

Classification Performance Analysis

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1 Step 1: Data Analysis and Confusion Matrix Construction

1.1 1.1 Corrected Data Mapping &

1.2 1.2 Grouping by Gold Labels

$$\text{Gold Positive} = \{1, 2, 5, 10, 18, 19, 20\} \quad (7 \text{ instances}) \quad (1)$$

$$\text{Gold Negative} = \{6, 7, 8, 9, 11, 14, 15, 16\} \quad (8 \text{ instances}) \quad (2)$$

$$\text{Gold Neutral} = \{3, 4, 12, 13, 17\} \quad (5 \text{ instances}) \quad (3)$$

1.3 1.3 Detailed Prediction Analysis

For Gold Positive (7 instances):

- ID 1: Predicted Positive ✓
- ID 2: Predicted Negative
- ID 5: Predicted Neutral
- ID 10: Predicted Positive ✓
- ID 18: Predicted Positive ✓
- ID 19: Predicted Negative
- ID 20: Predicted Positive ✓

Result: 4 Positive (correct), 2 Negative, 1 Neutral

For Gold Negative (8 instances):

- ID 6: Predicted Negative ✓
- ID 7: Predicted Positive
- ID 8: Predicted Neutral

- ID 9: Predicted Negative ✓
- ID 11: Predicted Negative ✓
- ID 14: Predicted Negative ✓
- ID 15: Predicted Negative ✓
- ID 16: Predicted Positive

Result: 2 Positive, 5 Negative (correct), 1 Neutral

For Gold Neutral (5 instances):

- ID 3: Predicted Positive
- ID 4: Predicted Neutral ✓
- ID 12: Predicted Positive
- ID 13: Predicted Neutral ✓
- ID 17: Predicted Negative

Result: 2 Positive, 1 Negative, 2 Neutral (correct)

1.4 Confusion Matrix

$$C = \begin{bmatrix} & \text{Pred Pos} & \text{Pred Neg} & \text{Pred Neu} \\ \text{Gold Pos} & 4 & 2 & 1 \\ \text{Gold Neg} & 2 & 5 & 1 \\ \text{Gold Neu} & 2 & 1 & 2 \end{bmatrix}$$

2 Step 2: Precision Calculation

2.1 Mathematical Foundation

$$\text{Precision}_c = \frac{\text{TP}_c}{\text{TP}_c + \text{FP}_c} = \frac{\text{Number correctly predicted as } c}{\text{Total predicted as } c}$$

2.2 Per-Class Precision

Positive Class:

$$\text{Total predicted as Positive} = 4 + 2 + 2 = 8 \quad (4)$$

$$\text{Correctly predicted as Positive} = 4 \quad (5)$$

$$\text{Precision}_{\text{Pos}} = \frac{4}{8} = 0.500 \quad (6)$$

Negative Class:

$$\text{Total predicted as Negative} = 2 + 5 + 1 = 8 \quad (7)$$

$$\text{Correctly predicted as Negative} = 5 \quad (8)$$

$$\text{Precision}_{\text{Neg}} = \frac{5}{8} = 0.625 \quad (9)$$

Neutral Class:

$$\text{Total predicted as Neutral} = 1 + 1 + 2 = 4 \quad (10)$$

$$\text{Correctly predicted as Neutral} = 2 \quad (11)$$

$$\text{Precision}_{\text{Neu}} = \frac{2}{4} = 0.500 \quad (12)$$

3 Step 3: Recall Calculation

3.1 3.1 Mathematical Foundation

$$\text{Recall}_c = \frac{\text{TP}_c}{\text{TP}_c + \text{FN}_c} = \frac{\text{Number correctly predicted as } c}{\text{Total actually } c}$$

3.2 3.2 Per-Class Recall

Positive Class:

$$\text{Total actually Positive} = 4 + 2 + 1 = 7 \quad (13)$$

$$\text{Correctly predicted as Positive} = 4 \quad (14)$$

$$\text{Recall}_{\text{Pos}} = \frac{4}{7} = 0.571 \quad (15)$$

Negative Class:

$$\text{Total actually Negative} = 2 + 5 + 1 = 8 \quad (16)$$

$$\text{Correctly predicted as Negative} = 5 \quad (17)$$

$$\text{Recall}_{\text{Neg}} = \frac{5}{8} = 0.625 \quad (18)$$

Neutral Class:

$$\text{Total actually Neutral} = 2 + 1 + 2 = 5 \quad (19)$$

$$\text{Correctly predicted as Neutral} = 2 \quad (20)$$

$$\text{Recall}_{\text{Neu}} = \frac{2}{5} = 0.400 \quad (21)$$

4 Step 4: F-measure Calculation

4.1 4.1 Harmonic Mean Formula

$$F_1(c) = 2 \times \frac{\text{Precision}_c \times \text{Recall}_c}{\text{Precision}_c + \text{Recall}_c}$$

4.2 Per-Class F-measure

Positive Class:

$$F_1(\text{Pos}) = 2 \times \frac{0.500 \times 0.571}{0.500 + 0.571} = 2 \times \frac{0.286}{1.071} = 0.533$$

Negative Class:

$$F_1(\text{Neg}) = 2 \times \frac{0.625 \times 0.625}{0.625 + 0.625} = 2 \times \frac{0.391}{1.250} = 0.625$$

Neutral Class:

$$F_1(\text{Neu}) = 2 \times \frac{0.500 \times 0.400}{0.500 + 0.400} = 2 \times \frac{0.200}{0.900} = 0.444$$

5 Step 5: Macro-Averaged Metrics

5.1 Macro-Averaged Precision

$$\text{Macro-Precision} = \frac{1}{3}(0.500 + 0.625 + 0.500) \quad (22)$$

$$= \frac{1.625}{3} \quad (23)$$

$$= \boxed{0.542} \quad (24)$$

5.2 Macro-Averaged Recall

$$\text{Macro-Recall} = \frac{1}{3}(0.571 + 0.625 + 0.400) \quad (25)$$

$$= \frac{1.596}{3} \quad (26)$$

$$= \boxed{0.532} \quad (27)$$

5.3 Macro-Averaged F-measure

$$\text{Macro-F}_1 = \frac{1}{3}(0.533 + 0.625 + 0.444) \quad (28)$$

$$= \frac{1.602}{3} \quad (29)$$

$$= \boxed{0.534} \quad (30)$$

6 Step 6: Accuracy Calculation

6.1 6.1 Formula and Calculation

$$\text{Accuracy} = \frac{\text{Correct Predictions}}{\text{Total Instances}} \quad (31)$$

$$= \frac{4 + 5 + 2}{20} \quad (32)$$

$$= \frac{11}{20} \quad (33)$$

$$= \boxed{0.550} \quad (34)$$

7 Final Results Summary

Class	Precision	Recall	F-measure	Support
Positive	0.500	0.571	0.533	7
Negative	0.625	0.625	0.625	8
Neutral	0.500	0.400	0.444	5
Macro-Avg	0.542	0.532	0.534	20

Overall Accuracy: 0.550 (11/20 correct)