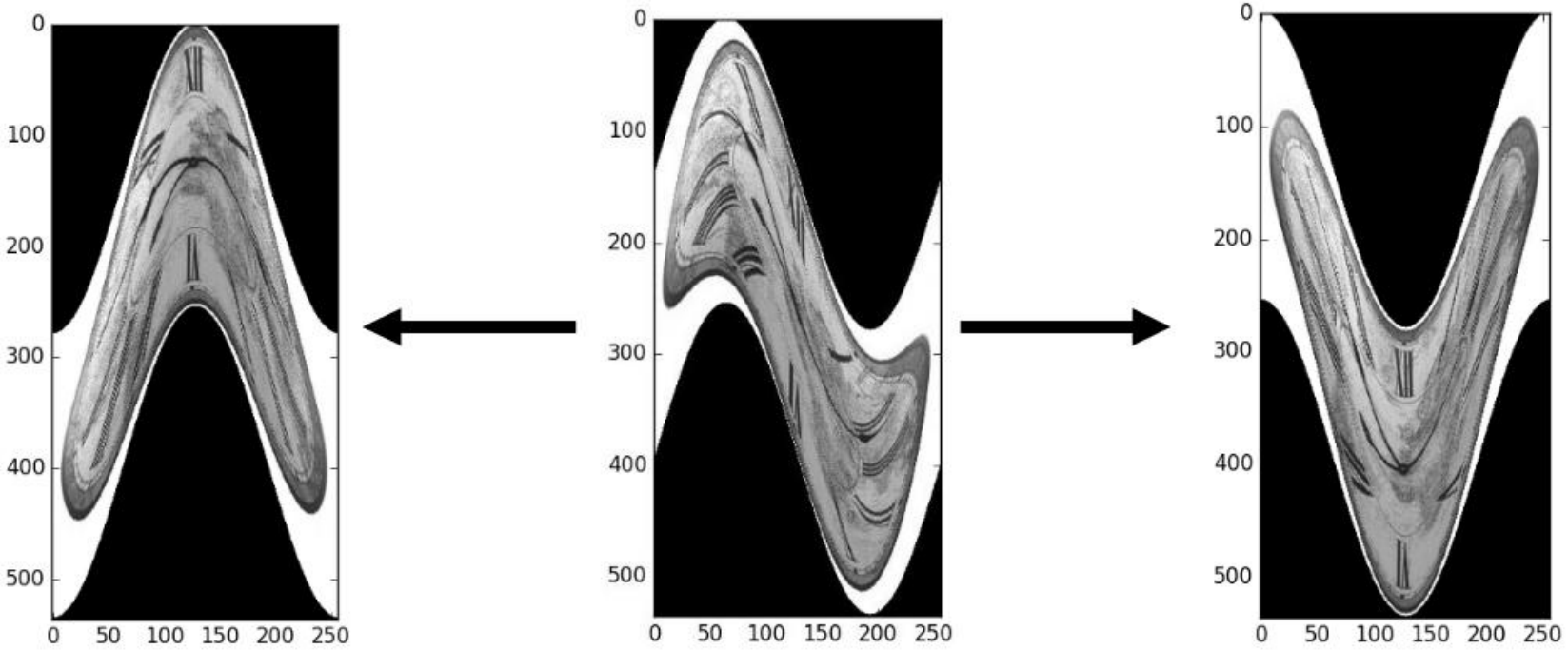
# Task 3.2: Wave Warps

$$\nu - frequency$$

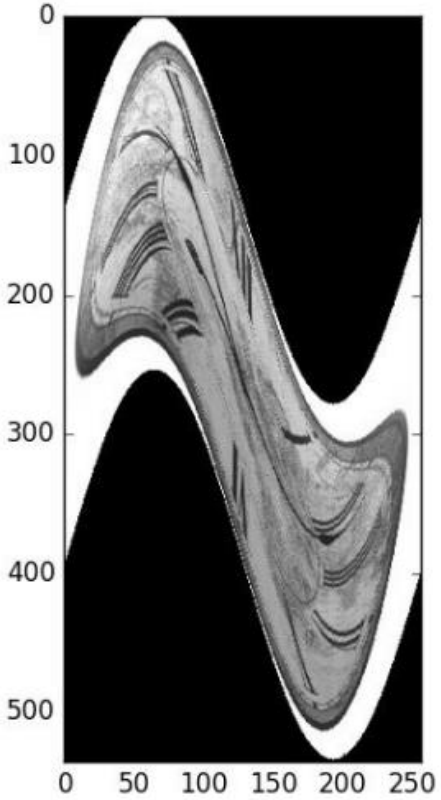


# Task 3.2: Wave Warps

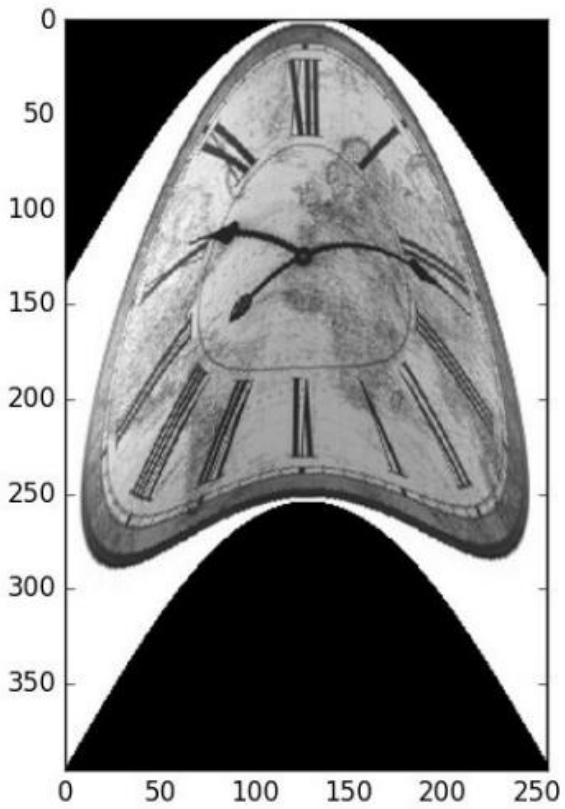
$$\phi - phase$$



# Task 3.2: Wave Warps

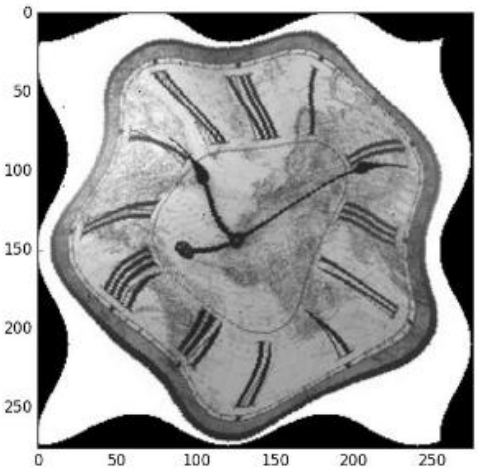



$\alpha = 140, \nu = 256, \phi = \pi$



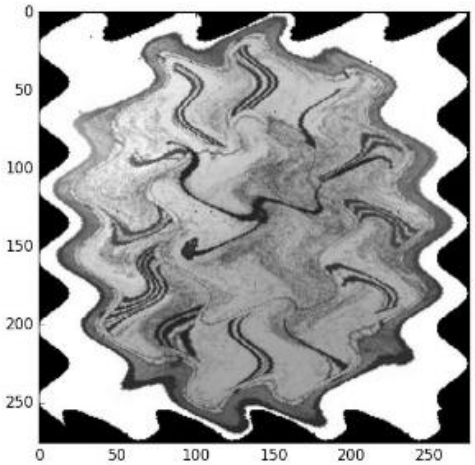

$\alpha = 140, \nu = 512, \phi = \pi$

# Task 3.2: Wave Warps



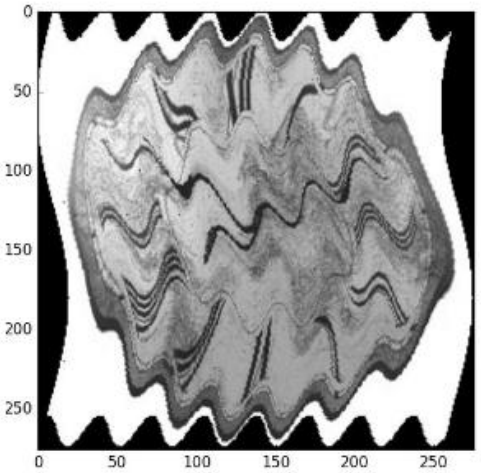

$\alpha = 10, \nu = 120, \phi = 2.5 \cdot \pi$

$\alpha = 10, \nu = 120, \phi = \pi$




$\alpha = 10, \nu = 60, \phi = \pi$

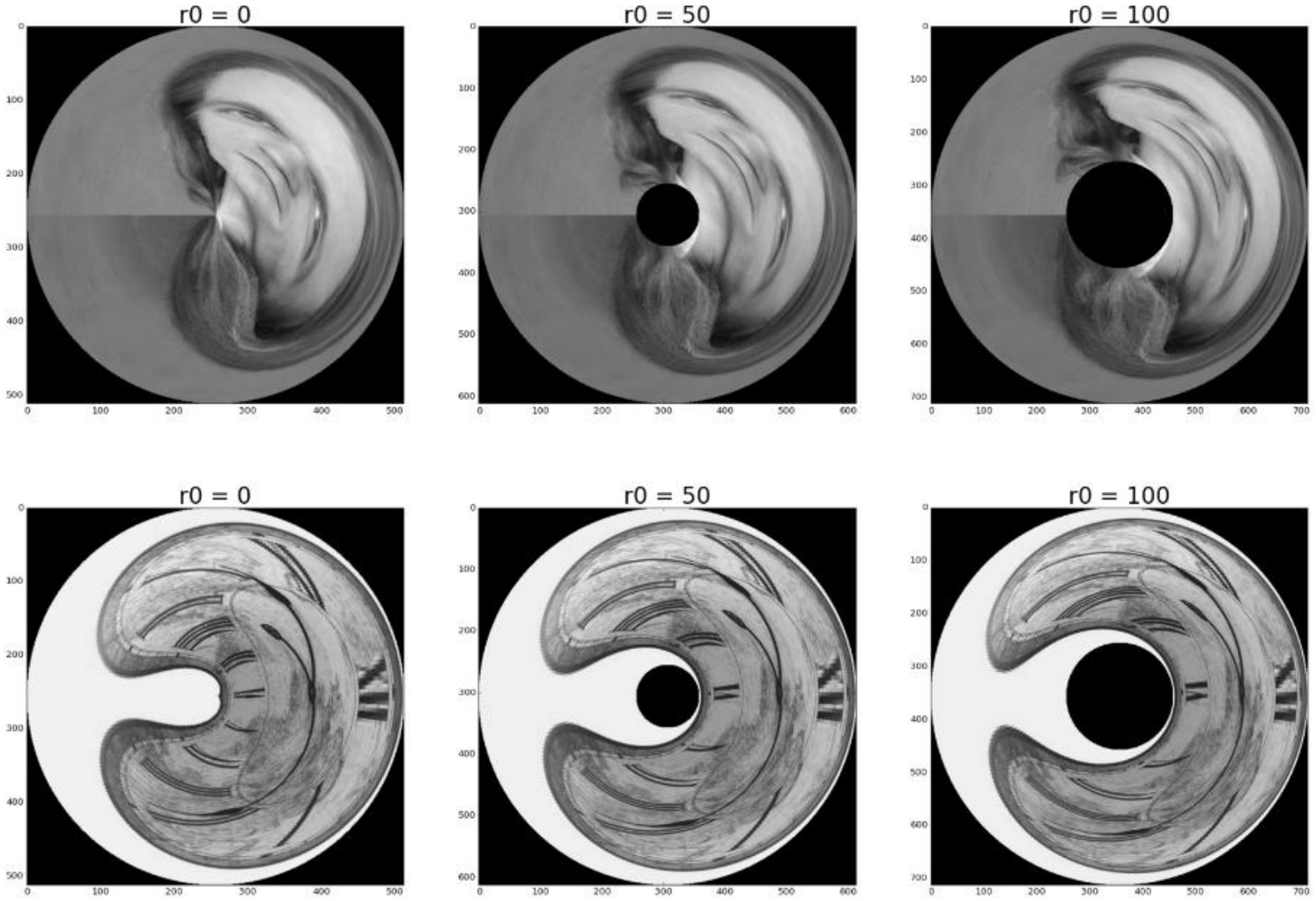
$\alpha = 10, \nu = 45, \phi = 0.5 \cdot \pi$




$\alpha = 10, \nu = 33, \phi = 1.5 \cdot \pi$

$\alpha = 10, \nu = 240, \phi = \pi$

# Task 3.3: Cylinder Anamorphosis



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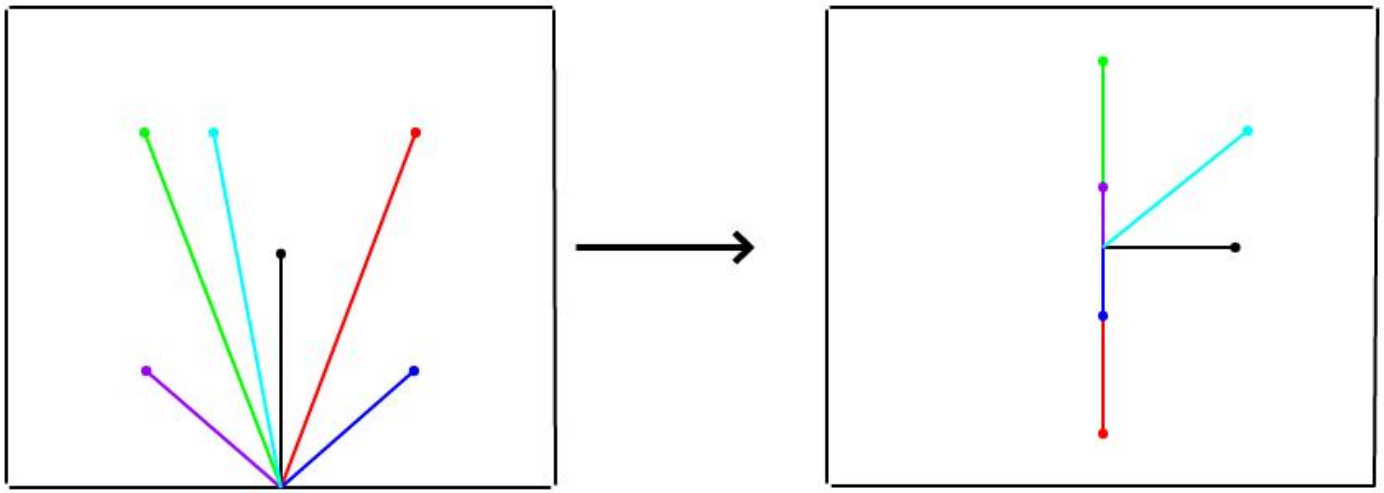

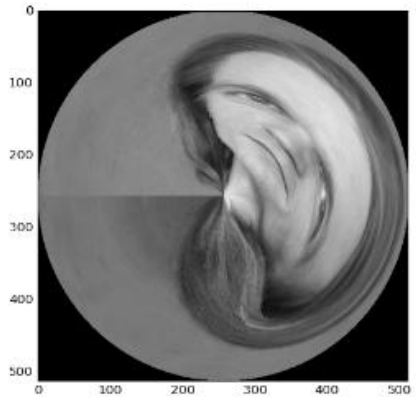

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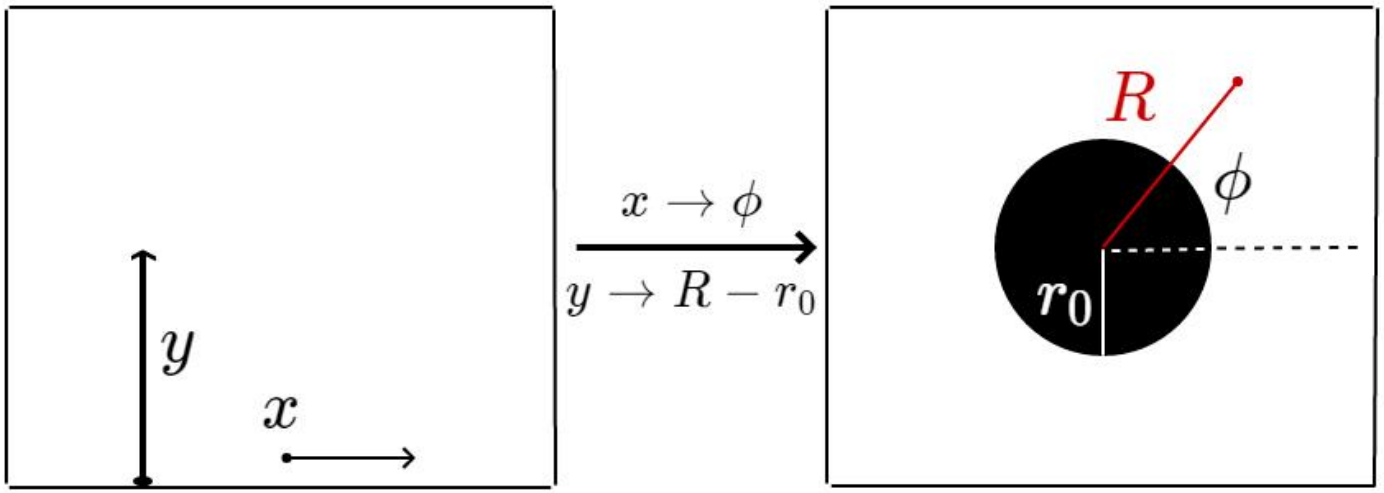


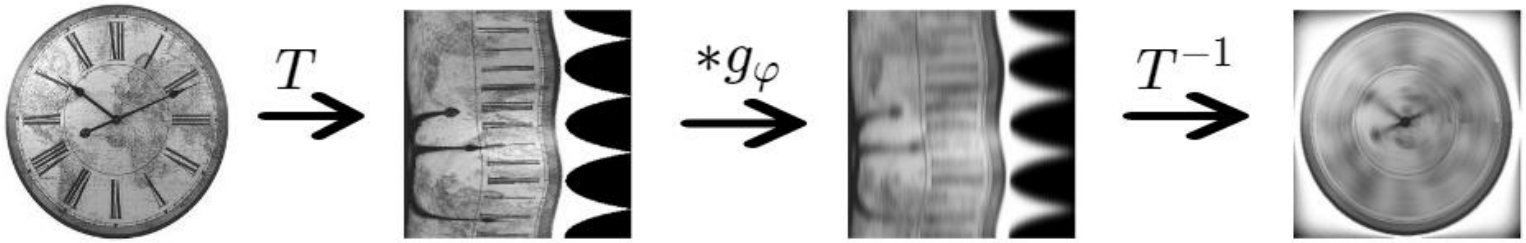

Direct mapping:

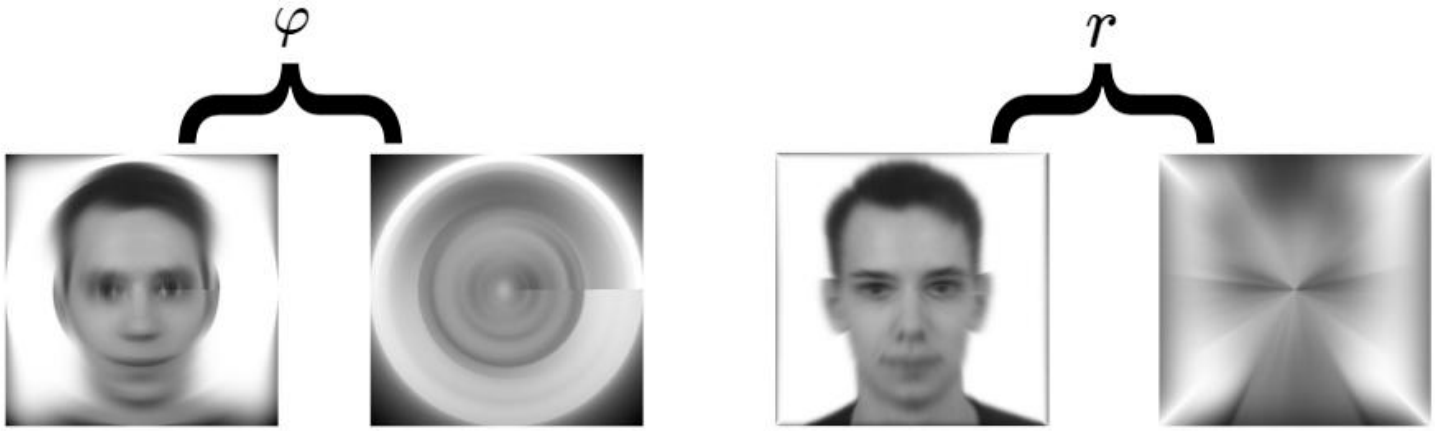
$$\begin{cases} x' = \frac{W'}{2} + R\cos\phi \\ y' = \frac{H'}{2} - R\sin\phi \end{cases}$$

Inverse mapping:

$$\begin{cases} x = \frac{W}{2}(1 - \frac{\phi}{\pi}) \\ y = H - (R - r_0) \end{cases}$$

# Task 3.4: Smoothing in Polar Coordinates



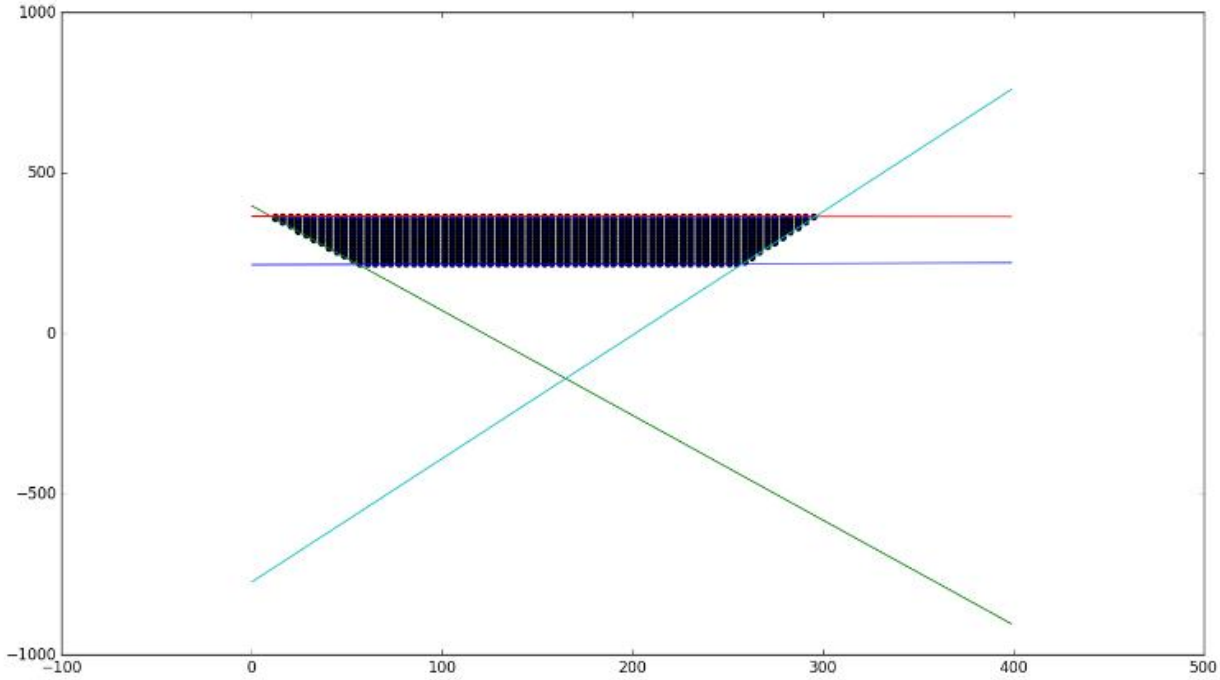



# Task 3.5: Perspective Mappings

Given 4 vertices,
allocate the projection.

# Task 3.5: Perspective Mappings

First step - define the affected area



# Task 3.5: Perspective Mappings

Next steps:

Solve a system of linear equations, do transform,

do PULL warp using scipy image interpolation.

# Task 3.5: Perspective Mappings

And again, and again..

# Task 3.5: Perspective Mappings

Another application example

Take the clock..

..and a cup

# Task 3.5: Perspective Mappings

Apply Canny filter for edges detection, use Hough Vouting to fit an ellipse, get the biggest and the smallest horde (for 4 points)

# Task 3.5: Perspective Mappings

Put the clock into a cup