isazi

"Transforming Logistics and Education: Leveraging Data & Analytics for Optimal Planning"

> Avi Bank Niambh Blundell



Overview

Isazi Consulting: ML and Optimisation

Data Science platform: Hudson

Optimisation Projects:

- Depot Replenishment
- Teacher Assignment and Scheduling



- Hudson ™ is an AI integration layer and data pipeline that uses a library of mathematical models, integrating seamlessly into a variety of data systems and sources.
- Able to ingest a variety of data, which are both internal and external and are at various levels of data quality.
- Imputes missing data, performs semi-automated data cleaning, and assesses data integrity
- Seamless data integration across diverse projects and departments.
- Empowers teams to adopt agile and data-driven strategies.







Integration with Gurobi:

- Hudson serves as a vital trigger for optimisation processes, including the integration with sophisticated tools like Gurobi.
- This allows for efficient and data-informed decisions in a time-sensitive environment.
- Minimises manual intervention and speeds up the decision-making process.
- This results in enhanced operational efficiency and cost reduction through optimised decision-making and resource allocation.



Future features:

- Automation of data ingestion
- Al-driven generation of interactive dashboards for user input, output and data visualisation
- GUI which allows non-technical users to connect and combine cleaned input with models and model output in order to design their own pipeline.



Impact on Analytics Toolchains and Planning Processes

- Hudson ensures **available** data is turned into **usable** data.
- This allows precise forensic debugging at various stages of the analytics chain.
- This level of organisation frees up time to focus on the more important (fun) things, like modelling and discovering complex operational patterns.
- Data cleaning results in a clearer representation of what is actually going on and what needs to fixed at the source.
- Data driven decisions can now be made.
- Automated data pipeline -> responsive to dynamic changes and trends in the data



Depot Replenishment Process Optimisation

Problem Overview:

- Calculating the optimal amount of stock to move, where and when , in order to meet customer demand, while minimising costs.
- Type of network flow problem.
- Appliance company with hundreds of SKUs.
- Millions of variables!
- Previously done 'by hand' using *some* data but mostly intuition.
 - Time consuming
 - Prone to error



What is DRP

How much stock needs to be transferred in a network, to maximise profit (minimise costs)?



- Stock Transfer Order (STO)
- Manual planning is very time consuming and subject to errors
- Cannot consider all aspects at once (lead time, demand, transit costs etc)
- A linear optimisation model can do it better and faster.
- We don't model deliveries to **customers.** Demand is consolidated to reduce model runtime.



Hudson DRP System



- Bash, R, Python framework \bullet
- CMD interface ۲

runs.log

- Shiny Dashboard \bullet
- **MILP Solver** (Gurobi/CPLEX/CBC) Gurobi is best

Challenges

Data

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Challenges



Delivery days are more important to some than others...

Flexible deliveries mean less lost sales.

for each product in model products do	
for each day D in model days do	
Calculate window W	
Maximum delivery amount $M \leftarrow 0$	
Find set of customers who accept deliveries on day D	
for each customer C do	
$X \leftarrow All \text{ orders of customer } C \text{ whose requested delivery day}$	
falls within the window W	
$M \leftarrow M + X$	
end	
end	
end	

Algorithm 1: Algorithm for calculating the maximum delivery amount for each day.



Challenges

Data: warehouses are always over the specified capacity



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DRP Output

Depot Replenishment	Ξ						i	*	?	Sign out	
STOs	updated at: 2023-10-16 09:16:46 SAST										
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Depot Replenishment Process Optimisation

- Model has to run hourly!
- Need a fast, reliable solver
- Tried a few, and Gurobi seems to handle this problem the best.



Problem Overview:

- An online school with thousands of students and hundreds of teachers.
- The previously used software was inadequate for the job.
- Two stages teacher assignment and timetable.
 - Student class assignment done with heuristics.



Challenges:

- Business rescue means reducing teaching staff but the student requirements still have to be met.
- Managing diverse curricula, grades, teaching formats, and language of instruction.
- Unclear and inconsistent rules and inputs
- Bad data management
- High staff turnover and many students leaving and joining.



Timetable Optimality:

- In general, one timetable is as good as another as long as constraints are met.
- Objective function terms will depend on the needs of the particular school.
- Went from objective function terms to hard constraints now every valid solution is also an optimal one.
 - Takes longer to solve, but more likely to find optimal solution in time limit.



Outcomes:

- Less overworked/under utilised teachers.
- Optimal number of teachers on staff.
- No time clashes for students or teachers.
- Staff freed up to spend more time on curriculum development and student support.
- Saved company!



- Interactive and user driven.
- User inputs changes, gets output
- Data moves from one process to another automatically.





Start over

Teacher Assignment & Timetable

ḋ View timetable	Change teacher points	Add new teachers	Remove teachers	Modify teachers	Modi	fy subject leader subjects Get r	iew teacher	assignment			
f [⊡] View teacher assignment	First name		Last name		E	Employee code		Timetable co	de		
😪 Stats	Sette		Frummagem			SF001		SFRU			
🔀 Edit teacher assignment	Add new teacher										
🕑 Edit teacher info											
	New teachers										
	Show 10 \checkmark entries							Sear	rch:		
	First Name 🔶 La		Last Name		Employee Code		🗍 Timetable Code				÷
	Luke		Skywalker		LS001		LSKY				
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Teacher Assignment & Timetable

By teacher	By phase								
Select a phase			Select a teacher						
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Teacher Assignment & Timetable

Optil	Assignment full	Assignment summ	ary Recent cha	anges								
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Output example



Conclusion

- Model is only as good as data (garbage in, garbage out)
- Data gets stale: having the *latest* data is critical
- Having an automated pipeline to feed the latest data into the best model/solver gives the best output



