

Assignment 12: Exploring the Periodic Table

81 Points scaled to 20 Points

Introduction

To explore the correlation between variables using scatterplots and correlation metrics (e.g., Pearson and Spearman correlation coefficients), in this assignment you will analyze the Periodic Table of the Elements. As the name suggests, there are patterns in the elements' properties and characteristics, resulting in periodic trends. The Periodic Table can be viewed at this website: <https://pubchem.ncbi.nlm.nih.gov/periodic-table/>. This dataset ("periodic_table.csv") was obtained from Kaggle: <https://www.kaggle.com/datasets/psycon/periodic>. The dataset has been provided on the course page (the link above may no longer be active).

Objectives

- *Prepare data for analyses*
- *Create graphs and generate correlation metrics when some values are missing*
- *Create scatterplots and/or line graphs to compare variables*
- *Use correlation metrics to assess correlation*

Deliverables

- *Jupyter Notebook (Python) or R Markdown file (R) with all code and graphs embedded. Files can be rendered to HTML webpages if your instructor requires this. Questions or prompts should be stated and answered within Markdown cells.*

Background Questions

Question 1. Explain the difference between a linear correlation and a monotonic correlation. (2 Points)

Question 2. Explain the difference between the Pearson and Spearman correlation coefficients? (2 Points)

Question 3. Relating to the Periodic Table, explain the following terms: Period, Group, Atomic Number, Atomic Mass, and Atomic Radius. (4 Points)

Question 4. Relating to the Periodic Table, explain the following terms: Proton, Neutron, Electron, Valence Electron, Electron Shell, and Isotope. (4 Points)

Question 5. Relating to the Periodic Table, explain the following terms: First Ionization Energy and Electronegativity. (4 Points)

Questions and Tasks

This assignment can be conducted using either Python or R, whichever you prefer or whichever your instructor requires. Generate code to perform the following tasks and answer the associated questions. Note that there are some missing values in the data that may impact your analysis, so some data cleaning/preparation is required.

Task 1. Create a scatterplot to compare the Period in which an element occurs ("Period") to its Number of Electron Shells (NmberofShells"). Calculate the Pearson correlation coefficient for these two variables. Explain the relationship between Period and Number of Electron Shells. (5 Points)

Task 2. Create a scatterplot to compare how the Number of Valence Electrons ("NumberofValence") varies by group ("Group"). Explain the observed pattern. (5 Points)

Task 3. Create a scatterplot to compare the Number of Protons ("NumberofProtons") and the Number of Neutrons ("NumberofNeutrons") in the nucleus of the atom. Calculate the Pearson and Spearman correlation coefficients for these variables. Explain the relationship between the Number of Protons and Number of Neutrons in the nucleus of an atom. Why is this relationship not perfectly linear? (5 Points)

Task 4. Create a scatterplot to compare the Atomic Number of an element ("AtomicNumber") with its Atomic Mass ("AtomicMass"). Calculate the Pearson and Spearman correlation coefficients for these variables. Explain the relationship between Atomic Number and Atomic Mass? Why is the relationship not perfectly linear? (5 Points)

Task 5. Create a scatterplot to compare the Atomic Number ("AtomicNumber") and Atomic Radius ("AtomicRadius") for just elements in Period 5 ("Period"). Explain the observed relationship. (5 Points)

Task 6. Create a scatterplot to compare the Atomic Number ("AtomicNumber") and Atomic Radius ("AtomicRadius") for just elements in Group 1 ("Group"). Explain the observed relationship. Describe and compare how Atomic Radius generally changes within a Group and across a Period. (5 Points)

Task 7. Create a scatterplot to compare the Atomic Number ("AtomicNumber") and Number of Isotopes ("NumberofIsotopes") for all elements. Explain the observed relationship. Calculate the Pearson and Spearman correlation coefficients. Which correlation metric is higher and why? (5 Points)

Task 8. Create a scatterplot to compare how the First Ionization Energy ("FirstIonization") varies based on Atomic Number ("AtomicNumber") across Period 5 ("Period"). Explain the observed relationship. (5 Points)

Task 9. Create a scatterplot to compare how the First Ionization Energy ("FirstIonization") varies based on Atomic Number ("AtomicNumber") within Group 1 ("Group"). Explain the observed relationship. (5 Points)

Task 10. Create a scatterplot to compare how Electronegativity ("Electronegativity") varies based on Atomic Number ("AtomicNumber") across Period 5 ("Period"). Explain the observed relationship. (5 Points)

Task 11. Create a scatterplot to compare how Electronegativity ("Electronegativity") varies based on Atomic Number ("AtomicNumber") within Group 1 ("Group"). Explain the observed relationship. (5 Points)

Task 12. Create a scatterplot to compare how Density ("Density") changes with Atomic Number ("AtomicNumber") for only Metals (Metal == "yes"). Explain the observed pattern. Calculate the Pearson and Spearman correlation coefficients for these variables. Explain the relationship between Density and Atomic Number for metals? (5 Points)

Task 13: Create a scatterplot to compare how Electronegativity ("Electronegativity") varies by Atomic Number ("AtomicNumber") for all elements in the periodic table. Explain the observed, nonlinear patterns. (5 Points)

