Study of the Gaia AlertPipe performance and test of the likelihood detector

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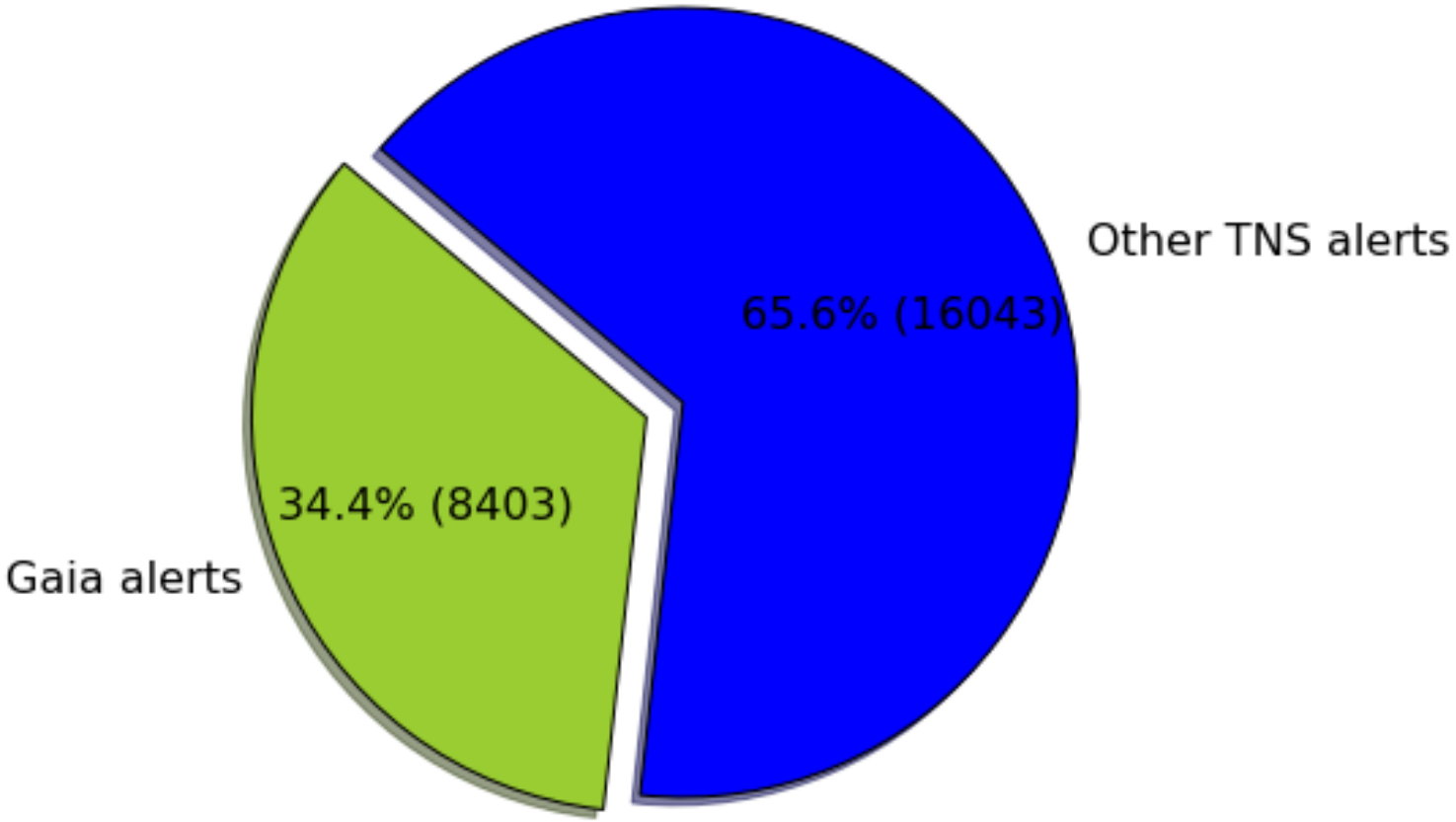
Motivation and goals

- ESA Prodex Gaia Transients project
  - performance of AlertPipe
  - development of new tools for detecting transients
  - testing new tools
- TNS and reconstruction of the AlertPipe
- Likelihood Detector

Performance

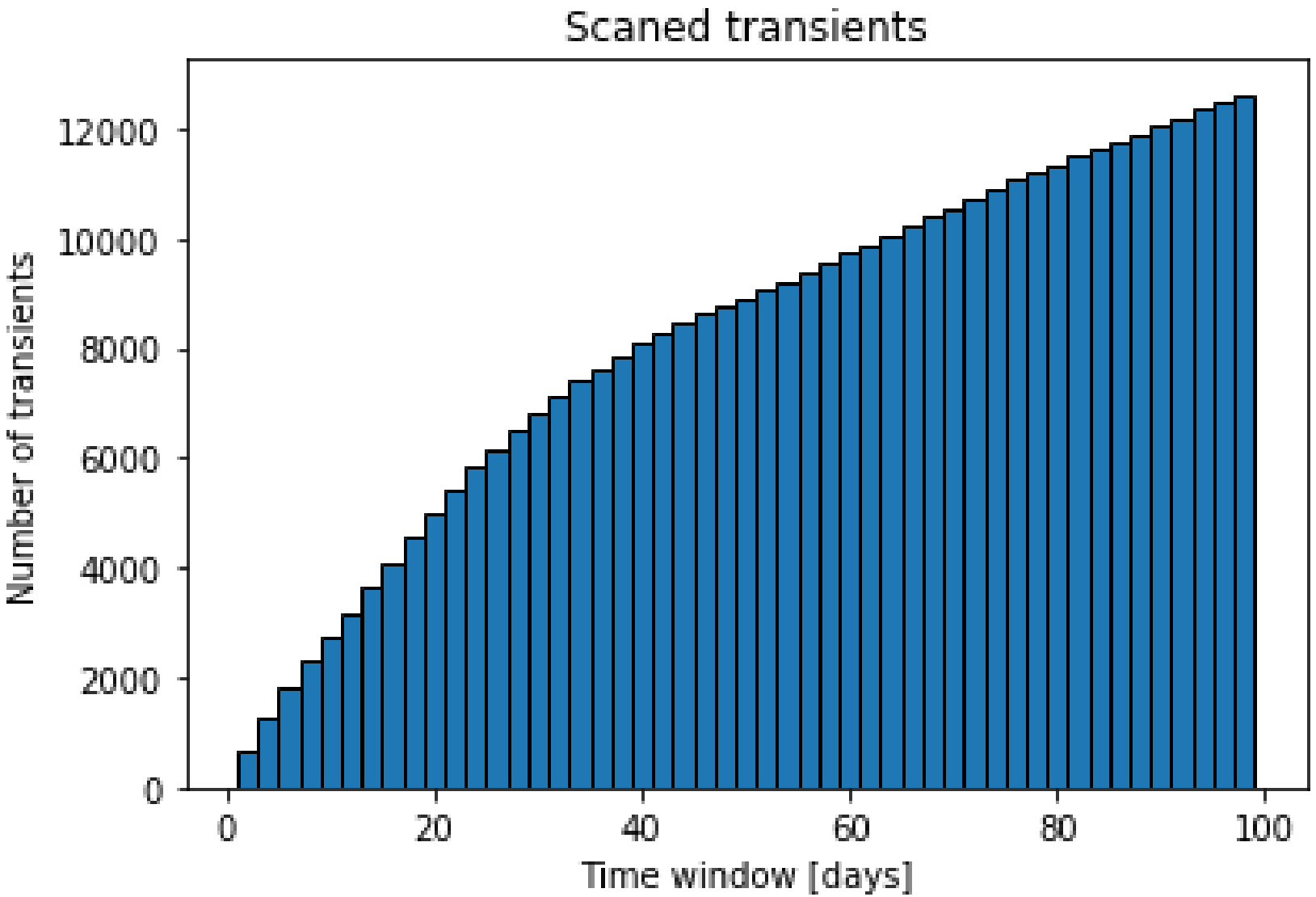
Method

- Transients form TNS
  - AlertPipe update: 20th November 2015
  - Start of analysis: 14th January 2019



Performance

Method



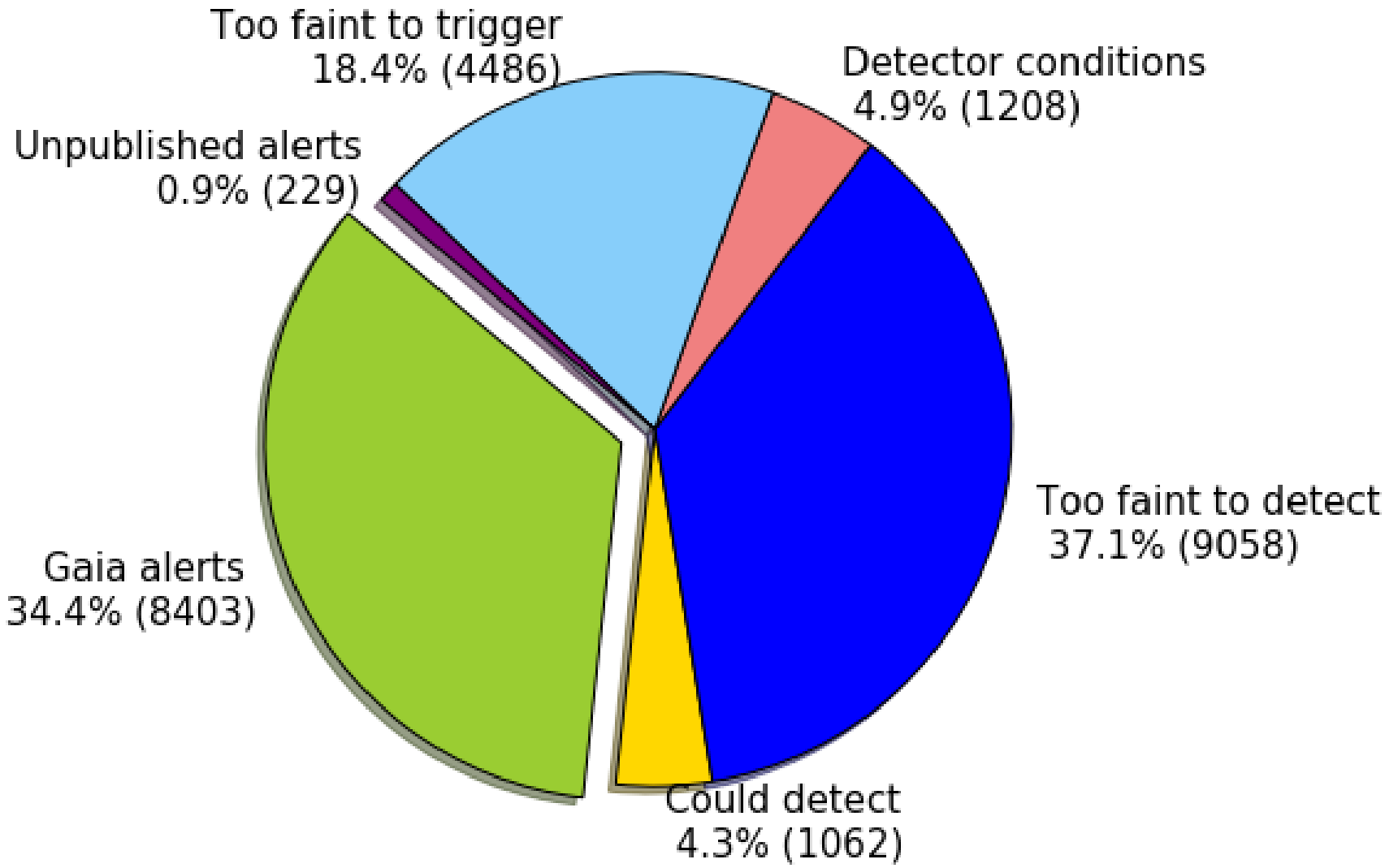
Performance

Method

- Reconstrucion of the AlertPipe
  - New Source Detector
    - 2 or more detections for a source $G \leq 19$
    - Time between detections < 40days
    - ...
  - Old Source Detector
    - 2 or more detections: $\Delta m \geq 1$ and $\sigma \geq 3$ (OldSourceDeltaMag)
    - 2 or more detections: $\Delta m \geq 0.15$ and $\sigma \geq 6$ (OldSourceMeanRms)
    - ...

Performance

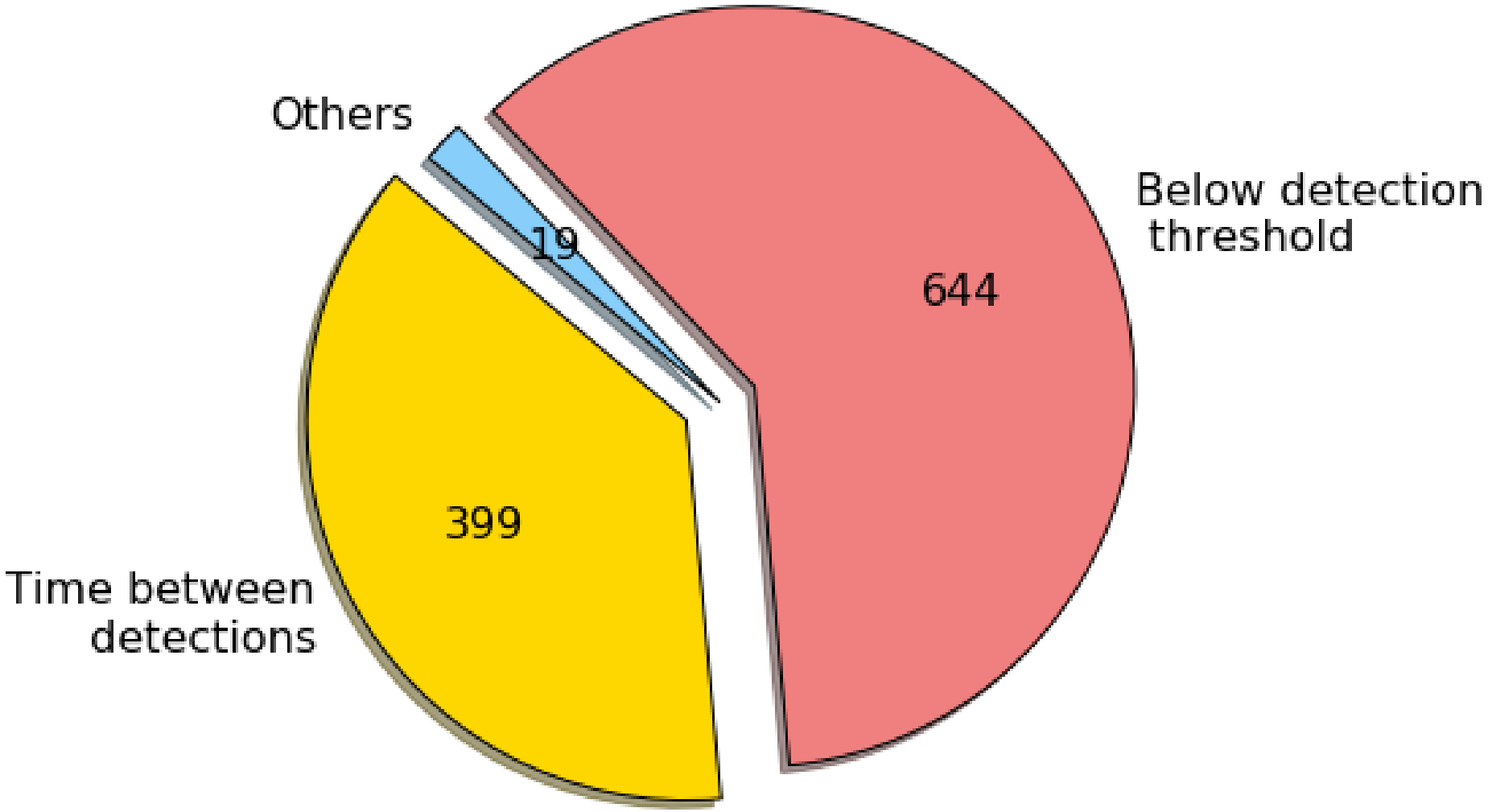
Results



Performance

Results

- Reasons for rejections



Performance

Parameter optimization

- Recommended changes

parameter	current	recommended
magnitude limit	19	19
time window	40	60
good CCD fluxes	8	7
historic detections	10	8
Δm (DeltaMag)	1	1
Δm (MeanRms)	0.15	0.15
σ (DeltaMag)	3	3
σ (MeanRms)	6	6

Likelihood Detector

- Statistical method, described in *G. Bélanger, 2013*

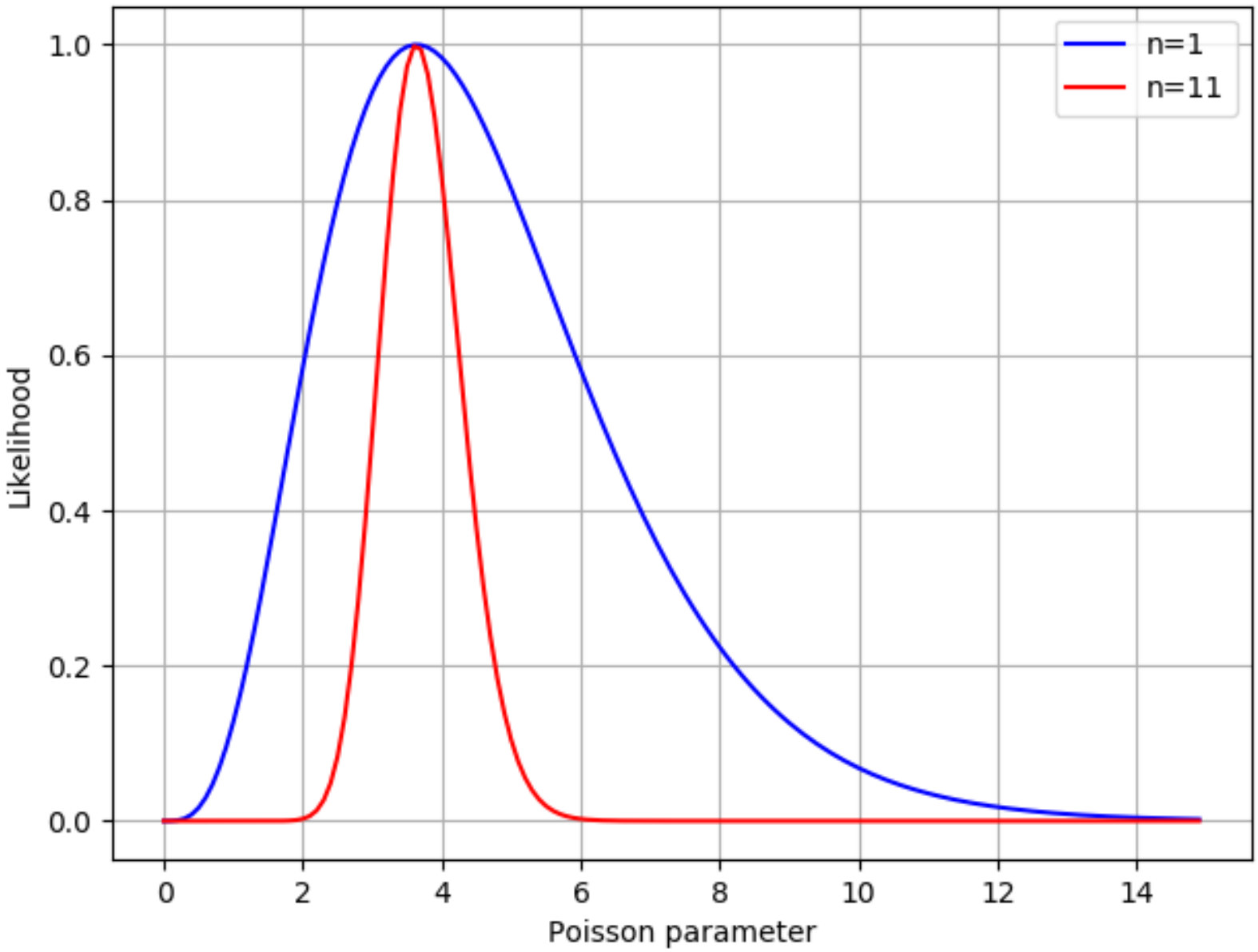
- Likelihood function

$$L(\mu, \sigma|\mathbf{x}) = \prod_i \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x_i-\mu)^2}{2\sigma^2}}$$

  - ratio r between current likelihood and joint likelihood

  - if ratio smaller than threshold value, we have an anomaly

Likelihood Detector

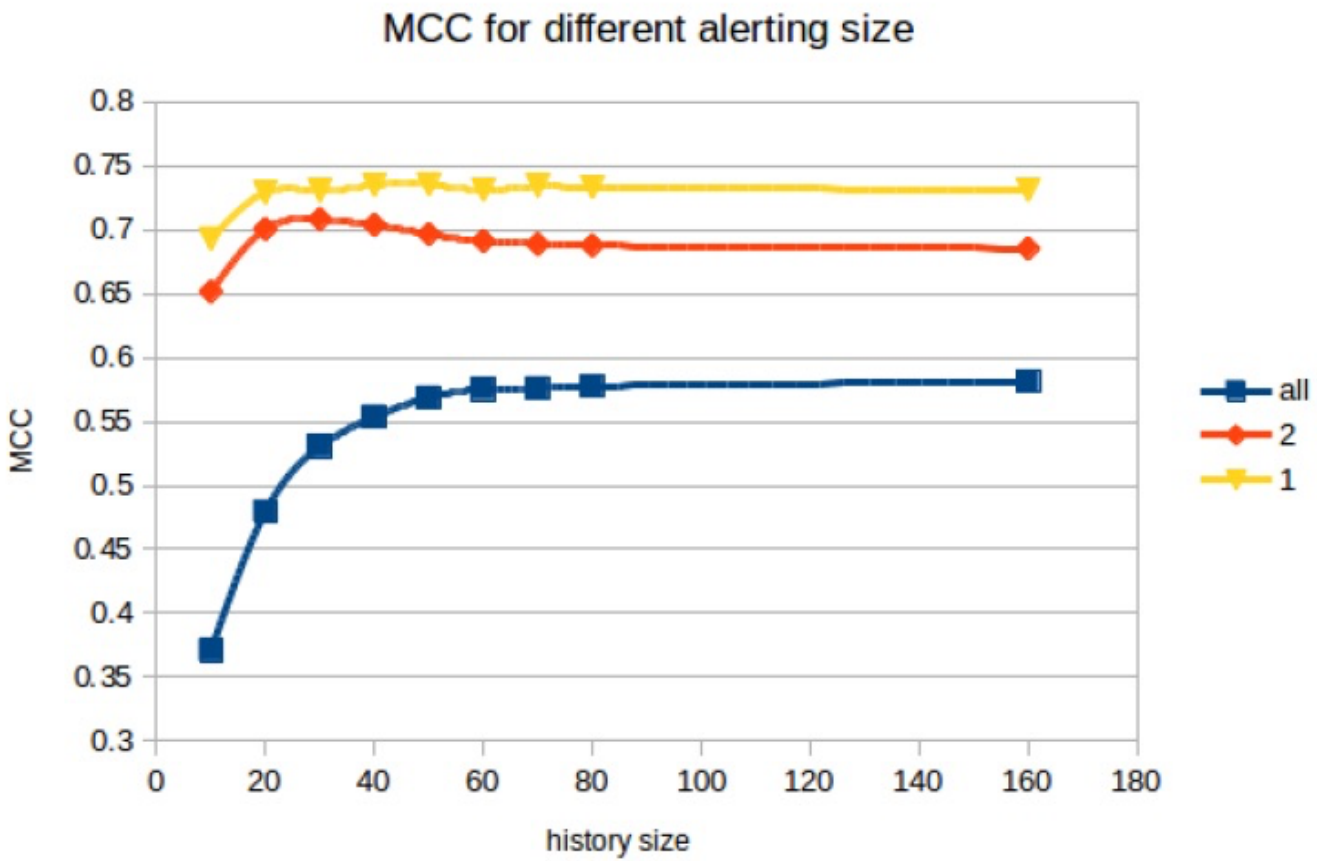


Likelihood Detector

Calibration

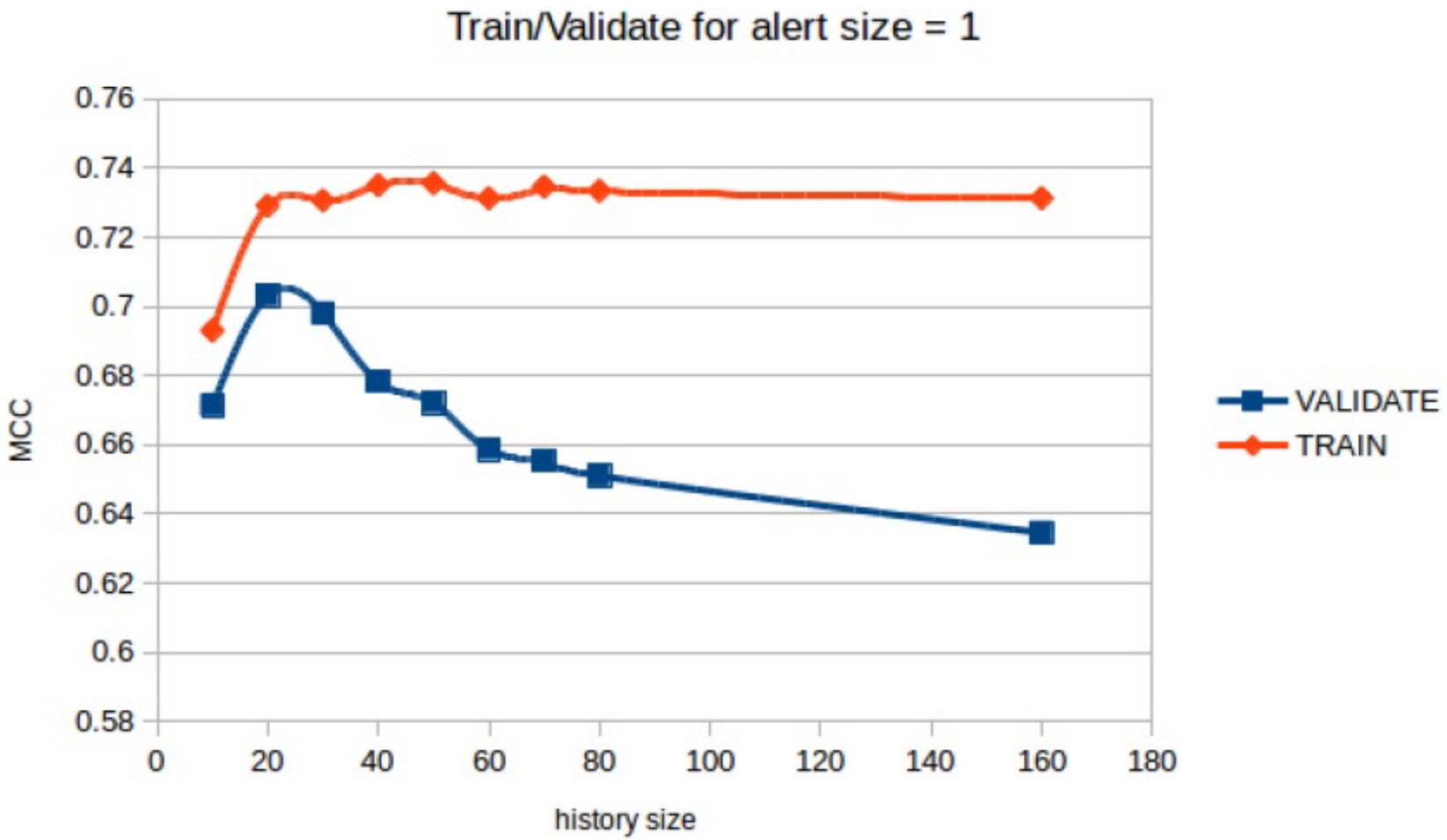
- Matthews correlation coefficient

$$MCC = \frac{TP \times TN - FP \times FN}{\sqrt{(TP + FP)(TP + FN)(TN + FP)(TN + FN)}}$$



Likelihood Detector

Calibration



Likelihood Detector

Calibration

- An optimization method was used to find the optimal likelihood ratio r during the training phase

alert size history size	1 30					
	all	TP	FN	TN	FP	MCC
TRAINING SET	10093	228	70	9704	91	0.73
VALIDATION SET	7016	152	48	6734	82	0.69

Takeaway message

- AlertPipe performance

- The Likelihood Detector