

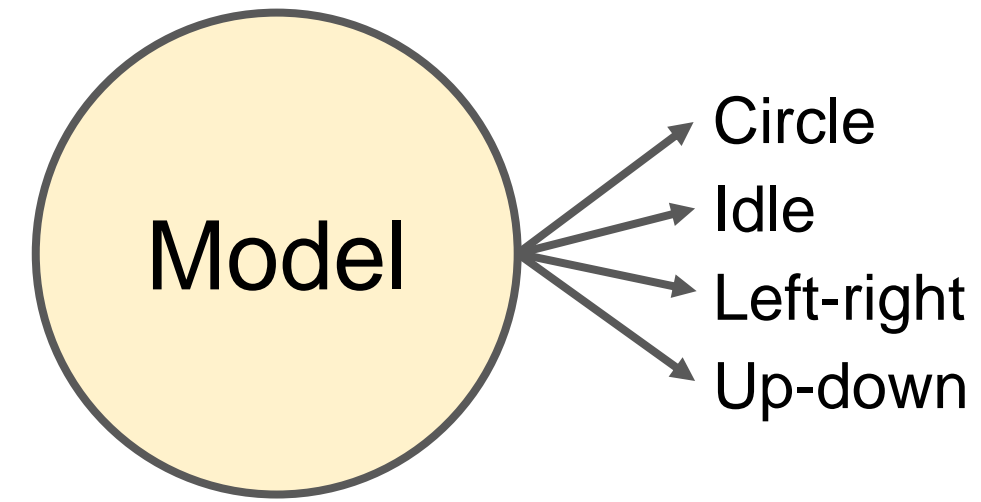
Confusion Matrix

Actual Label

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

Validation Set

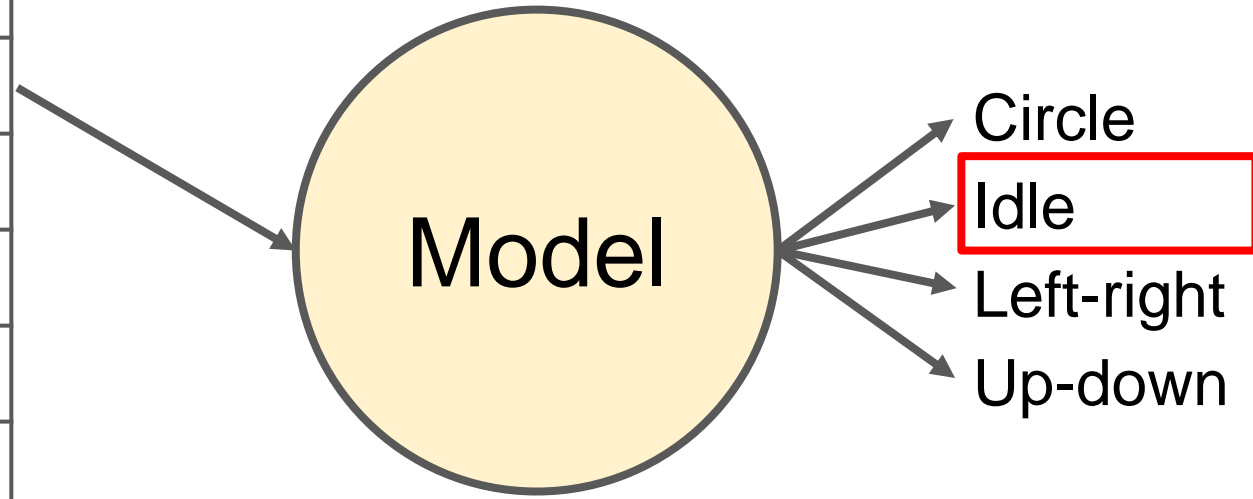
Validation Sample	Actual Label
1	Idle
2	Circle
3	Circle
4	Up-Down
5	Left-Right
6	Up-Down
⋮	⋮



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

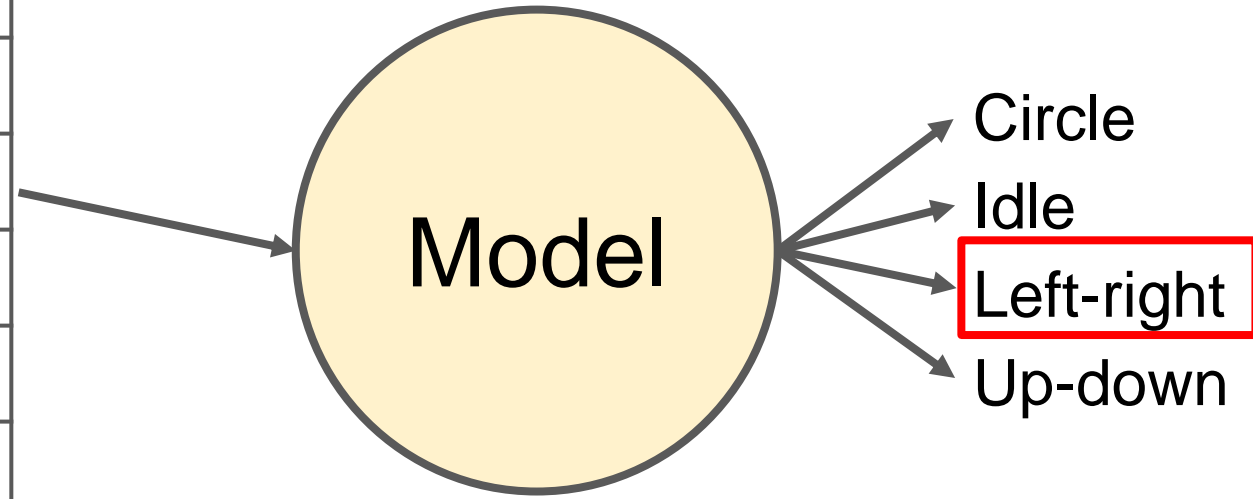
Confusion Matrix

Actual Label

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

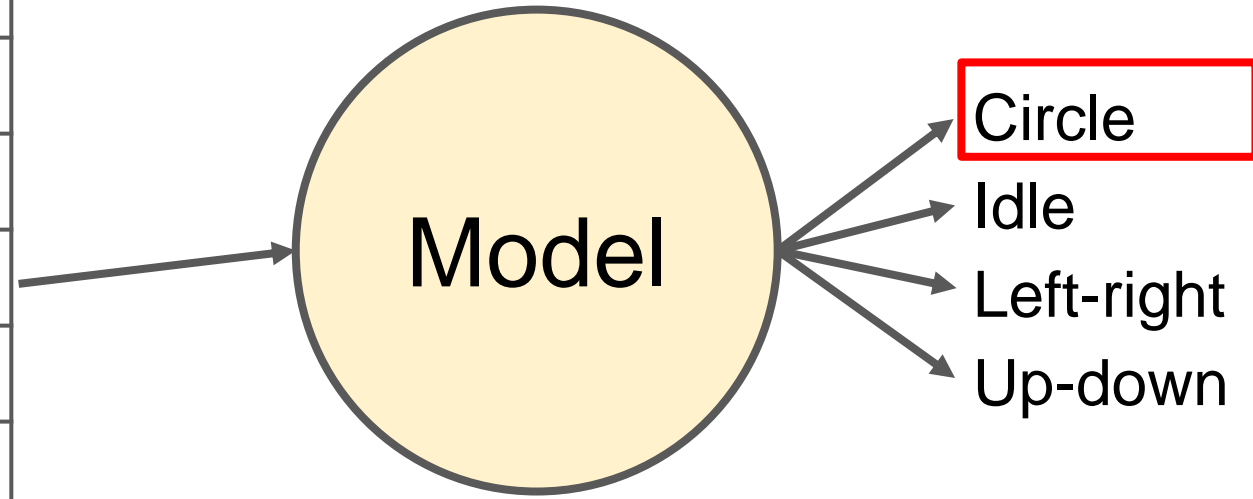
Confusion Matrix

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

Validation Set

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



Predicted Label

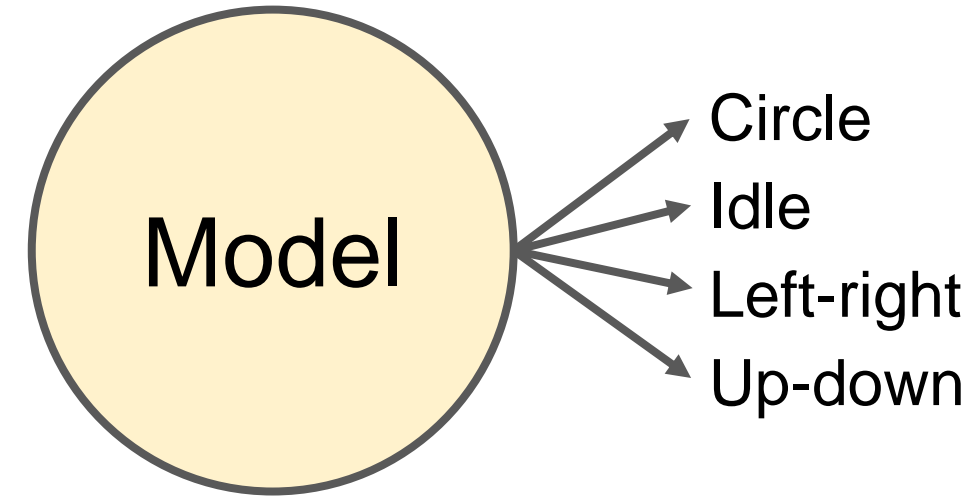
Confusion Matrix

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

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

Total accuracy: $\frac{\sum correct}{\sum all} = \frac{813}{1000} = 0.813$

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

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

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

		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 (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

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

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

$$\begin{aligned}
 TPR &= \frac{TP}{P} = \frac{TP}{TP + FN} = \frac{\text{Green Box}}{\text{Green Box} + \text{Purple Box}} \\
 &= \frac{199}{199 + 38} = 0.840
 \end{aligned}$$

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

$$\begin{aligned}
 TNR &= \frac{TN}{N} = \frac{TN}{TN + FP} = \frac{\boxed{\text{blue}}}{\boxed{\text{blue}} + \boxed{\text{orange}}} \\
 &= \frac{728}{728 + 35} = 0.954
 \end{aligned}$$

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

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

Actual 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

	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

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