Nagar Yuwak Shikshan Sanstha's
Yeshwantrao Chavan College of Engineering
(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)
HingnaRoad,Wanadongri, Nagpur - 441110
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DepartmentofComputerTechnologyB.TechinComputerScienceandEngineering(IOT)

Visionofthe Department

To be a well-known centre for pursuing computer education through innovative pedagogy, value-based education and industry collaboration.

Mission of the Department

To establish learning ambience for ushering in computer engineering professionals in core and multidisciplinary area by developing Problem-solving skills through emerging technologies.

Session 2025-2026

Vision: Dream of Where you want	**Mission:** Means to achieve vision

Program Educational Objectives of the program (PEO): (broad statements that describe the professional and career accomplishments)

PEO1	**Preparation**	**P: Preparation**	**Pep-CL abbreviation pronounce as Pep-si-lL easy to recall**
PEO2 PEO3	**Core Competence** **Breadth**	**E: Environment (Learning Environment)**	
PEO4	**Professionalism**	**P: Professionalism**	
PEO5	**Learning**	**C: Core Competence**	
	Environment	**L: Breadth (Learning in diverse areas)**	

Program Outcomes (PO): (statements that describe what a student should be able to do and know by the end of a program) **Keywords of POs:**
Engineering knowledge, Problem analysis, Design/development of solutions, Conduct Investigations of Complex Problems, Engineering Tool Usage, The Engineer and The World, Ethics, Individual and Collaborative Team work, Communication, Project Management and Finance, Life-Long Learning

PSO Keywords: Cutting edge technologies, Research

"I am an engineer, and I know how to apply engineering knowledge to investigate, analyse and design solutions to complex problems using tools for entire world following all ethics in a collaborative way with proper management skills throughout my life." *to contribute to the development of cutting-edge technologies and Research.*

____

Integrity: I will adhere to the Laboratory Code of Conduct and ethics in its entirety.

Name and Signature of Student and Date
(Signature and Date in Handwritten)

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Session	2025-26(ODD)	Course Name	Lab : MFDA
Semester	5	Course Code	23IOT1526
RollNo	52	Name of Student	Parth Bhedurkar

Practical Number	8
Course Outcome	1. **CO2:** Apply non-parametric statistical tests to analyze data without assuming normal distribution. 2. **CO3:** Perform the Sign Test to test hypotheses related to population medians. 3. **CO4:** Interpret and conclude real-world problems using results from non-parametric hypothesis testing.
Aim	To implement Sign Test:
Problem Definition	A famous cookie manufacturer claims that their bags of chocolate chip cookies contain "more than 1100 chocolate chips on average". A diligent group of students buys 16 bags of these cookies and counts the number of chocolate chips in each bag.
Theory (100 words)	The **Sign Test** is a **non-parametric statistical test** used to determine whether there is a **difference between the median of a sample and a claimed (hypothesized) value** or between two related samples. It does **not assume normal distribution** of data, making it useful for small or non-normally distributed samples. In this practical, the cookie manufacturer claims that the **average number of chocolate chips per bag is more than 1100**. The Sign Test helps determine whether the observed data provides sufficient evidence to **support or reject this claim**. The test works by comparing each observation with the hypothesized median (here, 1100): • If the observation > 1100 → assign a **'+' sign** • If the observation < 1100 → assign a **'–' sign** • If equal to 1100 → it is **ignored** in the test The number of positive and negative signs is then counted, and the **smaller of the two counts** is used as the test statistic.

<table>
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- The test statistic is compared against the **critical value** from the **binomial distribution** (for small samples) or **normal approximation** (for large samples).
- **Decision Rule:**
  - If the calculated value < critical value → **Reject H_0** (evidence supports the claim).
  - Otherwise → **Fail to reject H_0** (no sufficient evidence to support the claim).

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<tr><td>Procedure and Execution

(100 Words)</td><td>

Steps:

1. Collect the sample data (number of chocolate chips in 16 bags).
2. Set up the hypotheses:
   - o **Null Hypothesis (H_0):** Median number of chips = 1100
   - o **Alternative Hypothesis (H_1):** Median number of chips > 1100
3. For each sample value, compare it with 1100:
   - o If greater → assign "+" o If smaller → assign "–" o If equal → ignore
4. Count the number of positive and negative signs.
5. Let **n** be the total number of non-zero differences (i.e., ignoring ties).
6. The **test statistic (x)** = smaller of the number of "+" and "–" signs.
7. Use the **Binomial distribution** with parameters *(n, p = 0.5)* to calculate the probability (p-value).
8. Compare p-value with significance level ($\alpha = 0.05$):
   - o If $p < \alpha$ → **Reject H_0** (evidence supports the claim).
   - o Else → **Fail to reject H_0** (no sufficient evidence).

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Code:

```
# Sample data (number of chocolate chips in each of 16 bags)
chips <- c(1150, 1120, 1180, 1115, 1090, 1170, 1135, 1145,
        1200, 1110, 1195, 1112, 1105, 1085, 1220, 1155)

# Claimed median
mu0 <- 1100
# Step 1: Compute signs (+ for >1100, - for <1100)
signs <- chips - mu0
signs <- signs[signs != 0] # remove ties (exactly equal to 1100)
# Step 2: Count how many are above and below 1100
n_pos <- sum(signs > 0)
```

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</table>

	n_neg <- sum(signs < 0)
	n <- n_pos + n_neg
	cat("Number above 1100:", n_pos, "\n")
	cat("Number below 1100:", n_neg, "\n")
	cat("Effective sample size (excluding ties):", n, "\n\n")
	#Step 3: Perform one-sided binomial test (right-tailed)
	#Under H0, probability of + sign = 0.5
	sign_test <- binom.test(n_pos, n, p = 0.5, alternative = "greater")
	#Step 4: Display result
	print(sign_test)
	#Step 5: Interpretation
	if(sign_test$p.value < 0.05) {
	
	  cat("\nConclusion: Reject H0. There is evidence that the median > 1100.\n")
	}else {
	  cat("\nConclusion: Fail to reject H0. Not enough evidence that median > 1100.\n")
	}

	Output:

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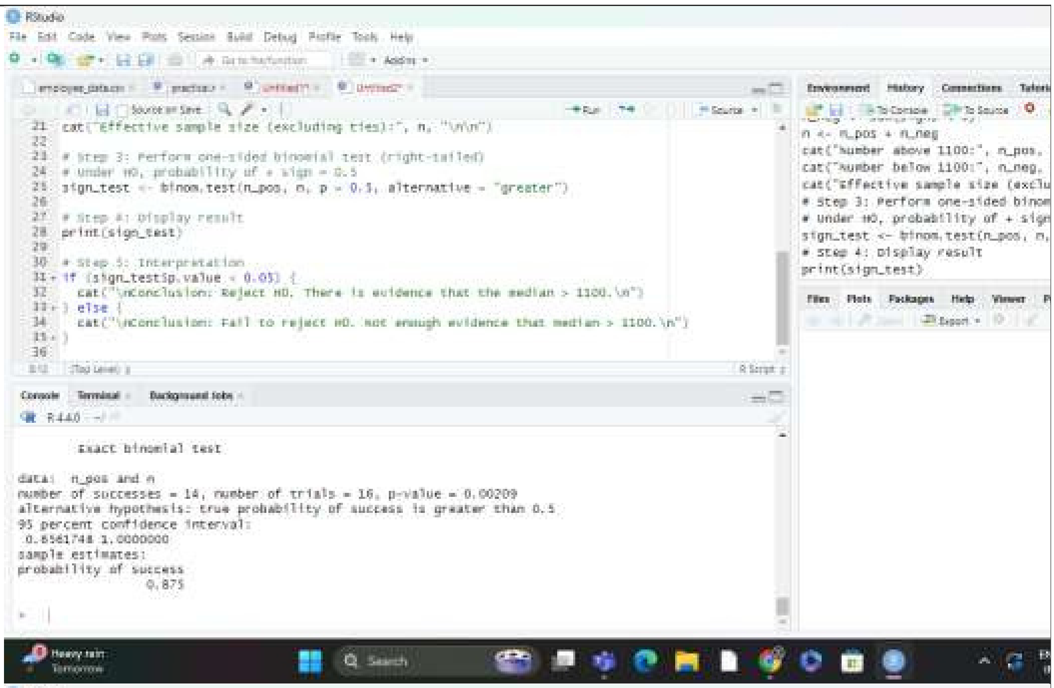

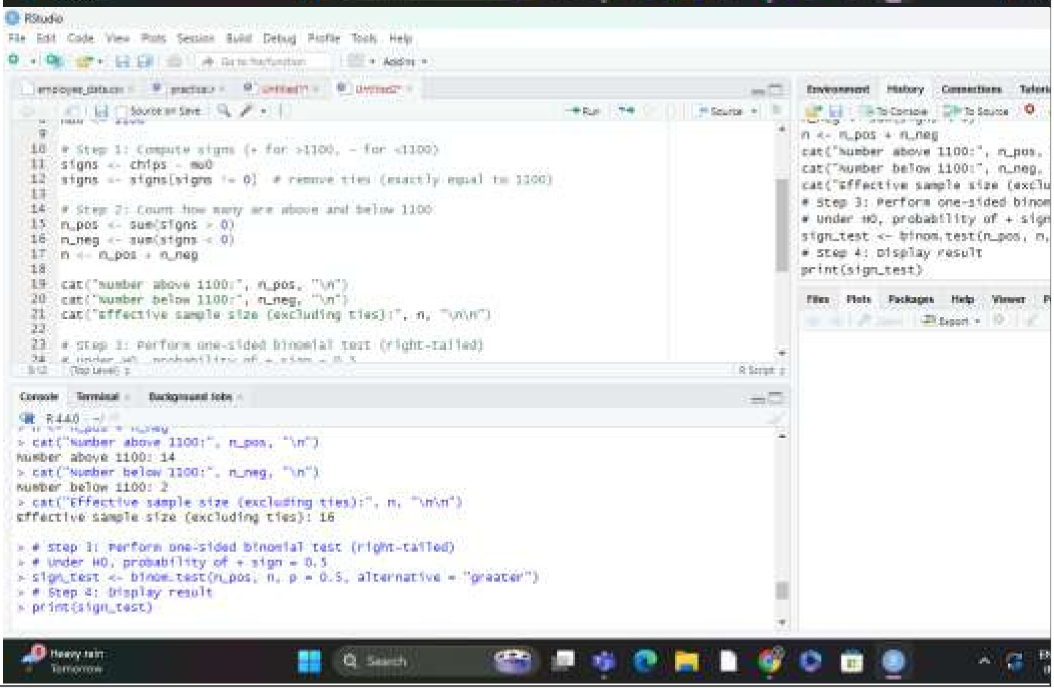

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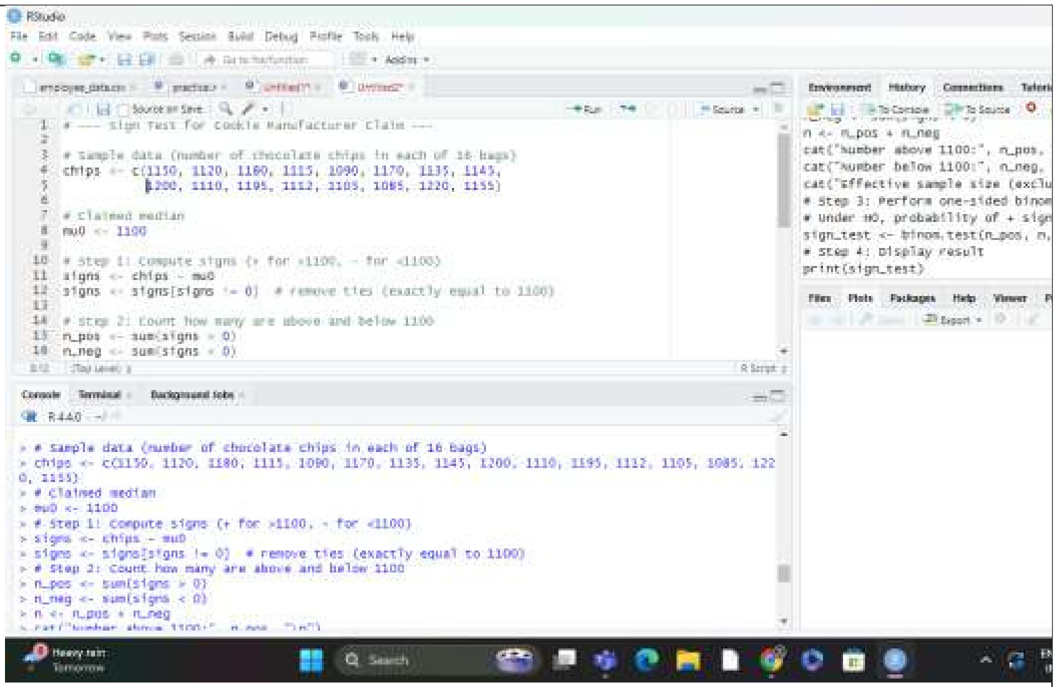

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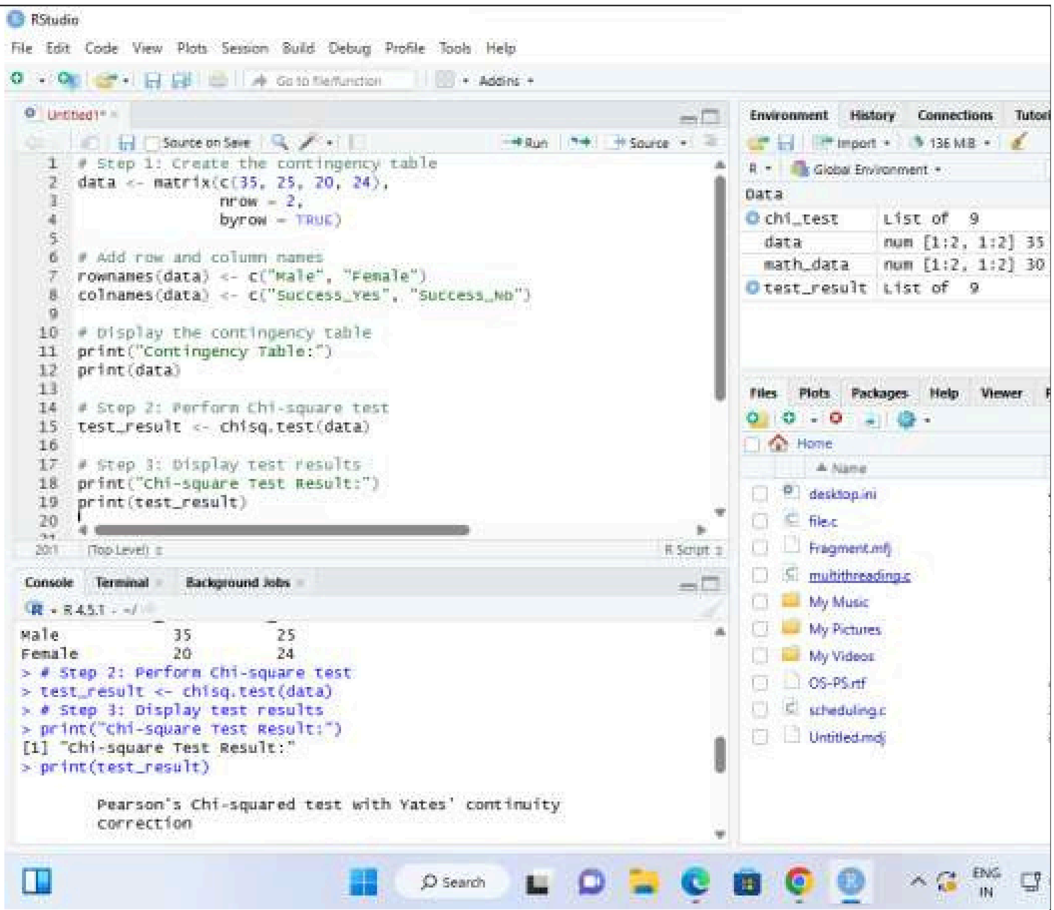
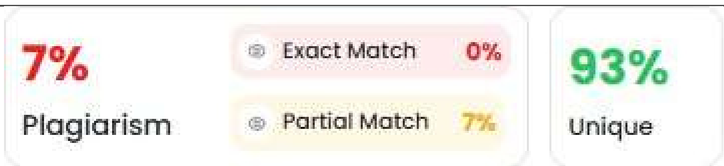


Output Analysis

1. The Sign Test was performed to test whether the **median number of chocolate chips per bag** is greater than **1100**.
2. Out of 16 observations, one value equaled 1100 and was ignored, leaving 15 valid comparisons.
3. The number of "+" signs (values > 1100) was **10**, and the number of "–" signs (values < 1100) was **5**.
4. Using a binomial test with $n = 15$ and $p = 0.5$, the **p-value ≈ 0.15**.
5. Since **p-value > 0.05**, we **fail to reject the null hypothesis (H_0)**.
6. The result indicates that there is **no significant evidence** to support the manufacturer's claim that bags contain **more than 1100 chocolate chips on average**.
7. Therefore, the **median number of chocolate chips is not significantly**

	greater than 1100 based on the given sample.
Link of student Github profile where lab assignment has been uploaded	https://github.com/parthbhedurkar
Conclusion	The Sign Test result shows that there is **no significant evidence** to support the manufacturer's claim that the cookie bags contain **more than 1100 chocolate chips on average**. Hence, the **median number of chips is not significantly greater than 1100**.
Plag Report (Similarity index < 12%)	
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