Using Convolutional Neural Networks for the Helicity Classification of Magnetic Fields

Nicolò Pinciroli - Ibrahim A. Hameed - Michael Kachelrieß
nicoloop@stud.ntnu.no - ibib@ntnu.no - michael.kachelriess@ntnu.no

37th International Cosmic Ray Conference -ICRC2021-

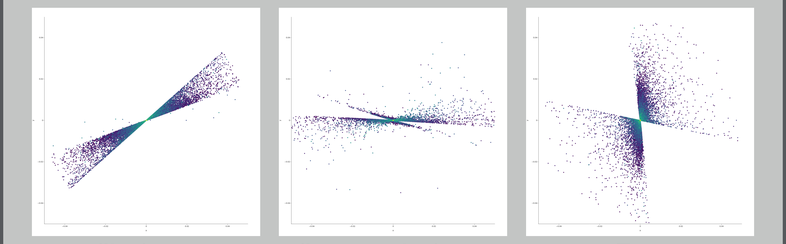
Overview

- **Non-zero helicity** in intergalactic magnetic fields $\Longrightarrow$ primordial processes that break **CP invariance**
- **Problem:** determining helicity
- **Previous attempt:** estimator Q based on the triple scalar product
- **Our proposal:** Convolutional Neural Networks
- **Result:** significant improvement w.r.t. Q estimator

Background

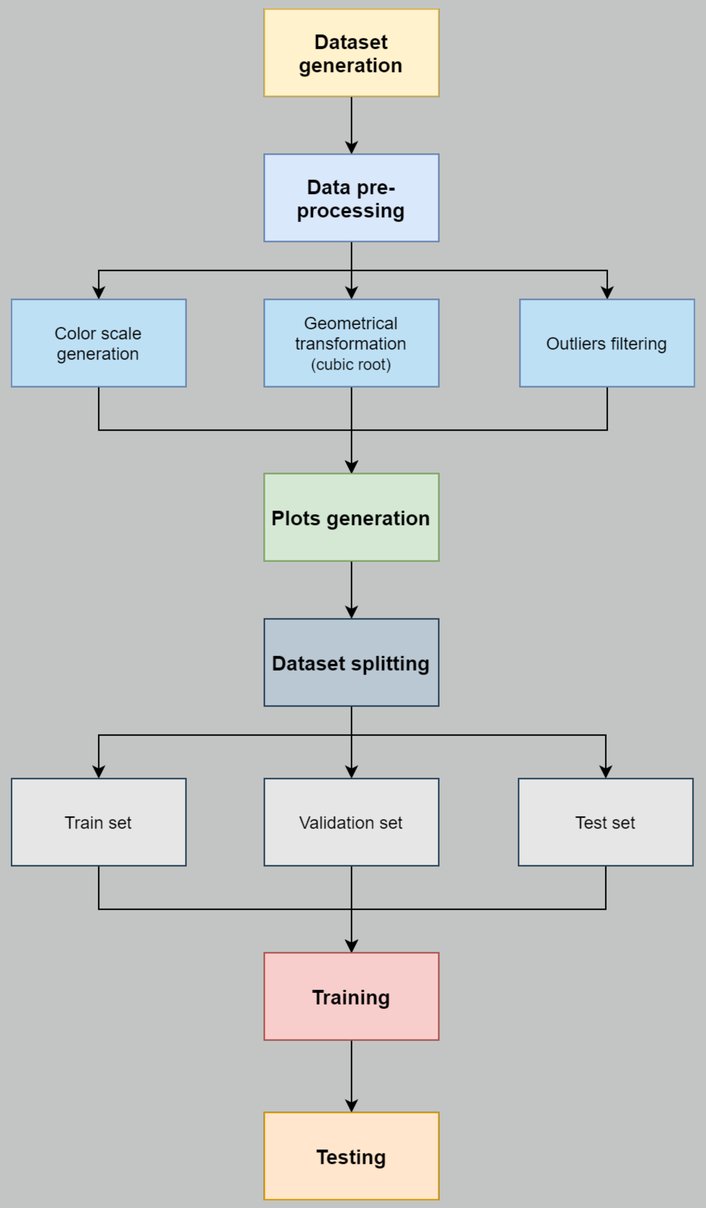
- Good knowledge of magnetic fields up to galactic **scales**
- Elusive role of magnetic fields on larger scales $\Longrightarrow$ amplification of weaker **seed** fields?
- If the primordial generation of the seed fields breaks CP $\Longrightarrow$ **non-zero helicity** increasing with time
- Observed non-zero helicity $\Longrightarrow$ clean signature for a primordial origin of the IGMF
- Vachaspati and collaborators introduced the **Q estimator** to detect helicity (74% accuracy)

Helicity

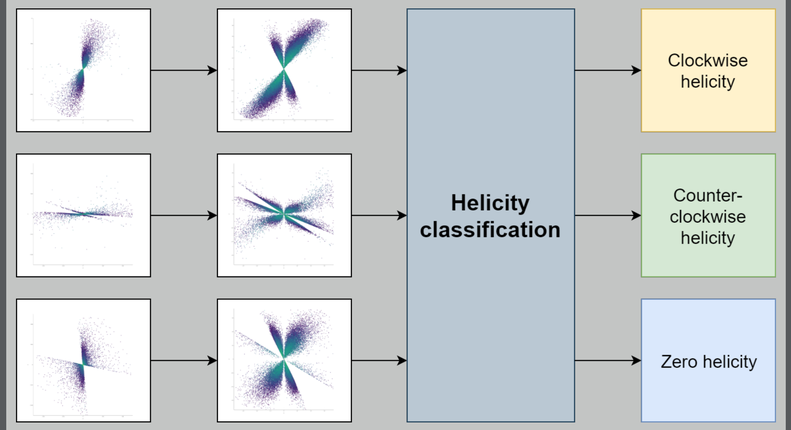


Clockwise | Counter-clockwise | Zero

Workflow



Classification



Conclusions

- Better accuracy
- Other plot transformations possible
- Other networks possible

Read our article

SCAN ME

https://arxiv.org/abs/2106.06718