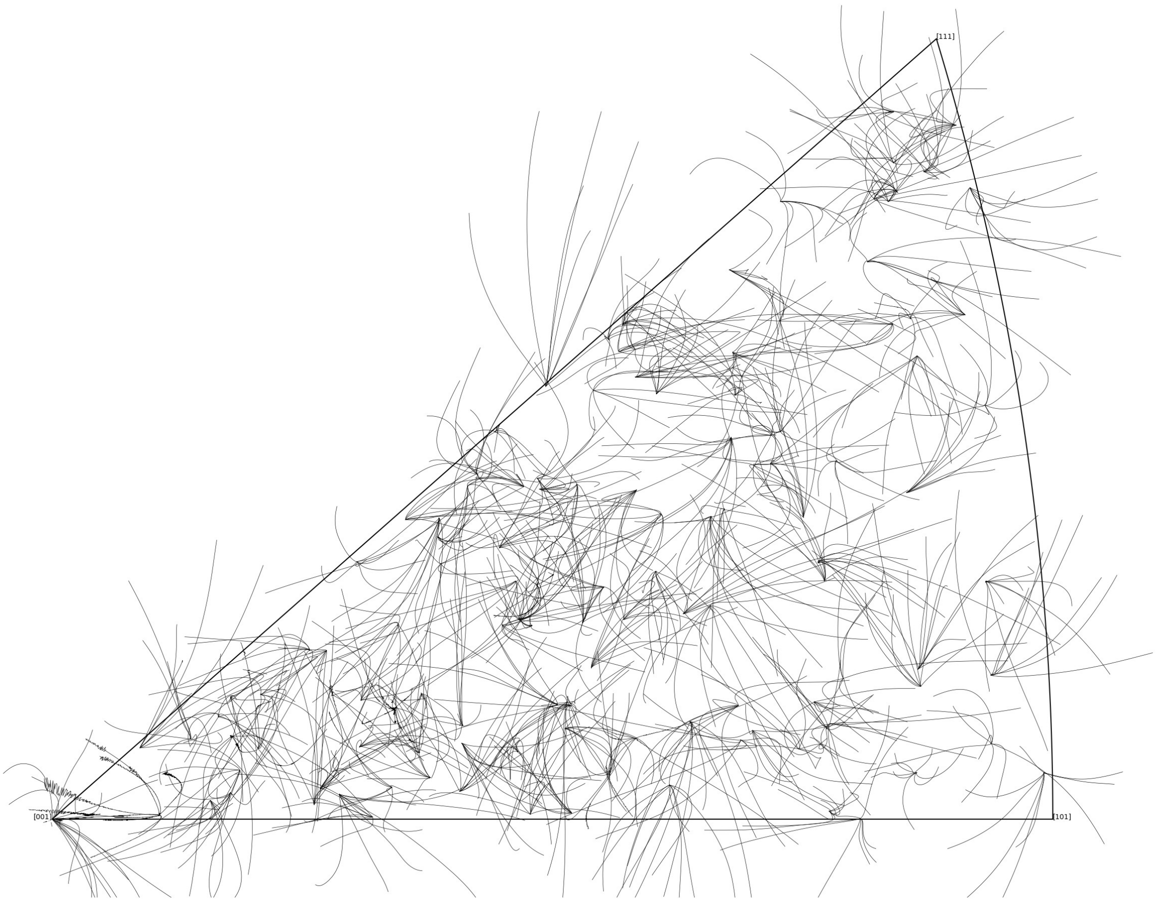
Draft Zero

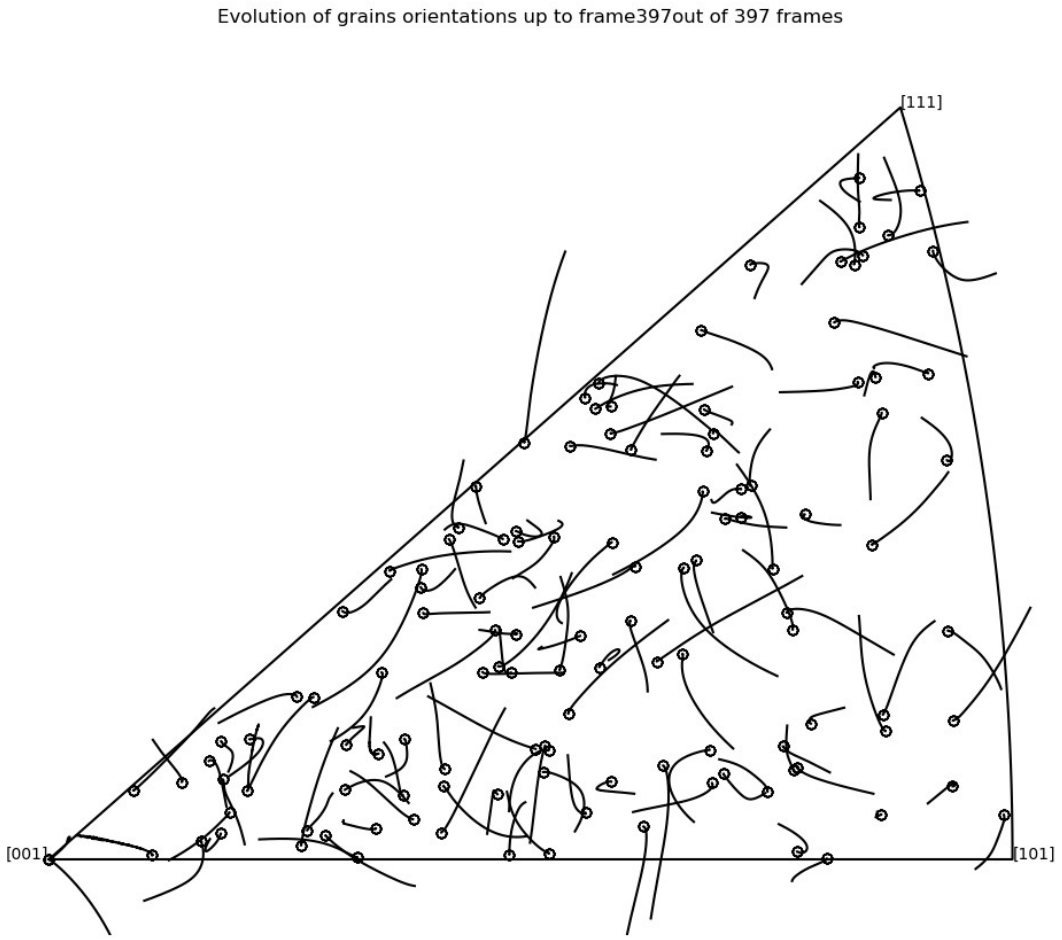
Evolution of grains orientations up to frame397out of 397 frames



./All/GrainOrientationEvolution_ToFrame397.OfAllGaussPoints.png
This contains (124) all grains times 8 gauss points per grain;

So there are five methods that we've used:

1. Graphical average:



./All/GrainOrientationEvolution_ToFrame397graphicalAverage.png

Plots the dot at the mean x-coordinate and mean y-coodinate.

Advantage:

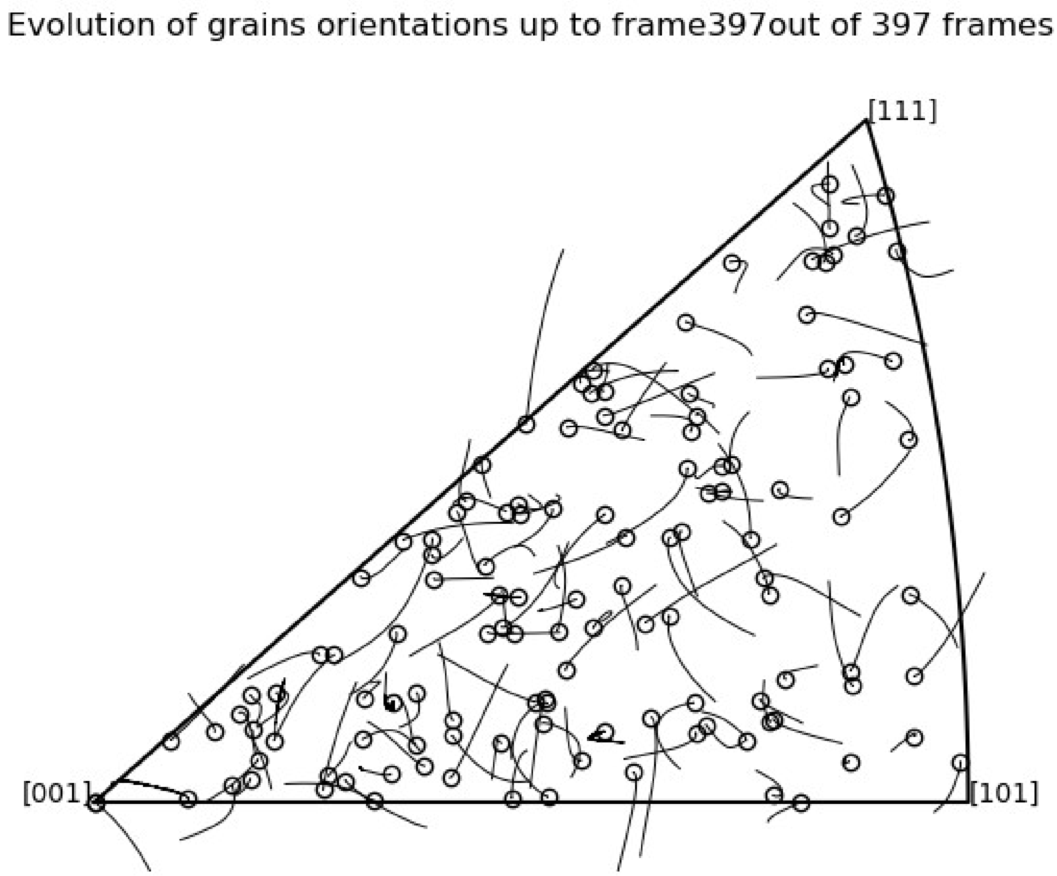
Gives no discontinuity; all paths traced out by grains are smooth lines.

Disadvantage:

No real physical/mathematical basis to carry out such averaging operation

Does not take into account for the tan $\theta/2$ distortion when points are mapped onto a pole figure

2. **Sum of Eigenmatrix**



./CorrectAveraging/GrainOrientationEvolution_ToFrame397misorientationMinimizationAverage_small.png

Code:

```
def averageQuat(qList):
	matrix = np.zeros([4,4])
	for q in qList:
		Matrix += outerProduct(q,q)
	EigenVal, EigenMat= np.linalg.eig(Matrix)
	average = EigenMat.T[np.argmax(EigenVal)]
	return average*np.sign(average[0])
#In the report, we'll have to include all this as LaTeX maths as well
```

Advantage:

Numerically accurate

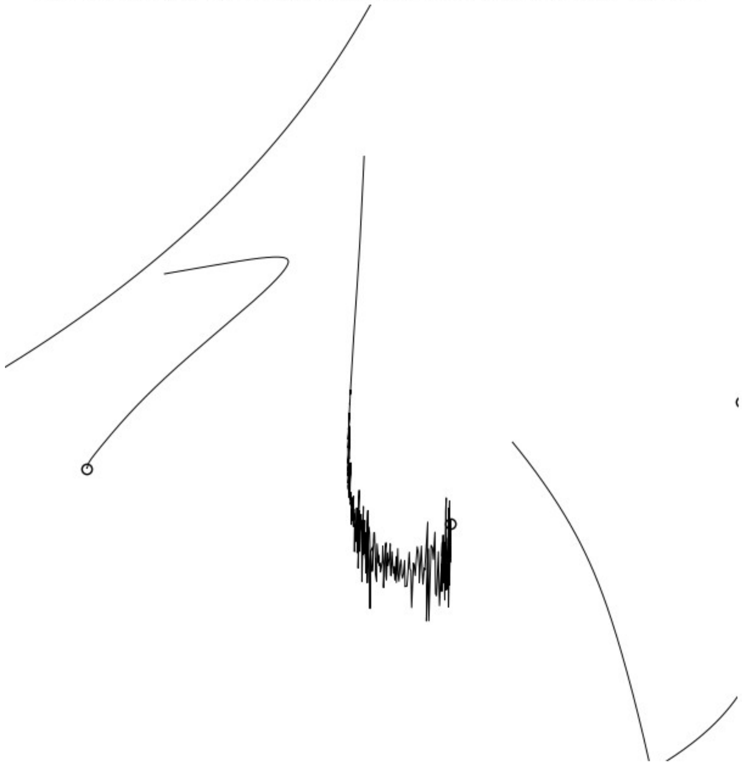
Disadvantage:

Will sometimes generate complex-valued index for the quaternion (which is mathematically invalid) and cause ComplexWarning when turning the quaternion into a rotational matrix;

(but once the imaginary part of these indices are discarded this still gives a useful result.)

Still, some grains' paths are observed with minor fluctuation (see next page)

Evolution of grains orientations up to frame397out of 397 frames

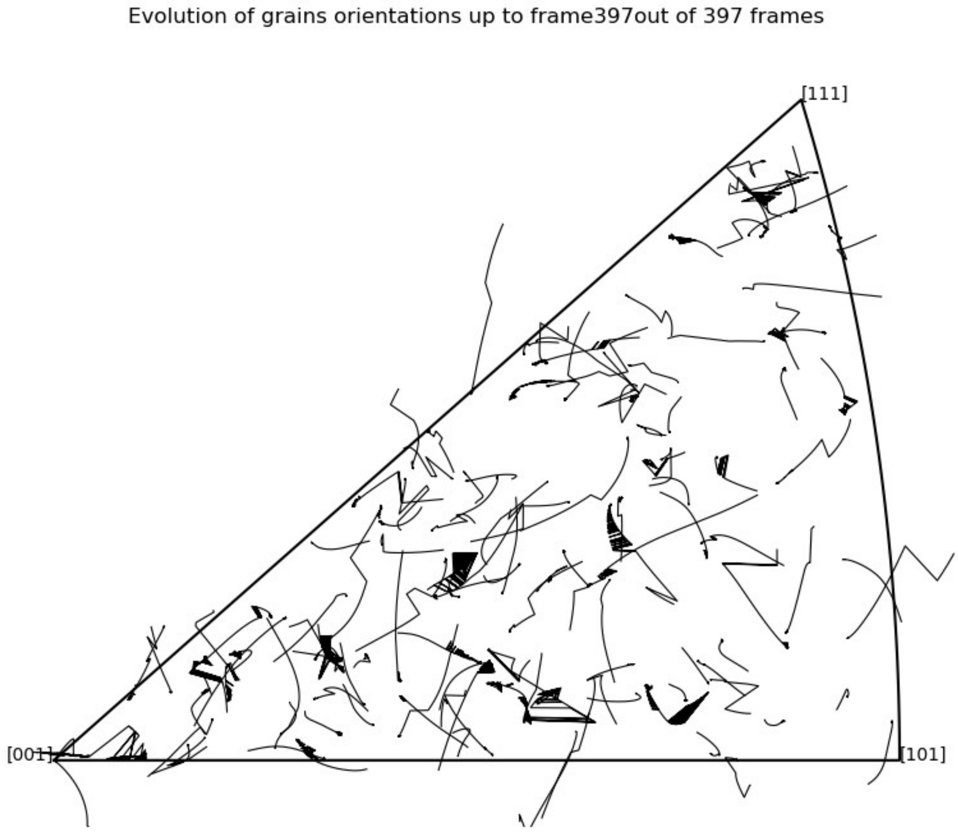


./CorrectAveraging/Enlarged.png

Evolution of grains orientations up to frame397out of 397 frames

./CorrectAveraging/Enlarged2.png

3. **Median method**



./Median/medianMethodEnd.png

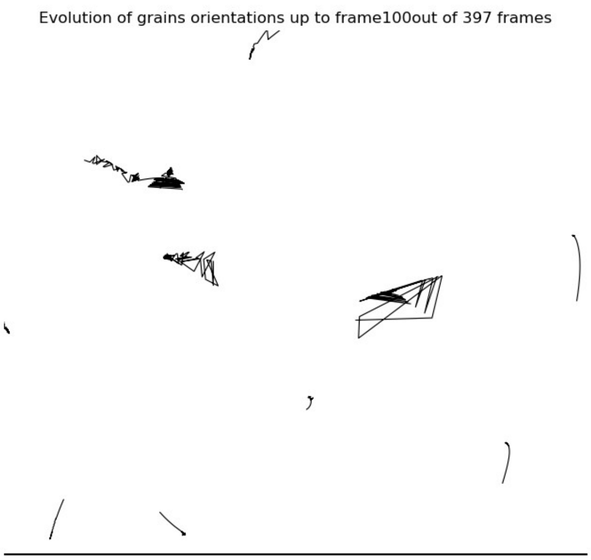
Advantage:

Always works for any number of Gauss points. Simple to implement once a subprogram for finding misorientation has been written.

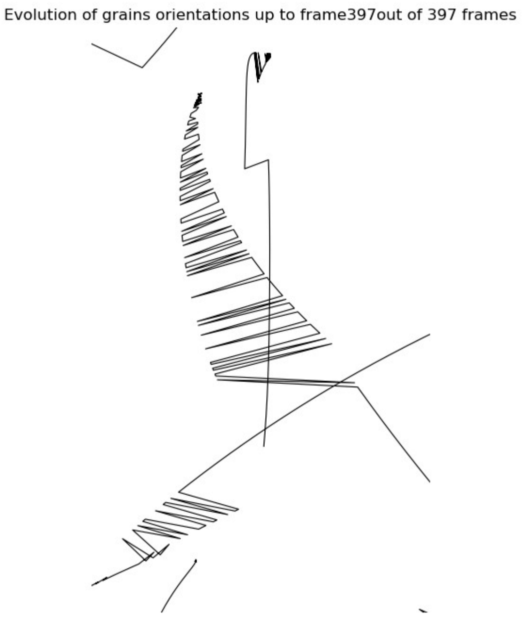
No large discontinuous jumps across from one inverse pole figure sector another.

Disadvantage:

Instability at low scatter as it jumps between quaternions that are close in the quaternion space.



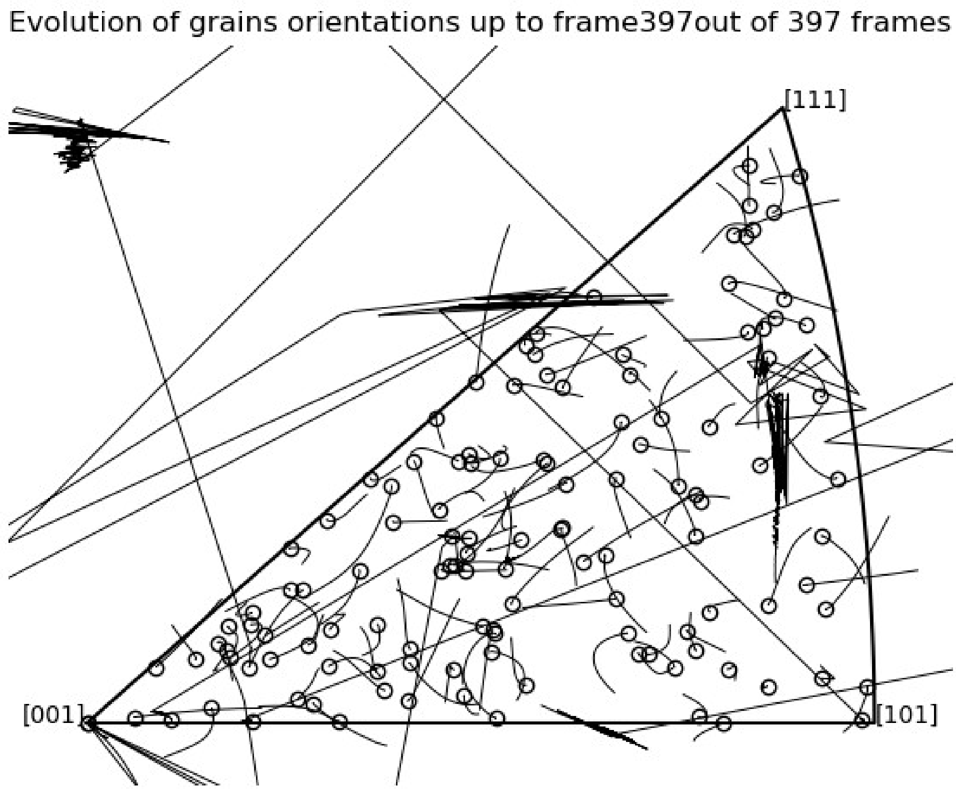
./Median/medianMethodProblem.png



./Median/medianMethodEndProblem.png

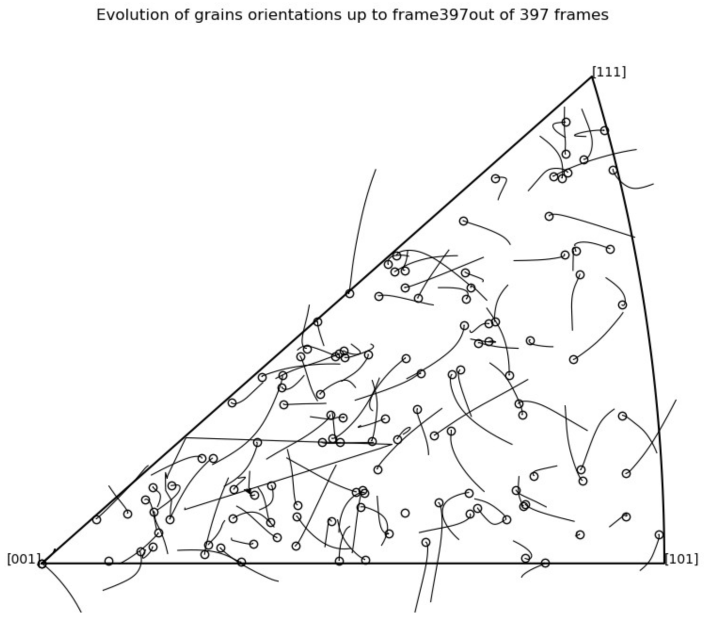
The width of this zig zag path will decrease if there’s a higher number of Gauss points per grain; but there is no guarantee that it will disappear.

4. **Minimize angle**
Iteratively find the particular quaternion that has the minimal misorientation angle from every other Gauss point's quaternion.



./MinimizeAngle/GrainOrientationEvolution_ToFrame397misorientationMinimizationAverage_small.png

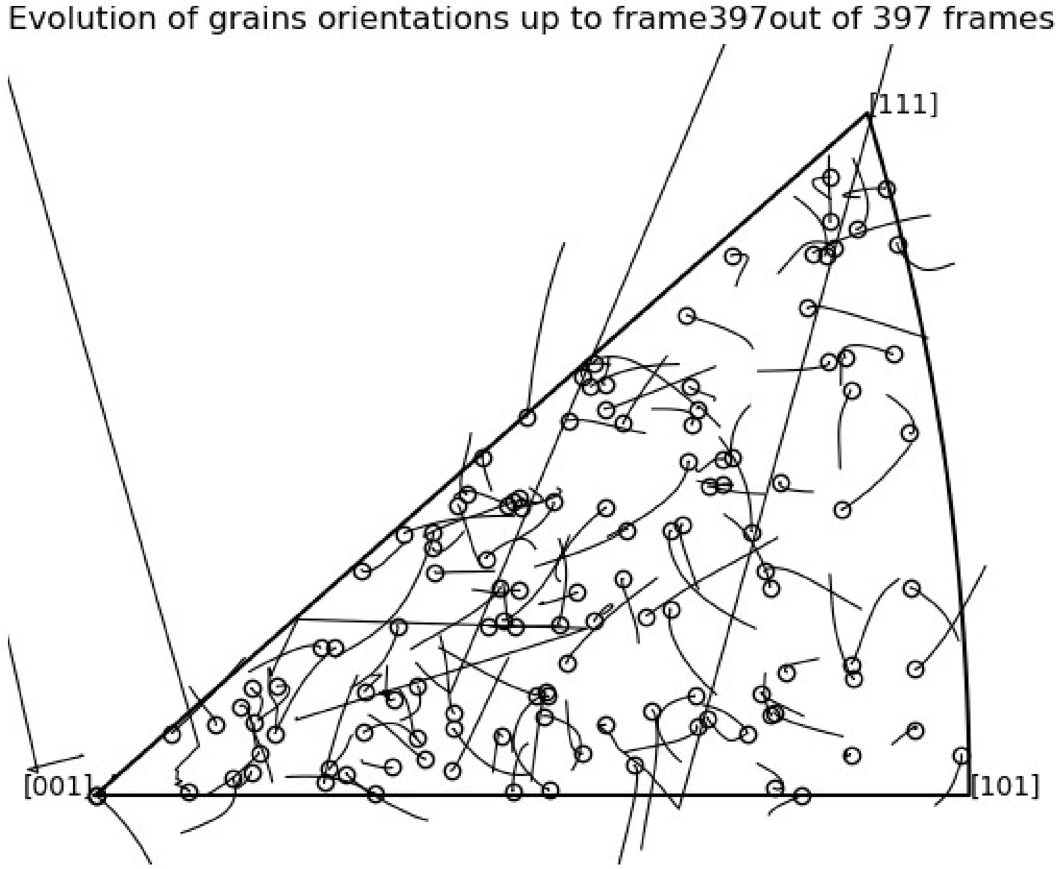
Advantage:
Can be used to demonstrate the principle.
Disadvantage:
Very time consuming, therefore this method is NOT recommended:
- computing time (Each frame takes around 1 minute to solve.)
- programming time (require manually removing anomalous grains)
  - See the photo below for the result after removing the discontinuity:



./MinimizeAngle/GrainOrientationEvolution_ToFrame397DiscontinuityRemoved.png

5. **Normalized Sum**

Add up all quaternions, and then divide the result by it’s own length.



./RenormalizedMean/GrainOrientationEvolution_ToFrame397.png

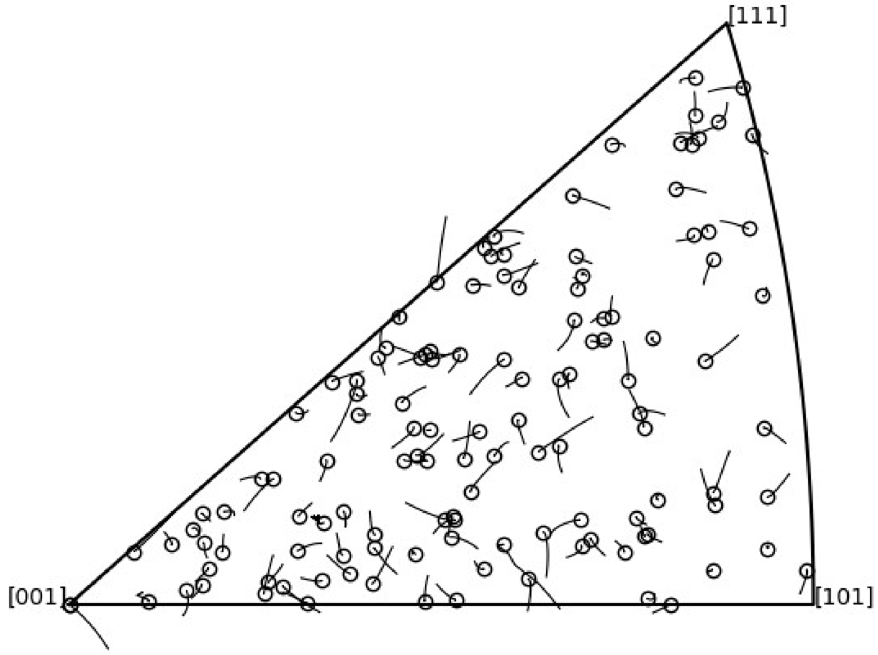
Advantage:

Easy to implement
Short computing time
Always give a real result without fault.

Disadvantage:

No mathematical basis
Some discontinuity may be generated, needs to be manually removed:

Evolution of grains orientations up to frame198out of 397 frames



./RenormalizedMean/GrainOrientationEvolution_ToFrame198.png