Lab 07: Principal Component Analysis

**Due date:** Sunday, April 13, 2025 submitted as Word document to Canvas ***Lab07*** link

This lab counts 9 % toward your total grade.

**Objectives:** In this lab, you will practice your skills in

1. Reduce dimensionality,
2. Visualize key components,
3. Interpret variance explained,
4. Create composite images using PCA results.

**Format of answer:** Submit your answers as a **Word document** with graphs and verbal descriptions, properly labeled in the task sequence, with answers in red text and only relevant content included. **For each task, please provide R code, and screenshot of the result.**

# Task 1: Load data (1 pts)

1. In the rs folder, there are 9 image files, each corresponding to an individual Landsat 8 band.
2. Use the paste0() function to construct the file paths for bands 1 through 9.
3. Use the rast() function from the **terra** package to read and combine these bands into a single multi-band raster object.
4. After loading the raster, examine and explain the following:
   1. The number of bands (layers)
   2. The pixel resolution
   3. The image dimensions: number of rows (nrow), number of columns (ncol),

*filenames <- paste0('rs/LC08\_044034\_20170614\_B', 1:9, ".tif")*

*landsat <- rast(filenames)*

# Task 2: Create RGB composites for Visualization (2 pts)

Landsat 8 has multiple bands that can be combined into RGB composites for visual interpretation.

1. Use the plotRGB() function to generate a natural color composite using bands 4 (Red), 3 (Green), and 2 (Blue). Apply the "lin" stretch to improve visualization.

# Task 3: Apply PCA (4 pts)

PCA helps reduce data dimensionality by finding directions of maximum variance.

1. Using global() in the terra package to check the min, max, mean, and standard deviation of the data. Based on the result, please explain whether we need to scale the data first. (1 pt)
2. Use the rasterPCA() function from RStoolbox package to apply PCA to the data. (1 pt)
3. Use summary() to examine the PCA model. Interpret the variance explained by each principal component. (1 pt)
4. Examine the eigenvector of each variable for the principal component. (1 pt)

# Task 4: Visualize Principal Component Rasters (1 pt)

Each principal component (PC) becomes a new raster layer showing spatial variation.

Use plot() to visualize the principal components that you think can explain the more variable compared to the rest of the PCs. (1 pt)

# Task 5: Build a PCA-Based RGB Composite (1 pts)

1. Using PCA components that you think can maximum explain the variance to build an RGB composite. Which features are visible in the new RGB composite? (1 pt)