

# A review of applied operations research projects at the Instituto de Cálculo (2007-2016)

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Based on projects with Alejandro Antuña, Federico Bertero, Marcelo Bianchetti, Andrés Cardemil, Flavia Bonomo, Jaime Catalán, Diego Delle Donne, Guillermo Durán, Santiago Durán, Rafael Epstein, Alexis Jawtuschenko, Ivo Koch, Federico Larumbe, Min Chih Lin, Federico Mascialino, Graciela Nasini, Francisco Pigretti, Daniela Sabán, Nicolás Stier-Moses, Juan Ignacio Villasante, Andrés Weintraub, and Francisco Wesner

# The Instituto de Cálculo



- **1958:** The creation of the Instituto de Cálculo is proposed.
- **1958:** A Ferranti Ltd. Mercury computer is purchased, at £152.099.
- **1961:** Official start of activities of **Clementina**.
- J. Aguirre y R. Carnota. *Historia de la informática en Latinoamérica y el Caribe: Investigaciones y testimonios*. Universidad Nacional de Río Cuarto, 2009.

# Clementina



- RAM composed by 1024 words, with 40 bits each.
- 4 drums (initially, two) with 4096 words each.
- Input/output by a teleprinter tape, with five perforations.
- 10 racks for the hardware, 4 additional racks for the drums, and 5 racks for the power units.



- An OR group was created, which performed many projects:
  - ① Simulation of andean rivers.
  - ② Applications of critical path.
  - ③ Simulation of economic models.
  - ④ Applications of linear programming.
- D. Negrotto, *La investigación operativa en el Instituto de Cálculo durante el período 1960-1966*. *Saber y Tiempo* 23 (2012) 84–93.

# OR at the Instituto de Cálculo

- Since 2007, the Instituto de Cálculo strongly supports OR applied projects.
  - ① Such projects **complement** the academic education of its participants.
  - ② Consultancy and tech transfer are primary university goals.
  - ③ They provide **new problems** for research!
  - ④ They provide **additional income** :)
- (Ideal?) criteria for OR applied projects at a university:
  - ① The project must contain some well-defined **original research**.
  - ② It must not clone a previous project.
  - ③ It should involve **people education**, either students or company staff.
  - ④ It should leverage the **"OR brand"** among the users.



- OR has serious **branding issues!**
- Since the 2000s many efforts in order to leverage the OR brand have been undertaken.
  - 1 [www.orchampions.com](http://www.orchampions.com)
  - 2 [www.scienceofbetter.co.uk](http://www.scienceofbetter.co.uk)
  - 3 [www.learnaboutor.co.uk](http://www.learnaboutor.co.uk)



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- It is **up to us** to revert this situation, with high-quality, high-profile projects.

# OR at the Instituto de Cálculo (2007–2016)

- In the period 2007–2016, the Instituto de Cálculo undertook many kinds of projects:
  - 1 Sports projects.
  - 2 Projects with public institutions.
  - 3 Projects with software companies.
  - 4 Projects with non-software companies.



## [1/4] Sports projects

- 1 **Scheduling** sports leagues (i.e., determining the matches to be played throughout the league).
  - Argentine first division volleyball league, since 2007 (minimizing travel distances).
  - Argentine first and second division basketball leagues (combining **pre-specified tours** proposed by the teams).
  - South-American World Cup Qualifiers (maximizing fairness), in collaboration with the University of Chile.
- 2 Optimization model for the “Gran DT” **fantasy game**, with the objective of searching for ideal teams.
- 3 Scheduling the **umpire assignment** for the Argentine basketball leagues.

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DEPORTES

 Imprimir  Enviar   Tamaño de texto

UN EQUIPO DE DOCENTES Y ESTUDIANTES CALCULARON UN "DREAM TEAM" QUE HUBIESE TOTALIZADO 2.068 PUNTOS

## El juego que llegó hasta las aulas de Ciencias Exactas

Lo hicieron mediante un software que les permitió saber cuáles hubiesen sido los cambios óptimos.

Por: Jorge O. Blanco

Pero profesor, ¿para qué me sirve aprender esto?. Si esa pregunta que todo estudiante alguna vez hizo hubiera retumbado con más fuerza en este grupo de matemáticos, más de dos millones de entrenadores hoy no podrían conocer el equipo óptimo del Gran DT. Es decir, el que cumpliendo todos los requerimientos y reglas del Torneo Fantástico hubiera obtenido nada menos que 2.068 puntos.



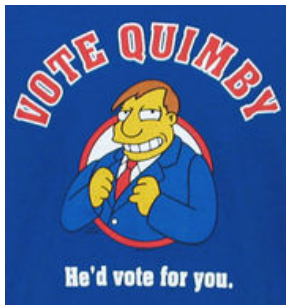
Los cuervos seguimos haciendo números y Perfil Sanlorençista cambió la óptica gracias a la iniciativa de Guillermo Durán, un fana cuervo que aparte es profesor del Departamento de Matemática de Exactas de la UBA. Los resultados arrojaron que las probabilidades de salvarse de todo son de un 28%.

- 👍 Huge **media impact!** Good for the university.
- 👍 A very active sports scheduling community, with a conference circuit, open problems and challenges.
- 👎 Sports projects regarded as academically “not quite serious”.

## [2/4] Projects with public institutions

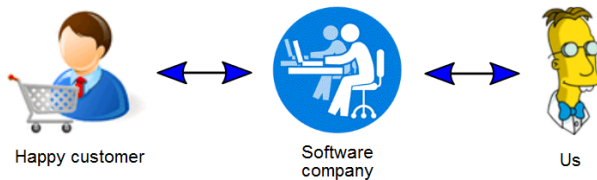
- 1 Design and computational solution of a **combinatorial auction** for providing Internet to schools in Buenos Aires City.
- 2 Optimization of the collection of urban waste.
  - 1 Buenos Aires City (containers collection).
  - 2 Morón (recyclable waste).
  - 3 San Carlos de Bariloche (home collection).
  - 4 Concordia (home collection).
  - 5 Salta (street cleaning).
  - 6 Tucumán (districting).
- 3 Traffic/people simulation.
  - 1 La Matanza (traffic).
  - 2 Avellaneda (people in downtown).

## [2/4] Projects with public institutions

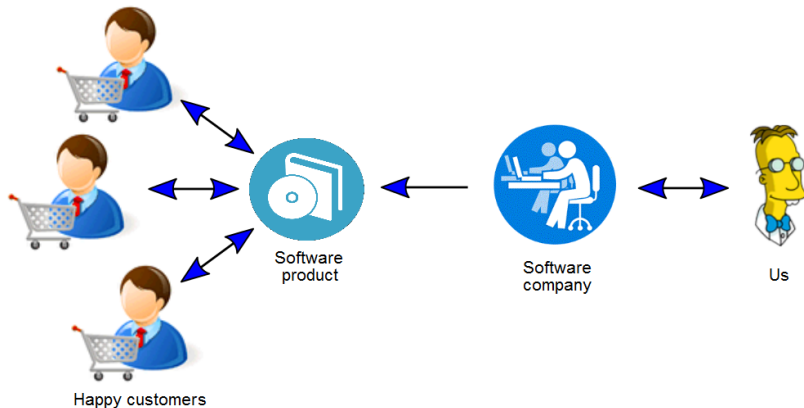


- 👎 Partners do not always have **good will** to collaborate ...
- 👎 Structures not used to receive external help.
- 👎 Projects usually close with a final document.

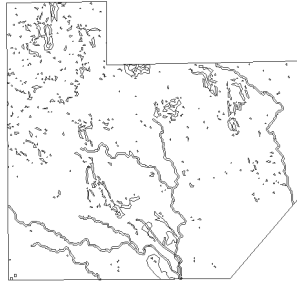
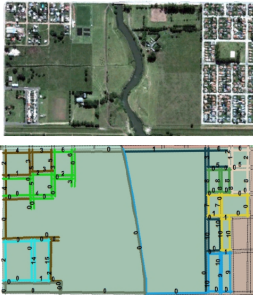
## [3/4] Projects with software companies



# [3/4] Projects with software companies

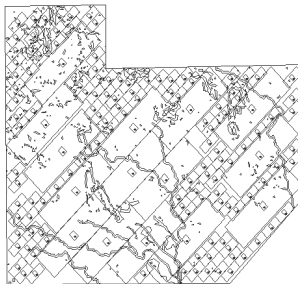
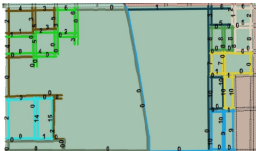


## [3/4] Projects with software companies



- 1 Plan the **dwelling**s to be visited by each census taker in the Buenos Aires Province, for the 2010 National Census.
- 2 Optimization of **location**s in unconventional oil and gas fields.

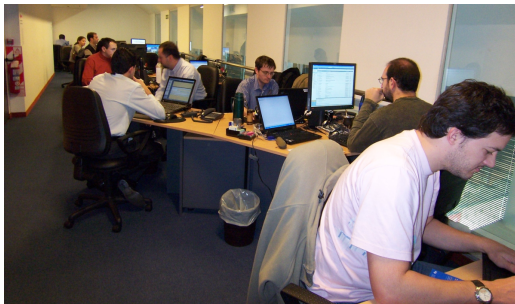
## [3/4] Projects with software companies



- 1 Plan the **dwelling to be visited** by each census taker in the Buenos Aires Province, for the 2010 National Census.
- 2 Optimization of **locations** in unconventional oil and gas fields.
- 3 Optimization of **team movement** in difficult terrains.



## [3/4] Projects with software companies



- 👍 Technical issues/dialog are very smooth, since we usually interact with IT people, or with staff having technical background.
- 👍 The company handles technical issues, interfaces, user assistance, etc.
- 👎 There is no clear **project closure**.
- 👎 No contact with **final users**.

# [4/4] Projects with non-software companies

Programación de la producción

Home

Nuevo Abrir Guardar Guardar como Resolver Configuración Salir

Archivo Resolución Exit

Datos Fijos

Datos Variables

Solución

Nombre	Rend...	Neto	Pred...	Costo...	Costo...	Costo...	C.Tra...	Calibr...	Calibr...	Facto...	Coef...	T.E. ...	Cong...	Coef...	T. Max...
Hon4...	0,899	0,7	7,5	0,415	0,194	0,15	0,351	4	5	1	1,97	1	<input checked="" type="checkbox"/>	1	10
Hon5...	0,899	0,7	7,7	0,415	0,194	0,15	0,351	5	6	1	1,97	1	<input checked="" type="checkbox"/>	1	10
Brasil...	0,904	0,7	7,8	0,349	0,245	0	0	4,53	5,44	1	1,47	1	<input type="checkbox"/>	1	1
Brasil...	0,904	0,7	7,8	0,349	0,245	0	0	5,44	6,35	1	1,47	1	<input type="checkbox"/>	1	1
Brasil...	0,904	0,7	7,8	0,349	0,245	0	0	6,35	13,06	1	1,47	1	<input type="checkbox"/>	1	1
TC60...	0,607	0,9	11,6	0,874	0,282	0,15	0,259	0,6	0,9	2	1,81	1	<input checked="" type="checkbox"/>	1	10
TC90...	0,607	0,9	11,6	0,874	0,282	0,15	0,259	0,9	1,2	2	1,81	1	<input checked="" type="checkbox"/>	1	10
TC12...	0,607	0,9	11,6	0,874	0,282	0,15	0,259	1,2	1,5	2	1,81	1	<input checked="" type="checkbox"/>	1	10

Agregar desde Excel

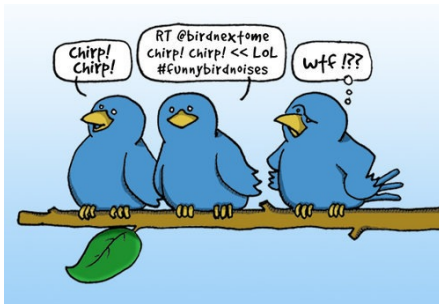
Agregar Borrar

Datos generales Clientes Productos Productos degradados Calibres Pesos Medios Distribuciones Distribuciones MP Lineas Compatibilidades

Versión: 1.05

- 1 Scheduling of **fish movements** in ships and trucks for a salmon farm company in Chile.
- 2 Production planning for a salmon company in Chile (both projects in collaboration with the University of Chile).

## [4/4] Projects with non-software companies



- 👎 We must overcome the **language barrier**!
- 👎 The whole project range must be covered (functional analysis, development, deployment, maintenance, etc.).
- 👎 We must allocate human resources after the project has “ended”.
- 👎 Direct access to the **project impact**.

# Lessons learnt along the way

- 1 Do not restrict yourself to a **single technique** (as, e.g., integer programming, metaheuristics, constraint programming, etc.). New projects may be better suited to a different toolset than yours!
- 2 When preparing a project proposal ...
  - a) A good **contact network** is more effective than a perfect résumé.
  - b) Do not underestimate the **scientific appeal** in proposals.
  - c) Do not underestimate the **commercial side** of every project.
- 3 Commit to doing **high-quality** work, even if you think it will not be appreciated by your customers.
- 4 **Customer care** is very important! Prompt response times, clear answers, professional development make the difference.