CMSC 426: Homework 1
Due: February 11, 2020

Homework reminders:

- Please show your work, don't just write an answer. Explain what you're doing.
- Please write the paper and pencil part of the homework neatly, in pencil.

1. Warm up. Find the equation of the plane that contains the following points $p_1 = (-1, 2, 2)$, $p_2 = (0, 1, 3)$ and $p_3 = (-1, 1, 2)$. 10 points.

2. If two planes are not parallel then they will intersect in a line. Find the line defined by the intersection of the following two planes:

   (a) $3x + y + 4z - 4 = 0$

   (b) $2x + 2y - z + 2 = 0$

   20 points.

3. Find the distance of the point $p_0 = (1, 4, 14)$ to the plane $3x + 4y + 5z - 4 = 0$. 20 points.

4. This problem has three parts. Please solve it in Python and hand in three programs: `part_a.py`, `part_b.py` and `part_c.py`.

   (a) Write a Python program to find the similarity transformation T that maps the points $p_1 = (1, 1)$, $p_2 = (1, 7)$ and $p_3 = (3, 3)$ to $p'_1 = (11.5, 6.5)$, $p'_2 = (17.5, 9.5)$ and $p'_3 = (14.5, 5.5)$ respectively. 10 points.

   (b) Write a Python program using Pillow to draw the triangle defined by p_1, p_2 and p_3 above in white on a black background. Call the output: `triangle1.png`. 10 points.

   (c) Write a Python program to draw the same triangle in part (b) and compute T as in part (a) and apply T to the triangle using Pillow. Call the output: `triangle2.png`. 10 points.

5. This problem has two parts. The second part is more complicated and is extra credit. Szelizki's book defines a line as $\tilde{x} \cdot \tilde{l} = ax + by + c$ where $\tilde{x} = (x, y, 1)$ and $\tilde{l} = (a, b, c)$.

   (a) Szeliski's book claims that the line joining two points can be computed as $\tilde{l} = \tilde{x_1} \times \tilde{x_2}$. Prove this fact. 20 points.

   (b) Szeliski's book claims that the intersection of two lines can be computed as $\tilde{x} = \tilde{l_1} \times \tilde{l_2}$. Prove this fact. Extra credit. 20 points.