

Topological Time Series analysis

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Time Series Data

- **Comparing trends over time across different regions/products**
 - Comparing how multiple stock- markets perform across similar time periods
 - Comparing product sentiment over time across different types of bread
- **Forecasting future sales or population**
 - Forecasting population growth
 - Forecasting how much impact an epidemic might have in region
- **Detecting future changes in system behavior**
 - Price spikes in grain
 - Stock market crashes
 - Public health crisis leveling out

Comparing Time Series

- Stationary assumption
- Measurement at same time points
- Autocorrelation assumptions
- No outliers
- Fréchet distance

Fréchet distance



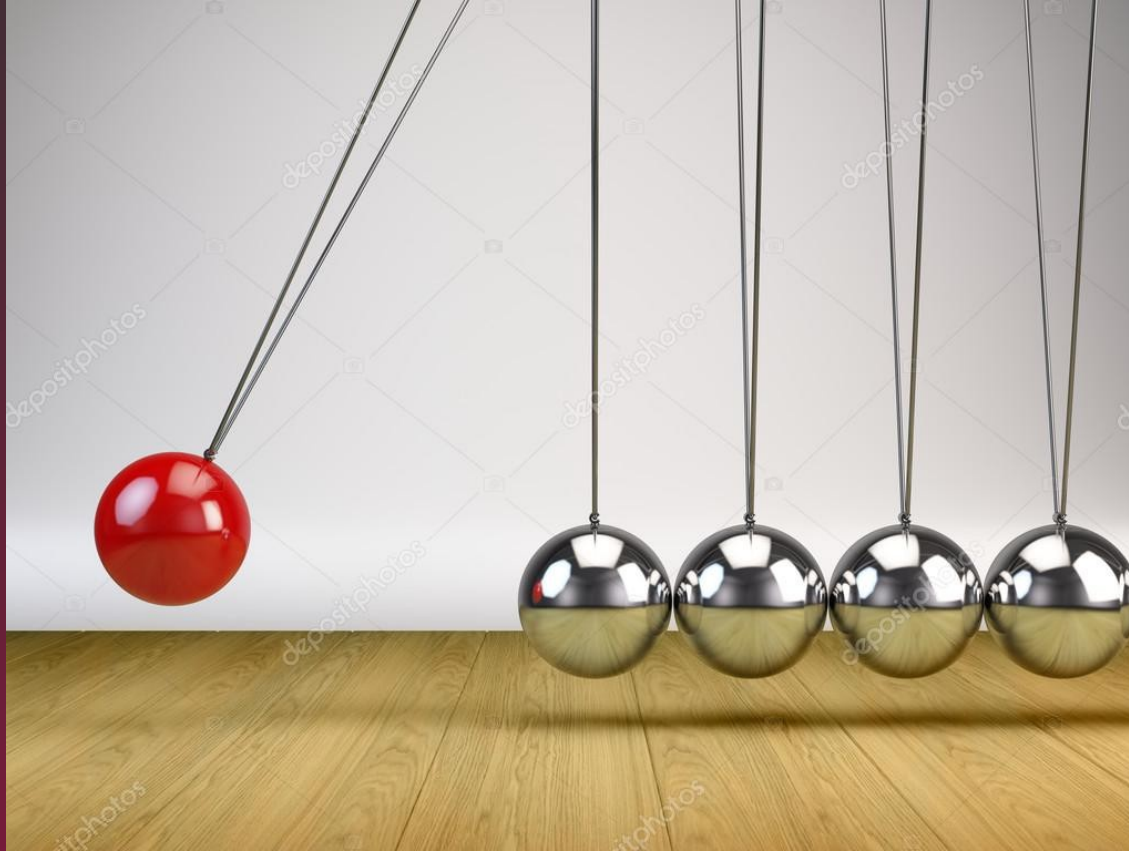
In mathematics, the Fréchet distance is a measure of similarity between curves that takes into account the location and ordering of the points along the curves. It is named after Maurice Fréchet. [Wikipedia](#)

Comparison of Share Prices with Stock Market Chart

This graph/chart is linked to excel, and changes automatically based on data. Just left click on it and select "Edit Data".



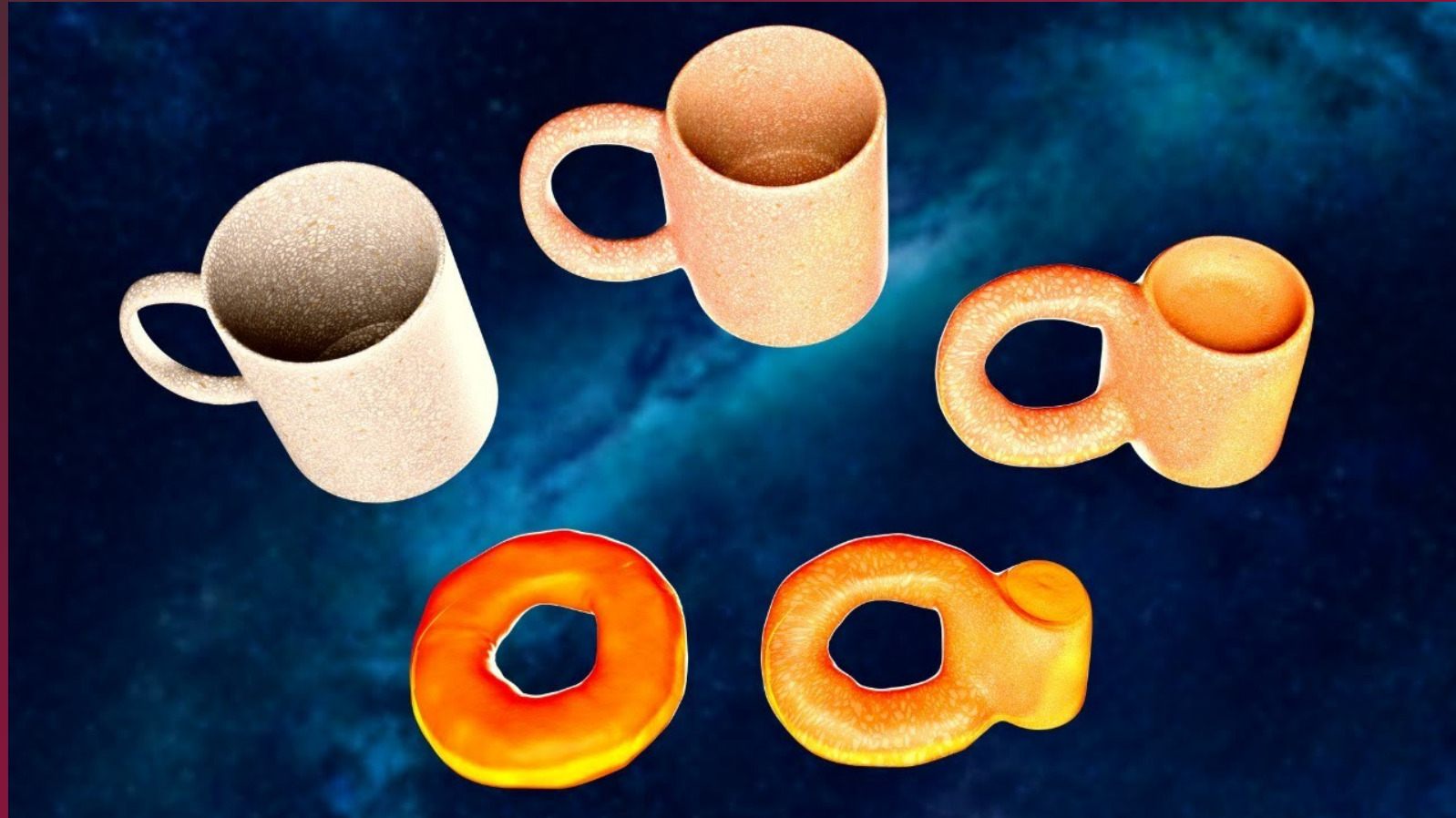
Time Series as Dynamic System

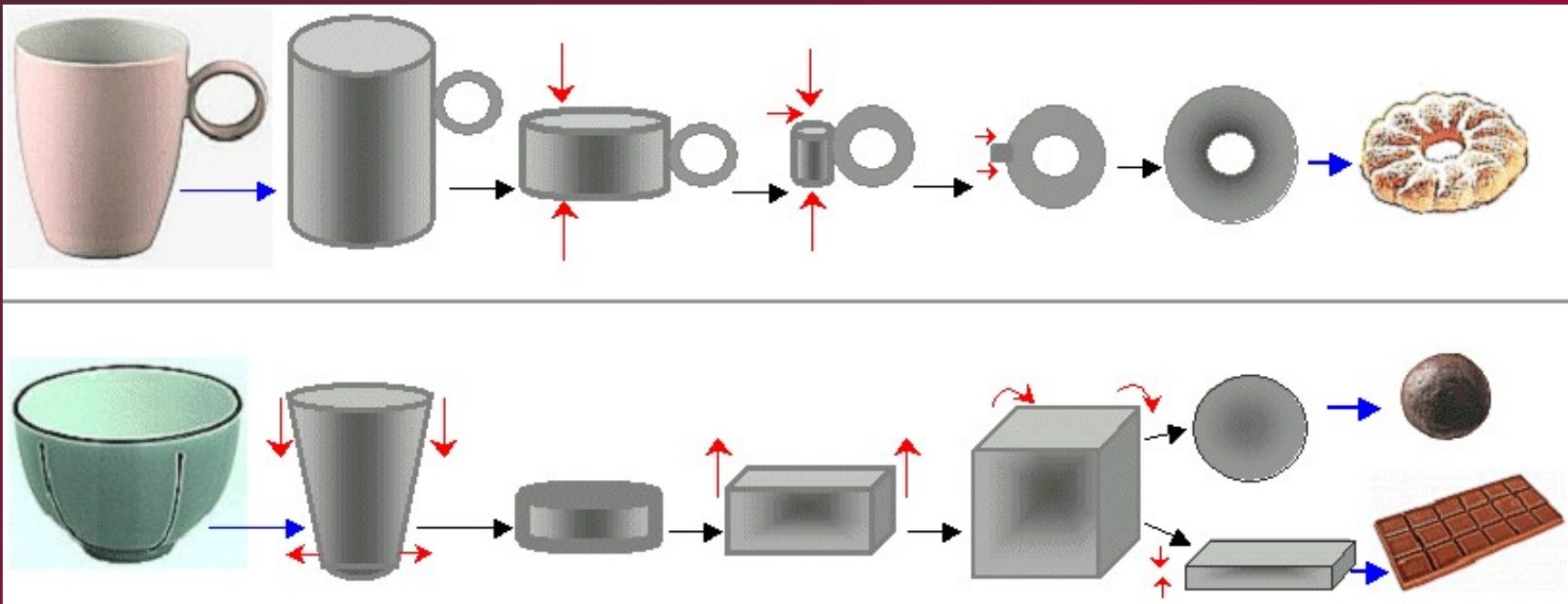
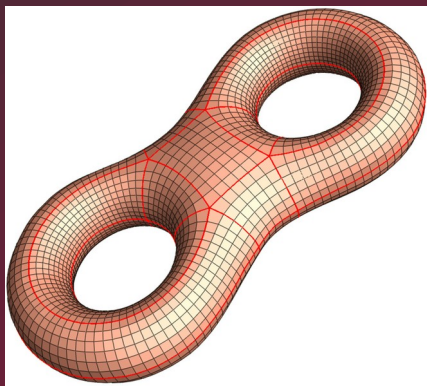
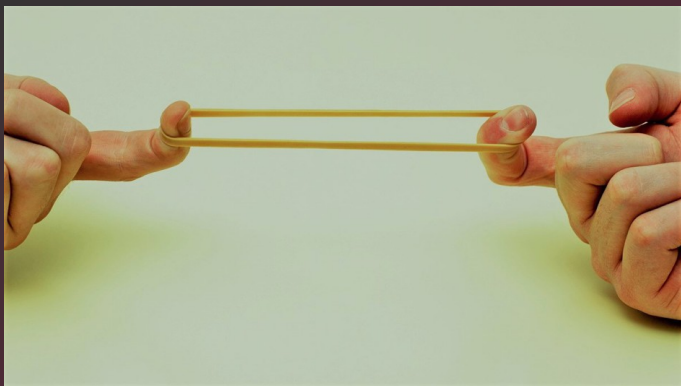


- Sampling of dynamic system at different or similar intervals of time
- Comparison of the systems themselves useful in comparison tasks
- Allows for the use of a field called topology to model the components of the system underlying the time series data

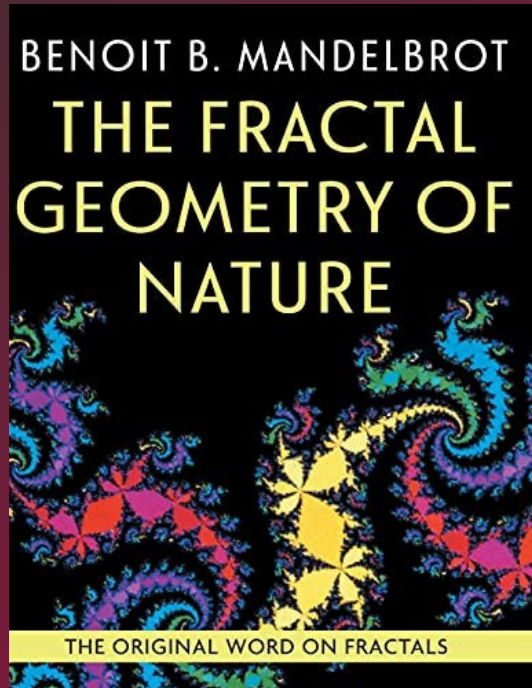
Topology.....?

- Global properties of a space
 - *Many invariants (hole-counting)*
 - *Not concerned with distances or curvature*
- Donuts and coffee mug example
 - *Solid ring with a hole in the middle*

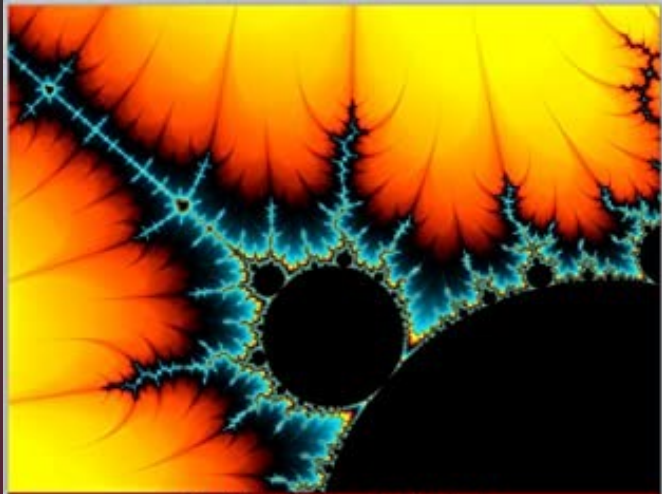




Topology, as a geometry, is extended to the definition of fractal structures by characterising equivalences in different levels of detail. A group of distinct topological fractals are defined by taking the equipotence and multiplicity properties of sets.







IZI K. LANN

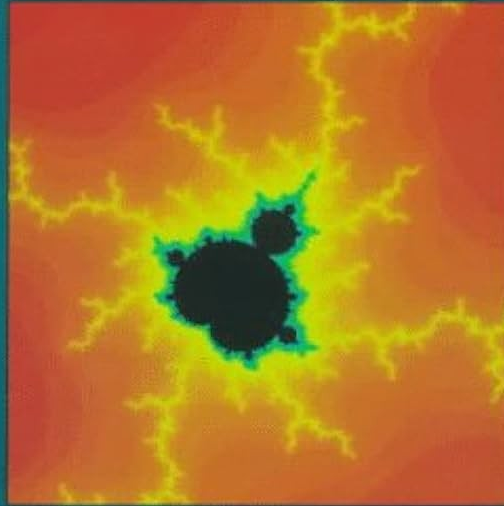
Chaos Theory and Fractals

The Biggest Ideas In Science

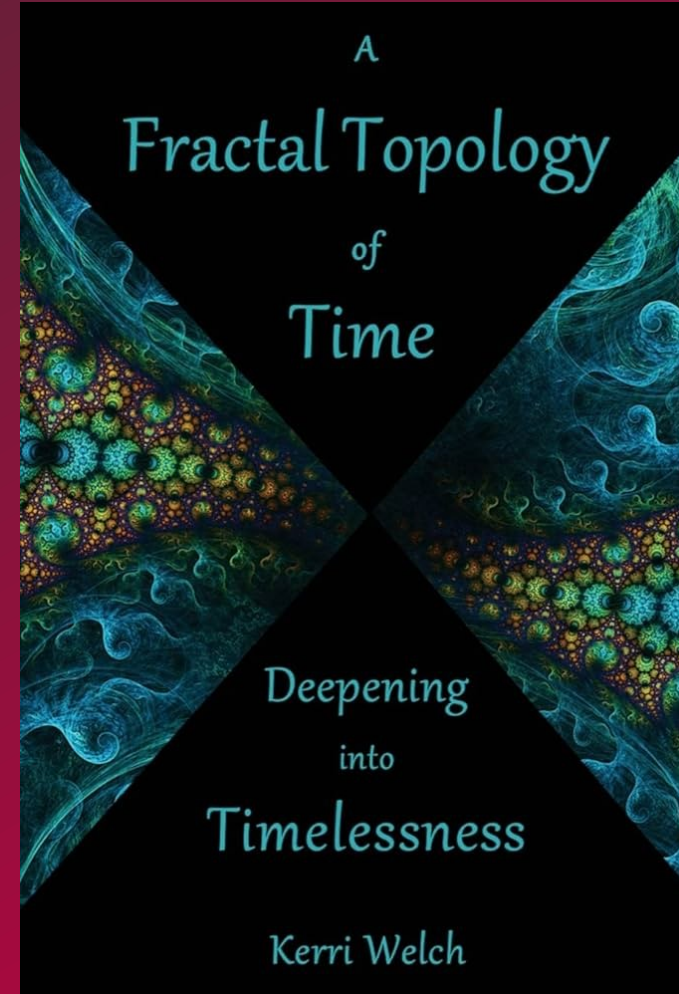
Chaos, Fractals, and Dynamics

COMPUTER EXPERIMENTS
IN MATHEMATICS

Robert L. Devaney



ADDISON-WESLEY



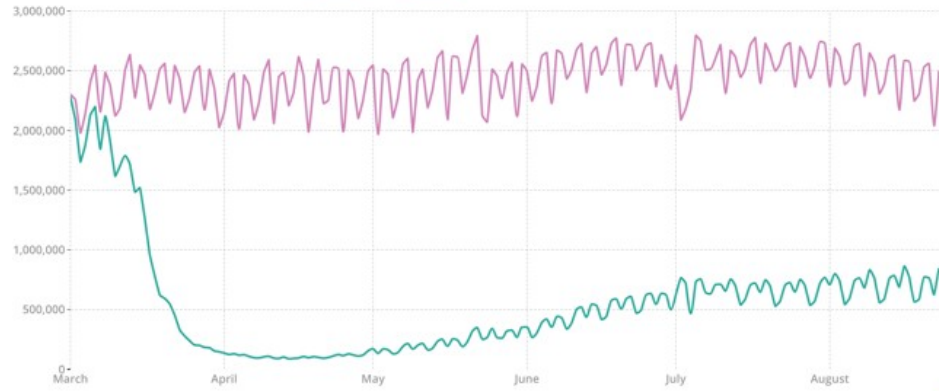
A Fractal Topology of Time

Deepening
into
Timelessness

Kerri Welch

U.S. passenger air travel

TSA checkpoint travel numbers for 2019 and 2020 (same weekday)



Source: www.tsa.gov/coronavirus/passenger-throughput



Time Series Analysis & Forecasting - Airline Traffic (Australia)

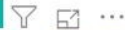
Operator Type

Cargo Only

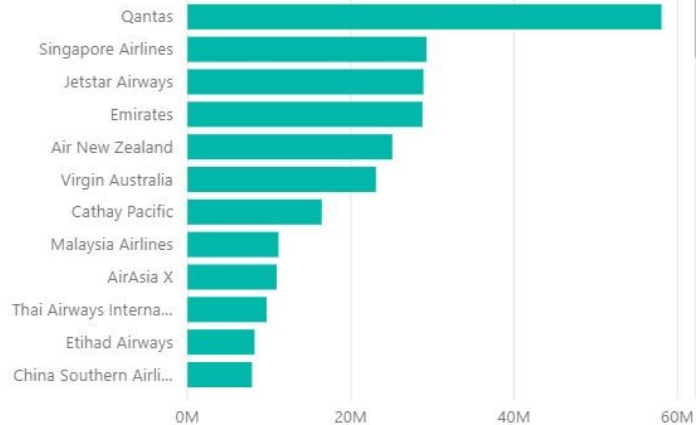
PAX + Cargo

PAX Only

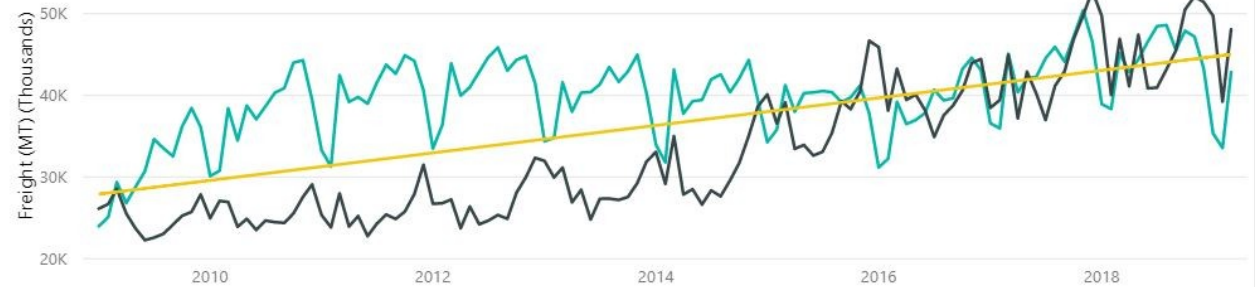
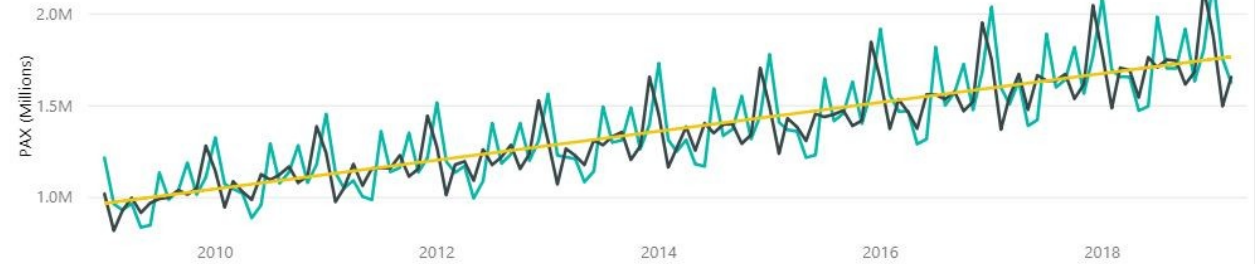
Traffic Locations



Operators (Airline)



Movement Type ● Inbound ● Outbound

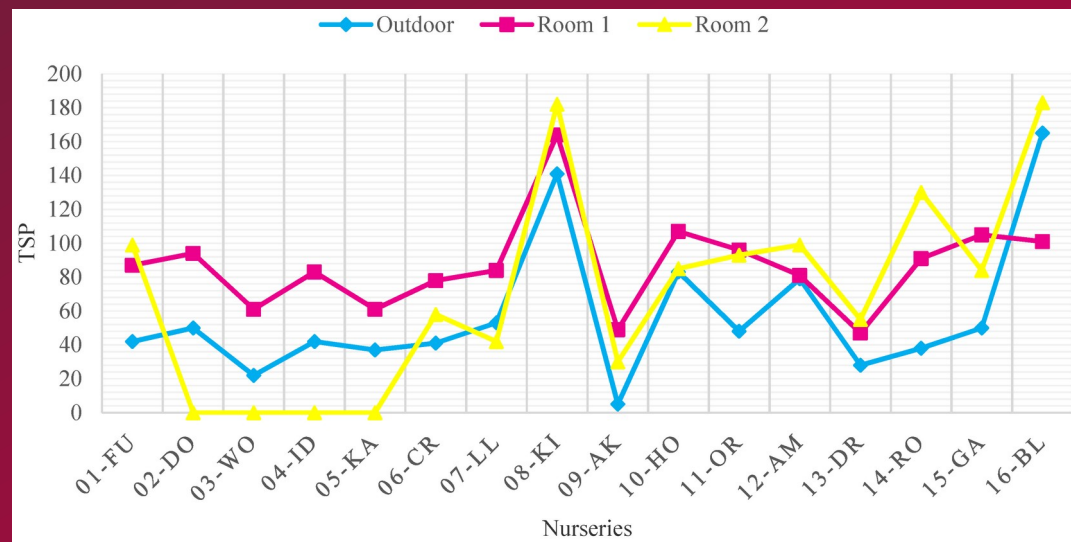
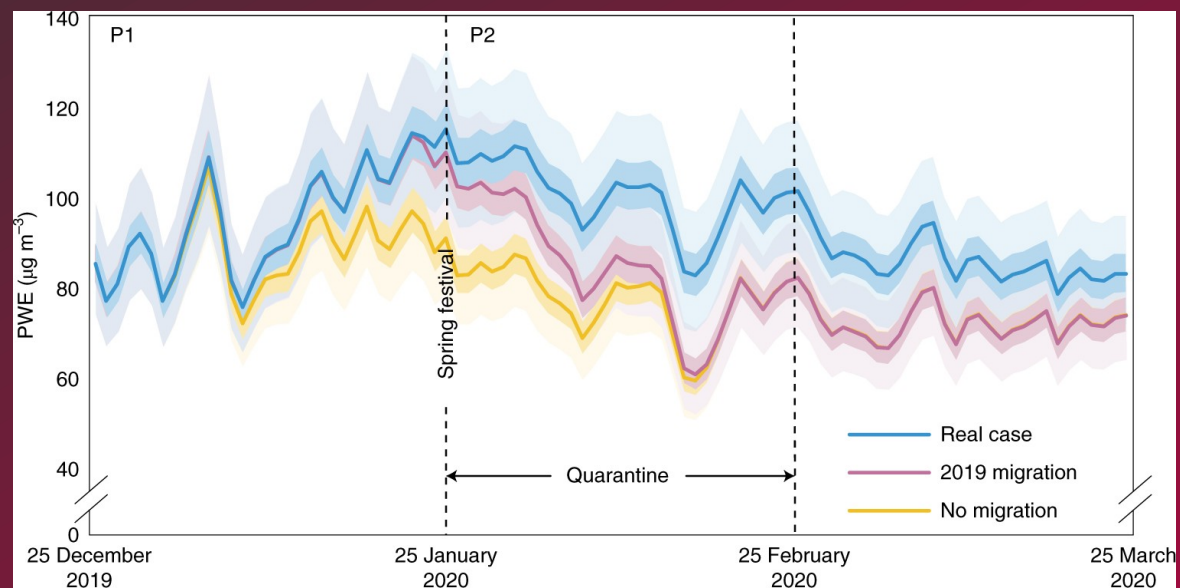
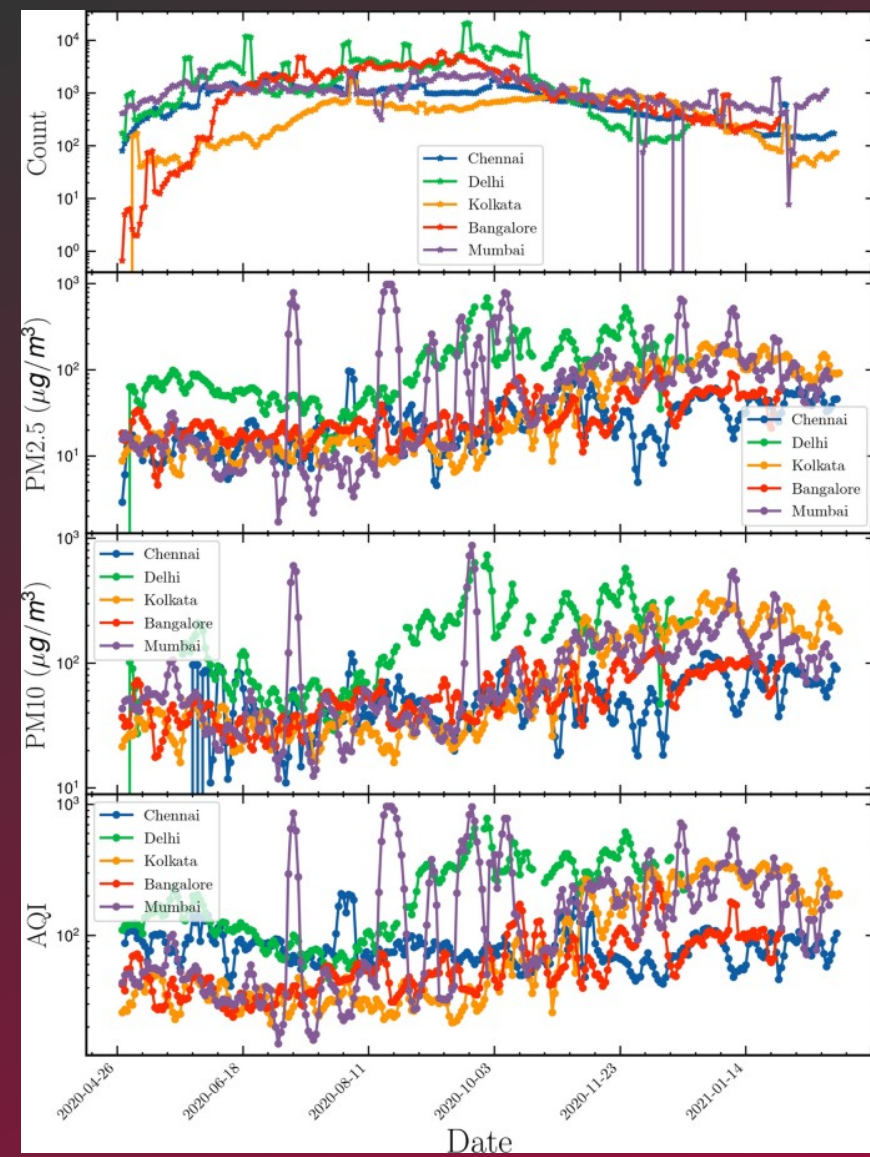


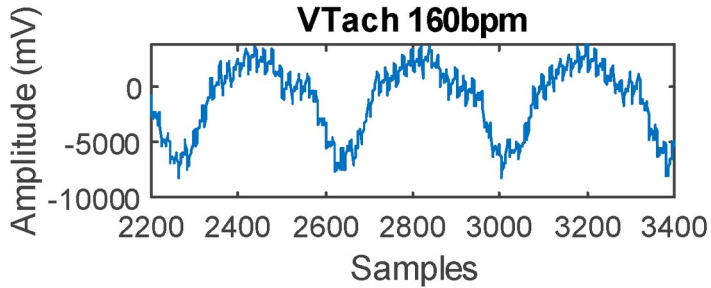
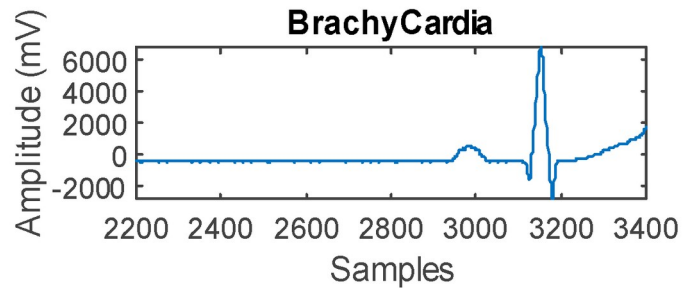
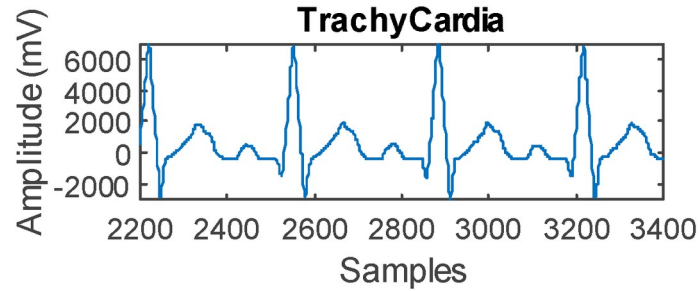
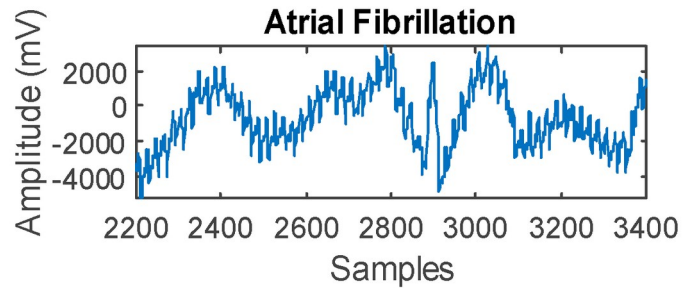
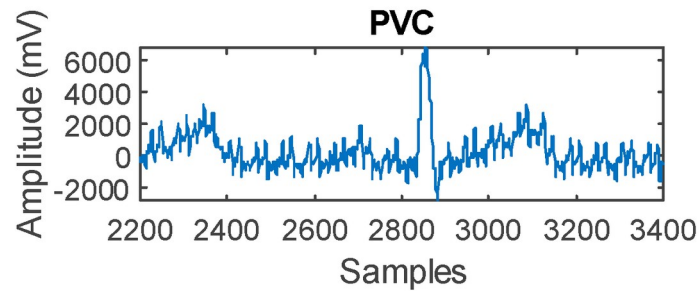
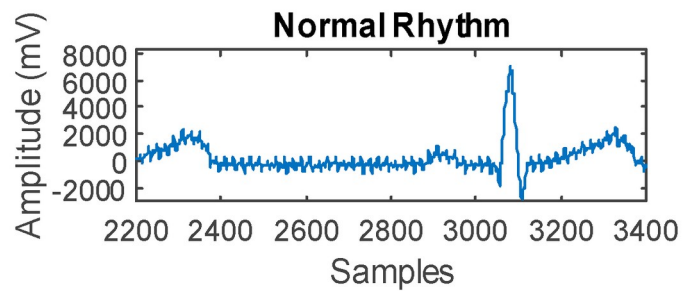


Air Pollution in the World: Real time Air Quality map

Map Satellite







The Use of Time-Frequency Moments as Inputs of LSTM Network for ECG Signal Classification

by Grzegorz Kłosowski ^{1,*} , Tomasz Rymarczyk ^{2,3} , Dariusz Wójcik ³ ,
 Stanisław Skowron ¹ , Tomasz Cieplak ¹ and Przemysław Adamkiewicz ^{2,3}

What we can use....?