4.1 transform_homography():

1. Homogenize the input to make a N-by-3 matrix
2. Apply homography matrix to *src*
3. De-homogenize the output and return it's transpose

4.2 wrap_image()

1. Construct N-by-2 matrix that contain all coordinate in image
2. Apply the inverse of homography to the matrix
3. Apply remap function based on the transformed points
4. Cover the original image by the wrapped image

5.1 compute_affine_rectification()

1. Find l based on two set of parallel lines
2. Compute $\boldsymbol{H}_p^T$ based on $l = [l_1, l_2, l_3]$
3. Apply inverse and transpose on $\boldsymbol{H}_p^T$ and that is the final homography. We assume that the affinity matrix is identity matrix

5.2 compute_metric_rectification_step2()

1. Construct 2-by-3 matrix $\boldsymbol{A}$ based on give 2 set of orthogonal lines
2. Solve the equation $\boldsymbol{A}\boldsymbol{s} = 0$ using SVD
3. Construct matrix $\boldsymbol{S} = \begin{bmatrix} s_1 & s_2 \\ s_2 & s_3 \end{bmatrix}$
4. Compute $\boldsymbol{K}$ from $\boldsymbol{S}$ using Cholesky
5. Construct $\boldsymbol{H}_a = \begin{bmatrix} \boldsymbol{K} & \boldsymbol{0} \\ \boldsymbol{0}^T & 1 \end{bmatrix}$ and return it's inverse

compute_metric_rectification_onestep() Implementation:

1. Construct 5-by-6 matrix $\boldsymbol{M}$ using 5 orthogonal line pairs.
2. Use SVD to solve $\boldsymbol{M}\boldsymbol{c} = 0$
3. Suppose that $\boldsymbol{c} = [a, b, c, d, e, f]$, construct

$$\boldsymbol{C}_\infty^{*'} = \begin{bmatrix} a & b/2 & d/2 \\ b/2 & c & e/2 \\ d/2 & e/2 & f \end{bmatrix}$$

4. Apply SVD on $\boldsymbol{C}_{\infty}^{*'}$: $\boldsymbol{U}, \boldsymbol{S}, \boldsymbol{V} = SVD(\boldsymbol{C}_{\infty}^{*'})$

5. Notice that $\boldsymbol{C}_{\infty}^{*'}$ may be corrupted by noise such that $\boldsymbol{S} \neq \boldsymbol{C}_{\infty}^{*}$. In this case, we need to manually construct $\boldsymbol{C}_{\infty}^{*}$:

$$\boldsymbol{C}_{\infty}^{*'} = \boldsymbol{U}\boldsymbol{A}^{-1}\boldsymbol{A}\boldsymbol{S}\boldsymbol{A}^{T}\boldsymbol{A}^{-T}\boldsymbol{V}$$

   such that $\boldsymbol{A}\boldsymbol{S}\boldsymbol{A}^{T} = \boldsymbol{C}_{\infty}^{*}$. It is found that $\boldsymbol{A} = diag(\frac{1}{\sqrt{s_1}}, \frac{1}{\sqrt{s_2}}, 1)$ where s_1 and s_2 are singular value of $\boldsymbol{C}_{\infty}^{*'}$.

6. Then $\boldsymbol{H}$ can be computed by:

$$\boldsymbol{H} = (\boldsymbol{U}\boldsymbol{A}^{-1})^{-1} = \boldsymbol{A}\boldsymbol{U}^{-1}$$

compute_homography_error()
Just implement the equation
compute_homography_ransac
Just follow the procedure in lecture note