Deep Call Stack Analysis: Maritime Transport Scheduling Algorithm

Executive Summary

The `solution.generate_schedule()` call stack represents a **sophisticated multi-modal maritime logistics optimization engine** that orchestrates the complex coordination of tugboats, barges, and cargo handling equipment across sea and river transport networks. This system implements a **constraint satisfaction problem solver** with **temporal reasoning**, **resource allocation optimization**, and **multi-stage route planning**.

Algorithmic Architecture Overview

Core Algorithm Pattern: Multi-Stage Constraint Optimization

The system follows a **hierarchical decomposition approach**:

1. **Resource Assignment Layer** - Assigns barges to orders based on constraints
2. **Transport Coordination Layer** - Coordinates sea-to-river tugboat handoffs
3. **Timeline Synchronization Layer** - Ensures temporal consistency across operations
4. **Schedule Optimization Layer** - Optimizes crane and equipment utilization

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Phase-by-Phase Deep Analysis

Phase 1: Initial Resource Assessment

```
assign_barges_to_single_order(order, barges)
```

Abstract Pattern: Greedy Resource Allocation with Constraint Filtering

Algorithmic Behavior:

- Implements a **capacity-constrained bin packing variant**