Group 16 - Individual Contributions

Documentation

Assignment: Probability Distributions, Bayesian Inference, and Gradient Descent **Date:** June 22, 2025

Team Member	Primary Responsibility	Key Deliverable
Mitali Bela	Project Leader & Poisson Distribution	`src/poisson_distribution.py`
Stecie Niyonzima	Data Analysis & Visualization	Call center analysis & plots
Elizabeth Limpho	Bayesian Inference Implementation	`src/bayesian_inference.py`
Kariza Charlotte	Gradient Descent & SciPy Integration	`src/gradient_descent.py`

Individual Contributions

Mitali Bela - Project Leader & Poisson Distribution

Code Implementation:

- Built complete `PoissonDistribution` class without external statistical libraries
- Implemented PMF, CDF, mean, variance methods with custom factorial calculation
- Created real-world call center scenario with λ=8 calls/hour
- Developed visualization functions for distribution analysis

Manual Calculations:

- Performed Gradient Descent Iteration 1 by hand
- Data: X=[1,3], y=[3,6], initial m=−1, b=1, α=0.1
- Results: Updated to m = 1.7, b = 2.1

Project Leadership:

- Set up repository structure and coordinated team workflow
- Integrated all team components into final notebook
- Managed version control and documentation standards

Stecie Niyonzima - Data Analysis & Visualization

Code Implementation:

- Created visualization functions in `src/poisson_distribution.py`
- Built `visualize_poisson_distribution()` and `compare_different_lambdas()` functions
- Developed comprehensive matplotlib charts with business insights
- Generated call center staffing recommendations from probability analysis

Manual Calculations:

- Performed Gradient Descent Iteration 2 by hand
- Continued from Iteration 1 results ((m=0.3000, b=2.3000))
- Applied gradient calculations and parameter updates

Analysis Contributions:

- Researched realistic call center parameters (λ=8 calls/hour)
- Created business interpretation of Poisson probability results
- Developed practical scenarios for probability questions

Elizabeth Limpho - Bayesian Inference Specialist

Code Implementation:

- Built complete `Bayesian Inference` and `Medical Diagnosis` classes
- Implemented step-by-step Bayes' theorem calculations
- Created sequential test updating system with visualizations
- Developed COVID-19 medical test interpretation scenario

Manual Calculations:

- Performed Gradient Descent Iteration 3 by hand
- Continued parameter optimization sequence
- Documented mathematical process with detailed steps

Medical Scenario Development:

- Researched realistic medical test parameters (95% sensitivity, 90% specificity, 1% prevalence)
- Created comprehensive test interpretation system
- Built practical explanations of medical decision-making

Kariza Charlotte - Gradient Descent & SciPy Integration

Code Implementation:

- Developed complete `GradientDescentLinearRegression` class
- Built transparent step-by-step gradient descent implementation
- Created SciPy integration and validation system
- Implemented required visualization plots (m, b, and error over iterations)

Manual Calculations:

- Performed Gradient Descent Iteration 4 (Final) by hand
- Completed 4-iteration sequence with final parameters
- Verified convergence and validated against SciPy results

Technical Excellence:

- Created professional matplotlib visualizations without warnings
- Built mathematical comparison between manual and SciPy optimization
- Developed comprehensive performance analysis and documentation

Project Summary

Assignment Completion:

- Part 1: Poisson Distribution (custom implementation, no libraries)
- Part 2: Bayesian Inference (medical diagnosis application)
- Part 3: Manual Gradient Descent (4 iterations, one per member)
- Part 4: Python Implementation (SciPy validation, required visualizations)

Code Quality:

- Modular design with separate classes for each concept
- DRY principle followed throughout
- Custom mathematical implementations as required
- Comprehensive documentation and error handling

Individual Expertise: Each team member developed specialized knowledge in their assigned area while contributing to the overall project success.