# Milestone 1 - Identify a Problem to Solve

Milestone 1 is where you begin working on your course project, a proposal for your own autonomous AI. Your goal is to: propose a use case, describe the value of the problem, and analyze the current system and its limitations.

You may use one of the case studies presented in the course as examples, but we strongly encourage you to be innovative and curious enough to create your own.

## 1 | Use Case Title: From Mine to Port Rail Scheduling Optimization

## 2 | Use Case Overview *(<=100 words) Provide a brief description of the use case and the system that your autonomous AI will improve.*

The client needs solutions for its different rail operations to carry out rail operations smoothly and efficiently to optimize the planning and scheduling of train operations to provide solutions for the client supply chain. Multiple parameters like maintenance, break down, congestion in rail network, speed restriction etc. must be taken into consideration when providing solutions to such problems. The optimized scheduling supposed to be used for weekly, daily, and hourly planning. It uses real-time data for generating predictions. If the scheduling stops working the client’s rail operations will be affected which is critical to their operations. The application should intelligently handle different parameters of the iron ore supply chain and generates optimal predictions for the future movements of trains from mine to port. This application provides optimal solution by using the available resources efficiently and by reducing the congestion in the rail network.

## 3 | Use Case Value *(<=100 words) Explain the value of improving the performance of this system.*

To maximize the Capacity, which is about 17~18 trains per day, 7/24/365, around 180~190 mtpa (million tones per annual). Every percent of the scheduling improvement will give huge business value impact.

## 4 | Current Methods *Select and explain the current methods used to control or optimize the system*

|  |  |  |
| --- | --- | --- |
|  | **Method** Check all that apply | **Description** |
|  | Human Operator / Engineer | The client operator has to conduct the rescheduling after any changes from the downstreams or upstreams, condition changes, i.e. weather etc. |
|  | Expert System |  |
|  | Control Theory (PID, MPC) |  |
|  | Optimization Techniques | network optimization techniques, but it uses the priority rule-based logic to resolve train conflicts. It also ensures that no deadlocks are created through its meet-pass decisions |
|  | Other |  |

## 5 | Limitations of current methods *Select and explain the limitations of current methods*

|  | **Limitation**  Check all that apply | **Description** |
| --- | --- | --- |
|  | Ability to control well across scenarios / conditions |  |
|  | Multiple or changing optimization goals |  |
|  | Human Operator /  Engineer Limitations  May include  · Difficulty managing many variables and dimensions  · Difficulty adapting to changing conditions  · Large performance discrepancy between novice and expert operators  · Inconsistency across expert operators | When more constrains added, the current system can’t get a solution in time.  · It’s very challenging to manage many variables and dimensions, and difficulty adapting to changing conditions, such as,  Equipment Capacity (Car Dumpers, Hopper, Conveyors, Ship loaders)  Operational and Contractual Rules  Capacity of areas and routes (equipment’s combination)  Arrival of trains  ETB, ETD, Lay day and volumes of shipments  Capabilities of hoppers and routes  ETAs and batch sizes  Scheduled maintenance  Stockyards capacities  Vessel available to load  Demurrage and Prize  Tides, etc. |
|  | Uncertainty in the measurement of the inputs or the process make it difficult to control or optimize. |  |
|  | Time to develop control or optimization system is prohibitive | 5~10 minutes response rate is not achieved all the time, either due to the data collection or model speed |

**Milestone 1 – Ends Here**

The remainder of this worksheet (Part 2) can be completed after you have finished the “Learning the Solution” module (which includes course items 3.1 to 3.4).

# Milestone 2 - Identify Autonomous AI Components to Use

For this week’s milestone, we will continue working on the proposal for an autonomous AI that you began last week. This week, you will propose an autonomous AI solution, determine which of the components you’ve learned about the system will include, and explain the autonomous AI superpowers that your autonomous AI brain will exhibit.

*You may want to update Sections 1 & 2 with any new insights you’ve gained.*

## 6 | Autonomous AI Overview *(<=100 words) Provide a brief description of how your proposed autonomous AI would improve the process.*

It is a complex business operation managing from Mine to the Port through the Rail network. To narrow down the high value use cases, and optimize it step by step, we break down the end-to-end scheduling to Rail scheduling and Port scheduling. Assuming Port scheduling as the client high priority and break the business process of port scheduling to Dumping plan, Storage plan, Stock and reclaiming plan, and Berthing plan. Within these stages, here I choose the Stock & Reclaiming plan to be the first Autonomous AI use case.

Stock & reclaiming plan considers the allocation of the equipment and quality targets to move the material minute by minute.

The Autonomous AI will assist the operator to provide the most optimal arrangement based on the real-time dynamic inputs and situations.

## 7 | Optimization Goal *List and describe the key performance indicators that will define control/optimization of the system (Example: maximize (throughput)*

Blend iron ore in stockyards to achieve the desired quality.

The stockpile should be used in cargo plan to achieve the efficiency.

Maximize the use of equipment, routes and stockyards.

Subject to Restrictions: stockyard and routes capacities, target quality, equipment’s capacities, maintenance scheduled etc.

## 8 | Autonomous AI Components *Select and explain the automation methods your AI will use.*

|  | **Method**  Check all that apply | **Description** |
| --- | --- | --- |
|  | Math (control systems) |  |
|  | Menus (optimization) |  |
|  | Manuals  (expert rules and systems) |  |
|  | Machine learning | Consider combining intensification and diversifications strategies for use of equipment. Analysing the current capability gaps when use metaheuristic algorithms, such as Iterated Local Search (ILS), Random Variable Neighborhood Descent (RVND), Simulated Annealing (SA). |
|  | Deep reinforcement learning | It will be 10300 different possible solutions when considering the optimization possibilities.  For blend and cargo plan, start from analysing Construction of stockyard possible states through heuristics and Mixed-Integer Programming models decides the best stock distribution to load the vessels in the blend and cargo planning. It’s possible that new piles could be created, or the recycle of current active piles.  Metaheuristic are used to decide operational, daily usage of equipment and routing handle conflicts and maximizing use.  Equipment and area maintenance, rate restrictions and interdictions are considered.  With the simulation of the environment, a DRL brain could be trained to achieve the multiple competing goals under dynamic changing conditions and constrains/rules. |

## 9 | Autonomous AI Superpowers *Select the superpowers that your autonomous AI brain will exhibit and explain how they will lead to an improvement in the process.*

|  | **Superpower**  Check all that apply | **Description** |
| --- | --- | --- |
|  | Makes human-like decisions | The DRL modules that implement the strategies will autonomously learn human-like decisions |
|  | Perceives, then acts | In Stock & reclaiming plan use case, advance perception won’t have much perceive requirements. |
|  | Learns and adapts | The Deep Reinforcement Learning modules will practice in simulator to learn the strategies, even in unlikely scenarios |
|  | Spots patterns | If we decide to use Machine Learning, the brain will spot patterns and will be able to classify/predict the type of Stock & reclaim plan/scheduling |
|  | Infers from experience | The DRL part of the brain practices in simulator, therefore it infers from that experience. |
|  | Improvises and strategizes | The DRL part of our brain will certainly learn strategy and it will adapt to rare situations because it would have already practice on those scenarios |