Math 241: Matlab Project 1
due Thursday, Feb. 13 in the discussion session

You first have to download the files `plotpts.m`, `fillpts.m`, `nice3d.m` , `parallepip.m` from the course web page. Use the command `nice3d` after the plotting commands.

Remember that you can work in teams of up to 3 students. Sharing of material between different teams is not permitted.

1.

(a) Consider the four points $(2,0,0)$, $(0,2,0)$, $(1,1,1)$, $(1,1,-1)$. Show that these four points form a parallelogram. Plot this parallelogram using `fillpts` and find its area using a formula from class.

(b) Consider the six points $(\pm 2,0,0)$, $(0,\pm 2,0)$, $(0,0,\pm 2)$ and the eight points $(\pm 1,\pm 1,\pm 1)$. Plot these fourteen points together with the parallelogram from (a). How many parallelograms like the one from (a) do these points form? Plot all these parallelograms using `fillpts` , use `alpha(0.6)` to make everything transparent.

(c) Find the volume enclosed by all the parallelograms in (b) using a formula from class (split the volume into tetrahedra and possibly a cube, use symmetry).

(d) Show that you can split the volume from (c) into four parallelepipeds of the same size. These parallelepipeds have $(0,0,0)$ as a vertex. Give the vectors $\vec{a}$, $\vec{b}$, $\vec{c}$ for each parallepiped. Plot three of the parallepipeds together using `parallelepip` (use three different colors). Compute the volume from (c) using the volume of the four parallepipeds.

2. Consider the triangle with the vertices $(1,0,0)$, $(0,1,0)$, $(0,0,1)$.

(a) Plot this triangle using `fillpts` together with the three points $\vec{A} = (0.5, 0.5, 1)$, $\vec{B} = (0, 1.1, 0.9)$, $\vec{C} = (0, 0.4, 1.6)$.

(b) For the point $\vec{A}$ find the closest point $\vec{A}'$ in the triangle. Find the distance from $\vec{A}$ to $\vec{A}'$.
Repeat this with the points $\vec{B}$ and $\vec{C}$.
Make a plot which shows the triangle together with lines from $\vec{A}$ to $\vec{A}'$, from $\vec{B}$ to $\vec{B}'$, from $\vec{C}$ to $\vec{C}'$.
Hint: The closest point may be in the interior of the triangle, it may be on one of the three sides of the triangle, or it may be one of the three vertices of the triangle. First find the closest point in the plane of the triangle (which may not be inside the triangle). Then consider the line given by one of the sides of the triangle, and find the closest point on this line. Finally check the distance to the vertices.