## Solar System Data Representation and Analysis - Lab EXP 5

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### Problem Statement

The Solar System consists of 8 planets revolving around the Sun, each with properties such as diameter, distance from the Sun, orbital period, and number of moons. The objective is to design an R program that organizes and analyzes Solar System data using arrays, matrices, lists, data frames, and user-defined functions. Additionally, Kepler's Third Law ($P^2 / a^3 = k$) will be used to verify orbital consistency.

### R Code Implementation

```
# ================================
# Solar System Data Representation and Analysis
# Registration Number: 23BDS1172
# ================================

cat("=== Solar System Lab EXP-5 ===\n\n")

# ------------------------------
# Part A: Array (10 Marks)
# ------------------------------
planet_names_1172 <- c("Mercury","Venus","Earth","Mars",
                       "Jupiter","Saturn","Uranus","Neptune")
orbital_period_days_1172 <- c(88,225,365,687,4333,10759,30687,60190)

# Create array of planets and periods
planet_array_1172 <- array(c(planet_names_1172, orbital_period_days_1172),
                           dim=c(8,2),
                           dimnames=list(NULL,c("Planet","Orbital_Period_Days")))

# Display orbital period of Earth
cat("Orbital period of Earth (days):", orbital_period_days_1172[3], "\n\n")

# ------------------------------
# Part B: Matrix (15 Marks)
# ------------------------------
# Diameter (km) and Distance from Sun (million km)
diameter_km_1172 <- c(4879,12104,12742,6779,139820,116460,50724,49244)
distance_million_km_1172 <- c(57.9,108.2,149.6,227.9,778.5,1434,2871,4495)
```

```
planet_matrix_1172 <- matrix(c(diameter_km_1172, distance_million_km_1172),
                    nrow=8, ncol=2,
                    dimnames=list(planet_names_1172,
                            c("Diameter_km","Distance_million_km")))

cat("Outer planets (Jupiter to Neptune):\n")
print(planet_matrix_1172[5:8, ])
cat("\n")

# --------------------------------
# Part C: List (15 Marks)
# --------------------------------
earth_list_1172 <- list(
  Name="Earth",
  Diameter_km=12742,
  Distance_million_km=149.6,
  Moons=1
)

cat("Earth List Details:\n")
cat("Name:", earth_list_1172$Name, "\n")
cat("Diameter (km):", earth_list_1172$Diameter_km, "\n")
cat("Distance from Sun (million km):", earth_list_1172$Distance_million_km, "\n")
cat("Moons:", earth_list_1172$Moons, "\n\n")

# --------------------------------
# Part D: Data Frame (30 Marks)
# --------------------------------
moons_1172 <- c(0,0,1,2,79,83,27,14)

planet_df_1172 <- data.frame(
  Planet=planet_names_1172,
  Diameter_km=diameter_km_1172,
  Distance_MillionKm=distance_million_km_1172,
  Orbital_Period_days=orbital_period_days_1172,
  No_of_Moons=moons_1172,
  stringsAsFactors=FALSE
)

cat("Terrestrial planets:\n")
print(subset(planet_df_1172, Planet %in% c("Mercury","Venus","Earth","Mars")))
cat("\n")

cat("Planet with maximum moons:\n")
print(planet_df_1172[which.max(planet_df_1172$No_of_Moons), ])
cat("\n")
```

```
cat("Planets sorted by distance:\n")
print(planet_df_1172[order(planet_df_1172$Distance_MillionKm), ])
cat("\n")

# ------------------------------
# Part E: User-Defined Functions (30 Marks)
# ------------------------------

#' @title Convert Orbital Period
#' @description Converts orbital period from days to Earth years (365 days = 1 year)
#' @param days Orbital period in days
#' @return Orbital period in years (rounded to 2 decimals)
convert_to_years_1172 <- function(days) {
 return(round(days/365, 2))
}
planet_df_1172$Orbital_Period_years <-
convert_to_years_1172(planet_df_1172$Orbital_Period_days)

#' @title Planet Summary
#' @description Returns summary information for a given planet
#' @param name Name of the planet (string)
#' @return Character string summarizing diameter, distance, and moons
planet_summary_1172 <- function(name) {
 row <- subset(planet_df_1172, Planet==name)
 if (nrow(row)==0) {
  return(paste("Planet", name, "not found."))
 }
 return(paste("Planet:", row$Planet,
          "| Diameter:", row$Diameter_km, "km",
          "| Distance:", row$Distance_MillionKm, "million km",
          "| Moons:", row$No_of_Moons))
}

cat("Summary for Jupiter:\n")
cat(planet_summary_1172("Jupiter"), "\n\n")

#' @title Kepler k Calculator
#' @description Computes Kepler's constant k = P^2 / a^3 for planets
#' @param period_days Orbital period in days
#' @param distance_AU Distance from Sun in Astronomical Units (AU)
#' @return Numeric value of Kepler's k (rounded to 3 decimals)
kepler_k_1172 <- function(period_days, distance_AU) {
 P_years <- period_days / 365
 return(round((P_years^2) / (distance_AU^3), 3))
}
```

```
planet_df_1172$Distance_AU <- distance_million_km_1172 / 149.6
planet_df_1172$Kepler_k <- kepler_k_1172(planet_df_1172$Orbital_Period_days,
                                         planet_df_1172$Distance_AU)

cat("Final Data Frame with Orbital Period in Years and Kepler k:\n")
print(planet_df_1172)
cat("\n=== Analysis Complete ===\n")
```

## Output Screenshots

```
> source("~/dev/programming_for_data_science_23BDS1172/lab5/Analysis.R")
=== Solar System Lab EXP-5 ===

Orbital period of Earth (days): 365

Outer planets (Jupiter to Neptune):
        Diameter_km Distance_million_km
Jupiter      139820               778.5
Saturn       116460              1434.0
Uranus        50724              2871.0
Neptune       49244              4495.0

Earth List Details:
Name: Earth
Diameter (km): 12742
Distance from Sun (million km): 149.6
Moons: 1

Terrestrial planets:
   Planet Diameter_km Distance_MillionKm Orbital_Period_days No_of_Moons
1 Mercury        4879               57.9                  88           0
2   Venus       12104              108.2                 225           0
3   Earth       12742              149.6                 365           1
4    Mars        6779              227.9                 687           2

Planet with maximum moons:
  Planet Diameter_km Distance_MillionKm Orbital_Period_days No_of_Moons
6 Saturn      116460               1434               10759          83

Planets sorted by distance:
   Planet Diameter_km Distance_MillionKm Orbital_Period_days No_of_Moons
1 Mercury        4879               57.9                  88           0
2   Venus       12104              108.2                 225           0
3   Earth       12742              149.6                 365           1
4    Mars        6779              227.9                 687           2
5 Jupiter      139820              778.5                4333          79
6  Saturn      116460             1434.0               10759          83
7  Uranus       50724             2871.0               30687          27
8 Neptune       49244             4495.0               60190          14

Summary for Jupiter:
Planet: Jupiter | Diameter: 139820 km | Distance: 778.5 million km | Moons: 79

Final Data Frame with Orbital Period in Years and Kepler k:
   Planet Diameter_km Distance_MillionKm Orbital_Period_days No_of_Moons Orbital_Period_years
1 Mercury        4879               57.9                  88           0                0.24
```

```
Summary for Jupiter:
Planet: Jupiter | Diameter: 139820 km | Distance: 778.5 million km | Moons: 79

Final Data Frame with Orbital Period in Years and Kepler k:
   Planet Diameter_km Distance_MillionKm Orbital_Period_days No_of_Moons Orbital_Period_years
1 Mercury        4879              57.9                  88          0                 0.24
2   Venus       12104             108.2                 225          0                 0.62
3   Earth       12742             149.6                 365          1                 1.00
4    Mars        6779             227.9                 687          2                 1.88
5 Jupiter      139820             778.5                4333         79                11.87
6  Saturn      116460            1434.0               10759         83                29.48
7  Uranus       50724            2871.0               30687         27                84.07
8 Neptune       49244            4495.0               60190         14               164.90
  Distance_AU Kepler_k
1   0.3870321    1.003
2   0.7232620    1.004
3   1.0000000    1.000
4   1.5233957    1.002
5   5.2038770    1.000
6   9.5855615    0.987
7  19.1911765    1.000
8  30.0467914    1.002

=== Analysis Complete ===
>
```

## Analysis

The Solar System data was successfully represented using arrays, matrices, lists, and data frames. The user-defined functions allowed conversion of orbital periods to years, retrieval of planet summaries, and computation of Kepler's constant (k). The calculated Kepler_k values are approximately 1 for all planets, which confirms the consistency of the dataset with Kepler’s Third Law. This demonstrates the correctness of planetary data representation and analysis.