MIT Center for Transportation & Logistics

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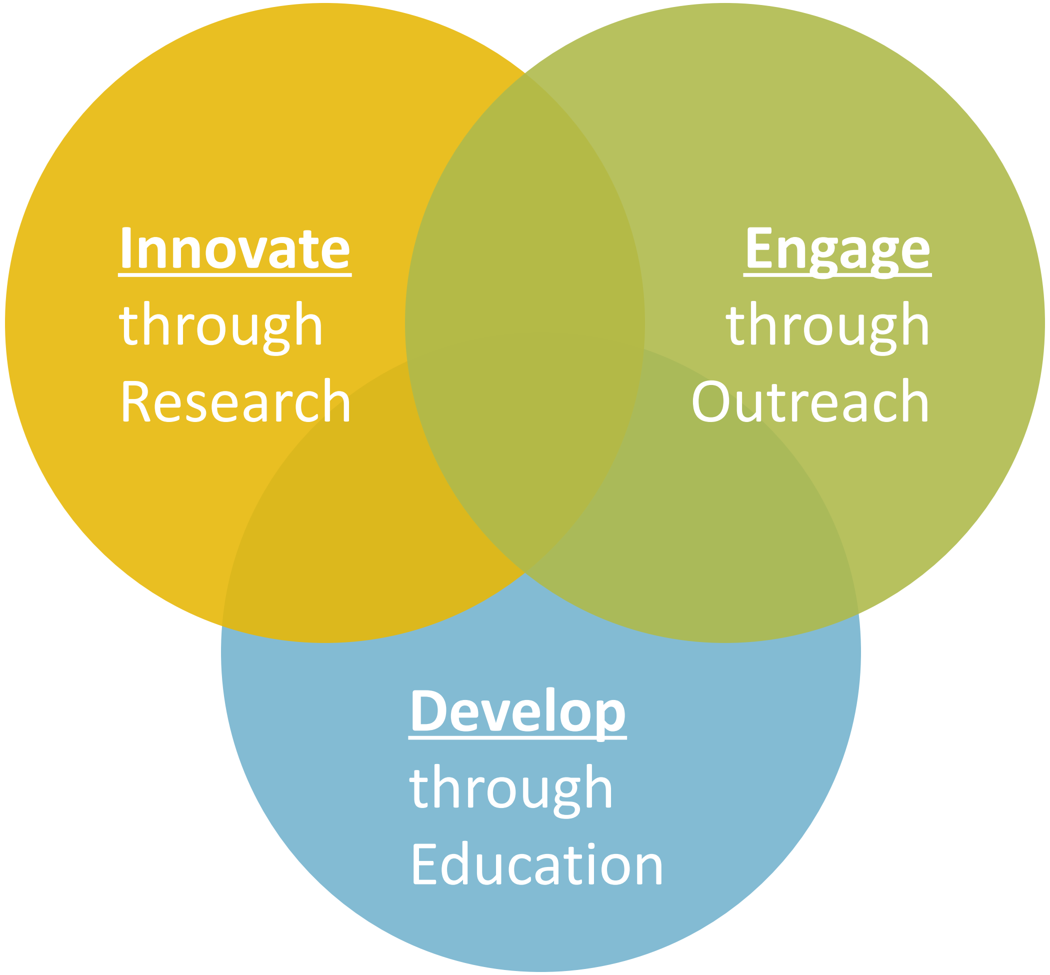
Deep Knowledge for SCM Lab

What is MIT CTL?

"Create supply chain innovation and drive it into practice."



- Roundtables
- Capstone projects
- Industry-driven workshops & symposia

- Supply Chain Management masters program
- Graduate Certificate in supply chain management
- MicroMasters Program in supply chain management
- Customized courses
- Executive Education

- 15 Research Labs
- 6 Research Centers worldwide
- 20+ Active research projects
- 60+ Faculty & researchers across MIT

MIT Global SCALE Network

10 + EDUCATIONAL PROGRAMS

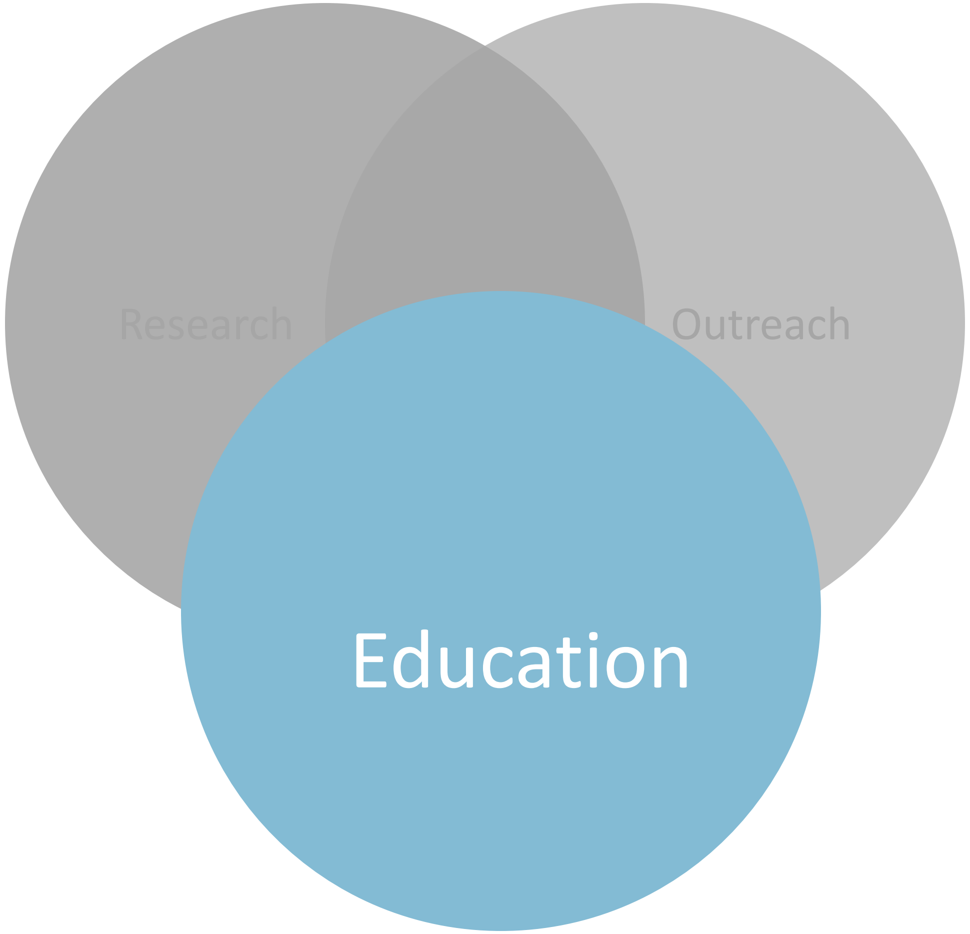
80 + RESEARCHERS & FACULTY

150 + CORPORATE PARTNERSHIPS

200 STUDENTS ANNUALLY

2000 + ALUMNI GLOBALLY

Education



GCLOG

SCM

MIT Center for Transportation & Logistics

GCLOG - Mission and eligibility criteria

"...A life changing experience..."

MIT GRADUATE CERTIFICATE IN
LOGISTICS & SUPPLY CHAIN MANAGEMENT

- "Amplifying graduate SC education for **emerging markets**"
- An elite academic program geared towards outstanding professionals
  - **At least 3 years of working experience in SCM**
  - ***Preferably,*** **admitted to, enrolled in** or **recently graduated from** a graduate program
- Taught by senior industry experts, MIT and SCALE-recognized researchers

GCLOG structure

GCx module

- ✓ 8-week course with asynchronous content and webinars
- ✓ Build and refresh foundations of SCM&L

120 hours

Mid-May to early July

Summer residential seminar

- ✓ Residential experience
- ✓ 3-week seminar at MIT campus
- ✓ Workshop and lectures

150 hours

2nd to 4th week July

Capstone project

- ✓ Research oriented project
- ✓ Solve industry, society and/or government issues in SCM&L

150 hours

August - December

Global SCALE Connect Conference

- ✓ Residential experience
- ✓ 3-week seminar at MIT campus
- ✓ Network and connection with other students

100 hours

2nd to 4th week January

520 hours of learning in a 9-month program

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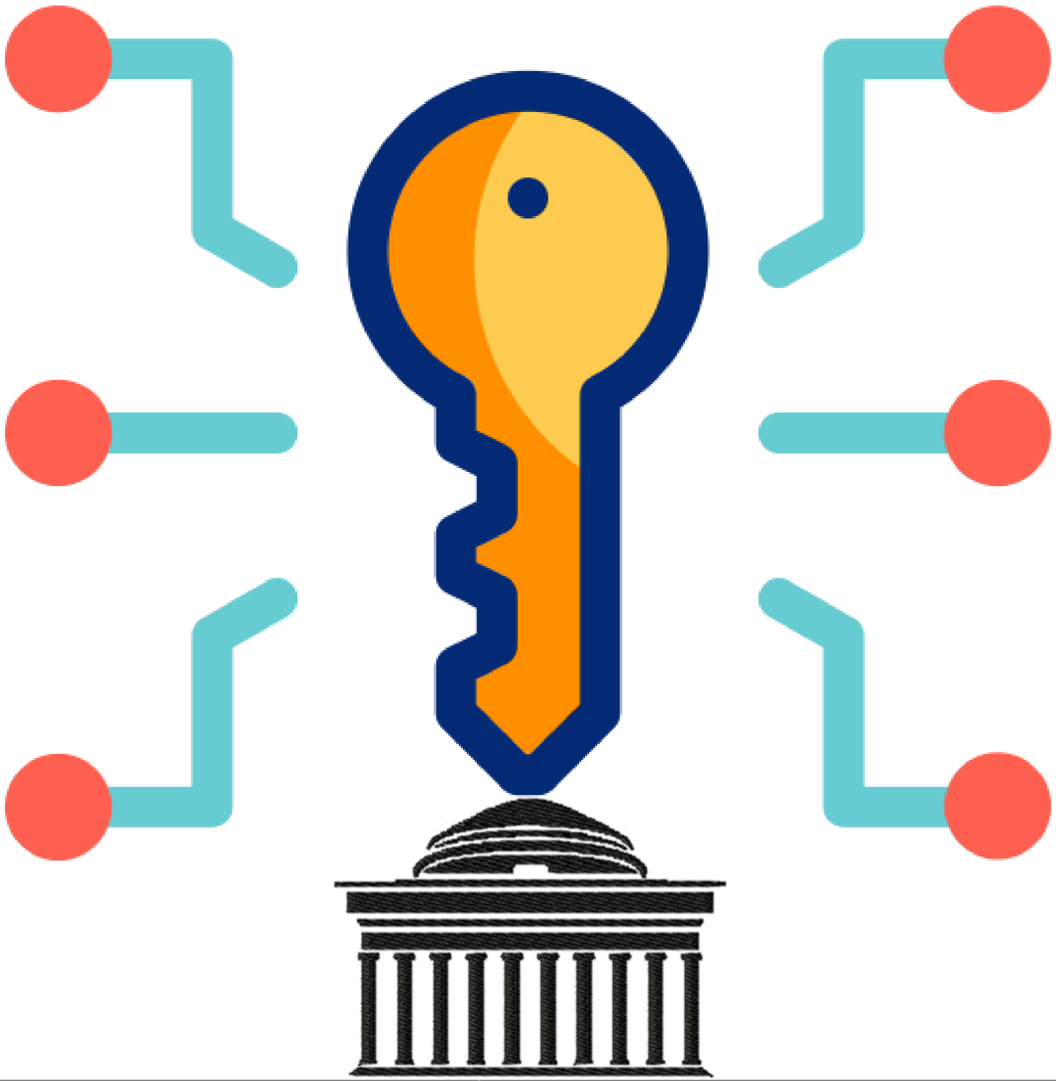
GCLOG - Key takeaways

Hybrid, high-quality, and flexible program

Applied knowledge and multicultural networking



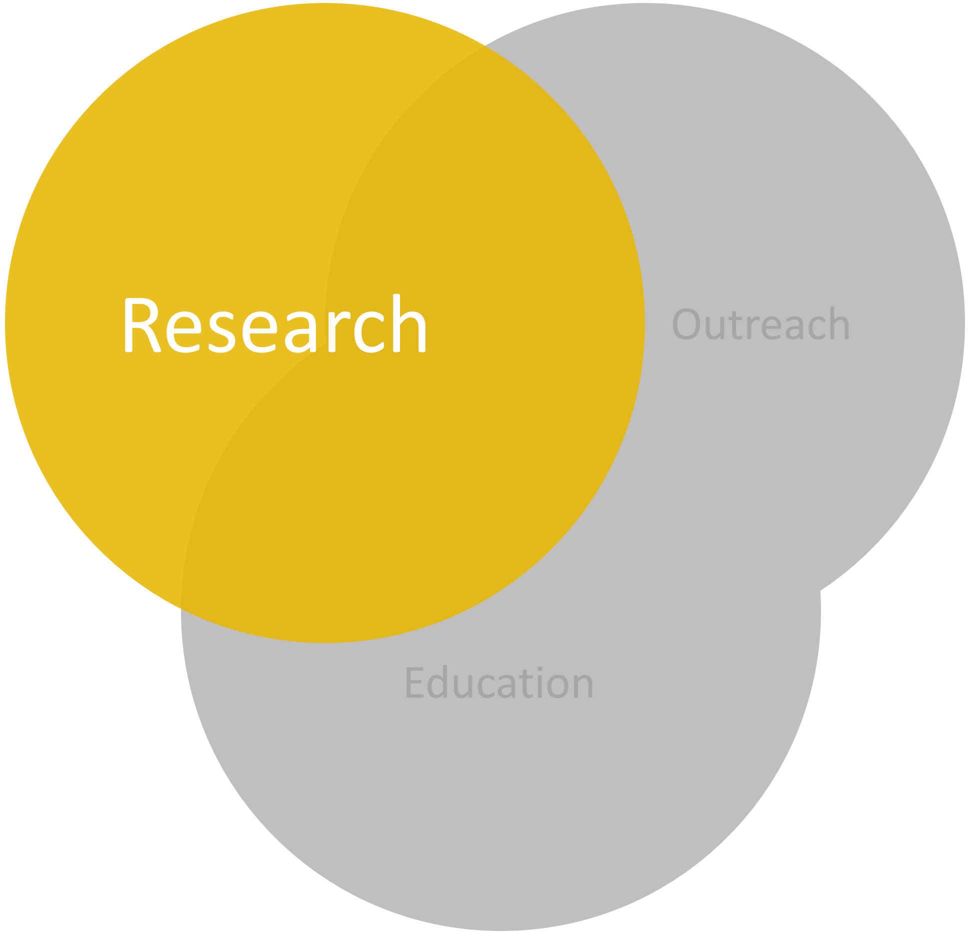
#1 graduate program in SCM worldwide (EdUniversal, 2025)

Change mindset and provide practical tools to solve issues

Industry-centered and international capstone projects in EME

Be part of the MIT alumni community

Research



Deep Knowledge for SCM Lab

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Maritime Logistics

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Contents

1. Published Research
2. Current Research
3. Future Research

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1. Published Research

Sponsor: DOT Freight Logistics Optimization Works (FLOW)
Data Sources: AIS Data, Import Genius

1

DBSCAN: Ship congestion points and infrastructure

ANT 2024

MIT Supply Chain MANAGEMENT

2

Predicting port congestion for East Coast Ports

GraphEx 2025 Graph Exploitation Symposium May 20–21, 2025

IEEE HPEC High Performance Extreme Computing

TRB

3

Ship sequencing in ports and prediction of stay

TRB

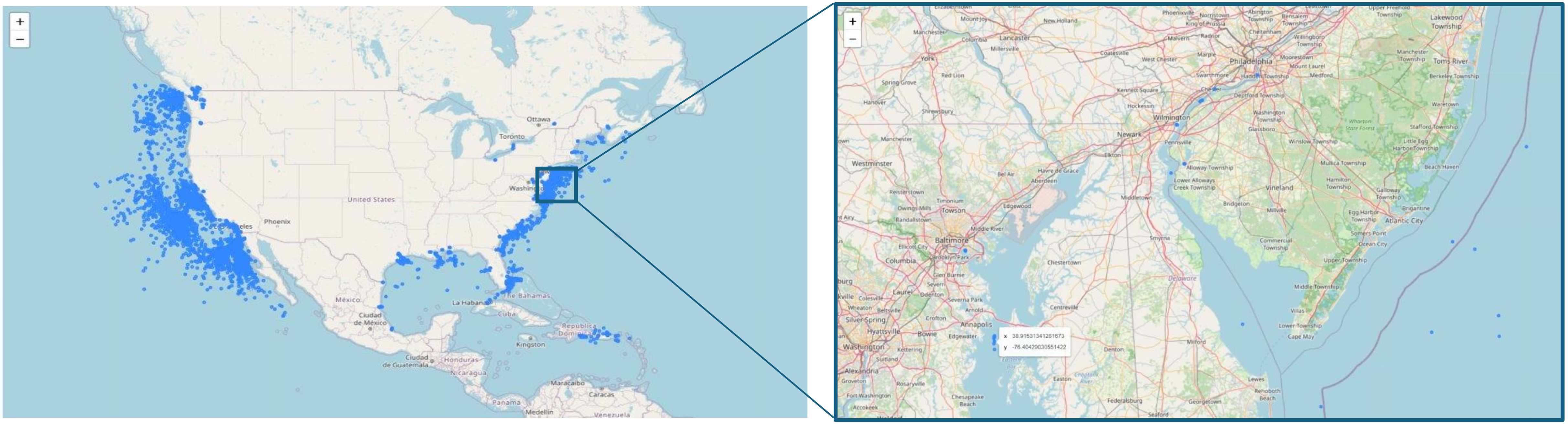
Transportation Research Part E: Logistics and Transportation Review

***Under Submission**

1. Published Research

1 2 3

DBSCAN: Ship congestion points and infrastructure from AIS data



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1. Published Research

1 2 3

DBSCAN: Ship congestion points and infrastructure from AIS data

- Congestion points automatic classification
- Automatic ship to terminal assignment
  (New York/New Jersey, Los Angeles/Long Beach)

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1. Published Research

1 | 2 | 3

Predicting port congestion for East Coast Ports:

LSTM (Long Short Term Memory)

XGBoost (Gradient Boosted Trees)

Liquid S4 (Structural State-Space Model)

ST-GNN (Spatio-Temporal Graph Neural Network)

01/02/2015 — 08/31/2023 — 09/30/2023

Training | Testing

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1. Published Research

1 2 3

Terminals at Port of New York / New Jersey

- Primary features:
  - 31 Terminals
  - 22 Operators
  - 7 Ship Size Groups
  - 7-day History

Other features:
  - Time
  - Node-specific features

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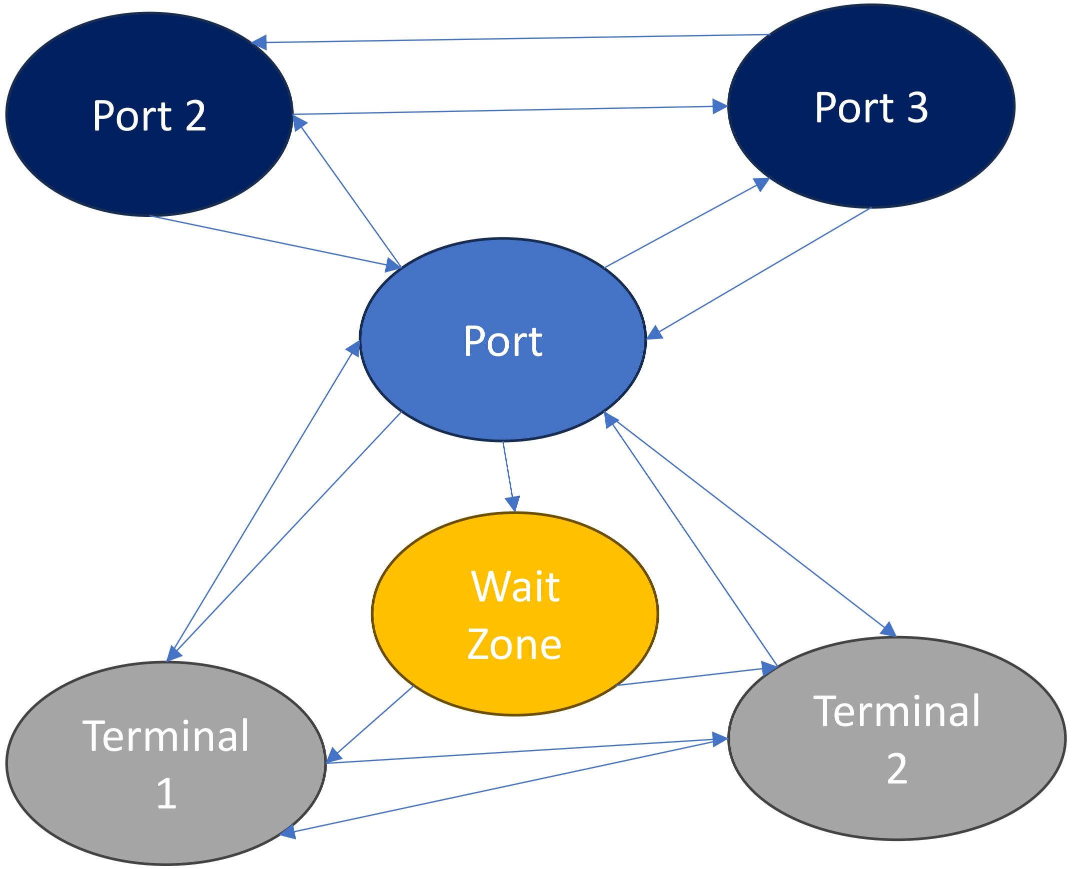
1. Published Research

1 2 3

- Used 5 ports, 5 wait zones and available terminals at each of the 5 ports
  - Ports connected to each other
  - Ports connected to internal nodes
    - Wait Zone
    - Terminals
  - Wait Zones connected to Terminals at port
  - Terminals connected to other Terminals
- Adjacency matrix used the distance between ports, and fixed distance inside ports, normalized by standard deviation



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1. Published Research

1 2 3

Predicting port congestion for East Coast Ports

Port Terminal	Model	MAE	MAPE
APM Terminals *(high throughput)*	LSTM	1.57	37.64
	STGNN	1.52	55.16
	XGBoost	**0.52**	**12.28**
	Liquid	0.93	29.26
Port Liberty Bayonne Terminal *(medium throughput)*	LSTM	0.70	50.68
	STGNN	**0.51**	**37.75**
	XGBoost	0.67	58.92
	Liquid	0.63	32.36
The Red Hook Container Terminal (low throughput)	LSTM	**0.36**	**57.94**
	STGNN	1.39	79.62
	XGBoost	0.94	72.32
	Liquid	0.5	59.58

- Different models for terminals
- Improving one terminal makes others worse ***-> comparing Liquid to all 3 different winning models results***
- Liquid consistently ranks second across all terminals
  - Further parameter tuning or architectural changes could potentially improve its performance

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1. Published Research

1 2 3

Ship sequencing and prediction of stay (Inverse Reinforcement Learning)

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1. Published Research

1 2 3

Ship sequencing and prediction of stay (Inverse Reinforcement Learning)

Terminal	Window	Model Base	MAE (Mean Absolute Error), number of time windows	Ships, predicted stay difference	
				In 18h %	In 24h %
APM	6h	State-based	1.98	81%	**89%**
APM	6h	Ship-based	**1.94**	82%	**92%**
Maher	6h	State-based	**2.73**	71%	**79%**
Maher	6h	Ship-based	3.99	51%	**63%**
Savannah	6h	State-based	**2.82**	69%	**78%**
Savannah	6h	Ship-based	3.32	55%	**71%**

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1. Published Research

1 2 3

Ship sequencing and prediction of stay (Inverse Reinforcement Learning)

Maher State-Based model variations

Model variations	MAE (Mean Absolute Error), number of time windows	Ships, predicted stay difference	
		In 18h %	In 24h %
Maher	2.73	71%	**79%**
Maher + 1	**2.56**	74%	**83%**
Maher + Attention	***2.61***	72%	**80%**
Maher + Attention + 1	**2.52**	75%	**83%**
Maher Bayesian small	*4.38*	51%	**58%**

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MIT CTL Research Project 2025

Simulation at APMT Port Elizabeth with Port Authority NY/NJ

- Developed using open-source software in Python.
- Provides a flexible and scalable framework for future research.
- Discussions with APMT and PANYNJ stakeholders and observations at the terminal have identified hinterland locations suitable for transitioning some truck volume to short-haul rail.
- Using the simulation model, we will test various scenarios of this transition and assess the impact on terminal resources.

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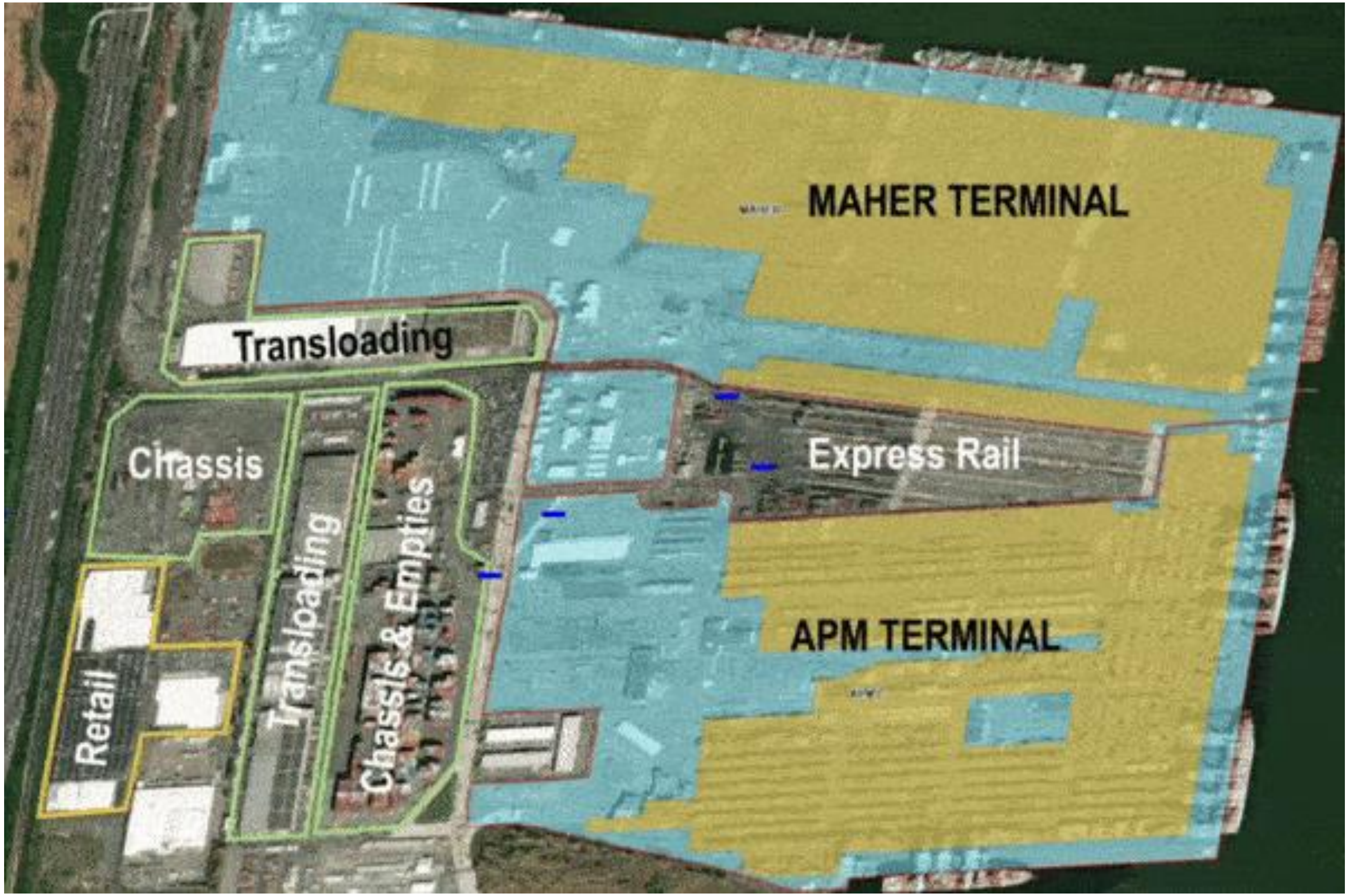
2. Current Research – Example Simulation

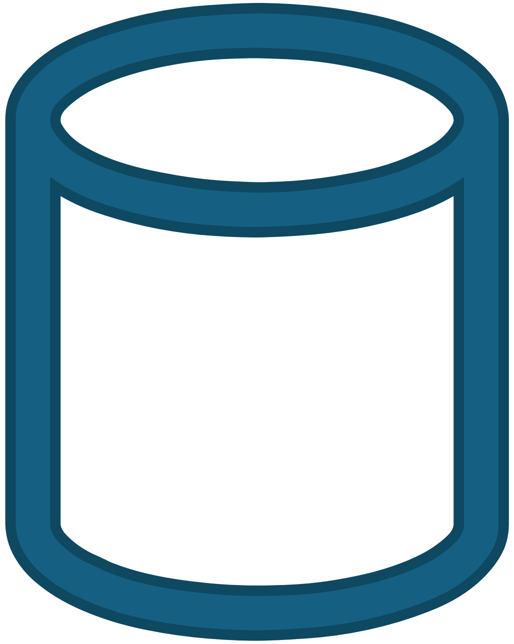


2. Current Research – Data Requirements

- **Ocean Operations**: Extensive work using AIS data to model vessel arrivals.
- **Terminal Operations**: ImportGenius data (CBP shipping manifest data), filtered to generate container-level insights for the Port of NY/NJ.
- **Combined Approach**: By integrating AIS and ImportGenius, we can develop a comprehensive model of historical import arrivals using publicly available data
- **Taking it a Step Further:** Using the container numbers obtain from ImportGenius analysis, we can automate web-tracking tools online offered by carriers and terminal operators, to download container movements.

This gives us a method to estimate container throughput of individual terminals using only publicly available data.

We gain insights into the volume of containers arriving at the terminal, where those containers are headed, the time each spent in the port, and how the container left the port.



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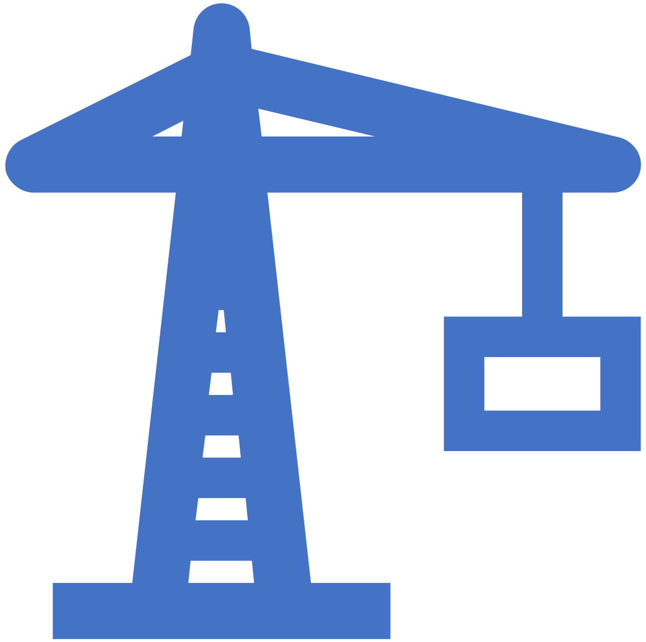
2. Current Research – Analysis



Impact of Operational Changes on Port Efficiency

- **Objective**: Evaluate how changes in resources and container volumes impact port efficiency and dwell times.
- **Key Variables**:
  - **Resources**: Crane availability, yard use, truck/rail throughput.
  - **Container Volumes**: High-peak vs. low-volume scenarios.
- **Outcomes**:
  - Measure yard utilization, throughput and container dwell times.
  - Identify bottlenecks caused by resource or volume constraints.
- **Use Cases**:
  - Support decision-making for resource allocation and infrastructure investments.
  - Optimize operations during peak periods or constrained scenarios.

2. Current Research – Supporting Analysis

Commodity Classification using Natural Language Processing

A semi-fine-tuned Bidirectional Encoder Representations from Transformers (BERT) model is applied for this task

Additional fine-tuning on a labelled dataset of ImportGenius records has shown promising results for commodity classification

Could result in the addition of features to the simulation based on commodity.

3. Future Research – Container Tracking

1. Smart Container Tracking and Monitoring – Edge AI
2. Supply Chain and Container Flow Prediction – Edge & Cloud AI
3. Optimizing Container Placement and Routing with Reinforcement Learning – Cloud AI

**** Potential Sponsored Research Project***

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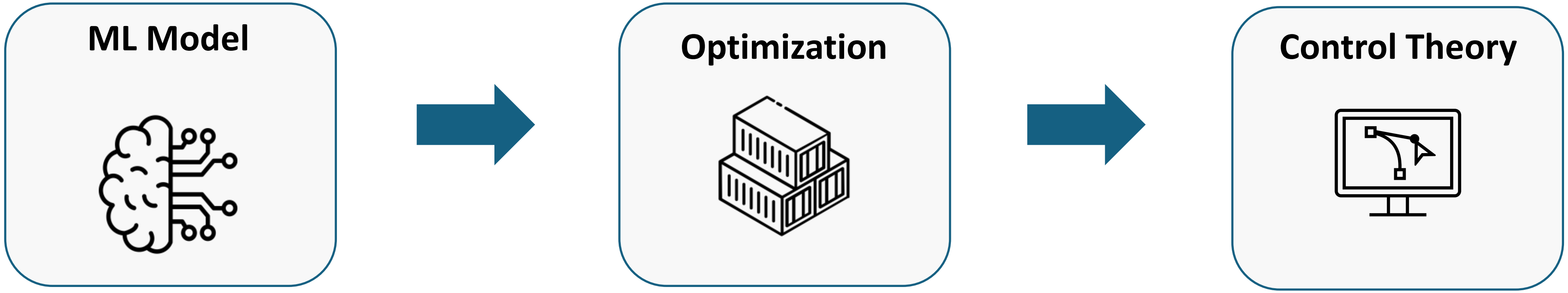
3. Future Research – Yard Optimization



1. Cost Estimation Model – Machine Learning
2. Optimal Cost – Optimization Model
3. Transition from Current State to Optimal State – Control Theory

**** Potential Sponsored Research Project***

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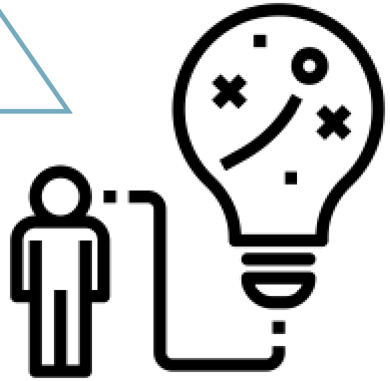
Call to Action



1. **Capstone Projects** with the GCLOG or SCM programs
2. **Professional Development** in the GCLOG or SCM programs
3. **Executive Education** for Middle Eastern professionals
4. **Sponsored Research** with MIT CTL on Maritime Logistics