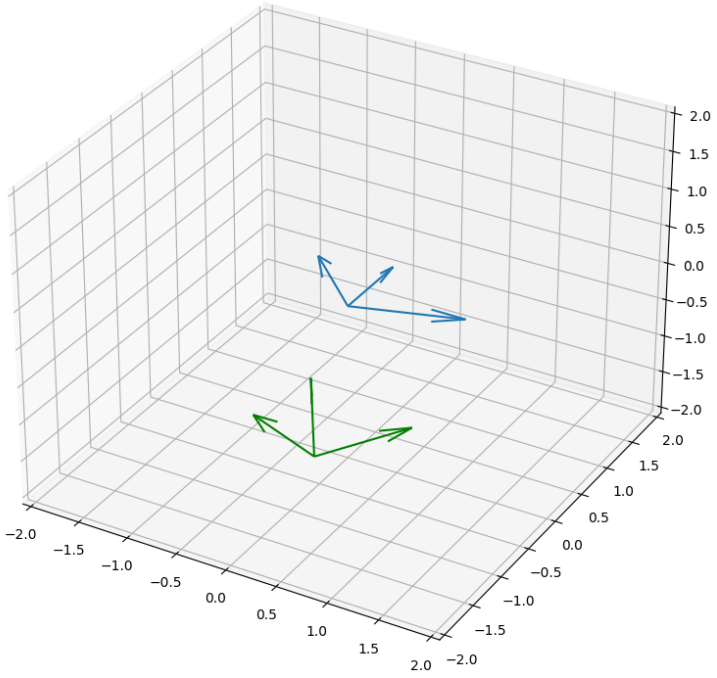
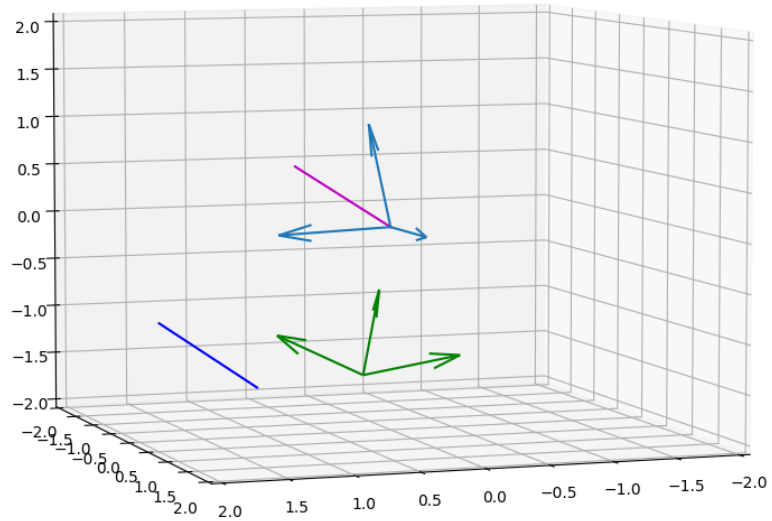
1. Figures from the Hw-04 (blue – β basis; green – β' basis)



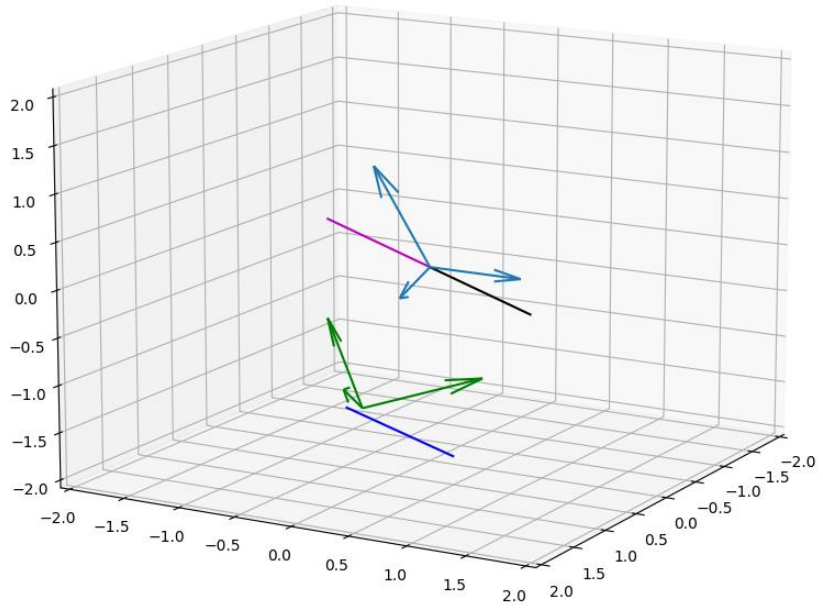
2. a_0: We know that rank(R-I)=2 and o_prime_beta is different from 0. Therefore, the equation will have a non-dimensional space of solutions. The null space and range(R-I) will intersect only in the zero vector. So, one point for a_0 will be the zero vector and the other one the null space of R-I.

   a_1: In order to find the a_1 axis, I solved the system of equation given by (R-I)*x=-o_prime_beta and find out a point that lies on a_1. For finding its direction, we know that a_1 will be parallel with the rotation axis (which, in this case, corresponds with a_0) and it will have the same direction.

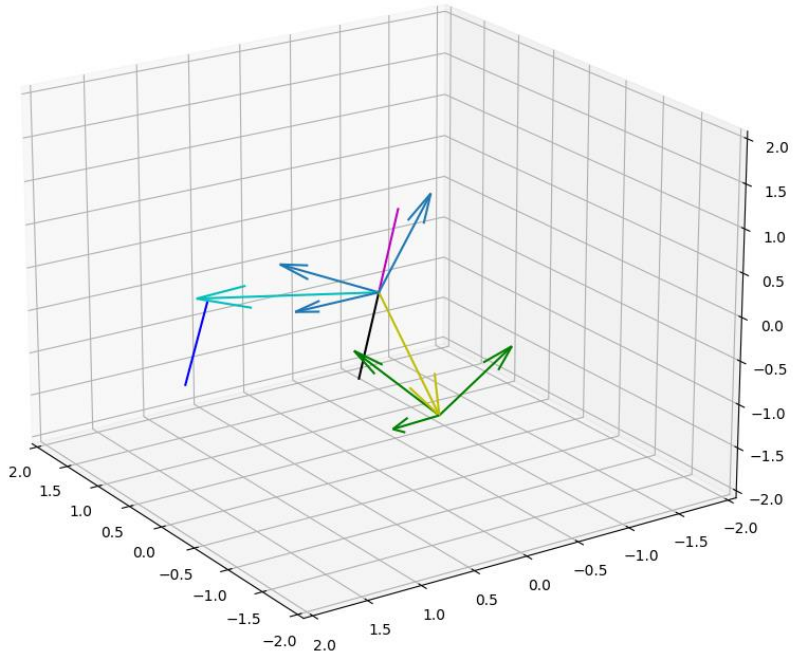
3. Coordinate systems and motion axes (magenta - a_0; blue – a_1)



4. The rotation axis gives us the points that are left fixed by the pure rotation R i.e. Rx=x. Hence, it can be computed using (R-I)x=0 and we can use the null space of R-I to find the solutions. We can see that the rotation axis coincides with a_0 (a_0 is a rotation only) and must be parallel with a_1 (also has a translation). (rotation axis – black)

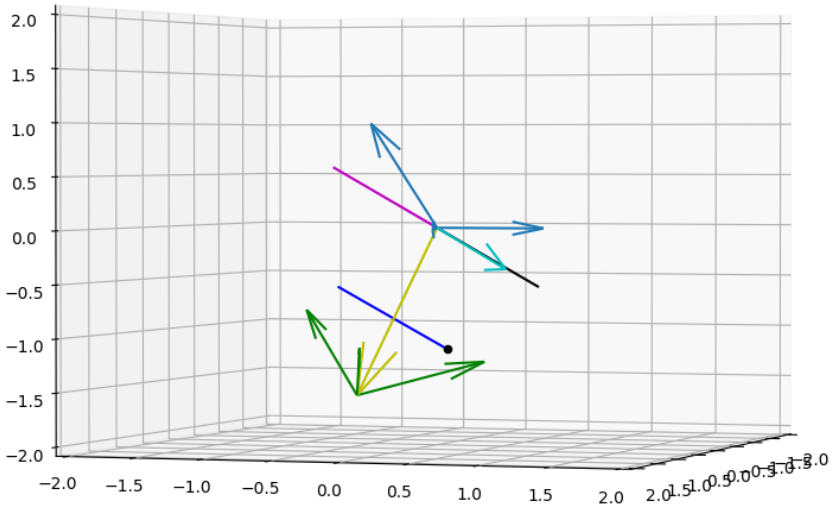


5. One of the generators of σ plane will be given by o_prime_beta. The other one was computed using the cross function of the first sigma values and r which will give us a vector that is perpendicular to r (sigma1 – yellow; sigma2 – light blue).

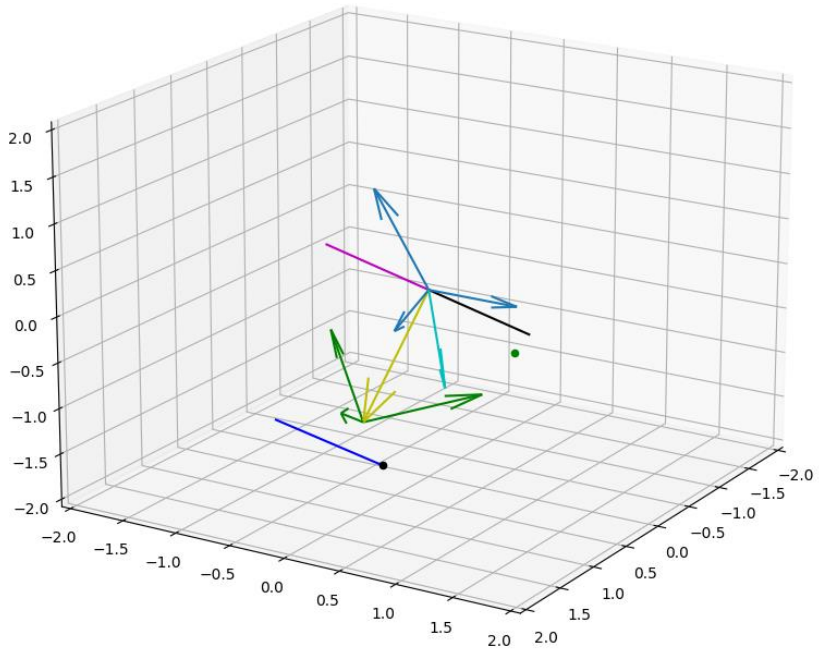


7. The plane σ is in the range of R-I, therefore, both sigma1 and sigma2 must be in the range(R-I).

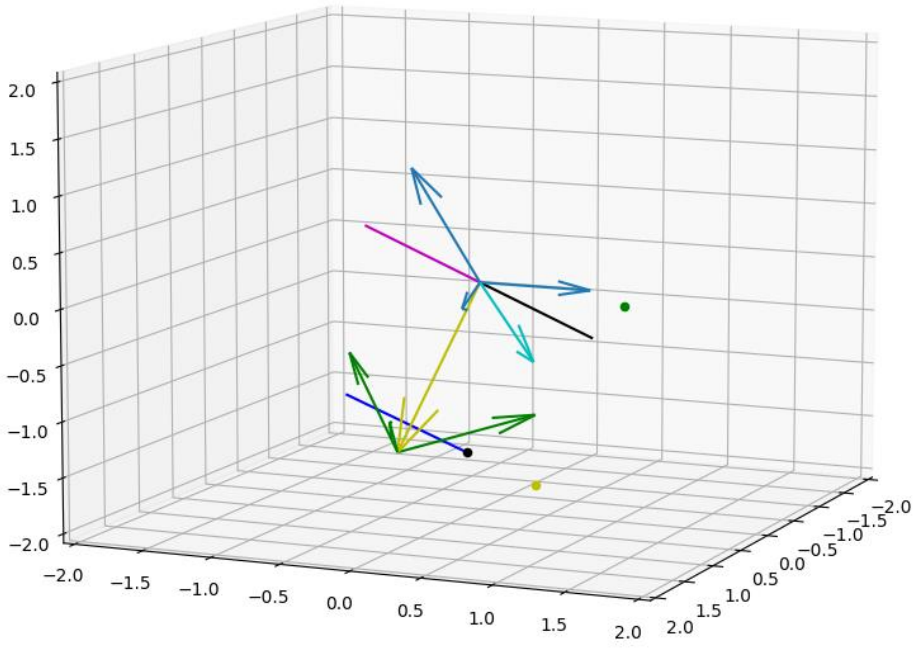
8. Point P (black point)



9. Point P’ (green point)



10. P'' point (yellow point)



11. P is the point where axis a_1 intersects with the σ plane. P is rotated in σ away of a_1 to P', so P' prime does not lie on a_1. After adding the translation to P' we obtain P'' which will lie on a_1 axis.

12. The relationship between the rotation axis r and the motion axis a_1 when:
    - R=I. If R=I, then R-I=0 and we are in the case when rank(R-I)=0 so the equation will work for every x_β (every x_β will be inside of a fixed space), hence, an infinity of motion axes (lines going through every point in space).
    - o_prime_beta=0. If o_prime_beta is 0, the motion axis will be a pure rotation and will coincide with the rotation axis.
    - o_prime_beta is an eigenvector of R. If o_prime_beta is an eigenvector of R, then it will not be in the range of R-I and will not be in the same plane with r.