# Gaia Spark analysis platform

## Progress update

D Morris July 2021

D.Morris
Institute for Astronomy,
Edinburgh University

Original GDAF system

Zeppelin & Spark deployed on physical hardware

Initial goal for our project

- replicate GDAF in the cloud
- DONE

Subsequent goals

- scalable deployment
- portable deployment
- more users
- more data
  - DR3
  - DR4

Gaia DPAC Data Processing & Analysis Consortium

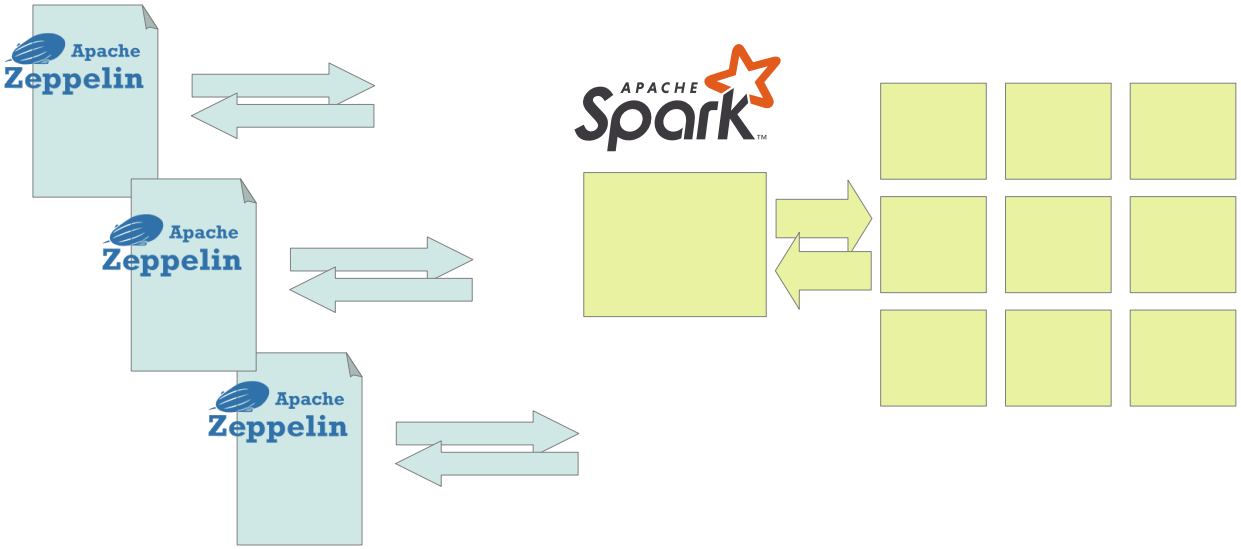
Gaia Data Analytics Framework (GDAF) description

D.Morris
Institute for Astronomy,
Edinburgh University

Gaia Spark platform
Progress update
July 2021

## Hadoop/Yarn *"known unknowns"*

- Spark cluster deployed on static resources
- Zeppelin notebooks all interact with the same Spark cluster




- Automated with Ansible

99% automated

- create-all
- delete-all

3 deployments

- dev
- test
- live

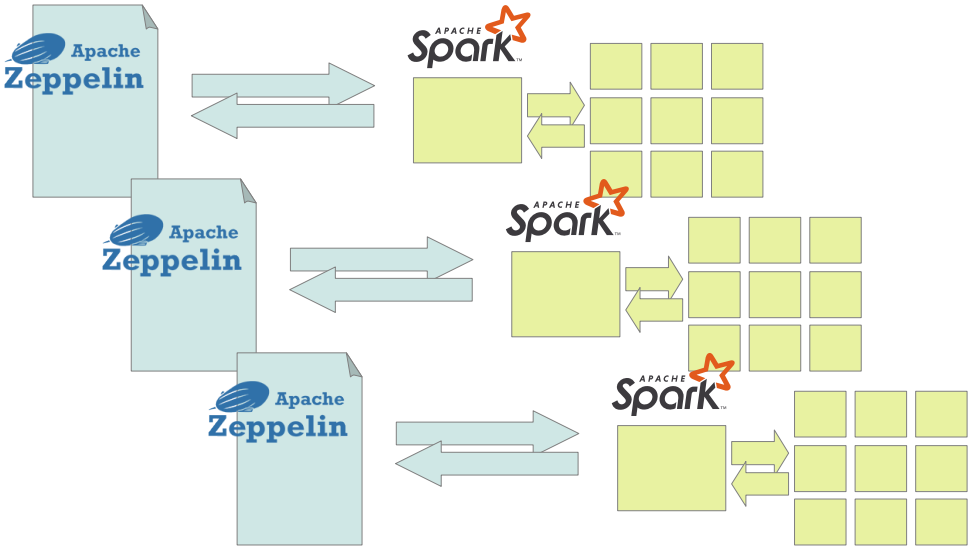
- In place and working
- eDR3 with neighbors

D.Morris
Institute for Astronomy,
Edinburgh University

Gaia Spark platform
Progress update
July 2021

*“unknown unknowns”*

- Spark cluster on demand
- Notebooks launch their own Spark cluster




- Automated with Helm

99% automated

- create-all
- delete-all

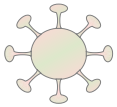
3 deployments

- dev
- test
- live

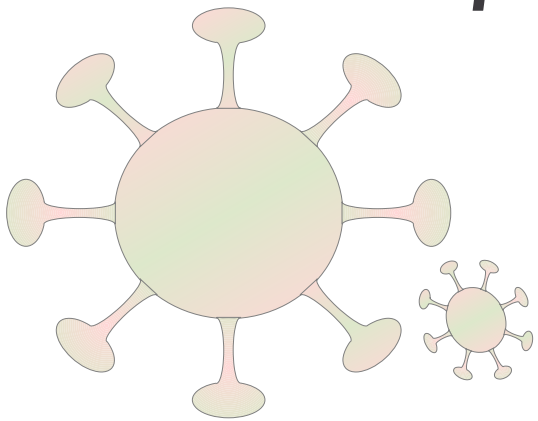
- Experimental in 2020/21
- Not ready for production

D.Morris
Institute for Astronomy,
Edinburgh University

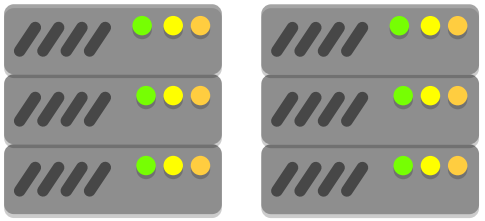
Gaia Spark platform
Progress update
July 2021



## COVID-19



- Cloud based notebook service
- Remote working, ideal application



UNIVERSITY OF CAMBRIDGE

HPC cloud

- Limited access to the data center
- **Huge thank you to the system admins who kept the system running**
- Impact on hardware deployment schedules
- 2021/2022 resources and upgrades will be delayed

D.Morris
Institute for Astronomy,
Edinburgh University

Parquet https://parquet.apache.org/

Apache Parquet columnar storage format

- Gaia eDR3 sources - 561Gbytes

- 2MASS PSC 37G bytes
- 2MASS PSC Gaia eDR3 best neighbors 60G bytes

- Pan-STARRS MeanObjectView 270G bytes
- Pan-STARRS Gaia eDR3 best neighbors 163G bytes

- ALLWISE 341G bytes
- ALLWISE Gaia eDR3 best neighbors 177G bytes

D.Morris
Institute for Astronomy,
Edinburgh University

Cross match using best neighbor tables

Familiar SQL based JOIN syntax

```
SELECT
    gaia.source_id,
    gaia.ra, gaia.dec,
    ps1.g_mean_psf_mag AS ps1_g,
    ps1.r_mean_psf_mag AS ps1_r
FROM
    gaia_source AS gaia
INNER JOIN
    gaia_source_ps1_best_neighbours AS ps1
ON
    gaia.source_id = ps1.source_id
```

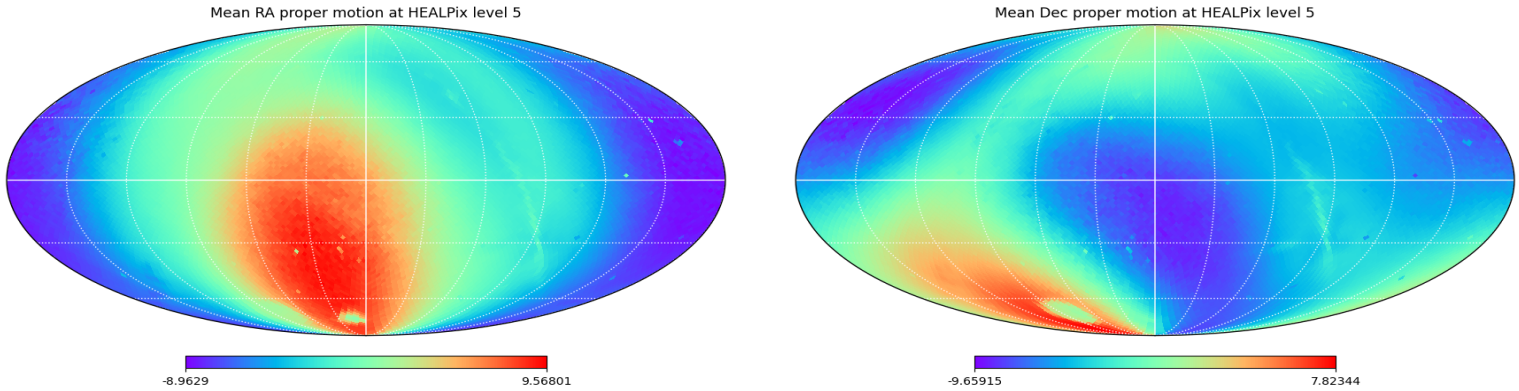
D.Morris
Institute for Astronomy,
Edinburgh University

# HEALPIX partitioning

Parquet files partitioned based on HEALPIX value embedded in Gaia source_id

Placing adjacent sources in the same file reduces shuffle between Spark workers

```
SELECT
    floor(source_id / 562949953421312) AS hpx5,
    COUNT(*) AS n, AVG(pmra), AVG(pmdec)
FROM
    gaia_source
GROUP BY
    hpx5
```




Mean proper motions over the sky – 1min 28sec to calculate and plot

D.Morris
Institute for Astronomy,
Edinburgh University

# Machine learning application

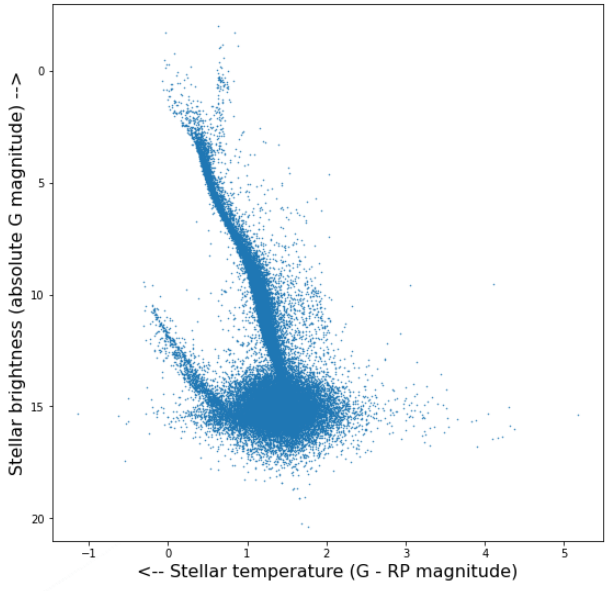
Based on the Gaia EDR3 performance verification *"The Gaia Catalogue of Nearby Stars" (Smart et al. 2021)*.

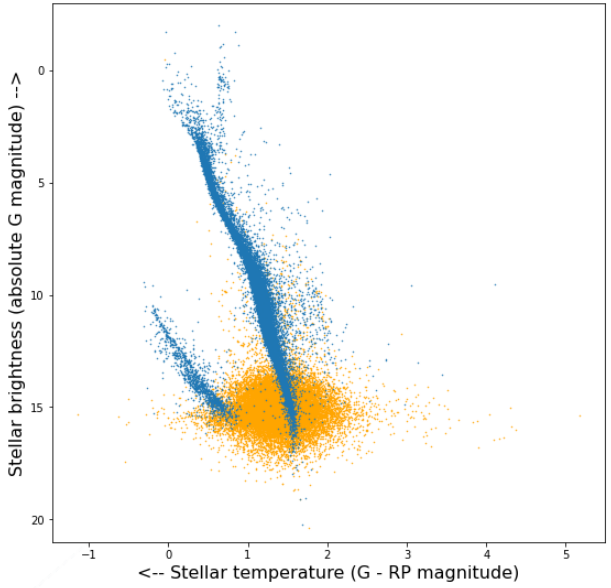
Training a supervised Random Forrest to classify astrometric solutions as ‘good’ or ‘bad’.

SparkSQL queries to generate the training and validation data.

4min to train the classifier

25sec to classify 1,724,028 sources and plot the results




D.Morris
Institute for Astronomy,
Edinburgh University

Gaia Spark platform
Progress update
July 2021

## Network filesystem

CephFS via Openstack Manila
to store the science data

Issues with concurrent access and IO bandwidth

ML RandomForest example :

- First pass with empty cache, 4min to train the classifier
- Second pass with populated cache, 24min to train the classifier

Pattern of disc access changes depending on the cache contents.

- Empty cache generates sequential requests for large blocks
- Populated cache generates random access requests for small fragments

Current CephFS system does not handle this pattern well

Solving this may take time – see COVID-19 and hardware deployment

D.Morris
Institute for Astronomy,
Edinburgh University

## Beta testing

Call for people interested in being beta testers

Booked sessions with tech support

Q4 2021

Outline of the science case you would like to explore

Outline of the technology or algorithm you are interested in using

Contact a member of the development team

- Nigel Hambly <nch@roe.ac.uk>
- Dave Morris <dmr@roe.ac.uk>
- Stelios Voutsinas <stv@roe.ac.uk>

Prizes for the most likely to break the system