

Integrating Reinforcement Learning and Pattern Mining with FRAM to Analyze Hospital-to-Home Transition Pathways

By **Saba Tamizi**
Supervisor: Dr. Doug Smith
Memorial University of Newfoundland

Healthcare Transitions as Complex Connected Systems

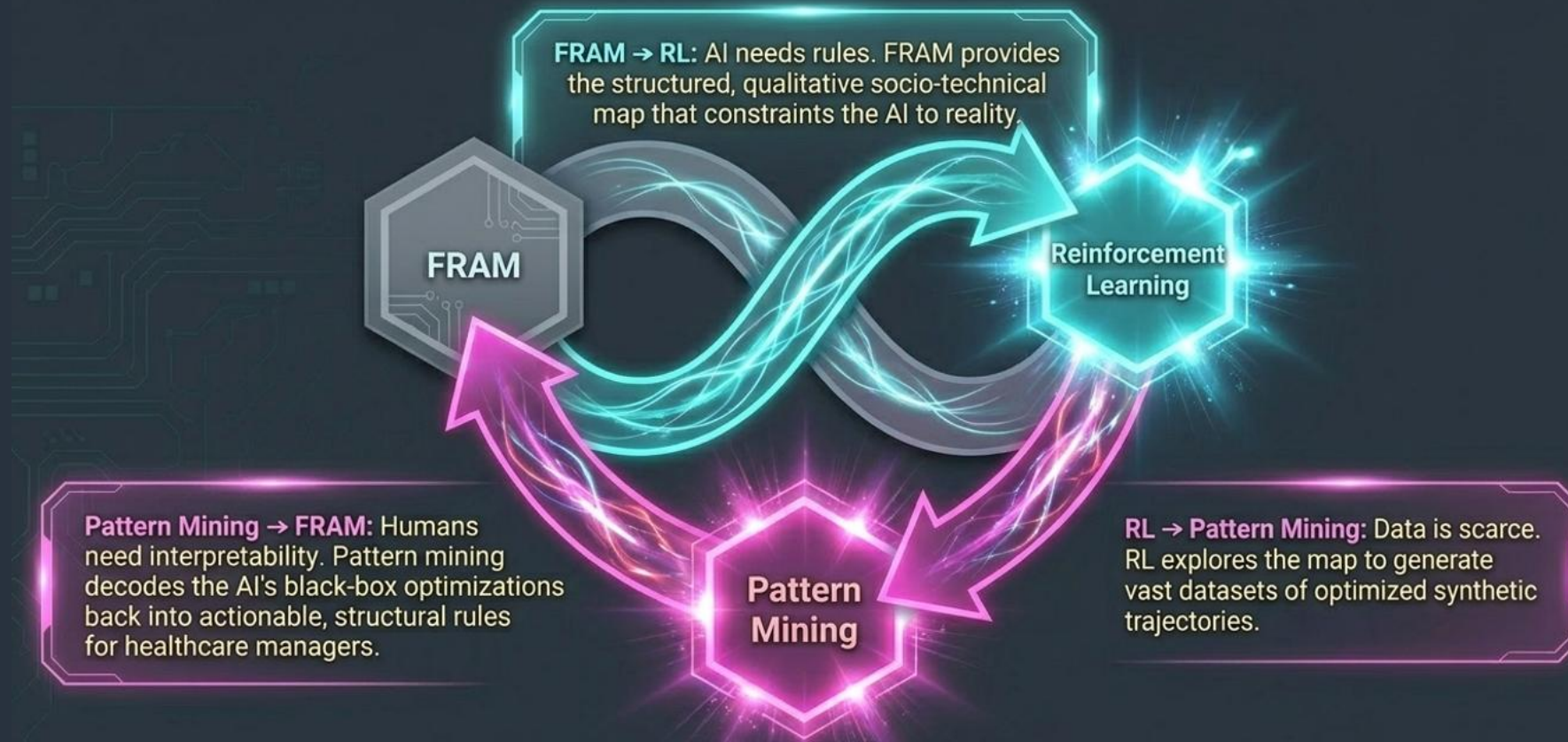


Challenge: Variability spreads across the care network.

Bottleneck: Traditional FRAM maps the system, but does not simulate or optimize pathways.

Need: A way to test, compare, and optimize possible care pathways before applying them in practice, even when data is limited.

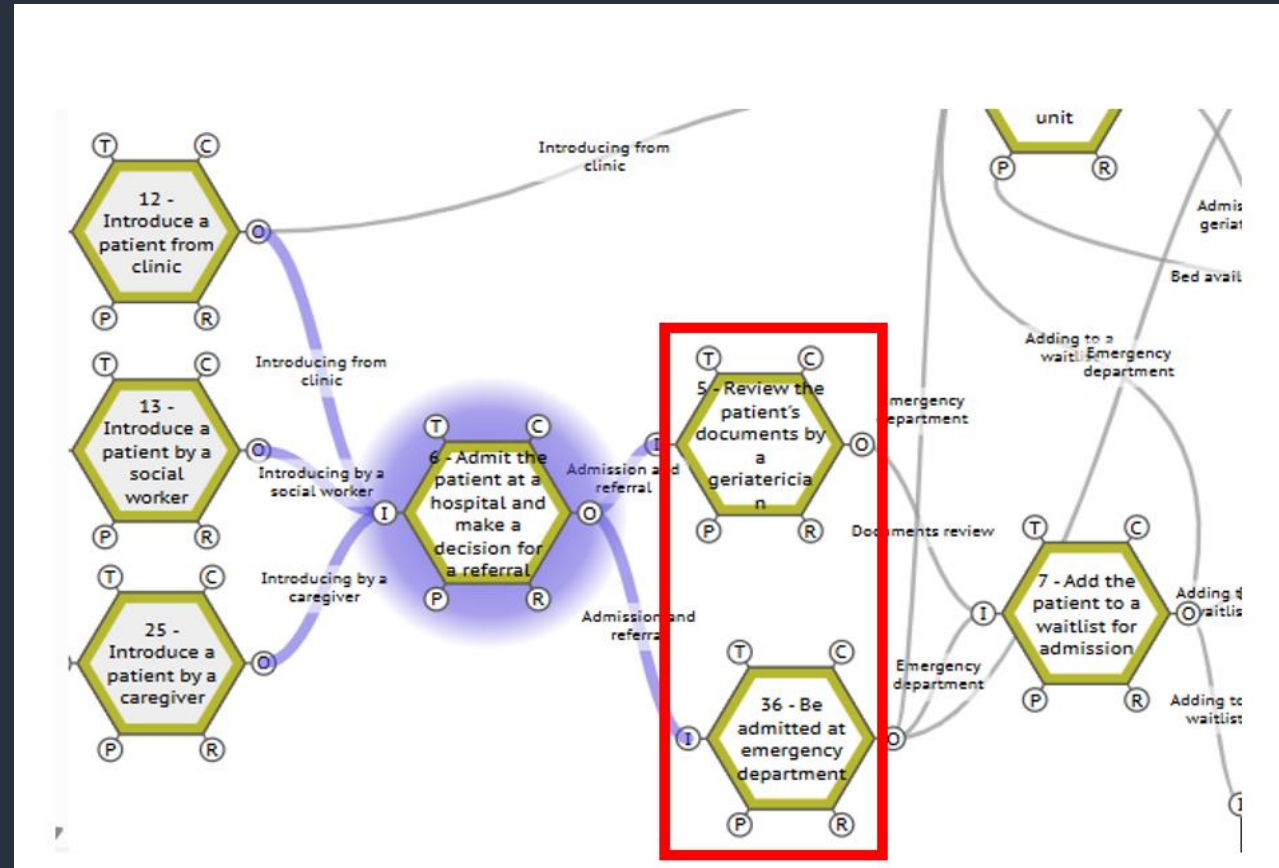
New Approach: Integrating Reinforcement Learning and Pattern Mining with FRAM



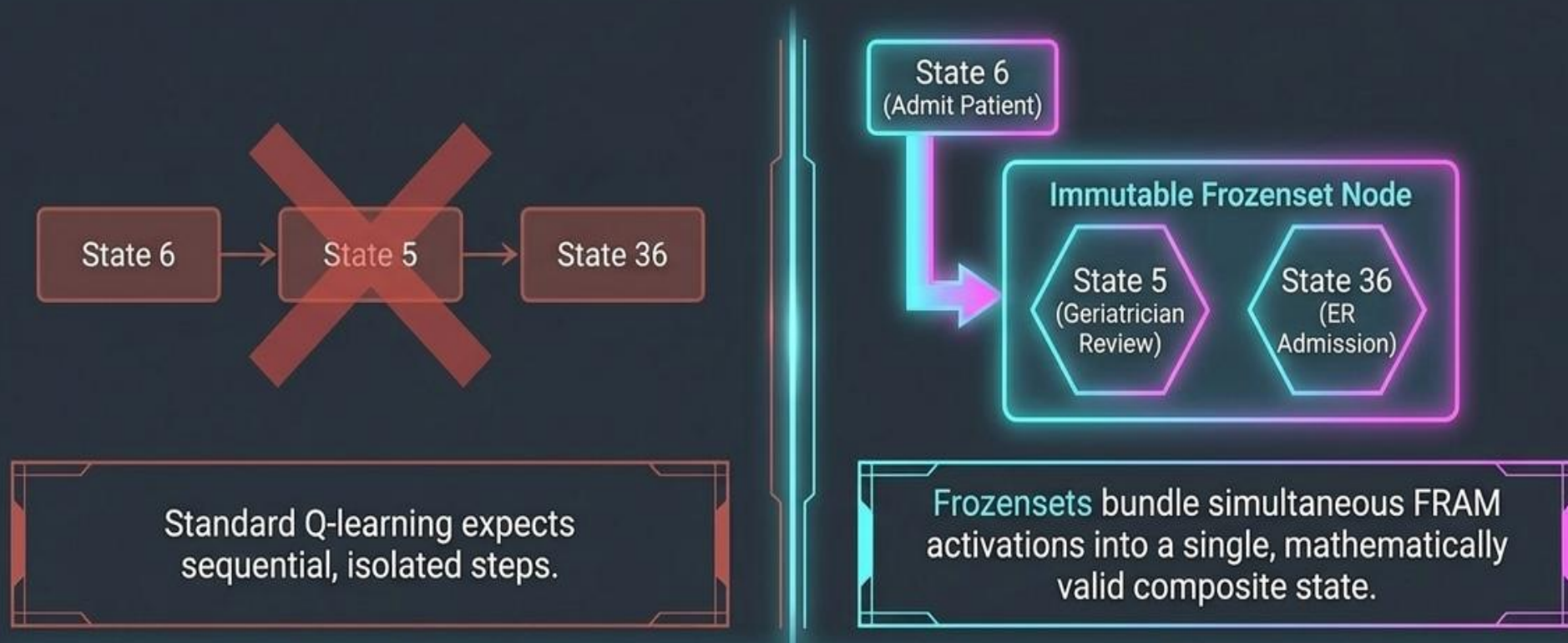
Traditional FRAM vs. RL-Enhanced FRAM

	Traditional FRAM	RL-Enhanced FRAM
Nature of Output	Qualitative & Descriptive.	Quantitative & Data-Driven.
Data Requirement	Heavy reliance on expert judgment.	Generates Agent Signatures (synthetic trajectories) to overcome healthcare data scarcity.
Handling Variability	Describes how variability propagates.	Optimizes and predicts outcomes under variability.
Outcome Focus	Safety mapping and risk identification.	Pathway optimization and performance extraction.

Handling Simultaneous Function Activations in FRAM-Based Reinforcement Learning



Handling Simultaneous Function Activations in FRAM-Based Reinforcement Learning



The Three-Dimensional Reward Function


$$\text{Reward} = \frac{1}{3} \text{Time} + \frac{1}{3} \text{Cost} + \frac{1}{3} \text{Quality}$$




Time (Normalized & Inverted): Shorter execution times yield higher rewards, reflecting reduced patient waitlists.

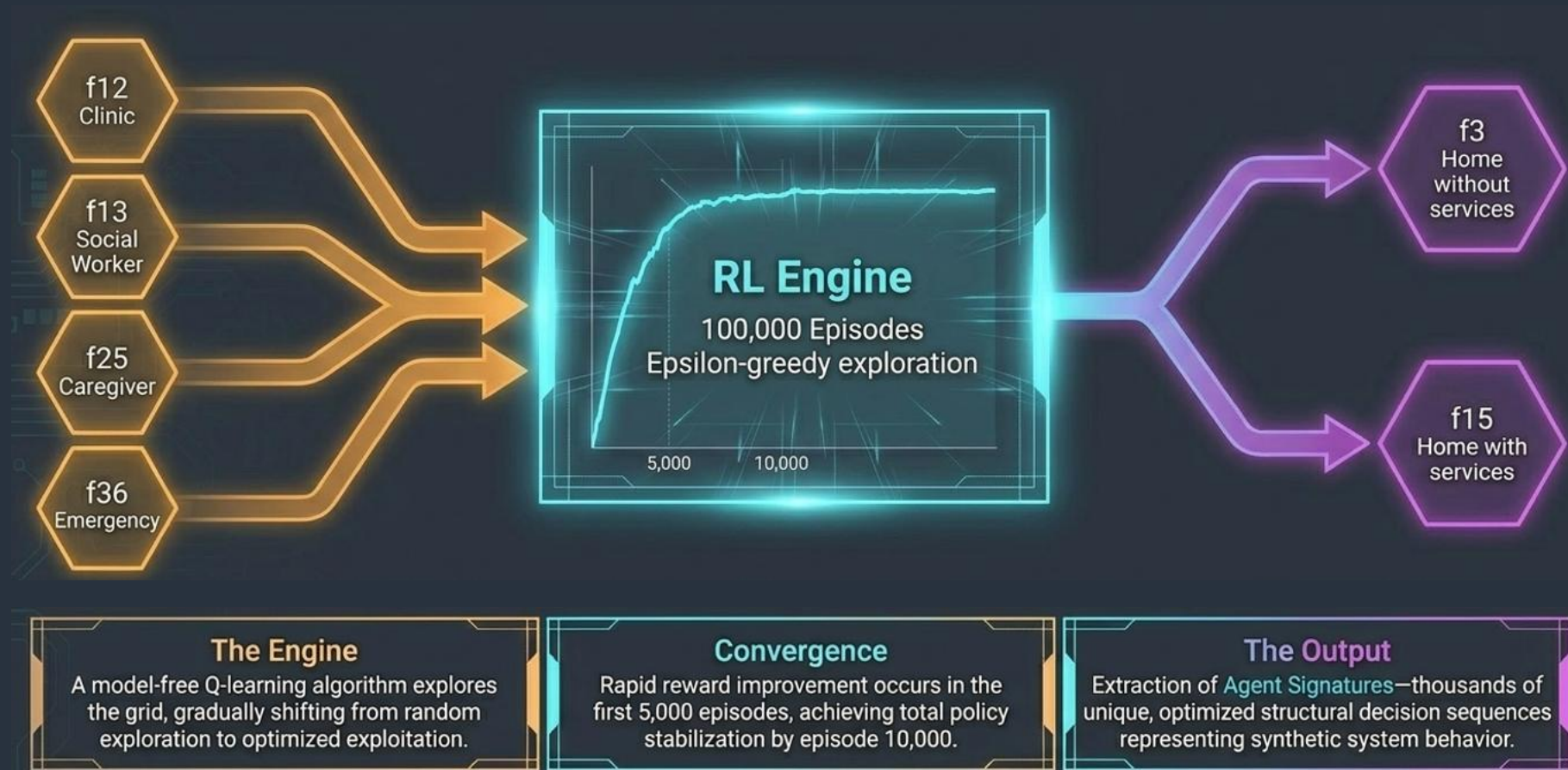


Cost (Normalized & Inverted): Lower personnel hours relative to average wages ensure optimal resource utilization.



Quality (Scaled): Reflects the effectiveness of care delivery, team coordination, and discharge planning.

Training the Q-Learning Agent to Generate Sythetic Pathways (Agent Signature)



Decoding Agent Signatures via Pattern Mining

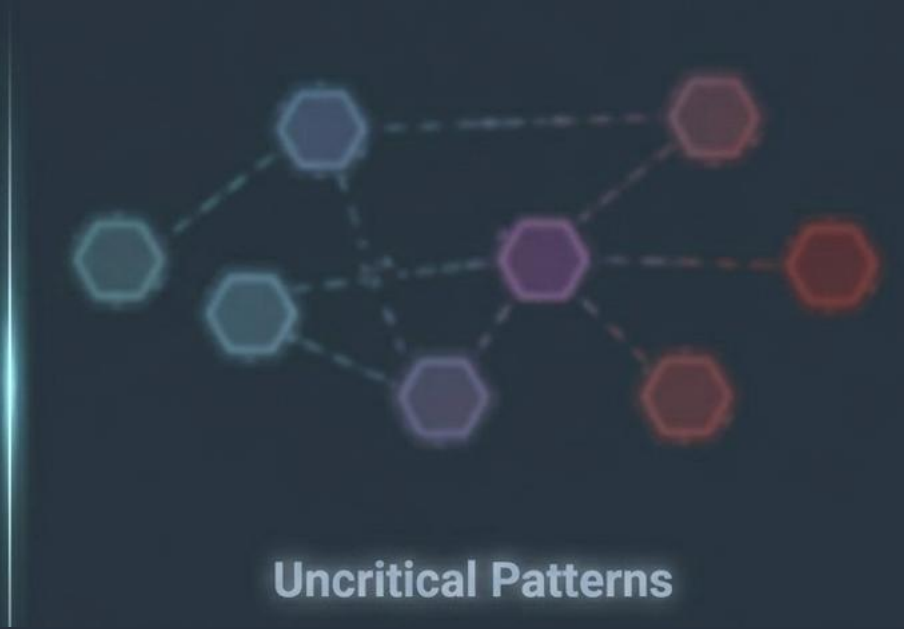


Critical Patterns vs. Non-Critical Patterns



Critical Patterns

Critical Patterns: Items or combinations that remain consistent across high-ranking rules.



Uncritical Patterns

Non-Critical Patterns: Secondary Items that vary without altering the performance outcome.

An Example of a Low-Performance Signature

Discovered Pattern:

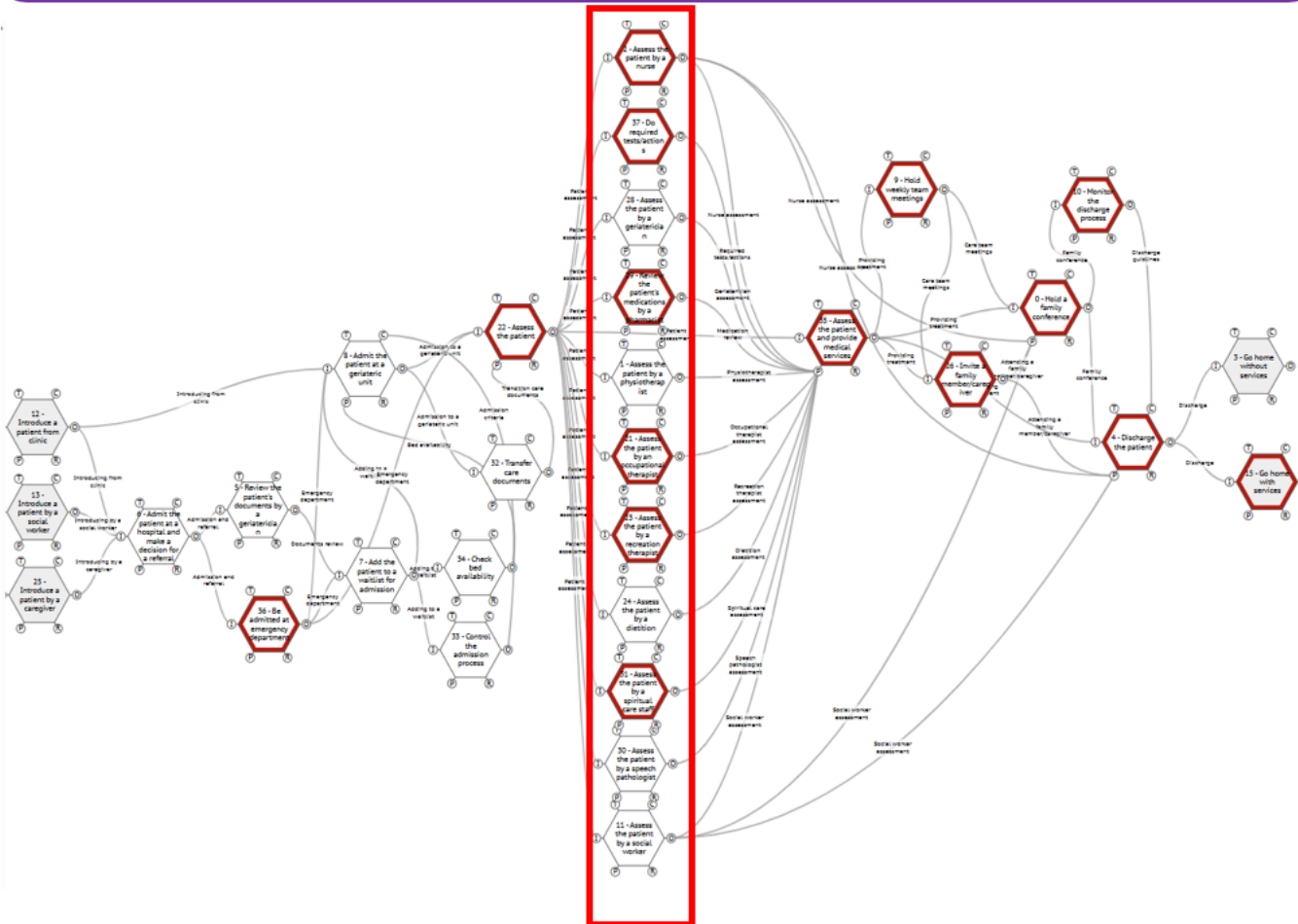
IF Reward Cycle 2 = Mid AND Reward Cycle 4 = Low → Final Performance = Low

Trajectory:

36 → 22 → frozenset({'37','29','23','21','31','2'}) → 35 → 9 → 26 → 0 → 10 → 4 → 15

Intermediate Reward Categories:

low → mid → mid → low → low → low → low → low → Final Performance = Low



Reward Cycle 2 = Mid



Medium performance up to the second function

Reward Cycle 4 = Low



Low performance up to the fourth function

AND

Final Performance



An Example of a High-Performance Signature

Discovered Pattern:

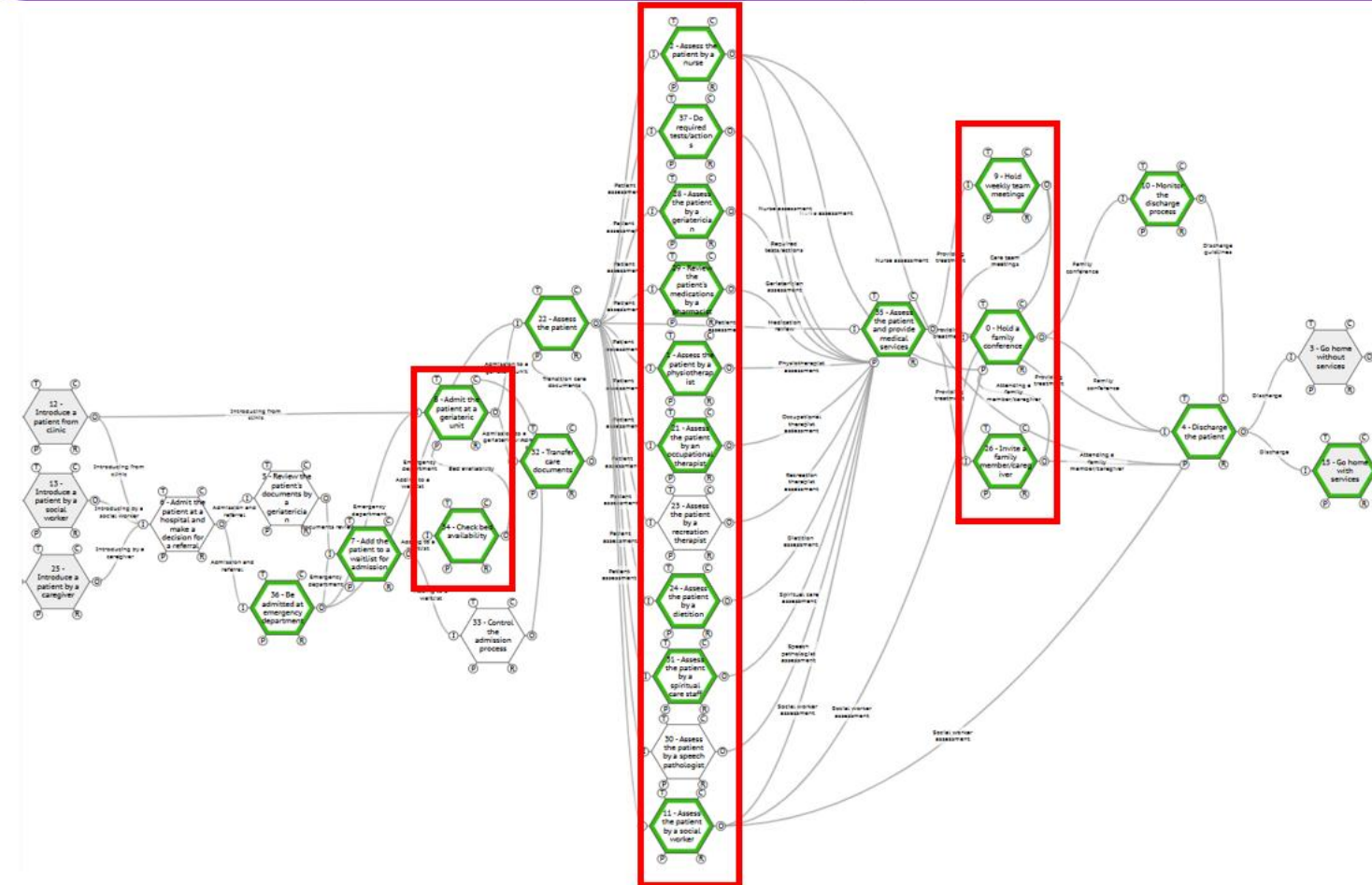
IF Reward Cycle 8 = High → **Final Performance = High**

Trajectory:

36 → 7 → frozenset({'34','8'}) → 32 → 22 → frozenset({'37','11','31','24','28','29','21','2','1'}) → 35 → frozenset({'26','9','0'}) → 0 → 10 → 4 → 15

Intermediate Reward Categories:

low → low → low → low → mid → mid → mid → **high** → mid → high → **Final Performance = High**



Reward Cycle 8 = High



High performance up to the eighth function

Final Performance



From Algorithmic Optimization to Hospital Action



Look Past Early Delays

High-performance pathways prove that initial intake friction (Cycles 1-3) does not doom a transition. Resources shouldn't be over-indexed here at the expense of later stages.



Monitor the Mid-Stage Trap

Cycles 4 through 7 are the operational danger zone. Compounding variability here guarantees failure. This is where management intervention is most critical.



Fortify the Final Mile

The simultaneous activation of family conferences, team meetings, and discharge planning (Cycles 8-10) is the ultimate determinant of success. Protect these couplings at all costs.

Discussion