Popper Framework – Biweekly Progress Reports

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Project: Popper Framework
Period: August 1, 2025 – September 30, 2025

Executive Summary

During this two-month period, I contributed to the Popper Framework by developing two key agents: the **Data Validation Agent** and the **Bias Detection Agent**. The first phase in August focused on the Data Validation Agent, where I built automated data quality checks, schema validation, model evaluation, and detailed visualization reports including ROC/PR curves, calibration plots, and feature importance analysis. The second phase in September centered on the Bias Detection Agent, where I implemented fairness metrics, integrated LLM-powered analysis for interpretability, and added representation bias assessment with advanced diversity indices and temporal tracking. By the end of September, both agents were production-ready prototypes with robust reporting, visualization, and interactive dashboards, significantly enhancing the Popper Framework's ecosystem of transparent and trustworthy AI agents.

Biweekly Period 1: August 1 – August 14, 2025

Project: Data Validation Agent

Activities:

- Reviewed Popper framework architecture and agent design patterns.
- Set up environment, dependencies, and sample datasets.
- Implemented schema validation, missing value checks, and rule-based quality checks.
- Designed initial visualizations for confusion matrix and ROC curves.

Highlights:

- Automated rule execution pipeline in `validators.py`.
- First HTML validation report generated with quality checks and performance metrics.

Challenges:

- Adapting validation logic to heterogeneous datasets.
- Handling inconsistent schema definitions.

Outcomes:

- Established a working baseline for automated validation.
- Delivered first demonstration of visual reports for validation results.

Next Steps:

- Expand validation pipeline with more advanced evaluation metrics.
- Improve visualization modules for interpretability.

Biweekly Period 2: August 15 – August 28, 2025

Project: Data Validation Agent

Activities:

- Expanded validation pipeline with calibration curves, feature importance plots, and robustness analysis.
- Developed visualization utilities (`popper_visualisation.py`) for ROC/PR and calibration plots.
- Finalized validation report format with embedded interactive charts.
- Tested across multiple datasets for consistency.

Highlights:

- Completed full validation workflow from dataset ingestion to report generation.
- Produced comprehensive validation outputs interpretable by technical and non-technical stakeholders.

Challenges:

- Managing dependency conflicts across environments.
- Balancing report detail with readability.

Outcomes:

- Delivered a complete, repeatable validation process.
- Validation reports suitable for compliance and audit use.

Next Steps:

- Transition from prototype to stable, reusable package.
- Document agent setup and workflows for future users.

Biweekly Period 3: August 29 – September 14, 2025

Project: Bias Detection Agent

Activities:

- Implemented fairness metrics including demographic parity, equal opportunity, and disparate impact.
- Developed fairness report generation in JSON and Markdown.
- Integrated GROQ LLM for insights, severity assessment, and recommendations.
- Built a Streamlit dashboard prototype for fairness metric visualization.

Highlights:

- First complete bias detection pipeline operational.
- Successfully tested on UCI Adult dataset, identifying gender and race biases.

Challenges:

- Designing fairness thresholds applicable across domains.
- Ensuring LLM responses remained structured and interpretable.

Outcomes:

- Deployed an intelligent fairness evaluation system combining metrics and AI-driven insights.
- Dashboard prototype enabled interactive exploration of bias trends.

Next Steps:

- Extend system with additional fairness metrics.
- Strengthen integration with real-world datasets for broader testing.

Biweekly Period 4: September 15 – September 30, 2025

Project: Bias Detection Agent

Activities:

- Added representation analysis and demographic benchmarking against U.S. Census distributions.
- Implemented 15+ diversity indices (Shannon, Simpson, Hill numbers, Gini-Simpson, Theil).
- Enabled temporal tracking of bias and diversity.
- Expanded README with setup, usage, and troubleshooting documentation.
- Recorded demonstration videos and completed project handoff.

Highlights:

- Delivered comprehensive bias detection system combining fairness metrics, LLM interpretability, and representation analysis.
- Produced compliance-ready reports and interactive dashboards for stakeholders.

Challenges:

- Handling scalability for large datasets within Streamlit.
- Managing complexity of multiple diversity indices in unified reports.

Outcomes:

- Produced production-ready prototype capable of compliance-oriented bias analysis.
- Documentation and demo videos ensured smooth knowledge transfer.

Next Steps:

- Add bias mitigation strategies into the pipeline.
- Enhance dashboard scalability and user experience.

Conclusion

Between August and September, I successfully developed two key agents for the Popper Framework: The **Data Validation Agent** and the **Bias Detection Agent**. The Data Validation Agent automated end-to-end dataset validation and model evaluation with comprehensive visual reports, while the Bias Detection Agent provided fairness assessment, LLM-driven insights, and representation benchmarking. Together, these contributions created a robust foundation for transparent, auditable, and trustworthy AI systems. The outcomes demonstrate readiness for future integration with real-world datasets and compliance workflows, with clear paths forward in bias mitigation and dashboard scalability.
