

Evaluation of maritime event detection against missing data

Maximilian Zocholl¹, Clément Iphar¹, Manolis Pitsikalis², Anne-Laure Jouselme¹,
Alexander Artikis^{2,3}, Cyril Ray⁴

¹ NATO STO Centre for Maritime Research and Experimentation, La Spezia, Italy

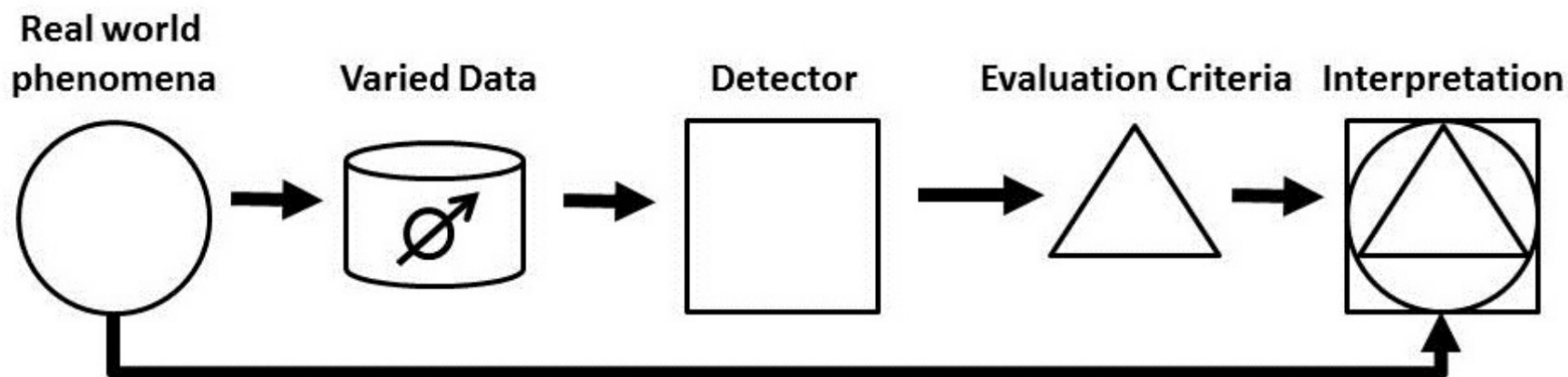
² NCSR Demokritos, Athens, Greece

³ University of Piraeus, Greece

⁴ Naval Academy Research Institute, Brest, France

1. Evaluation of MSI detection with data removal
2. Maritime Events
3. Dataset variations
4. Discussion
5. Conclusions

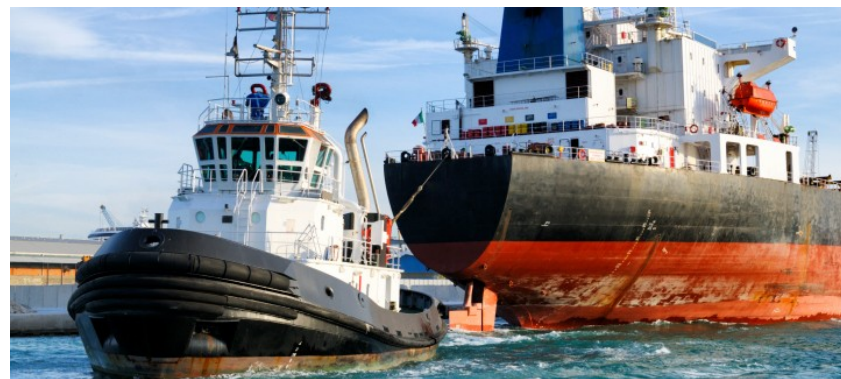
Evaluation of MSI detection with missing data



- The interpretation of evaluation results requires a systematic data variation with domain specific evaluation criteria.

From a Maritime Event to a decision

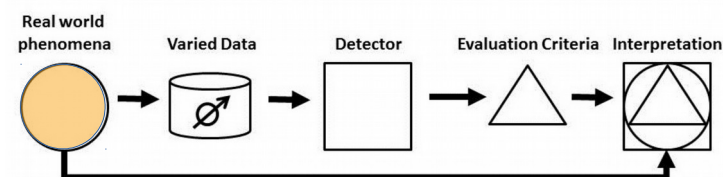
- Maritime Events
- AIS data



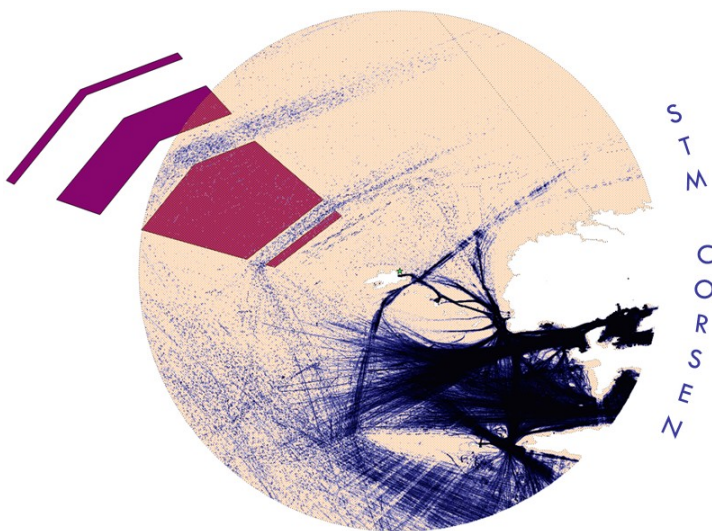
<https://www.acadiainsurance.com/tug-boats-vs-push-boats/>

Problems with AIS data: Data removal inspired by variations of message reception rate, influenced by distance, geography, weather, transceiver, etc.

- Tasks performed on AIS data



From a maritime dataset to an experimental input

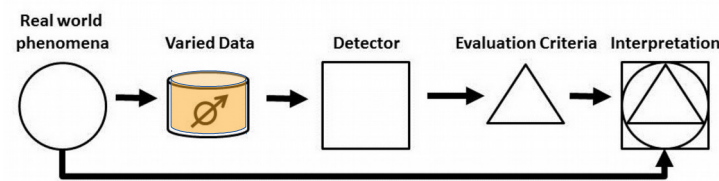
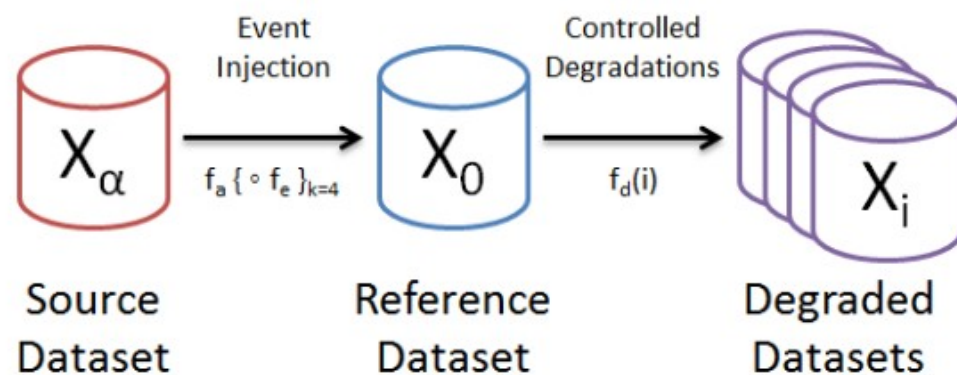


10.5281/zenodo.1167595

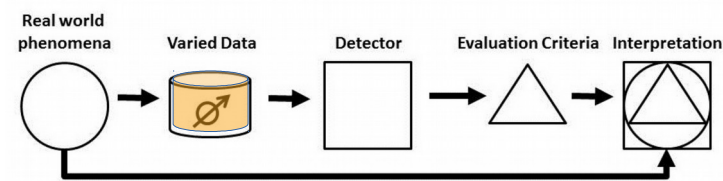
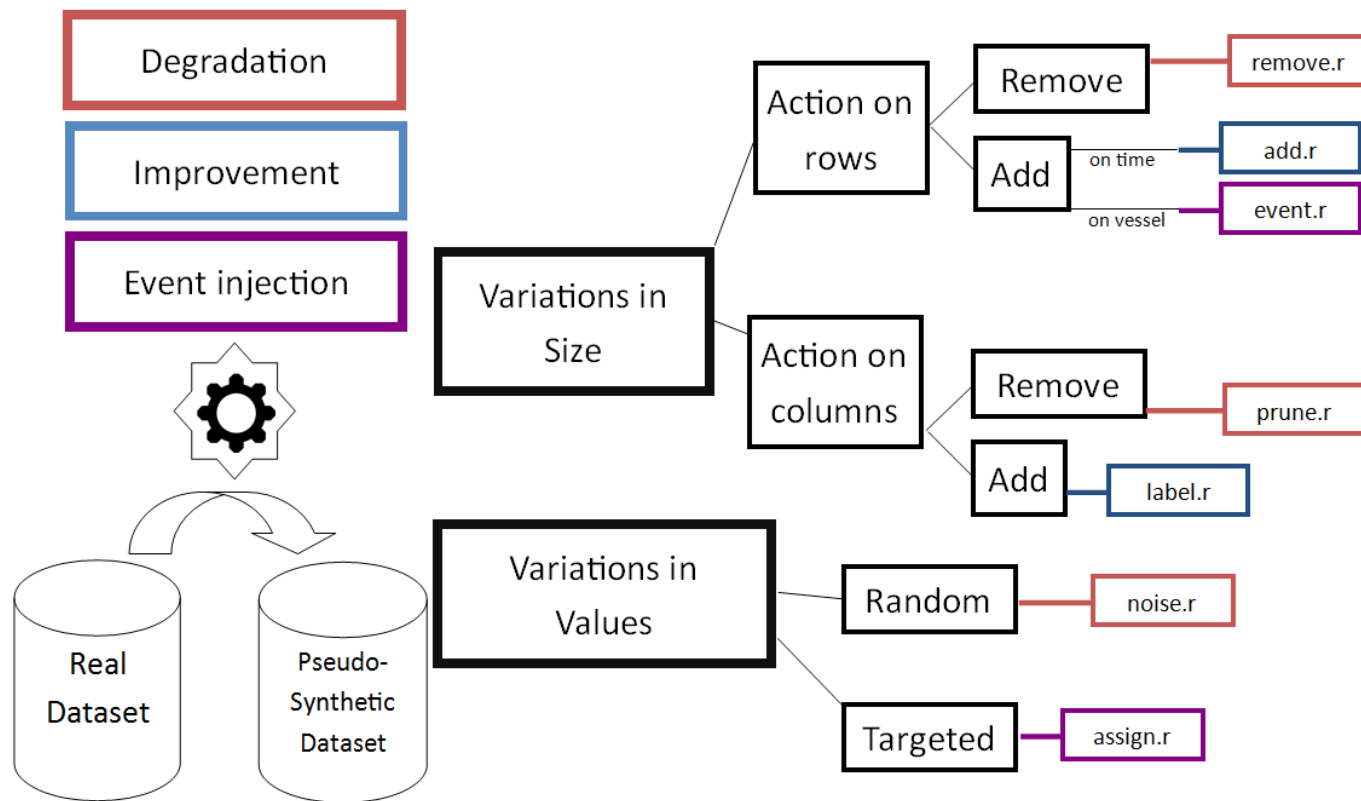
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Heterogeneous Integrated Dataset for Maritime Intelligence, Surveillance, and Reconnaissance. RAY, Cyril; DRÉO, Richard; CAMOSSI, Elena; JOUSSELME, Anne-Laure. 2018



Library for dataset modifications



Dataset variations – used modification functions

Assign $f_a(\mu, c, A, V) : \bar{X}_n^m \mapsto \hat{X}_n^m$

μ = mode (direct/offset)
 c = column
 A = subset of rows
 V = value of the assignment

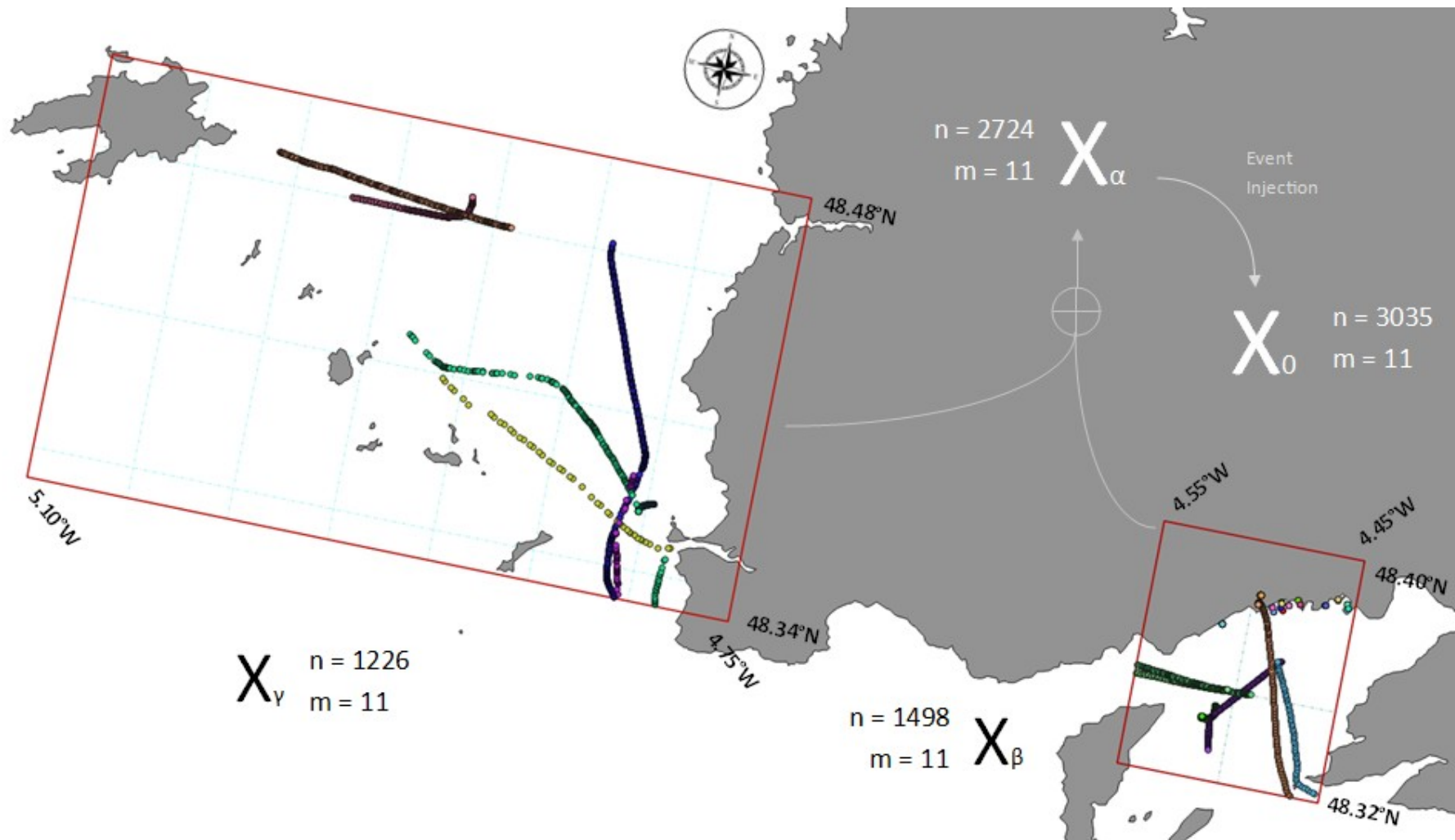
Event $f_e(q, E, p) : \bar{X}_n^m \mapsto \hat{X}_{n+Card(E)}^m$

q = number of events
 E = nature of event
 p = set of parameters

Remove $f_r(\alpha, A_p, N) : \bar{X}_n^m \mapsto \hat{X}_{n-\lceil \alpha \cdot Card(A_p) \rceil}^m$

α = rate of removal
 A_p = subset of interest
 N = nature of the removal

Dataset for experiments

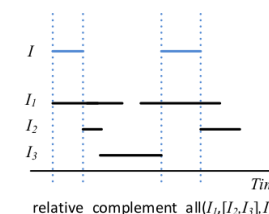
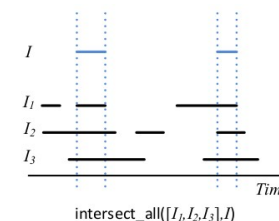
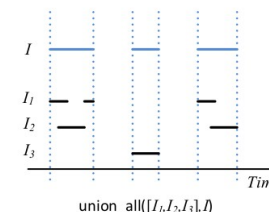


Maritime Situational Indicators

#	Maritime Situational Indicator	#	Maritime Situational Indicator
1	Close to critical infrastructure	15	No AIS reception
2	Within a given area	16	AIS reception interrupted
3	On a maritime route	17	Change in AIS static information
4	Proximity to other vessels	18	AIS error detection
5	In stationary area	19	Under way
6	Null speed	20	At anchor or moored
7	Change of speed	21	Movement ability affected
8	Mismatch speed area	22	Aground
9	Mismatch speed vessel type	23	Engaged in fishing
10	Mismatch speed vessel history	24	Tugging
11	Mismatch speed user defined value	25	In Search And Rescue (SAR) operation
12	Change of course	26	Loitering
13	Mismatch course vessel destination	27	Dead in water, drifting
14	Mismatch course user defined value	28	Rendez-vous

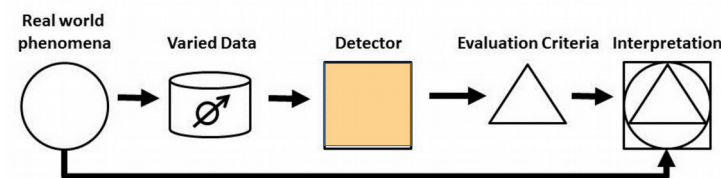
Formalisation of Maritime Events with RTEC

Predicate	Meaning
$\text{happensAt}(E, T)$	Event E occurs at time T
$\text{holdsAt}(F = V, T)$	The value of fluent F is V at time T
$\text{holdsFor}(F = V, I)$	I is the list of the maximal intervals for which $F = V$ holds continuously
$\text{initiatedAt}(F = V, T)$	At time T a period of time for which $F = V$ is initiated
$\text{terminatedAt}(F = V, T)$	At time T a period of time for which $F = V$ is terminated



$\text{initiatedAt}(\text{gap}(\text{Vessel}) = \text{Status}, T) \leftarrow \text{happensAt}(\text{gap_start}(\text{Vessel}), T),$
 $\text{happensAt}(\text{coord}(\text{Vessel}, \text{Lon}, \text{Lat}), T), \text{portDistance}(\text{Lon}, \text{Lat}, \text{Status}).$

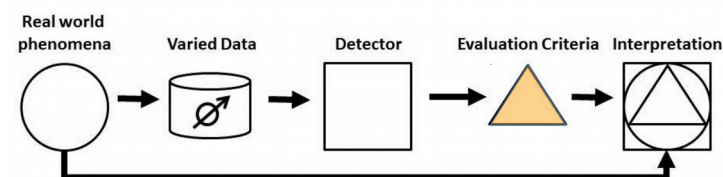
$\text{terminatedAt}(\text{gap}(\text{Vessel}) = \text{Status}, T) \leftarrow \text{happensAt}(\text{gap_end}(\text{Vessel}), T).$



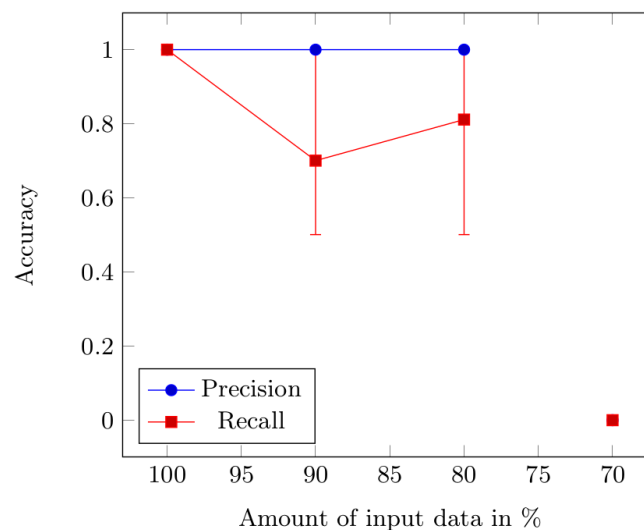
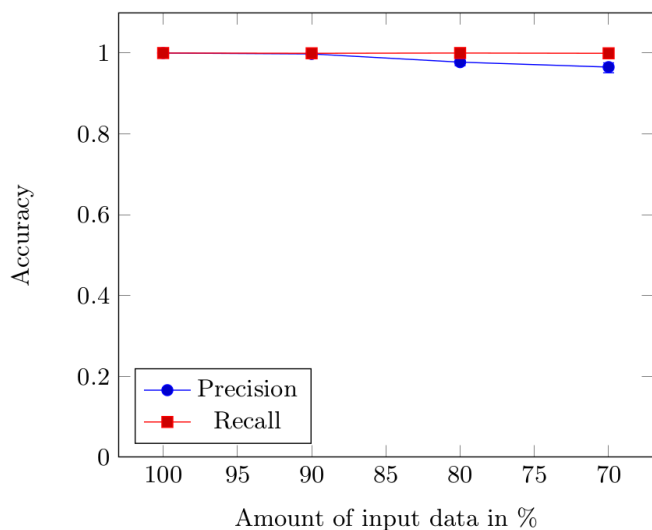
Evaluation of MSI accuracy under missing data (F1)

#MSI	Pattern	90%	80%	70%
8	High speed near coast	0.999	0.989	0.982
19a	Moving speed	0.996	0.995	0.976
19	Underway	0.997	0.989	0.975
2	Within area	0.987	0.979	0.974
24a	Tugging speed	0.996	0.989	0.971
11	Low speed	0.992	0.983	0.96
9	Unusual speed	0.981	0.957	0.933
25a	SAR course	0.934	0.835	0.89
7	Changing speed	0.939	0.888	0.815
16	Gap	0.946	0.885	0.809
6	stopped	0.911	0.795	0.63
21	MAA	0.8	0.876	-

- The larger the data degradation, the lower Recall, Precision and F1.
- The performance of most event detectors decreases slower than the data volume.



Margin of MSI accuracy variations due to data removal

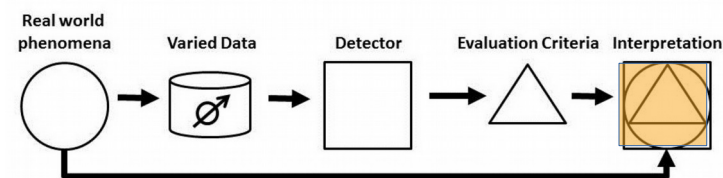


High speed near coast

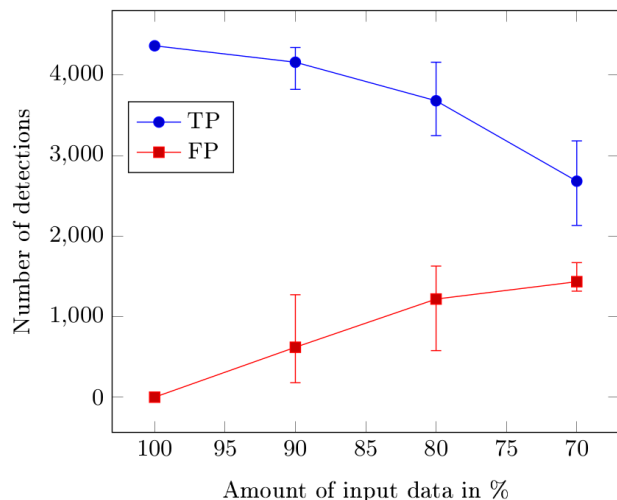
- Small variations

Movement ability affected

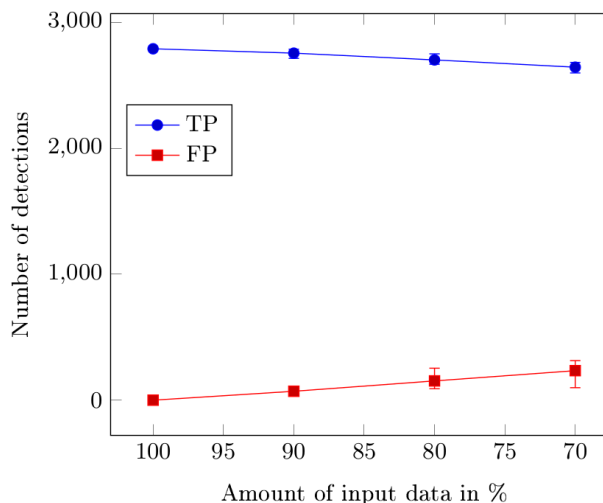
- Large variations



Speed-based simple fluent patterns with large variations in response to data removal

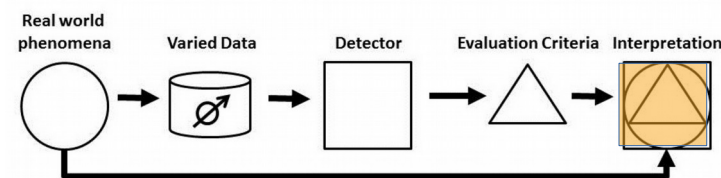


- Stopped
 - strong decrease of TPs
 - strong increase of FPs



- Unusual speed
 - weak decrease of TPs
 - weak increase of FPs

- FPs are not expected for stopped, underway or withinArea, unusual speed.



Perspectives

- Creating removal method that removes only P detections.
- Creating detector- or task specific evaluation metrics, e.g. to not penalize twice FN-FP pairs for changingSpeed.

Conclusions

- Application of existing AIS data variation methods for controlled data degradations
- Exemplary performance comparison of 12 maritime event detectors capturing robustness against missing data
- Reduction of interpretation space for reasons of dropping performance
- Perspective for future selection method of evaluation criteria based on applications and/or classifiers