CSE 586A **Due by Feb 26** $11:59:59$**PM**

Problem Set II

1. (30%) **Euler's method:** `https://en.wikipedia.org/wiki/Euler_method`

   For $\frac{dy}{dt} + 2y = 2 - e^{-4t}, y(0) = 1$,

   (a) Derive its closed-form solution.

   (b) Use Euler's Method to find the approximation to the solution at $t = \{1, 2, 3, 4, 5\}$, and compare to the exact solution in (a).

   (c) Use different step size $h = \{0.1, 0.05, 0.01, 0.005, 0.001\}$ and plot out the approximated function value.

2. (70%) **Geodesic shooting.** Implement geodesic shooting by the following two strategies and compare the differences between the final transformations ϕ_1 at time point $t = 1$.

   (a)

$$\frac{dv_t}{dt} = K[(Dv_t)^T \cdot v_t + \mathrm{div}(v_t v_t^T)],$$
$$\frac{d\phi_t}{dt} = v_t \circ \phi_t.$$

   (b)

$$\frac{dv_t}{dt} = -K[(Dv_t)^T \cdot v_t + \mathrm{div}(v_t v_t^T)],$$
$$\frac{d\phi_t}{dt} = -D\phi_t \cdot v_t.$$

   Note: Use your code of frequency smoothing in PS1 to implement the smoothing operator K (set the truncated number of frequency as 16^2).

   (c) Deform a given source image by using the transformations ϕ_1 obtained from (a) and (b).

   * Use Euler integration to solve the above ordinary differential equations.

   IMPORTANT NOTES:

   * Interpolation function: MATLAB function interp2 with the option 'spline'.

   * Initial velocity field v_0 and source image are included in the data folder. The initial transformation ϕ_0 is an image coordinate, which can be easily generated from MATLAB.

   * All results should be clearly reported and discussed in the report.