Thank you for inviting me to share my thoughts on this publication.

I will attempt to talk through the paper and identify the key points, making use of the figures to illustrate these as much as possible but if you have specific questions please feel free to chime in at any point.

Ok so lets begin. This article is all about studying efficient and robust methods for outlier detection (or anomaly detection) in time series data

**Section 2 (Background)**

**2.1 Nomenclature and types of time series anomalies**

**Time series data -** anything where a quantity is measured repeatedly at a series of different times. A collection of such data is known as a time-series.

These are very useful for and have applications in a huge range of fields, weather forecasting, software development

In astrophysics these known as light curves and I use them to measure the masses of black holes in distant galaxies. Also can be used to hunt for planets around other stars and look for signs of extra-terrestrial life. More terrestrial applications include hospital patients, jet engines, manufacturing processes

**Anomaly -** anything that doesn’t fit with the rest of the time series. If you want a more mathematical answer, its any point in the time-series that is very unlikely assuming some background distribution (Figure for example...)

This paper consider three types of outliers (Figure 2)

**Contextual Anomalies within a given time-series.** – a few rogue points amongst many examples of ‘ordinary’ behavior

**Anomalous sub-sequences within a given time series –** have a period of anomalous behavior rather than just a few points.

**Anomalous series within a space of collection of series –** Rather than rogue points within a time series, have an entire anomalous time-series relative to normally behaved time-series.

**2.2 Streaming data challenges**

**Batch Processing:** All the time series is available prior to outlier detection.

**Data Streams:** Outlier detection must be done continuously as new time series data comes in. The behavior of the system may change with time (non-stationarity) and the model must evolve its outlier detection to distinguish new ‘typical’ behavior from actual outliers (see my mod-sc code for examples of how to deal with non-stationarity in evolving time series).

**2.3 Extreme Value Theory : Outlier detection algorithm proposed for non-stationary time series data. (Uses Extreme Value Theory)**

**Extreme Value Theory: The statistics of extreme value distributions**

**(Figure 3)**

. I have a Gaussian distribution and I draw 10 values from it.

. I calculate the maximum value in the sample of 10.

. Repeat this and build up a new distribution of the extreme values.

Important therem in Extreme Value Theory is that regardless of the parent distribution, for large sample sizes, the maximum value distributions will always converge to one of 3 distributions Frechet, Weibul or Gumbell distribution.