

Confusion Matrix

Actual Label

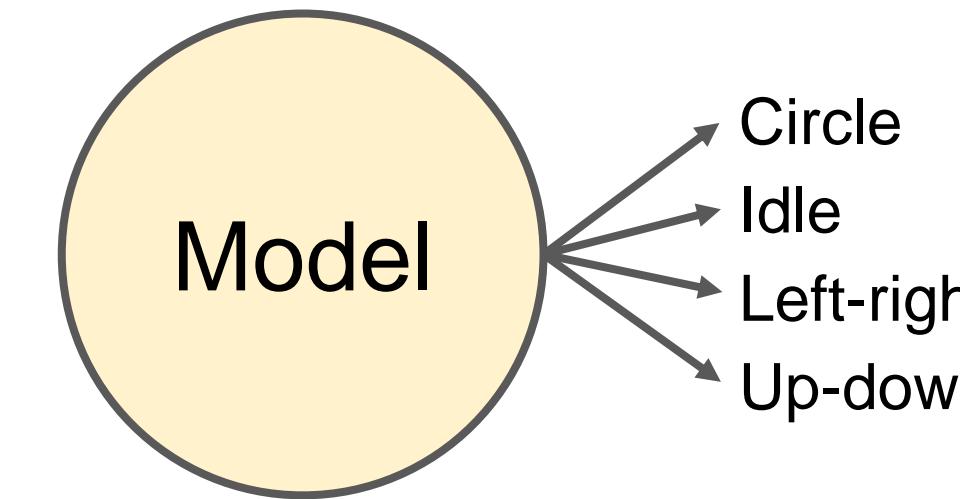
| | Circle | Idle | Left-Right | Up-Down |
|------------|--------|------|------------|---------|
| Circle | | | | |
| Idle | | | | |
| Left-Right | | | | |
| Up-Down | | | | |

Validation Set

| Validation Sample | Actual Label |
|-------------------|--------------|
| 1 | Idle |
| 2 | Circle |
| 3 | Circle |
| 4 | Up-Down |
| 5 | Left-Right |
| 6 | Up-Down |

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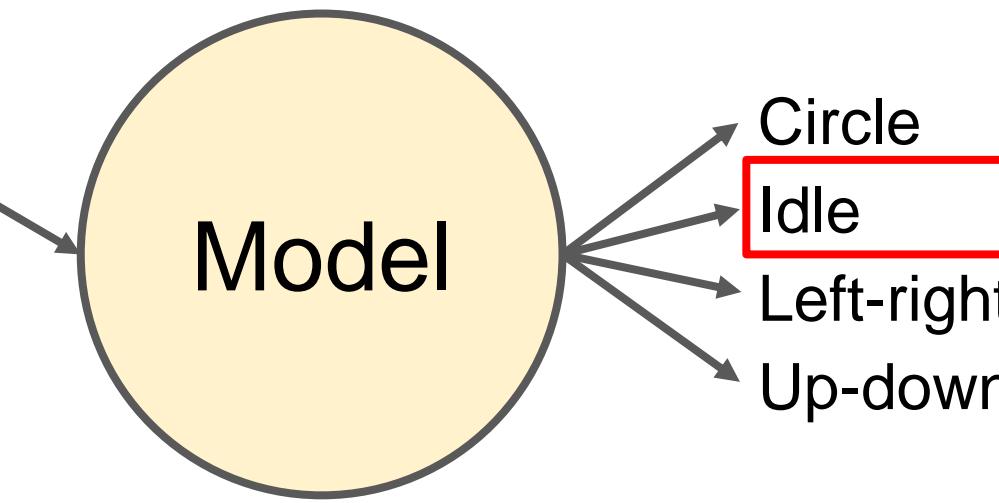
:



Predicted Label

Validation Set

| Validation Sample | Actual Label |
|-------------------|--------------|
| 1 | Idle |
| 2 | Circle |
| 3 | Circle |
| 4 | Up-Down |
| 5 | Left-Right |
| 6 | Up-Down |
| : | : |



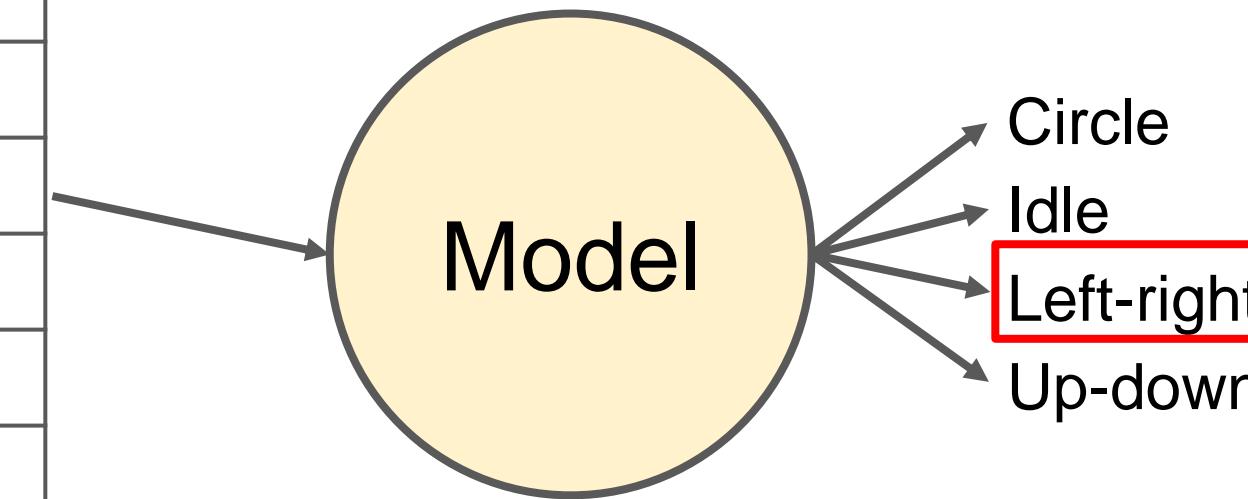
Predicted Label

Confusion Matrix

| Actual Label | Circle | Idle | Left-Right | Up-Down |
|--------------|--------|------|------------|---------|
| Circle | 0 | 0 | 0 | 0 |
| Idle | 0 | 0 | 0 | 0 |
| Left-Right | 0 | 0 | 0 | 0 |
| Up-Down | 0 | 0 | 0 | 0 |

Validation Set

| Validation Sample | Actual Label |
|-------------------|--------------|
| 1 | Idle |
| 2 | Circle |
| 3 | Circle |
| 4 | Up-Down |
| 5 | Left-Right |
| 6 | Up-Down |
| : | : |



Predicted Label

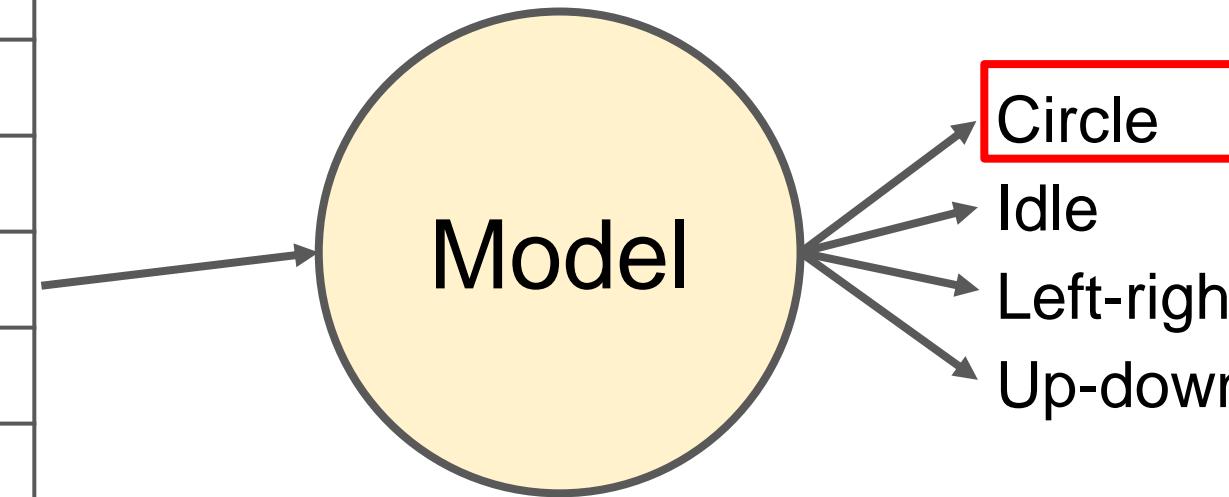
Confusion Matrix

| Actual Label | Circle | Idle | Left-Right | Up-Down |
|--------------|--------|------|------------|---------|
| Circle | 0 | 0 | 1 | 0 |
| Idle | 0 | 1 | 0 | 0 |
| Left-Right | 0 | 0 | 0 | 0 |
| Up-Down | 0 | 0 | 0 | 0 |

Confusion Matrix

Validation Set

| Validation Sample | Actual Label |
|-------------------|--------------|
| 1 | Idle |
| 2 | Circle |
| 3 | Circle |
| 4 | Up-Down |
| 5 | Left-Right |
| 6 | Up-Down |
| : | : |



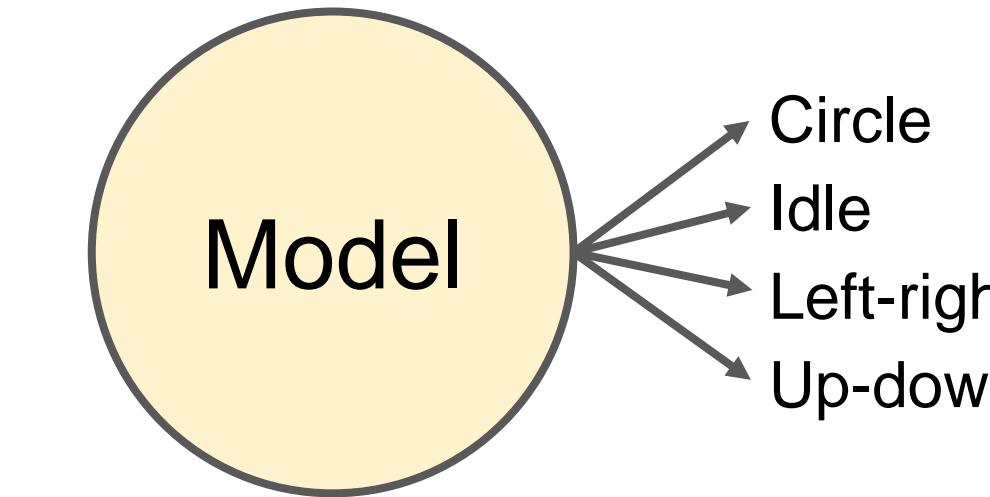
Predicted Label

| | Circle | Idle | Left-Right | Up-Down |
|------------|--------|------|------------|---------|
| Circle | 1 | 0 | 1 | 0 |
| Idle | 0 | 1 | 0 | 0 |
| Left-Right | 0 | 0 | 0 | 0 |
| Up-Down | 0 | 0 | 0 | 0 |

Confusion Matrix

Validation Set

| Validation Sample | Actual Label |
|-------------------|--------------|
| 1 | Idle |
| 2 | Circle |
| 3 | Circle |
| 4 | Up-Down |
| 5 | Left-Right |
| 6 | Up-Down |
| : | : |



Predicted Label

| | Circle | Idle | Left-Right | Up-Down |
|------------|--------|------|------------|---------|
| Circle | 205 | 10 | 1 | 46 |
| Idle | 6 | 199 | 0 | 32 |
| Left-Right | 9 | 17 | 223 | 34 |
| Up-Down | 21 | 8 | 3 | 186 |

Confusion Matrix

| | | Predicted Label | | | |
|--------------|------------|-----------------|------|------------|---------|
| | | Circle | Idle | Left-Right | Up-Down |
| Actual Label | Circle | 205 | 10 | 1 | 46 |
| | Idle | 6 | 199 | 0 | 32 |
| | Left-Right | 9 | 17 | 223 | 34 |
| | Up-Down | 21 | 8 | 3 | 186 |

Total accuracy:

$$\frac{\sum \text{correct}}{\sum \text{all}} = \frac{813}{1000} = 0.813$$

Confusion Matrix

Total accuracy:

$$\frac{\sum \text{correct}}{\sum \text{all}} = \frac{973}{1000} = 0.973$$

| | | Predicted Label | | | |
|--------------|------------|-----------------|------|------------|---------|
| | | Circle | Idle | Left-Right | Up-Down |
| Actual Label | Circle | 0 | 6 | 0 | 0 |
| | Idle | 0 | 973 | 0 | 0 |
| | Left-Right | 0 | 11 | 0 | 0 |
| | Up-Down | 0 | 10 | 0 | 0 |

Confusion Matrix

| | | Predicted Label | |
|--------------|----------|-----------------|----------|
| | | Positive | Negative |
| Actual Label | Positive | 38 | 17 |
| | Negative | 3 | 42 |

True Positive (TP): Predicted positive matches actual positive

True Negative (TN): Predicted negative matches actual negative

False Positive (FP) (“Type I Error”): Predicted positive does not match actual negative

False Negative (FN) (“Type II Error”): Predicted negative does not match actual positive

Confusion Matrix

| | Circle | Idle | Left-Right | Up-Down |
|------------|--------|------|------------|---------|
| Circle | 205 | 10 | 1 | 46 |
| Idle | 6 | 199 | 0 | 32 |
| Left-Right | 9 | 17 | 223 | 34 |
| Up-Down | 21 | 8 | 3 | 186 |

True Positive (TP): Predicted positive matches actual positive

True Negative (TN): Predicted negative matches actual negative

False Positive (FP) (“Type I Error”): Predicted positive does not match actual negative

False Negative (FN) (“Type II Error”): Predicted negative does not match actual positive

Confusion Matrix

| | | Predicted Label | | | |
|--------------|------------|-----------------|------|------------|---------|
| | | Circle | Idle | Left-Right | Up-Down |
| Actual Label | Circle | 205 | 10 | 1 | 46 |
| | Idle | 6 | 199 | 0 | 32 |
| | Left-Right | 9 | 17 | 223 | 34 |
| | Up-Down | 21 | 8 | 3 | 186 |

Accuracy

$$ACC = \frac{TP + TN}{P + N} = \frac{TP + TN}{TP + TN + FP + FN} = \frac{\text{Green Box} + \text{Blue Box}}{\text{Total}}$$
$$= \frac{199 + 728}{1000} = 0.927$$

Confusion Matrix

| | | Predicted Label | | | |
|--------------|------------|-----------------|------|------------|---------|
| | | Circle | Idle | Left-Right | Up-Down |
| Actual Label | Circle | 205 | 10 | 1 | 46 |
| | Idle | 6 | 199 | 0 | 32 |
| | Left-Right | 9 | 17 | 223 | 34 |
| | Up-Down | 21 | 8 | 3 | 186 |

True Positive Rate (TPR), Sensitivity, Recall, Hit Rate

$$TPR = \frac{TP}{P} = \frac{TP}{TP + FN} = \frac{\text{[Green Box]}}{\text{[Green Box]} + \text{[Purple Box]}}$$
$$= \frac{199}{199 + 38} = 0.840$$

Confusion Matrix

| | | Predicted Label | | | |
|--------------|------------|-----------------|------|------------|---------|
| | | Circle | Idle | Left-Right | Up-Down |
| Actual Label | Circle | 205 | 10 | 1 | 46 |
| | Idle | 6 | 199 | 0 | 32 |
| | Left-Right | 9 | 17 | 223 | 34 |
| | Up-Down | 21 | 8 | 3 | 186 |

True Negative Rate (TNR), Specificity, Selectivity

$$TNR = \frac{TN}{N} = \frac{TN}{TN + FP} = \frac{\boxed{}}{\boxed{} + \boxed{}}$$
$$= \frac{728}{728 + 35} = 0.954$$

Confusion Matrix

| | | Predicted Label | | | | |
|--|--|-----------------|------|------------|---------|-----|
| | | Circle | Idle | Left-Right | Up-Down | |
| | | Circle | 205 | 10 | 1 | 46 |
| | | Idle | 6 | 199 | 0 | 32 |
| | | Left-Right | 9 | 17 | 223 | 34 |
| | | Up-Down | 21 | 8 | 3 | 186 |

Positive Predictive Value (PPV), Precision

$$PPV = \frac{TP}{TP + FP} = \frac{\text{[Green Box]}}{\text{[Green Box]} + \text{[Orange Box]}}$$
$$= \frac{199}{199 + 35} = 0.850$$

Confusion Matrix

| | | Predicted Label | | | |
|--------------|------------|-----------------|------|------------|---------|
| | | Circle | Idle | Left-Right | Up-Down |
| Actual Label | Circle | 205 | 10 | 1 | 46 |
| | Idle | 6 | 199 | 0 | 32 |
| | Left-Right | 9 | 17 | 223 | 34 |
| | Up-Down | 21 | 8 | 3 | 186 |

F1 Score

$$F_1 = 2 \cdot \frac{PPV \cdot TPR}{PPV + TPR} = \frac{2TP}{2TP + FP + FN}$$

$$= 2 \cdot \frac{0.850 \cdot 0.840}{0.850 + 0.840} = 0.845$$

Confusion Matrix

| | | Predicted Label | | | |
|--------------|------------|-----------------|------|------------|---------|
| | | Circle | Idle | Left-Right | Up-Down |
| Actual Label | Circle | 205 | 10 | 1 | 46 |
| | Idle | 6 | 199 | 0 | 32 |
| | Left-Right | 9 | 17 | 223 | 34 |
| | Up-Down | 21 | 8 | 3 | 186 |

Per-class accuracy 0.907 0.927 0.936 0.856

F1 scores 0.815 0.845 0.875 0.721

Total accuracy: 0.813

F1 average: 0.818

Confusion Matrix

| | | Predicted Label | | | |
|--------------|------------|-----------------|------|------------|---------|
| | | Circle | Idle | Left-Right | Up-Down |
| Actual Label | Circle | 0 | 6 | 0 | 0 |
| | Idle | 0 | 973 | 0 | 0 |
| | Left-Right | 0 | 11 | 0 | 0 |
| | Up-Down | 0 | 10 | 0 | 0 |

Per-class accuracy 0.994 0.973 0.989 0.99

F1 scores 0.0 0.986 0.0 0.0

Total accuracy: 0.973

F1 average: 0.247

Predicted Label

| | A | B | C |
|---|-----|-----|-----|
| A | 193 | 7 | 0 |
| B | 5 | 173 | 22 |
| C | 10 | 1 | 189 |

Total: 600

Total accuracy: 92.5%

TP(C): 189

FP(C): 22

FN(C): 11

$$F1(C) = (2 * 189) / (2 * 189 + 22 + 11) = 0.9197 \sim 0.920$$

Predicted Label

Actual Label

| | A | B | C |
|---|-----|-----|-----|
| A | 312 | 27 | 8 |
| B | 0 | 265 | 11 |
| C | 0 | 1 | 276 |

Total: 900

Total accuracy: $853 / 900 = 94.8\% = 0.948$

TP(A): 312

FP(A): 0

FN(A): 35

$F1(A) = (2 * 312) / (2 * 312 + 0 + 35) = 0.947$