Beltone 2nd AI Hackathon

*Powered by: **Robin***

Problem Statement Overview:

Efficient multi-warehouse vehicle routing problems **(MWVRP)** are a critical challenge in modern logistics. Traditional algorithms struggle to handle the complexity, having to account for:

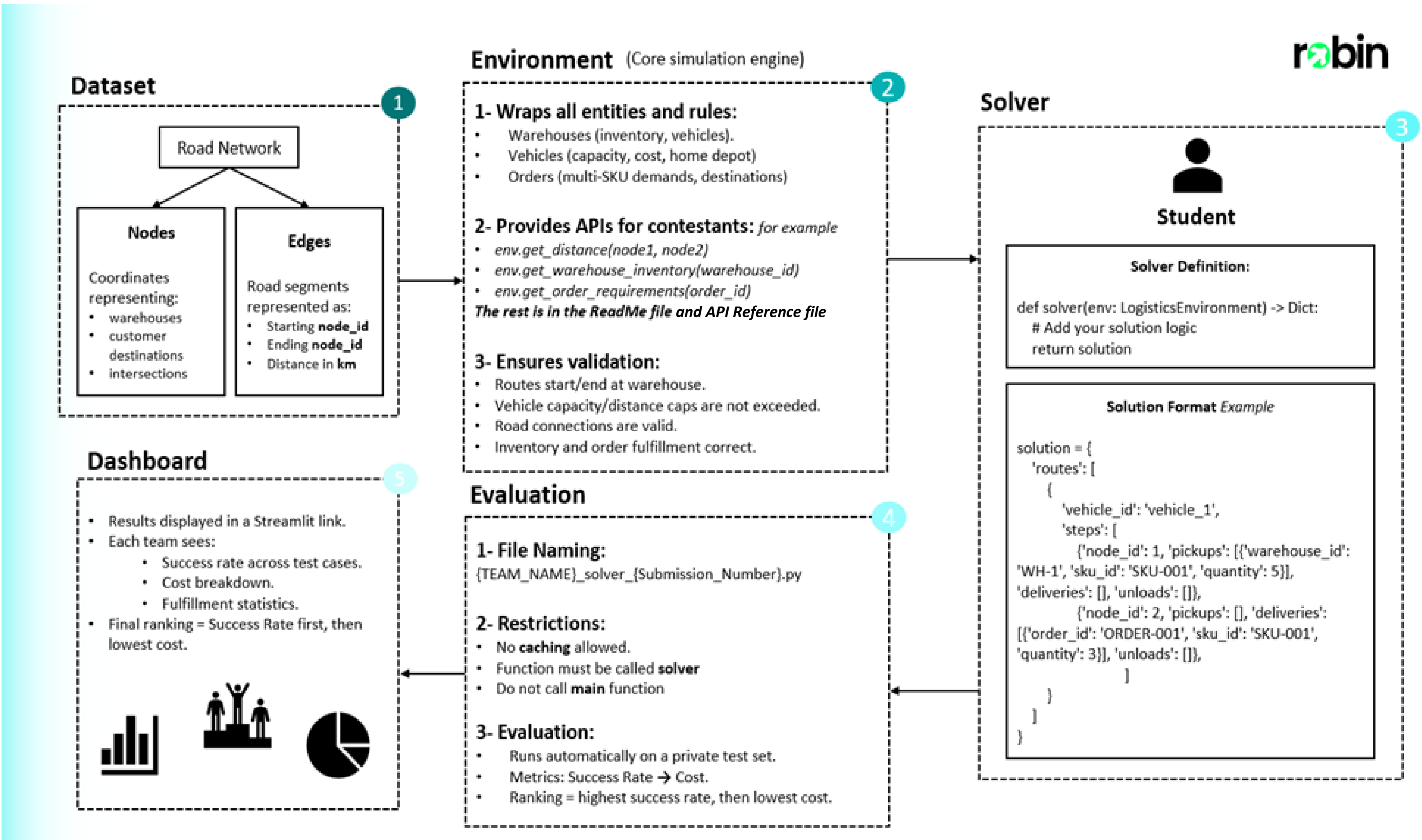
- Limited inventory distributed across multiple warehouses
- Directional road network constraints
- Vehicular capacity limits (weight & volume)
- Multi-warehouse pickup coordination
- Real-time inventory tracking during routing

Participants must design an **intelligent optimization solver** that dynamically plans delivery routes which:

- Respect road network connectivity
- Allocate and track inventory across warehouses
- Ensure vehicle capacity feasibility
- Sequence pickups across multiple depots correctly
- Optimize cost, efficiency, and fulfillment rates

The solution will be evaluated on **order fulfillment, operational cost minimization, vehicle utilization, and real-world feasibility** under constrained and imperfect logistics conditions.

robin


robin
Dataset
1
Road Network
Nodes
Coordinates representing:
• warehouses
• customer destinations
• intersections
Edges
Road segments represented as:
• Starting node_id
• Ending node_id
• Distance in km
Environment (Core simulation engine)
2
1- Wraps all entities and rules:
• Warehouses (inventory, vehicles).
• Vehicles (capacity, cost, home depot)
• Orders (multi-SKU demands, destinations)
2- Provides APIs for contestants: for example
• env.get_distance(node1, node2)
• env.get_warehouse_inventory(warehouse_id)
• env.get_order_requirements(order_id)
The rest is in the ReadMe file and API Reference file
3- Ensures validation:
• Routes start/end at warehouse.
• Vehicle capacity/distance caps are not exceeded.
• Road connections are valid.
• Inventory and order fulfillment correct.
Solver
3
Student
Solver Definition:
def solver(env: LogisticsEnvironment) -> Dict:
# Add your solution logic
return solution
Solution Format Example
solution = {
'routes': [
{
'vehicle_id': 'vehicle_1',
'steps': [
{'node_id': 1, 'pickups': [{'warehouse_id': 'WH-1', 'sku_id': 'SKU-001', 'quantity': 5}], 'deliveries': [], 'unloads': []},
{'node_id': 2, 'pickups': [], 'deliveries': [{'order_id': 'ORDER-001', 'sku_id': 'SKU-001', 'quantity': 3}], 'unloads': []},
]
}
]
}
Dashboard
5
• Results displayed in a Streamlit link.
• Each team sees:
• Success rate across test cases.
• Cost breakdown.
• Fulfillment statistics.
• Final ranking = Success Rate first, then lowest cost.
Evaluation
4
1- File Naming:
{TEAM_NAME}_solver_{Submission_Number}.py
2- Restrictions:
• No caching allowed.
• Function must be called solver
• Do not call main function
3- Evaluation:
• Runs automatically on a private test set.
• Metrics: Success Rate → Cost.
• Ranking = highest success rate, then lowest cost.

Dataset:

The dataset used is a collection of entries that represent locations in all of Cairo. The dataset models roads and locations in Cairo as a graph network comprised of nodes and edges. This data is represented as follows:

1- Nodes: These represent a landmark in Cairo identified as co-ordinates.
2- Edges: These represent directional links between 2 Nodes (not necessarily bidirectional), identified using the 2 nodes and the length between them.

This image shows a small portion of the dataset highlighting the area from Masr el-gedida and Madinat Nasr to the beginning of El-Rehab City.

Environment:

The **Robin Logistics Environment** simulates a large-scale real-world logistics network for solving **multi-warehouse vehicle routing problems (MWVRP)** under strict operational constraints.

- **Road Network:** 332k nodes, directional/bi-directional roads, Dijkstra-based pathfinding.
- **Warehouses:** Multiple depots with limited inventories and defined vehicle fleets.
- **Vehicles:** Light vans to heavy trucks, capacity (weight & volume) limits, fixed + variable costs, max distance constraints.
- **Orders & Inventory:** Multi-SKU customer orders, distributed demand, real-time inventory tracking, scarcity-driven allocation.
- **Constraints:**
    - Routes start/end at home warehouses
    - Capacity checks at every step
    - Valid road connections only
    - Full order fulfillment (partials take points but not fully)
    - One route per vehicle
    - Running-Time of solvers submitted should **not exceed 30 minutes** (more than this won't be evaluated)
    - **Environment manipulations or altercations is NOT ALLOWED** (don't play in environment, which is robin-logistics-env)
    - **Building a string solution is not allowed, solver is being evaluated against environment and scenarios.**
    - **Has to be a Python (.py) file.**
- Allowed:
    - Multi-pickup from several warehouses
    - Multi-vehicle per order
    - Unload to any warehouse
    - Directed roads
    - Vehicles start/end at home warehouse

Challenge Characteristics *(Variable to change according to scenario)*: 50 orders, 12 vehicles, 3 SKUs, 2 Warehouses and constrained resources over a massive road network. Solutions must optimize **cost, capacity use, and fulfillment rates** while passing strict **validation on connectivity, inventory, and business logic compliance**.

Please use **"pip install robin-logistics-env"** to install the environment.

Evaluation:

Process

- Solvers are tested on **Private Scenarios** (hidden) and **5 Public Scenarios** (for local testing).
- Each private scenario evaluates both **cost efficiency** and **fulfillment rate**.
- Presentation will be held for **top teams** after deadline, to present solutions against the panel, **affecting final ranking**

Scoring Equation

For every scenario:

$$\text{Scenario Score} = \text{Your Scenario Cost} + \text{Benchmark Solver Cost} \times (100 - \text{Your Fulfillment \%})$$

- **Lower = Better**
- Missing fulfillment is heavily penalized.
- Once fulfillment is high, cost efficiency becomes the differentiator.

Dynamic Ranking & Points

1. After computing scenario scores for all solvers, they are **ranked dynamically** (lowest → highest score).
2. Points are awarded based on rank:
    - Rank 1 = 20 points
    - Rank 2 = 19 points
    - Rank 3 = 18 points
    - … and so on.
3. Final score = **sum of points across all private scenarios**.

This ensures:

- Rankings **shift dynamically** as new solvers are submitted.
- Strong, consistent performance across scenarios matters more than excelling in just one.
- Even a single weak scenario can change the leaderboard significantly.

Leaderboard

- Updated **live** throughout the hackathon.
- Displays each team's **total points** across all scenarios.
- The leaderboard is **dynamic** — every submission can reshuffle rankings.

Submission:

Link for the submission portal: AI Hackathon Submission

All participating teams have to follow a strict pipeline for submissions. The submission process will be done as:

1- After testing the model locally, the model should be saved as a .py file using the following naming convention {TEAM_NAME}_solver_{Submission_Number} e.g.(Robin_solver_1), The submission number starts from 1 and is incremented by 1 for every submission. **(It is the team's responsibility to ensure the correct naming for each submission, any inconsistencies may result in an unevaluated submission)**

2- The Model is then evaluated automatically using a private testing set.

3- The results will be posted on a live leaderboard hosted on Streamlit. Results Dashboard

Rules and Regulations:

- The submitted file must have a main function defined as follows:
  def solver(env):
- The submitted file **MUST NOT** use any caching techniques.
- **Do not import or initialize** the environment inside the solver function only in main
- **Comment out the main function** when submitting the solver file

Starter Skeleton — baseline solver to get participants started

Below is a compact, ready-to-run baseline skeleton you can include in your repository and adapt. It is intentionally simple and **meant as a launchpad**. Use it to get fast local runs and then iterate.

Solver skeleton is included as a python file named solver.py

Local Scenario Dashboard – Statistics based on your solver (optional):

run_dashboard.py is a file that when runs a dashboard that helps you to visualize your solver – **this is an optional tool**

Dashboard is included as a python file named run_dashboard.py

---

Functions Documentation Excel file:

Included is an excel file named functions_exmaples_documentation, which contains a documented rows of functions , with examples of it's input and output used for the Hackathon Problem.

Excel file name is functions_examples_documentation

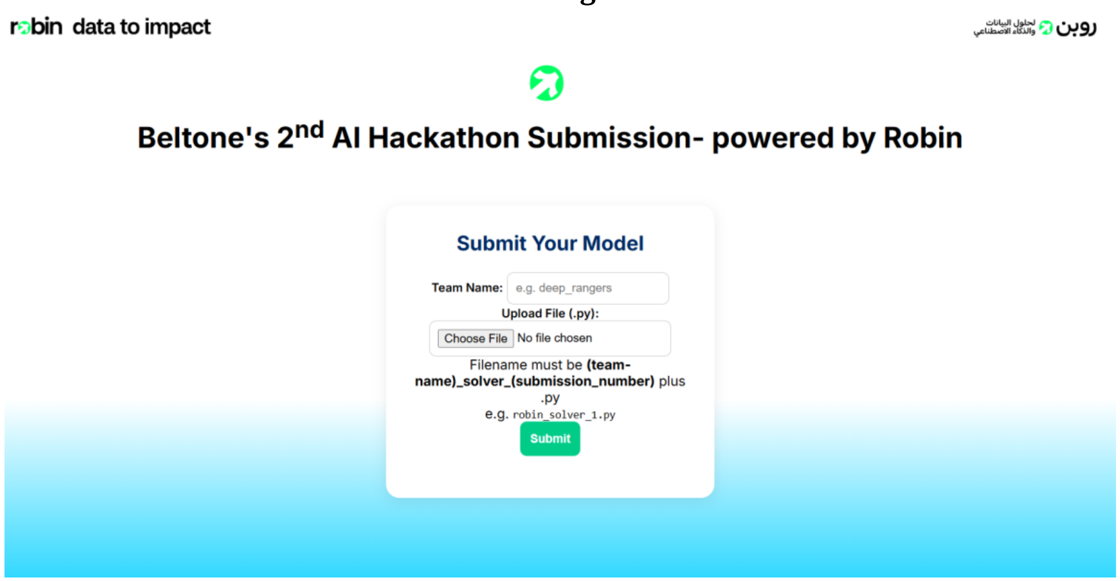
Submission Portal Link: AI Hackathon Submission

When Submitting the Solver file, it should be named according with your team name, like example below:

You team name is : Robin

Then the solver file you're submitting should be accordingly:
Robin_solver_1.py (DO NOT WRITE MANULLAY .py , THIS IS FILE TYPE)
and inside the portal in team name area you write , Robin (has to be identical to the team name naming of the solver file you submitted)

like this image below:



If you did another iteration (you can submit more than once to increase your ranking), then you should increment the number of submission id (eg: 1), to be 2 , then a 3rd iteration to be 3 , and so on…
example : 2nd iteration: Robin_solver_2.py

example : 3nd iteration: Robin_solver_3.py