Image source: Port of Virginia

AUTOMATED INTELLIGENCE

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INTRODUCTION

Why is realizing the full potential of automated terminals for operational performance taking so long? And, for those who succeed in automation, why is it so complex and difficult? In the 'promised land' of terminal automation, the missing piece is the confidence in regards to how robots, software and humans, performing as a whole, will achieve greater levels of operational performance.

Automated decision making is a fundamental piece of that 'promised land'; automated or not, decisions at container terminals must be prescriptive, looking ahead to better deal with the inherent dynamics of planning. They must also be resilient, adapting to addressing the required flexibility at execution. So far, container terminals have found challenges in making automated decision making effective, empowering efficiency, safety, and sustainability.

Taking into account the progress made by emerging technologies such as artificial intelligence (AI) and machine learning (ML), it is natural to think these will help optimization algorithms to read the operational situation and then help to apply quick and robust solutions over an operational reality full of dynamics and exceptions.

We already see AI and ML in our everyday lives, including the famous battle in 2016 between AlphaGo, a robot developed by Google DeepMind, and Lee Sedol, the world champion of the ancient Chinese game Go. Go is very complex and requires a lot of connections, thinking and intuition to play. AlphaGo beat Lee Sedol in March, 2016, ten years earlier than expected.

AlphaGo's victory required training and repetition by having AlphaGo play computer games over and over. The process produced amazing results because it is a general-purpose, problem-solving intelligence, creating a human way of thinking.

This article outlines a vision and a mutual belief of the authors in what AI and ML could provide to automated decision making at container terminals.

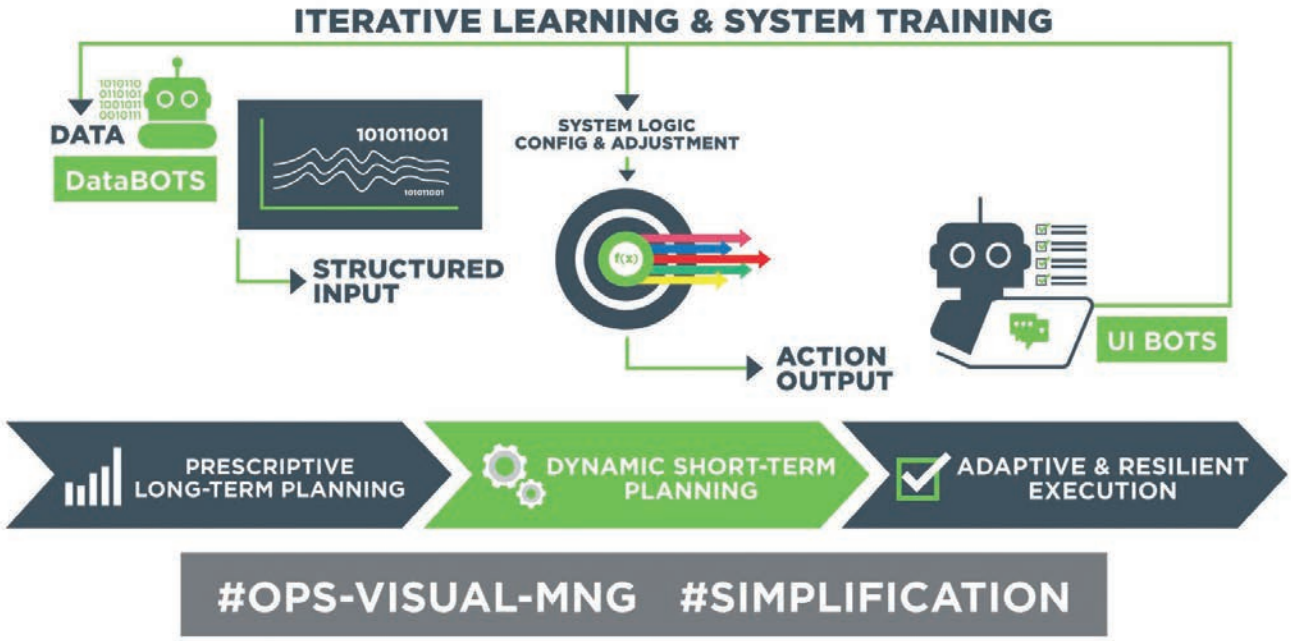
OPTIMIZATION SOFTWARE AND DOMAIN CONTENTION

Automated terminals rely on automated decision making to function properly. Typical decisions are:

- Which stack to use for a box that is being discharged from the ship or gating in
- Where to move a box inside a stack (or one entering or exiting)
- Which horizontal transport device should perform a work instruction
- When a container should be moved outside the stack to avoid equipment conflicts
- How to reorganize a stack during idle periods to facilitate future work.

Traditionally at terminals, scoring algorithms have been applied by different software systems. Parameterized equations then create a move score:

SCORE = A*X1 + B*X2 + C*X3 + …+



where A, B, and C are parameters that modulate the independent variables X1, X2, X3 to emphasize varying levels of importance. For example, X1 could be the distance from the ideal location, X2 could be minutes until vessel load, X3 could be a mixed pile penalty, and so on.

While the optimization algorithms rank the scores and pick the best result, today container terminal experts struggle in different areas:

- **Algorithms parameterization:** Setting or changing the parameters controlling the logic behavior is very difficult, and the level of abstraction of the parameters is usually disconnected from the operational behavior. More modern optimizers perform very complex analyses on data to create the "most optimal result", but this can take lots of computing power and lots of time to execute optimization cycles
- **Fine Tuning:** To include all the required aspects of the operational scenarios at the specific terminal, and implement required situational logic to deal with the operational circumstances and exceptions handling, which usually depends strongly on the cargo profile, gang composition, and terminal lay out and equipment configuration
- **Scattered logic across software systems:** At automated terminals especially, operational decisions are scattered across different software systems, to coordinate the choreography between the different operational decisions, across different operational areas and time horizons. This means a myriad of suppliers must engage to execute automated decision making effectively

Beyond these challenges, we will continue having robots, humans, and software at most automated container terminals. We need those actors to keep doing what they are good at, and to help compliment the other actors' capabilities to deal with operational reality:

- Humans are good at:
  - o Perception-driven intuition
  - o Multidimensional assessment
  - o Creative and experience-based decision making
- Robots are good at:
  - o Predictability
  - o Precision
  - o Repeatability
- Lastly, software is good at:
  - o Abstract intelligence and problem solving, but software can only act with a clear direction, and clean input data. This means that the missing pieces at container terminals are:
  - o Data analysis and correlation
  - o Deep learning and cognitive training

Within this scenario, the need for the "best" solution is a fallacy. We are moving containers after all. The outlined vision relies on two main principles:

1. The value is no longer in a single application but in the whole set of software pieces; domain contention between software applications needs to be applied to enable the 'whole system' prescriptive 'look ahead' planning, simplified user interaction and enabling proactive feedback loops from operations execution
2. Optimization of our automated terminals is tied to synthesis of both rules and scoring. Optimization algorithms can be assisted by emerging artificial intelligence and machine learning technologies, for quicker and more robust operational decisions. This is the start of automated intelligence

AUTOMATED INTELLIGENCE

When thinking about decisions at automated terminals, software must be the bridge for humans and robots to help each other. To make sure software can be this bridge, we need to consider two main things:

1. Information still needs to be transformed into meaningful data. A lot of data still needs to be extracted, analyzed, and understood
2. Better visibility into real-time information to make better decisions and create trusting relationships between robots, software, and users is critical for progress

Why should we use artificial intelligence? When looking at the problems we have today and at the capabilities generated by AI, it has most of the capabilities we are demanding:

- Self-learning and understanding the reality in front of us
- Adaptation when something does not go according to plan
- Prediction and pattern recognition to be able to look ahead
- Deep analysis and recommendations to the user

Responding to complicated and dynamic environments has already been proven in the banking and airline industries, which are demanding industries full of dynamics and real-time updates.

This paper's vision is about a future empowered by AI and ML in the following way:

- On the robot side DataBOTS will deal with huge amounts of data and focus on automated repetitive tasks for finding insights and transforming data into meaningful information.
  o AI can help us by managing unstructured data and performing complex tasks
- On the software side, enhanced algorithms will capture and productize knowledge and structuring data in a reusable and configurable form. But to be effective AI and ML will help:
  o AI can analyze and correlate data, including generating data
  o ML can train and constantly update, automatically adjusting the configuration of the parameters controlling algorithm behavior
- For the user, UIBOTS will help to process output and real-time feedback to drive proactive user interaction and effective exception handling, and in this case:
  o AI can mimic the human brain and to drive reaction to input situations
  o ML can integrate cognition and best performance behaviors

All these different elements will work together to create an impact to consistently connect long-term planning, short-term planning, and flexible execution.

CONCLUSION

In conclusion, AI and ML are already proven technologies and their value offerings tackle some of the fundamental constraints we have today to drive shipping operations to be more efficient, safer, and more sustainable for everyone.

There are different types of intelligence that need to be combined in order to address the flexibility and resiliency of decisions; other industries have already driven the path addressing intelligence and simplicity. Our industry is looking forward for concrete and simple examples to realize this vision as a reality.

ABOUT THE AUTHOR

Dr Oscar Pernia (PhD., Telecommunications & Industrial Engineering) worked in the shipping industry for 16 years and is responsible for ATOM Labs, an operational innovation team at Navis driving 'lean thinking' and 'rapid prototyping' on specific areas for improving impact from software and data-driven tools on efficiency, safety and sustainability and for addressing effective technical integration between processes, systems, and users at container terminals and ocean carriers. Prior to Navis, he played technology roles at port, ocean carrier and terminal sides, maintaining a strong focus on optimisation and automation at ports and terminals, including deep background on R&D projects applied to ports operations. Oscar is married to Rosa and has one son, Oscar v2.0, and one daughter, Catalina.

Rich Ceci joined VIT in May 2016 as Senior Vice President of Technology and Projects. He is currently responsible for major projects in the Port of Virginia and is leading the recently announced pair of expansion projects which will add significant capacity to the Port of Virginia and the USEC. This expansion includes advanced technology focused on improving both safety and productivity in the port. Previously Rich was VP of Information Technology for GCT USA in Bayonne NJ where he managed the Global Expansion Project, winner of several industry awards. The GEP was completed on-time and on budget and is one of the most technically advanced terminals in the US.

ABOUT THE ORGANISATION

Navis understands that as operational processes become more complex, efficiency, collaboration and productivity are essential. As a trusted technology partner, Navis offers the tools and personnel necessary to meet the requirements of a new, and ever-evolving, global supply chain. The Navis N4 terminal operating system is a platform that can integrate partner technologies, enabling terminals to optimise productivity and enhance the service delivered to its customers.

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