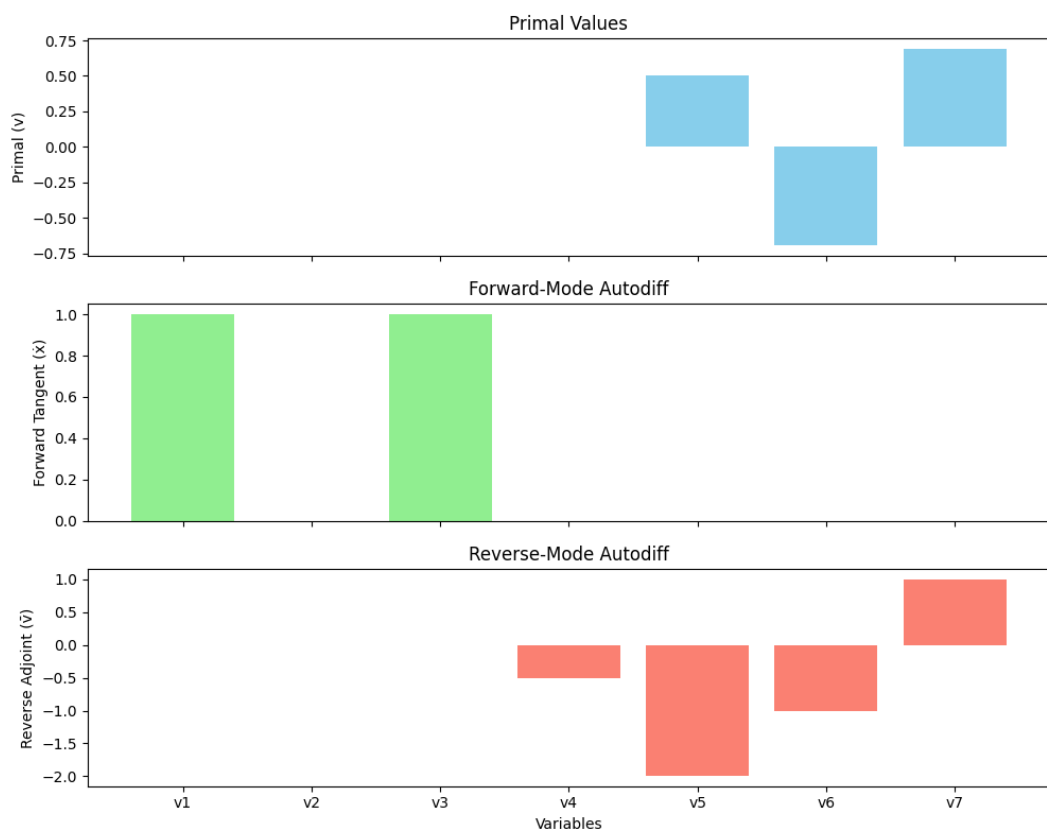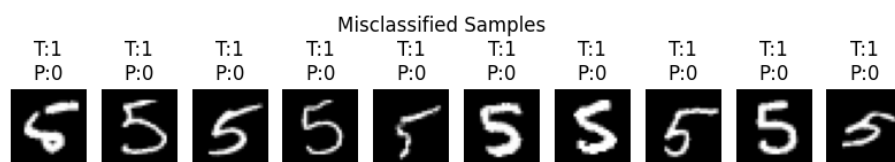# LAB5_inclass

results:

```
Test Accuracy (is 5 or not): 0.9364

Autodiff Trace Table (first sample):
  Variable  Primal (v)  Forward Tangent (ẋ)  Reverse Adjoint (v̄)
0    v1      0.000000                  1.0                  -0.0
1    v2      0.000000                  0.0                  -0.0
2    v3      0.000000                  1.0                  -0.0
3    v4      0.000000                  0.0                  -0.5
4    v5      0.500000                  0.0                  -2.0
5    v6     -0.693147                  0.0                  -1.0
6    v7      0.693147                 -0.0                   1.0
```


Misclassified Samples

Results Discussion:

The graph shows three types of values for each variable in the computational graph:

1⃣ Primal Values
Displays the actual value of each intermediate variable (v1 to v7)

v1, v2: input feature values (such as pixel values)

v3: may be the sum of the results (such as v1+v2)

v4: may be multiplication or weighted sum

v5: is the result of sigmoid (prediction probability), approximately between 0 and 1

v6: cross-entropy loss (negative log probability)

v7: final loss (-v6)

These values represent the entire forward process from input to loss.

2⃣ Forward-Mode Autodiff ($\dot{x}$)
This part tracks how other variables change if the input feature x1 changes a little bit

We can see that only v1, v2, v3 have non-zero derivatives (because they are directly related to x1)

The forward gradient of the subsequent variable is zero, indicating that the change has not yet been passed on.

3⃣ Reverse-Mode Autodiff ($\bar{v}$)
This is the core of backpropagation: the gradient of each variable with respect to loss

The gradient of v5 is the largest and negative: it means that the prediction probability is very sensitive to loss

The negative value of the gradient of v6 is also obvious because it is the log probability

v7 = -v6, so its gradient is 1, which is the starting point of the reverse chain rule.

These gradients are propagated back to the weight updates during training.

We observed the forward tangent highlights how features affect the final prediction, and the reverse adjoint shows how error backpropagates during training. The logistic

regression model achieved reasonable accuracy even with only one digit class vs. all others.