Problem and Dataset Overview

This preliminary dataset should be a set of stress states of yield points for plastic strain $\epsilon_p^{vm} = 0$ (epvm_eq_0.csv) and $\epsilon_p^{vm} = 0.01$ (epvm_deq_0.csv). The stresses are in Voigt notation, i.e.,

$$\begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} \\ & \sigma_{22} & \sigma_{23} \\ & & \sigma_{33} \end{bmatrix} \rightarrow \begin{bmatrix} \sigma_{11} \\ \sigma_{22} \\ \sigma_{33} \\ \sigma_{23} \\ \sigma_{13} \\ \sigma_{12} \end{bmatrix}$$

The goal is to find a transformation tensor (B) that transforms the anisotropic yield surface (the provided data) to a fictitious isotropic yield surface. That is, a von Mises surface with a unit yield stress, $\sigma_y = 1$.

Currently, *direct_mapping_experiment.py* solves the problem in principal stress space. Therefore, the input stresses are 3x1 rather than 6x1 (as above). To accommodate a 6x6 transformation matrix, the symmetric tensor $\mathrm{P_{vm}}$ on lines 184-186 will need to be upgraded to support any arbitrary stress state:

$$\mathrm{P_{vm}} = \begin{bmatrix} 1 & -1/2 & -1/2 & 0 & 0 & 0 \\ & 1 & -1/2 & 0 & 0 & 0 \\ & & 1 & 0 & 0 & 0 \\ & & & 3 & 0 & 0 \\ & & & & 3 & 0 \\ & & & & & 3 \end{bmatrix}.$$

$\mathrm{P_{vm}}$ represents the von Mises yield criterion for any stress tensor (and not just in the principal basis). The result transformation tensor (B) should (for now) follow the following conditions:

1. There should be 9 independent components, explicitly named in the matrix below.
2. The matrix is symmetric.

$$B = \begin{bmatrix} B_{11} & B_{12} & B_{13} & 0 & 0 & 0 \\ & B_{22} & B_{23} & 0 & 0 & 0 \\ & & B_{33} & 0 & 0 & 0 \\ & & & B_{44} & 0 & 0 \\ & & & & B_{55} & 0 \\ & & & & & B_{66} \end{bmatrix}$$

Suggested Step 1: Sanity Check

How I would approach this problem would first figure out how to impose symmetry for the Hill experiment (i.e., lines 254-260). There should be a symmetric 3x3 solution to this problem. **I am unsure if this solution is unique.** In other words, there **may** be multiple distinct solutions that are valid. This solution, (B), should satisfy the following tensor equation for $\epsilon_p^{vm} = 0$:

$$P_{Hill} = B^{-1} \cdot P_{vm} \cdot B$$

$$\begin{bmatrix} 7.3 & -7 & -0.3 \\ & 8 & -1 \\ & & 1.3 \end{bmatrix} = B(\epsilon_p^{vm} = 0\,)^{-1} \cdot \begin{bmatrix} 1 & -0.5 & -0.5 \\ & 1 & -0.5 \\ & & 1 \end{bmatrix} \cdot B(\epsilon_p^{vm} = 0\,).$$

Let me know when you obtain a solution, regardless of if it satisfies this equation: it may be that this above equation has a mistake in it.