- Students code the following questions in the Ipython Notebook shared via email.

Let P be a matrix,

$$P = \begin{bmatrix} -1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & 1 \end{bmatrix}$$

A, B, and C are three points in a 3D-space, the coordinates (x,y,z) of A, B, and C **respectivey** picked up from the first, the second, and the last row of matrix P.

(1) [3 points] Fill python code for the following functions:
   a) normal_of_face
   b) normal_of
   c) averaged
   d) area
   e) interpolate
   f) reflect
   g) o2c_vec

(2) [1 points] On the ray passing Point [1, 0, 0] and along $\mathbf{n}_{BAC}$; choose a point D such that AD = 5 units. Fill code to function deter_D to determine point D

(3) [2 points] On the ray passing A (i.e., ray OA) and along $-\mathbf{n}_{ABC}$; choose a point P_{eye} such that AP_{eye} = 10 units. Place the camera at P_{eye}. The camera looks at point B given above; and its orientation is $[0,1,0]^T$.
   - Determine P_{eye};
   - Determine M_{model}, M_{view} and $M_{model\text{-}view}$ (also named: M_{mv})
   - Let M_{o2c_vec} be the matrix for transforming every vector in object space to camera space. M_{o2c_vec} is computed from M_{mv} by taking the inversion and then transpose of M_{mv}

     Fill code to determine P_{eye}, M_{model}, M_{view}, $M_{model\text{-}view}$ and M_{o2c_vec}

2) [2 points] Let A_c, B_c and C_c be the point A, B, C repsectively in camera space; Fill code in NoteBook to determine A_c, B_c and C_c.
3) [1 points] Let M be middle point of AB and Q be the middle point of MD. Detemine Q
4) [2 points] Determine the color of Q with following information:
   - Shading model: BUI Tuong Phong
   - Light source at (in world space): `[10, 10, -10]^T`

   Materials specified in matrix K in the following (columns: red, green, blue):

```
K = [
[0.6, 0.8, 0.8], #diffuse
[1,0, 0.8, 0.4], #specular
[0.6, 0.8, 0.2], #ambient
]
```

   - Light intensity specified in matrix I in the following (columns: red, green, blue):

```
I =[
[1, 0.4, 1], #diffuse
[1, 0.4, 1], #specular
[1, 0.4, 1], #ambient
```

]

- Shininess：200

---THE END---