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MIT MANAGEMENT BUSINESS ANALYTICS

OPERATIONS RESEARCH CENTER

HANDLE

A data driven approach to building healthcare asset rosters

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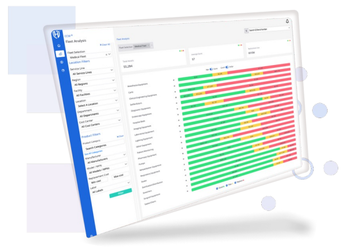
1 HANDLE Global

HANDLE Global is a **data-driven healthcare supply chain analytics** and fulfillment solutions provider

HANDLE is focused on **improving data quality, enhancing transparency, and empowering strategic decision-making** for their clients



2 Problem statement

No data driven approach currently exists for making **budget allocation** and **capital asset expenditure decisions** in sequence:

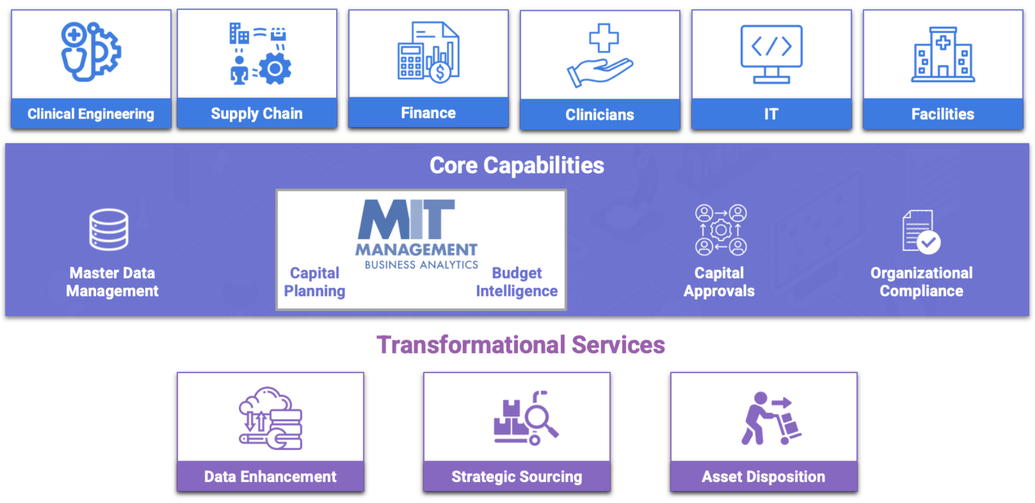
- How many dollars should be spent next year?
- Which business units should receive funding and which specific assets should be replaced?

Can we **predict budget allocation** and use this to inform **asset acquisition prescriptions** using **historical client data**?

Smarter spending

Improved patient care

3 The HANDLE ecosystem



4 Data

4.1 Elementary data analysis

4.2 Feature engineering

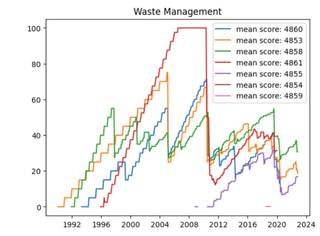
❖ **Add features**
Add asset scores and active status

❖ **Impute missing data**
Impute scores where no data is available for continuity

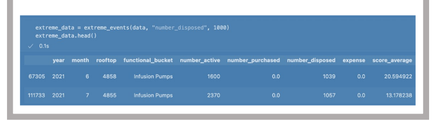
❖ **Compute statistics**
Aggregate across chosen category and compute mean, std, minimum and maximum

4.3 Dataset and insights

❖ **New plotting functionality**



❖ **Historic fleet analysis**



	year	month	rooftop	functional_bucket	number_active	number_purchased	number_disposed	expense	score_average
67305	2021	6	4858	Infusion Pumps	1600	0.0	1039	0.0	20.594922
111733	2021	7	4855	Infusion Pumps	2370	0.0	1057	0.0	13.178238

5 Methodology

Dataset creation & feature engineering → Machine learning → Predict budget allocation → Optimization → Prescribe asset acquisition → Improved care environment

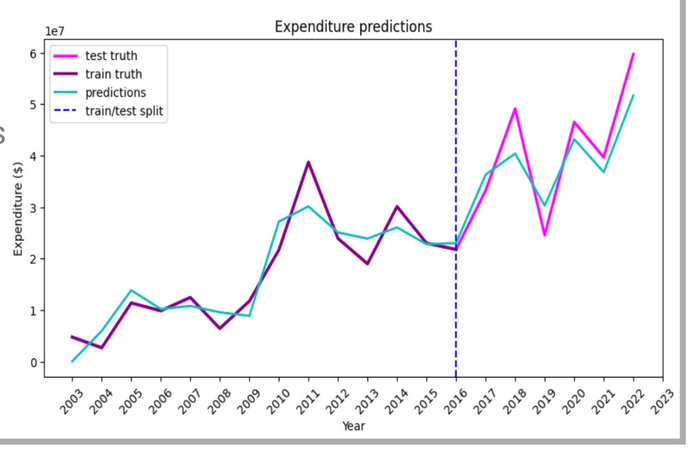
5.1 Machine learning

Predict healthcare system budgets for the upcoming year(s)

Linear models, tree-based models and traditional timeseries

Used as **input for optimization**

74%
Improvement over baseline



5.2 Optimization

Prescribe optimal purchasing decisions via binary optimization modeling

Objective: minimize average asset scores
Constraints: budget, fleet allocations, maximum average score allowed, etc…

Optimal decisions concerning **10s of thousands of assets** provided within **1 minute**

Novel **scenario/counterfactual simulation tool**

$$\min_{x} \sum_{s\in\mathcal{S}}\sum_{c\in\mathcal{C}^s} \frac{(1+log_{1e9}(1+\frac{\sigma_{sc}}{100}))}{n_{sc}+g_{sc}} \sum_{i\in\mathcal{N}_s^c} \lambda_{sci} x_{sci}$$

$$\text{s.t.} \quad x_{sci} \le a_{sci} \quad \forall s\in\mathcal{S} \quad \forall c\in\mathcal{C}^s \quad \forall i\in\mathcal{N}_s^c$$

$$\sum_{s\in\mathcal{S}}\sum_{c\in\mathcal{C}^s}(\kappa^g_{sc} g_{sc} + \kappa_c \sum_{i\in\mathcal{N}_s^c} a_{sci}(1-x_{sci})) \le \beta$$

$$(1-\epsilon_s)\beta_s \le \sum_{c\in\mathcal{C}^s}(\kappa^g_{sc} g_{sc} + \kappa_c \sum_{i\in\mathcal{N}_s^c} a_{sci}(1-x_{sci})) \quad \forall s\in\mathcal{S}$$

$$\sum_{c\in\mathcal{C}^s}(\kappa^g_{sc} g_{sc} + \kappa_c \sum_{i\in\mathcal{N}_s^c} a_{sci}(1-x_{sci})) \le (1+\epsilon_s)\beta_s \quad \forall s\in\mathcal{S}$$

$$\sum_{i\in\mathcal{N}^c}(x_{sci} + a_{sci}(1-x_{sci})) = n_{sc} \quad \forall s\in\mathcal{S} \quad \forall c\in\mathcal{C}^s$$

$$\frac{1}{n_{sc}+g_{sc}} \sum_{i\in\mathcal{N}_s^c} \lambda_{sci} x_{sci} \le \Phi \quad \forall s\in\mathcal{S} \quad \forall c\in\mathcal{C}^s$$

$$x_{sci} \ge a_{sci} \frac{\theta - \lambda_{sci}}{100} \quad \forall s\in\mathcal{S} \quad \forall c\in\mathcal{C}^s \quad \forall i\in\mathcal{N}_s^c$$

$$x_{sci} \in \{0,1\} \quad \forall s\in\mathcal{S} \quad \forall c\in\mathcal{C}^s \quad \forall i\in\mathcal{N}_s^c$$

6 Business impact

6.1 Current strategy

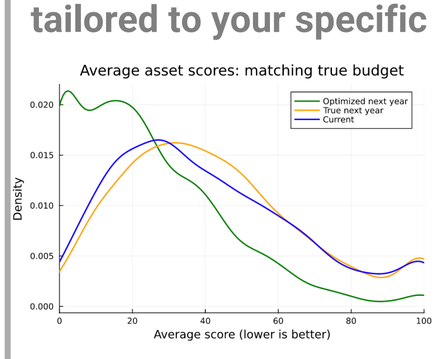
Prediction
No predictions whatsoever – **exclusively user input**

Prescription
Greedily select assets within user inputted splits until money runs out given **no fleet context**

Make predictions to provide a strong default budget and improve purchase prescriptions to save money and/or improve fleet health

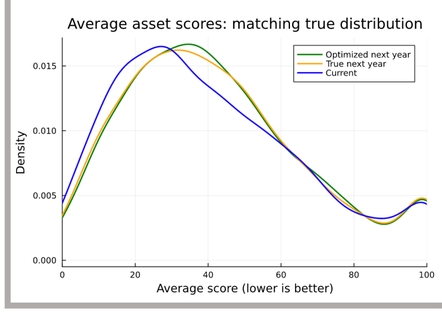
6.2 Decision making support tool

Make decisions confidently by using a model tailored to your specific needs and ambitions



18%
improvement in overall fleet health with no budget impact

68%
reduction in categories past useful life on average

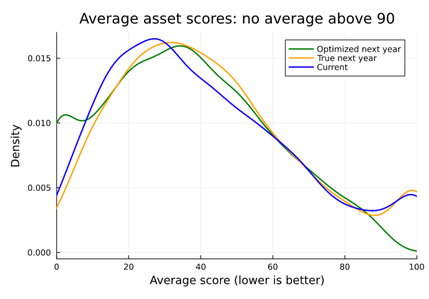


14.3% = $6.2M
of total budget saved while matching the true realized fleet health distribution

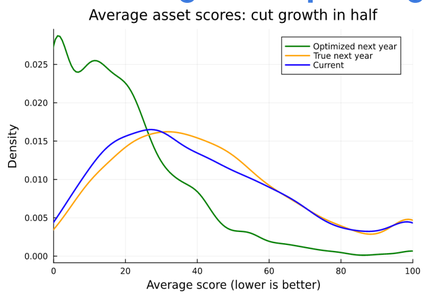
6.3 Scenario / counterfactual simulation

Test various scenarios to analyze optimal purchasing decisions under different conditions

No average scores above 90



Decrease growth spending



❖ Provide clients the flexibility to run the optimization model under customizable settings to simulate various scenarios

❖ Aggregate across scenarios to identify what decisions are consistent, and what are scenario dependent

7 Transition plan & handover

Well documented code → Early alignment on tech stack → Meetings with all key stakeholders → Two weeks dedicated to handover

8 Project extensions

❖ Extend binary optimization model to a multi-year optimization for long-term horizon planning

❖ Incorporate growth modeling and consider fleet shrinkage

❖ Include category priority classes