

AI in Healthcare

AI for resource and process optimization in hospitals

Prof. Dr.-Ing. Sasanka Potluri
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About me

- **Prof. Dr. Sasanka Potluri**

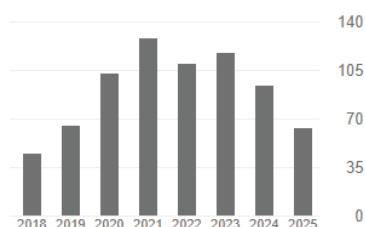
- Professor of Computer Science and Medical Informatics
- Research Group Leader – KI-LoV (University Hospital Jena)

- Researcher focus applying AI and deep learning in
 - Healthcare
 - logistics
 - Sport sciences
 - Automation
 - Cybersecurity
 - predictive analytics

- International educator and mentor
 - 2 – Bachelor Thesis
 - 20 – Master Thesis
 - 1 - PhD



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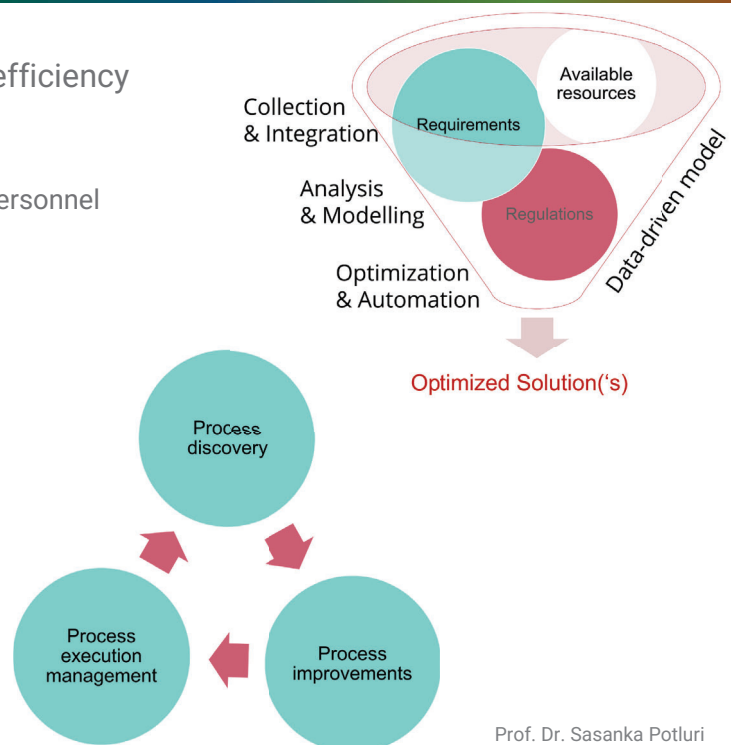


- The challenges
- Why not always AI?
- Why AI?
- Use cases
 - Actual research
 - Research focus
- Conclusion



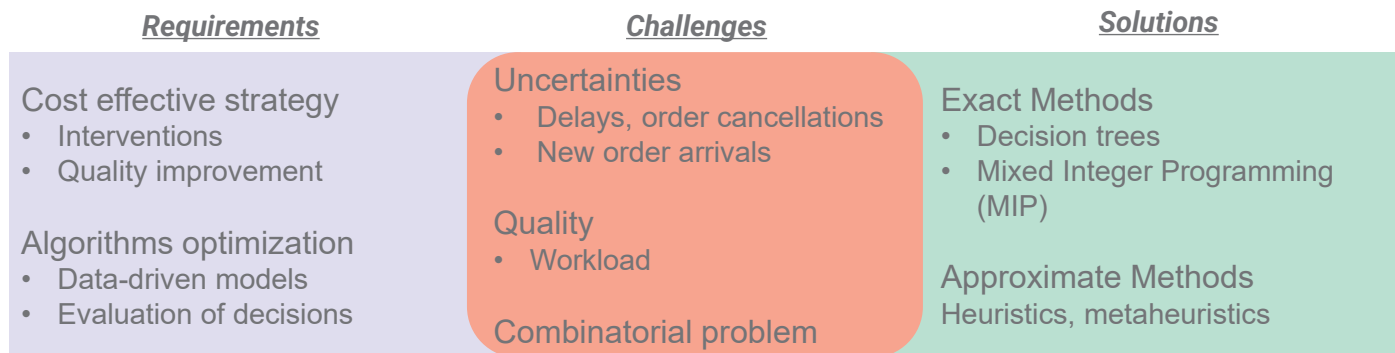
Resource / Process optimization

- Are the strategies for improving business efficiency
- Resource optimization:
 - Efficient use of assets like: time budget and personnel
 - To maximize productivity
 - Minimize waste
- Process optimization
 - Systematically improving workflows
 - Enhance efficiency, quality and productivity



Resource / Process optimization in Hospitals

- High-quality and continuous services
- Multi-objective approach (i.e., resources, optimization of logistics processes)
- Handling emergencies and uncertainties



The challenges

Resource / Process optimization in Hospitals

- Resources – Human resources, medical equipment, medications and supplies, etc.
 - Staff workforce optimization
 - Nurse scheduling optimization – Shift assignment
 - Float pool management – Predictive models
 - Operating room optimization
 - OR block scheduling
 - Surgery distribution prediction
 - OR equipment optimization
 - ED capacity forecasting, Diagnostic & Ancillary Services Optimization, Space Utilization etc.
- Processes – Patient transport, admission and discharge processes, supply chain and inventory management, emergency and intensive care, etc.
 - Patient flow optimization
 - Admission, Transfer and Discharge Coordination
 - Streamlines Emergency Department (ED) Triage
 - Pharmacy Workflow Optimization, Supply chain optimization

1. Not every problem is a data problem
 - mainly depends on large volume of clean, relevant and un-biased data
 - Unclear goals or flawed process
2. Increases complexity, not always clarity
 - Incredibly powerful, but it adds layers of complexity
 - Requires expertise and infrastructure
3. Can amplify existing biases
 - Reflects the data its trained on
 - Cannot automate fairness
4. Isn't cost effective
 - Data pipelines, Model tuning
 - Cloud compute, Continuous monitoring



<https://markmcneilly.substack.com/p/the-best-memes-about-ai>

Why AI?

1. Fewer errors
 - Efficiently removes mistakes caused by human error
 - Improved predictions and outcomes
2. Improve efficiency
 - Sport redundancies
 - Cuts hours spent on analysis
3. Improve consistency
 - Attention to detail in every task (parameters)
 - Repetitive tasks → same performance
4. Improve performance
 - Deep and actionable insights
 - Support decision making with proper knowledge base



https://www.linkedin.com/posts/kamil-hitman_the-ceos-chasing-ai-meme-is-everywhere-activity-7371633223111663616-aVsb/

Actual research

Duty scheduling



AI for resource and process optimization in hospitals

Patient transport



Transfusion medicine



Prof. Dr. Sasanka Potluri

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Actual research

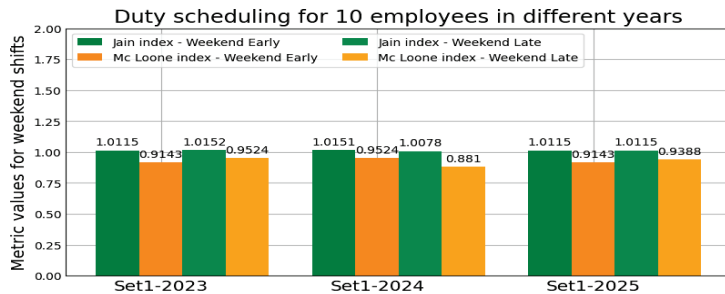
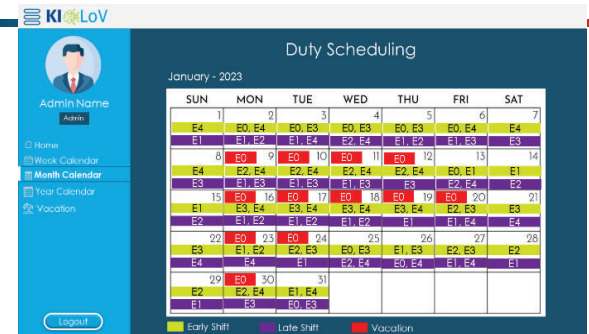
Duty scheduling (Resource optimization)

- Highly demanded and needed service
- Highly complex due to the involvement of several factors
 - Contract terms
 - Staffing levels
 - Preferences & vacation etc.
- Causes of emergencies and vulnerable situations (rescheduling)
- Challenges
 - Optimal solution for the **longer term**
 - **Impact** in the following weeks
 - Balance between **fairness and flexibility**

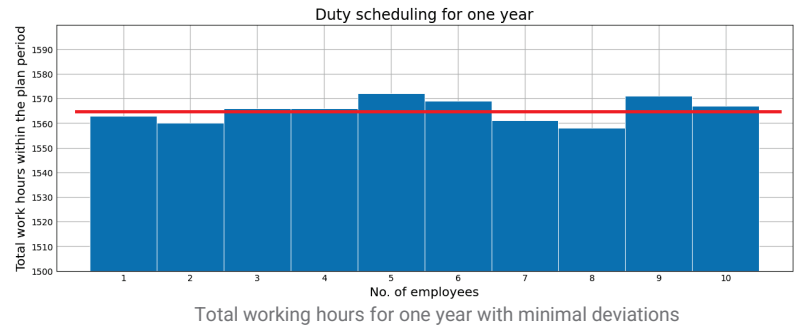
Duty scheduling (Resource optimization)

Results

- Empirical analysis of the results
 - Different vacation preference sets
 - Different sizes of the workforce



Assessment of empirical results for overall and contract-specific requirements



Total working hours for one year with minimal deviations

Actual research

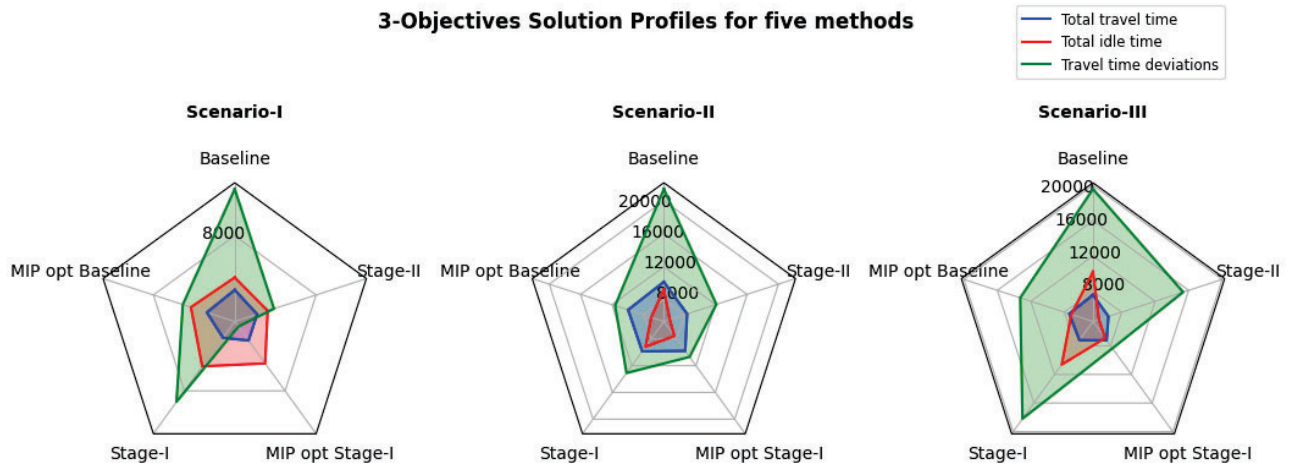
Patient transport (Process optimization)

- Intra-hospital patient transport
 - Highly regular logistics operations
 - Route plan with too many stops
- Multi-objectives
 - Optimization of staffing levels and balancing of workload
 - Different modes of transportation
 - Dealing with uncertainty
- Challenges
 - Increasing **punctuality**
 - **Improving** route planning
 - **Fair distribution** of workload

Patient transport (Process optimization)

Results

3-Objectives Solution Profiles for five methods



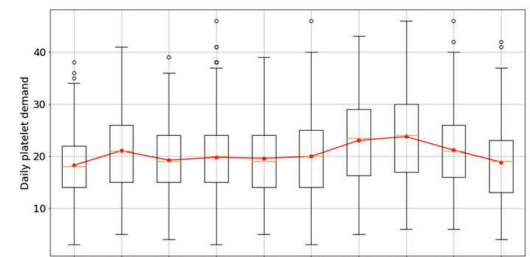
Performance methods other than scoring strategies for patient transport

Actual research

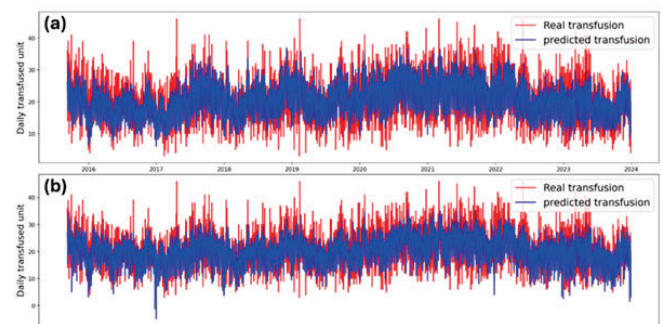
Transfusion medicine (Resource optimization)

Forecast of platelet requirements

Algorithm in prediction	Public holiday feature	Shelf life weights	Expired waste units	Outdating rate	Purchase units	Shortage rate
Real UKJ data	--	--	2120	3.37%	40	0.0636%
RNN LSTM	No	No	499	0.79%	141	0.2242%
RNN LSTM	Yes	No	386	0.61%	107	0.1701%
RNN LSTM	Yes	Yes	333	0.53%	56	0.0903%
Lasso	No	No	521	0.83%	141	0.2242%
Lasso	Yes	No	433	0.69%	93	0.1479%
Lasso	Yes	Yes	346	0.55%	52	0.0816%
Ridge	No	No	521	0.83%	143	0.2274%
Ridge	Yes	No	432	0.69%	94	0.1495%
Ridge	Yes	Yes	345	0.55%	51	0.0799%
Elastic net	No	No	520	0.83%	143	0.2274%
Elastic net	Yes	No	436	0.69%	93	0.1479%
Elastic net	Yes	Yes	350	0.56%	50	0.0789%



Annual demand for platelets at the UKJ



Prediction of daily platelet requirements using (a) RNN LSTM and (b) Lasso.

- We are working of new use cases
 - Patient flow in Emergency department
 - Seasonal impacts
 - Staff planning
 - Equipment planning
 - Bed management with AI and digital twin
 - Develop digital twin of every bed in hospital – Patient flow optimization
 - AI for predicting – length of stay
 - Resilient hospitals
 - Risk management - Systematically identify and prioritize risks to prepare for various emergencies such as natural disasters, pandemics, or armed conflicts
 - Learning and improvement - ability to learn from shocks and thus improve over time to be better prepared in the future

Conclusion

- The performance of the developed models is currently being tested in hospitals.
- Our approaches offer added value for the optimization of resources and processes in hospitals.
- The development of the necessary user interfaces and integration into the hospital environment are currently underway.
- Open for new collaborations.

Many thanks for your attention !!!

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