Optimization for Social Good

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Optimization for Social Good

- Focus on the applications of **Operations Research and Analytics** to make a positive **Impact on the Society**.
- Applications to
  - **Humanitarian Logistics**
  - **Social Care**
  - **Health Care**
  - Environmental
  - Decision problems from NGO humanitarian organizations, social care organizations, public services and entities, hospital or primary health institutions.

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Operations Research & Analytics

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Analytics

- Analytics is defined by three categories:
  - **Descriptive analytics**
    - …gives insight into past events, using historical data.
  - **Predictive analytics**
    - …provides insight on what will happen in the future.
  - **Prescriptive analytics**
    - …helps with decision making by providing actionable advice.
    - How can we make it happen?
    - What should be done?
    - How can we make the best decisions for the future?

* Source: https://www.informs.org/Explore/Operations-Research-Analytics (accessed: 24/08/2020)

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UPF Business Analytics Research Group Projects

Operations Research and Analytics for Social Good (ORA4SG)

Focus on the Wellbeing of the People and the Planet

Mathematical Models and Algorithms: Linear Programming, Metaheuristics, Machine Learning, Exact Methods, Intelligent Optimization, Simulation

- ORA4 Integrated Home Health and Social Care
- ORA4 Sustainability
- ORA4 Development
- ORA4 Ageing Population
- ORA4 Logistics of Home Care
- ORA4 Collaborative Transportation
- ORA4 Sustainable Farming
- ORA4 School and Health Centers Location
- ORA4 Immigration and Refugees

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Projects in Optimization for Social Good

Intelligent Optimization

The social urgency of a growing elderly population: Building sustainable home care services
La Caixa Social Research 2020

Logistics Optimization for the Home Health and Social Care Services
Ministry of Science, Innovation and Universities of the Government of Spain

EPHoCaS

OptCare Services

Industrial PhDs

Other Applied Projects

Mobility Optimization for Social Care Services
Logistics Optimization of the Home Social Care Services
Generalitat de Catalunya
Universitat Pompeu Fabra & Barcelona City Council

Optimizing Sample Collection Routes

Location of Schools in Developing Countries

Health Mobility in Rural Areas

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Outline

- Collecting and Distributing
  - The route optimization for collection Covid-19 samples
  - The route optimization for distributing food
    - Banc d'Aliments
- Home Care Services
  - Integrated Social and Health Care
- Social Care Organizations
  - Optimization in Assistive Technology programs: case study "Banc del Moviment" in Barcelona
- Lessons learned, Recommendations and Conclusions

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Collecting and Distributing

- The objective is to design a system to collect or distribute products.
  - **Pedro Martins** and **Antonio Trigo** (*Polytechnic Institute of Coimbra),* **Helena Ramalhinho** (UPF)
- The real applications:
  - Collection of COVID-19 swab clinical samples.
  - Food delivery – NGOs organizations
- We have developed:
  - A mathematical model (solved with CPLEX)
  - An Iterated Local Search Intelligent Algorithm (Metaheuristic)
  - An excel-based system

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Collecting and Distributing

- Time-Constraint Capacity Open VRP
  - A direct graph $G = (V, A)$; $V = \{0, 1, \ldots, n\}$ is the set of $n + 1$ nodes and A is the set of arcs.
    - Node 0 represents the depot (laboratory), while the remaining nodes V' = $V \setminus \{0\}$ corresponds to the n collecting points.
  - Each collection point i ϵ V' has q_i boxes to be transported to the depot (assume $q_0 = 0$).
  - Distance and travel times between each node.
  - Open routes (start at the first collecting point and finish at the laboratory)
  - The vehicle fleet is composed M = {1,…, m} identical vehicles with capacity Q.
  - The travel maximum time between the first collecting point to the laboratory is 2 hours.
  - **Minimize the total distance (or transportation costs)**

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Collecting and Distributing

- The mathematical model…
  - The 2-commodity flow formulation (2CFF) for the OVRP

minimize $\sum_{i\in N}\sum_{j\in N^0}(t_{ij} + it_i)\cdot x_{ij}$

subject to

$\sum_{j\in N^0} x_{ji} = 1$, for all $i\in N$

$\sum_{j\in N^0} x_{ij} = 1$, for all $i\in N$

$\sum_{i\in N^0} y_{ji} - \sum_{i\in N^0} y_{ij} = iq_j$, for all $j\in N$

$iq_i \cdot x_{ij} \le y_{ij} \le (qq - iq_j)\cdot x_{ij}$, for all $i\in N$ and $j\in N^0$ with $i \ne j$

$\sum_{i\in N^0} w_{ji} - \sum_{i\in N^0} w_{ij} = \sum_{i\in N^0}(t_{ji} + it_j)\cdot x_{ji}$, for all $j\in N$

$(t_{ij} + it_i)\cdot x_{ij} \le w_{ij} \le (tt - it_j)\cdot x_{ij}$, for all $i\in N$ and $j\in N^0$ with $i \ne j$

$y_{0j} + w_{0j} \le x_{0j}$, for all $j\in N$

$x_{ij}\in\{0,1\}$ for all $(i,j)\in A$

x_{ij} , $y_{ij} \ge 0$ for all $(i,j)\in A$

Variables:

$x_{ij} = \begin{cases} 1 & \text{if arc } (i,j) \text{ is in the solution} \\ 0 & \text{otherwise} \end{cases}$, for all $(i,j)\in A$

$y_{ij} \equiv$ number of boxes passing through arc (i,j), for all $(i,j)\in A$

$w_{ij} \equiv$ traveling time of the vehicle when passing through arc (i,j), for all $(i,j)\in A$

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Collecting and Distributing

- Data

Location ID (i)	Name	Adress	Latitude (x)	Longitude (y)	Must be visited?	Pickup amount (Qi)	Service time (ST)
0	Hospital Clínic	Carrer de Villarroel, 170, 08036, Barcelona, Spain	41.389153	2.150911			
1	CAP Lluís Sayé	Centre d'Atenció Primària Doctor Lluís Sayé	41.384335	2.165182	y	2	10
2	CAP Drassanes	Centre d'Atenció Primària Drassanes	41.376550	2.173411	y	1	10
3	CAP Gòtic	Centre d'Atenció Primària Gòtic	41.378814	2.177034	y	1	10
4	CAP Barceloneta	Centre d'Atenció Primària Barceloneta	41.383433	2.194692	y	2	10
5	CAP Casc Antic	Centre d'Atenció Primària Casc Antic	41.390333	2.180485	y	2	10
6	CAP Carles I	Centre d'Atenció Primària Carles I	41.398705	2.182278	y	1	10
7	CAP Passeig Sant Joan	Centre d'Atenció Primària Passeig Sant Joan	41.392679	2.178971	y	2	10
8	CAP Sagrada Família	Centre d'Atenció Primària Sagrada Família	41.410198	2.176709	y	2	10
9	CAP Roger de Flor	Centre d'Atenció Primària Roger de Flor	41.398895	2.172756	y	3	10
10	CAP Casanova	Centre d'Atenció Primària Casanova	41.390425	2.153314	y	2	10
11	CAP Comte Borrell	Centre d'Atenció Primària Comte Borrell	41.389505	2.146406	y	3	10
12	CAP Manso	Centre d'Atenció Primària Manso	41.376475	2.160129	y	3	10
13	CAP Les Hortes	Centre d'Atenció Primària Les Hortes	41.371650	2.166823	y	3	10
14	CAP de la Marina	Centre d'Atenció Primària de la Marina	41.361809	2.136303	y	3	10
15	CAP Doctor Carles Ribas	Centre d'Atenció Primària Doctor Carles Ribas	41.358293	2.144328	y	3	10
16	CAP Bordeta - Magòria	Centre d'Atenció Primària Bordeta - Magòria	41.369869	2.141268	y	3	10
17	CAP Roger	Centre d'Atenció Primària Roger	41.377408	2.128514	y	3	10
18	CAP Numància	Centre d'Atenció Primària Numància	41.381887	2.140460	y	3	10
19	CAP Sants	Centre d'Atenció Primària Sants	41.376766	2.13508	y	2	10
20	CAP Montnegre	Centre d'Atenció Primària Montnegre	41.387617	2.138748	y	1	10
21	CAP Les Corts	Centre d'Atenció Primària Les Corts	41.384846	2.123751	y	1	10
22	CAP Les Planes	Centre d'Atenció Primària Les Planes	41.427163	2.088665	y	2	10
23	CAP Vallvidrera	Centre d'Atenció Primària Vallvidrera	41.413845	2.104183	y	2	10
24	CAP Sarrià	Centre d'Atenció Primària Sarrià	41.402367	2.121532	y	1	10
25	CAP Adrià	Centre d'Atenció Primària Adrià	41.400453	2.138808	y	2	10
26	CAP Vallcarca-Sant Gervasi	Centre d'Atenció Primària Vallcarca-Sant Gervasi	41.415815	2.141888	y	2	10
27	CAP Larrard	Centre d'Atenció Primària Larrard	41.410518	2.156161	y	3	10
28	CAP Sanllehy	Centre d'Atenció Primària Sanllehy	41.413363	2.163054	y	2	10
29	CAP Vila de Gràcia-Cibeles	Centre d'Atenció Primària Vila de Gràcia-Cibeles	41.398698	2.162003	y	3	10
30	CAP Pare Claret	Centre d'Atenció Primària Pare Claret	41.404125	2.164621	y	3	10
31	CAP Sardenya	Centre d'Atenció Primària Sardenya	41.409468	2.165567	y	3	10
32	CAP Guinardó	Centre d'Atenció Primària Guinardó	41.419029	2.178785	y	3	10
33	CAP El Carmel	Centre d'Atenció Primària El Carmel	41.420858	2.150043	y	3	10
34	CAP Horta	Centre d'Atenció Primària Horta	41.428842	2.157002	y	3	10
35	CAP San Rafael	Centre d'Atenció Primària San Rafael	41.42627	2.140431	y	3	10
36	CAP Turó	Centre d'Atenció Primària Turó	41.433082	2.170587	y	3	10
37	CAP Guineueta	Centre d'Atenció Primària Guineueta	41.439533	2.16605	y	2	10
38	CAP Roquetes	Centre d'Atenció Primària Roquetes	41.446174	2.173934	y	1	10
39	CAP Rio de Janeiro	Centre d'Atenció Primària Rio de Janeiro	41.439844	2.181124	y	1	10
40	CAP Chafarinas	Centre d'Atenció Primària Chafarinas	41.446975	2.183294	y	2	10
41	CAP Ciutat Meridiana	Centre d'Atenció Primària Ciutat Meridiana	41.460414	2.181436	y	2	10
42	CAP Trinitat Vella	Centre d'Atenció Primària Trinitat Vella	41.450981	2.192785	y	1	10
43	CAP Bon Pastor	Centre d'Atenció Primària Bon Pastor	41.438975	2.206215	y	2	10
44	CAP Sant Andreu	Centre d'Atenció Primària Sant Andreu	41.433213	2.183642	y	2	10
45	CAP La Sagrera	Centre d'Atenció Primària La Sagrera	41.422424	2.190364	y	3	10
46	CAP Passeig Maragall	Centre d'Atenció Primària Passeig Maragall	41.415741	2.180747	y	2	10
47	CAP El Clot	Centre d'Atenció Primària El Clot	41.411837	2.192697	y	3	10
48	CAP Vila Olímpica	Centre d'Atenció Primària Vila Olímpica	41.390455	2.194741	y	3	10
49	CAP Poblenou	Centre d'Atenció Primària Poblenou	41.405766	2.202385	y	3	10
50	CAP Ramon Turró	Centre d'Atenció Primària Ramon Turró	41.406334	2.211231	y	3	10
51	CAP Besòs	Centre d'Atenció Primària Besòs	41.415398	2.215456	y	3	10
52	CAP Sant Martí	Centre d'Atenció Primària Sant Martí	41.414165	2.197349	y	3	10
53	CAP La Pau	Centre d'Atenció Primària La Pau	41.42293	2.208665	y	3	10

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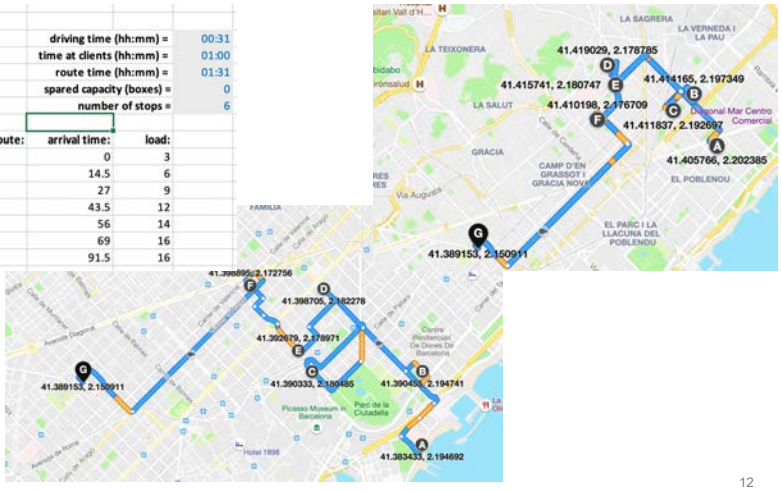
Collecting and Distributing

- Solution: an Iterated Local Search metaheuristics

Vehicle 1:		
	driving time (hh:mm) =	00:31
	time at clients (hh:mm) =	01:00
	route time (hh:mm) =	01:31
	spared capacity (boxes) =	0
	number of stops =	6
route:	arrival time:	load:
CAP Poblenou	0	3
CAP Sant Martí	14.5	6
CAP El Clot	27	9
CAP Guinardó	43.5	12
CAP Passeig Maragall	56	14
CAP Sagrada Família	69	16
Hospital Clínic	91.5	16



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Home Care Services

- **Home Care** could be understood as health and social care provided to a person in the place, he/she lives with the aim to maintain him/her at his own environment and achieve a maximum level of **health, quality of life and wellbeing and autonomy**.
- **Integrated Home Care** is a model of care where different professionals from health and social care **act jointly**, sharing information and goals and taking joint or **coordinated decisions** to guarantee Integrated Care at home.

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Home Care Services

- **Home Health Care (HHC)** is defined as “medical and paramedical services delivered to patients at home”.
  - The basic forms of Home Health Care are Home Hospitalization and In-Home Primary Health Care.

- **Home Social Care (HSC)** refers to provide social work, personal care, protection or social support services to risk or needed population due illness, disability, old age or poverty.
  - The HSC services include a great variety of services as cleaning activities; companionship activities, personal care, delivery meals at home, etc.

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Home Health and Social Care

- As reported by National Audit Office (2017) the integration and coordination of both kinds of services, Integrated Home Care (IHC), is a real need in many countries.
- Applications in Barcelona City Council and Suara

Motivation:

- Barcelona:
  - * 24000 people in 2018
  - * 40000 expected in 2019
  - * A cost of 53 million € (2015) to 84 million € (2018)
  - * About 3500 workers

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Actual situation

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Home Care Services

- The main benefits of the **Integrated Health Care (IHC)** service are:
  - the **quality** of life perceived by **patients or caretakers** that stay at home is higher than if they stay at the hospital or seniors' housing and long-term care;
  - the significant decrease in the **hospitalization rate** that leads to **costs reduction** in the whole health system.

- **New decision models of integrated and coordinated care are needed**…


LA VANGUARDIA

ACCIÓN SOCIAL

Innovador, social y de calidad, así es el Servicio de Ayuda a Domicilio de Accent Social en Barcelona

Las personas dependientes encuentran en la asistencia domiciliaria un aliado para mejorar su calidad de vida y fomentar su autonomía

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Home Health and Social Care

- The impact of Synchronization in Home Health and Social Care Services
  - * Jésica de Armas, Marcelus Fabri, Helena Ramalhinho (UPF)
- Optimizing an integrated home care problem: a heuristic-based decision-support system
  - * Bruno Vieira, Jesica de Armas, Helena Ramalhinho

  - The aim is to design and develop new mathematical models and optimization algorithms for the routing and scheduling problems associated to the syncronization of both HHC and HSC, obtaining integrated HHSC:
  - **Scheduling**: assignment of staff members to jobs along the planning horizon
  - **Routing**: creation of the corresponding routes for the staff members

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Home Health and Social Care

- Mixed Integer Programming Model
  - Main decision variables
    - $\beta_{in} \in \{0,1\}$: 1 if the caregiver $n \in \mathcal{N}$ need a break before the job $i \in \mathcal{J}$
    - $p_{nt} \in \{0,1\}$: 1 if the caregiver $n \in \mathcal{N}$ need a break on day $t \in \mathcal{T}$
    - $w_i \in \mathbb{R}$: Waiting time before job $i \in \mathcal{J}$
    - $x_{ijn} \in \{0,1\}$: 1 if job j is performed by caregiver n directly after job i, $(i,j,n) \in \Omega_i^+$
    - $z_i \in \mathbb{R}$: Start time of job $i \in \mathcal{J}$
    - $s_i \in \mathbb{R}$: Tardiness of job $i \in \mathcal{J}$
    - $e_i \in \mathbb{R}$: Earliness of job $i \in \mathcal{J}$
    - $\delta_{nk} \in \{0,1\}$: 1 if the caregiver $n \in \mathcal{N}$ is associated to caretaker $k \in \mathcal{K}$
    - $n_k \in \mathbb{N}$: Number of caregivers working for each caretaker $k \in \mathcal{K}$

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Home Health and Social Care

- Objective function
  - Minimize total time
    - * travel times, waiting times, and breaks

$$\text{minimize} \quad \sum_{i\in\mathcal{J}}\sum_{j\in\mathcal{J}}\sum_{n\in\mathcal{N}} d_{ij}x_{ijn} + \sum_{i\in\mathcal{J}} w_i + \sum_{n\in\mathcal{N}}\sum_{t\in\mathcal{T}} B \cdot p_{nt}$$

  - Maximize service quality
    - * Caregivers loyalty and soft time windows

$$\text{minimize} \quad \frac{\sum_{k\in\mathcal{K}^0}\sum_{n\in\mathcal{N}} y_{nk}}{\sum_{k\in\mathcal{K}^0} C_k} + \frac{\sum_{K\in\mathcal{K}} n_k}{\sum_{K\in\mathcal{K}} J_k}$$

$$\text{minimize} \quad \frac{\sum_{i\in\mathcal{J}} e_i + s_i}{\sum_{i\in\mathcal{J}} h_i} + \frac{\sum_{(i,j)\in\mathcal{J}^{syn}} \mu^+_{(i,j)} + \lambda^-_{(i,j)}}{\sum_{(i,j)\in\mathcal{J}^{syn}} g_{ij}}$$

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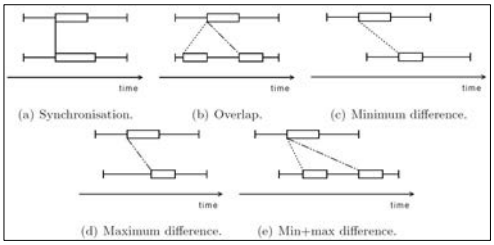
Home Health and Social Care

- Constraints
  - General Constraints
    - Each job must be done
    - Caregivers schedule
  - Working Regulations
  - Breaks
  - Interdependencies
  - Continuity of care



- Small instances are solved with CPLEX and larges one are solved by a heuristic approach.
  - Optimizing an integrated home care problem: a heuristic-based decision-support system (Bruno Vieira, Jesica de Armas, Helena Ramalhinho)

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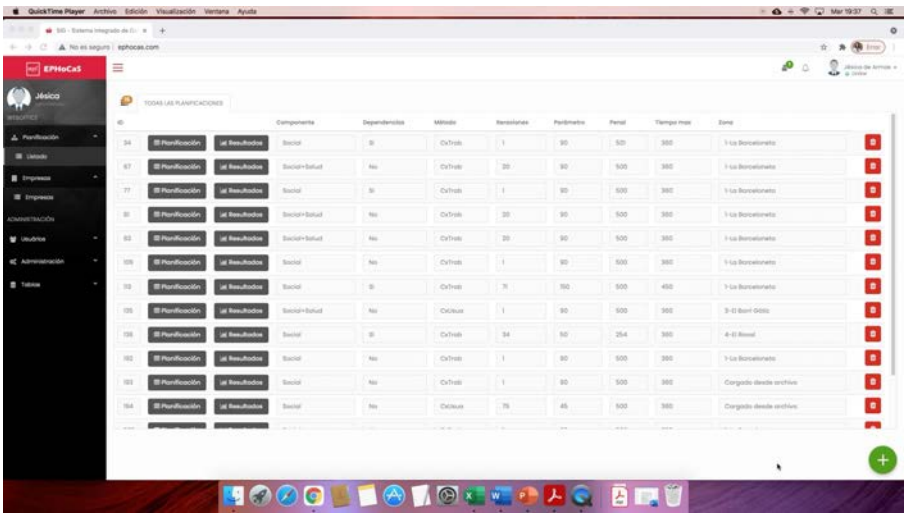
Web-based system to optimize home care



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Many problems in Health and Social

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SCM & Logistics in Health

- "A doctor isn't much good to anyone in the middle of the desert if she doesn't have her medicines delivered at the right time and place, at the right temperature. Without logistical support, MSF wouldn't be able to work with the speed and efficiency that we do."
  - Chris Houston, MSF LOGISTICIAN
  - https://www.msf-me.org/emergency-logistics

Emergency logistics

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Social Care Services

- Optimization in Assistive Technology programs: case study "Banc del Moviment" in Barcelona
  - De Armas J., Rodriguez-Pereira J. Vieira B. and Ramalhinho H. (2021), Optimizing Assistive Technology Operations for Ageing Populations, Sustainability, 13(12), 6925; https://doi.org/10.3390/su13126925.

World Health Organization

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Assistive Technology Organization *Banc del Moviment (BM)*

banc del moviment
xarxa solidària de productes de suport

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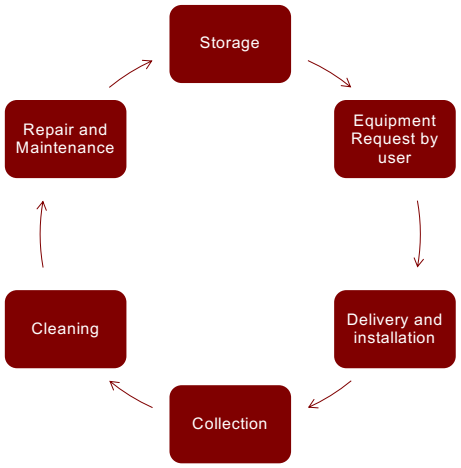
BM bases its service in Circular Economy principles



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Optimizing the AT Operations

- Three main operational problems in the Assistive Technology (AT) programs:
  - the location of warehouses and customer service points
  - the inventory management of the different types of equipment
  - the optimization of the pick-up and delivery routes.

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Location of warehouses and customer service points

subject to

	A	B	C	D	E	F
1	ID	Nom	X	Y	Demand service 1	Demand service 2
2	1	el Raval	2.1704919	41.378963	1	2
3	2	el Barri Gòtic	2.1774467	41.381099	2	6
4	3	la Barceloneta	2.1901586	41.377202	3	5
5	4	Sant Pere Santa Caterina i la Ribera	2.1834368	41.386794	7	5
6	5	el Fort Pienc	2.1814867	41.397418	4	6
7	6	la Sagrada Família	2.1765842	41.405448	3	4
8	7	la Dreta de l'Eixample	2.1681985	41.393885	9	4
9	8	l'Antiga Esquerra de l'Eixample	2.1551509	41.389357	5	9
10	9	la Nova Esquerra de l'Eixample	2.1489777	41.38306	7	10
11	10	Sant Antoni	2.1593504	41.378538	2	7
12	11	el Poble Sec	2.1582486	41.365416	7	3
13	12	la Marina del Prat Vermell	2.142603	41.339334	2	5
14	13	la Marina de Port	2.1398416	41.35997	2	1
15	14	la Font de la Guatlla	2.1448666	41.369748	10	6
16	15	Hostafrancs	2.1442432	41.375317	9	6
17	16	la Bordeta	2.1364107	41.36904	4	4
18	17	Sants - Badal	2.1277307	41.374675	6	0
19	18	Sants	2.136348	41.377466	9	5
20	19	les Corts	2.1346997	41.386039	8	10
21	20	la Maternitat i Sant Ramon	2.1174165	41.381218	4	3

0.Start | 1.Locations | 2.Demand

$$\text{Minimize} \sum_{k\in K}\sum_{i\in I}\sum_{j\in J} d_j c_{kij} x_{kij} + \sum_{k\in K, i\in I} f_k y_{ki} \qquad (7)$$

$$\sum_{k\in K}\sum_{i\in I} x_{kij} = 1 \quad \forall j \in J, \qquad (8)$$

$$x_{kij} \le y_{ki} \quad \forall k \in K, i \in I, j \in J, \qquad (9)$$

$$x_{kij} \le y_i \quad \forall k \in K, i \in I, j \in J, \qquad (10)$$

$$\sum_{k\in K} y_{ki} = p_1, \qquad (11)$$

$$\sum_{i\in I} y_i = p_2, \qquad (12)$$

$$y_{ki} \in \{0,1\} \quad \forall k \in K \cup I, \qquad (13)$$

$$x_{kij} \in \{0,1\} \quad \forall k \in K, i \in I, j \in J. \qquad (14)$$

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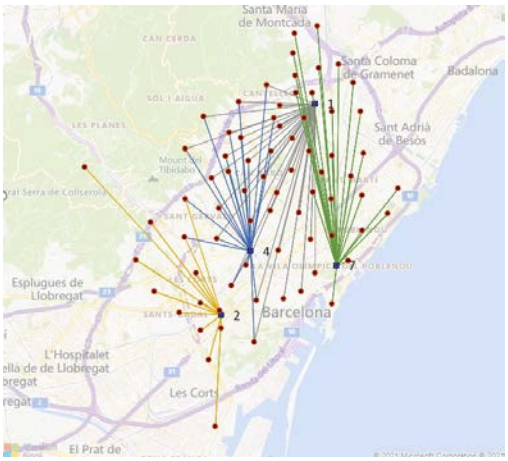
Location of warehouses and customer service points



- Visualization example for a p-median problem.

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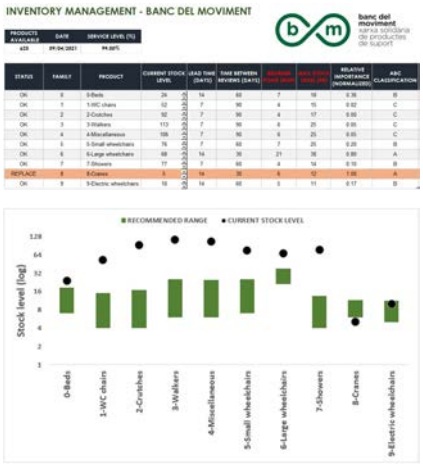
Inventory management of the different types of equipment



- Minimum Recommended Stock Level
- Maximum Recommended Stock Level
- ABC classification

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Optimization of the pick-up and delivery routes

	A	B	C
1	PARAMETER	VALUE	
2	Number of vehicles per day	1	
3	Number of working days per week	5	
4	Pick-up and delivery routes	•	
5	Number of warehouses	2	
6	Average vehicle speed	70	
7	Bing Maps Key		
8			
9			
10			

Transportation Console | 1. Pick-up locations | 2. De

	A	B	C	D
1	VEHICLE ID	FIXED COST PER TRIP	COST PER UNIT DISTANCE	DRIVING TIME LIMIT (min)
2	1	26	1,84	270
3	2	26	1,84	270
4	3	26	1,84	270
5	4	26	1,84	270
6	5	26	1,84	270
7				
8				

Transportation Console | 4. Vehicles

$$\text{Minimize } c \sum_{(i,j)\in E} d_{ij} \sum_{k\in K} x_{ij}^k + p \sum_{i\in C} \left(1 - \sum_{k\in K} z_i^k\right), \quad (19)$$

subject to

$$\sum_{k\in K} z_i^k \le 1 \qquad \forall i \in C, \quad (20)$$

$$\sum_{j\in E(i)} x_{ij}^k = z_i^k \qquad \forall i \in V, k \in K, \quad (21)$$

$$\sum_{j\in E(i)} x_{ji}^k = z_i^k \qquad \forall i \in V, k \in K, \quad (22)$$

$$\sum_{i\in D} z_i^k = 1 \qquad \forall k \in K, \quad (23)$$

$$\sum_{i\in C} \sum_{r\in D} w_{ir} z_i^k \le Q \qquad \forall k \in K, \quad (24)$$

$$\sum_{k\in K} x_{ir}^k \le b_{ir} \qquad \forall i \in C, r \in D, \quad (25)$$

$$\sum_{k\in K} x_{ri}^k \le b_{ir} \qquad \forall i \in C, r \in D, \quad (26)$$

$$\sum_{k\in K} x_{ij}^k + b_{ir} + \sum_{m\in C, m\ne i} b_{jm} \le 2 \qquad \forall i, j \in C, i \ne j, r \in D, \quad (27)$$

$$\sum_{(i,j)\in E} t_{ij} x_{ij}^k \le 270 \qquad \forall k \in K, \quad (28)$$

$$u_i^k - u_j^k + Q x_{ij}^k \le Q - \sum_{r\in D} w_{jr} \qquad \forall i, j \in C (i \ne j),$$

$$w_{ir} + w_{jr} \le Q, k \in K, \quad (29)$$

$$z_i^k \sum_{r\in D} w_{ir} \le u_i^k \le Q z_i^k \qquad \forall i \in C, k \in K, \quad (30)$$

$$u_i^k \in Z^+ \qquad \forall i \in C, k \in K, \quad (31)$$

$$z_i^k \in \{0,1\}, x_{ij}^k \in \{0,1\} \qquad \forall (i,j) \in E, k \in K. \quad (32)$$

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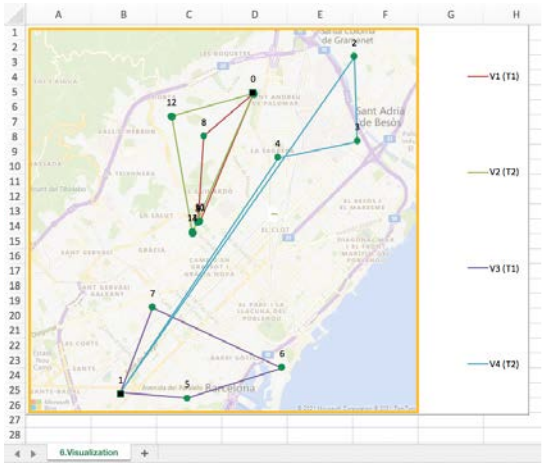
Optimization of the pick-up and delivery routes



- Visual representation of the routes in a map using Bing Maps.

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Other projects of the BARG members

- Campaign Optimization
  - Eurekathon - Daniel Badell, Laura Portell Jessica Rodriguez, Bruno Vieira
- School Location in developing countries
  - Improving the accessibility to public schools in urban areas of developing countries - Jesica de Armas. Helena Ramalhinho, Marta Reynal
- Disaster response in Caribbean region
  - Rodríguez-Pereira, J., Balcik, B., Rancourt, M. È., & Laporte, G. https://doi.org/10.1111/poms.13403.
- Real-Time Response to Roadside Incidents
  - Build, R., de Armas, J., Riera, D., Orozco, S. https://doi.org/10.3390/math9161982
- Logistics optimization of Metges Sense Fronteres vaccine campaigns
  - Adrià Bartuí, Jessica Rodriguez, Helena Ramalhinho
- Location of Daycare Centers
  - Barcelona, Rio de Janeiro - Luciana Pessoa, Helena Ramalhinho, Jesica de Armas

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Lessons Learned

- Many possible applications of Optimization for Social Good.
- The challenge of developing a simple tool but that make a **positive impact in the society**.
- New state-of-the art **solutions (Models and Algorithms)** based on mathematical models and algorithms of the Operations Research.
  - Stochastic elements, new objective functions, social value, real aspects and constraints, adaptability…
- The tools must be **simple to understand and use**.
- Work on **real applications**
  - Measure the Social Impact (Social Return of Investment)

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Recommendations

- Listen Listen Listen
  - Try to understand as much as possible the system that you want to optimize.
- Careful with the meaning of the words
  - Optimal solution as a different meaning.
- Define well the objective function
  - How to measure quality on health and social care services?
- People People People
  - You are working with people, so anything can happen.
- Explain Explain Explain
  - Explain your model and algorithm in an accessible way by everyone Simplicity is the best...

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Future Work

Operations Research Models for Planetary and People Wellbeing

Logistics in health emergencies, social care services and needs in rural areas

Stakeholder Collaborative Engagement
Access context and data
Test solutions and make suggestions

Health Emergency	Common aspects on the studied problems: • Social value • Uncertainty • Adaptability • Resilience • Real assumptions	Theoretical Mathematical Models Deterministic and Stochastic	Managerial Implications
Social Care Services		Algorithms – Metaheuristics & Simheuristics *User Friendly and Online*	Decision Making Tools
Rural Areas Services		Test and validation	Social Impact and wellbeing
		Collaboration among researchers	

Knowledge impact – Scientific publications

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Conclusions

- The OR models work on optimizing resources, but in the health, social, humanitarian and environmental sectors, most of the time, the resources are **people**.
  - not things like boxes, cars, machines.
- The incorporation of aspect like **people satisfaction, stochasticity, simplicity and accessibility** is more relevant than never to be able to put on practice the models and algorithms developed.
- Operations Research and Analytics can make a Great Impact in the Society leading to Social Good..

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