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TALARIA Statistics module: design and implementation

2025

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Our services and spaces are designed to focus on users and their needs. We exploit novel ICT technologies and mobile devices for creating innovative services for accessing and sharing knowledge among researchers, students and the public.
NILDE (Network for Inter-Library Document Exchange), is a web-based resource-sharing software for libraries and end-users. The next generation of NILDE software is named TALARIA, its source code is released under the GPL 3.0 open source license.
We have created this series of Project reports for librarians and software developers, with the dual purpose of documenting the software and training new librarians, making the services provided to end-users increasingly effective and professional.

Version	**Authors**	**Publication Date**
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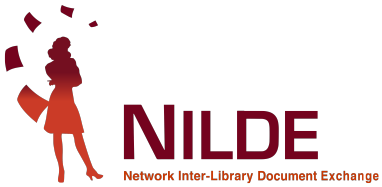
Abstract

This project report details the design and implementation of the TALARIA statistics module. It begins by defining the conceptual data schema and the logic for aggregating borrowing and lending statuses to simplify statistics management by end-users. The document then outlines the various statistics APIs created to calculate metrics such as request distribution, fill rate, turnaround time and geographical data. Finally, it illustrates the user interface designed to visualize these statistics through a series of graphs, charts and tables.



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1 Definition of conceptual data schema

TALARIA statistics are based on these conceptual data stored in the DB:

Table Libraries:

- ID
- Name
- `Country` => {ID, name, code}
- `Institution` => {ID, `Country`, `Institution Type` => {ID, name}}
- `Subject` => {ID, name}

Table References:

- ID
- Material type (article, book chapter, thesis, cartography/map, manuscript)
- Publication year
- Publication title
- OA link
- ACNP
- DOI
- ISBN
- ISSN
- ISSN_L
- PMID
- SBN DOC ID
- SID

Table Docdel:

- ID
- `Borrowing library`
- `Lending library`
- `Reference`
- Borrowing status
- **Aggregated borrowing status** - See Defining aggregated borrowing status
- Lending status
- **Aggregated lending status** - See Defining aggregated lending status
- Request date
- Fulfill date
- Fulfill type (Delivery Method)
- Not fulfill type (Reason Unfilled)
- Forward
- Trash type
- Orphaned
- Request PDF editorial
- Request special delivery
- Archived

1.1 Defining aggregated borrowing status

Note that all *italic* statuses are NOT to be shown to the public and they're just a way to understand the distribution.
`TRASHED` requests are all the requests that have `trash_type = 1`, meaning that the item sent does not satisfy the borrower (wrong PDF file, bad quality etc. . .)

ID	Aggregated status	Notes
0	New	`newRequest`
1	In progress	`requested` + `cancelRequested`
2	Received	`documentReady` + `fulfilled` - `TRASHED`
3	Not received	`notReceived`
4	Canceled	`canceled` + `canceledAccepted`
5	Reiterated	All the requests that have `forward = 1`
6	Not received but fulfilled by lender	`documentNotReady` + `TRASHED`
(7)	*Patron direct request*	*All patron requests that have been directly fulfilled*

1.2 Defining aggregated lending status

Note that all *italic* statuses are NOT to be shown to the public and they're just a way to understand the distribution.
`ORPHANED` requests are all the requests that have `orphaned = 1` but have `lending_status = requestReceived`. Since no lender has taken care of those, they should be sorted in *(0) New*.

ID	Aggregated status	Notes
(0)	*New*	`null` + `ORPHANED`
1	In progress	`requestReceived` + `willSupply` + `cancelRequested`
2	Received	`copyCompleted`
3	Not received	`unFilled`
4	Canceled	`canceledAccepted`
~~5~~	~~Reiterated~~	*Does NOT exist for lender*[1]
(6)	*Archived as Not Received*	`null`
(7)	*Patron direct request*	*All patron requests that have been directly fulfilled*

2 Real case scenarios

In this chapter we analyze the sorting provided from the aggregations defined in subsection 1.1 and subsection 1.2 in some real case scenarios.

1. **Successful request**: The borrower makes a request to a specific lender that fulfills it. The borrower then receives the correct item.

Agg. borrowing status	Agg. lending status
Received (2)	Fulfilled (2)

2. **Unsuccessful request**: The borrower makes a request to a specific lender that does not fulfill it. The borrower then proceeds to archive the request.

Agg. borrowing status	Agg. lending status
Not received (3)	Not fulfilled (3)

3. **Request in progress - NOT ORPHANED**: The borrower makes a request to a specific lender and is awaiting a response.

Agg. borrowing status	Agg. lending status
In progress (1)	In progress (1)

[1] Lender does not know if the borrower reiterates or trashes the fulfilled/unfilled request. Lender knows only if he fulfills the request or not (or cancels it).

4. **Request in progress - ORPHANED**: The borrower makes a request to ALL LIBRARIES and is awaiting a response.

Agg. borrowing status	Agg. lending status
In progress (1)	*New (0)*

5. **New request**: The borrower makes a new request and does not send it to anyone yet.

Agg. borrowing status	Agg. lending status
New (0)	*New (0)*

6. **Item not received**: The borrower makes a request to a specific lender. The lender fulfills the request but the file sent (via mail) has never arrived.

Agg. borrowing status	Agg. lending status
Not received but fulfilled by lender (6)	Fulfilled (2)

7. **Incorrect file (trashed)**: The borrower makes a request to a specific lender. The lender fulfills the request but the file sent (via SED) is incorrect. The borrower proceeds to trash the request.

Agg. borrowing status	Agg. lending status
Not received but fulfilled by lender (6)	Fulfilled (2)

8. **Archived as not received**: The borrower makes a request to a specific lender. The lender does not fulfill the request. The borrower reiterates the request and archives it as not received.

Req. no	Agg. borrowing status	Agg. lending status
1	Reiterated (5)	Not fulfilled (3)
2	Not received (3)	*Archived as not received (6)*

9. **Trashed request archived as not received**: The borrower makes a request to a specific lender. The lender fulfills the request but the file sent (via SED) is incorrect. The borrower then trashes the request, reiterates it and archives it as not received.

Req. no	Agg. borrowing status	Agg. lending status
1	Reiterated (5)	Fulfilled (2)
2	Not received (3)	*Archived as not received (6)*

3 Implemented statistics API

This chapter provides explanations of all the statistics APIs implemented in TALARIA.

3.1 Fill rate stats

This API calculates the borrowing fill rate of the requests by applying the following formula:

$$Fill\ Rate = \frac{Received}{Completed\ Requests}$$

`Received` requests are all those that have `aggregated_borrowing_status = Received`, while `Completed requests = Total not forwarded - (New + In progress + Canceled)`.
This API is accessible via the endpoint `/fillrate` and it accepts 2 optional parameters: `year` of the requests and `library_id` of the borrowing library or `institution_id` of the borrowing institution or `country_id` of the borrowing country.
This API returns an object containing several values:

```
{
    "total_borrowing": "(www+xxx)",
    "total_lending": "(yyy+zzz)",
    "borrowing_fill_rate": "(borrowing_fill_number/total_borrowing) *
     100",
    "borrowing_fill_number": "www",
    "borrowing_unfill_rate": "(borrowing_unfill_number/total_borrowing)
     * 100",
    "borrowing_unfill_number": "xxx",
    "lending_fill_rate": "(lending_fill_number/total_lending) * 100",
    "lending_fill_number": "yyy",
    "lending_unfill_rate": "(lending_unfill_number/total_lending) * 100"
     ,
    "lending_unfill_number": "zzz"
}
```

3.2 Requests distribution stats

This API gives information about the distribution of the requests, both borrowing and lending.
It is accessible via the endpoint `/requests-distribution` and it accepts 3 optional parameters: `year` of the requests, `material_type` of the references and `library_id` or `institution_id` or `country_id`.
This API returns an object containing multiple information:

```
{
    // Total number of borrowing requests
    "total_borrowing_requests": "xxx",
    // Distribution by aggregated borrowing status
    "by_borrowing_status": [
        {
            "key": "New",
            "count": "xxx",
            // For each status returns the distribution by reference
               material type
            "material_types": {
                "1": "xxx",
                ...
            }
        },
        ...
    ],
    // Total number of lending requests
    "total_lending_requests": "xxx",
    // Distribution by aggregated lending status
    "by_lending_status": [
        {
            "key": "New",
            "count": "xxx",
            "material_types": {
                "1": "xxx",
                ...
            }
        },
        ...
    ],
    // Delivery method of the received borrowing requests
```

```
    "borrowing_fulfilled_distribution": [
        {
            "key": 1,
            "count": "xxx",
            "material_types": {
                "1": "xxx",
                ...
            }
        },
        ...
    ],
    // Reason of unfillment of the not received borrowing requests
    "borrowing_unfilled_distribution": [
        {
            "key": 1,
            "count": "xxx",
            "material_types": {
                "1": "xxx",
                ...
            }
        },
        ...
    ],
    // Delivery method of the fulfilled lending requests
    "lending_fulfilled_distribution": [
        {
            "key": 1,
            "count": "xxx",
            "material_types": {
                "1": "xxx",
                ...
            }
        },
        ...
    ],
    // Reason of unfillment of the unfilled lending requests
    "lending_unfilled_distribution": [
        {
            "key": 1,
            "count": "xxx",
            "material_types": {
                "1": "xxx",
                ...
            }
        },
        ...
    ]
}
```

3.3 Geographical stats

This API gives information about the countries that request or provide.
It is accessible via the endpoint `/countries` and it accepts 3 optional parameters: `year` of the requests, `library_id` or `institution_id` or `country_id`. If neither `library_id`, `institution_id` nor `country_id` are provided the API returns a leaderboard of most requesting and providing libraries.

This API returns an object containing the following information:

```
{
    // List of the providing countries, ordered by "count"
    // Here countries are "lending_library.country"
    "requesting_from": {
        "total": "xxx",
        "countries": [
            {
                "name": "ITALY",
                "code": "ITA",
                "count": "xxx"
            },
            ...
        ]
    },
    // List of the requesting countries, ordered by "count"
    // Here countries are "borrowing_library.country"
    "providing_to": {
        "total": "xxx",
        "countries": [
            {
                "name": "ITALY",
                "code": "ITA",
                "count": "xxx"
            },
            ...
        ]
    }

}
```

3.4 Working time distribution stats

This API provides information about request response times, grouped into three categories: “Within a day”, “Within a week”, “More than a week”.
It is accessible via the endpoint `/working-time` and it accepts 3 optional parameters: `year` of the requests, `material_type` of the references and `library_id` or `institution_id` or `country_id`.
This API returns an object containing the following information:

```
{
    "total_borrowing": "xxx",
    "total_lending": "yyy",
    // If I am a borrower
    "as_borrower": [
        {
            "key": "Within a day",
            "doc_count": "xxx",
            "by_material_type": {
                [
                    {
                        "key": 1,
                        "doc_count": "xxx"
                    },
                    ...
                ]
```

```
            }
        },
        {
            "key": "Within a week",
            "doc_count": "xxx",
            "by_material_type": {
                [
                    {
                        "key": 1,
                        "doc_count": "xxx"
                    },
                    ...
                ]
            }
        },
        {
            "key": "Longer than a week",
            "doc_count": "xxx",
            "by_material_type": {
                [
                    {
                        "key": 1,
                        "doc_count": "xxx"
                    },
                    ...
                ]
            }
        },
    ],
    // If I am a lender
    "as_lender": [
        {
            "key": "Within a day",
            "doc_count": "xxx",
            "by_material_type": {
                [
                    {
                        "key": 1,
                        "doc_count": "xxx"
                    },
                    ...
                ]
            }
        },
        {
            "key": "Within a week",
            "doc_count": "xxx",
            "by_material_type": {
                [
                    {
                        "key": 1,
                        "doc_count": "xxx"
                    },
                    ...
                ]
            }
```

```
        },
        {
            "key": "Longer than a week",
            "doc_count": "xxx",
            "by_material_type": {
                [
                    {
                        "key": 1,
                        "doc_count": "xxx"
                    },
                    ...
                ]
            }
        },
    ],
}
```

3.5 Average working time stats

This API calculates the average working time (all values are in milliseconds, to convert it to days divide it by `/ 1000 / 60 / 60 / 24`) of requests for both borrowing and lending and grouped by year and by month.
It is accessible via the endpoint `/avg-working-time` and it accepts 3 optional parameters: `year` of the requests, `material_type` of the references and `library_id` or `institution_id` or `country_id`.
This API returns an object containing the following information:

```
{
    "2023": {
        "yearly_borrowing": { "value": "xxx" },
        "yearly_lending": { "value": "xxx" },
        "2023-07": {
            "borrowing": "xxx",
            "lending": "xxx"
        },
        "2023-08": {
            "borrowing": "xxx",
            "lending": "xxx"
        },
        ...
    },
    "2024": {
        ...
    }
}
```

3.6 Reference turnaround stats

This API returns information about the average processing time (in days) of a reference, grouped by reference's material type.
It is accessible via the endpoint `/reference-turnaround` and it accepts 2 optional parameters: `year` of the requests and `library_id` or `institution_id` or `country_id` of the borrower.
This API returns an object containing the following information:

```
// Format -> Material type: time (in days)
{
    "1": "xxx",
```

```
    "2": "xxx",
    "3": "xxx",
    "4": "xxx",
    "5": "xxx",
}
```

3.7 Reference publication year distribution

This API shows the distribution of the publication year of the reference by year.
It is accessible via the endpoint `/pubyear-distribution` and it accepts 3 optional parameters: `year` of the requests, `material_type` of the references and `library_id` or `institution_id` or `country_id`.
This API returns an object containing the following information:

```
{
    "as_borrower": [
        {
            "year": 2025,
            "doc_count": "xxx"
        },
        ...
    ],
    "as_lender": [
        {
            "year": 2025,
            "doc_count": "xxx"
        },
        ...
    ]
}
```

3.8 Requests per library stats

This API returns the necessary data to fill the table defined below.

- Year: “xxx”
- # of total requests: “xxx”
- Fillrate: “xxx”% (via `/fillrate`)
- # of borrowing libraries: “xxx”
- # of lending libraries: “xxx”
- Average number of fulfilled requests per library: “xxx”
- # of fulfilled requests for books: “xxx” (via `/requests-distribution`)
- # of fulfilled requests for acticles: “xxx” (via `/requests-distribution`)
- # of fulfilled requests for thesis + manuscript/map + manuscript: “xxx” (via `/requests-distribution`)

It is accessible via the endpoint `/borrowing-libraries` and it accepts no parameters.
This API returns an object containing the following information:

```
{
    "2023": {
        "total_requests": "xxx",
        "borrowing_libraries": "xxx",
        "lending_libraries": "xxx"
    },
    ...
}
```

3.9 OpenAccess stats

This API gives information about the unique references object of requests, how many of them are Open Access and its distribution by aggregated borrowing status and a sub aggregation by request with pdf editorial.
It is accessible via the endpoint `/oareferences` and it accepts no parameters.
This API returns an object containing the following information:

```
{
    "unique_references": "xxx",
    "references_with_oa": "xxx",
    "unique_references_with_oa": "xxx",
    "New": {
        "count": "xxx",
        "by_pdf_editorial": [
            {
                "key": 0,
                "doc_count": "xxx"
            },
            {
                "key": 1,
                "doc_count": "xxx"
            }
        ]
    },
    ...
}
```

3.10 Export

This API gives information about all the sent and received requests.
It is accessible via the endpoint `/export` and it accepts 3 optional parameters: `year` of the requests, `material_type` of the references and `library_id` or `institution_id` or `country_id`.
This API returns a CSV file containing all the requests that match the applied filters.

4 Implemented statistics user interface

This chapter illustrates all the statistics web pages available to the user in TALARIA.
When the API documentation specifies that filters can be applied, the interface changes based on the user's permissions.
Figure 1 shows the filters for admins and managers, Figure 2 shows the filters for normal users.

Figure 1: Filters for admin users

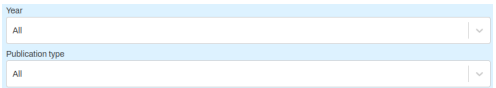

Figure 2: Filters for normal users

4.1 Statistics general trends

The charts in Figure 3 and Figure 4 show the general trends for borrowing and lending requests for all operational years of the service.

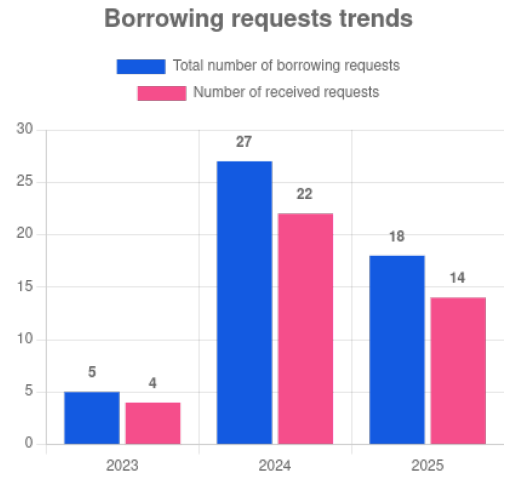

Figure 3: General trends for borrowing requests

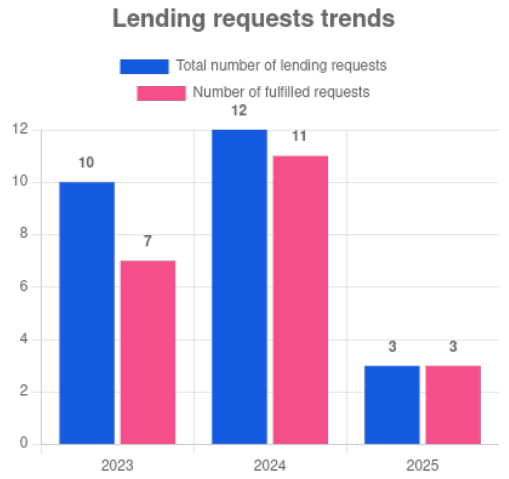

Figure 4: General trends for lending requests

4.2 Requests distribution

The charts show the borrowing and lending requests that have been managed. They are divided by the request's actual status (Figure 5 and Figure 6) and by publication types (Figure 7 and Figure 8).

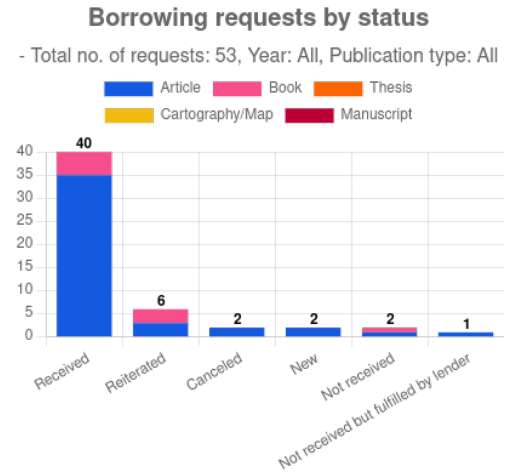

Figure 5: Borrowing requests by status

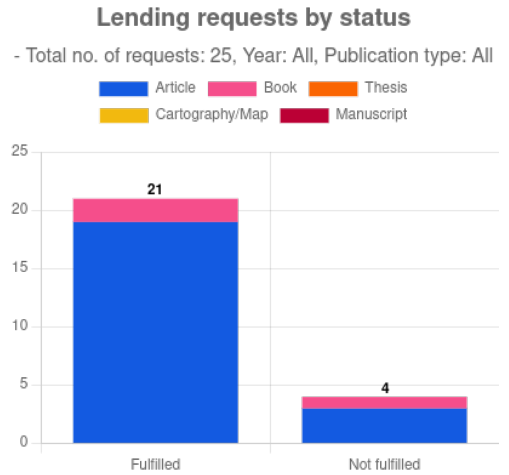

Figure 6: Lending requests by status

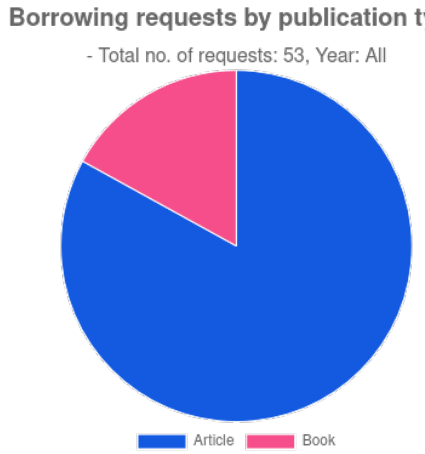

Figure 7: Borrowing requests by publication type

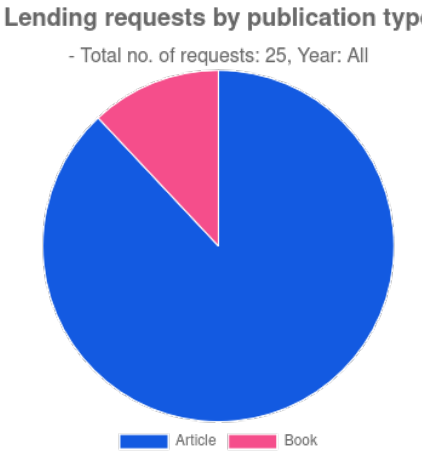

Figure 8: Lending requests by publication type

4.3 Requests details

The charts in Figure 9 and Figure 10 show the borrowing received requests and the lending fulfilled requests by their delivery method.

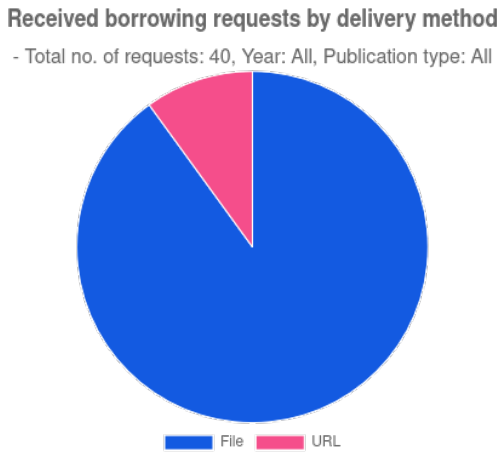

Figure 9: Received borrowing requests by delivery method

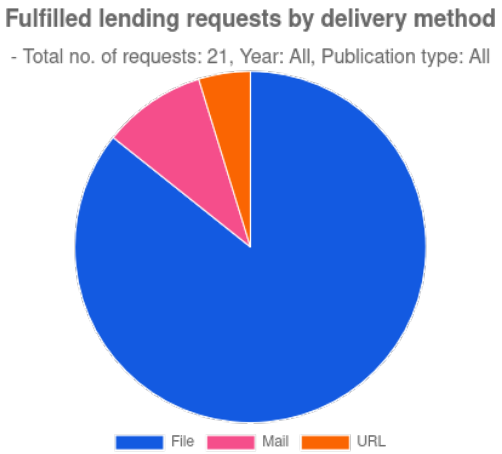

Figure 10: Fulfilled lending requests by delivery method

The charts in Figure 11 and Figure 12 show the borrowing not received requests and the lending not fulfilled requests by their reason of unfillment.

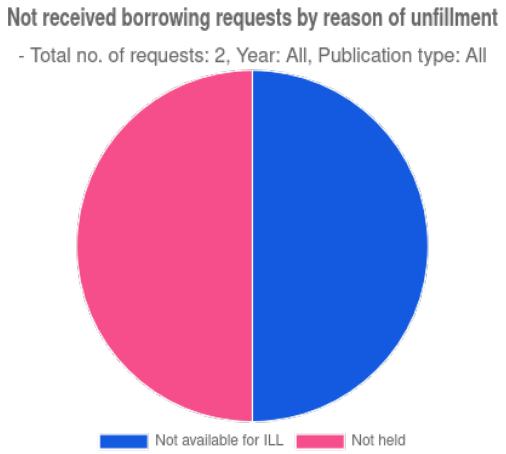

Figure 11: Not received requests by reason of unfillment

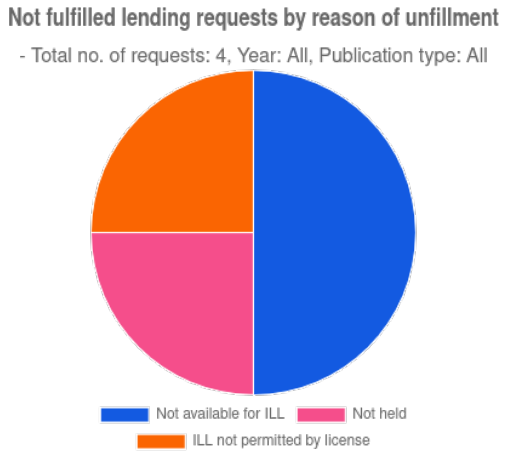

Figure 12: Not fulfilled requests by reason of unfillment

4.4 Fill rate

The charts show the fill rate for borrowing and lending requests.
Borrowing fill rate (Figure 13) is the ratio of received requests over the total number of received and not received requests. Canceled, in progress and new requests are not counted. Reiterated requests are not counted as well because they refer to the same bibliographic reference and the fill rate aims to be an indicator about the ability of retrieving the desired references.
Lending fill rate (Figure 14) is the ratio of fulfilled requests over the total number of fulfilled and not fulfilled requests.

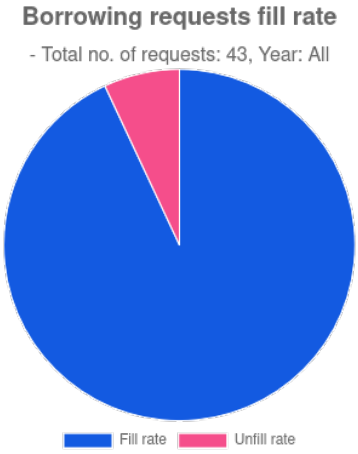

Figure 13: Borrowing fill rate

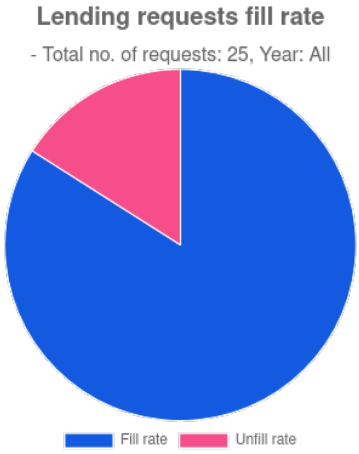

Figure 14: Lending fill rate

4.5 Turnaround time

The charts in Figure 15 and Figure 16 show for borrowing and for lending the number of requests managed within a day, within a week and more than a week.

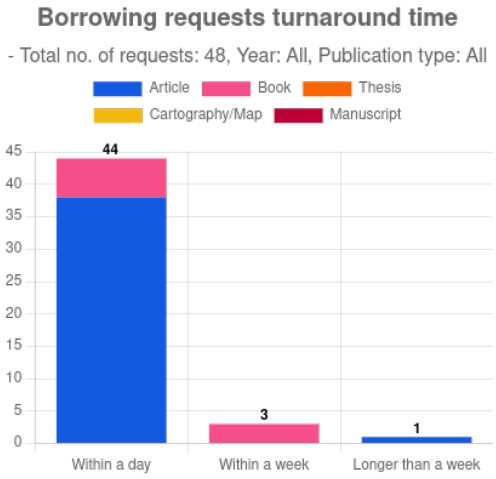

Figure 15: Borrowing turnaround time

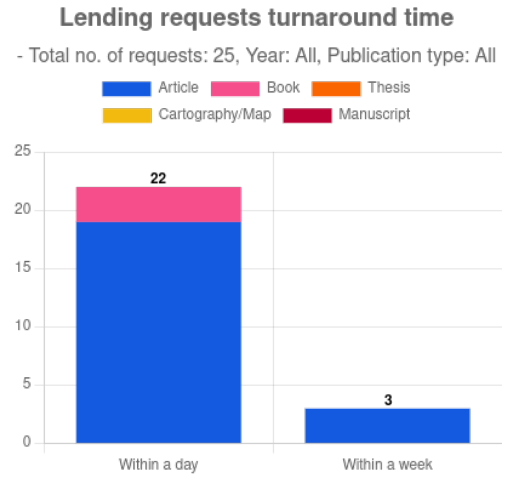

Figure 16: Lending turnaround time

The chart shows the average turnaround time in days for borrowing and lending requests (Figure 17). If a year is selected, the chart shows the monthly trend for the selected year (Figure 18).

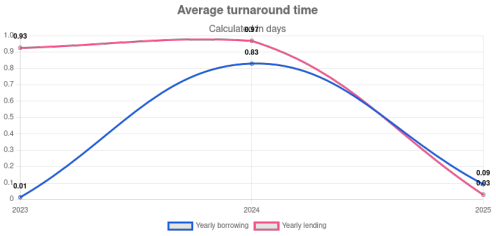

Figure 17: Yearly average turnaround time

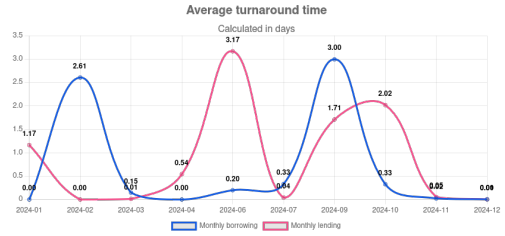

Figure 18: 2024 monthly average turnaround time

4.6 Requests distribution by country

The Figure 19 shows the fulfilled requests that have been requested from and supplied to the other libraries grouped by the belonging country.

Country	Requested from	Supplied to
ARGENTINA	0	1
BELARUS	0	1
BELGIUM	1	0
IRELAND	0	1
ITALY	11	8
LEBANON	4	1
MEXICO	1	0
PAKISTAN	0	1
QATAR	2	3
SPAIN	12	2
TURKEY	2	3
UNITED KINGDOM	2	0
UNITED STATES	5	0

Figure 19: Requests distribution by country

4.7 Export data

It is possible to export all the requests sent and received in CSV format.
The CSV file includes information about the borrowing and lending libraries, the requested reference, request and fulfillment dates, aggregated borrowing and lending statuses (see subsection 1.1 and subsection 1.2), delivery method or reason for unfulfillment, and flags indicating whether a request is orphaned, forwarded, archived, or trashed.