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A Review On The Shapiro Wilk Test's Application In Various Fields

Analytical review

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Abstract

The study's main objective is to examine the Shapiro-Wilk test's application in different academic areas namely computational statistics and applied mathematics, medicine, engineering financial management and psychology, and ascertain the implications of applying the test in numerous conditions and situations. To accomplish this task, the study comprehensively covers 18 literature from several reputable academic databases such as Springer, JSTOR, ScienceDirect, IEEE Xplore, PubMed, and others from 2016 to 2023. According to the findings, the Shapiro-Wilk test needs to be supported by the Monte Carlo simulation results when providing evidence about whether the nominal test level is preserved or not. It was also revealed that the Shapiro Wilk test yields different normality distribution test results when applied in medical, finance and pyschology fields. By conducting a review of studies across various fields, the study enhances understanding of how various researchers deal with the complexities of testing the data's normality. Most importantly, the review provides an in-depth analysis of the Shapiro-Wilk test's methodological validity and consistency across diverse fields. Theoretically, the review provides essential ideas that are pivotal for guiding researchers in making the best decisions about their datasets' normality. Moreover, by understanding how the test is applied or taught in various subject areas, the study enhances understanding of how the Shapiro-Wilk test's concepts are relayed in educational situations.

Keywords: Educational settings, Normality distribution, Shapiro-Wilk test, Various fields.

1. INTRODUCTION

1.1 Background Information on the Subject

Testing a data set's normality is an essential aspect of any study field. Amid such observations, the Shapiro-Wilk test has gained a commendable reputation in this regard and has witnessed its applications increasing and extending to various fields like engineering, psychology, biology and economics. For example, the Shapiro-Wilk test is often used for accurate forecasting and modelling purposes, especially in finance. In that regard, researchers often use the test to ensure that statistical examinations like risk assessment and portfolio optimization are highly valid in meeting the required assumptions. In other fields like psychology, the Shapiro-Wilk test can be applied in assessing and inferring conclusions concerning human behaviour, while in biology the test becomes instrumental in verifying a biological dataset's assumptions.

1.2 The Rationale for the Review

The main rationale behind this review is to synthesize results from various fields so as to contribute to the development of the best and most effective methods of applying the Shapiro-Wilk test. By conducting a review of studies across various fields, the study enhances understanding of how various researchers deal with the complexities of testing the data's normality. Most importantly, the review provides an in-depth analysis of the Shapiro-Wilk test's methodological validity and consistency across diverse fields.

1.3 Aim and Objectives of the Review,

The study's main objective is to examine the Shapiro-Wilk test's application in different academic areas namely computational statistics and applied mathematics, medicine, engineering financial management and psychology, and ascertain the implications of applying the test in numerous conditions and situations. In this context, the review answers the following questions:

1) With regards to examining data distributions' normality, to what degree is the Shapiro-Wilk test employed in different fields??

2) What are the implications of applying the Shapiro-Wilk test in different academic areas like engineering, psychology, biology or economics?

1.4 Outline of the Organization and Structure of the Review

A five-structure outline was followed in conducting and presenting this review. Accordingly, the first section introduces the study's topic by highlighting its background, rationale, aims and objectives. The second section provides details about the applied methodology used in conducting this review while the fourth section focuses on the presentation of the reviewed studies. Discussions and conclusions are made in the fourth section while the fifth section concludes the study by summarizing the main findings and highlighting the practical and theoretical implications inferred from the study. Thus, by adopting this structure, the researchers ensure that ideas are concisely and coherently presented for easy understanding.

2. METHODOLOGY

In order to accomplish the review's intended purpose of examining the Shapiro-Wilk test's application in different academics namely computational statistics and applied mathematics, medicine, engineering financial management and psychology, and ascertain the implications of applying the test in numerous conditions and situations, literature from several reputable academic databases was covered. The academic databases comprised 18 Springer, JSTOR, Science Direct, IEEE Xplore, PubMed, and others from 2016 to 2023. Thus, by drawing information from various reputable academic databases, the study enhances the validity of its findings and conclusions. In that context, valid and reliable findings and implications can be drawn. Among such databases were published journal articles, books, dissertations, conference proceedings, and peer-reviewed journals presenting findings on theoretical frameworks, empirical studies, novel approaches, and critical reviews. Hence, studies not fitting this criteria were excluded from the review.

Among the fields covered are engineering, psychology, biology or economics, and others and the goal was to ascertain the implications of applying the test in numerous conditions and situations. Thus, by covering more fields, the study broadens its scope and enhances understanding of the implications, limitations and effectiveness of the Shapiro-Wilk test in addressing normality issues. This also extends to cover aspects such as forecasting and modelling, which are crucial in enhancing the effectiveness and robustness of educational and pedagogical decision-making activities.

3. REVIEWS

This section of the study presents findings obtained from the 18 reviewed empirical studies spanning from 2016 to 2023 drawn from computational statistics and applied mathematics, medicine, engineering financial management and psychology fields.

To commence with the computational statistics and applied mathematics field, Hanusz et al. (2016) conducted a study aimed at examining the Shapiro–Wilk test with known mean using the Shapiro–WilkW and t-tests and Kolmogorov test for power. As per their findings, it was discovered that the W_0 test is superior and should be used instead of the traditional Shapiro-Wilk W test. Such findings have a huge bearing on both the computational statistics and applied mathematics field and other fields as well as it directs attention to the need to place measures to enhance the Shapiro-Wilk W test's effectiveness in either similar or different situations. In another instance within the same filed, Monter-Pozos, and González-Estrada (2024) found that the Shapiro–Wilk test preserves the nominal test size and turns out to be competitive in terms of power against existing tests for the same problem. Meanwhile, in the same context, González-Estrada and Cosmes (2019) applied the Shapiro–Wilk test and Monte Carlo simulation good properties of the proposed tests in comparison to existing tests for the same problem. Their findings also showed that a random sample follows a skew-normal (SN) distribution with unknown parameters. Additional insights supporting these observations can be drawn from González-Estrada, Villaseñor and Acosta-Pech's (2022) study on the Shapiro-Wilk test for multivariate skew-normality. They established findings of Monte Carlo simulations show that the nominal test level is kept in general, and that these tests are more powerful than existing tests for the same problem compared to the researched alternatives.

Lukáč, Olexová and Kudlová's (2022) study on factors predicting companies' crisis in the engineering industry from the point of view of financial analysis verified the prevalence of a normally distributed dataset. Tobisova et al. (2022) applied the Kruskal–Wallis test, Shapiro Wilk and ANOVA while Almagsoosi et al. (2022) employed the Shapiro–WilkTest, box-whisker plot and statistical process control. Both studies showed that the variables were normally distributed period. Again, this aligns with the above mentioned establishements (Bistrovic, Manola and Lucijanic, 2022; Chakrabarti et al., 2016; Ting et al., 2023; Wei, 2022). Adding further, the establishments of results supporting the prevalence of a normall distribution is also supported in the psychology field. For instance, in public health psychology, Sobhani et al. (2022) used the Shapiro–Wilks test and independent t-test and discovered that the anthropometric, physiological, and psychological variables were normally distributed. In Psychiatry, Aiello et al. (2022) employed the Shapiro–Wilks test, Kruskal-Wallis and one-way ANOVA and revealed that the test data passed the Shapiro–Wilks test. Lastly, in the sports medicine field, Pasha, Mohammadi, and Baghbanian (2023) deployed the Shapiro–Wilks test and Levene variance test and revealed that the cross-examind data was normally distributed across mild to moderate multiple sclerosis patients. Therefore, this supports the notion that the Shapiro Wilk test yields different normality distribution test results when applied in the medical, finance and pyschology fields. To further reinforce this notion, different results were also observed in the engineering field. For instance, Riaji, El Hassani and Alaoui (2022) used the Sample t-test and Shapiro–Wilk test in conducting a study in the area of signal, image, video and communications and the results showed that the values obtained indicate a worse fit. In applied sciences, Parody et al. (2022) employed the Shapiro–Wilk and the findings showed that the marks' distribution was normally distributed. On the contrary, in applied biomaterials, de Souza et al. (2023) used the Shapiro–Wilk test and the

Kruskal–Wallis nonparametric test and uncovered that the nanofibers' diameter and biological

assay data were normally distributed. Table 1 provides a summary of reviewed studies.

Table 1. Summary of reviewed studies

Researchers	Field	Methodology	Results
Computational statistics and applied mathematics field			
Hanusz et al. (2016)	Statistics	The Shapiro–WilkW and t-tests and Kolmogorov test for power	The W_0 test is more adequate and should be used instead of the classical Shapiro–Wilk W test
González-Estrada and Cosmes (2019)	Statistical Computation and Simulation	Shapiro–Wilk test and Monte Carlo simulation	good properties of the proposed tests in comparison to existing tests for the same problem. a random sample follows a skew-normal (SN) distribution with unknown parameters.
González-Estrada, Villaseñor and Acosta-Pech (2022)	Computational Statistics	Shapiro-Wilk test for multivariate skew-normality.	Monte Carlo simulation results provide evidence that the nominal test level is preserved, in general and that these tests are in general more powerful than existing tests for the same problem versus the studied alternatives.
Monter-Pozos, and González-Estrada (2024)	Computational and Applied Mathematics	Shapiro–Wilk test.	The test preserves the nominal test size and turns out to be competitive in terms of power against existing tests for the same problem.
de Souza et al. (2023)	Agronomy	Shapiro-Wilk test	Small sample sizes per experimental unit led to biased estimates of the test, where it was either under or overestimated.
Medical field			
Chakrabarti et al. (2016)	Endocrinology and metabolism	QQ plot, Shapiro––Wilk test, Anderson–Darling test and the Kolmogorov–Smirnov (KS) test	Oxidative stress data was normally distributed among hypothyroid patients.
Wei (2022)	Medicine	Shapiro––Wilk test and the Kolmogorov–Smirnov (KS) test	a normality test via the KS test, which is suitable for the assumption that the parameters of the distribution are completely known. However, it is difficult to specify the parameters initially or completely without knowing the distribution of specific data. T

Bistrovic, Manola and Lucijanic (2022)	Medical	Logistic regression and Shapiro-Wilk test.	Numerical variables did not follow normal distribution
Ting et al. (2023)	Orbit	Linear regression and Shapiro–Wilk test	The data did not deviate from a normal distribution
Financial management field			
Pattawe et al. (2022)	Financial management	Shapiro–Wilk Test	Unlike pretest data and post-test data was normally distributed.
Lukáč, Olexová and Kudlová (2022)	Financial analysis	Shapiro–Wilk Test	The normality of the distribution was verified.
Tobisova et al. (2022)	Sustainability	Kruskal–Wallis test, Shapiro–Wilk and ANOVA Test	Variables were normally distributed
Almagsoosi et al. (2022)	Finance and economics	Shapiro–Wilk Test, box-whisker plot and statistical process control	Variables were normally distributed period 2005-2019
Engineering field			
Riaji, El Hassani and Alaoui (2022)	Signal, Image, Video and Communications	Sample t-test and Shapiro–Wilk test	The values obtained indicate a worse fit
Parody et al. (2022)	Applied Sciences	Shapiro–Wilk	The distribution of the marks was normally distributed.
de Souza et al. (2023)	Applied Biomaterials	Shapiro–Wilk test and the Kruskal–Wallis nonparametric test	The nanofibers' diameter and biological assay data were normally distributed.
Psychology field			
Sobhani et al. (2022)	Public health psychology	The Shapiro–Wilks test and independent t-test	Anthropometric, physiological, and psychological variables were normally distributed.
Aiello et al. (2022)	Psychiatry	The Shapiro–Wilks test, Kruskal-Wallis and one-way ANOVA	The test data passed the Shapiro–Wilks test.
Pasha, Mohammadi, and Baghbanian (2023)	Sports medicine	Shapiro–Wilks test and Levene variance test	Cross-examined data was normally distributed across mild to moderate multiple sclerosis patients.

4. DISCUSSION AND COMPARISON

Several academic studies have been conducted examine the Shapiro-Wilk test's application in different academic areas namely computational statistics and applied mathematics, medicine, engineering financial management and psychology. In this section, such studies and their implications in numerous conditions and situations were reviewed.

Following González-Estrada and Cosmes (2019) and González-Estrada, Villaseñor and Acosta-Pech's (2022) study results on power and the preservation of the nominal test level, one can contend that the Shapiro-Wilk test needs to be supported by the Monte Carlo simulation results to verify its power to yield intended normality distributions results. As a result, the review's findings have an important bearing on other fields as they advocate them to test the Shapiro-Wilk test's power thereby contributing to enhanced accuracy, validity and reliability. However, the Shapiro–Wilk test's ability to determine a dataset's normal distribution cannot be refuted as evidenced by Monter-Pozos, and González-Estrada's findings (2024) showing that the test preserves the nominal test size and turns out to be competitive in terms of power against existing tests for the same problem. Hence, other fields can be advocated to apply the test when deternming a dataset's normal distribution.

Being a popular statistical tool for determining data normality, The Shapiro-Wilk test remains vital and its application in various fields is instrumental for guiding decisions and policies. Nonetheless, to completely verify its efficacy, the test must be supported with Monte Carlo simulation data. Such a simulation offers researchers a regulated environment in which they can use established normality distributions to construct synthetic data sets. As a result, this allows them to compare the expected results with the test findings.

CONCLUSIONS

The review's main goal was to examine the Shapiro-Wilk test's application in different academic areas namely computational statistics and applied mathematics, medicine, engineering financial management and psychology, and ascertain the implications of applying the test in numerous conditions and situations. To accomplish this task, the study comprehensively covers literature from 18 reputable academic databases such as Springer, JSTOR, ScienceDirect, IEEE Xplore, PubMed, and others from 2016 to 2023. Consequently, both objectives were achieved leading to inferences being drawn from the findings that the Shapiro-Wilk test produces diverse normalcy distribution results, researchers should proceed with caution, taking into account the practical, interpretive and methodological, implications. Therefore, the application of discipline-specific norms, alternative tests, and transparent reporting is critical for assuring the reliability and validity of research findings. The review shows that the Shapiro-Wilk test needs to be supported by the Monte Carlo simulation results when providing evidence about whether the nominal test level is preserved or not.

On a practical basis, the review contributes to the development of the best and most effective methods of applying the Shapiro-Wilk test. Thus, by conducting a review of studies across various fields, the study enhances understanding of how various researchers deal with the complexities of testing the data's normality. Theoretically, the review provides essential ideas that are pivotal for guiding researchers in making the best decisions about their datasets' normality. Moreover, by understanding how the test is applied or taught in various subject areas, the study enhances understanding of how the Shapiro-Wilk test's concepts are relayed in educational situations.

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