

# Iris Flower Measurements

N = 150 · Dataset: iris.csv

## Statistical Tests Used

| Objective                                                                                | Test                      | Variables                                            | Why this test                                    |
|------------------------------------------------------------------------------------------|---------------------------|------------------------------------------------------|--------------------------------------------------|
| To describe the sepal_length, sepal_width, petal_length, and petal_width of the flowers. | Descriptive Statistics    | sepal_length, sepal_width, petal_length, petal_width | Summary statistics for the continuous variables. |
| To determine the relationship between petal_length and petal_width.                      | Spearman Rank Correlation | petal_length, petal_width                            |                                                  |
| To determine the relationship between sepal_length and petal_length.                     | Spearman Rank Correlation | sepal_length, petal_length                           |                                                  |
| To determine the relationship between sepal_length and sepal_width.                      | Spearman Rank Correlation | sepal_length, sepal_width                            |                                                  |

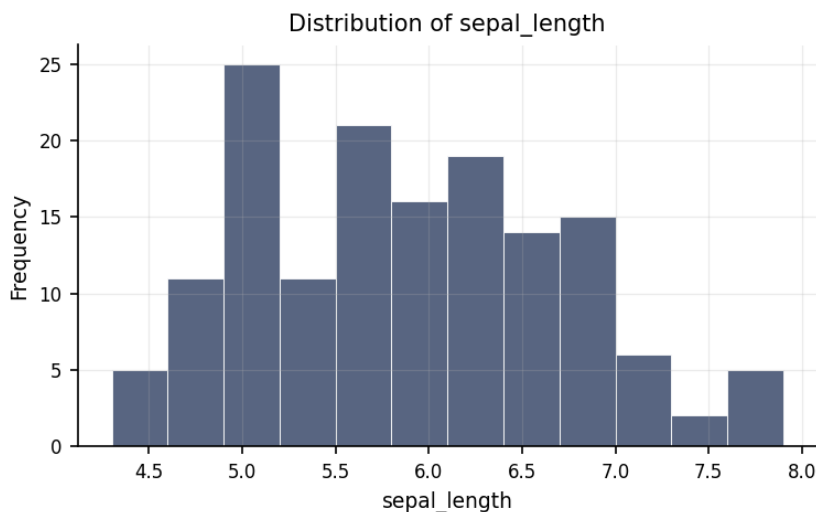
## Methods

All statistical analyses were performed in Python using the SciPy and statsmodels libraries via thericerca's deterministic analysis engine (v0.1.0). Statistical significance was evaluated at  $\alpha = .05$  (a 95% confidence level). Descriptive statistics were computed to summarise the study's variables. To assess monotonic associations between variables, a Spearman rank-order correlation was used (Spearman, 1904). For each inferential test, the appropriate effect size is reported with its 95% confidence interval, alongside the achieved statistical power to detect the observed effect (Cohen, 1988).

# Results

**To describe the sepal\_length, sepal\_width, petal\_length, and petal\_width of the flowers.**

This simply summarises the data — the average, spread, and range of each variable are in the table above.



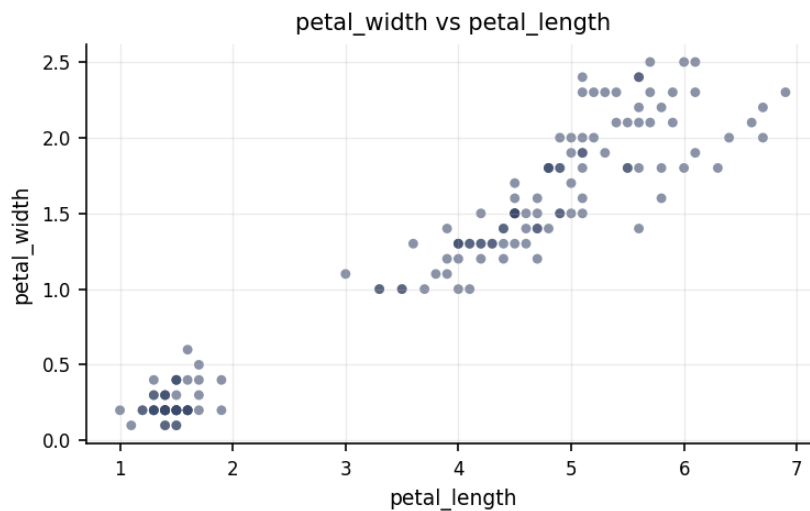
Distribution of sepal\_length.

| max | mean  | median | min | mode | n   | range | std   | variable     | variance |
|-----|-------|--------|-----|------|-----|-------|-------|--------------|----------|
| 7.9 | 5.843 | 5.8    | 4.3 | 5    | 150 | 3.6   | 0.828 | sepal_length | 0.686    |
| 4.4 | 3.057 | 3      | 2   | 3    | 150 | 2.4   | 0.436 | sepal_width  | 0.19     |
| 6.9 | 3.758 | 4.35   | 1   | 1.4  | 150 | 5.9   | 1.765 | petal_length | 3.116    |
| 2.5 | 1.199 | 1.3    | 0.1 | 0.2  | 150 | 2.4   | 0.762 | petal_width  | 0.581    |

**To determine the relationship between petal\_length and petal\_width.**

We looked at whether petal length and petal width move together. They do — as one goes up, the other tends to go up too. The strength of this pattern is large.

Statistically:  $\rho = .94$ ,  $p < .001$ , achieved power = 1.00



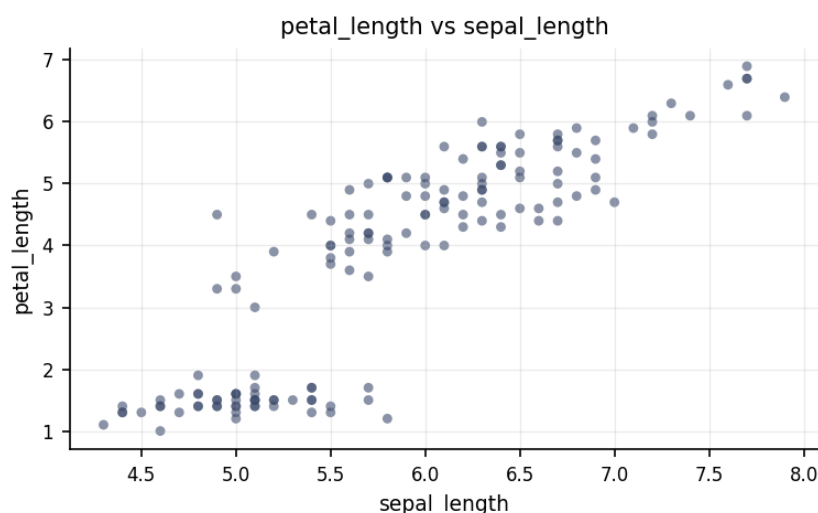
Relationship between petal\_length and petal\_width.

△ Spearman Rank Correlation was used instead of the Pearson Correlation because the latter's assumption(s) were not met (Normality of petal\_length (Shapiro-Wilk), Normality of petal\_width (Shapiro-Wilk)).

## To determine the relationship between sepal\_length and petal\_length.

We looked at whether sepal length and petal length move together. They do — as one goes up, the other tends to go up too. The strength of this pattern is large.

Statistically:  $\rho = .88$ ,  $p < .001$ , achieved power = 1.00



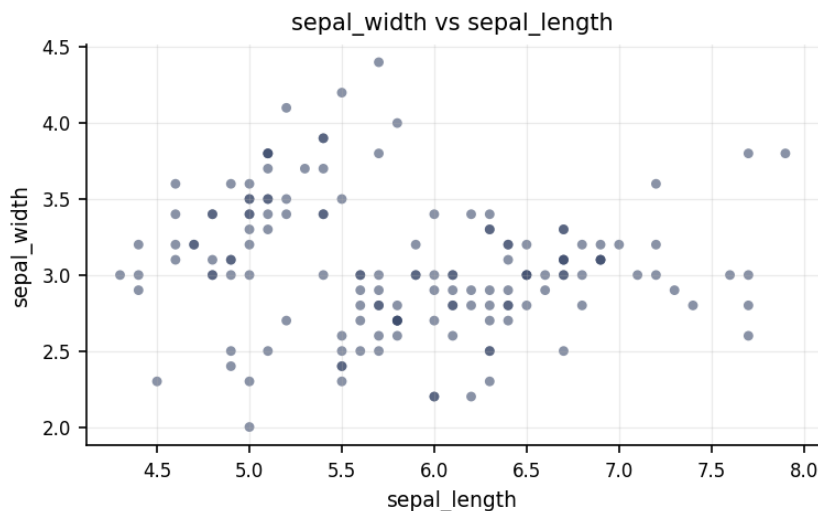
Relationship between sepal\_length and petal\_length.

△ Spearman Rank Correlation was used instead of the Pearson Correlation because the latter's assumption(s) were not met (Normality of sepal\_length (Shapiro-Wilk), Normality of petal\_length (Shapiro-Wilk)).

## To determine the relationship between sepal\_length and sepal\_width.

We looked at whether sepal length and sepal width move together. They do — as one goes up, the other tends to go down. The strength of this pattern is small.

Statistically:  $\rho = -.17$ ,  $p = .041$ , achieved power = 0.53



Relationship between sepal\_length and sepal\_width.

△ Spearman Rank Correlation was used instead of the Pearson Correlation because the latter's assumption(s) were not met (Normality of sepal\_length (Shapiro-Wilk)).

## Discussion

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**The relationship between petal length and petal width.** The analysis of petal length and petal width revealed a statistically reliable large positive relationship. In practical terms, higher values of petal length tend to accompany higher values of petal width. An association of this strength indicates the two measures share a substantial amount of common variation, though a correlation on its own cannot establish that one variable causes the other.

**The relationship between sepal length and petal length.** The analysis of sepal length and petal length revealed a statistically reliable large positive relationship. In practical terms, higher values of sepal length tend to accompany higher values of petal length. An association of this strength indicates the two measures share a substantial amount of

common variation, though a correlation on its own cannot establish that one variable causes the other.

**The relationship between sepal length and sepal width.** The analysis of sepal length and sepal width revealed a statistically reliable small negative relationship. In practical terms, higher values of sepal length tend to accompany lower values of sepal width. An association of this strength indicates the two measures share some common variation, though a correlation on its own cannot establish that one variable causes the other.

The study evaluated three distinct pairs of physical flower traits to determine how plant dimensions relate to one another. First, the relationship between petal length and petal width showed an exceptionally strong positive connection. In practical terms, this means that as a flower's petal grows longer, its width expands in close proportion, indicating that petal dimensions develop together in a highly coordinated fashion. Second, the relationship between sepal length and petal length demonstrated a strong positive association. Flowers with longer outer sepals systematically tend to possess longer inner petals, highlighting a clear structural alignment between different parts of the blossom. Third, the relationship between sepal length and sepal width revealed a subtle negative link, where increases in sepal length are accompanied by a slight decrease in sepal width. All three of these relationships were confirmed to be statistically reliable, which means that the patterns observed in the sample are extremely unlikely to be mere flukes or artifacts of random sampling chance. Instead, they represent systematic, trustworthy physical traits across the observed specimens.

## **Conclusions**

In conclusion, the study successfully achieved all of its core objectives by providing a detailed picture of how sepal and petal dimensions interconnect. The findings demonstrate a coherent set of physical relationships: petal length and petal width are bound by a remarkably strong positive coupling, sepal length and petal length exhibit a strong positive coordination across distinct floral organs, and sepal length and sepal width display a mild inverse relationship. Because these outcomes are statistically reliable and virtually impossible to attribute to random

luck, they offer a solid empirical foundation for understanding floral architecture and growth patterns. These conclusions fulfill the research goals and provide a dependable basis for strategic decision-making and further botanical inquiry, provided one keeps in mind the specific sample and observational context from which the data were drawn.

## **Recommendations**

Based on these findings, several actionable steps are recommended for future research and practical application. First, to confirm that these structural patterns generalise across broader populations, researchers should replicate this investigation using an independent sample of plants drawn from diverse environments. Second, because an observational study can only show that traits move together rather than proving that one directly drives another, future work should employ experimental or longitudinal designs—such as tracking floral growth over time—to evaluate the causal mechanisms behind these dimensional links. Third, future reporting should consistently present both statistical reliability and the practical strength or magnitude of relationships, ensuring that decision-makers can distinguish between minor physical tendencies and major structural growth trends. Finally, data collection procedures should enforce rigid protocols to standardize measurement conditions, screen rigorously for extreme outliers or missing entries, and prevent duplicate data records from entering the pipeline.

## **Limitations**

Several important caveats should be kept in mind when interpreting these results. First, a fundamental boundary of this work is its observational nature. Although statistically reliable connections were established between traits such as sepal length and petal length or petal width, these correlations do not prove direct causation; unmeasured underlying factors, such as shared genetic pathways or environmental conditions, could be driving the observed patterns. Second, on a data quality level, a few duplicate records were present in the initial raw dataset, underscoring the importance of rigorous pre-analysis data screening. Third, the findings specifically describe the particular sample evaluated in this study, meaning that extending these conclusions to

wider plant species or different environmental populations relies on the assumption that the sample fully represents those broader groups.

## References

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1. Spearman, C. (1904). The proof and measurement of association between two things. *American Journal of Psychology*, 15(1), 72-101.
2. Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Lawrence Erlbaum Associates.
3. Seabold, S., & Perktold, J. (2010). statsmodels: Econometric and statistical modeling with Python. *Proceedings of the 9th Python in Science Conference*, 92-96.
4. Virtanen, P., Gommers, R., Oliphant, T. E., et al. (2020). SciPy 1.0: Fundamental algorithms for scientific computing in Python. *Nature Methods*, 17, 261-272.

## Python Code Appendix

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### Descriptive Statistics

```
df[['sepal_width', 'petal_length', 'petal_width']].describe()
```

### Spearman Rank Correlation

```
r, p = stats.spearmanr(df['petal_length'], df['petal_width'])
```

Numeric-claim validation: PASSED (16 numbers checked). Engine v0.1.0 · Registry v0.2.0. Prose source: llm:gemini.