



## Data-driven Conflict Detection Enhancement with Machine Learning

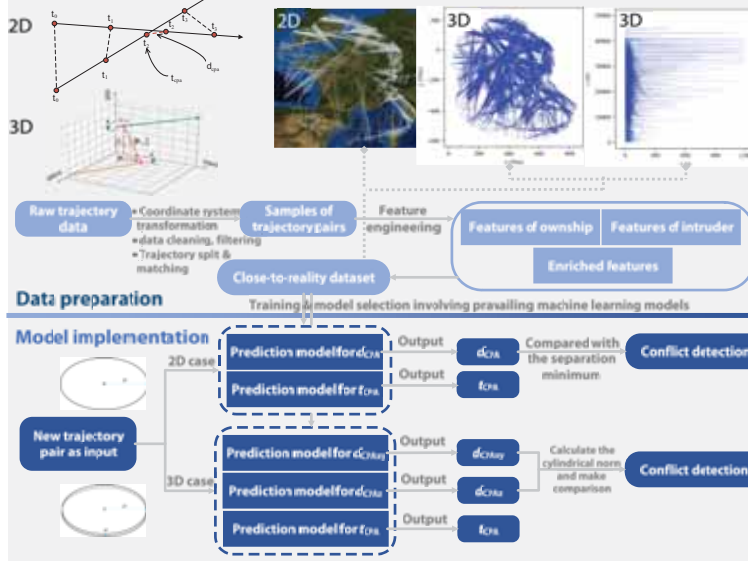
### Objective:

To propose a novel data-driven conflict detection framework with machine learning for performance enhancement in actual operations.

### Methodology:

**Closest Point of Approach (CPA):** Positions at which two dynamically moving objects reach their closest possible distance. It is a key concept in the algorithmic level for conflict detection.

**Main problem of conventional model:** Assumption cannot be ensured in real operations.



### Results:

2D case:	CPA prediction					Conflict detection										
	Models	$d_{CPA}(Nm)$	$d_{CPA}(ft)$	$t_{CPA}(s)$		Models	TP	FN	TN	FP						
		MAE	RMSE	MAE	RMSE		Num	Rate	Num	Rate	Num	Rate	Num	Rate		
	Baseline	9.76	8.09	83.08	766.37	Baseline	6359	92.15%	542	7.85%	10293	95.81%	450	4.19%		
	RF	22.25	31.36	237.19	3809.65	FFNNs	6551	94.93%	350	5.07%	10377	96.59%	366	3.41%		
	FFNNs	1.96	1.91	43.89	38.53	KNN	5729	83.02%	1172	16.96%	9852	91.71%	891	8.29%		
	KNN	1.76	16.83	78.31	125.18	GBM	<b>6673</b>	<b>96.70%</b>	<b>228</b>	<b>3.30%</b>	<b>10517</b>	<b>97.90%</b>	<b>226</b>	<b>2.10%</b>		
	GBM	<b>1.82</b>	<b>2.83</b>	<b>28.81</b>	<b>45.66</b>	RF	6514	94.39%	387	5.61%	10418	96.97%	325	3.02%		
	RF	2.14	4.20	34.26	72.26											
3D case:	Models	$d_{CPA}(Nm)$	$d_{CPA}(ft)$	$t_{CPA}(s)$		Models	TP	FN	TN	FP						
		MAE	RMSE	MAE	RMSE		Num	Rate	Num	Rate	Num	Rate	Num	Rate		
	Baseline	4.52	9.63	29.01	203.3	42.73	67.83	Baseline	18543	72.62%	6992	27.38%	221191	99.35%	1453	0.65%
	FFNNs	0.30	0.56	9.32	66.85	<b>3.83</b>	<b>13.05</b>	FFNNs	24088	94.33%	1447	5.67%	222148	99.78%	496	0.22%
	KNN	1.56	2.13	12.88	95.96	13.67	30.85	KNN	18742	73.40%	6793	26.60%	217772	97.81%	4872	2.19%
	GBM	<b>0.20</b>	<b>0.43</b>	<b>7.35</b>	<b>49.22</b>	4.63	13.39	GBM	24914	97.57%	621	2.43%	214018	96.13%	8626	3.87%
	RF	0.51	0.80	20.13	90.22	5.08	15.24	RF	23917	93.37%	1618	6.34%	212627	95.50%	10017	4.50%

\* TP: True Positive FN: False Negative TN: True Negative FP: False Positive

Zhengyi Wang<sup>1</sup>  
zhengyi.wang@enac.fr

Man Liang<sup>2</sup>  
annie.liang@urisa.edu.au

Daniel Delahaye<sup>1</sup>  
delahaye@recherche.enac.fr

<sup>1</sup>Ecole Nationale de l'Aviation Civile

<sup>2</sup>University of South Australia

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founding members

