TRACK 5 - SMART AUTOMATION

⚠️ **IMPORTANT: Hardware Requirements & Disqualification Rules**

Bring Your Own Hardware: Teams must supply all necessary components. No hardware will be provided at the venue.

100% On-Site Assembly: Components must arrive completely unassembled. Any team found bringing a partially or fully pre-built project will face immediate disqualification upon inspection.

HTH-SA-01: Exception-Based Workforce Attendance & Compliance Automation

Category	Details
Industry	Enterprise HR Operations
Scenario	Manually reviewing attendance across a large workforce for compliance/payroll issues is slow; managers need only the exceptions, not raw logs.
Problem Statement	Automate attendance capture via simulated RFID/QR input, and instead of just generating reports, automatically detect exception patterns (repeated late-arrival, pattern absences before/after holidays, shift-mismatch) and route them to the correct manager for action with suggested next steps.
What Teams Should Build	Simulated attendance-event ingestion, exception-pattern detection engine, routing/escalation logic with suggested action.
24-Hour MVP	Simulated attendance logs for 100+ employees over several weeks, exception detection (3+ pattern types), manager-routed exception queue.
Data / Input	Simulated attendance event data (documented generation).
Key Constraints	Must detect patterns, not just threshold-based single absences; routing must reflect org hierarchy (simulated).
Expected Output	Exception dashboard per manager with pattern type and suggested action.
Evaluation Criteria	Pattern-detection sophistication, routing logic correctness, practical HR usefulness.
Bonus Features	Auto-drafted, editable communication to flagged employee/manager.

HTH-SA-02: Throughput-Optimized Adaptive Traffic Signal Controller

Category	Details
Industry	Smart City / Traffic Engineering
Scenario	Fixed-timing traffic signals cause unnecessary congestion during variable demand; city engineers want signals that adapt to real conditions but stay within safety constraints.
Problem Statement	Automatically adjust signal timing based on simulated real-time density per approach at an intersection, optimizing throughput while respecting minimum/maximum green-time safety constraints and pedestrian crossing requirements.
What Teams Should Build	Simulated multi-approach density stream, adaptive signal-timing algorithm, safety-constraint enforcement layer (hard min/max bounds, pedestrian phase guarantee).
24-Hour MVP	Simulated 4-way intersection with variable density patterns, adaptive controller demo showing throughput improvement vs. fixed-timing baseline, safety constraints never violated.
Data / Input	Simulated intersection traffic-density data (documented generation, including a rush-hour and off-peak scenario).
Key Constraints	Hard safety bounds (min/max green, mandatory pedestrian phase) must never be violated regardless of optimization pressure; must show quantified improvement vs. fixed-timing baseline.
Expected Output	Live signal-timing simulation dashboard with throughput comparison vs. baseline.
Evaluation Criteria	Optimization quality, safety-constraint guarantee, quantified improvement.
Bonus Features	Emergency-vehicle preemption scenario mid-demo.

HTH-SA-03: Usage-Pattern-Based Automated Inventory Restocking System

Category	Details
Industry	Retail / Warehouse Operations
Scenario	Fixed reorder-point thresholds cause both stockouts (during demand spikes) and overstock (during slow periods) because they ignore actual usage patterns.
Problem Statement	Automatically trigger restocking alerts/purchase orders based on learned usage patterns (trend + seasonality) rather than fixed thresholds, and adjust reorder points dynamically as patterns shift.
What Teams Should Build	Usage-pattern learning model, dynamic reorder-point calculator, automated PO-generation trigger with human-approval step.
24-Hour MVP	Public/synthetic inventory usage dataset, dynamic reorder-point calculation vs. fixed-threshold baseline comparison, automated draft PO generation.
Data / Input	Public retail inventory/sales datasets or synthetic usage-pattern generator.
Key Constraints	Reorder points must adapt over time, not be static; must show comparative stockout/overstock reduction vs. fixed-threshold baseline; supplier lead-time must be factored in.
Expected Output	Dynamic reorder dashboard with draft purchase orders and baseline comparison.
Evaluation Criteria	Pattern-learning quality, quantified improvement over static threshold, realistic lead-time handling.
Bonus Features	Supplier-selection logic when multiple suppliers with different lead times/costs exist.

HTH-SA-04: Deficit-Aware Smart Irrigation Automation Under Water Restriction

Category	Details
Industry	AgriTech / Resource-Constrained Farming
Scenario	During drought restrictions, farms are allocated a hard water quota and must automate irrigation decisions that respect the quota while minimizing crop stress.
Problem Statement	Automatically control simulated water valves/pumps based on soil moisture and weather forecasts, respecting a hard daily/weekly water quota, and prioritize which zones get water first when the quota is insufficient for all.
What Teams Should Build	Simulated soil-moisture/weather-driven control logic, hard-quota enforcement, multi-zone prioritization under insufficient total supply.
24-Hour MVP	Simulated multi-zone farm with a fixed weekly water quota insufficient for full irrigation, automated control decisions with visible trade-offs and prioritization rationale.
Data / Input	Simulated soil-moisture/weather data (documented generation) or public agri-weather datasets.
Key Constraints	Quota is a hard cap, never exceeded; must show explicit zone-level trade-offs, not silent averaging.
Expected Output	Irrigation control log with quota-usage tracker and zone-priority rationale.
Evaluation Criteria	Constraint enforcement, prioritization logic quality, realistic resource trade-off handling.
Bonus Features	Forecast-responsive pre-emptive watering before a hot/dry spell within quota limits.

HTH-SA-05: Deadline-Aware Workload-Balanced Task Scheduler with Auto-Reassignment

Category	Details
Industry	Enterprise Operations / Project Management
Scenario	Manual task assignment leads to uneven workload and missed deadlines; managers need automation that reassigns intelligently, not just flags misses after the fact.
Problem Statement	Automatically assign and schedule tasks based on employee workload, availability, and priority, and when a deadline is at risk of being missed, automatically propose (not silently execute) a reassignment that respects skill-fit and current workload of alternates.
What Teams Should Build	Workload/availability tracking, priority-based scheduling algorithm, at-risk-deadline detection, skill-aware reassignment proposal engine (with human approval step).
24-Hour MVP	Simulated team of 10–15 employees with tasks/skills/availability, scheduling demo showing automatic reassignment proposal when a simulated delay occurs mid-demo.
Data / Input	Simulated employee/task dataset (documented generation with skills, capacity, priority).
Key Constraints	Reassignment must respect skill-fit, not just availability; must propose for human approval rather than fully autonomous reassignment (accountability constraint).
Expected Output	Live scheduling dashboard with at-risk flags and reassignment proposals with rationale.
Evaluation Criteria	Scheduling logic quality, skill-aware reassignment sophistication, practical human-in-loop design.
Bonus Features	Workload-balance visualization showing fairness across the team over time.

HTH-SA-06: Occupancy- and Footfall-Responsive Adaptive Street Lighting

Category	Details
Industry	Smart City / Municipal Energy
Scenario	Always-on or fixed-schedule street lighting wastes significant energy in low-traffic periods, but safety requires responsiveness to actual pedestrian/vehicle presence.
Problem Statement	Automatically adjust street-light brightness based on simulated ambient light and movement detection, ensuring lights ramp up fast enough for approaching pedestrians/vehicles (safety constraint) while minimizing energy use during idle periods.
What Teams Should Build	Simulated ambient-light/motion sensor stream, adaptive brightness-control logic with guaranteed ramp-up latency, energy-savings tracking vs. always-on baseline.
24-Hour MVP	Simulated street segment with variable pedestrian/vehicle traffic patterns over a 24-hour cycle, adaptive control demo with quantified energy savings vs. baseline, and a safety-latency test scenario.
Data / Input	Simulated ambient-light/motion sensor data (documented generation, including a low-traffic and high-traffic scenario).
Key Constraints	Ramp-up latency to full brightness must meet a defined safety bound when motion is detected; must show quantified energy savings vs. always-on baseline.
Expected Output	Control simulation dashboard with brightness timeline, energy-savings %, and safety-latency verification.
Evaluation Criteria	Responsiveness/safety-latency guarantee, quantified energy savings, realistic control logic.
Bonus Features	Weather-adaptive dimming (adjust for fog/rain visibility needs).

HTH-SA-07: Statistically-Calibrated Automated Quality Control Inspector

Category	Details
Industry	Manufacturing / Quality Assurance
Scenario	Manual pass/fail inspection is inconsistent and slow, but a naive automated inspector risks high false-reject rates that halt production unnecessarily.
Problem Statement	Automate pass/fail inspection on a simulated production line using image or sensor input, calibrate the decision threshold against a defined acceptable false-reject vs. false-accept trade-off (cost-based), and flag borderline items for human review rather than forcing a binary call.
What Teams Should Build	Defect-detection model (image or sensor-based), cost-based threshold calibration, three-way decision logic (pass/fail/human-review) for borderline cases.
24-Hour MVP	Public/synthetic defect-detection dataset, automated inspection demo with calibrated threshold showing false-reject/false-accept trade-off table, borderline-case routing to human review.
Data / Input	Public manufacturing-defect datasets (e.g., MVTec AD) or synthetic sensor-based defect data.
Key Constraints	Must explicitly calibrate threshold against a stated cost trade-off (cost of false-reject vs. false-accept), not use a default 0.5 cutoff; must include a human-review path for borderline confidence.
Expected Output	Inspection dashboard with pass/fail/review decisions, confidence, and trade-off calibration report.
Evaluation Criteria	Detection accuracy, quality of cost-based threshold reasoning, sensible borderline-handling design.
Bonus Features	Defect-type breakdown and root-cause hint (e.g., correlated with a specific production line/shift).

HTH-SA-08: Utilization-Maximizing Meeting Room Auto-Release System

Category	Details
Industry	Corporate Facilities Management
Scenario	Booked-but-unused meeting rooms are a common corporate waste problem; automation should reclaim rooms without disrupting legitimate late-starting meetings.
Problem Statement	Automatically detect no-shows using simulated occupancy sensors and release rooms after a grace period, while avoiding false releases for meetings that start slightly late — and recommend booking-policy changes based on observed utilization patterns.
What Teams Should Build	Simulated occupancy-sensor stream, no-show/grace-period detection logic, auto-release automation, utilization-pattern analytics feeding policy recommendations.
24-Hour MVP	Simulated multi-room booking + occupancy data over a week, auto-release demo with configurable grace period, utilization report with policy recommendations (e.g., "reduce default booking length for Room B").
Data / Input	Simulated room-booking and occupancy sensor data (documented generation).
Key Constraints	Grace period must avoid falsely releasing rooms for slightly-late-but-legitimate meetings; must produce room-utilization insights, not just individual release events.
Expected Output	Live release-automation log plus a weekly utilization/policy-recommendation report.
Evaluation Criteria	Automation correctness/false-release rate, quality of utilization insights, practical policy recommendations.
Bonus Features	Predictive no-show likelihood scoring at booking time based on historical patterns.

HTH-SA-09: Comfort-vs-Cost Balanced Automated HVAC Controller

Category	Details
Industry	Facilities Management / Energy
Scenario	HVAC is a major energy cost driver, but over-optimizing for cost harms occupant comfort; facilities need automation that explicitly balances both with visible trade-offs.
Problem Statement	Automatically adjust heating/cooling based on simulated occupancy, time-of-day, and temperature readings, explicitly optimizing a configurable comfort-vs-cost trade-off (not cost alone), and explain each adjustment decision.
What Teams Should Build	Simulated occupancy/temperature stream, control logic with a configurable comfort-cost weighting parameter, decision-explanation layer, energy-savings tracking vs. static-schedule baseline.
24-Hour MVP	Simulated building zone with occupancy/temperature data over 24 hours, automated control demo at two different comfort-cost weightings showing the trade-off explicitly, savings vs. baseline.
Data / Input	Simulated occupancy/temperature/weather data (documented generation) or public building datasets.
Key Constraints	Comfort-cost trade-off must be configurable and visible, not hardcoded to pure cost-minimization; each control decision must have a stated rationale.
Expected Output	Control dashboard with decision log, rationale, and comfort-vs-cost comparison across weighting settings.
Evaluation Criteria	Control logic quality, trade-off configurability/transparency, quantified energy impact.
Bonus Features	Occupant feedback loop adjusting future weighting.

HTH-SA-10: SLA-Aware Automated Support Ticket Routing & Escalation System

Category	Details
Industry	Customer Support Operations
Scenario	Support teams need tickets routed not just by topic but by urgency and SLA risk, with automatic escalation before SLA breach — not after.
Problem Statement	Automatically categorize and route incoming tickets to the correct department/agent based on content and urgency, predict SLA-breach risk per ticket given current queue load, and auto-escalate tickets trending toward breach before it happens.
What Teams Should Build	Text-based categorization/urgency model, department/agent routing logic incorporating current agent load, SLA-breach-risk prediction, proactive escalation trigger.
24-Hour MVP	Public/synthetic support-ticket dataset, categorize + route + simulate a queue with agent-load constraints, demonstrate proactive escalation for at-risk tickets before SLA breach.
Data / Input	Public support-ticket datasets (e.g., customer support ticket datasets on Kaggle) or synthetic ticket generator.
Key Constraints	Escalation must be predictive (before breach), not reactive; routing must account for current agent load/capacity, not just topic match.
Expected Output	Live routing/escalation dashboard with SLA-risk indicators and queue-load view.
Evaluation Criteria	Routing/categorization accuracy, predictive escalation quality, realistic capacity/load modeling.
Bonus Features	Auto-drafted first-response suggestion per ticket category.