Steps Towards Continual Learning in Multivariate Time-Series Anomaly Detection using Variational Autoencoders

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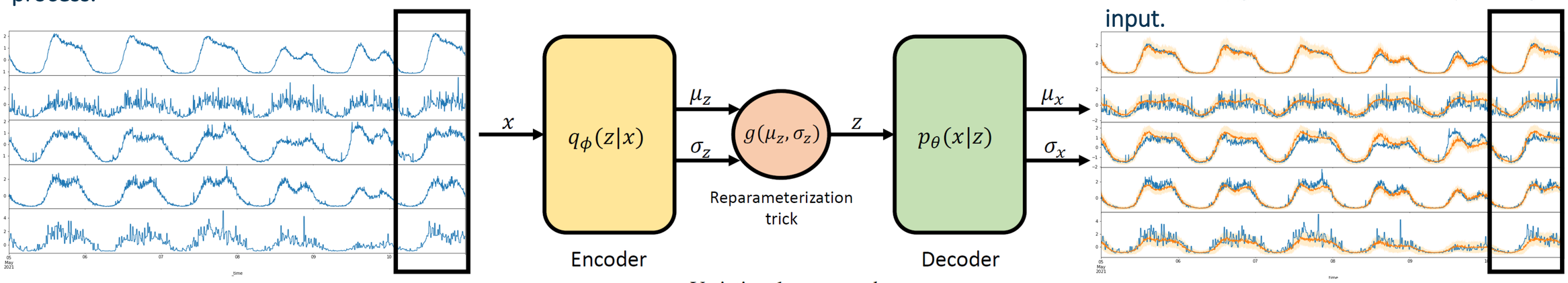
Network monitoring data often consists of hundreds, or thousands of variables periodically measured and analyzed in the form of time-series, resulting in a complex-to-analyze multivariate time-series (MTS) process.

Dilated Convolutional – Variational Auto-Encoders (DC-VAE) an unsupervised and multivariate approach to anomaly detection in time-series, based on popular Variational Auto-Encoders (VAEs)

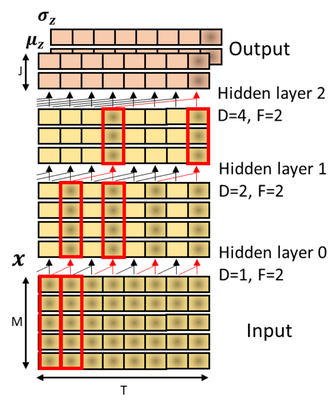
For a given input, DC-VAEs produce as output prediction not only an expected value but also the associated standard deviation, corresponding to the distribution the model understands (i.e., has learned) generated the corresponding input.



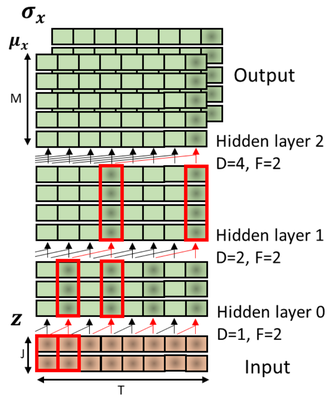
Variational autoencoder

To exploit the temporal dependencies and characteristics of time-series data in a fast and efficient manner, we take a Dilated Convolutional (DC) Neural Network (NN) as the VAE's encoder and decoder architecture

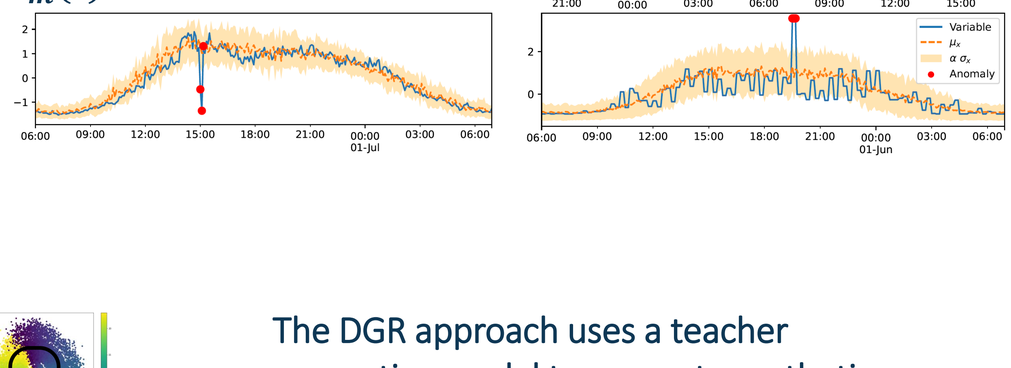
- Encoder network



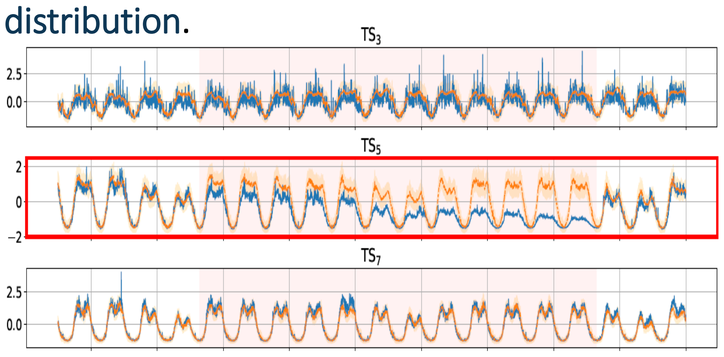
- Decoder network

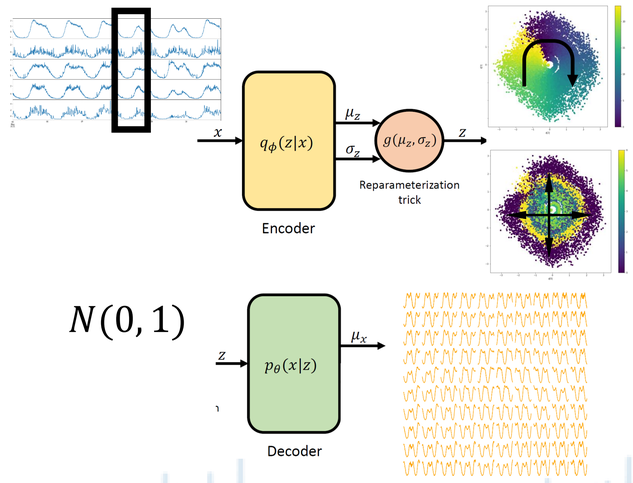


For each of the univariate time-series $\boldsymbol{m}$, an anomaly is detected at time t if its value $\boldsymbol{x_m(t)}$ falls outside the normal-operation region, defined by $\boldsymbol{\mu_m(t)}$ and $\boldsymbol{\sigma_m(t)}$



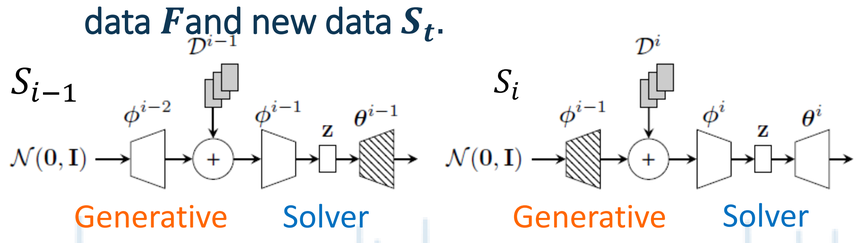
One of the main challenges faced by learning-driven anomaly detection systems is their ability to cope with Concept Drift (CD) in the analyzed data – i.e., modifications of the underlying distribution.





We therefore, explore different approaches to cope with the described CDs, in particular exploiting the generative nature of the DC-VAE model for continual learning.

The DGR approach uses a teacher generative model to generate synthetic data $\boldsymbol{F_{1\to(i-1)}}$ that mimics former training examples in $\boldsymbol{S_1, \cdots S_{i-1}}$. Then, the new student model is trained on joint synthetic data $\boldsymbol{F}$ and new data $\boldsymbol{S_t}$.



Wiewel, Felix, and Bin Yang. "Continual learning for anomaly detection with variational autoencoder." ICASSP 2019-2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). IEEE, 2019.

https://github.com/GastonGarciaGonzalez/DC-VAE

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