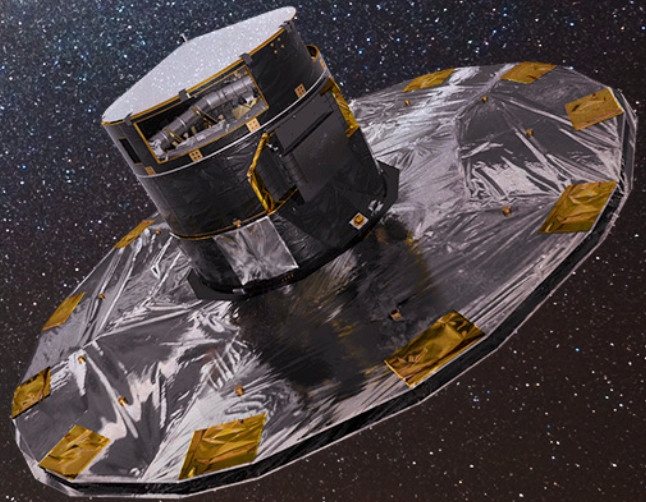
Open data Access / Provissioning

Maximising data reach: bringing the Gaia dataset to the world

Juan González-Núñez, J. Salgado, R. Gutiérrez-Sánchez, JC. Segovia, J. Duran, E. Racero, M. Marcos, D. Baines, A. Mora, J. Bakker, B. Merín, C. Arviset

ESAC Science Data Centre (ESDC) - ESA



Why Open Archives?

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Gaia

Refereed Gaia papers since launch

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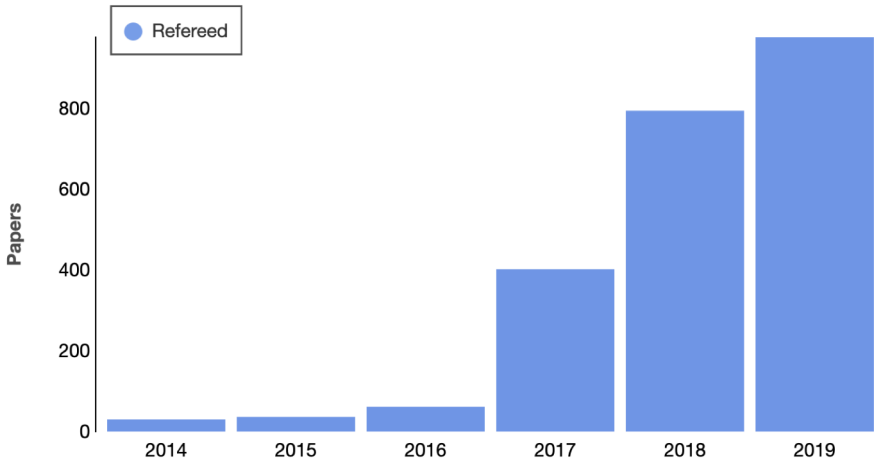

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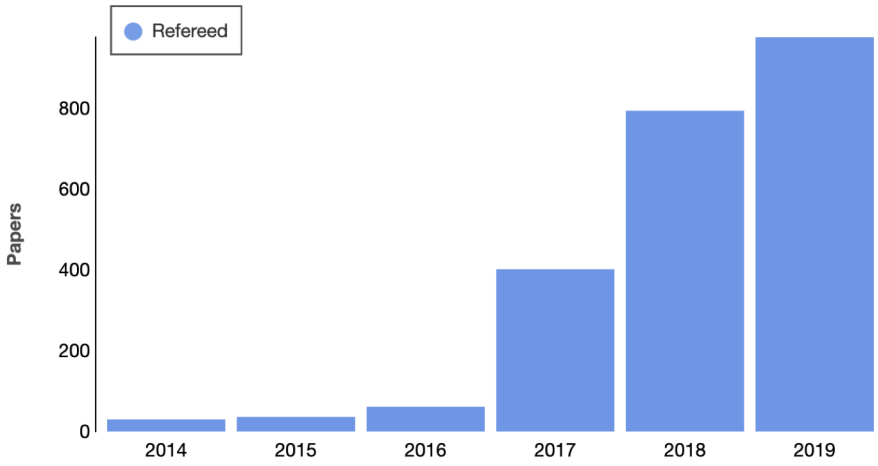

- How can open scientific archives increase the scientific output/outcome of a mission?

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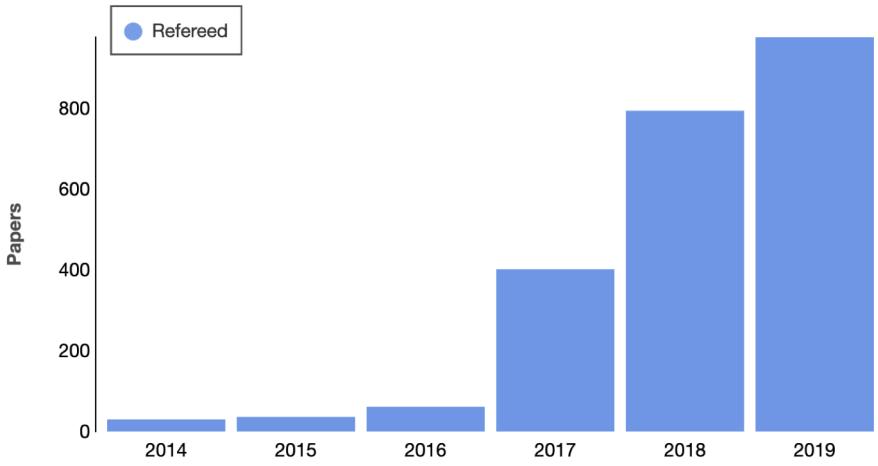

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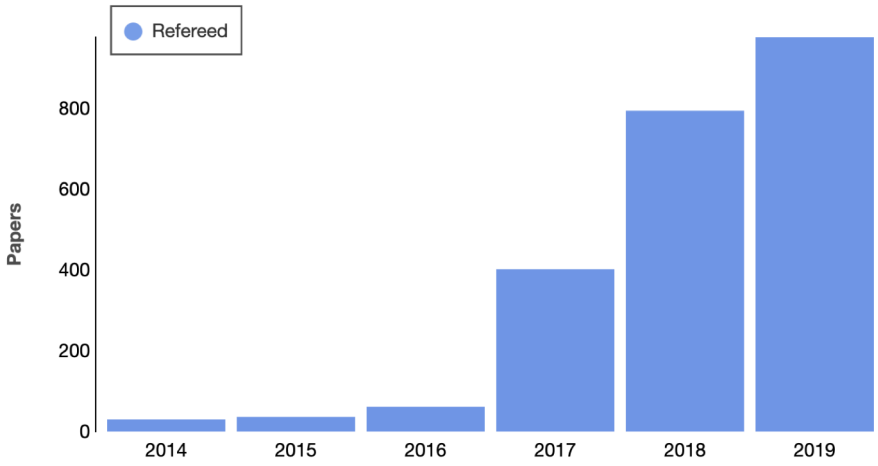

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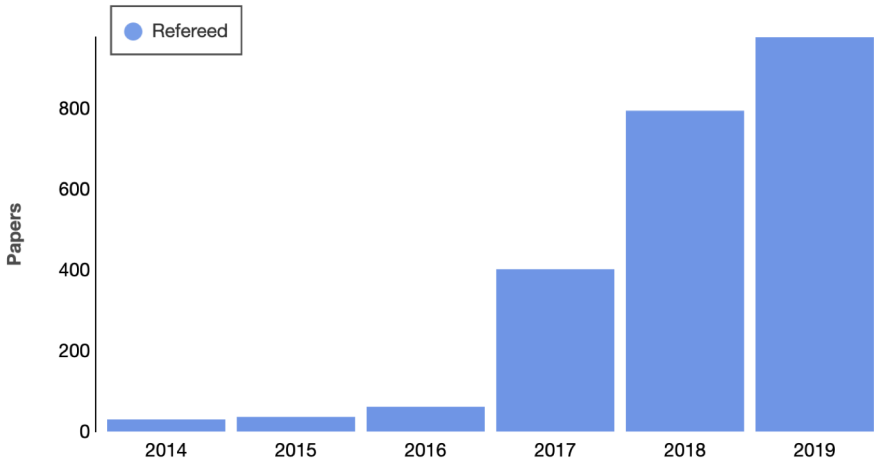

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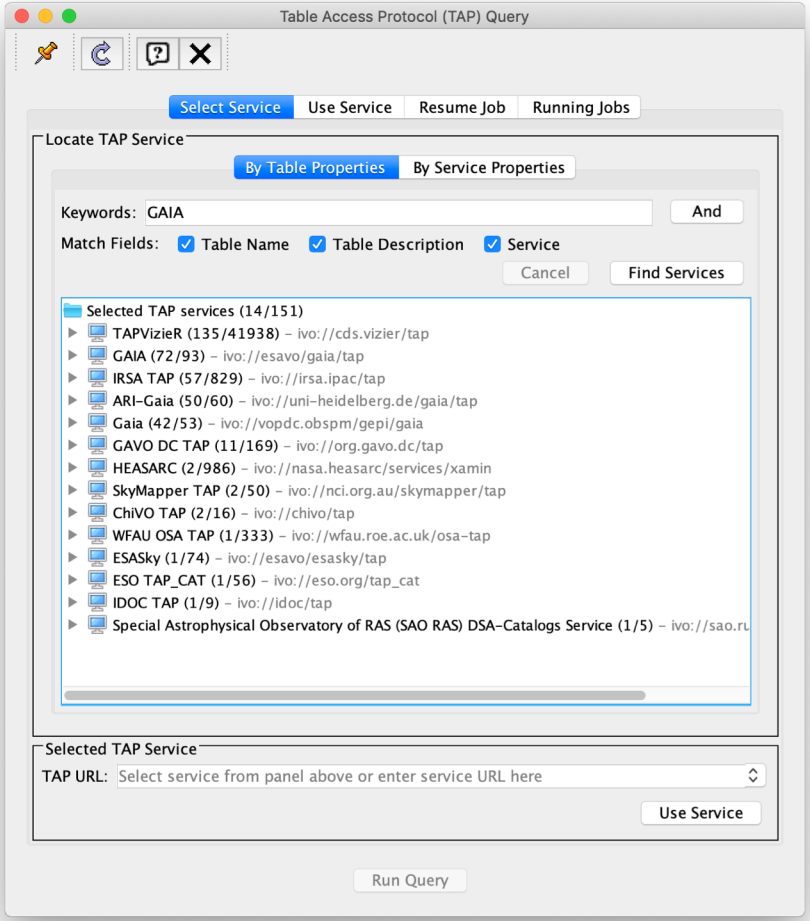
  - Improve Data **preservation** through Open Data Models

Openness in Scientific Archives

- The ESA Gaia Archive, ESA Gaia Mission and DPAC Consortium have made efforts in 4 areas:
  - Open Data
  - Open Software
  - Open Protocols
  - Open Data Models

Open Data

- Gaia Data License:
  - "The Gaia data are **open** and **free** to use, provided credit is given to 'ESA/Gaia/DPAC' […] "
- Does not specifically state limitations to use and reuse. Enables distribution by third parties of the full dataset (redistribution)
- Attribution requirement – compatible with Open Data
- No proprietary exploitation period
  - Direct access to all Scientific community



Data redistribution

- DPAC Partner and Associate Data Centres:
  - Validated data delivered in advance
  - Eg. CDS, AIP, ARI, ASI SSDC…
- Positive effects in functionality
  - Local copies per service enable for quicker data correlation
  - Eg. crossmatch between catalogues
- Traffic is lower, more stable and more predictable due to aggregation of traffic
  - **Less resources** per datacentre needed, and **more predictable**

Open Software

OS Off the Shelf

DB

PostgreSQL

Postgres-XL

Greenplum

Content SV

Apache Tomcat

APACHE HTTP SERVER PROJECT

Red Hat

Components/FW

GWT

OpenJDK

spring SECURITY

jasig

CI/CC

Maven

Sonatype Nexus

SUBVERSION

sonarqube

Jenkins

OS Libraries

- VOLLT
  - TAPLib
  - UWSLib
  - ADQLLib

OS Communities

python

GitHub

The Astropy Project

Database Software

- PostgreSQL
  - Ready to use: only requiring tuning to specific HW and general administration costs – **efficient usage of resources**
  - High uptimes (No DB software caused downtime in **3 years** of public ops)
  - Remarkable performance
  - Cluster versions (Greenplum CE)

- Q3C
  - Geometrical indexing extension
  - S.Koposov, O. Bartunov.

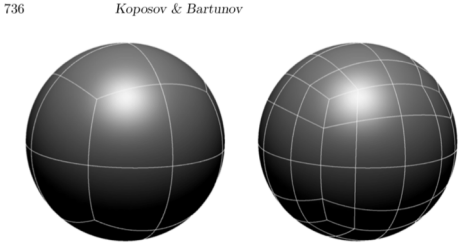
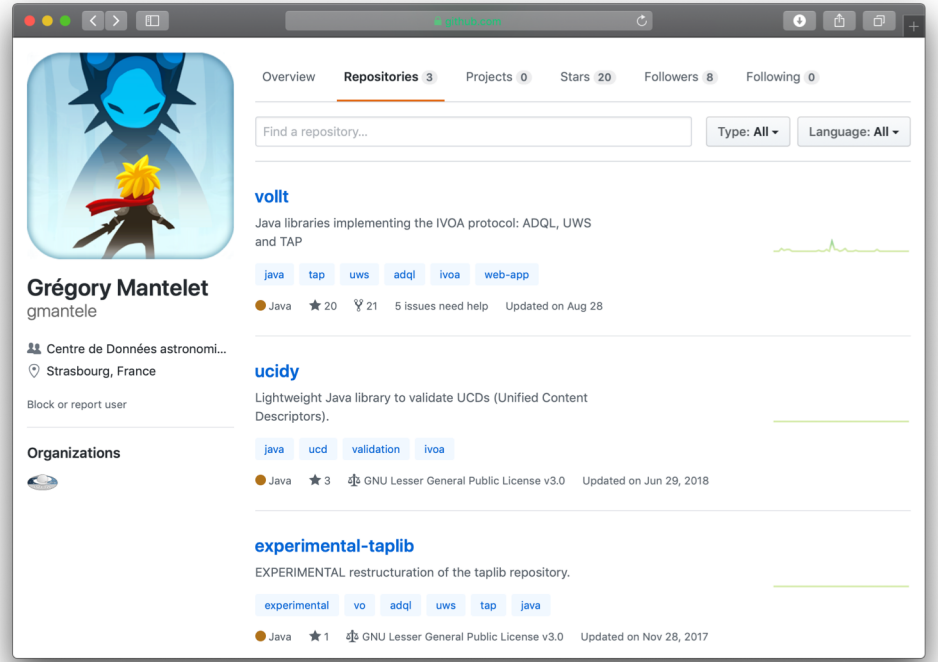


Figure 1. The sphere segmentation in Q3C.

Open Software TAP



- VOLLT: Java library implementing several VO protocols – G. Mantelet
  - TAPLib, UWSLib, ADQLLib
- In-house development only of TAP+ adaptation (authentication, user spaces, etc.) – **reduced dev. effort**

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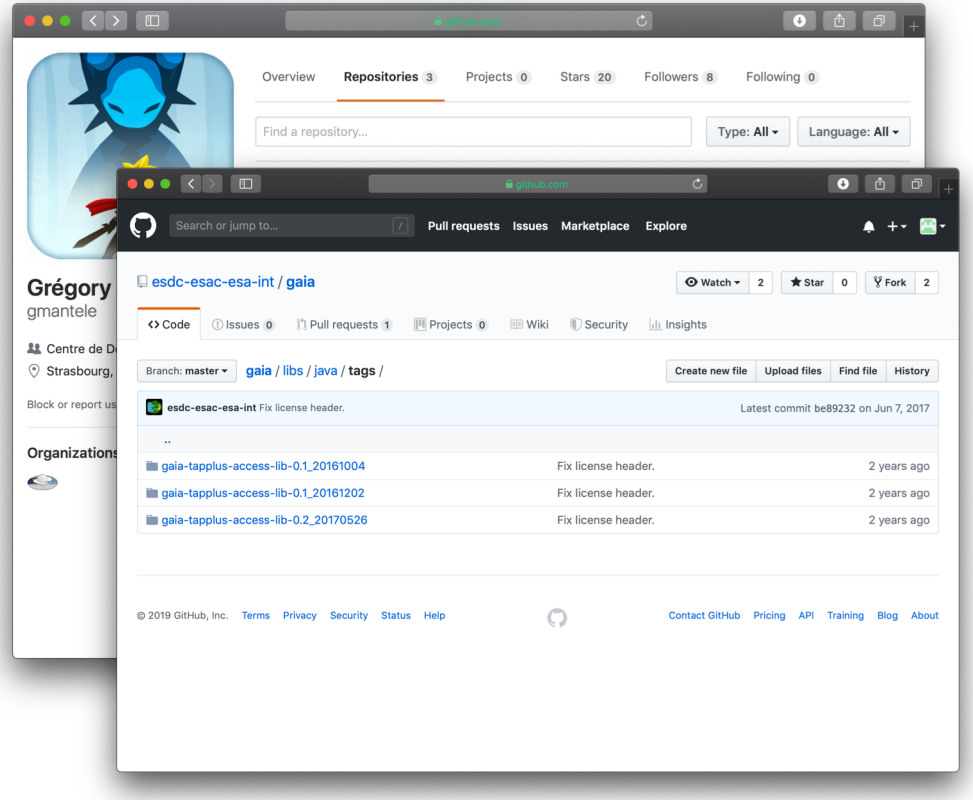

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- In-house development only of TAP+ adaptation (authentication, user spaces, etc.) – **reduced dev. effort**
- Released TAP+ fork (2017)
  - GNU-LGPL
  - https://github.com/esdc-esac-esa-int/gaia

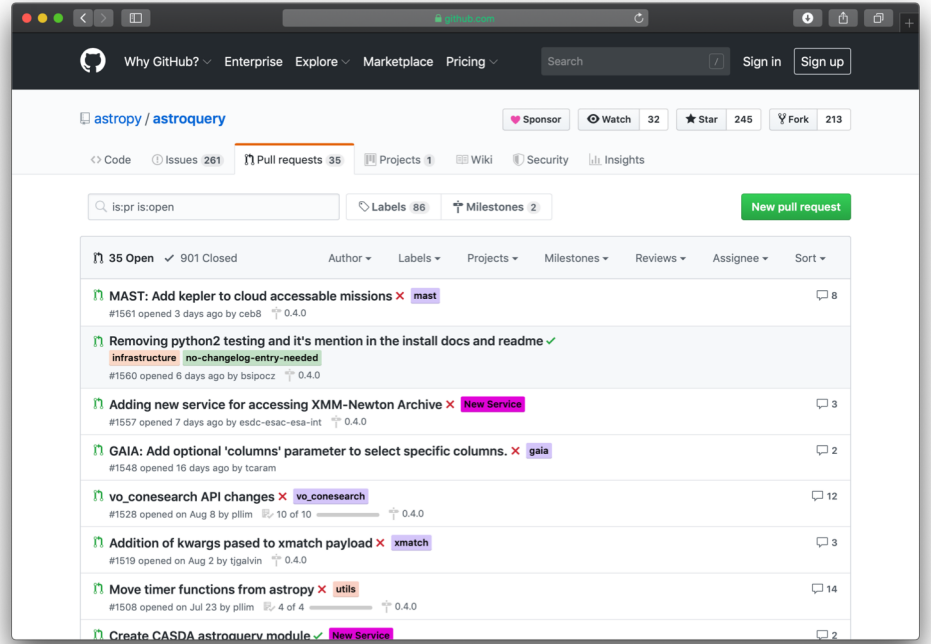
Open Source communities

- Data Centres should jump beyond the ”service” level to provide data access libraries on Astronomical data analysis packages that are Open Source

- Bringing specific data access mechanisms in the languages/environments where data analysis is happening dramatically reduces the data access barrier, **increases data usage** and scientific **productivity**

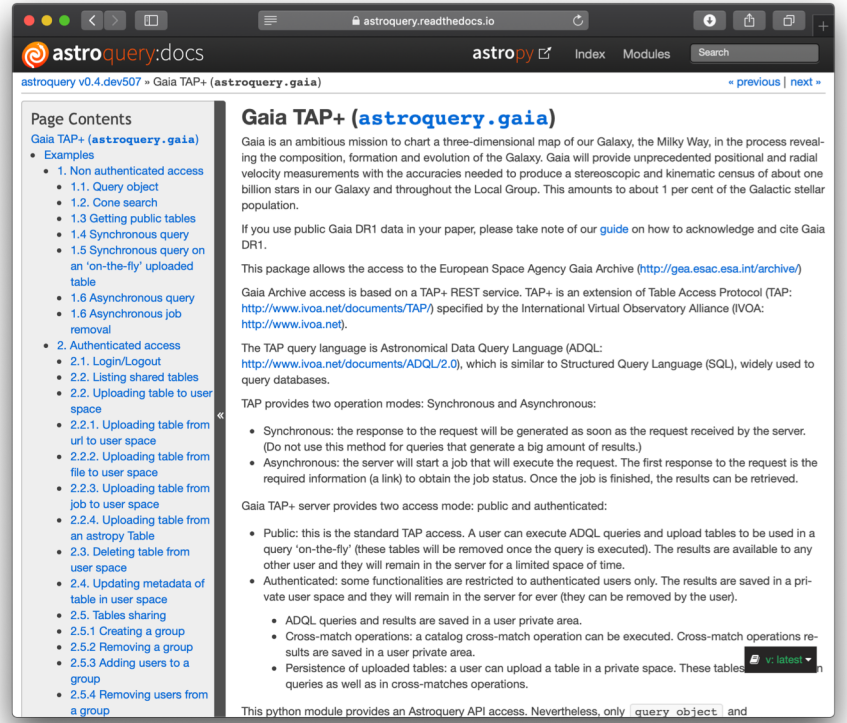
- Community contributions keep the overall **development cost low** to each data centre

Open Source communities



- Eg. Astroquery
  - GITHub with Branch/Pull request mechanism enables to integrate minor contributions from may developers/institutions in an agile workflow
  - Branch (open)
  - Codify
  - Pull request (open)
  - Review
  - Merge

Open Source communities



- Gaia: Extensions of Astroquery contributed on specific packages, eg.
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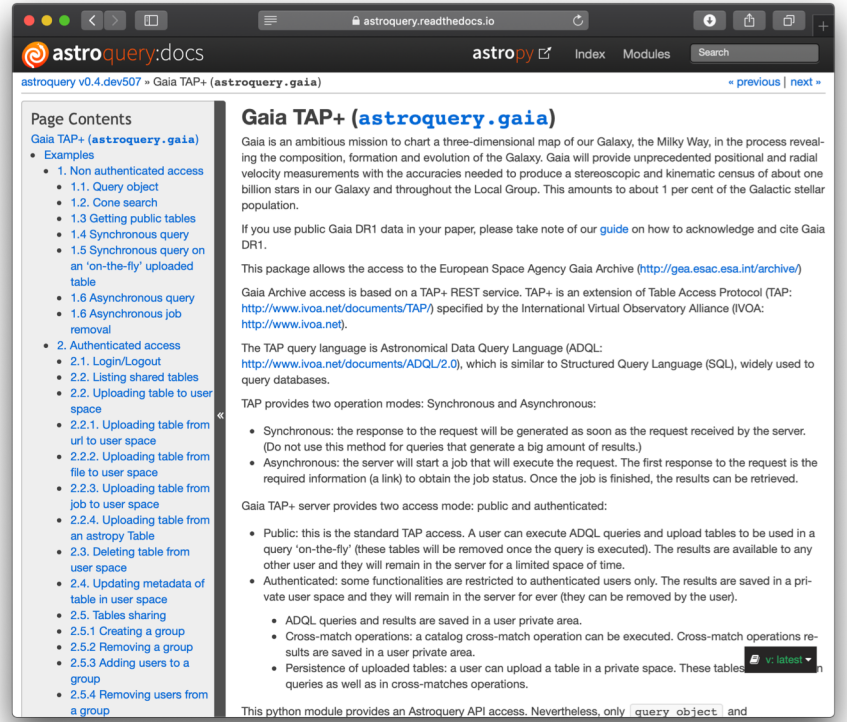

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- ESDC has made several other contributions to OS communities:
  - astroquery.esasky
  - astroquery.hubble
  - astroquery.xmm (ongoing)
  - Proba2 (ongoing)

sunpy
A Community Python Library for Solar Physics

HelioPy

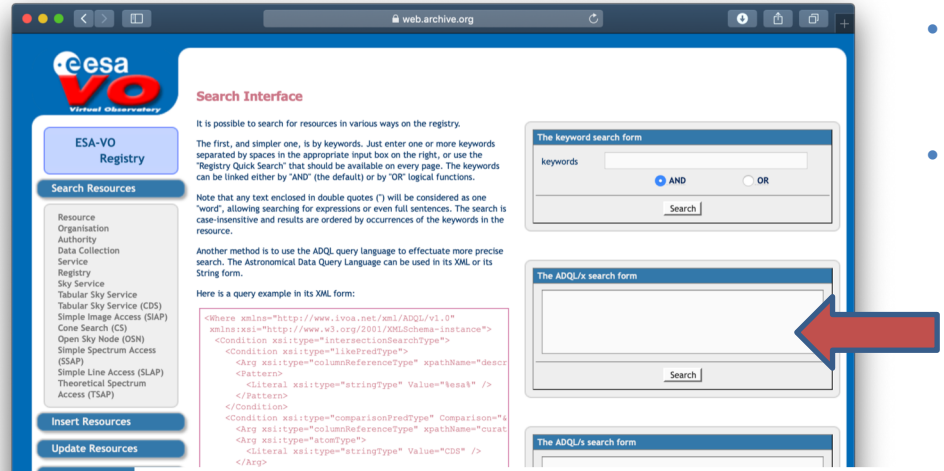
Open Protocols

- Long standing commitment by ESA with the IVOA

- IVOA fosters the creation of open standards
  - Freely available to use and re-use
  - Open definition process (transparency, broad consensus)

- Key dates
  - 2002 – ESA joined IVOA upon its foundation
  - 2005 – First ESA VO services (on-top layer)
    - ISO & XMM Image/Spectra (SIAP/SSAP) services
  - 2014 – First ESA VO Inside archive (Gaia)
  - 2016 – First ESA VO Inside multi-mission archive (ESASky)

Open Protocols: Early implementations




```
WHERE #description# LIKE '%esa%' AND #curation/publis
```

Note that the elements to search should be specified using the xpathName attribute for the XML form and enclosed in sharp characters (#) for the String form. The ADQL versions currently supported are v0.7.4, v0.8, v0.9 and v1.0 ; it must be specified by using the proper XML namespace declaration.

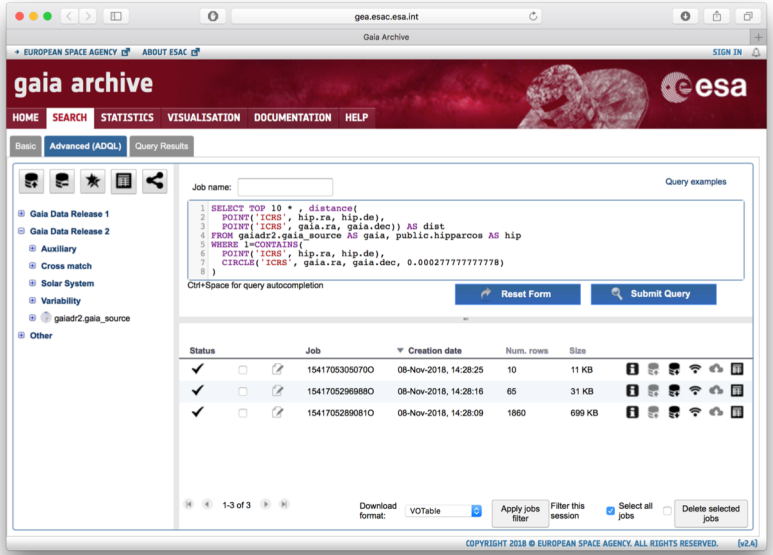
- ESA VO Registry of Resources
  - Released **June 2005**
- First ESA service with **ADQL query**
  - Before ADQL became REC
  - Experimental **14** years ago
  - Early implementations help to drive standards development and also **build specific knowledge**

Open Protocols in the ESA Gaia Archive

- Many VO protocols are the **core** backbone of the Gaia Archive server side, not an on-top addition over tailored protocols
  - TAP -> catalogues
  - DataLink -> associated data products

- All APIs used by the Archive **are public and documented**

- When a VO protocol does not fully fit the purpose, it is **extended**, keeping compatibility. Eg. TAP+



http://archives.esac.esa.int/gaia

Gaia Query sources

I/F	Tool	Origin	
TAP	Python	astroquery.gaia	17.7M
ConeSearch	TOPCAT		9.1M
TAP	Python	other	184K
TAP	Web	archives.esac.esa.int/gaia	128K
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ConeSearch	Java		5K
TAP	Python	urllib	1.2K

June-September 2019 data

- Others can query your service!
  - Availability through other data access tools increases the data **availability** and hence, scientific **productivity**
- Usage of open protocols as internal data centre protocols reduces implementation costs and associated costs of external interfaces, for a **more efficient** development

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June-September 2019 data

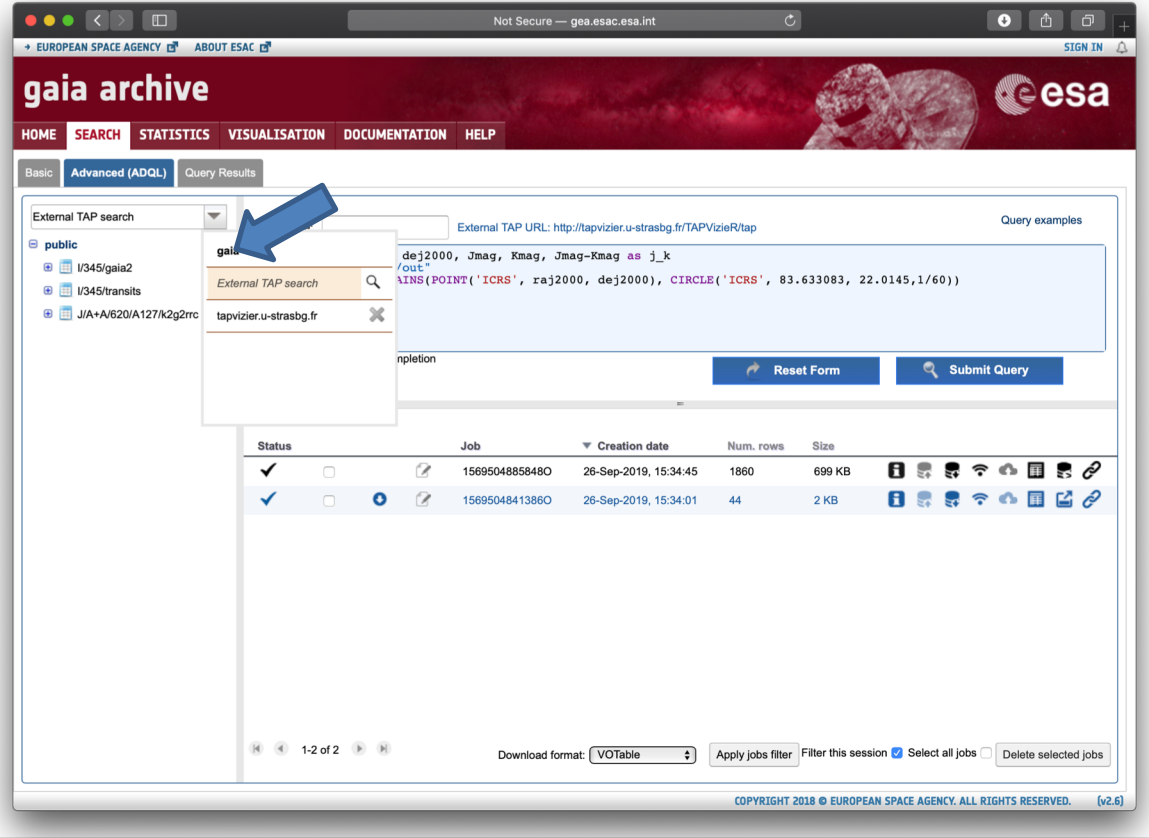
- Correspondence between # of queries and knowledge extracted is by no means direct, but…
- **65%** of the query traffic corresponds to Open Source projects
- **98%** of the query traffic corresponds to Open Source projects + VO tools

98%

Of all the query traffic would not exist without

- Open Source projects contributions
- Open VO protocols compatibility

External queries in the Gaia archive



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  - Search on GloTS: table level metadata search for any public table
  - Almost 50K catalogues (and growing!)

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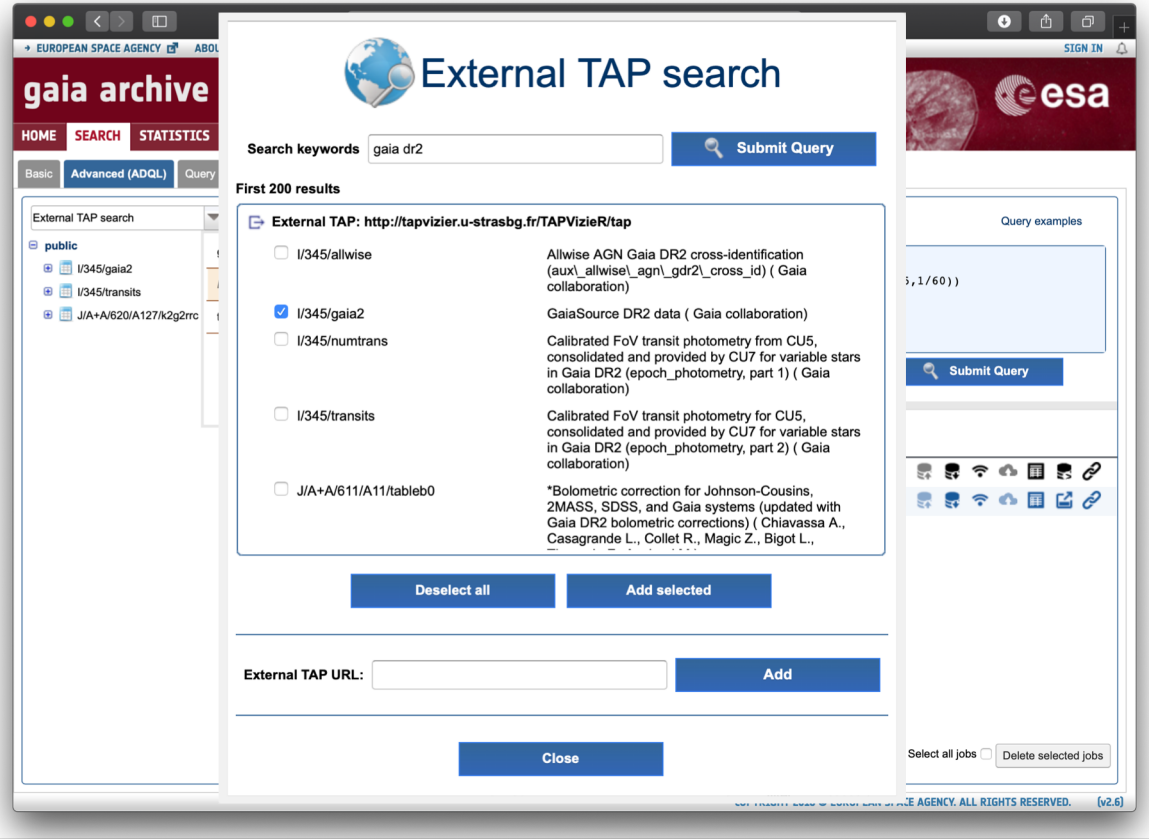

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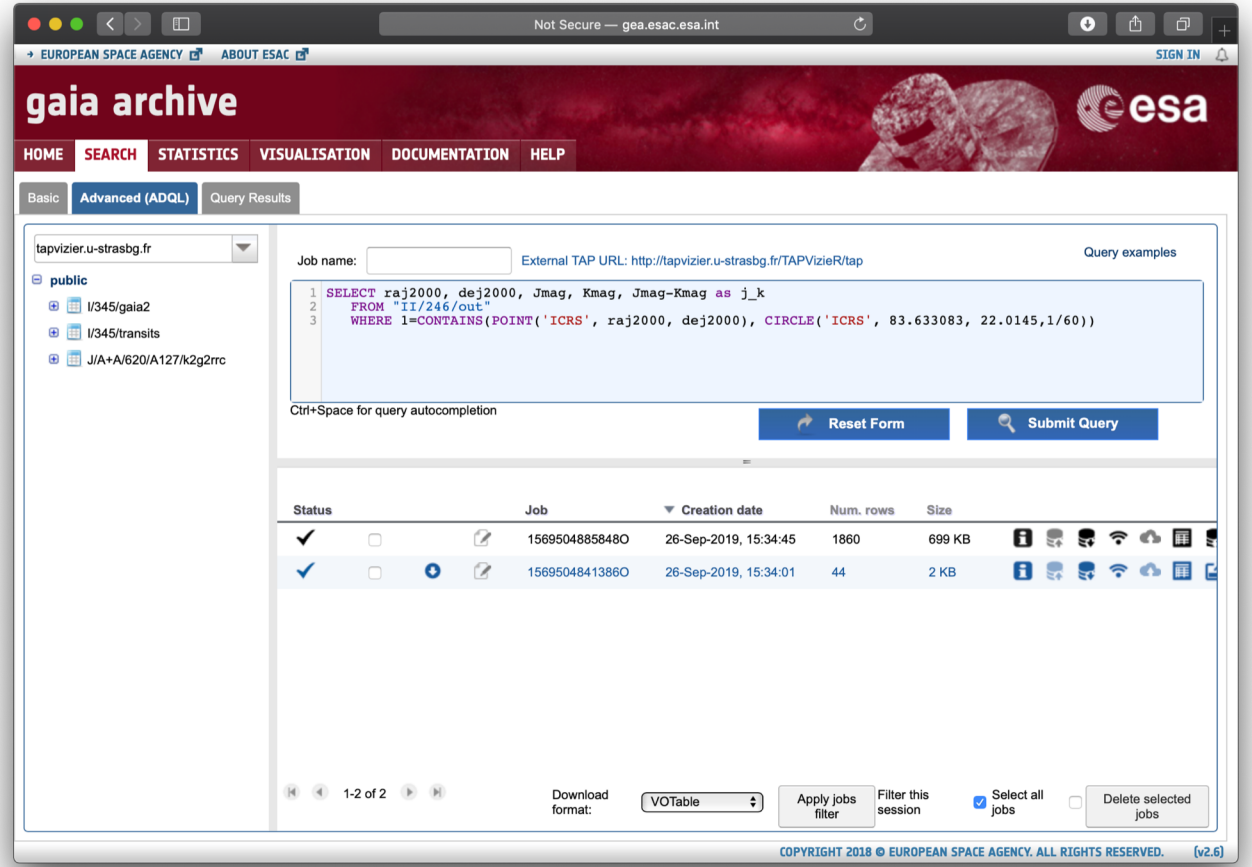


- External query results (in blue) are stored in the Gaia TAP service
- Possibility to upload them to user DB spaces or cross reference in subsequent queries

Open Protocols

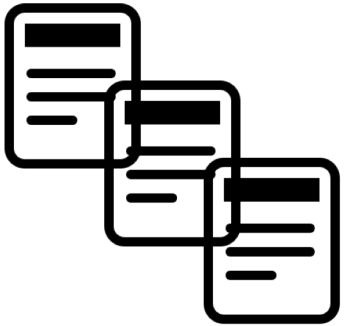
- Many other service implementors rely on open protocols: a quickly increasing toolbox

- IVOA protocols require 2 reference implementations to become REC
  - Mainly Open Source
  - Great efficiency by **using** these implementations and spending project resouces in **extending** them

- TAP, ADQL, UWS, VOSpace, DataLink, etc.

Open Data Models

- Requires to go from Mission level thinking to global, long-term metadata
- Long term data access is guaranteed by
  - Adaptation of internal mission DM with view in **standard DMs**
  - **On the fly** serialisation through DataLink (adaptable) for data products



- Gaia DM
- VO DM serialisations
  - Spectrum, TimeSeries, etc.

Is it working?

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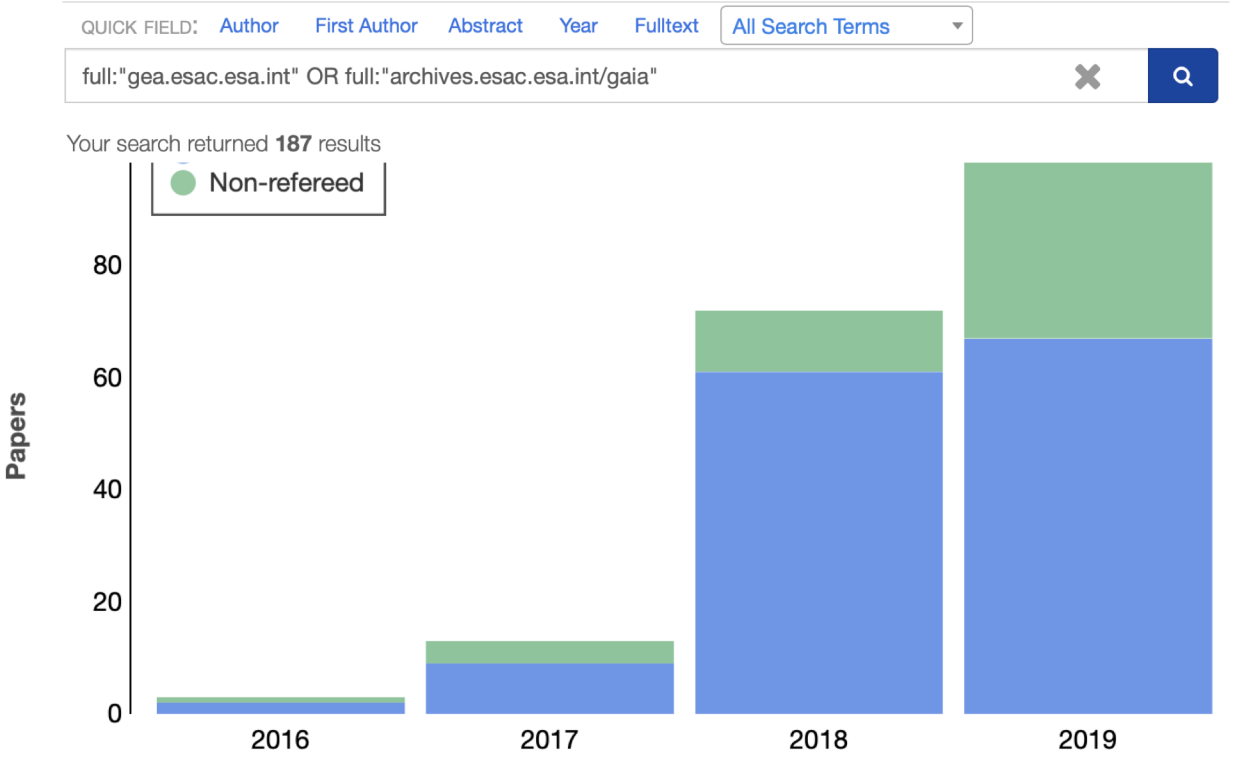

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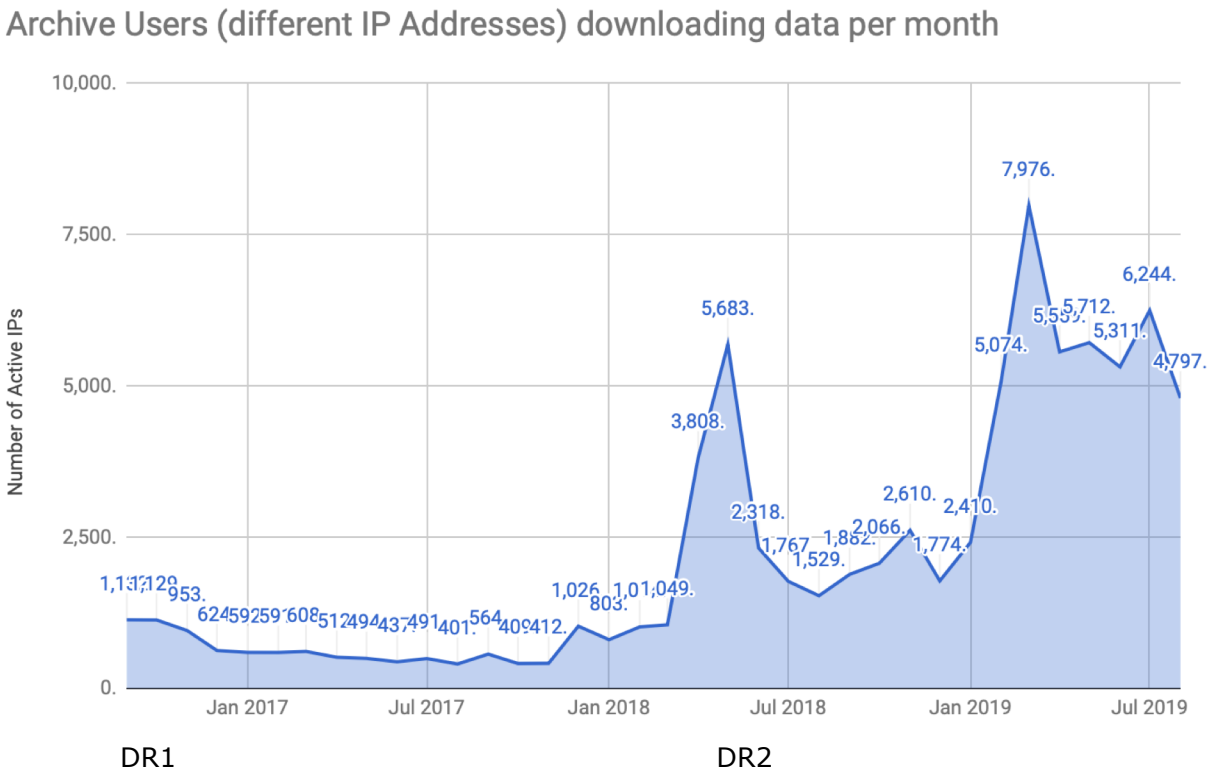

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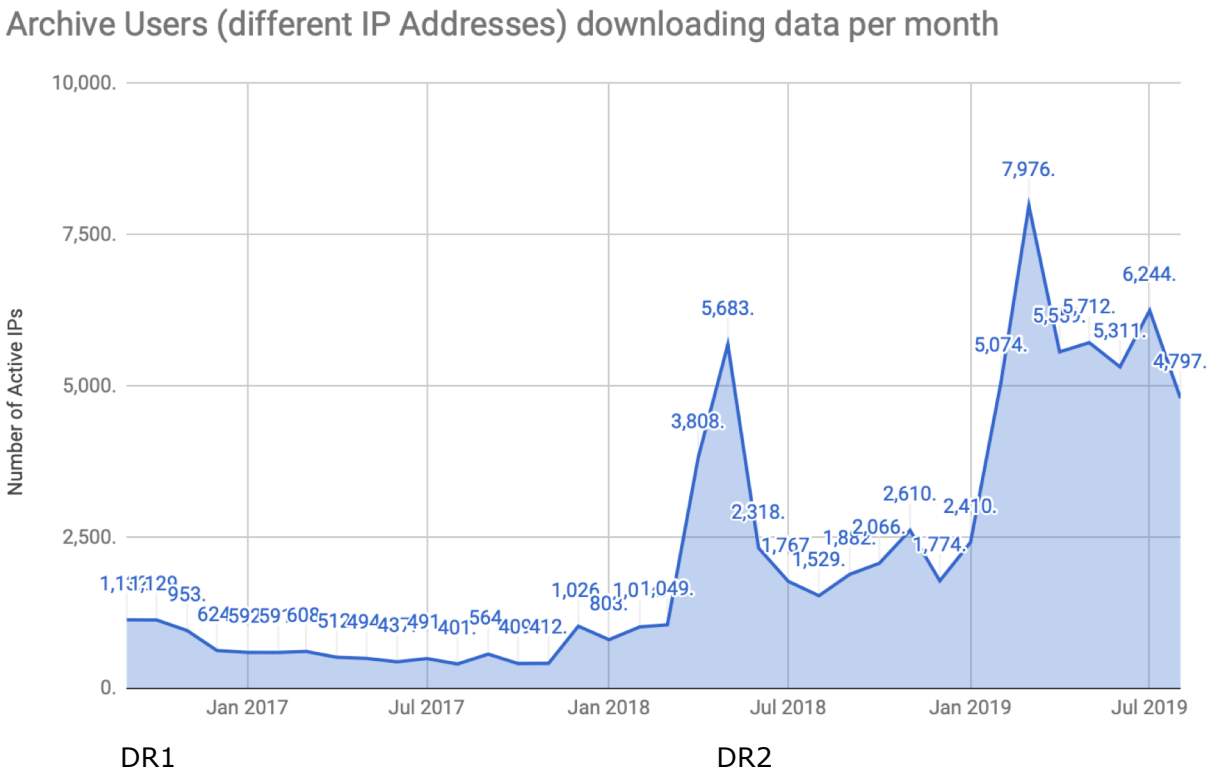

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  - 2K registered archive users

Thanks for your attention

Questions?