**ABAPYMAT-PXTAL-2D**: Python and MATLAB codes to generate and analyse 2D poly-crystalline checkerboard model for use in crystal plasticity based finite element analysis in ABAQUS

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**FUNCTIONALITY**: **ABAPYMAT-PXTAL-2D** can:

1. generate parametric two dimensional checker board model of the poly-crystalline metallic grain structures, through a simple set of inputs
2. generate crystallographic orientation data from experimentally measured texture volume fractions of up to 5 texture components for cubic metals
3. associate grain orientation data to checkerboard model in the format requested by the user-material FORTRAN sub-routine of Huang [reference]
4. automate post-processing of solution data, extract field variable and history output data, and write analysis data and images to file for different analysis time-frames

**PURPOSE**:

1. To enable the user with, fast and easy creation of checker board grain structure model having information of texture and grain structure morphology
2. To enable the user with, automated post-processing capabilities and further visualization of post-processed data
3. To save valuable time which the user would have to invest in manually creating and analysing crystal plasticity based finite element model of parametric grain structure and texture

**Statement of need**:

Crystal plasticity based finite element analysis of complex grain structures takes a lot of effort in preparing the model itself and the subsequent analysis of the large result data set in the solution. In order to generate a model which is both parametric and realistic, a large number of input grain structure datasets would be needed, which is seldom developed. However, any finite element analysis of a single grain structure is limited in explaining that grain structure and not any other. To overcome this obstacle, a simplified model of the grain structure is needed, where with just a few simple geometric parameters, can generate a parametric finite element model. This further simplifies the post-processing analysis procedure and renders for easy automation and explanation. Such models serve as first line of analysis before a more detailed analysis of very realistic grain structures are conducted. Python scripts such as ABAPY (Charleux, 2015) have been written to offer functionalities to generate different types of finite element meshes and finite element analysis, but there is an important need to extend the user capability to crystal plasticity based finite element analysis.

**REPOSITORY CONTENTS**:

Python scripts “prestart.py”, “starter.py”, “CHK\_2D\_prep\_V1.0.py” and “CHK\_2D\_postp\_v4.2.py”, which execute in ABAQUS scripting environment are provided to generate such grain structures and post-process the solution data. The MATLAB script “chk\_gen\_umat\_data\_v1” helps instantiate crystallographic orientations from the volume fraction data and subsequently generate a text file containing the ABAQUS material data in the right format.

**ONGOING PROJECTS**: The codes are used by the author in his PhD research work. The author is continually developing the codes into more user-friendly versions and eventually bring all codes under the completely open source python environment. The codes in “**ABAPYMAT-PXTAL-2D**” are used in a much bigger software project involving creation of temporally and spatially instantiated multi-phase gradient 2D and 3D grain structures and texture, being developed by the author.

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**REFERENCES**

Ludovic Charleux, Laurent Bizet, Vkeryvin, & Mousta. (2015, May 19). abapy: Abapy\_v1.0 (Version v1.0). Zenodo. <http://doi.org/10.5281/zenodo.17784>

**Documentation**

Conventions

Benefits of **ABAPYMAT-PXTAL-2D**

Softwares needed

Workflows

Running the tests

**Tutorials**