RaceIQ

Real-Time Racing Intelligence & Strategy Platform

Toyota Gazoo Racing Hackathon 2025

University of Tsukuba Malaysia

GitHub: `github.com/khaisernong/RaceIQ`

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- Pit stop timing in endurance racing is decisive yet often based on gut feel.
- Pitting too early: lost track position. Too late: lap time loss from tire degradation.
- Teams need real-time, data-driven strategy — not post-race analysis.

- AI-powered platform that transforms raw race data into pit stop recommendations.
- Live dashboard built with **Python + Streamlit** and **Plotly**.
- Tire degradation model learns track-specific wear patterns.
- Clear GO / MONITOR / PIT-NOW guidance for fast decisions.

1. Race Overview (KPIs, lap times, results)
2. Strategy Analysis (tire age, lap vs. tire age, stints)
3. Performance Trends (sectors, consistency, distributions)
4. Pit Stop Optimizer (recommendation, forecast, metrics)

Sample tracks used: **Barber** and **COTA**.

- GR Cup Series across 7 tracks, 12 races, 33k+ data points.
- Files: results, sector analysis, weather, lap times.
  Telemetry present but not used in current demo.
- For repository size, sample data includes **Barber** and **COTA** only.

Four Layers

1. **Data Ingestion**: Flexible CSV loader with auto-detection, fallbacks.
2. **Analytics Engine**: Feature engineering, consistency metrics, rolling stats.
3. **Decision Support**: Tire degradation model, pit window logic.
4. **Presentation**: Streamlit dashboard (4 tabs) with Plotly visuals.

- Algorithm: **Polynomial regression** (degree 2) via scikit-learn.
- Features: tire_age, tire_age^2, air_temp, track_temp.
- Performance observed: R^2 = 0.17–0.27, RMSE = 1.7–3.7s (varies by track).
- Output used for: lap time forecasting, degradation rate, optimal pit lap.

- **Barber Race 1**: R^2 test = 0.170, RMSE = 3.667s (532 samples).
- **COTA** (with sector fallback): model runs and produces recommendations.
- Clear degradation trends: lap times rise with tire age; optimizer identifies pit window.

- **Race Overview**: KPIs, lap time chart, official results.
- **Strategy Analysis**: Tire age progression, lap vs tire age, stint analysis.
- **Performance Trends**: Sector times, consistency, lap distribution.
- **Pit Optimizer**: Recommendation (GO/MONITOR/PIT), forecast, degradation metrics.

1. Real-time **predictive** analytics (beyond visualization).
2. **Track-specific** learning for degradation behavior.
3. **Multi-factor** inputs (tire age, temps, consistency).
4. Actionable alerts: clear guidance, not just charts.
5. Deployment-ready (Streamlit Cloud or on-prem).

- Lap 18 decision: pit now or push 5 laps?
- Current: 2:15.3. Predicted lap 23: 2:18.8 ($\sim$3.5s slower).
- Recommendation: **PIT NOW**. Time saved across stint: $\geq$ 15s.

- Live telemetry integration for real-time streams.
- Fuel strategy optimization (joint tire + fuel windows).
- Driver-specific models; multi-vehicle comparison.
- Mobile companion app for pit crews.

- Local dev server: `streamlit run src/ui/dashboard.py`
- Cloud ready: Streamlit Cloud with repo `khaisernong/RaceIQ`
- Dataset handling: sample (Barber/COTA) in-repo; full dataset external.

- Put RaceIQ in the hands of Toyota GR Cup teams.
- Pilot during practice sessions; validate time savings and decision quality.
- Expand to full live telemetry and fuel strategy.

Common Questions

- **Accuracy**: R^2 0.17–0.27; combined with degradation rates for robust pit windows.
- **Live data**: Architecture supports streaming; current demo is post-race.
- **Weather shifts**: Model adapts with merged weather features and updates.
- **New track setup**: < 5 minutes with auto-detection and training.