SPRINT: Optimization of Staff Management for Desk Customer Relations Services at Hera

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joint work with A. Gordini, C. Caremi (OPTIT)
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What is SPRINT?

• SPRINT is a Decision Support System for medium and short-term planning of the Staff Allocation to Customer Contact Desks (CCDs)
  • Developed for Hera Comm in 2009-10
  • Operational since February 2011
Summary

• Background and objectives
• Solution approach
  • Demand Forecasting
  • Adaptive Staff Optimizer
• Results and conclusions
Gruppo Hera

• Hera is the 2nd largest Italian multi-utility company
  • based in Emilia-Romagna
  • serving 3.5 million citizens
  • turnover 4.5 billion Euros (2012)
  • Gas (4^), electricity (7^), water (2^) and waste (1^)

• Hera Comm is a company of Hera
  • commercialization of energy (Gas and Electricity)
  • responsible of CRM for Hera
DEI-OR and OPTIT

• DEI-OR group is active since more than 20 years in personnel management optimization
  • in ‘93-’95 FARO and FASTER prizes for personnel management at Italian Railways
  • EU projects (TRIO, TRIS, REORIENT …)

• OPTIT is spinoff company created in 2007
  • DSS based on state-of-the-art OR for logistics, energy and services optimization
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CRM at Hera

- Major component for competitiveness after market deregulation
- Quality of CRM is 2\textsuperscript{nd} reason (after price) for Energy provider choice (Hera customers survey)

- **Desk CRM** is a distinctive element with respect to many competitors (ENEL, ENI, EDISON, GDF-SUEZ, EON…)
- 25% of 3M yearly contacts
Hera’s CCD network

>80 CCDs with 200 staff
• 8 TOP and 20 Medium
• 750K customers/year

• TOP and Medium CCDs:
  • include many counters (15-20)
  • supervised by Desk Managers
CCD Management: Challenges ...

WORKING TIME of a DESK EMPLOYEE

FRONT OFFICE
Contact Desk Activities

BACK OFFICE and SALES

• Efficacy: maintain high service quality at FO
  • Mean and max wait time

• Efficiency:
  • long and more compact intervals for BO/sales
  • reduction of resource requirements (even with increase in demand rate)
… and opportunities

• Pre-SPRINT
  • Good average quality of service
  • High variability of performance among CCDs
  • High resource requirements
  • Long Waiting Time in case of peaks
  • Back Office inefficiency (switch BO/FO and vv)
  • Limited proactive sales activities

→ Need of prediction and optimization tools to improve Efficiency and Efficacy
The SPRINT project

• Follows the redesign of CRM in 2007/08
• Started in 2009 with Optit SPRINT
• Design a complete DSS for Staff Management:
  • Forecasting of the arrivals at the CCDs
  • Scheduling and rostering of the personnel of each CCD
  • Performing “what if” analysis
  • Defining KPIs and control them during the year
• SPRINT DSS is operational since Feb 2011 and covers 85% of the CCDs demand
SPRINT Objectives (vs 2009)

- **Efficacy**
  - >20% reduction of the mean waiting time (MWT) (was 16’)
  - >25% reduction of PW40, % of users waiting >40’ (was 9%)
  - Increase of the customer satisfaction index (CSI) for desk services (was 72).

- **Efficiency**
  - >30% reduction of the backlog of back office (BBO) requests allocated to desk staff (was 10,000).
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SPRINT planning architecture

- demand forecasting
- long/medium term planning
- revision and control

Peripheral users (Desk managers)

Monthly forecast & master plan

Central Planning Unit

Monthly available staff & feedbacks

Peripheral user (Desk manager)

- operational planning
The main SPRINT modules

- The modules are used for
  - medium term planning
  - operational management support (with limited functionalities)
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Demand Forecasting

• Crucial for the success of staff scheduling
• Historical data on arrivals (last three years)

• Requirements:
  • for each CCD arrivals every 15’ and per user type
  • medium-term forecast (1-3 months)
  • very ambitious target of 13% MAPD (was >15-20%)

• Current literature:
  • Existing methods (moving avg, ARIMA …)
    • Work only for short term forecast (1-3 days)
    • For long term equivalent to historical avg (MAPD >15-20%)
Mission impossible?

- Daily arrival forecast is performed through a M5 model tree approach
  - combines regression and classification
  - used successfully in other contexts
  - easy to use and understand, fast to train
  - we integrated billing and special events information

→ 25-30% better than historical average for monthly forecasts
Demand Forecast results

TOP CCDs in 5 months of 2011: 125K arrivals
• BF : historical average (literature reference)
• HF (our approach) is 30% more accurate!
Forecast results (2011-13)

• The quality is rather constant during time
  • heavy crisis period (+ 50% written complaints, +34% contacts ad CCDs)

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<th>12.00%</th>
<th>14.00%</th>
<th>16.00%</th>
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<tbody>
<tr>
<td>MAPD</td>
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Staff Scheduling at HC

• Peculiar characteristics
  • Staff assignment to CCDs is fixed
  • CCDs are open 8am-3pm/Mon-Fri
  • most staff has working shift larger that CCD opening time
  • simplified meal break rules

¬ Aggregated scheduling for each day of the month (# staff used per time slot)
¬ Monthly staff rosters are easily obtained
Daily Staff Scheduling at HC

- Planning slots: 15 minutes
- Arrivals per slot: 5-20
- Average service time 10-22 minutes
- Maximum waiting time 40 minutes

High congestion: average # busy servers ~6
The SPRINT Staff Optimizer

- **Demand Forecast (DF) Module**
- **Data Analysis (DA) Module**
- **Schedule Generator (SG) Module**
- **Schedule Evaluator (SE) Module**

- **Minimize FTEs given the staffing**
- **Check solution feasibility (target SLAs)**

Flowchart:

1. Arrivals
2. Data Analysis (DA) Module
3. Schedule Generator (SG) Module
4. Schedule Evaluator (SE) Module
5. Solution Acceptance or Model Revision

- Service levels, Cost (# FTEs)
- Two-phase Scheduler

**Parameters and Equations**

- $\beta$
Requirements

• Fast optimization algorithm: hundreds of optimization problems to be solved daily

• Simple staffing approaches from the literature do not work on HC problems:
  • Period-by-Period staffing (SIPP) and LagMax
    (see Green et al. 2001, 2003)

• Another Mission Impossible ?
The solution: Adaptive staffing

- Staffing at time slot depends on a weighted sum of the arrivals in current and subsequent periods
  - \((\text{Staff work time})_{t1,t2} = f(N_{t1}, N_{t1+1}, \ldots, N_{t2}, \beta)\)
  - the open desks “cover” a fraction of the arriving users

- Staffing is controlled by a single parameter \(\beta \in [0,1]\)
  - \(\beta=0\): mostly served within 15-30’ ➔ high staff, short MWT
  - \(\beta=1\): mostly served within 45-60’ ➔ low staff, long MWT

\[(\text{Staff work time})_{t1,t2} = f(N_{t1}, N_{t1+1}, \ldots, N_{t2}, \beta)\]
Role of $\beta$ parameter

![Graph showing the role of $\beta$ parameter with 'target MWT' highlighted.](image)
Scheduling algorithm

• Based on an integer programming model

• maximizes the unused staff
• respects adaptive staffing and opening/closing rules
• relaxes the target-SLA constraints
Parameters & dec. variables

- $Q_s(t_1,t_2)$: total time needed for type $s$ in $[t_1, t_2]$.
- $B_t$: staff available at time $t$.
- $K^O, K^C$: min n. of time slots a desk must remain open or closed.
- $g_t$: unused personnel at time $t$ (available for Back Office duties).
- $y_{it}$: opening event for desk $i$ at time $t$.
- $x_{it}$: status of desk $i$ at time $t$.
- $d_{st}$: not served work time of type $s$ at time $t$. 
The ILP model

\[
\begin{align*}
\text{max} & \quad D \sum_{t \in T} g_t - M \sum_{s \in S, t \in T} d_{st} - \varepsilon \sum_{i \in I, t \in T} y_{it} \\
& \quad x_{it} - y_{it} - [x_{i(t-1)}]_{t>0} \leq 0 \quad \forall i \in I, t \in T \\
& \quad g_t + \sum_{i \in I} x_{it} = B_t \quad \forall t \in T \\
& \quad x_{it} - \sum_{p=\max(1,t-K^C+1)}^{t} y_{ip} \geq 0 \quad \forall i \in I, t \in T, t > 1 \\
& \quad \sum_{p=t-K^C}^{t-1} x_{ip} + K^C y_{it} \leq K^C \quad \forall i \in I, t \in T, t > K^C \\
\text{staffing} & \quad \sum_{i \in I_s} \left( D \sum_{t=t_1}^{t_2} x_{it} \right) + (d_{st_2} - [d_{s(t_1-1)}]_{t_1>1}) \geq Q_s(t_1, t_2) \quad \forall t_1, t_2 \in T, t_2 \geq t_1, s \in S \\
& \quad x_{it}, y_{it} \in \{0, 1\} \quad \forall i \in I, t \in T \\
& \quad g_t \geq 0 \quad \forall t \in T \\
& \quad d_{st} \geq 0 \quad \forall s \in S, t \in T
\end{align*}
\]
Adaptive scheduler results

- The model is solved very quickly
  - 32 time slots, 11 counters, 4 types
    - <1-2 sec with Cplex
- Evaluator: given the solution computes the service levels to see if the solution is feasible
  - fast custom discrete event simulator implemented in Java that runs 1500 day-simulations in 3-10 seconds
- Binary search on $\beta$ to meet target-SLA
Comparison with literature

<table>
<thead>
<tr>
<th>Congestion</th>
<th>Arrivals</th>
<th>FTE</th>
<th>MWT</th>
<th>PW40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>160</td>
<td>7.4</td>
<td>8</td>
<td>3%</td>
</tr>
<tr>
<td>High</td>
<td>200</td>
<td>8.6</td>
<td>9</td>
<td>4%</td>
</tr>
<tr>
<td>Very High</td>
<td>240</td>
<td>10.0</td>
<td>16</td>
<td>12%*</td>
</tr>
</tbody>
</table>

<p>|  | Adaptive | SIPP | LAG max |</p>
<table>
<thead>
<tr>
<th></th>
<th>FTE</th>
<th>MWT</th>
<th>PW40</th>
<th>FTE</th>
<th>MWT</th>
<th>PW40</th>
<th>FTE</th>
<th>MWT</th>
<th>PW40</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>FTE</td>
<td>MWT</td>
<td>PW40</td>
<td>8.3</td>
<td>3</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.8</td>
<td>10</td>
<td>6%*</td>
<td>8.7</td>
<td>10</td>
<td>6%*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.9</td>
<td>25</td>
<td>23%*</td>
<td>9.0</td>
<td>25</td>
<td>24%*</td>
<td></td>
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</tbody>
</table>
Ongoing work

• Incorporate robustness with respect to arrival rate uncertainty
  • improved short-term forecast
  • fast scenario-based two-phase stochastic optimization approach
  • proactive within-day re-optimization
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SPRINT results

• Sprint results Video
Benchmarking (vs other MU)

Mean wait time at desks (min) in 2011

- Hera: 10.5 minutes, # desks: 84
- A2A (2010): 13.5 minutes, # desks: 24
- Iren: 20 minutes, # desks: 33
- Acsm-Agans (2010): 22 minutes, # desks: 17
- AcegasAps: 27 minutes, # desks: 7
- Veritas Venezia: 27 minutes, # desks: 19
- Acea Roma: 38 minutes, # desks: 20

• Leadership in QoS - Utility Industry
• Service not available for Multinational Competitors
Achieved results: Quality, Cost, Sales

Medium and Large CCDs (85% of contacts)

<table>
<thead>
<tr>
<th></th>
<th>2009 (pre SPRINT)</th>
<th>mar-dec 2011 (SPRINT)</th>
<th>jan 2012-march 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average monthly requests (n.)</td>
<td>31.871</td>
<td>38.527</td>
<td>42.839</td>
</tr>
<tr>
<td>Average Waiting Time (min)</td>
<td>16.00</td>
<td>10.32</td>
<td>10.37</td>
</tr>
<tr>
<td>% Customers Waiting &gt; 40 min</td>
<td>9.0%</td>
<td>4.6%</td>
<td>4.6%</td>
</tr>
<tr>
<td>Customer Satisfaction Index (n.)</td>
<td>72</td>
<td>78</td>
<td>81</td>
</tr>
<tr>
<td>Staff available (n.)</td>
<td>193</td>
<td>189</td>
<td>188</td>
</tr>
<tr>
<td>Back Office Requests Backlog (n.)</td>
<td>10000</td>
<td>1500</td>
<td>600</td>
</tr>
<tr>
<td>Avg. BO time per employee (min/day)</td>
<td>45</td>
<td>65</td>
<td>70</td>
</tr>
<tr>
<td>Monthly Sales by Desk Staff (n.)</td>
<td>417</td>
<td>1420</td>
<td>3360</td>
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</tbody>
</table>

QUALITY

COST

SALES
Achieved results: CSI & sales

Customer Satisfaction Index per quarter

<table>
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<tr>
<th>1TR</th>
<th>2TR</th>
<th>3TR</th>
<th>4TR</th>
<th>1TR</th>
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<th>1TR</th>
<th>2TR</th>
<th>3TR</th>
<th>4TR</th>
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<tbody>
<tr>
<td>73</td>
<td>75</td>
<td>74</td>
<td>77</td>
<td>78</td>
<td>77</td>
<td>79</td>
<td>80</td>
<td>80</td>
<td>81</td>
<td>83</td>
<td>82</td>
<td>81</td>
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</tr>
</tbody>
</table>

new customers acquired at desk (EE+Gas) per quarter

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<th>1TR</th>
<th>2TR</th>
<th>3TR</th>
<th>4TR</th>
</tr>
</thead>
</table>

- Contribution to 2 Corporate Objectives (MBO for Hera Top-Mgmt):
  - 1. Customer Satisfaction
  - 2. Sales
An important “lesson learned”

• Proactive re-optimization:
  • it is worth re-optimizing within day when arrival rate is different from forecast

<table>
<thead>
<tr>
<th></th>
<th>17-Jan-12</th>
<th></th>
<th>18-Jan-12</th>
<th></th>
<th>19-Jan-12</th>
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<tbody>
<tr>
<td></td>
<td>MWT</td>
<td>O/F%</td>
<td>MWT</td>
<td>O/F%</td>
<td>MWT</td>
<td>O/F%</td>
</tr>
<tr>
<td>initial scheduling</td>
<td>27:54</td>
<td>1,57</td>
<td>05:51</td>
<td>0,60</td>
<td>31:06</td>
<td>0,80</td>
</tr>
<tr>
<td>re-optimization at 9:00</td>
<td>24:59</td>
<td>1,30</td>
<td>08:53</td>
<td>0,95</td>
<td>28:43</td>
<td>1,06</td>
</tr>
<tr>
<td>re-optimization at 10:00</td>
<td>24:50</td>
<td>1,25</td>
<td>09:14</td>
<td>0,97</td>
<td>14:02</td>
<td>1,28</td>
</tr>
<tr>
<td>re-optimization at 11:00</td>
<td>24:07</td>
<td>1,36</td>
<td>10:06</td>
<td>0,86</td>
<td>13:55</td>
<td>1,29</td>
</tr>
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HEAVY (EXPECTED) DAY (269 vs 217)
HIGH intial arrival rate: limited effect as all resources are used

LIGHT (EXPECTED) DAY (184 vs 192)
LOW initial arrival rate: saving of FTEs possible

HEAVY (UNEXPECTED) DAY (245 vs 171)
LOW initial arrival rate: MWT can be controlled
Conclusions

• Christian Fabbri (Hera Comm CEO):
  • … high quality-of-service improvement was combined with important operation costs reduction. Moreover, Sprint is widely used and appreciated by Desk Managers … and this is perhaps one the most important results.
  • … we estimate the Break-Even Point of Sprint Project to be reached in less than 2 years.

• Matteo Pozzi (Optit CEO):
  • After two full year of operations of the Service, we are proud to provide Hera Comm with a value added service recognized to be an area of excellence at national level
  • SPRINT is a key asset in the company’s value proposition with new significant sales to important players in the Italian utilities market
Conclusions and next steps

• Successful application of OR techniques to a real world context with very good results
• Huge commitment from Low and Top Mgmt
• Implementation of proactive scheduling support and further data analysis tools
• Extension to Call Centers (>2Million requests)
• Optit product (SPOT) currently implemented at another Multi-utility and at the leader of Electricy market in Italy
Thank you for your attention