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Mathematics for Decisions

Project 1: The RBBC Case
InterLibrary Loan Service

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Overview

Teaching cases

- Constructivist teaching method based on **cases** (different from "case studies");
- Cases present a situation (or problem space) not necessarily taken from real life;
- No solution is provided but it is up to the learners to generate possible solutions that might fit the facts of the case;
- By challenging yourselves, you explore the case to **make a decision** or **solve a problem**;
- Meanwhile, you acquire **specific skills** and **knowledge** through inquiry.

Strategy

What you'll do:

- Reason critically;
- Propose appropriate courses of action.

What you'll use:

- Your own understanding;
- Your values, perspectives and ideas;
- Your knowledge and background.

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;
- Ability to identify issues as they arise;
- Ability to evaluate information;
- Ability to extract informative data;
- Collaborative skills.
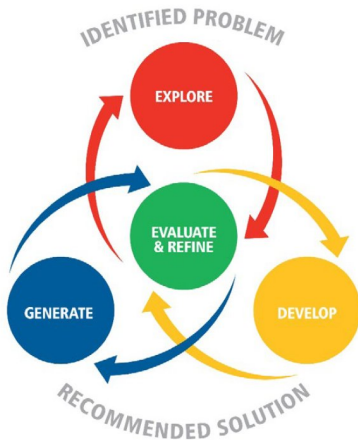
Teamwork

How will you do this?

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

InterLibrary Loan Service (ILS)

A service that allows you to borrow books, music sheets, CDs, DVDs and other items not only from your library, but **from all libraries** in the network.

ILS - How it works?

1. The user makes a request to his or her home library, in person or through an online catalogue on the system;
2. The request is received and accepted by one of the libraries having the desired item;
3. This second library prepares the desired item, which is subsequently collected by a courier;
4. After a while (usually a few days or a week), the courier delivers the desired item at the user's home library, which notifies the user that the item is ready.

Our case - RBBC

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

- *Network*: composed of the public libraries in the provinces of Brescia, Cremona and Mantova;
- *Channels*: to use ILS, the user can ask directly to his or her home library or use the *Online Public Access Catalogue* (i.e., OPAC) platform;
- *Price*: completely free for users.

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RBBC - Online Public Access Catalogue (OPAC)

- After logging in, the user can see its current situation in the "MyDiscovery" section;
- The user can look for any resources in the network.

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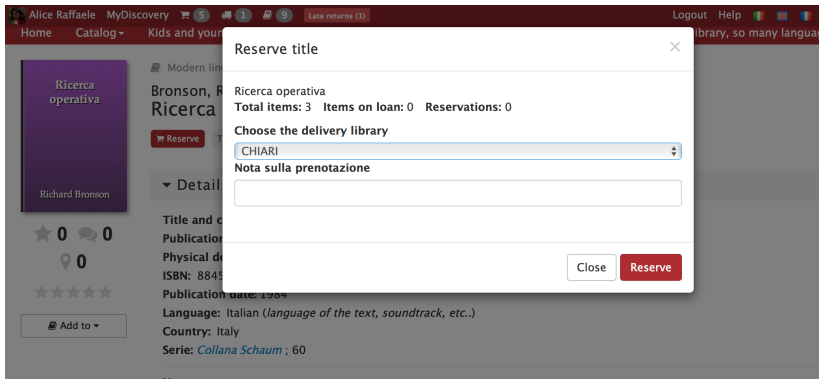
- In this case, the user can select the delivery library, i.e., the user can choose where he or she would like to collect the desired item (**not** the library where the desired item will come from).

RBBC - More details about the requests

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

RBBC - The couriers

- RBBC uses a service provided by a **logistics company**;
- By contract, the company offers a maximum 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**, tentatively on the same day of the week, usually during their opening hours. 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 items immediately after pick-up, but bring them instead to **depots** located in the network.

RBBC - The network
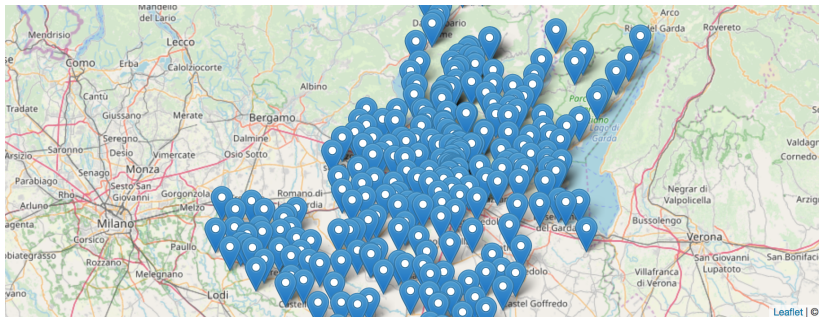
The network is composed of:

- 329 libraries + 2 offices (i.e., the "Ufficio Biblioteche" of the Province of Brescia and the "Ufficio Biblioteche" of the Province of Cremona);
- Depots to temporarily collect items.

RBBC: Lines

- Currently, libraries are organized in **fixed lines**;
- Each line is served by a courier multiple times a week, according to the demand;
- Couriers start from a depot, then 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
OA	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
BD	BASSANO BRESCIANO	2	BASSA

Data - Libraries

library_system	library_id	description	label	library_code	address	phone	fax	email	billing_address	city	province	latitude	long
Bassa Bresciana Cent	1	BIBLIOTECA DI AZZANO MEL	AZZANO MELLA	AA	Via Vittorio Veneto 2	309748804	0	biblioteca@comune.azzanomella.b	25020	AZZANO MELLA	BS	454.547.087	101.1
Bassa Bresciana Cent	2	BIBLIOTECA DI BORGO SAN (	BORGO SAN GIACO	AB	Piazza San Giacomo 3	309948348		biblioteca.borgosangiaco	25022	BORGO SAN GIACOI	BS	453.497.176	99.66
Bassa Bresciana Cent	3	BIBLIOTECA DI DELLO	DELLO	AD	Via XI Febbraio 5	309719220		biblioteca.comune.dello.bs.it	25030	DELLO	BS	454.177.374	100.7
Bassa Bresciana Cent	4	BIBLIOTECA DI MAIRANO	MAIRANO	AH	Via Mazzini 3/F - Pievedizo	309975612	3E+08	biblioteca.mairano@gmail.com	25030	MAIRANO	BS	454.614.100	100.8
Bassa Bresciana Cent	5	BIBLIOTECA DON ANGELO BI	POMPIANO	AI	Piazza Sant'Andrea 30/A	309465310		biblio@comune.pompiano.brescia.	25030	POMPIANO	BS	454.314.600	99.81
Bassa Bresciana Cent	6	BIBLIOTECA DI SAN GERVASI	SAN GERVASIO BRES	AJ	Via Barbara Ferrazzi 24	309934124		biblioteca@comunesangervasio.it	25020	SAN GERVASIO BRES	BS	453.061.720	101.5
Bassa Bresciana Cent	7	BIBLIOTECA DI SAN PAOLO	SAN PAOLO	AK	Piazza Aldo Moro 27	309970001		biblioteca@comune.sanpaolo.bs.it	25020	SAN PAOLO	BS	453.476.876	99.70
Bassa Bresciana Cent	8	BIBLIOTECA DI ISORELLA	ISORELLA	AL	Via Garibaldi 3	0309958117	int.8	biblioteca@comune.isorella.bs.it	25010	ISORELLA	BS	453.087.589	103.2
Bassa Bresciana Cent	9	SISTEMA BIBLIOTECARIO BA	SISTEMA BIBLIOTEC	BO	VIA INSURREZIONE NAZION	309387294		biblioteca@comune.manerbio.bs.	25025	MANERBIO	BS	453.534.331	101.4
Bassa Bresciana Cent	10	BIBLIOTECA DI ALFIANELLO	ALFIANELLO	BA	P.ZZA PAVONI	0	0	mail	25020	ALFIANELLO	BS	452.671.600	101.4
Bassa Bresciana Cent	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 Cent	12	BIBLIOTECA DI BARBARIGA	BARBARIGA	BC	Via Roma 29	309971356		biblioteca@comune.barbariga.bs.it	25030	BARBARIGA	BS	454.051.715	100.5
Bassa Bresciana Cent	13	BIBLIOTECA DI BASSANO BRI	BASSANO BRESCIAN	BD	Via Martinengo 33	309591112	3E+08	biblioteca@comune.bassano-bresc	25020	BASSANO BRESCIAN	BS	453.258.357	101.2
Bassa Bresciana Cent	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 Cent	15	BIBLIOTECA DI CAPRIANO DE	CAPRIANO DEL COL	BF	Piazza Mazzini 8	309748683		biblioteca@comune.capriano.bs.it	25020	CAPRIANO DEL COLI	BS	454.551.200	101.2
Bassa Bresciana Cent	16	BIBLIOTECA DI CIGOLE	CIGOLE	BG	Via Roma 19	309959767		biblioteca@comune.cigole.bs.it	25020	CIGOLE	BS	453.092.567	101.9
Bassa Bresciana Cent	17	BIBLIOTECA R.REMONDI" FIE	FIESSE	BH	Via Gramsci 1	309950044		biblioteca@comune.fiesse.bs.it	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 13:03	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	*7E4A6F981956!	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	*1883A62556E4	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	*553F581CBD92	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	*09627AE88B21(	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	08/11/13 12:57	05/04/13 16:26	07/02/13 12:57	184	173	173
15925061	*6155509B484F-	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	*8C28489E86BE|	53	GADESCO PIEVE DELMONA	04/10/12 14:08	14/02/13 16:54	19/02/13 12:47	16/05/13 16:54	108	238	238
15933054	*C4D518DAF8A/	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	*89FD87FCE2B3	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	*E9D221E8924D	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	*B9F25BBF4B57(	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**: user data;
- **request_date**: when the user makes the request;
- **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; you will focus on the pick-up and delivery parts by developing routes for couriers, while trying to reduce the costs paid by RBBC.

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

- How many times a week should couriers visit a particular library?
- Where should the depots be located?
- What is the capacity of a vehicle? And are vehicles *homogenous* or not?

Variables, parameters, constraints... Can you identify them in this problem? Thinking about and discussing the problem, you may also find 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 with new insights and suggestions** about the decisions they have to make, for instance choosing a good logistics 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 to 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.

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