High-performance local search for TV media planning on TF1

Frédéric Gardi

Bouygues e-lab & LocalSolver, Paris

fgardi@localsolver.com

EURO 2012, Vilnius

Context

Bouygues: €33 billion revenue

- Bouygues Construction, Colas, Bouygues Immobilier
- TF1, Bouygues Telecom

TF1 Group, media branch: €2.6 billion revenue

- TF1, the largest European private TV channel
- Eurosport, the largest European sports network

TF1 Publicité, advertising subsidiary

- Manages advertising on TV, radio, web channels

Problem definition

TF1 launched a new commercial offer in 2012

Classical offer: clients of TF1 send some requests for each of their ads.

Example: “I want to buy 30 seconds in the 8:30 PM commercial break on May 24th for my Miss Dior perfume”.

New offer: clients send some requests for their entire ad campaign.

Example: “I want to plan a campaign over 3 weeks with maximum budget 200 k€, with commercials of duration 15s and 25s, with 30 % of audience in prime time.”

Problem definition

New offer: clients define their campaign using goals (= objectives)

Primary: budget or audience collected, repartition of audience (in %) over day-parts, periods of the campaign, spot durations.

Secondary: spacing of spots in the day, balancing the number of spots each day, augmenting audience collected during lunch or week-end, augmenting audience collected on another target market, etc.

The goals are ordered, since all the goals may not be achieved.

Problem definition

The global optimization problem

Plan the TV spots of the given campaigns in commercial breaks.

Constraints:
- Do not exceed the capacity of each commercial break (packing)
- Respect concurrences between campaigns (mutual exclusion)

Objectives:
1) Satisfy at best client goals for each campaign (service)
2) Maximize expected revenue until diffusion (revenue)

Each night, active campaigns + new ones are rescheduled.

Instance scale

Real-life large-scale optimization problem

5000 commercial breaks partially filled with classical offer.
50 campaigns, that is on average 3000 spots to schedule.
20 goals per campaign on average.

1 hour of computing time (1 min per campaign ≈ 2 sec per goal).
1 thread on a standard computer.

→ Multidimensional knapsack problem
→ Highly combinatorial, NP-hard

Local Search

Our vision:

LS = incomplete & non deterministic search

Our methodology for LS industrialization:

1) Pure & direct : no decomposition, no hybridization.

2) Highly randomized : any decision taken is randomized.

3) **Aggressive** : millions of feasible solutions explored.

LS methodology

LS = randomized moves + incremental computation

Therefore, our work is concentrated on:

- Designing moves for an effective exploration of the search space
- Speeding up the evaluation of moves

"Incremental computation", what's that?

Given a solution S to an optimization problem and a transformation Δ: $S \rightarrow S'$. Denote by $|\Delta|$ the length of "changes" between S and S'.

Issue: design an $O(|\Delta|)$-time algorithm to compute the cost of S'.

elab
BOUYGUES INNOVATION & OPTIMISATION

Implementation of a large pool of moves

Derived from basic transformations: insert spots, remove spots, move spots, exchange spots.

Derived according to characteristics of spots: randomized spots, spots in the same campaign, in the same day, in the same day-part, etc.

→ Nearly 30 different moves, picked randomly at each iteration

→ Neighborhood induced of size $O(n^k)$ with small k but large O

→ Neighborhood explored randomly in a first-improvement fashion

Difficulty: incremental computation for each campaign goal

Many goals can be expressed as a sum, or a ratio of two sums, of some attributes associated to each spot:

- Evaluation of “linear” goals = main part of the running time
- Each “linear” goal evaluated in $O(1)$ time in practice

Factorization of incremental computation codes of linear goals through object-oriented derivation.

Project figures

150 man-days, 150 k€ paid by TF1 to Bouygues e-lab.
8 months of work over 2011.

Alpha	March	API + input/output checkers
Beta	June	80% functional, 10 000 iterations/sec
1.0	August	100% functional, 100 000 iterations/sec
1.1	October	Functional adjustments (= evolutions)

Exploitation started in November 2011.
50 M€ of TV commercials planned on 2012 (projection).

Outcomes

Automation of the selling & scheduling process

- Only 2 people work to schedule 50 M€ of TV commercials per year
- Speeding up and securing the business process

Optimization of the selling & scheduling process

- Increase service level to the clients: better campaigns, faster.
- Reoptimization of the schedule each night:
  - Pack in order to schedule more campaigns
  - Optimize expected revenue until diffusion

Increase new-offer revenue by 1% compared to hand-made solutions.
5 % of high-quality stock (Lunch, Access, Prime) saved for classical offer.

LocalSolver
mathematical programming by local search

Following this LS methodology, we start developing in 2007 a math programming solver based on local search.

LocalSolver handles 0-1 nonlinear models with millions of variables, intractable using state-of-the-art IP/CP/SAT solvers.

The current 2.1 version can be downloaded at

www.localsolver.com

Free for faculty and students

LocalSolver Team: T. Benoist, J. Darlay, B. Estellon, F. Gardi, R. Megel, K. Nouioua