

Mathematics for Decisions

Project 1: The RBBC Case Study InterLibrary Loan Service

Romeo Rizzi, Alice Raffaele

University of Verona

romeo.rizzi@univr.it, alice.raffaele@unitn.it

March 2020

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What is a “Case Study”?



- Constructivist teaching method based on a **case** or a **story**;
- Challenging ourselves, you will explore the case to **make a decision** or **solve a problem**;
- In the meanwhile, you will acquire **specific skills** and **knowledge** through inquiry.

The strategy

What you'll do:

- Reason critically about situations;
- Propose appropriate courses of action.

What you'll use:

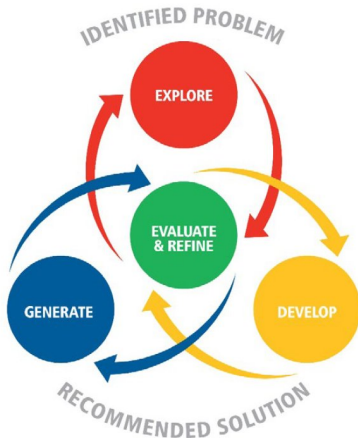
- Your own understandings;
- Your values, perspectives and ideas;
- Your knowledge.

What you'll need to develop:

- An analysis of the problem;
- A “plan of attack”;
- One or more possible solutions.

What you'll cultivate and get:

- Analytical skills;
- Critical thinking;
- Capability of identifying issues as they arise;
- Evaluation of information value;
- Collaborative skills.



Team working

How will you do this?

- Discussions;
- Group works;
- Cooperative learning;
- Individual research.



InterLibrary Loan Service (ILS)



- It's a service that allows to borrow books, music, DVDs and other documents not only of one library, but **also from others** in the same network.

ILS - How it works?

1. The user makes a request with his/her home library, in person or using the online catalogue of the library network;
2. The library system places the request, that is received and accepted by one of the libraries with the desired item;
3. The other library prepares the desired item, which is collected by a courier;
4. After a while (usually few days or a week), the courier delivers the desired item at the home library of the user, which sends an e-mail or calls the user that the item is ready.

Our Case Study - RBBC

Rete Bibliotecaria Bresciana e Cremonese (i.e., RBBC, Brescia and Cremona Library Network)

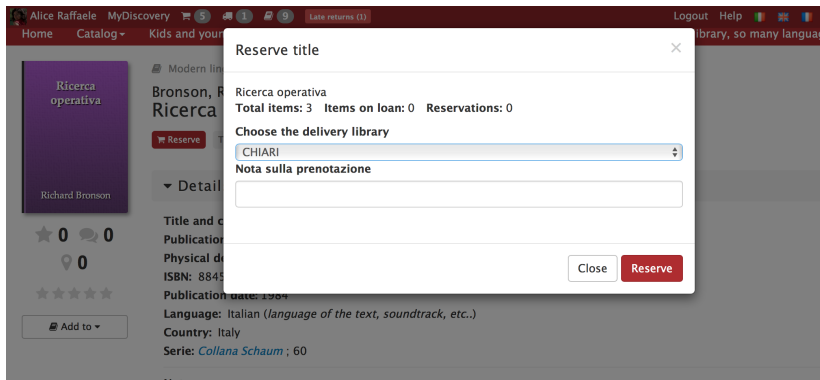
- *Network*: public libraries in the provinces of Brescia, Cremona and Mantova;
- *Channels*: to use ILS, the user can ask directly to his/her home library or use the *Online Public Access Catalogue* (i.e., OPAC) platform;
- *Price*: for users, completely free; to access any catalogues outside the network of public libraries, it's the libraries system or office which manages the deals.

RBBC - Online Public Access Catalogue (OPAC)

The screenshot shows the RBBC (Rete Bibliotecaria Bresciana e Cremonese) OPAC homepage. The header is red with the RBBC logo on the left, the name 'Rete Bibliotecaria Bresciana e Cremonese' in the center, and a search bar with 'Ricerca nel catalogo' and a 'Cerca' button. On the right, there are links for 'Logout', 'Aiuto', and a language selector. Below the header, there is a navigation bar with links: 'Home', 'Catalogo', 'Ragazzi', 'Sezione Locale', 'Generi fiction', 'Classifiche', 'Consigli di lettura', 'MLOL', 'Chi siamo', and 'Archivi'. A red banner below the navigation bar displays statistics: 'Prestiti in corso 256.209', 'Prestiti di oggi 1.590', and 'Iscritti alla RBBC 183.824'. To the right of the banner are social media icons for Facebook, Twitter, Instagram, and YouTube. Below the banner is a large advertisement for 'Laboratori creativi 2020' featuring various craft icons and text: 'dal 12 febbraio al 27 maggio con Adriana, Giorgia, Mariangela e Serena nella Biblioteca Sabao al mercoledì alle ore 14.30 Prenotazione necessaria'. At the bottom right, there are two book covers: 'Mercato nero' by Gian Mauro Costa and 'La fiamma nel buio' by Michael Connelly.

- After the login operation, the user can see its current situation in “MyDiscovery” section;
- The user can look for any resources in the network.

RBBC - Booking a resource online



- In this case, the user can select the delivery library, i.e., the user can choose where he/she would like to collect the desired item (**not** the library where the desired item will come from).

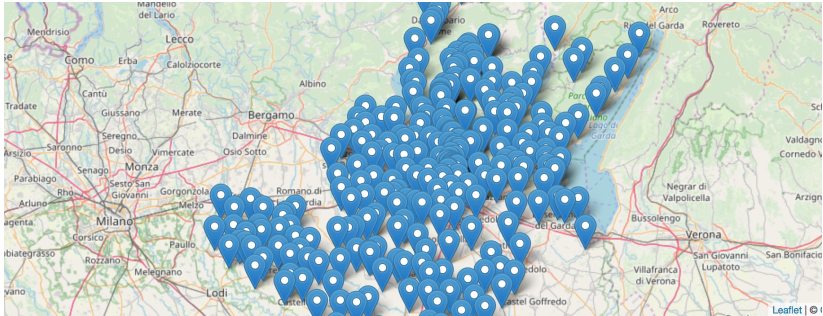
RBBC - More details about the requests

- Every resource is **owned** by a particular library, but actually it can be requested by all users from all over the network;
- The user can **request every resource** not labelled as “local loan” (i.e., only users of the owner library can borrow that labelled resource);
- **Duration of interlibrary loan:** 30 days (books and media kit) or 15 days (magazines, DVDs and music);
- Every user can ask for **at most 10 resources** at the same time.
- The user can **return the item to any libraries** in the network (not necessarily where he/she borrowed it).

RBBC - The couriers

- RBBC uses a service provided by a **logistic company**;
- According to an agreement, the company offers a certain number of **couriers to move items** from one library to another: RBBC pays some **fixed** amount for the rental of vehicles, plus some **variable costs** related to the length of the routes travelled by couriers;
- Couriers are supposed to **visit each library on a regular basis**, maybe the same days of the week; usually they visit libraries during their opening hours, but it may also happen during lunch breaks or when the library is closed to the public;
- When couriers visit a library, they simultaneously **pick-up** all items that have to go somewhere else and **deliver** all the ones addressed to that library;
- They do not deliver right away what they have just picked-up, but bring items to some **depots** located in the network.

RBBC - The network



The network is composed of:

- 329 libraries + 2 offices (Libraries Office of the Province of Brescia and Libraries Office of Cremona);
- Depots for temporarily collecting items.

RBBC: Lines

- At the moment, libraries are organized in **fixed lines**;
- Each line is served by a courier few times a week, according to the demand;
- Starting from a depot, couriers reach the start of the line and visit all libraries assigned to that line until the end, picking-up or delivering requested items; then couriers go back to the depot, where they leave all items picked-up.

code	library	line	library_system
PI	ACCADEMIA SANTA GIULIA	8	BRESCIA - SPECIALI
EA	ACQUAFREDDA	2	BRESCIA EST
QA	ADRO	4	OVEST BRESCIANO
LA	AGNADELLO	10	CREMASCO
SA	AGNOSINE	6	NORD EST
SB	ANFO	6	NORD EST
VA	ANGOLO TERME	7	VALCAMONICA
YA	ANNICCO	10	CREMASCO
UA	ARCHIVIO PROVINCIALE	8	BRESCIA - SPECIALI
VB	ARTOGNE	7	VALCAMONICA
LB	AZZANELLO	10	CREMASCO
AA	AZZANO MELLA	3	BASSA
YB	BAGNOLO CREMASCO	10	CREMASCO
BB	BAGNOLO MELLA	2	BASSA
SC	BAGOLINO	6	NORD EST
BC	BARBARIGA	3	BASSA
SD	BARGHE	6	NORD EST
BN	BASiglio BRESCIANO	9	BASCA

Data - Libraries

library_system	library_id	description	label	library_code	address	phone	fax	email	billing_address	city	province	latitude	longi
Bassa Bresciana Centi	1	BIBLIOTECA DI AZZANO MELLA	AZZANO MELLA	AA	Via Vittorio Veneto 2	309748804	0	biblioteca@comune.azzanomella.b	25020	AZZANO MELLA	BS	454.547.087	101.1
Bassa Bresciana Centi	2	BIBLIOTECA DI BORGIO SAN B	BORGIO SAN GIACOP	AB	Piazza San Giacomo 3	309948348		biblioteca@comune.borgiosan	25022	BORGIO SAN GIACOP	BS	453.497.176	99.66
Bassa Bresciana Centi	3	BIBLIOTECA DI DELLO	DELO	AD	Via XI Febbraio 5	309719220		biblioteca@comune.dello.bs.it	25020	DELO	BS	454.177.374	100.1
Bassa Bresciana Centi	4	BIBLIOTECA DI MAIRANO	MAIRANO	AH	Via Mazzini 3/F - Pieve	309975612	3E+08	biblioteca.mairano@gmail.com	25030	MAIRANO	BS	454.614.100	100.8
Bassa Bresciana Centi	5	BIBLIOTECA DON ANGELO B	POMPIANO	AI	Piazza Sant'Andrea 30/A	309465310		biblio@comune.pompiano.bres	25030	POMPIANO	BS	454.314.600	99.81
Bassa Bresciana Centi	6	BIBLIOTECA DI SAN GERVASIO	SAN GERVASIO BRES	AI	Via Barbara Ferrazzi 24	309934124		biblioteca@comunesangervasio	25020	SAN GERVASIO BRES	BS	453.061.720	101.5
Bassa Bresciana Centi	7	BIBLIOTECA DI SAN PAOLO	SAN PAOLO	AK	Piazza Aldo Moro 27	309970001		biblioteca@comune.sanpaolo.bs	25020	SAN PAOLO	BS	453.476.876	99.70
Bassa Bresciana Centi	8	BIBLIOTECA DI ISORELLA	ISORELLA	AL	Via Garibaldi 3	0309958117	int.8	biblioteca@comune.isorella.bs	25015	ISORELLA	BS	453.087.589	103.2
Bassa Bresciana Centi	9	SISTEMA BIBLIOTECARIO BA	SISTEMA BIBLIOTEC	BO	VIA INSURREZIONE NAZION	309387294		sistemabbc@comune.manerbio	25020	MANERBIO	BS	453.534.331	101.4
Bassa Bresciana Centi	10	BIBLIOTECA DI ALFIANELLO	ALFIANELLO	BA	P.ZZA PAVONI	0	0	mail	25020	ALFIANELLO	BS	452.671.600	101.4
Bassa Bresciana Centi	11	BIBLIOTECA DI BAGNOLO MI	BAGNOLO MELLA	BB	Via XXVI Aprile 48	30620828	3E+08	biblioteca@comune.bagnolomella	25021	BAGNOLO MELLA	BS	454.298.063	101.8
Bassa Bresciana Centi	12	BIBLIOTECA DI BARBARIGA	BARBARIGA	BC	Via Roma 29	309971356		biblioteca@comune.barbariga	25030	BARBARIGA	BS	454.051.715	100.5
Bassa Bresciana Centi	13	BIBLIOTECA DI BASSANO BRI	BASSANO BRES	BD	Via Martinego 33	309935112	3E+08	biblioteca@comune.bassano-bres	25020	BASSANO BRES	BS	453.258.357	101.2
Bassa Bresciana Centi	14	BIBLIOTECA DI BRANDICO	BRANDICO	BE	Via IV Novembre 8	30975893		biblioteca.brandico@gmail.com	25030	BRANDICO	BS	454.546.800	100.5
Bassa Bresciana Centi	15	BIBLIOTECA DI CAPIRIANO DI	CAPRIANO DEL COL	BF	Piazza Mazzini 8	309748683		biblioteca@comune.capriano	25020	CAPRIANO DEL COL	BS	454.551.200	101.2
Bassa Bresciana Centi	16	BIBLIOTECA DI CIGOLE	CIGOLE	BG	Via Roma 19	309959767		biblioteca@comune.cigole.bs	25020	CIGOLE	BS	453.092.567	101.5
Bassa Bresciana Centi	17	BIBLIOTECA R.REMONDI* FIE	FIESSE	BH	Via Gramsci 1	309950044		biblioteca@comune.fiesse.bs	25020	FIESSE	BS	452.321.201	103.2

- **library_system**: the system the library belongs to;
- **library_id** and **library_code**: two values to univocally identify the library;
- **description** and **label**: short and full name of the library;
- **address**, **phone**, **fax**, **email**, **billing_address**, **city**, **province**
- **latitude** and **longitude**: exact position of the library.

Data - Interlibrary loans

loan_id	patron_id	patron_age	patron_city	request_date	loan_date_begin	loan_date_end	due_date	from_library	to_library	end_library
15842662	*461CAA12F8C0	15	VOBARNO	18/09/12 16:26	29/05/13 18:10	25/07/13 13:03	28/06/13 18:09	136	164	149
15843559	*3E2DD1D0311C	38	BOVEZZO	21/03/12 00:00	19/09/16 16:34	19/09/16 16:34	04/10/16 00:00	128	168	168
15849314	*76D8176F2019	23	ISORELLA	19/09/12 17:36	28/02/13 16:53	28/02/13 18:01	30/03/13 16:53	15	8	8
15857437	*2BE5B335333B	56	MANERBIO	20/09/12 17:32	10/01/13 21:16	10/01/13 21:17	09/02/13 21:15	25	22	22
15868584	*2F08C397120A	32	ADRO	22/09/12 11:35	15/01/13 14:35	15/01/13 14:37	14/02/13 14:35	201	96	96
15870174	*7E4A6F981956F	27	CARPENEDOLO	22/09/12 10:19	27/05/13 14:32	06/07/13 09:31	26/07/13 00:00	143	68	68
15894472	*FB6CEBC9D141	13	BOVEZZO	06/09/12 00:00	15/03/13 09:35	15/03/13 09:35	14/04/13 10:35	96	168	168
15897305	*1B83A62556E4	9	CARPENEDA DI VOBARNO (BS)	27/09/12 18:02	29/05/13 18:10	12/08/13 15:51	28/06/13 18:09	163	164	164
15912403	*553F581CB092	20	GAVARDO	01/10/12 17:32	11/01/13 16:04	11/01/13 16:04	10/02/13 16:03	47	149	149
15913505	*09627AE8B821	20	26020 PALAZZO PIGNANO	02/10/12 11:00	18/01/13 11:17	18/01/13 11:18	17/02/13 11:17	52	268	268
15914865	*2A698761942A	34	25014 CASTENEDOLO	01/10/12 13:03	15/01/13 16:15	15/01/13 16:15	14/02/13 16:15	100	96	96
15922060	*A59F4928137B	71	PERSICO DOSIMO	03/10/12 12:23	21/10/13 17:48	30/08/14 10:21	20/11/13 16:48	245	244	245
15923913	*787D92805340	NULL	CONCESIO	02/10/12 11:33	08/01/13 12:57	05/04/13 16:26	07/02/13 12:57	184	173	173
15925061	*6155509B4B4F	14	SAREZZO	03/10/12 16:18	08/01/13 17:20	08/01/13 17:20	07/02/13 17:19	183	185	185
15927651	*425C7DDA423E	14	GARDONE VT	03/10/12 17:11	07/01/13 17:17	07/01/13 17:17	06/02/13 17:17	180	174	174
15931451	*8C28489E86BE1	53	GADESCO PIEVE DELMONA	04/10/12 14:08	14/02/13 16:54	19/02/13 12:47	16/03/13 16:54	108	238	238
15933054	*C4D518DAF8A7	92	25081 BEDIZZOLE	04/10/12 16:22	07/02/13 16:30	19/02/13 17:08	09/03/13 16:30	82	63	63
15936080	*FEA5FA37AD0B	18	Pandino	05/10/12 15:00	18/01/13 11:18	18/01/13 11:18	17/02/13 11:18	69	268	268
15937068	*89FD87FC2E83	20	Pandino	05/10/12 15:47	08/05/13 17:12	08/05/13 17:12	07/06/13 17:12	92	268	268
15941159	*E90221E8924D	15	BOVEZZO	05/10/12 15:44	25/01/13 08:37	25/01/13 08:40	24/02/13 08:37	185	168	168
15953528	*B9F25B8F4857F	47	ISORELLA	08/10/12 08:19	02/01/13 16:12	02/01/13 16:12	01/02/13 16:12	30	8	8

- **loan_id**: a value to univocally identify the loan;
- **patron_id**, **patron_age** and **patron_city**: data about the user;
- **request_date**: when the user requests a particular item;
- **loan_date_begin** and **loan_date_end**: duration of the loan;
- **due_date**: deadline for the user to return the item;
- **from_library** and **to_library**: pick-up and delivery libraries for the item;
- **end_library**: the library where the user returned the item.

Requirements - Focus

The goal is to **optimize the InterLibrary Loan Service**; of course one cannot think about optimizing right-away all the phases of the service, but we'll focus on the pick-up and delivery part, developing routes of couriers and thus trying to reduce costs paid by RBBC.

There are **some aspects** to take into account, for instance:

- How many times a week should a courier visit each library?
- Where should you put the depots?
- What is the capacity of a vehicle? And are vehicles *homogenous* or not?

Variables, parameters, constraints... Can you identify them in this problem? Thinking and discussing about the problem, you may find also other things to keep in consideration.

Requirements - What you can do

- Provide a **mathematical formulation** of the problem, maybe using linear programming, mixed-integer linear programming or whatever model you think it would be suitable;
- Analyze data using **statistics**, developing charts, figures, etc.;
- Look for similar problems in the **literature** and compare how they have been solved;
- **Implement** your model and use existing solvers to get a solution.

...basically **all you need to understand it better!**

Note: you don't have to strictly follow how RBBC is currently tackling the problem. You have to **stick to the data**, but for instance you may not use lines. You are **completely free!**

Requirements - What we are asking

- We **do not know the exact solution** and we are not asking you to find it (well, if you develop an optimal method...);
- We are looking for innovative **ideas and methods** to tackle this problem, **providing RBBC new insights and suggestions** about decisions they have to take, for example choosing a good logistic company.

Requirements - Tools

- You are free to use **any tools** you prefer;
- You can use methods, techniques and softwares we're going to study in this course, but also others you already know.

Requirements - Final report

- You will act like a **real consultant** for RBBC;
- In the end, you'll need to develop an **appropriate report**, containing:
 - How you have studied the problem;
 - Analyses you have done;
 - Methods you have developed;
 - What you suggest to RBBC to improve its management of the ILS, according to your results;
 - Everything else you think it's relevant.

Conclusions

- If you have any questions, don't hesitate and write us!
- We are in contact with the IT manager of RBBC, thus we can share with him all doubts and issues, or things we are not convinced of;
- We'll guide you through this path and in the development of your work.

References



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