StatsLibrary and Main Classes Documentation

May 6, 2025

Introduction

This document provides comprehensive documentation for two Java classes: `StatsLibrary` and `Main`. The `StatsLibrary` class consolidates functionality for statistical computations, including Poisson distribution calculations, Tschebyscheff's inequality, and marginal probability computations from a joint probability function. The `Main` class demonstrates the usage of `StatsLibrary` with example inputs. Each class is described with its purpose, methods, parameters, and example usage.

1 StatsLibrary Class

The `StatsLibrary` class provides methods for computing probabilities and statistics related to Poisson distributions, Tschebyscheff's theorem, and marginal probabilities from joint probability functions.

Class Overview

- **Package**: Default package
- **Purpose**: Consolidate statistical computations for Poisson distribution, Tschebyscheff's theorem, and marginal probability.
- **Constructor**: `StatsLibrary()`
- **Dependencies**: `java.lang.Math`

Fields

- `private double lambda`: Parameter for Poisson distribution.
- `private double mean`: Mean for Tschebyscheff's theorem.
- `private double variance`: Variance for Tschebyscheff's theorem.
- `private double[][] jointProb`: Joint probability matrix for marginal probability.
- `private int y1Size`: Number of Y1 values in the joint probability matrix.
- `private int y2Size`: Number of Y2 values in the joint probability matrix.

Methods

Poisson Distribution Methods

- **`public void setPoissonParameters(double lambda)`**
  - **Description**: Sets the Poisson distribution parameter λ.
  - **Parameters**:
    - `lambda`: Positive value for the Poisson parameter.

- **Throws**: `IllegalArgumentException` if $\lambda \leq 0$.

- **`public double getPoissonProbability(int k)`**
  - **Description**: Computes the Poisson PMF, $P(X = k) = \frac{e^{-\lambda}\lambda^k}{k!}$.
  - **Parameters**:

Tschebyscheff's Theorem Methods

* **`public void setTschebyscheffParameters(double mean, double variance)`**
  · **Description**: Sets the mean and variance for Tschebyscheff's theorem.
  · **Parameters**:
  · `mean`: Mean of the distribution.
  · `variance`: Variance of the distribution (non-negative).
  · **Throws**: `IllegalArgumentException` if `variance` < 0.
* **`public double getTschebyscheffProbabilityWithinK(double k)`**

Marginal Probability Methods

· **`public void setMarginalProbabilityParameters(double[][] jointProb)`**

Helper Methods

· **`private long factorial(int n)`**

Example Usage

```
StatsLibrary stats = new StatsLibrary();

// Poisson Distribution
stats.setPoissonParameters(2.5);
System.out.println("P(X = 2): " + stats.getPoissonProbability(2));
    // Approx. 0.2565
System.out.println("Mean: " + stats.getPoissonMean()); // 2.5
System.out.println("Variance: " + stats.getPoissonVariance()); //
    2.5

// Tschebyscheff's Theorem
stats.setTschebyscheffParameters(2.5, 2.5);
System.out.println("P(|X - mu| < 2sigma): >= " + stats.
    getTschebyscheffProbabilityWithinK(2.0)); // 0.75

// Marginal Probability
double[][] jointProb = {{0.1, 0.2, 0.05}, {0.15, 0.1, 0.1}, {0.05,
    0.15, 0.1}};
stats.setMarginalProbabilityParameters(jointProb);
double[] marginalY1 = stats.getMarginalY1();
for (int i = 0; i < marginalY1.length; i++) {
    System.out.println("P(Y1 = " + i + ") = " + marginalY1[i]);
}
```

2 Main Class

The `Main` class demonstrates the usage of the `StatsLibrary` class with example inputs for Poisson distribution, Tschebyscheff's theorem, and marginal probability.

Class Overview

Functionality

Example Usage

```
java Main
```

Example Output

```
Poisson P(X = 2): 0.256515625
Poisson Mean: 2.5
Poisson Variance: 2.5
Tschebyscheff P(|X - μ| < 2.0σ): >= 0.75
Marginal Probability of Y1:
P(Y1 = 0) = 0.35
P(Y1 = 1) = 0.35
P(Y1 = 2) = 0.3
```

3 Dependencies

4 Usage Notes