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3.

Below are the results of the 12-D variational system. Note that the initial condition of the matrix $\boldsymbol{\delta}$ was always the 3x3 Identity Matrix. In vector form: [1, 0, 0, 0, 1, 0, 0, 0, 1]

The column sums represent the total resulting variation along each axis (x,y,z).

a.

IC:[0, 1, 2]

$$\boldsymbol{\delta} = \begin{bmatrix} 2.361 & 5.087 & 0.46 \\ 1.886 & 4.135 & 0.358 \\ -0.028 & -0.086 & 0.665 \end{bmatrix}$$

Col sums:

[4.219 9.136 1.483]

b.

IC:[10, -5, 2]

$$\boldsymbol{\delta} = \begin{bmatrix} 2.12 & 3.884 & 3.028 \\ 1.631 & 3.023 & 2.462 \\ -0.478 & -1.101 & 0.01 \end{bmatrix}$$

Col sums:

[3.273 5.806 5.5]

c.

IC: [0, -1, 2]

$$\boldsymbol{\delta} = \begin{bmatrix} 2.361 & 5.087 & -0.46 \\ 1.886 & 4.135 & -0.358 \\ 0.028 & 0.086 & 0.665 \end{bmatrix}$$

Col sums:

[4.275 9.308 -0.153]

D.

Points (a) and (c) see the fastest variational growth, particularly in the y-direction, having the largest entries in the variational matrix.

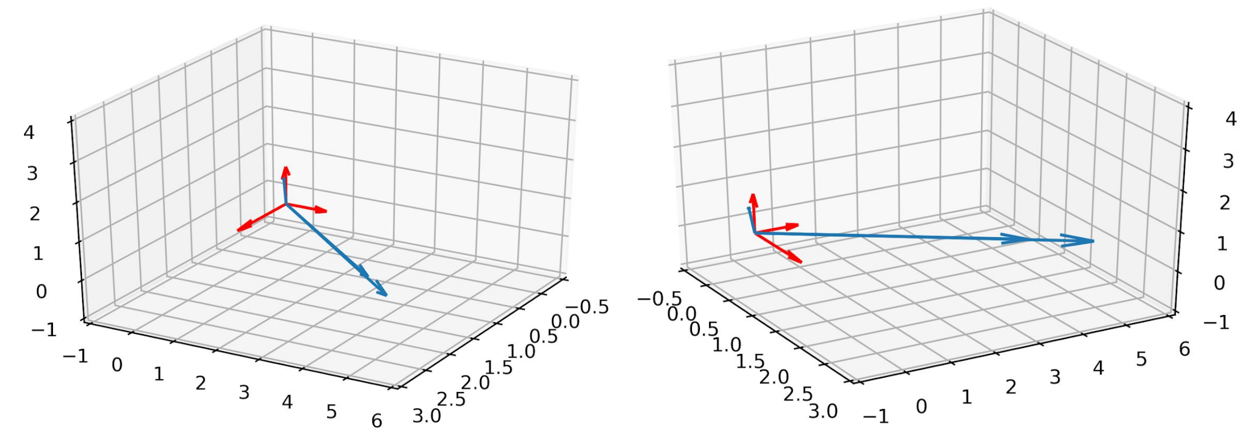
The variation in the y-direction, in all cases, grows the fastest. The column sums show this.

Some similarities are immediately apparent between points (a) and (c). They have the same component-wise variations (at least to 3 decimal places, and ignoring sign), and they are more-or-less symmetric. The only major difference is the difference in sign in the z-direction. This difference can be seen in the lean of the z-vector in the following plots.

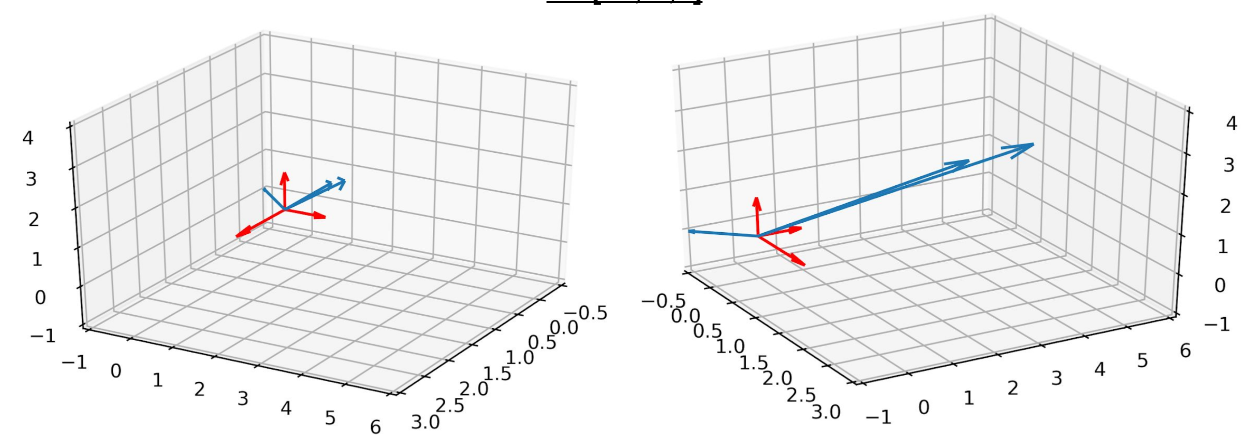
There are differences in point (b), such as the large variation in the z-direction, whereas there is far less z-variation starting from points (a) and (c).

Below are the transformations from the canonical basis (red), to the transformed basis (blue) constructed by the rows of the variational matrix.

IC:[0,1,2]



IC: [10,-5,2]



IC: [0,-1,2]