RStudio Presentation and Workflow Guide

Sensor Data Analysis using Sensor_Data.csv and Machine Learning (lm)

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Objective

This guide demonstrates how to use RStudio to import sensor data, summarize it, visualize relationships, and apply a simple machine learning model (linear regression using `lm()`) to predict sensor readings. The document serves both as a presentation and an instructional manual for students and STEM Club members.

1 Environment Setup

1.1 Installing and Loading Packages

Open RStudio and execute the following lines in the console:

```r
install.packages(c("tidyverse", "lubridate", "janitor", "caret"))
library(tidyverse)
library(lubridate)
library(janitor)
library(caret)
```

These packages provide tools for data cleaning, visualization, and machine learning.

1.2 Folder Structure

Recommended project layout:

- `data/` — place `Sensor_Data.csv`
- `R/` — contains analysis scripts
- `figs/` — stores generated plots
- `reports/` — output documents or summaries

2 Importing the Dataset

Place your CSV file in the `data/` directory and load it:

```
path <- file.path("data", "Sensor_Data.csv")
df <- read_csv(path) %>% janitor::clean_names()

# Quick inspection
glimpse(df)
summary(df)
```

Tip: `clean_names()` standardizes headers (e.g., converts `Temperature (C)` to `temperature_c`).

3 Descriptive Statistics

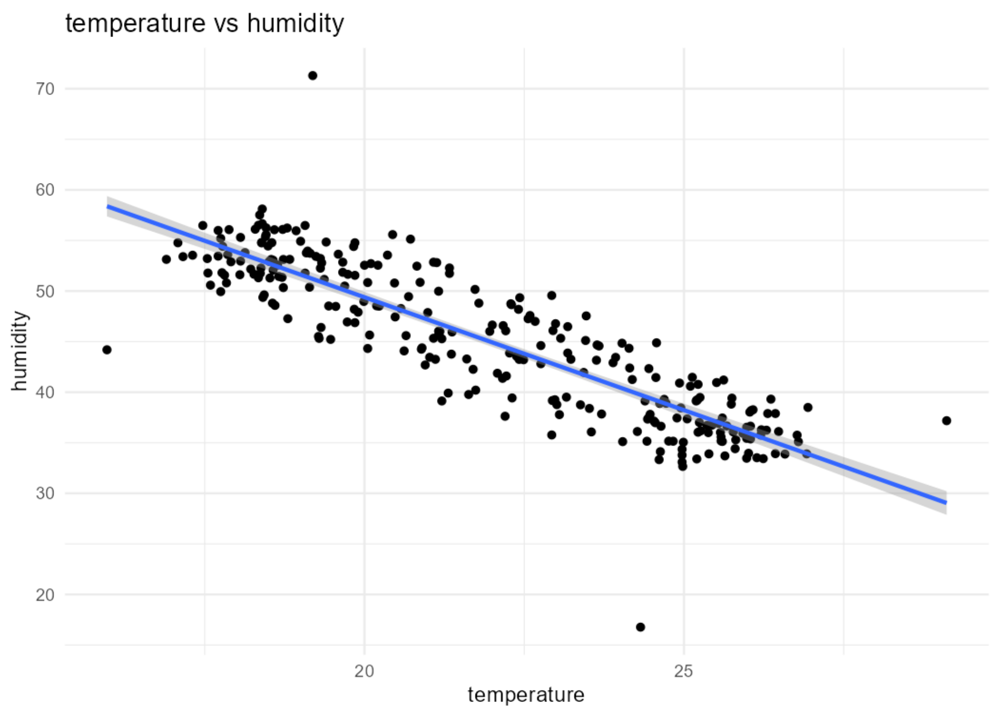
Compute the **sum**, **mean**, and **median** for each numeric column. If a timestamp column exists, the median date is also computed.

```
num_cols <- df %>% select(where(is.numeric))

summary_tbl <- num_cols %>%
  summarise(across(everything(), list(
    sum = ~sum(.x, na.rm = TRUE),
    mean = ~mean(.x, na.rm = TRUE),
    median = ~median(.x, na.rm = TRUE)
  )))
print(summary_tbl)

# Median timestamp if present
maybe_time <- df %>% select(matches("time|date|timestamp|datetime"))
if (ncol(maybe_time) > 0) {
  tcol <- names(maybe_time)[1]
  tvec <- parse_date_time(df[[tcol]], orders = c("Ymd HMS", "mdY HM", "mdY"))
  med_time <- median(as.numeric(tvec), na.rm = TRUE) %>%
    as.POSIXct(origin = "1970-01-01", tz = "UTC")
  print(med_time)
}
```

4 Visualization

We create a scatter plot to explore the correlation between two key sensor measurements (e.g., temperature and humidity):

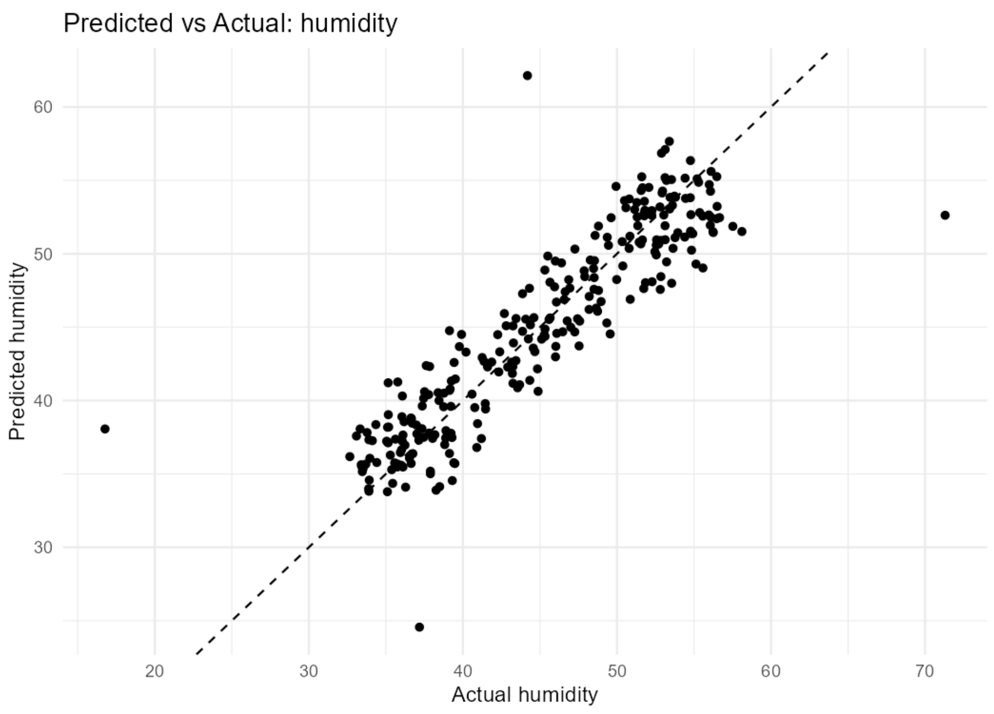
```
ggplot(df, aes(x = temperature, y = humidity)) +
  geom_point(color = "blue") +
  geom_smooth(method = "lm", col = "red") +
  theme_minimal() +
  labs(title = "Temperature vs Humidity", x = "Temperature", y = "Humidity")
```



5 Linear Regression (Machine Learning Model)

We apply the linear model function `lm()` to predict humidity from temperature or other predictors.

```
model <- lm(humidity ~ temperature, data = df)
summary(model)

df$predicted <- predict(model, df)

RMSE <- sqrt(mean((df$humidity - df$predicted)^2))
R2 <- cor(df$humidity, df$predicted)^2
cat("RMSE:", RMSE, "R:", R2)
```



6 Saving Visual Outputs

You can save the generated plots for reports or web dashboards:

```r
# Save the last plot
if(!dir.exists("figs")) dir.create("figs")

ggsave("figs/temp_vs_humidity.png", width = 7, height = 5, dpi = 150)
```

7 RStudio Shortcuts

Action	Shortcut
Run selected code	Ctrl + Enter
Insert assignment operator (<-)	Alt + -
Comment / Uncomment line	Ctrl + Shift + C
Run all code chunks	Ctrl + Alt + R
Reformat code	Ctrl + Shift + A
Find in file	Ctrl + F

8 Common Issues

- Ensure columns used in `lm()` are numeric.
- Remove or impute missing values with `na.omit()`.

- Use `clean_names()` to avoid spaces or special characters in column names.
- Verify the correct date format before parsing.

9 Next Steps

- Extend the model with multiple predictors: `lm(humidity   temperature + soil_moisture)`.
- Explore machine learning packages: `randomForest`, `xgboost`, or `caret::train()`.
- Automate periodic analysis using `R Markdown` or `knitr`.

Prepared for: STEM Club — Bunker Hill Community College
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