# Assignment 1

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# 1 Task 1

## 1.1 Task 1.1

We can see, that vectors $v_i$, $w_i$ form the plane. So this vectors should not lie in the same line to form a plane. If one of the vector of second plane not lie in the first plane, first and second planes would intersect, otherwise they are parallel.

So we can from two matrices A1 = [v1 w1 v2] and A2 = [v1 w1 w2]. If one of them is invertible (has independent columns), planes would intersect.

The code you can find in Task_1_1.m

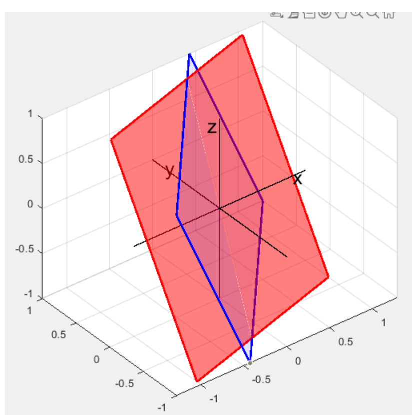


Figure 1: Intersection of 2 planes

## 1.2 Task 1.2

Find representation in form $n * (r - r_0) = 0$.

n is perpendicular to the plane, so it's perpendicular to vectors v and w - left null space of matrix [v w].

$r0$ is equal to any point in that plane. So let it be just p.

You can find a code in Task_1_2.m

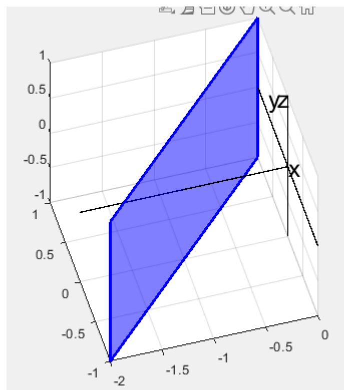


Figure 2: First plane in task 1.2

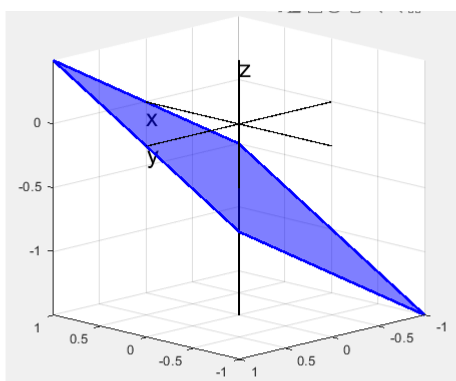


Figure 3: Second plane in task 1.2

## 1.3 Task 1.3

Line vector is equal to normal of the plane. To find a projection I am using the formula of projection: $g_{proj} = n * (n^T * n)^{-1} * n^T * g$

You can find a code in Task_1_3.m

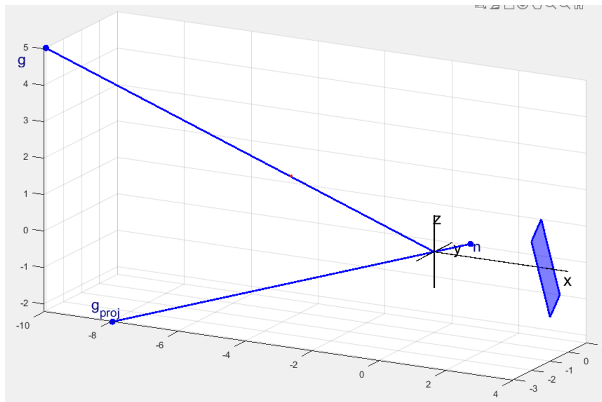


Figure 4: Solution of the task 1.3

## 1.4 Task 1.4

In this task I decompose vector g on two vectors: projection vector to plane s and perpendicular vector to the plane s equals to distance to that plane (n vector). So symmetrical point will compute as $g^* = g_{proj} - n$

You can find a code in Task_1_4.m

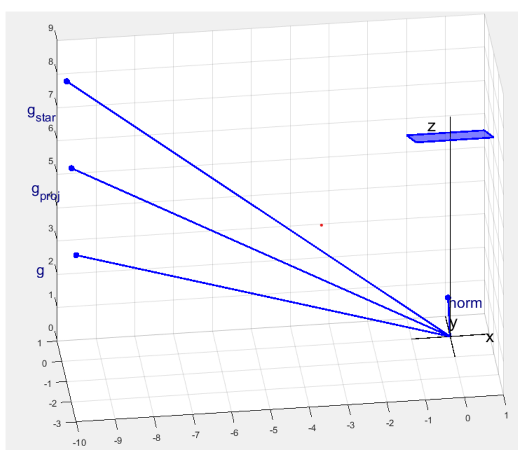


Figure 5: Solution of the task 1.4

# 2 Task 2

To get a basis of V, we should just compute null space of the matrix. This function is available in matlab.

Finding orthogonal projection onto V and onto the orthogonal compliment of V is similar as in task 1.4.

To recover g: $g = g^{\perp} + g^{||}$. To prove that $g^{\perp}$ and $g^{||}$ are perpendicular we can take scalar multiplication of this vectors, which should be equal to zero.

You can find a code in Task_2.m

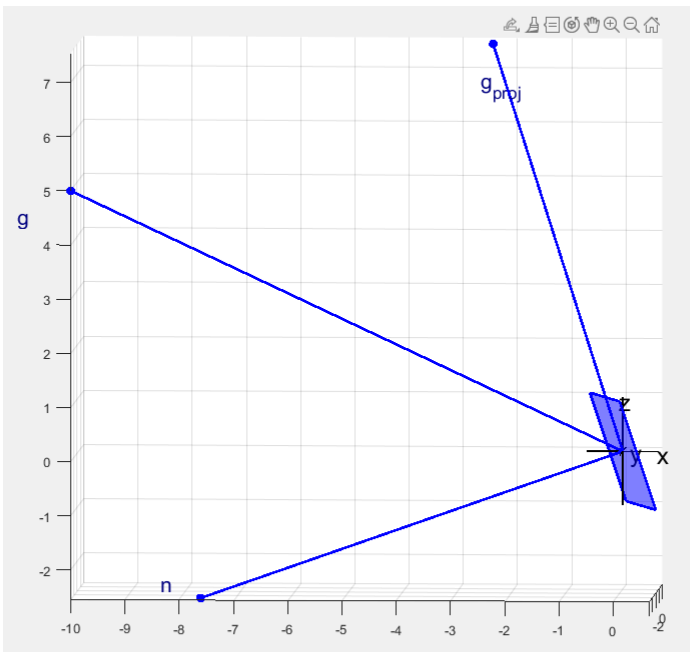


Figure 6: Solution of the task 2

# 3 Task 3

To rearrange optimization problem in another form we should use the following values:

$$H = \begin{bmatrix} 1 & 0 \\ 0 & 8 \end{bmatrix}$$

$$c = \begin{bmatrix} 0 & -32 \end{bmatrix}$$

$$c0 = 60$$

$$A = \begin{bmatrix} 1 & 1 \\ 1 & 2 \\ -1 & 0 \\ 0 & -1 \\ 1 & 1 \end{bmatrix}$$

$$b = \begin{bmatrix} 6 \\ 8 \\ 0 \\ 0 \\ 9 \end{bmatrix}$$

A solution on CVXPY and visualization you can find in Task_3.ipynb