

AUTHOR BY:

Sana Ur Rehman Arain

LEARNING JOURNAL 7

University of the People

2025

INSTRUCTOR: ANSON XUAN

MATH 1281-01 Statistical Inference – AY2025-T3

a: Run Logistic Regression in JASP

2

The screenshot shows the JASP software interface. On the left is a data table with columns 'Shuttle Mission', 'Temperature', and a binary outcome variable. The main panel is titled 'Logistic Regression' and shows the 'Logistic Regression' model selected. The 'Dependent Variable' is 'Damaged', and the 'Covariates' are 'Shuttle Mission' and 'Temperature'. The 'Model' section shows 'Model 1' selected. The 'Statistics' section has 'Estimates', 'Odds ratios', and 'Confidence intervals' checked. The 'Performance Diagnostics' section has 'Confusion matrix' checked. The 'Performance Metrics' section has 'Accuracy', 'AUC', 'Sensitivity / Recall', 'Specificity', 'Precision', 'F-measure', 'Brier score', and 'H-measure' checked. On the right, the 'Logistic Regression' results panel displays the 'Model Summary - Damaged' table, the 'Coefficients' table, and a note: 'Note. M₁ includes Temperature'.

Model	Deviance	AIC	BIC	df	$\Delta\chi^2$	p	McFadden R ²	Nagelkerke R ²	Tjur R ²	Cox & Snell R ²
M ₀	26.402	28.402	29.538	22			0.000		0.000	
M ₁	14.426	18.426	20.697	21	11.977	< .001	0.454	0.595	0.500	0.406

Note. M₁ includes Temperature

Model		Estimate	Standard Error	Odds Ratio	z	Wald Test			95% Confidence interval	
						Wald Statistic	df	p	Lower bound	Upper bound
M ₀	(Intercept)	-1.041	0.475	0.353	-2.193	4.810	1	0.028	-1.972	-0.111
M ₁	(Intercept)	23.775	11.820	2.115×10 ⁻¹⁰	2.011	4.046	1	0.044	0.607	46.942
	Temperature	-0.367	0.175	0.693	-2.093	4.382	1	0.036	-0.710	-0.023

Note. Damaged level "1" coded as class 1.

Logistic Regression ▼

Model Summary - Damaged

Model	Deviance	AIC	BIC	df	$\Delta\chi^2$	p	McFadden R ²	Nagelkerke R ²	Tjur R ²	Cox & Snell R ²
M ₀	26.402	28.402	29.538	22			0.000		0.000	
M ₁	14.426	18.426	20.697	21	11.977	< .001	0.454	0.595	0.500	0.406

Note. M₁ includes Temperature

Coefficients

Model		Estimate	Standard Error	Odds Ratio	z	Wald Test			95% Confidence interval	
						Wald Statistic	df	p	Lower bound	Upper bound
M ₀	(Intercept)	-1.041	0.475	0.353	-2.193	4.810	1	0.028	-1.972	-0.111
M ₁	(Intercept)	23.775	11.820	2.115×10 ⁺¹⁰	2.011	4.046	1	0.044	0.607	46.942
	Temperature	-0.367	0.175	0.693	-2.093	4.382	1	0.036	-0.710	-0.023

Note. Damaged level "1" coded as class 1.

b. Logistic Regression Equation

From the output:

- Intercept (β_0) = 23.775
- Temperature coefficient (β_1) = -0.367

Equation:

$$p^{\wedge} = 1 / (1 + e^{\wedge} (-(23.775 - 0.367 \cdot \text{Temperature})))$$

c. Statistical Significance of β_1

- **p-value for Temperature = 0.036**

Since $0.036 < 0.05$, the coefficient is **statistically significant at the 5% level**.

Interpretation: Temperature has a significant effect on the probability of O-ring damage.

d. Is Temperature a Justified Cause?

Yes. The model with Temperature (M_1) significantly improves fit over the model without it ($p < 0.001$ for ΔX^2).

Also, Temperature is statistically significant ($p = 0.036$), and model fit metrics (e.g., Nagelkerke $R^2 = 0.595$) show decent explanatory power.

Interpretation: There is sufficient statistical evidence to justify that temperature contributed to O-ring damage.

e. Estimated Probabilities

Using:

$$\hat{p} = \frac{1}{1 + e^{-(23.775 - 0.367 \cdot \text{Temperature})}}$$

Let's calculate:

1. **T = 51**

$$\begin{aligned}\hat{p} &= \frac{1}{1 + e^{-(23.775 - 0.367 \cdot 51)}} = \frac{1}{1 + e^{-4.038}} \\ &= \frac{1}{1 + 0.0176} = 0.9827\end{aligned}$$

2. T = 53°F:

$$\begin{aligned}\hat{p} &= \frac{1}{1 + e^{-(23.775 - 0.367 \cdot 53)}} = \frac{1}{1 + e^{-3.304}} \\ &= \frac{1}{1 + 0.0368} = 0.9644\end{aligned}$$

3. T = 55°F:

$$\begin{aligned}\hat{p} &= \frac{1}{1 + e^{-(23.775 - 0.367 \cdot 55)}} = \frac{1}{1 + e^{-2.570}} \\ &= \frac{1}{1 + 0.0765} = 0.9289\end{aligned}$$

4. T = 57°F:

$$\begin{aligned}\hat{p} &= \frac{1}{1 + e^{-(23.775 - 0.367 \cdot 57)}} = \frac{1}{1 + e^{-1.836}} \\ &= \frac{1}{1 + 0.1594} = 0.8626\end{aligned}$$

Temperature (°F)	\hat{p} (Estimated Probability)
51	0.9827
53	0.9644
55	0.9289
57	0.8626

These calculations show that as temperature decreases, the probability of O-ring damage increases, which aligns with engineering expectations for material behavior at lower temperatures.
