I am unable to generate a PDF file directly. However, I can provide the comprehensive content in a structured, document-like format using Markdown, consolidating the project scope, technical approach, constraints, and objectives discussed.

Technical Report: Carnival Casino Operations Snowflake ML POC

Project Title: Voyage-Aware Slot Denomination & Mix Optimizer
Consulting Team: BlueCloud & Snowflake

1. Executive Summary and Core Objectives

The primary goal of this Proof of Concept (POC) is to transition the Carnival Casino Operations team from a manual slot floor tuning process to a repeatable, data-driven method to maximize casino profitability. The solution will leverage Snowflake's cutting-edge native features to develop a recommendation system for optimizing slot machine denominations and minimum bets based on guest demographics and usage patterns.

Metric	Detail	Citation
Primary Goal	Increase overall casino profitability by optimizing slot denomination mix (penny vs. mid/high denomination).	
Key Metric of Success	Uplift in Daily Net Win Index (normalized measure comparing machine net win to ship average).	
Actionable Deliverable	A Pre-Voyage Change List that Operations can apply between sailings.	

Phased Implementation Approach

The project is structured in three phases to build capability and confidence:

1. Phase 1: Correlation Analysis to identify key performance drivers influencing mid/high denomination slot performance (e.g., player tiers, voyage length).
2. Phase 2: Establish Baseline Slot Mix per ship for average voyages, reducing operational complexity.
3. Phase 3: Generate Voyage-Specific Recommendations (e.g., "Convert X penny slots to mid/high denomination") with projected uplift.

2. POC Scope Constraints and Operational Practicability

The POC has defined constraints to ensure the solution is feasible and executable by the client team (Milen's team).

Constraint Type	Detail	Citation
Operational Feasibility	Denomination adjustments are limited to 10-15 machines per ship.	

Constraint Type	Detail	Citation
Timing	Changes must occur Pre-Voyage; no mid-cruise changes are allowed to prevent guest issues.	
Data Recency	Use recent data only (about the last year) (~100 GB total) as older behavior is less predictive, especially post-COVID.	
Data Access	All work must occur inside Carnival's Snowflake (CCL/Holland) in a separate, brand-isolated Global Gaming area. No cross-brand blending or external enrichments are in scope for the POC.	
Model Requirement	The model must have Trust/Explainability, ensuring the factors behind each recommendation make operational sense.	

3. Technical Approach and MLOps Pipeline

The technical strategy centers on leveraging Carnival's existing Snowflake environment for a robust MLOps framework.

A. Core Architecture and Tools

The solution relies entirely on Snowflake's native features:

1. Preparation and Transformation: Data is prepared and transformed using Snowflake ML APIs.
2. Feature Management: Features are managed within the Snowflake Feature Store.
3. Model Development: Models are developed using Snowflake ML functions or custom development leveraging Snowpark.
4. Model Deployment: Trained models are registered in the Snowflake Model Registry for inference and management.
5. Monitoring: Observability Monitoring for ML Models tracks performance using monitoring logs.

B. MLOps Governance

The project follows a framework of Unified Governance across five stages:

- Develop & Iterate
- Orchestrate & Automate
- Manage
- Deploy & Serve
- Monitor

4. Execution Steps and Technical Workflow

The 8-week POC is broken down into structured technical steps.

Step 1: Data Collection and Preparation (Weeks 1-2)

- Ingestion: Ingest member demographics and historic slot data files into Snowflake, leveraging storage integration.
- Cleaning: Handle missing values and perform deep dive analysis to identify data patterns based on business context.
- Encoding: Convert categorical data (like membership tier) into numerical formats for ML models.
- Splitting: Divide the prepared dataset into Training, Validation, and Test sets.
- Data Sources: Utilize slot telemetry (occupancy, spins, coin-in/out), player ratings/cohorts (value tiers, simple demographics), voyage-level aggregates (net win, average bet), and past denomination change outcomes.

Step 2: Feature Engineering and Model Training (Weeks 3-5)

- Feature Engineering: Extract new, basic features; convert transaction series into summary statistics/aggregations; and apply scale adjustments to numerical features to prevent dominance.
- Training: Train the chosen model(s) (classification or regression) using the Training data to establish the relationship between demographics and the target (denomination/bet).

Step 3: Model Evaluation and Documentation (Weeks 6-8)

- Evaluation: Use the trained model to make predictions on the unseen Test data. Compare the model's performance (e.g., accuracy, RMSE) against a simple baseline (e.g., recommending the most popular denomination).
- Success Verification: Confirm the model meets the required Explainability and Operational Practicability constraints.
- Final Output: Produce POC documentation detailing the data, model, performance metrics, and recommendations for future steps (like exploring more complex models or integrating real-time features).

5. Timeline and Commercials

Component	Detail	Citation
POC Duration	8 weeks.	
Team	Data Science Team (including AI/ML Engineer Selma Seljubac and LLM Engineer Cagan Kiper).	
Cost	The Total Cost to Carnival for the Point of View is $0, as BlueCloud and Snowflake are investing in the POC.	