

CDS Scientific Council meeting 2020

Summary of CDS activities 2019-2020

24 November 2020

1. Introduction	1
2. Highlights 2019-2020	2
2.1 Highlights of CDS in the Community	3
3. CDS Strategy	4
4. Activity Report for CDS Services 2019-2020	5
4.1 CDS Information System and Service Monitoring	5
4.2 SIMBAD	8
4.3 VizieR	10
4.4 CDS X-Match	13
4.5 Aladin	14
4.6 Service Integration and Portal Development	15
4.7 R&D	15
5. Projects	17
6. Status of the 2019 Recommendations from the CDS Scientific Council	21

1. Introduction

The past year has been a very busy one for CDS. The core operations for the ingestion of data from publications have continued to process an increased volume of data compared to previous years. The CDS XML journal processing tools have been brought to an operational phase. New and updated versions of CDS science tools have been released, and the services continue to be very heavily used. In this period there has been an emphasis on interacting with the scientific users at community events. CDS has also been visible in the wider data sharing community in the context of promoting Open Science, and we have renewed the CDS membership of the World Data System (WDS) of the International Science Council (ISC). CDS has played a leading role in European projects and new projects have been proposed. The CDS R&D program has fostered new developments for the scientific interoperability of multi-wavelength, multi-messenger and time domain data, with the strategy of preparing for the future based on scientific needs. CDS has however been strongly affected, like everyone, by the global COVID-19 pandemic.

The period since early March 2020 has involved many challenges because of the conditions and uncertainty caused by the pandemic. CDS activities have continued throughout this unusual period and much effort has gone into ensuring the operational stability and continuity of the CDS services. The CDS disaster recovery plan was activated and was adapted to take into account the need to manage the systems remotely. The ObAS IT services very quickly implemented new video and chat communication tools which have been indispensable for maintaining contact within the team and to facilitate virtual meetings. The situation required a rapid transition to remote working and the adaptation of many of the processes. Fortunately *work from home* procedures and equipment were already in place for some staff members, and the CDS scientists and engineers were already well equipped with laptops. Temporary portable computers were provided to those staff who needed them, and 11 new laptops were ordered. The timing however meant that some staff had sub-optimal equipment for up to 2-3 months before new laptops arrived.

Remote working was in place for 13 weeks from March until June 2020, followed by the summer period at ~50% level. There was a return to on-site working in September 2020 (with social distancing precautions), and then a second period of confinement commenced on 30 October 2020 which is expected to continue until at least early December 2020. The overall CDS operations have been unavoidably less efficient because of the changed working conditions and because of the diverse ways the situation has impacted the CDS staff and their families. Some specific impacts are described in the CDS service reports. The high level of dedication of the staff, and their efforts to adapt to the constantly evolving situation, have enabled the continuation of CDS services and important progress has been made in many areas. This report for the CDS Scientific Council focuses on the achievements of the period, and the ongoing adaptations that are still being made under the continuing conditions.

In terms of changes in the CDS staff, we are extremely pleased that a CNRS competition was opened in 2020 for a documentalist position, and that E. Collas was successful in her application, becoming a permanent documentalist. We also announce that G. Mantelet has been engaged on a continuing contract (CDI) starting January 2021. We thank CNRS-INSU, UNISTRA and the Scientific Council for their support that helped lead to these outcomes.

The CDS computing infrastructure has involved a number of regular upgrades and maintenance. The stability of the ObAS server room cooling system has been improved by a new maintenance service provider, and functioned well during another hot summer. The planned move of some servers to the UNISTRA Data Centre has been delayed, but is expected to take place in 2021.

In this report we present the highlights of the 2019-2020 period in Section 2. The CDS strategy is outlined in Section 3. The activities of the CDS services are in Section 4, and Projects in Section 5. Section 6 provides updates and responses about the issues identified in the 2019 recommendations of the CDS Scientific Council.

2. Highlights 2019-2020

VizieR 20000 Catalogue Milestone

The CDS VizieR service passed the milestone of 20000 catalogues in July 2020!

Aladin Desktop v11 release

A major version of Aladin Desktop, v11, was released in April 2020. It includes new features for:

- Improved support for temporal data (time plots with linked views, a time controller function, and time-coverage capabilities with the hierarchical time coverage system called TMOC).
- An advanced version of the Discovery Tree, allowing easy access and filtering of more than 20,000 data collections.
- Various improvements related to Virtual Observatory standards: VOTable 1.4, TAP 1.1, MOC 1.1, Data Link support, support of ADQL JOIN for TAP queries.
- Support of FITS images internal compression methods.
- Support of the hierarchical HEALPix map format used by the gravitational wave community.

Aladin Lite projection onto the Globe de Coronelli

A local highlight toward societal impact is the use of CDS services in the display of the newly renovated Coronelli Globe at the Observatoire de Strasbourg (Figure 1). The 0.8m globe was restored in a project led by the ObAS Director and done with the Jardin de Sciences. CDS tools have been used to map a full scan of the globe into the HiPS system, and the exhibit integrates a projection of an interactive Aladin Lite interface onto the enclosure of the globe, making for a spectacular visualisation of both the scanned globe and real data from CDS services.



Figure 1. - Projection of Aladin Lite onto the Coronelli Globe

2.1 Highlights of CDS in the Community

The CDS has actively participated in many astronomy community events where we have interacted with researchers, partners, journals/publishers, other data centres, observatories, missions and projects. One of the highlights was a dedicated CDS Lunch Session at the European Astronomical Society meeting (July 2020) following a successful proposal to the EAS to host the session. Presentations were made on SIMBAD, VizieR and the use of CDS services via python notebooks. We also continued the Vizier campaign called “*Make your data visible*” which provides information to researchers on how to describe their data for ingestion into VizieR. Other highlight events are listed below:

Astronomical Data Analysis Software and Systems (ADASS) Conference, Groningen, The Netherlands, 6-10 October 2019

CDS booth in exhibit hall (see the CDS-ADASS document for CDS contributions).

Interaction with astronomy data community.

IVOA Interoperability Meeting, Groningen, The Netherlands, 11-13 October 2019

(see the CDS-IVOA document for CDS contributions).

ESA/ESO SCIOPS multi-messenger meeting, ESAC Madrid, Spain, 19-22 November 2019

Addressing common challenges for FAIR data in astronomy (M. Allen).

American Astronomical Society (AAS) meeting, Honolulu, USA, 4-8 January 2020

CDS booth in the exhibit hall, interaction with AAS journals (M. Allen, E. Perret, A. Oberto, A. Nebot).

The 5th Scientific Writing for Young Astronomers, Kunming, China, 6-10 January 2020

Lectures/tutorials on *From your paper to VizieR and SIMBAD* (L. Cambrésy).

Kavli-IAU Workshop: International co-ordination of multi-messenger transient observations in the 2020s and beyond. Cape Town, South Africa, 3-7 February 2020

Role of the IVOA presentation (A. Nebot).

IVOA Interoperability Meeting, on-line, 4-8 May 2020

(see the CDS-IVOA document for CDS contributions).

Highlighted events in the French community:

UNISTRA Open Access Week, Strasbourg, 21 October 2019

Invited lecture on the Centre de Données astronomiques de Strasbourg (M. Allen)

Workshop for the INSU prospective challenge 14 “Open Access to Scientific Data”

/ Atelier prospective INSU défi 14, “Accès Ouvert aux Données Scientifiques”, 20-21 January 2020

Contributions to INSU prospective from CDS members. C. Bot co-led the workshop and led the writing of the conclusions.

Action Spécifique Observatoire Virtuel (ASOV) annual meeting, Paris 10-11 March 2020

Another special event was the visit of A&A and EDP to CDS, on 6 March 2020 for a dedicated meeting on improving the processes for the treatment of information/data from the A&A journal.

Communication were also done via our social media channels Facebook (@CDSportal) and Twitter (@CdSportal).

(Unfortunately the LISA conference was postponed. This conference is usually held every 3 years, and was highly anticipated as a venue for sharing data stewardship experience, where CDS documentalists work can be highlighted and shared. We also miss the contact with major journals and publishers as important in-person meetings would have been held at this conference. The conference is now planned to be held in June 2021 in London or on-line.)

3. CDS Strategy

The CDS strategy is constantly evolving based on the changing scientific and technical needs for reference data services, and the evolution of astronomy research. In 2020 the strategy was necessarily focused on the immediate issues of dealing with the unusual situation, and changing the modes of working. The main elements of the future strategy are however well established for the core CDS services, and much effort has been made in the past year to follow and participate in the national and European activities that define the wider policy landscape. Data sharing, Open Science and the FAIR principles are very prominent topics and high-level important changes are being driven at national and European levels that are directly relevant to the role of CDS, and for future developments and opportunities. The main elements of the strategy, updated with key concepts from the recent national and European policy developments is as follows:

The main strategy of CDS in the coming period is to continue its mission at the highest level as an astronomy reference data centre that serves needs of the international astronomy community. In-line with national and European priorities, the CDS mission will be carried out in the spirit of Open Science and with the application of FAIR principles. CDS will continue to develop its leadership role on added-value services, tools and interoperability to enable scientific progress.

The CDS is science-driven with strategic planning that adapts to the changing reference service needs of astronomy research. Astronomy has made a transition into a Big Data science characterised by large all sky surveys and inter-connected use of multi-wavelength astronomy data. The era of time-domain and multi-messenger astronomy has begun, and the way astronomers will use data and services is rapidly moving toward science analysis platform architectures where the computing is brought close to the data.

The proposed themes for the CDS strategy in 2022-2027 are: **i)** Reinforcement of the CDS core mission and role as a trusted reference data centre, **ii)** Enabling science with the CDS services, supporting specific scientific projects, direct support of astronomers, and development of the CDS science team, **iii)** Engagement with the astronomy community to ensure relevance of CDS services, and integration of the CDS in the French, European and international infrastructures of astronomy, **iv)** Adaptation and innovation of the CDS services to meet the challenges of the increasing volume of data, and to define a path for the sustainable technical evolution of the overall technical framework of the CDS, **v)** Building on the success of the CDS by maintaining specialised staff profiles and scientific-technical work environment that fosters innovative solutions and teamwork.

The specific policy developments that influence the CDS plans include: the French national prospective exercise of “Astronomy and Astrophysics” and the prospective exercise of CNRS-INSU (both to be published in 2021); the Astronet roadmap (being updated in 2020-2021), the French National Plan for Open Science¹. In terms of Open Science at the European level the relevant developments are outlined in the EOSC Partnership Proposal² and the current Strategic Research and Innovation Agenda for EOSC (v0.8)³.

The CDS strategic plan is presented on a 5 yearly basis to the HCERES (*Haut conseil de l'évaluation de la recherche et de l'enseignement supérieur*) evaluation campaigns as part of the documents that are prepared by the Observatoire Astronomique de Strasbourg. This was done in 2016-17, and the preparation for the next campaign is starting now, with submission of documents expected to be required in 2021. An early draft of specific text for the 2023-27 strategic plan is being prepared and will likely need to be finalised mid-2021.

¹ <https://www.ouvrirlascience.fr/the-national-plan-for-open-science/>

² https://ec.europa.eu/info/sites/info/files/research_and_innovation/funding/documents/ec_rtd_he-partnership-open-science-cloud-eosc.pdf

³ <https://www.eoscsecretariat.eu/sites/default/files/eosc-sria-v08.pdf>

4. Activity Report for CDS Services 2019-2020

4.1 CDS Information System and Service Monitoring

A detailed report of the status and evolution of the CDS information system was provided in last year's report showing the overall information flow in the CDS processes from data ingestion through to the data access mechanisms used in the public facing services. The global view of the system helps us identify areas for simplification and homogenisation. Progress was reported in 2019 about the rationalisation of the collection of the statistics of the usage of the various CDS services.

Main Services →	SIMBAD	VizieR	Aladin	Total (main services)
users / month	178k (+31%)	33k (+6%)	82k (+22%)	>178k
queries / day	736k (+61%)	520k (-26%)	603k (-29%)	1.9M
load / day	8.0 GB		57 GB	>65 GB
data volume	24 GB	46 TB	369 TB	415 TB
data content	11.5 M obj. (+9%)	20.2k cats (+13%)	869 HiPS (+47%)	
reliability	99.63 %	99.77 %	99,87 %	> 99.63%

Table 1. CDS statistics 2019-2020

The overall statistics for the main services are shown in Table 1. These show that the CDS services continue to be heavily used by the community. The total number of queries per day has risen to almost 2 million (compared to 1.75M in 2018-19), and the number of users has also risen for each service. We find that the average number of queries per day over a year can fluctuate a lot depending on whether large peaks of activity have occurred, or if large synchronisations are done by other data centres. An analysis of the fluctuations is included below. The reliability of the services is at a very high level.

During 2020, we completed the deployment of a global solution for monitoring that takes into account the activity, audience, content and reliability of the various components of the CDS services, including the services at mirror sites. This represents some fifteen measurement agents collecting information on a daily basis, and integrating and aggregating it in a dashboard accessible to CDS staff. This new dashboard (see Figure 2) enables us to monitor the day-to-day activity of our services, and its use helps us to have a more detailed understanding of changes in usage, and to be in a position to make the right strategic choices necessary for the development of the CDS over the medium and long term.

The dashboard provides a summary view of key figures for each service. Several elements emerge from an interpretation of the results :

- The growth of our services continues to be strong, both in terms of audience and activity. This has been a fundamental trend for many years.
- Our users have very diverse profiles: professional astronomers, amateur astronomers, partner institutes and data centres, as well as education audiences and the general public. The audience who are using the CDS services can comprise up to 60% of IP addresses

from tools such as Stellarium, which we interpret as a large public audience via individuals and planetaria (these queries although numerous are fortunately relatively light in terms of load on our servers). A large fraction of the activity (80%) is generated by third party tools from our institutional partners (e.g. synchronisation of HiPS, weekly ADS/NASA ingests of part of the SIMBAD content, etc...), and from dedicated libraries (astroquery, TOPCAT, ...). The portion of activity of users accessing our services via their browser (end of the chain) now represents only a small part of our activity.



Figure 2 - A snapshot of part of the Dashboard for monitoring CDS services.

- The "Planetarium" use of our services is growing strongly (for example Stellarium that makes use of SIMBAD and Aladin). We expect that it will increase further in the coming years with the deployment this year of The World Wide Telescope (WWT, which was originally a Microsoft Research project but now owned by AAS), and Digistar7 (Planetarium software by Evans & Sutherland) both now supporting the HiPS format for which CDS is the main worldwide provider (75% of the load provided by CDS).
- We interpret the activity statistics as being dominated by two modes: "regular continuous use", and "peaks" which are linked to specific actions. The ratio of "Peak" to "Background" use differs between the CDS services. Aladin is subject to the biggest peaks of activity, but at a low frequency (1 to 2 times a year) linked with periods of data synchronisation with our partner HiPS sites. VizieR has to manage a few large "peaks" per semester, often associated with the availability of a new catalogue (for example Gaia), or with a particular project or mission that requires VizieR data. The SIMBAD service statistics show very high continuous use and this drowns out many of the "peaks". (See Figure 3)
- The quality of our services, measured in up-time, continues to be very high (>99.66%). This excellent figure is mainly due to the strong redundancy policy implemented for many years [double machine room as far as possible, redundancy of IT equipment (network and machines) and technical equipment (electricity, cooling), numerous mirror sites managed by CDS or by our partners].

Another action was initiated this year to begin simplifying and homogenizing the various components of the CDS Information System. We are well aware that this is a very long-term project. We started with SIMBAD as a simplification of the interface, and associated elements is ongoing.

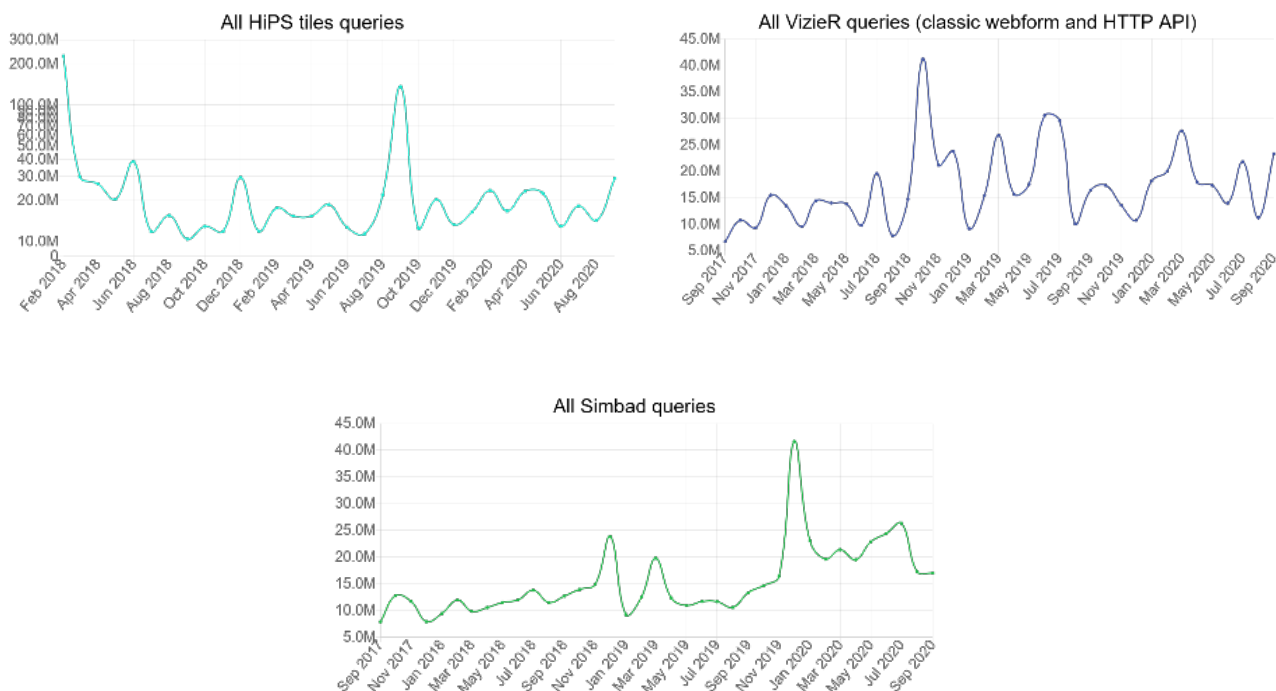


Figure 3 - Activity statistics for Aladin, VizieR and SIMBAD (queries/month)

Other important developments for the processing of journal articles have been brought into an operational phase in 2019-20. The XML processing of the journals is now active, and the DJIN tool has been renewed and is operational as described in the SIMBAD section 4.2. There have also been improvements in the internal tools for monitoring and organising the flow of incoming references.

The lockdown time has also been used to pursue some different activities and to be innovative under the unusual work conditions. For example we have taken advantage of the info-graphics skills in the team (in particular C. Halter, *CDS Secretary*) to help with new documentation materials (as mentioned in Section 4.2) for external and internal audiences. The examples of the new X-Match service logo, and the logo for the internal “Bibliography Centre Supervisor” are shown in Figure 3b.



Figure 3b. - New logos for the CDS X-Match service and the internal “Bibliography Center Supervisor”

4.2 SIMBAD

SIMBAD now contains 11.5 million astronomical objects, 36.6 million identifiers, and 381,000 bibliographic references. The number of references per year processed by SIMBAD is shown in Figure 4 with the references from main journals (A&A, AAS, MNRAS) and other journals shown separately. In 2019 there has been a significant increase in the number of references to over 14000 but this is largely due to an increase in the GCN circulars. The main journal references have increased by ~400 and we note many papers related to Gaia DR2. GCN circulars are processed as references, and these have increased by ~1600 in 2019. The final number of new references for 2020 is expected to be similar to 2019.

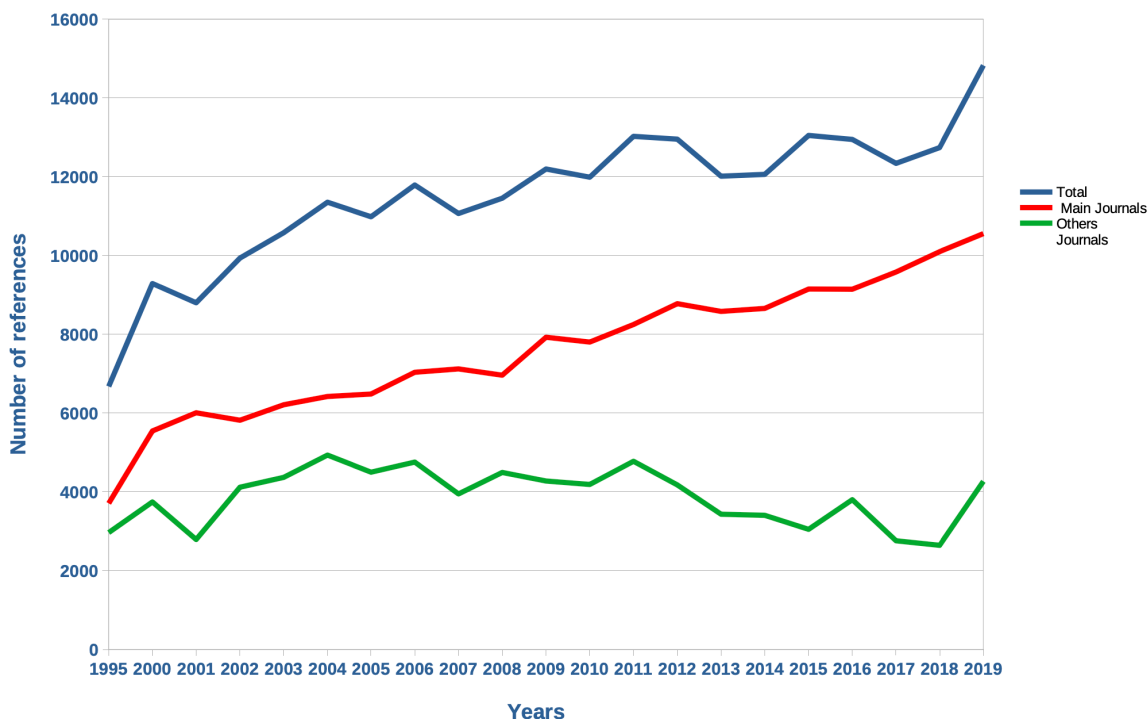


Figure 4 - Number of reference processed by SIMBAD 1995-2019

In the last years the number of new astronomical objects in SIMBAD has increased at the rate of ~1 million per year on average over the last 5 years. This is due to the release and ingestion of major surveys and catalogues. The number of documentalists working with the software DJIN to identify objects listed in the text, figures, and small tables did not change, but the increased volume means that this should be addressed. The documentalists in charge of ingesting tables of objects into SIMBAD with the COSIM software has however recently benefited from the recruitment of E. Collas, and also the return of M. Buga in September 2020 following a one-year leave.

Facing the lock down

The SIMBAD documentalists made an amazing work, maintaining the same level of ingesting references and tables of objects as in usual operations. The COSIM processing of tables of objects for SIMBAD ingested 590 tables of objects in 2019, and in September 2020 there are already 465 tables which have been processed, and at this rate we expect that there will not be any backlog at the end of the year. However, the lockdown had an impact on the appraisal step of the process which identifies and prioritises the tables of objects to be ingested in SIMBAD. The appraisal has been slowed down because we could maintain only one remote weekly meeting, instead of two, leading to a current backlog of about 100 references. Under the 2nd lockdown however, we manage to maintain 2 weekly appraisal meetings. Coupled with additional appraisal effort by an

astronomer we are confident that the present backlog will have been removed at the end of the year, reaching a similar level than in 2019 (845 references appraised).

The new DJIN

The new version of the DJIN software is being used in operations for most major journals. The restructuring of the processes and the creation of the new version has been a large effort involving the SIMBAD developers and the Documentalists. The underlying libraries for the treatment of references will also go beyond the DJIN tool and will be of future benefit also to Vizier. Additional improvements will continue to be made, especially to ingest some small journals.

The new list of object types

The re-organised list of astronomical objects types available in SIMBAD is finalised and available to the whole team internally on the CDS collaborative twiki. The new compatibilities and hierarchies have been implemented in a test version of the software COSIM. Tests until now are very positive. The warnings displayed by COSIM due to incompatible objects types are, as expected, much less frequent, leaving only the ones that require scientific expertise. It improves both the efficiency of the processing and the quality of the scientific content. All the documentalists of the COSIM team will soon use this new version. The re-organised list of object types still has to be implemented in other parts of SIMBAD software to finalise everything. Then the new list and new hierarchies will become publicly available.

Informing the users on the processing of journal articles

A new document⁴ on “How we process your article at CDS”, and “The status of a paper in SIMBAD”, has been made public that explains the status of the processing of journal articles at CDS (Figure 5). This document is designed to help answer the questions that are frequently asked by authors, such as “Why are my objects not in SIMBAD yet?” We also hope that by making the statuses more clear, we will enhance understanding in the community that the CDS processing is not automatic but requires multiple steps and checks to maintain the quality of the information and service.

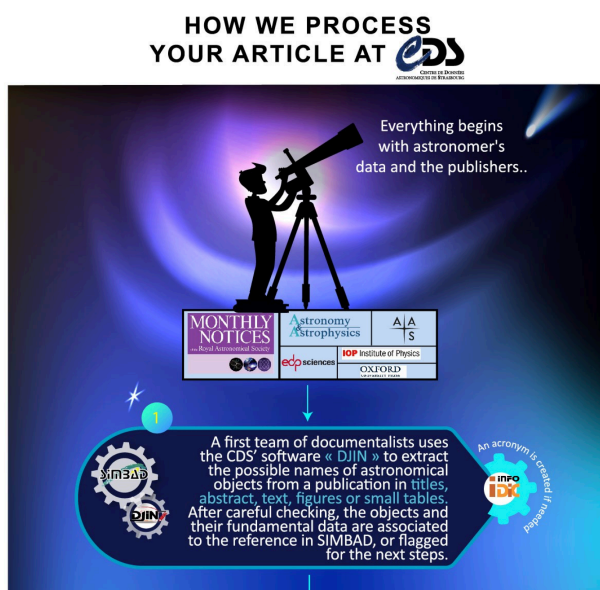


Figure 5 - Part of the new promotional material explaining to authors how journal articles are processed at CDS.

⁴ <http://simbad.u-strasbg.fr/Files/Status.pdf>

4.3 VizieR

VizieR content

The VizieR team has been able, after an adjustment period, to perform most, but not all, of its activities under remote working conditions. The standard VizieR treatment of catalogues has resumed smooth operation, as can be seen by the growth of VizieR content (Table 2) reaching >20000 catalogues as described in the highlights.

	2015	2016	2017	2018	2019	2020
Number of Catalogues	14 065	15 485	16 528	17 673	19189	~20300

Table 2 - VizieR content 2015-2020 (catalogues)

The lockdowns have however impacted the service in some specific areas:

- It has made the training of our newest contractor Coralie Fix (hired in September 2019, trained by E. Perret) more challenging because remote interaction is less efficient for explaining the tools and the process of VizieR ingestion than in person. However, Coralie has now processed more than 100 catalogues, and is now operating more autonomously.
- The weekly VizieR meetings are now held 100% on-line.
- The “Associated data crunch sessions” dedicated to the ingestion of associated data are usually done in person to benefit from each other’s feedback and experience for this relatively new service and process. With such meetings now impossible to organise in-person, these sessions have been suspended.

Very large versus long versus thick catalogs

Giacomo Monari has now been part of the team for a year (since October 2019), and has been responsible of the scientific validation of VizieR content, with an emphasis on surveys enabling galactic archeology, i.e. surveys providing precise astrometry, distances, chemical abundances, for stars and objects of the Milky Way. He is also the main scientific supervisor of the large catalogues section of VizieR. Under his supervision, and in collaboration with engineers F-X. Pineau and T. Boch and the documentalists, 9 large catalogues have been ingested, including the first data release of the Dark Energy Survey, unWISE, catWISE, and ESO phase 3 catalogues such as VVV VIRAC PM DR4.1, and a selection of them has been fed into the X-Match service. The large catalogue team has started working on the preparation of the Gaia EDR3, planned for release on the 3 December 2020. Ingestion of subsequent versions of ESO Phase 3 catalogs and GPS1+ is also planned in 2021.

Some other large catalogs are unfortunately on standby, and in some cases this is due to difficulties in obtaining the data. For example the Pan-STARRS data is a case where MAST (who host the data) have helped us for the DR1 release by assisting the preparation and download of the data to CDS, have not however been as responsive to our requests for the DR2. Problems with the release have been indicated by MAST who suggested that we should wait. It highlights that communications can be improved in this case.

The future of TAPVizieR

For TAPVizieR, the database technology we use is reaching its limit with the largest catalogues, and we identify the need to plan for the next development to support TAPVizieR. This will need to be coordinated with the overall CDS approach for very large data sets and in particular the specialised large catalogue infrastructure that is managed at CDS. We have made important decisions in the past years to host the largest data sets (Gaia, Pan-STARRS etc.) and have succeeded very well in doing so. The next generation of data sets will require another step-up in scale and this is challenging to the current size of the CDS infrastructure. The next generation of data will come on the timescale of ~5 years, although Gaia DR4 (2022) will already present challenges depending on which part of the data we decide to ingest at CDS. Part of the CDS strategy has been to foster high levels of interoperability (via IVOA standards) so that content stored elsewhere can also be made usable alongside data from CDS (e.g. the hierarchical approach of HiPS network), but there is a strong preference to maintain the reference data under the control of CDS servers. CDS does have the space to grow with the UNISTRA data centre and relations with other regional or national data centres could be established to address this issue. One of the key questions is what is the reference data that should be at CDS, and how do we need to scale the CDS to meet the needs.

Priorities in VizieR

In order to keep the incoming number of references to a manageable level given our resources, we have decided to implement a stronger prioritisation of the datasets considered for publication in VizieR. We prioritise observational data over simulated data, and sky data over laboratory data, because they benefit more from the homogenisation process. Low priority catalogues will be, for instance, atomic line lists, models of supernova yields, models of stellar populations isochrones, computations of particle reaction rates, etc. For the catalogues from A&A papers we have had a dedicated meeting where these priorities have been discussed and agreed. To monitor more closely the flow of catalogues from A&A a dashboard has been made available to A&A editors as well to allow them to track the number of references sent to CDS for ingestion each month, trying to stay below a limit of 40 refs/month and a total of 450 refs/yr.

VizieR usage

In terms of use of the service there was an average of 520 000 queries/day in 2019-20 (see Table 3). There were not as many large peaks as in 2018-19 as mentioned in Section 4.1. We do however expect large peaks in late 2020 and in 2021 with the imminent release of Gaia EDR3.

	2015*	2016	2017	2018	2019	2020
Web Service Queries/day	300 000	380 000	326 000	368 000	696 000	520 000
Associated Data Service Queries/day			270	80	543/150	845
VizieR TAP service Queries/day			5 250	3 700	2094	14 000

Table 3 - VizieR usage 2015-2020 (queries/day)

VizieR Associated Data Service

In 2016 VizieR opened a major new feature, the VizieR Associated Data Service for non-tabular data (e.g. spectra, images). This service includes an ingestion pipeline and the metadata mappings that are necessary to take into account the description of spectral, time-series and image data. Authors may provide these data, and the ingestion process (supervised by documentalists and engineers) maps the description to the standard IVOA ObsCore data model. These data are discoverable through a web interface, and also through IVOA protocols.

In 2020, the service received an average of 845 queries/day, an increase compared to last year. An important communication effort was undertaken as part of the EAS 2020 CDS Lunch Session event, dedicated to CDS tools, including VizieR. Although authors are able to document their data through the improved user interface for data submission, it is still unclear how to distribute this added workload on the service, and we are able to ingest only a fraction of the incoming catalogues having associated data.

Digital Object Identifiers

Since 2019, the VizieR ingestion pipeline routinely includes the DOI of articles published in A&A, and DOI for the catalogs are created, pointing to the catalog's landing page. This year, we have reached an agreement with AAS to extend this framework to their publications, and have yet to seek an agreement with MNRAS. A specific action was planned following suggestion made at the 2019 Scientific Council meeting to create a DOI for GAIA DR2 but this is again in standby, as we are waiting confirmation from ESA for us to proceed.

Textual search engine

The new textual search engine is now in production in the main VizieR query page. This new search uses the Open Source Elasticsearch and extends the current VizieR search capability. Based on a syntax and grammar close to that used by our partner ADS (in their service web interface). It enables the easy formulation of multi-criterion queries to discover catalogs, such as: "first_author:Bai year:2019", and other keywords such as ORCID/DOI, words contained in the abstract, etc. using keywords, wildcards and fuzzy-search.

Time domain

Metadata for the time columns are now routinely created in VizieR by the documentalists. As a result, it is possible to compute the epoch of observations in the reference time system used by VizieR, i.e. TCB/Barycenter. This output is now available in the VizieR web interface under the "compute" menu, as well as in the temporal SED tool.

Catalog Submission Interface

The catalog submission interface (also allowing to upload associated data) was reworked to improve user experience and ergonomics.

Workflow

On the documentalist's side of the workflow, a new tool is in development, which uses column information from the author-submitted README files to guess the column nature and to auto-fill the README following VizieR conventions, thereby speeding up the documentation process. The time gained there will allow the documentalists to reach a better understanding of the data, leading to higher quality metadata and display of the catalogue.

There is also ongoing work on the *Unified Content Descriptor 1+* builder, involving a CDS contractor (Louis Demange), to improve the automatic best-guess of which UCDs should be used based on information in the Readme file.

Mirrors

The China mirror of VizieR is currently experiencing a problem of incompleteness due to difficulties in transferring data, but the contacts are responsive and this is being addressed. The Cambridge mirror is offline due to the lack of a clearly identified contact point in Cambridge which needs to be followed-up.

4.4 CDS X-Match

The X-Match service continues to operate smoothly with the current hardware and software. The number of queries per day has dramatically increased in 2020 (+100% with respect to 2019). This is however to be put in perspective by the fact that in addition to the constant usage coming from various users (>700 IPs/month), the service records bursts of activity coming from a few distinct places. For 2020-21 we expect a new burst of activity with the publication of Gaia EDR3 in December 2020.

The X-Match service has been first made available for the community almost 10 years ago, and we are actively preparing the next version. At the ADASS 2019 conference we presented a prototype that dramatically improves the computation time. We have also been working on developments which are common between large catalogues (and their ingestion pipeline) and the cross-match service. The main ones are:

- A framework to easily support multiple file formats (Custom, FITS, VOTable, CSV, ..) at high speed (>500 MB/s with multi-threading) with text formatting and the possibility to compress information in a CDS custom format.
- An expression evaluation library to have SQL like functionalities, such as column selection and on-the-fly generation of new columns (\Leftarrow SQL SELECT) or row filtering (\Leftarrow SQL WHERE). We also updated the HEALPix library to better support catalogue queries with various spatial constraints.

To improve the handling of large catalogues, we re-designed and developed a Binary Search Tree stored in a file. This is similar to a database column index. It allows us to index a column so that it can be used to search for a record from an identifier, or to search for all of the rows that have a magnitude in a given range of values. The new implementation is intended to improve both the execution speed and the memory consumption when searching large catalogues. It is also intended to be more robust and does not require a daemon running in background. These developments are also designed so that they can easily be made available through a Web service or python APIs.

4.5 Aladin

Aladin Desktop

As highlighted in Section 2, Aladin Desktop v11 was released in April 2020.

HiPS

The HiPS ecosystem keeps on growing. Statistics on the access for HiPS tiles are now at 603k queries/day and the number of users has increased by 22%. The number of HiPS data sets has also continued to increase steadily as shown in the Table 2 below. While the increase of volume may seem smaller, but was in large part due to the ingestion of PanSTARRS the previous year and this year was devoted to the ingestion of a larger number of smaller surveys in size, yet important for the diversity of the HiPS collection (e.g. Hyper Suprime-Cam, UnWISE, Dark Energy Survey, ...). The number and volume have already reached 902 and 370TB respectively in late 2020.

	2012	2013	2014	2015	2016	2017	2018	2019	2020
HiPS data sets	81	128	175	236	325	380	575	676	603
HiPS volume	19 TB	30 TB	45 TB	50 TB	105 TB	137 TB	203 TB	310 TB	359 TB

The popularity of HiPS is also steadily increasing as witnessed by the number of new partners producing more and more HiPS and publishing them on the HiPS network. Two new HiPS nodes were created this year: ASTRON and JVO. Our partnership with existing facilities like ESO has also continued and we note as an example the availability of public links to the progenitor images.

As a side effect of this success, to avoid redundancies and alternative data products (uncertainty maps, count maps) in the Aladin data tree, a scientific validation step has been introduced to select which HiPS will appear in the Aladin Data tree. HiPS which are not selected will appear in the folder "Others".

HiPS2FITS

The hips2fits service developed in 2019 allows for fast generation of FITS images cutouts of arbitrary size and projection for any published HiPS. Its usage is now firmly established with around 4000 queries/day on average (and highs at 100k queries/day). We continue to actively advertise hips2fits (e.g. at ADASS and in tutorials) to raise awareness of this very new type of cutout service. Additionally we have strongly encouraged HiPS providers (e.g. at IVOA) to maintain the FITS versions of their HiPS (alongside .png or .jpg) so that the full benefits of hips2fits for making cutouts of the real-data values can be realised. In addition a prototype IVOA SIA2 discovery service for hips2fits images generation has been made public recently.

Aladin Lite

A new major version (v3) of Aladin Lite is being developed. Taking advantage of WebGL and WebAssembly technologies, it will enable new projections (AITOFF, Mollweide, ...), support the display of FITS tiles, allow for visualisation of medium-sized catalogues (up to 1M rows), while keeping the same API for the developers and integrators. We expect this update to be public in 2021. As mentioned in the highlights, the historical Coronelli globe from the Observatory of Strasbourg, restored this year, includes a modern display with a virtual version of the globe that uses HiPS and Aladin Lite.

4.6 Service Integration and Portal Development

CDS Portal

The CDS portal⁵ is a simple entry point to the CDS services which is used as a demonstration platform at events such as the AAS, EWASS and ADASS meetings, and also as part of a number of tutorials on CDS services. The portal is also used to help guide our approach to the provision of services in science platforms, for example the prototype version of Aladin Lite is connected to the portal⁶. The use of the services (SIMBAD, VizieR, Aladin) via the portal is incorporated into the individual service statistics.

Python

Increasing CDS engagement in the Python ecosystem has continued. In the past year a highlight has been demonstrating access to CDS services via Python in a series of Astrobetter⁷ articles (by K. Lutz, *CDS Postdoc*), which include animations of various tasks from a Jupyter notebook.

- The CDS and Python I: Explore the Sky with ipyaladin
- The CDS and Python II : To cover or not to cover – MOCs to the rescue!
- The CDS and Python III: VizieR & X-Match – 20k catalogues and tables at your fingertips
- The CDS and Python IV: SIMBAD – the yellow pages of astronomical sources

4.7 R&D

We have pursued a varied R&D program with both operational actions and exploratory work to prepare the future. This work was carried out by CDS software engineers with the help of 12 interns and 2 short contracts. Engineers from the ObAS GALHECOS team and from the Observatory IT Support were also involved in some actions. It is also important to mention that in several cases, the expertise of astronomers and documentalists was also very helpful.

We continued through two internships the work around the query of the CDS services in Natural Language. The objectives were both to extend its functionalities and to improve the user experience. Tests with a panel of users were also done and are planned again. The improvement of voice interaction capability opens a new field of investigation for people with disabilities. It is a noble and motivating challenge and a pathfinder to apply it to the other services.

Linked to the IVOA, an intern started the development of a CDS own VOSpace (access and sharing of astronomical data files) framework.

An internship followed by a short contract resulted in the development of a semantic analysis tool for the improved description (IVOA UCD1+ standard) of tables.

An intern (second time at CDS) worked on extraction of Radio visibility metadata to enable the discovery of radio astronomy data sets with ObsTAP (in phase with the new IVOA Radio IG).

The Integration of large tables stored in CDS-binary format wrapped in PostgreSQL is under investigation during a long internship.

⁵ <http://cdsportal.u-strasbg.fr>

⁶ <https://cdsportal.u-strasbg.fr/webgl/> (compatible with Chrome browser)

⁷ <https://www.astrobetter.com>

A new internship was also dedicated to the continuation of the development of a WebGL 3D visualisation prototype for large datasets like simulations.

An internship (communication) conducted with the Observatory director produced a video editing of the Observatory and another about the Coronelli globe.

A second internship in communication produced a new website for Euro-VO.

An operational tool was also developed by an intern (hired also during a short contract) to produce statistics from the CDS services access - as shown in Section 4.1.

Study and implementation of a solution for the automated management of package updates on Linux servers and workstations were also supported by CDS and supervised by the IT Support engineers.

5. Projects

Virtual Observatory and related projects

IVOA

CDS continues to play a leading role in the development of the Virtual Observatory. The full list of contributions to the IVOA are listed in the document provided “CDS Participation in IVOA”, which has been updated with a list of the standards developed in 2019-2020, and the CDS contributions to the IVOA interoperability meetings in Groningen, Oct 2019 and the first on-line meeting held May 2020. We continue to acknowledge the long term collaboration of M. Louys (ICUBE) and L. Michel (ObAS) with CDS on the development of the VO. Their contributions to IVOA are included in the document.

CDS has made significant contributions to the leadership of the IVOA, in particular via various working group chair positions. F. Genova ended her long term role as the OV-France representative [2004-2020]. M. Allen finished his term as the Chair of the IVOA Executive Committee [May 2018 - Oct 2019] and ensured a smooth transition to the new chair (C. Cui from China-VO). A new Radio Astronomy Interest Group was formed in 2020 and F. Bonnarel is the Deputy Chair with these activities being strongly in-line with his role in the ESCAPE project and the recent emphasis on radio astronomy at CDS. These responsibilities are listed below:

- **Chair of the IVOA Executive Committee** - M. Allen [*Chair until end Oct 2019*]
- **Executive Board member for EuroVO**— M. Allen
- **Executive Board member for France** - F. Genova [*until May 2020*]
- **Chair of the Time Domain Interest Group** - A. Nebot
- **Chair of the Data Curation and Preservation Interest Group** - A. Schaaff
- **Deputy Chair of the Radio Astronomy Interest Group** - F. Bonnarel
- **Deputy Chair of the Education Interest Group** - H. Heintl (*CDS-ESCAPE Support Engineer*)

Papers about the IVOA meetings have been published in the ADASS proceedings (Allen et al. 2019⁸, and Allen et al. 2020⁹) on behalf of the IVOA Exec and Technical Coordination Group. Details of the European contributions are also described in the ESCAPE Milestone reports (see below).

ESCAPE

The **ESCAPE** (European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures) project started in February 2019. CDS leads one of the six work packages (WP4, ‘CEVO’) on *Connecting ESFRI projects to EOSC through VO framework*.

The main entry point for the work of WP4 ‘CEVO’ is the wiki pages¹⁰. The CEVO objectives are focused on making the seamless connection of ESFRI and other astronomy research infrastructures to the EOSC through the Virtual Observatory framework. The project plan is structured into three main tasks: “**4.1** Integration of astronomy VO data and services into the EOSC”, “**4.2** Implementation of FAIR principles for ESFRI data through the Virtual Observatory”,

⁸ <https://ui.adsabs.harvard.edu/abs/2019ASPC..523..729A/abstract>

⁹ <https://ui.adsabs.harvard.edu/abs/2019arXiv191201481A/abstract>

¹⁰ https://wiki.escape2020.de/index.php/WP4_-_CEVO

and “**4.3 Adding value to trusted content in astronomy archives**”. There are approximately 40 people in 16 partners working in WP4 (total 348 PM over 48 months), and there are many cross-WP activities within the very large ESCAPE project. The wiki pages provide links to all the WP4 events and documents. All of the activities are progressing with Milestones and Deliverables submitted on time, with the exception of the deliverable associated with a first training event which was postponed because of the covid-19 situation.

A number of contractors are working on ESCAPE at CDS. M. Baumann is a software developer working on interoperability and visualisation aspects, in particular the WebGL version of Aladin Lite and mocpy. A CDS-ESCAPE support engineer (H. Heini) was hired in March 2020 to provide technical support to the running of the Work Package, and also contributing his VO expertise to training events. K. Lutz has made important contributions following her work in the earlier ASTERICS project. An ESCAPE postdoc has been recruited to start in March 2021.

The main WP4 activities in 2019-20 have been:

- **2nd WP4 Milestone** - Progress and Priorities at IVOA - *reported November 2019*.
- CTA and KM3NeT Provenance Meeting - Strasbourg, November 2019.
- EGO-Virgo partner visit to CDS - 26 January - 14 February 2020.
- **WP4 Technology Forum, Strasbourg 4-6 February 2020**
- ESCAPE Progress meeting, Brussels, 26-27 February 2020
- **D4.2** Intermediate Analysis Report on Use of IVOA Standards for FAIR ESFRI and Community Data - *Delivered March 2020*
- **3rd WP4 Milestone** - - Progress and Priorities at IVOA - *reported June 2020*
- Provenance Workshop - on-line, 7-8 September 2020

The project is coming up for the review of the first reporting period on 27 November 2020. The project activated ‘Article 51’ of the grant agreement in response to the COVID-19 pandemic, and a number of deliverables and milestones have been re-scheduled to take into account delays, and the project now has a 6-month no-cost extension so that the end date is now January 2023.

EOSC

The ESCAPE project is being done in the context of building the EOSC and brings CDS into contact with various projects connected with EOSC. The FAIRsFAIR project¹¹ is one of the important projects for EOSC that is “*Fostering Fair Data Practices in Europe*” and “*aims to supply practical solutions for the use of the FAIR data principles throughout the research data life cycle*”. M. Allen often represents ESCAPE in FAIRsFAIR events, and was selected as one of the FAIRsFAIR European Group of FAIR Champions (EGFC). F. Genova is on the High Level Advisory Committee for this project.

F. Genova is the vice-chair of the FAIR Working Group of the EOSC Executive Board¹², which is publishing a series of reports on different aspects of FAIR in EOSC, including “*Six Recommendations for Implementation of FAIR Practices*”¹³, and additional reports are in preparation about FAIR Metrics and Certification (led by F. Genova).

¹¹ <https://www.fairsfair.eu>

¹² <https://www.eoscsecretariat.eu/working-groups/fair-working-group>

¹³ <https://op.europa.eu/en/publication-detail/-/publication/4630fa57-1348-11eb-9a54-01aa75ed71a1/language-en/format-PDF/source-166584930>

European Project - EOSC-Future

CDS is part of a European Commission Horizon 2020 proposal called EOSC-Future which was submitted in the H2020-INFRAEOSC-03-2020 call. The proposal was led by the Technopolis Consulting Group Belgium and involves 34 partners comprising e-Infrastructure and research community partners over many scientific domains. From the proposal: “*EOSC Future integrates, consolidates, and connects e-infrastructures, research communities, and initiatives in EOSC to develop the EOSC-Core and EOSC-Exchange. EOSC Future will expand the EOSC ecosystem, integrate existing but disparate initiatives, and hand over key project outputs to the EOSC Association. EOSC Future will unlock the potential of European research through a vision of Open Science for Society.*” This project involves 40 M€ of funding, with CDS being a small partner (20 PM) for involvement in test science cases and training activities to enable community use of open science resources. The project has passed the first stage of the review but the details required some revisions and the outcome will be known in late 2020.

EuroPlanet Project / EuroPlanet Research Infrastructure 2020-2024

CDS is participating in the **Europlanet 2024 Research Infrastructure (EPN-2024-RI)** which started in February 2020. This is a large project (~10 M€) with 56 partners in both industrial and academic sectors. CDS has a minor participation (~3 PM, 20k€) to work on the VESPA activities for interoperability of planetary science data. The CDS effort in this project will be spread over the duration of the project as needed.

AENEAS

CDS was a minor, yet active, partner in the AENEAS¹⁴ (Advanced European Network of E-infrastructures for Astronomy with the SKA) project. AENEAS was a 3 year initiative funded by the Horizon 2020 program to pursue a design study for building European Regional Centres (ERC) for the challenging data of the Square Kilometre Array (SKA). The project concluded in December 2019. CDS was involved in WP5, which deals with data access and interfaces in the ERCs for the users. It aims at building upon existing Virtual Observatory (VO) experience and frameworks to provide interoperable access to scientists. All of the deliverables of the project are publicly available on the AENEAS web pages. The results of the project have been fed into the ESCAPE project activities, and connections made in the project have helped CDS relationships with SKA related institutes and projects. (e.g. M. Allen is now a member of the SKA Regional Centre (SRC) Science Archive Working Group.)

The Research Data Alliance

The CDS continued to be active in the Research Data Alliance (RDA). F. Genova had finished her second two-year term as co-chair of the RDA Technical Advisory Board (TAB) in November 2019 and remained a member for an additional year until mid-November 2020. She has been a member of the Governing Board of the project funded by the EC in support to the RDA from March 2018 to September 2020, RDA Europe 4.0. She leads the RDA France National Node in liaison with the *Direction de l'Information Scientifique et Technique* of the CNRS. The Node was established by the RDA Europe 4.0 project in March 2018. It is a remarkable success, with a very significant increase of the number of RDA members who work in France — a growth of more than 100% since March 2018 with high visibility in RDA. The support provided in 2019 to the RDA and its French chapter RDA France by the French Ministry of Higher Education, Research and Innovation (MESRI), in the framework of the National Plan for Open Science published in 2018, was continued in 2020. CNRS agrees to continue to host RDA France after the end of the RDA Europe 4.0 project.

¹⁴ <https://www.aeneas2020.eu>

Liaison with RDA is also one of the activities of the ESCAPE CEVO Work Package. The assessment of the FAIR practices of astronomy by CEVO (as a joint CDS-INAF activity) continued, with a contribution to the tests of the criteria for FAIR proposed by the RDA FAIR Data Maturity Model Working Group. It was very important to provide input to this WG, since the requirements of the astronomical community for Finding, Accessing, Interoperating and Reusing data are different from those of other communities, in particular those who have reproducibility as their overarching need. The Working Group published its recommendation¹⁵ in July 2020. The criteria described in the recommendation are reasonable, but the priorities assigned to them are more problematic with respect to astronomy practices, with for instance there is no "Essential" priority among the criteria for Interoperability, but this is essential for the discipline. There is a growing understanding that the RDA FAIR Data Maturity Model should be used as a toolbox, which fits well with our needs with respect to it. It is for instance the approach of the FAIR Working Group of the EOSC Executive Board to define criteria for FAIR data in EOSC. We will keep in touch with the RDA Working Group, which is now in Maintenance Mode, to continue to provide feedback.

XMM2ATHENA

CDS is a small but important part of the ObAS participation in a successful proposal in the Horizon 2020 call on SPACE-30-SCI-2020: Scientific data exploitation. The ObAS participation has been organised by the GALHECOS team. The project is designed to enhance and improve the data exploitation of the current European Space Agency mission XMM-Newton and notably the EPIC (European Photon Imaging Cameras) as well as the Optical Monitor (OM) and put into place the necessary software to exploit the future European Space Agency mission Athena. The CNRS/ObAS leads WP2 (Multi-wavelength/messenger counterparts) which makes full use of the CDS and its specialised knowledge in this area, as well as as members of the XMM-SSC and will advance algorithms designed in the framework of the former ARCHES project that they led. Ada Nebot will contribute to the project as part of her independent scientific research. The CDS involvement (~5 PM over 30 months) will be related to catalogue cross-matching (F.-X Pineau) with expected benefits for the main CDS X-Match efforts.

Radio astronomy interoperability

The past few years have involved a number of activities related to radio astronomy at CDS, and some of the results were visible in 2019-20. This includes the AENEAS project which successfully concluded in 2019, and the connection with radio astronomy partners (SKA, ALMA, JIVE, ASTRON) in the ESCAPE project. CDS helped create the IVOA Radio Astronomy Interest Group and F. Bonnarel became the Vice Chair. Two CDS postdocs (K. Lutz and Y. Stein) have helped the description of radio astronomy data in the CDS services. The SPECFIND 3.0 paper has been submitted to A&A with a corresponding VizieR catalogue with extra visualisation features (Stein et al. - *submitted 2020*). In the context of the ESCAPE project, we also experimented discovery and access strategies for radio interferometry visibility data based on VO protocols. This work has been initiated by an internship and presented in IVOA meetings, ESCAPE working meetings and published as a poster paper during virtual ADASS 2020 conference.

¹⁵ <https://www.rd-alliance.org/group/fair-data-maturity-model-wg/outcomes/fair-data-maturity-model-specification-and-guidelines-0>

6. Status of the 2019 Recommendations from the CDS Scientific Council

1. We are delighted that Mark Allen has applied to continue in another term as CDS Director. We strongly support his application. As a first action, we recommend an articulation of the development of CDS over the coming five years in the context of its service development and the developing international context of new large data sets, albeit with the uncertainties over ongoing negotiations with LSST, Euclid, SKA and other large data sources. Ideally this should also include a "plan de charge" showing the prediction of needs of FTE by each project over the years as well as the prediction of FTE expected (including future retirements).

Response:

This is addressed in Section 3 "CDS Strategy" and in the presentation that will be made during the meeting.

2. We recommend CDS continue their strategic thinking on the level of involvement and commitment to large proprietary survey projects, on a case by case basis, with a particular view to the creating and/or supplying the added value products in which CDS excels (such as, but not limited to, cross-matching).

Response:

CDS works best with public data as the CDS services make data freely and openly available in the full spirit of Open Science. At present CDS does not distribute any proprietary data and we do not currently have the systems to do so. Proprietary survey projects are however a reality and CDS involvement may be beneficial at earlier stages before the data are made public, allowing us to prepare for the public phase when the data may be ingested into CDS services.

3. We recommend that CDS continues its engagement in the development of the Virtual Observatory and its promotion at international and national level.

Response:

We thank the council for this recommendation which reinforces the CDS approach to contribute to the development of the Virtual Observatory framework. The contributions benefit the CDS services, the whole ecosystem of data services in astronomy, and the end users who benefit from VO services. At the national level this is done via the Observatoire Virtuel France (OVFrance) and VO activities are supported by the Action Spécifique Observatoire Virtuel (ASOV). CDS is strongly engaged in OVFrance and ASOV. At the European level OVFrance is a member of Euro-VO, and CDS participates in Euro-VO activities, in particular in the European projects involving Euro-VO partners, most recently ASTERICS and ESCAPE. CDS also hosts the Euro-VO web pages. At the international level CDS makes many contributions to the International Virtual Observatory Alliance (IVOA) including leadership roles (see the CDS-IVOA document for a list of all contributions). One of the most important current activities for CDS in IVOA is the standardisation of the Multi-Order Coverage (MOC 2.0) which includes time coverage - for the space-time indexing of astronomy data.

4. We recommend that new scientific staff positions are prioritised for having scientific interests that are aligned with areas in which CDS services will grow, for example (but not limited to) multimessenger astronomy or large spectroscopic surveys or large radio data sets etc.

Response:

CNAP scientific positions are recruited via national competitions, which are extremely competitive and in which the research and teaching aspects of applications are very important as well as the proposed service task. We provide here the (un-ranked) priorities for scientific service tasks at CDS, which are communicated formally to the CNAP committee.

- *Scientific support of SIMBAD*
- *Catalogue, spectral, data cube and multi-dimensional data expertise*
- *Radio and mm astronomy expertise for current and future very large data sets*
- *Astro-statistical and machine learning expertise (big catalogues and cross-id of astronomical sources)*

5. We recommend that CDS continues to aid the professional development of documentalists and, particularly for the fixed-term contract documentalists, mentors them into new roles.

Response:

All staff, including contractors, have access to and are encouraged to make use of the training courses made available via UNISTRA and CNRS. Recent examples are English courses, and other professional development topics.

6. We recommend that CDS continue to be mindful of the changing user base and their preferred communication channels, including the growing use by members of the science-inclined public

Response:

As outlined in the report the new dashboard monitoring of CDS services allows us to better identify the different users making use of the CDS services. This is in combination with activities in the astronomy community, and also public events that some CDS members contribute to such as Jardin de Science events, and public astronomy nights. In coordination with the Strasbourg planetarium, on the campus of UNISTRA, we have been in contact with the developers of planetarium software and projection systems, and this helps to understand this public community. Further developments are expected along these lines (ObAS/UNISTRA/Jardin de Science) as the new Strasbourg planetarium is being built.

7. We recommend that CDS consider interactions with the Zooniverse and other citizen science platforms to consider whether on a case by case basis there could be sources of authoritative data sets prior to publication in peer reviewed journals, or even without such publication.

Response:

We have not had time to follow up on this recommendation, apart from our awareness of the citizen science activities of the ESCAPE project.

8. *We recommend that the appointment of a replacement for Prof. Whitelock is mindful of the Council's demographic balance in all senses, including but not limited to gender, geography and expertise.*

Response:

A replacement has not yet been identified. This should be followed up with INSU.

9. *We recommend that all staff involved in line management and/or staff selection undergo the university training in equality and diversity, including awareness/mitigation of unconscious biases. This is simply to ensure CDS is in keeping with developments in best practice in the astronomical community worldwide.*

Response:

Two staff members (C. Bot, A. Nebot) had already participated in the UNISTRA training sessions on equality/diversity, specifically the "formation égalité professionnelle entre les femmes et les hommes niveau 2". C. Bot is also actively involved in a number of activities related to equality, namely she is the reference person for ObAS on equality for the CNRS delegation. In November 2020 two staff members (S. Lesteven, A. Schaafl, both involved in recruitment) have participated in a conference on unconscious bias ("les biais inconscients: un frein à l'excellence dans le monde universitaire") organised by UNISTRA.

10. *The CDS YouTube video tutorials are excellent and we suggest that these are also hosted from the CDS website for the benefit of those who find it difficult to access YouTube.*

Response:

An excellent suggestion. It has not yet been done and we need to decide how to host video content. It will be taken into account in web site renewal planned for 2021.

11. *In the interests of reducing our carbon footprint and our costs, the next meeting of this Council should be a virtual one. We note that this will require considerable effort all round to ensure effective participation from the CDS staff and full involvement in the discussions and decisions from the remote members of Council.*

Response:

The planning for this meeting has changed a number of times due to the changing remote-work/on-site conditions. The initial idea was to stream the meeting from the ObAS amphitheatre with CDS staff present on-site. The conditions in November 2020 require the meeting to be completely virtual with CDS members attending from their homes.