

# Data-driven Conflict Detection Enhancement in Closest Point of Approach Problem

Zhengyi Wang, Man Liang, Daniel Delahaye

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# Data-driven Conflict Detection Enhancement with Machine Learning

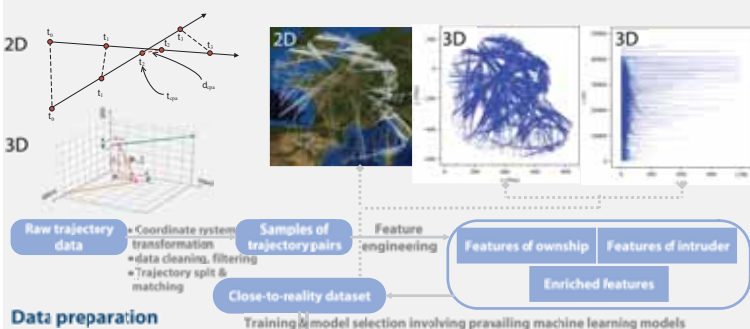
## Objective:

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:

CPA prediction

Models	$d_{CPA}(Nm)$		$r_{CPA}(ft)$	
	MAE	RMSE	MAE	RMSE
Baseline	3.76	8.09	83.05	766.31
FFNN	22.23	31.36	227.11	280.63
KNN	6.20	16.26	98.44	194.12
FFNNs	1.96	3.51	41.40	30.33
KNN	3.79	10.48	78.11	122.14
GBM	0.42	2.83	28.81	45.66
RF	2.14	4.20	94.26	72.28

Models	$d_{CPA_{norm}}(Nm)$		$d_{CPA}(ft)$		$r_{CPA}(ft)$	
	MAE	RMSE	MAE	RMSE	MAE	RMSE
Baseline	4.52	9.63	29.01	203.3	42.73	67.83
FFNNs	0.30	0.56	9.32	66.85	<b>3.83</b>	<b>13.05</b>
KNN	1.56	2.13	12.88	95.96	13.67	30.85
GBM	<b>0.20</b>	<b>0.43</b>	<b>7.35</b>	<b>49.22</b>	4.63	13.39
RF	0.51	0.80	20.13	90.22	5.08	15.24

Conflict detection

Models	TP		FN		TN		FP	
	Num	Rate	Num	Rate	Num	Rate	Num	Rate
Baseline	6359	92.15%	542	7.85%	10293	95.81%	450	4.19%
FFNNs	6551	94.93%	350	5.07%	10377	96.59%	366	3.41%
KNN	5720	83.02%	1172	16.98%	9852	91.71%	891	8.29%
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>
RF	6514	94.39%	387	5.61%	10418	96.97%	325	3.02%

Models	TP		FN		TN		FP	
	Num	Rate	Num	Rate	Num	Rate	Num	Rate
Baseline	18543	72.62%	6992	27.38%	221191	99.35%	1453	0.65%
FFNNs	24088	94.33%	1447	5.67%	222148	99.78%	496	0.22%
KNN	18742	73.40%	6793	26.60%	217772	97.81%	4872	2.19%
GBM	24914	97.57%	621	2.43%	214018	96.13%	8626	3.87%
RF	23917	93.37%	1618	6.34%	212627	95.50%	10017	4.50%

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

Zhengyi Wang<sup>1</sup>  
[zhengyi.wang@enac.fr](mailto:zhengyi.wang@enac.fr)

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

Man Liang<sup>2</sup>  
[annie.liang@urisa.edu.au](mailto:annie.liang@urisa.edu.au)

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

Daniel Delahaye<sup>1</sup>  
[delahaye@recherche.enac.fr](mailto:delahaye@recherche.enac.fr)

<sup>1</sup>University of South Australia

