Repository URL: https://gitlab.lrz.de/a-wie-anomalie/imapps.git

Applied Machine Learning:

Leak Detection in Water Pipelines

Andrea Maldonado

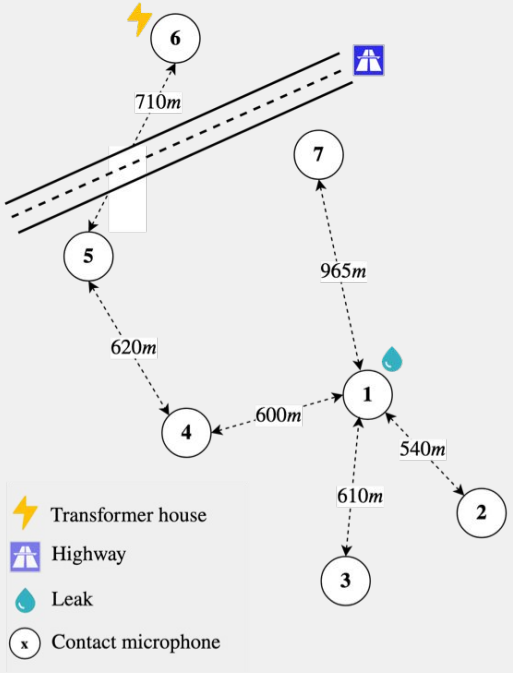
@andreamalhera

Praktikum Innovative Mobile Applications: “Gruppe A wie Anomalie”

Motivation

[1-3] Sources: https://www.wasser-macht-schule.de/trinkwasser...; https://www.br.de/radio/...; https://www.bund-naturschutz.de/alpen/...

Leak Detection in Water Pipelines

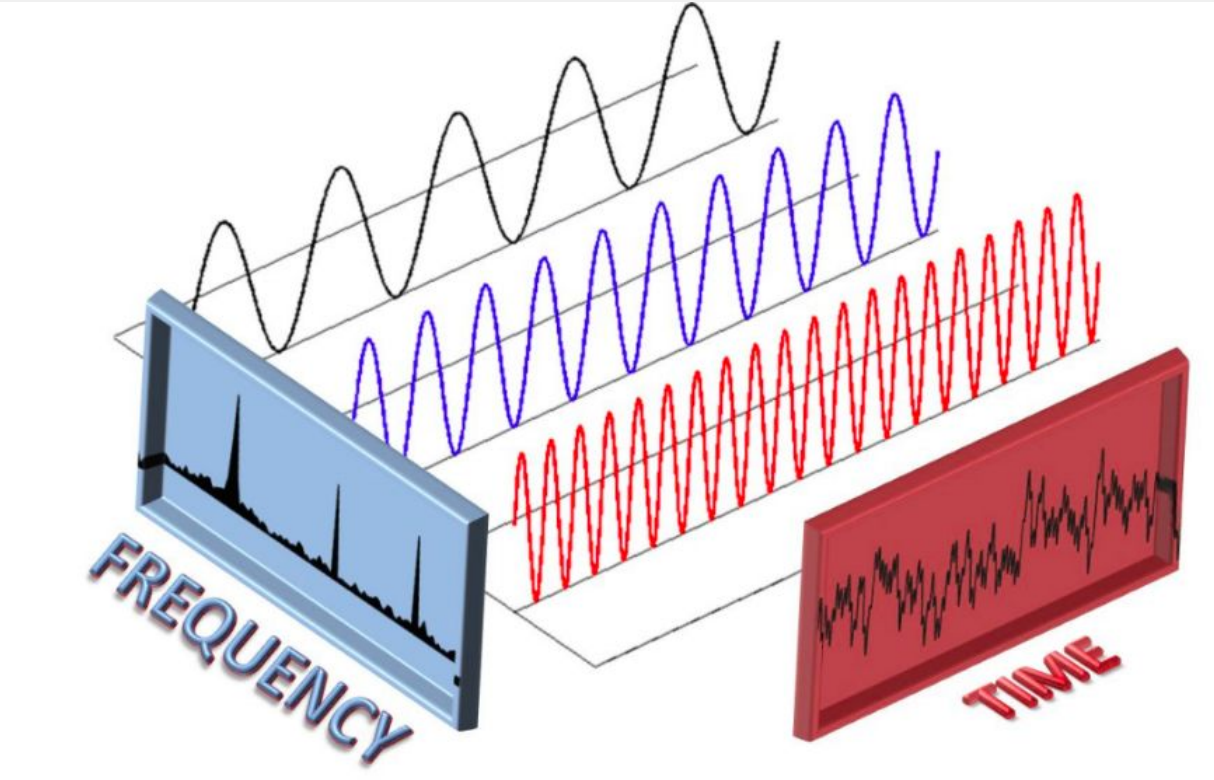


LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

SWM

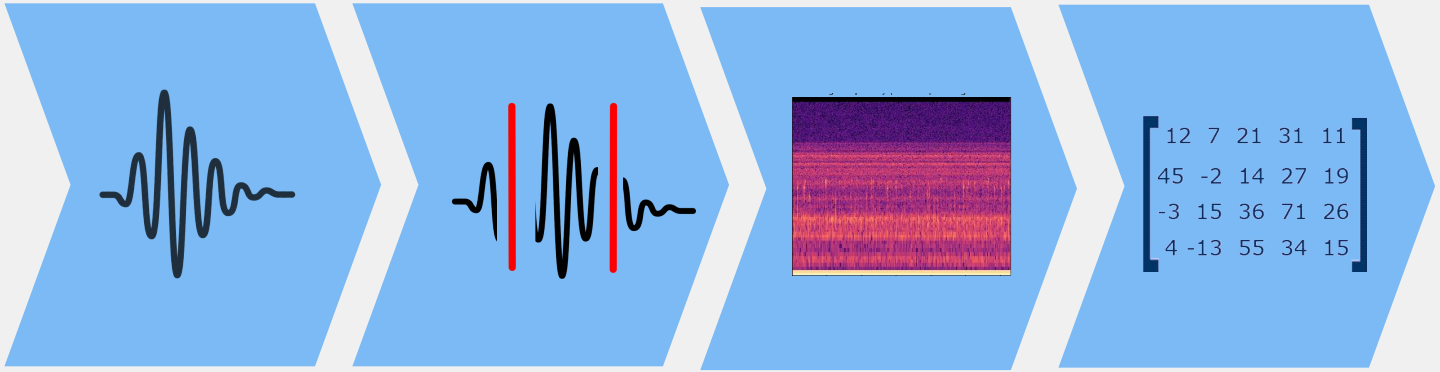
[4]: Source http://www.mobile.ifi.lmu.de/lehrveranstaltungen/praktikum-innovative-mobile-applications-sose19/

What is sound & how did we work with it?



[5] Source: https://steemit.com/steemstem/@wilians/fourier-series-and-transforms-applications-part-2

Preprocessing Pipeline



How does Anomaly Detection work in Machine Learning?

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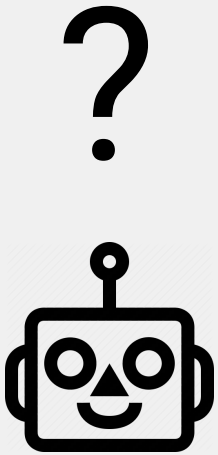

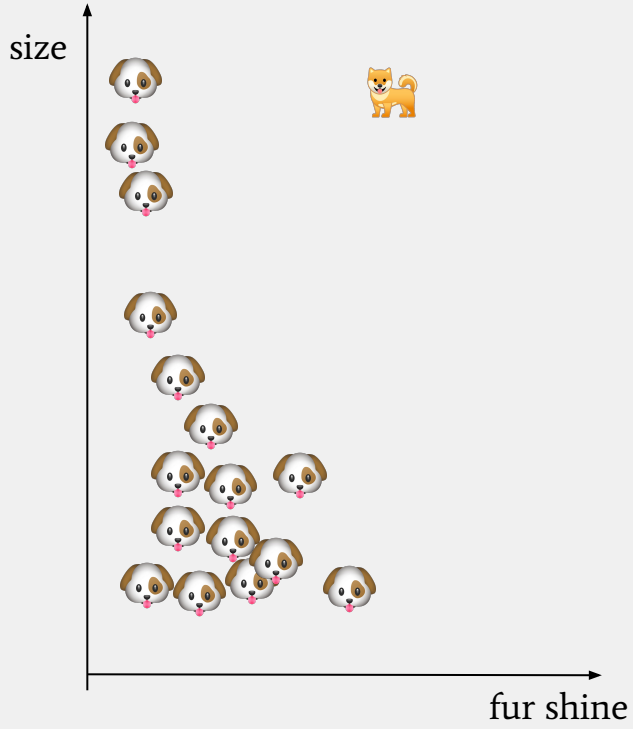

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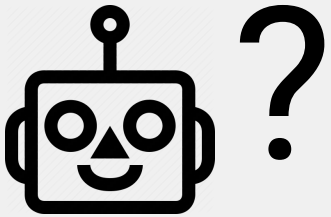

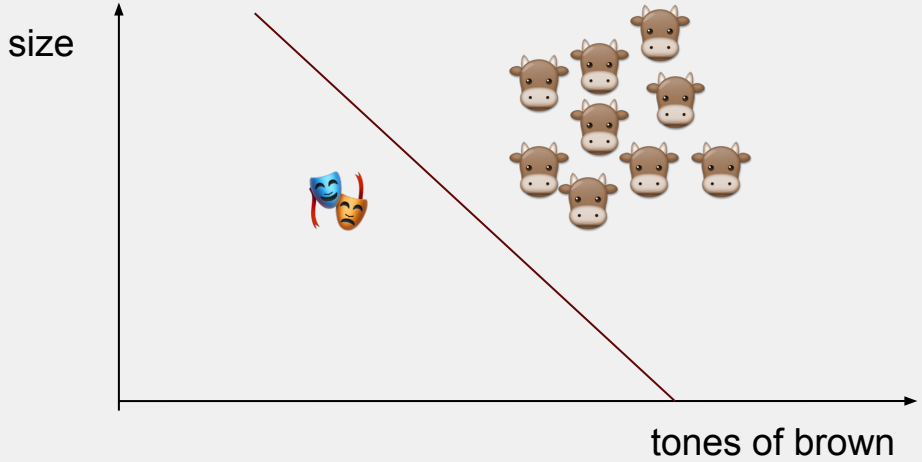

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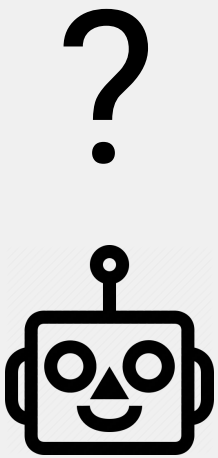
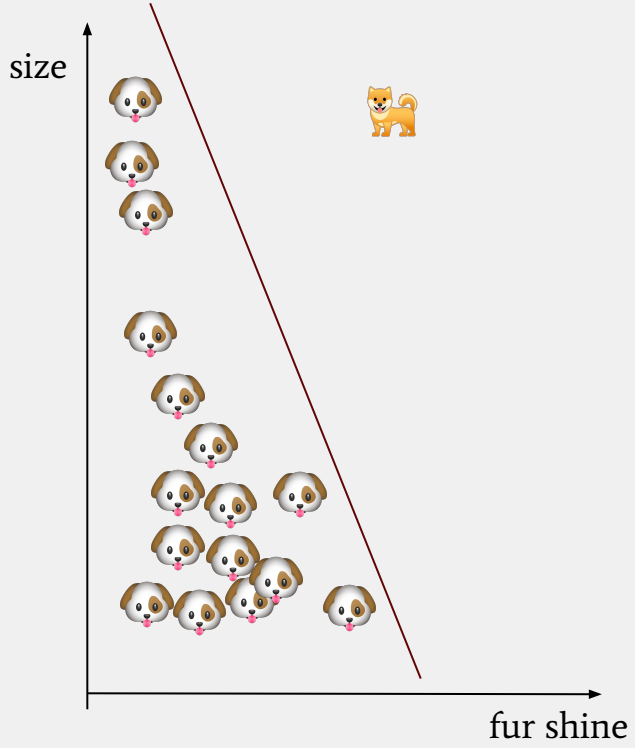




Autoencoder Principle

input

compress

$\rightarrow$

$$\begin{bmatrix} 0 \\ 2 \\ 1 \\ 0 \\ 3 \end{bmatrix}$$

decompress

$\rightarrow$

output

Autoencoder Principle

input

compress

$\rightarrow$

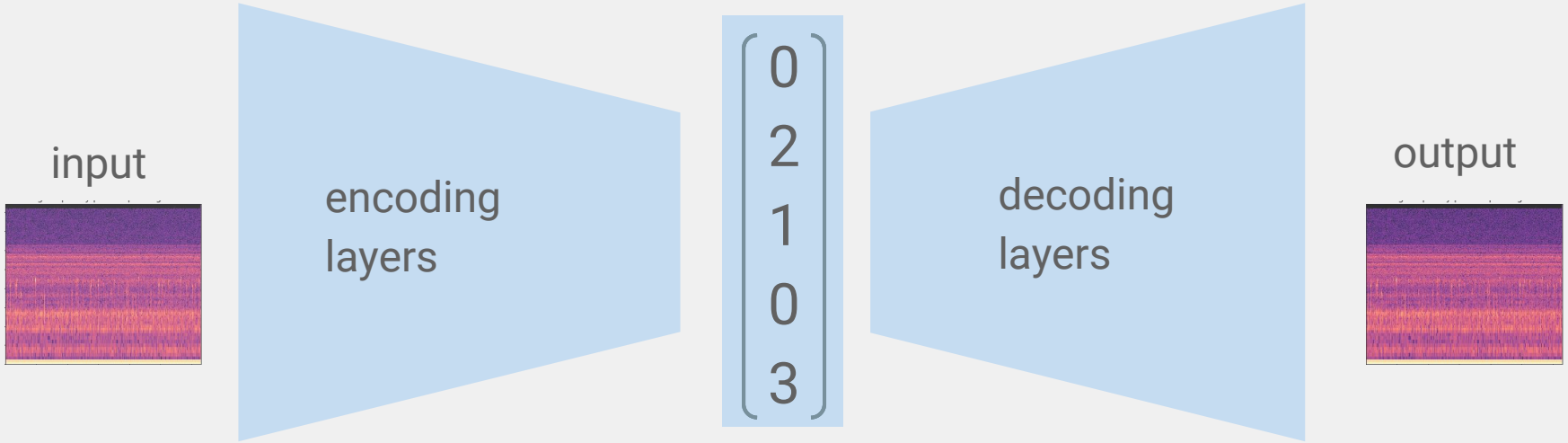
$$\begin{bmatrix} 0 \\ 2 \\ 1 \\ 0 \\ 3 \end{bmatrix}$$

decompress

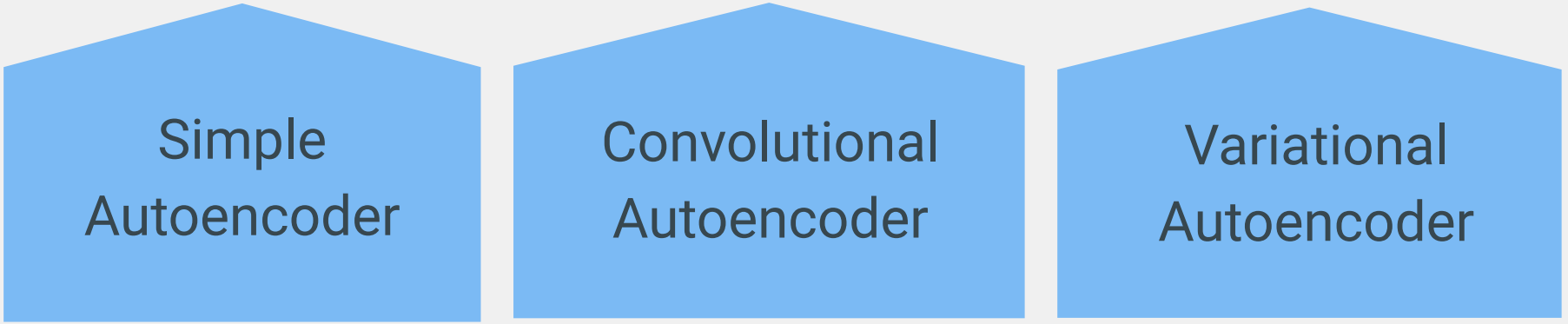
$\rightarrow$

output

Autoencoder Architectures



Autoencoder Architectures

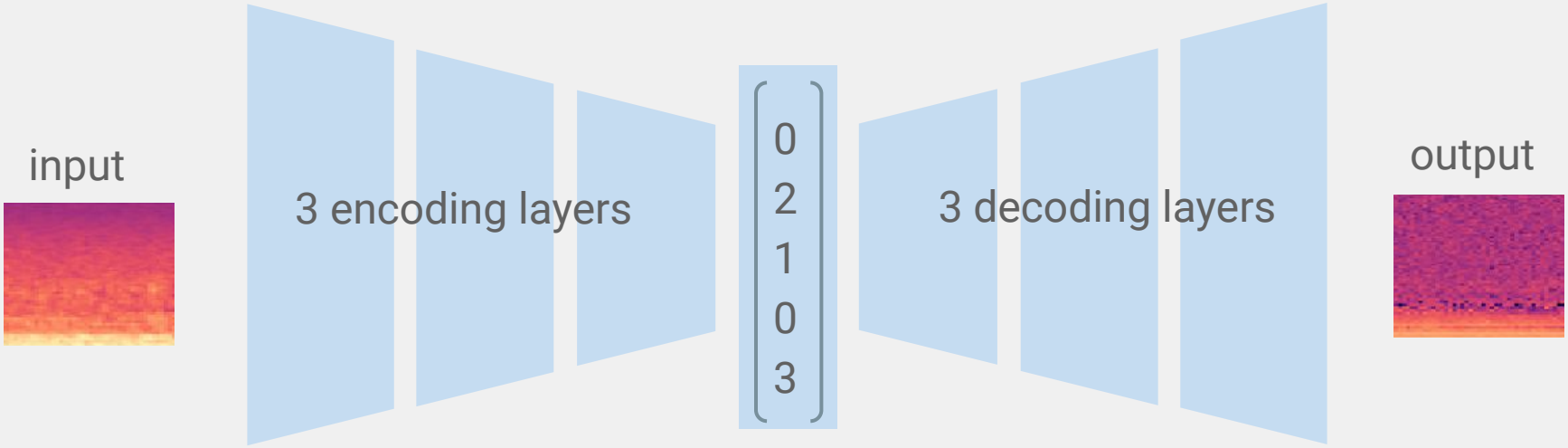


simple dense-layers

convolutions, max pooling, dense layers

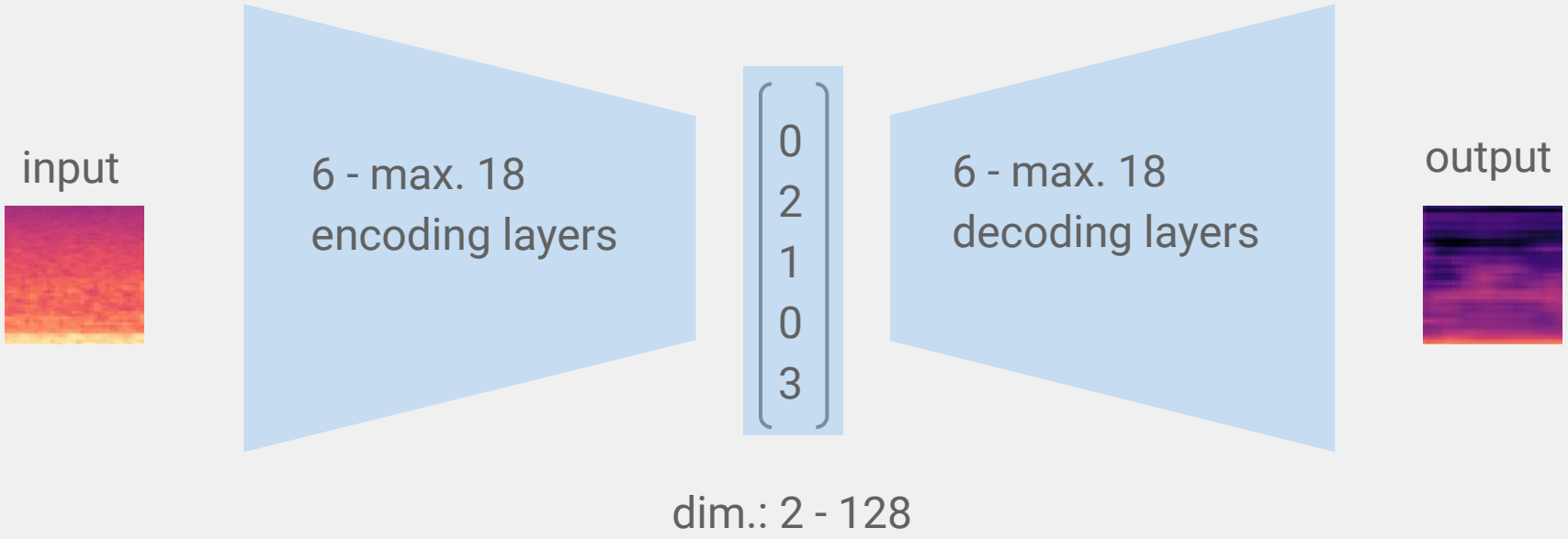
learns about data distribution

Autoencoder Architectures: Simple Autoencoder

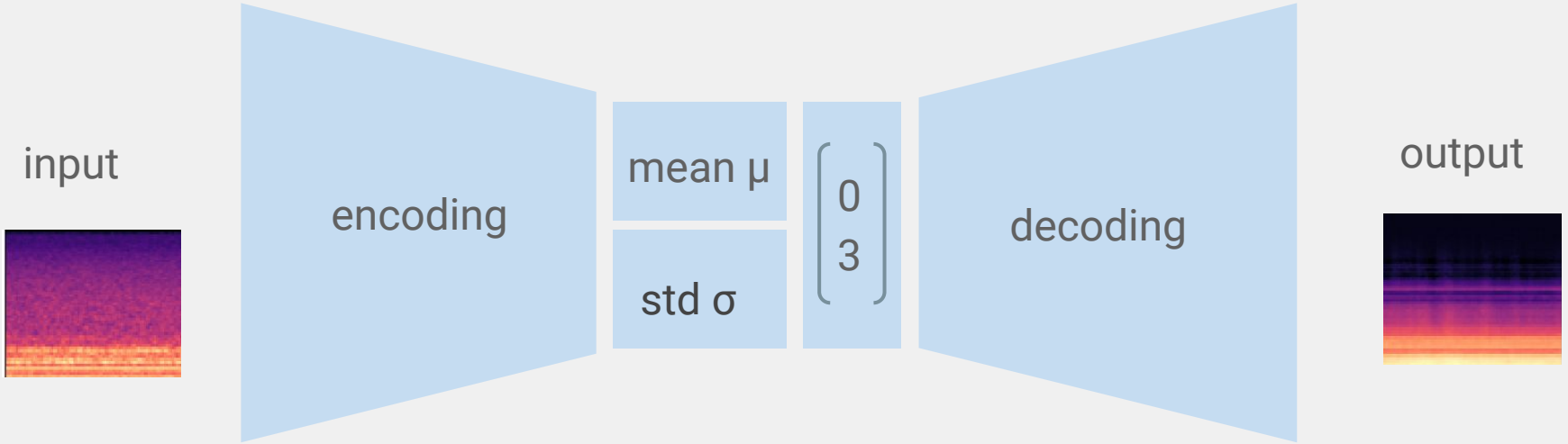


dense layers only

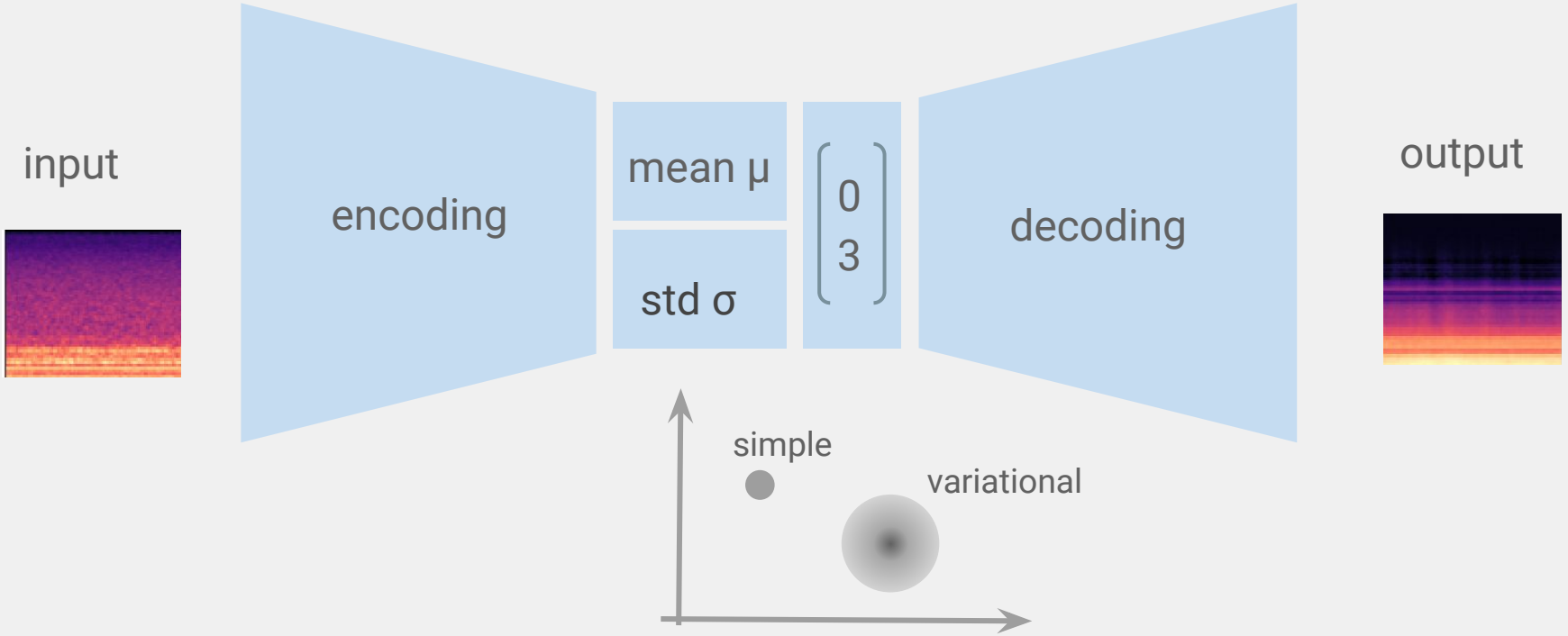
Autoencoder Architectures: Convolutional Autoencoder (CNN)



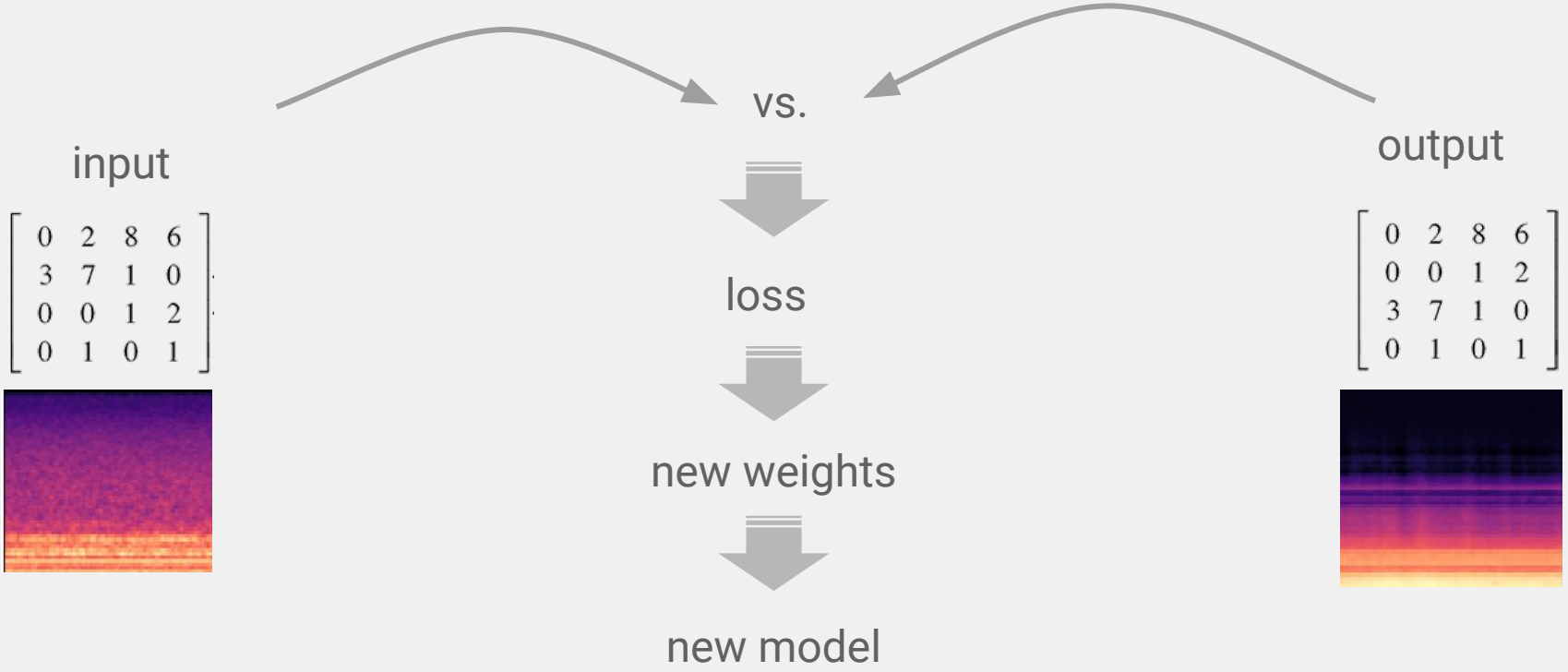
Autoencoder Architectures: Variational Autoencoder



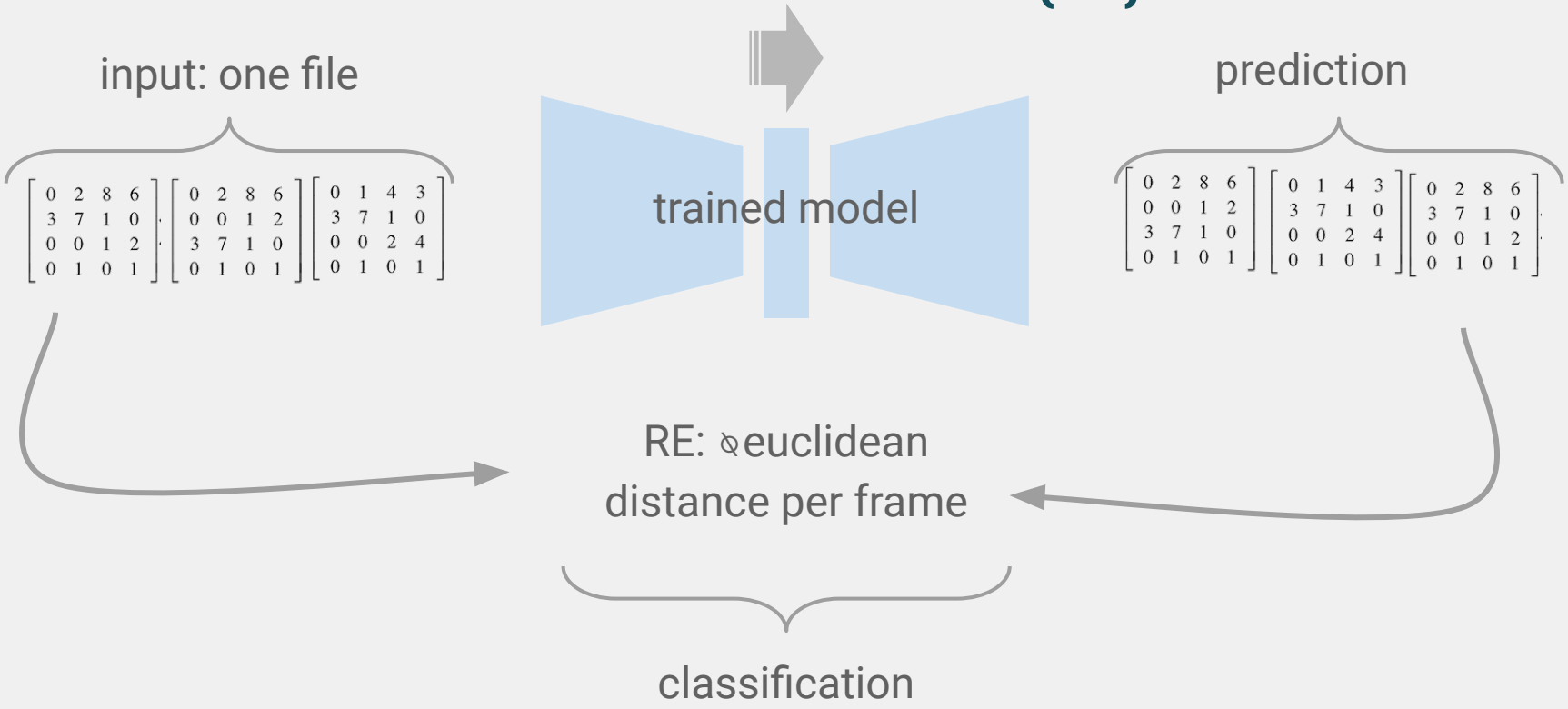
Autoencoder Architectures: Variational Autoencoder



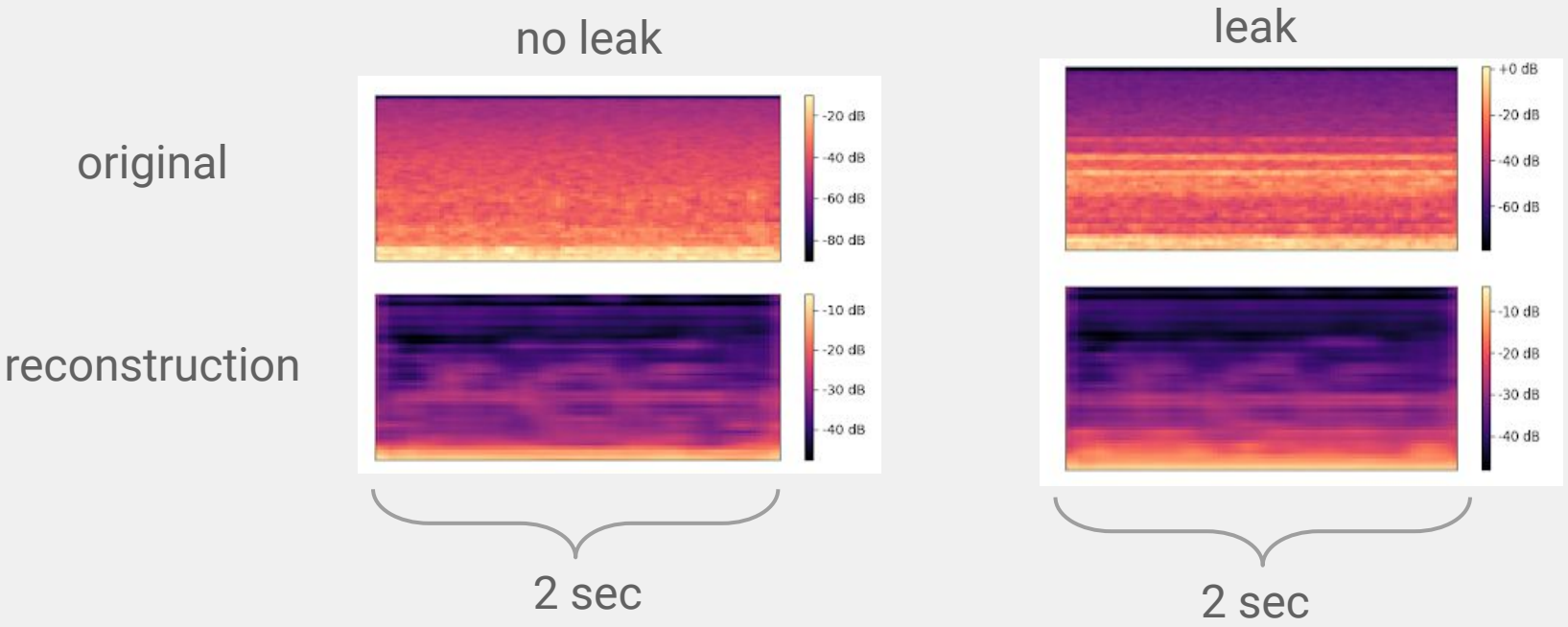
Autoencoder Architectures: Training



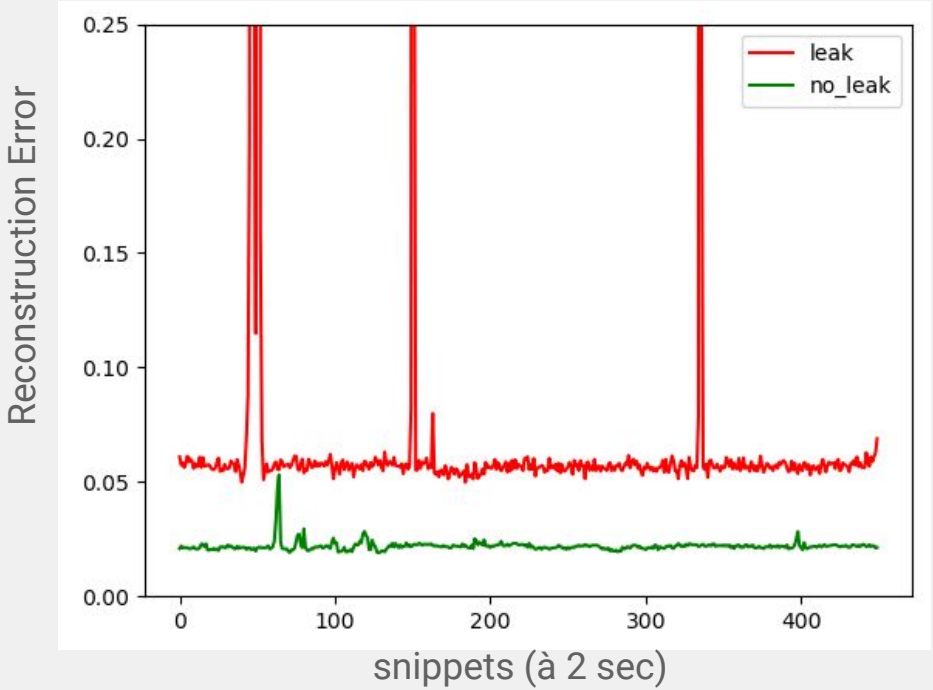
Data Classification: Reconstruction Error (RE)



Data Classification: E.g. CNN AE



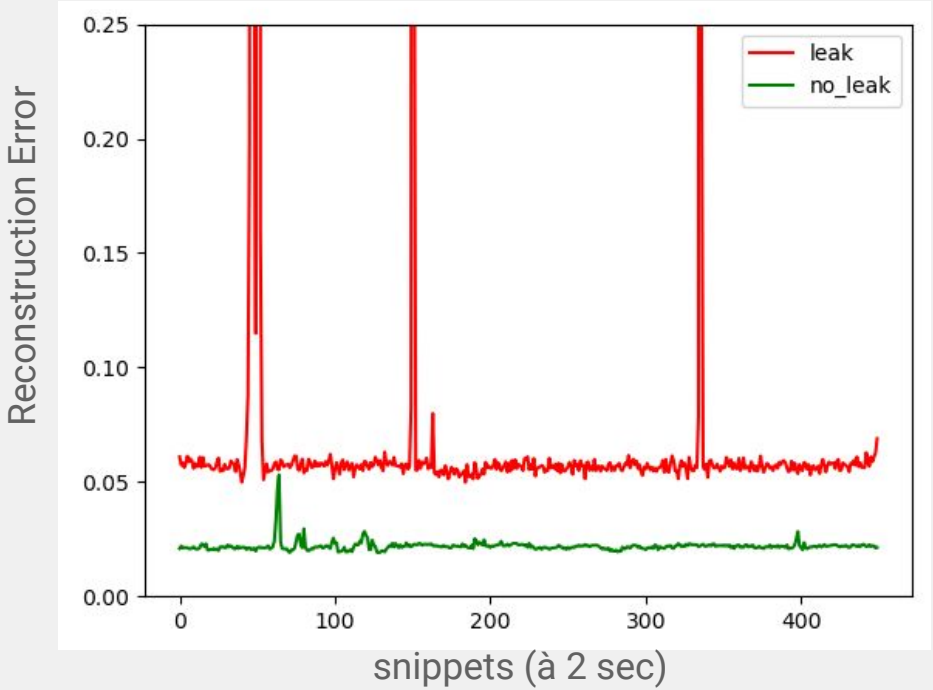
Data Classification: Reconstruction Error of Two Files



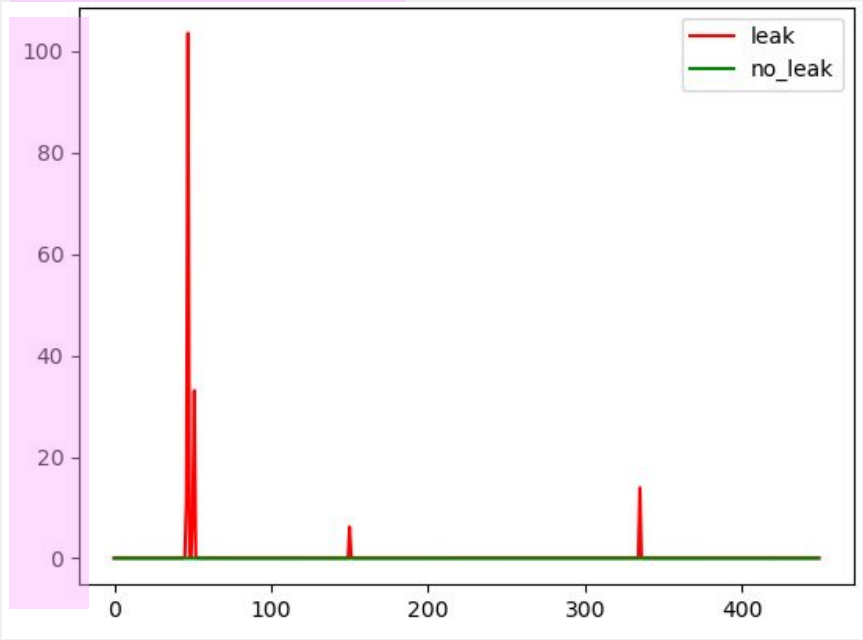
6 layers CNN-autoencoder,
encoding-dim. 2,
30 epoch training

E.g. for files with leak (red) vs. without leak (green)

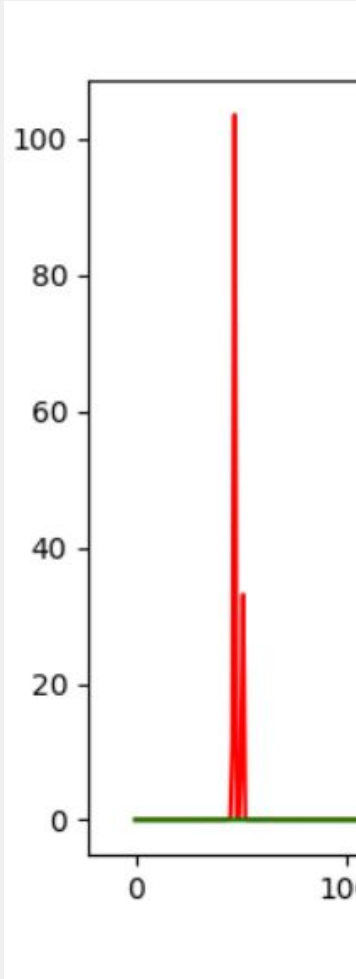
Data Classification: Reconstruction Error



Zoom-out in y-axis:

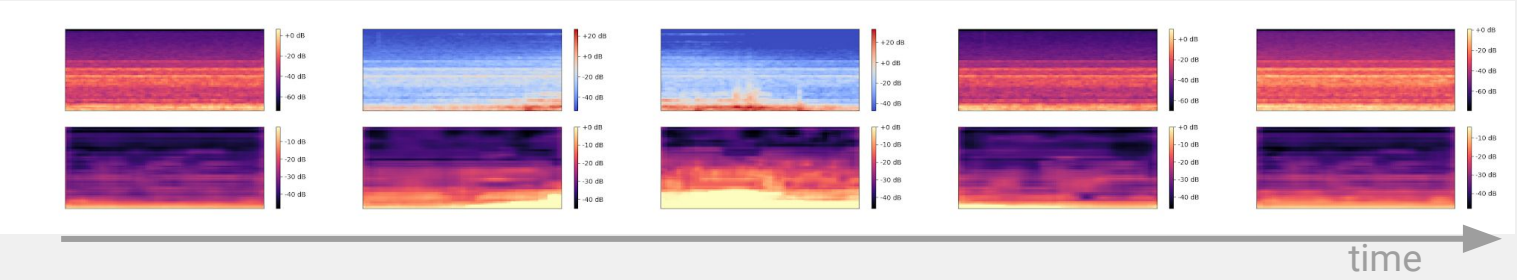


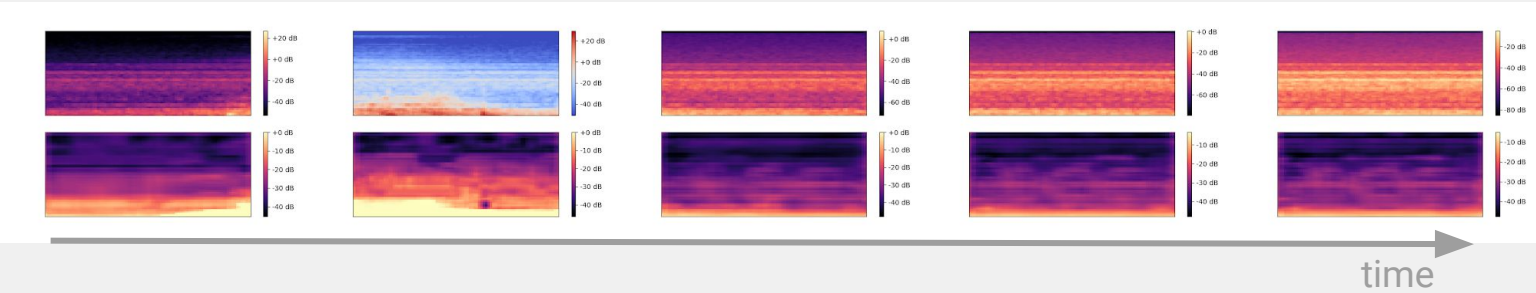
Data Classification: Reconstruction Error

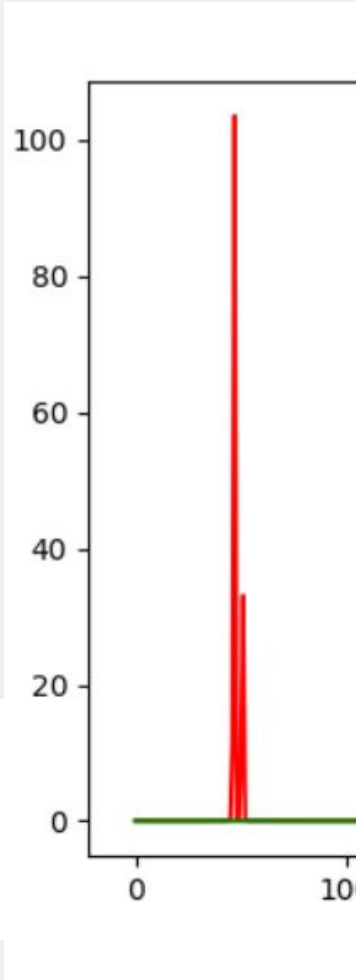


Data Classification: Reconstruction Error

snippet's leak spectrograms: input (top) vs. prediction (bottom)

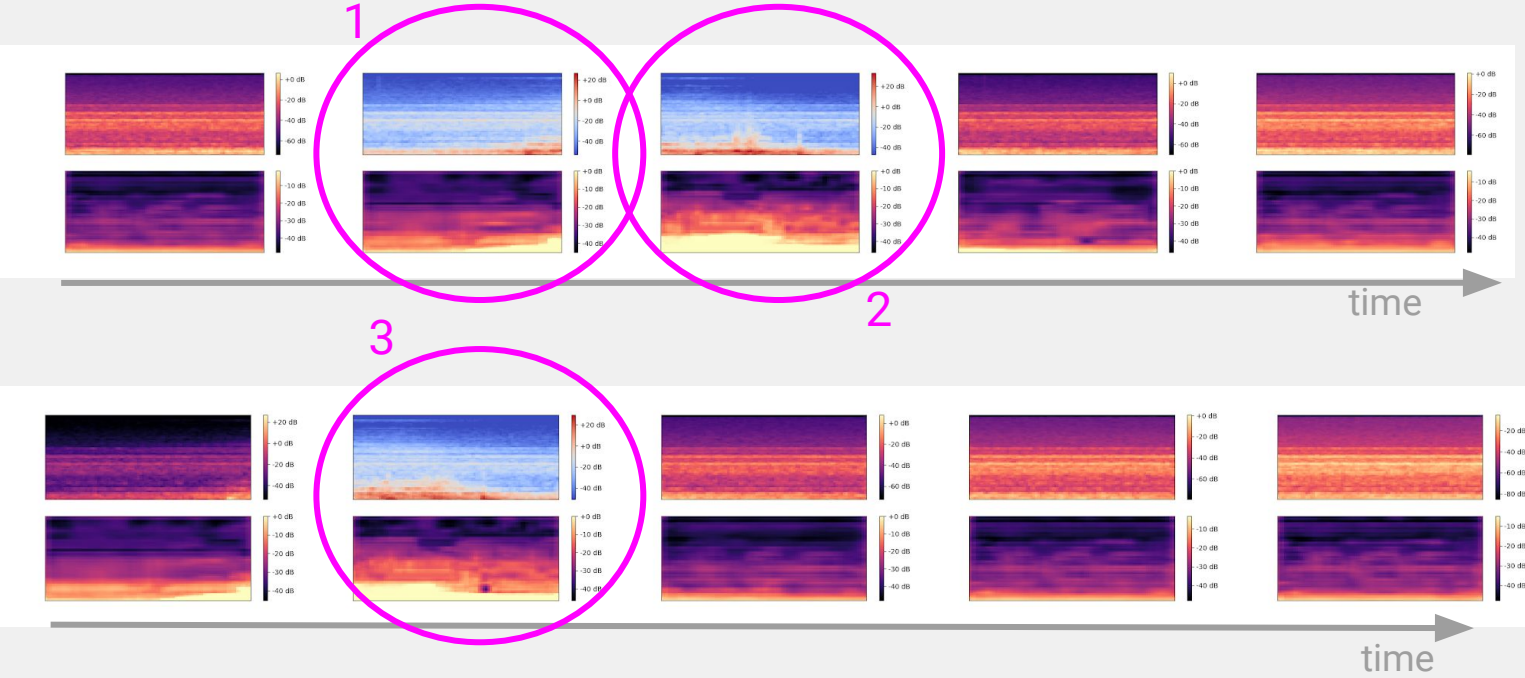


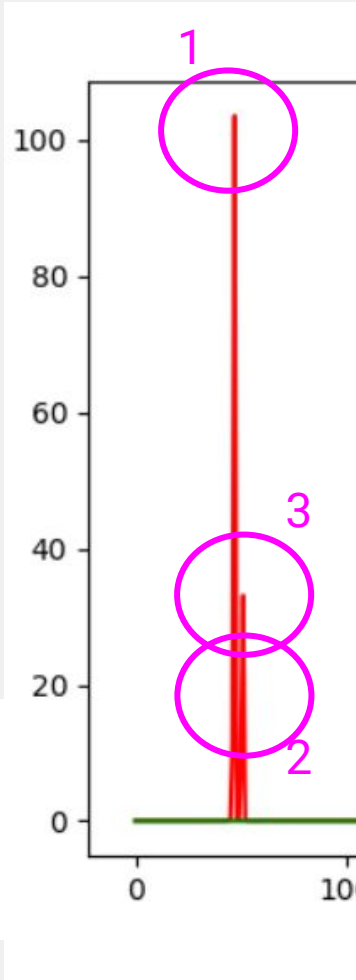




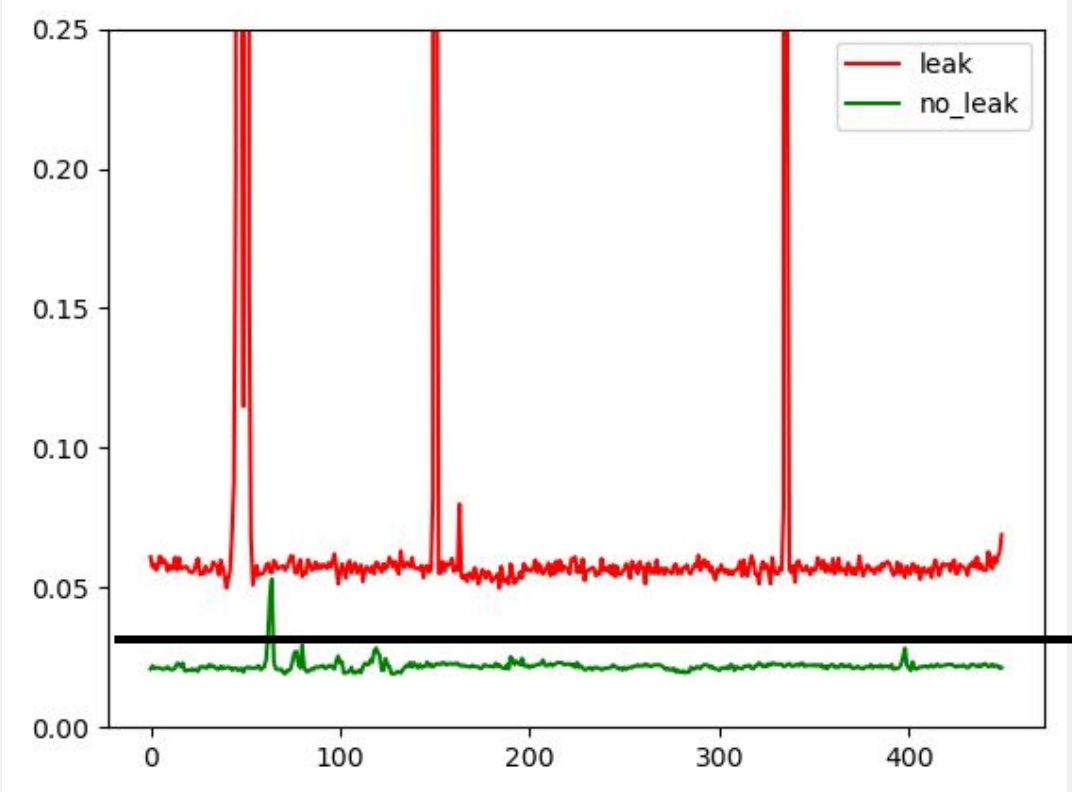
Data Classification: Reconstruction Error

snippet's leak spectrograms: input (top) vs. prediction (bottom)



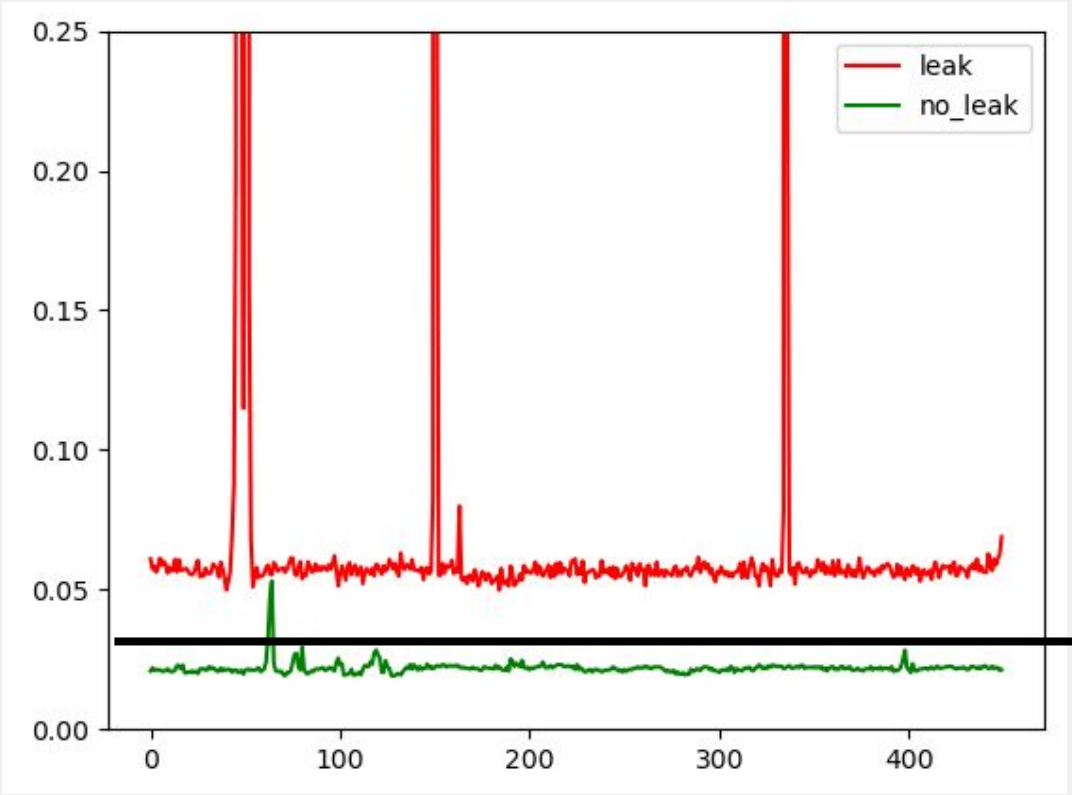


Classification with Threshold



E.g. threshold: leak data's mean + std

Classification with Threshold

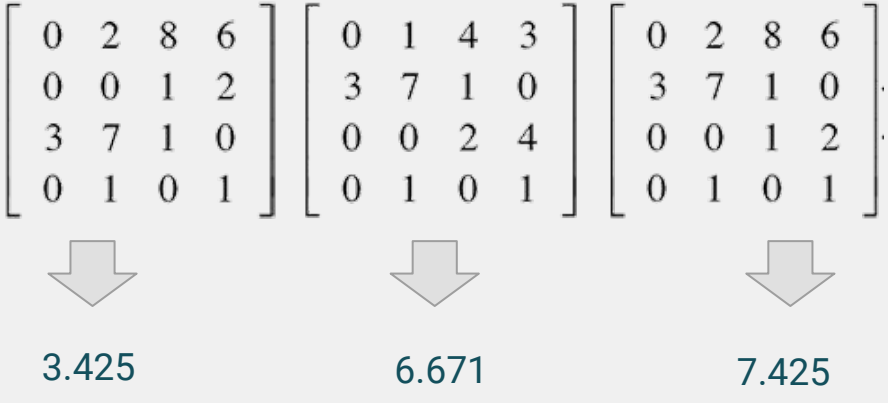


leak

E.g. threshold: leak data's mean + std

no leak

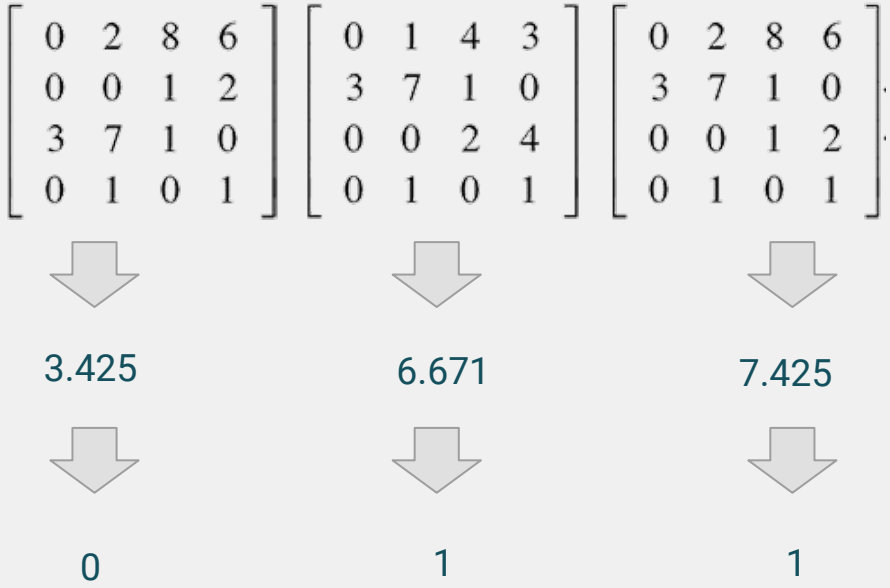
Classification with Threshold



input file
in snippets

reconstruction
errors

Classification with Threshold



input file
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reconstruction
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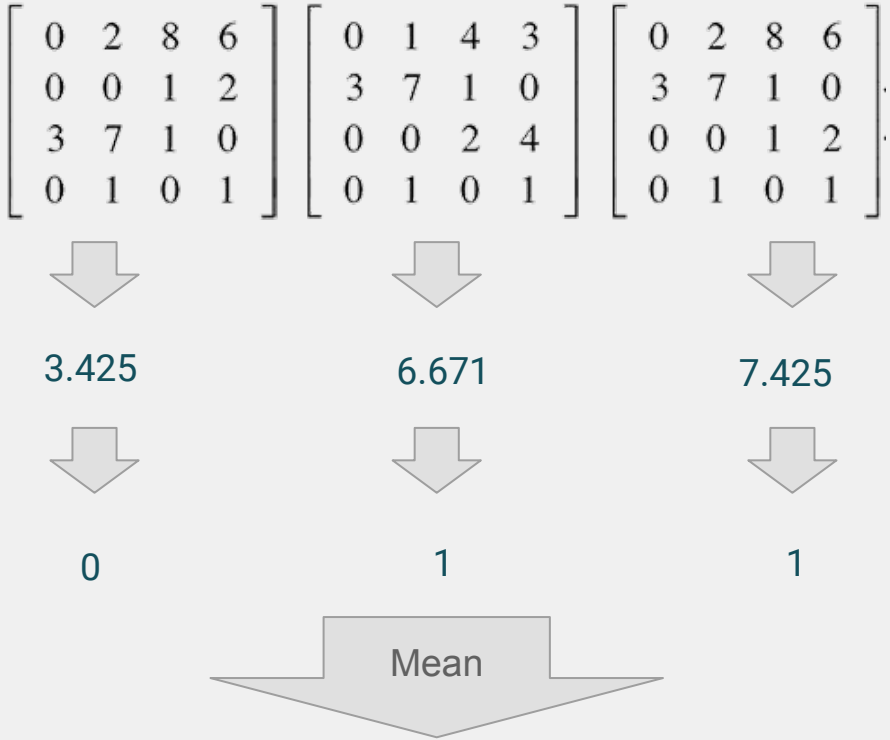
snippets'
scores

E.g. threshold: 0.4

Classification with Threshold



input file in snippets

reconstruction errors

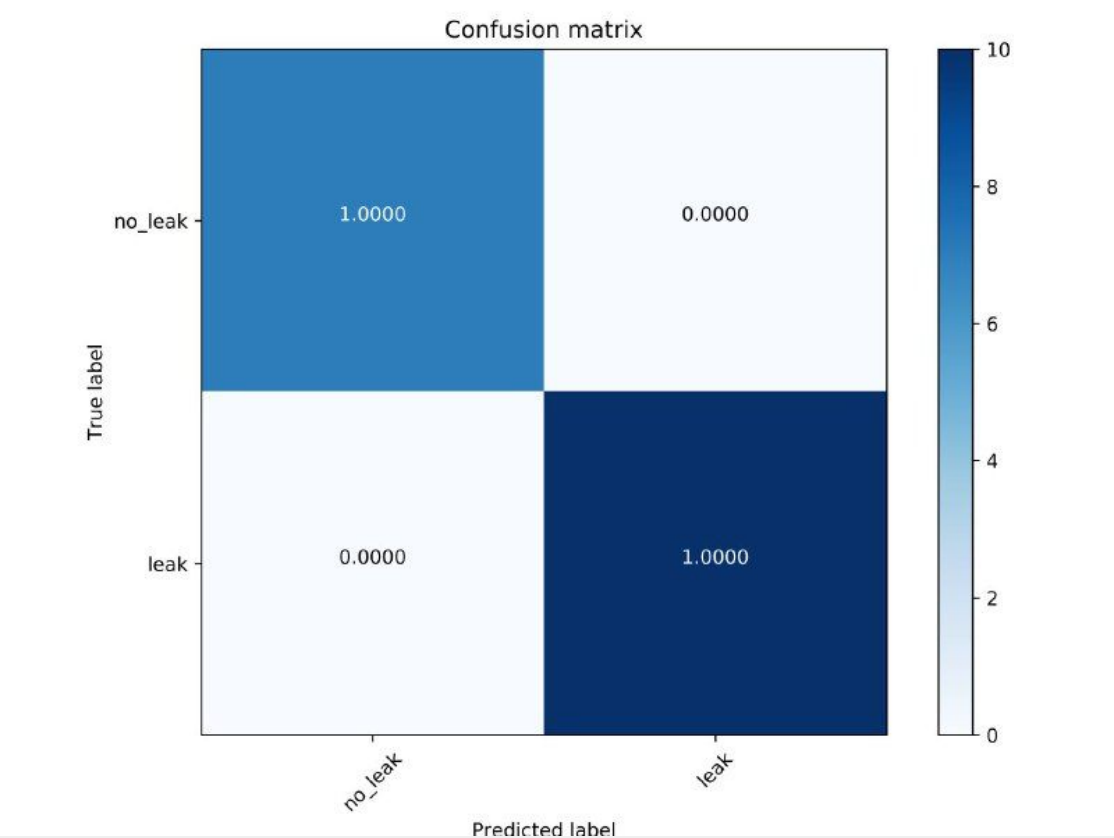
snippets' scores

E.g. threshold: 0.4

input file score

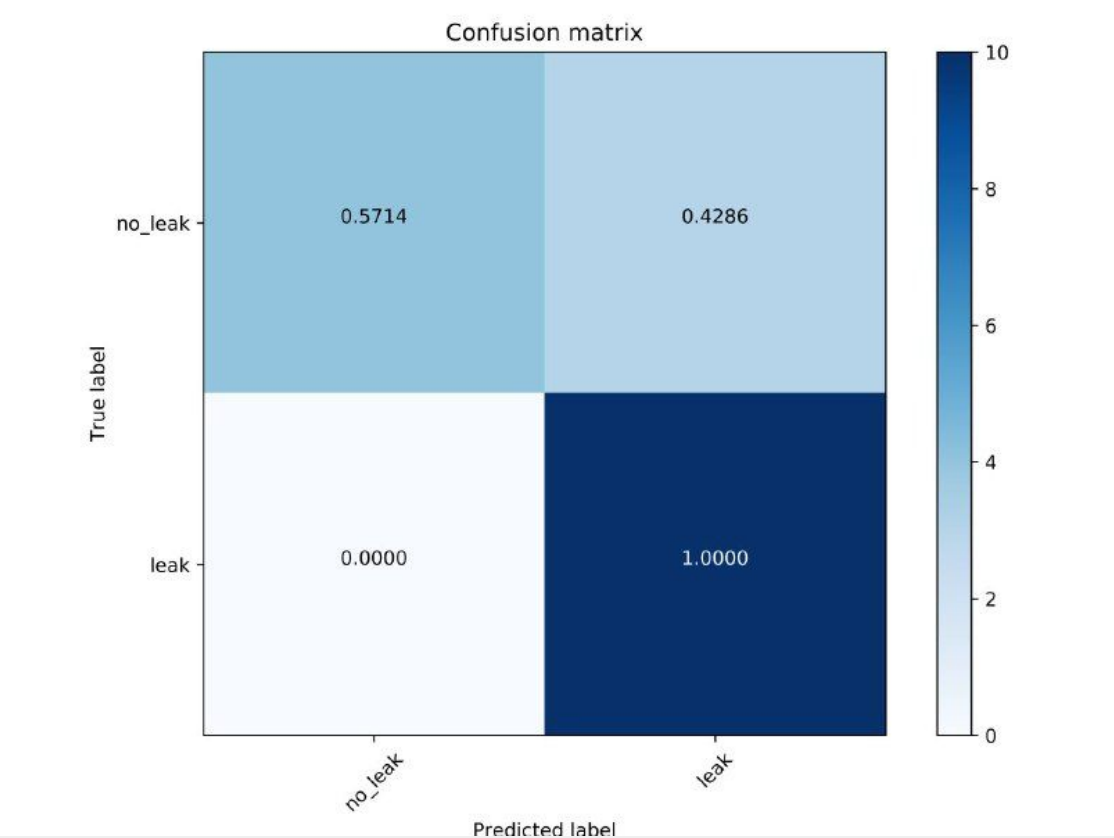
Evaluation: Confusion matrix

CNN with 2D



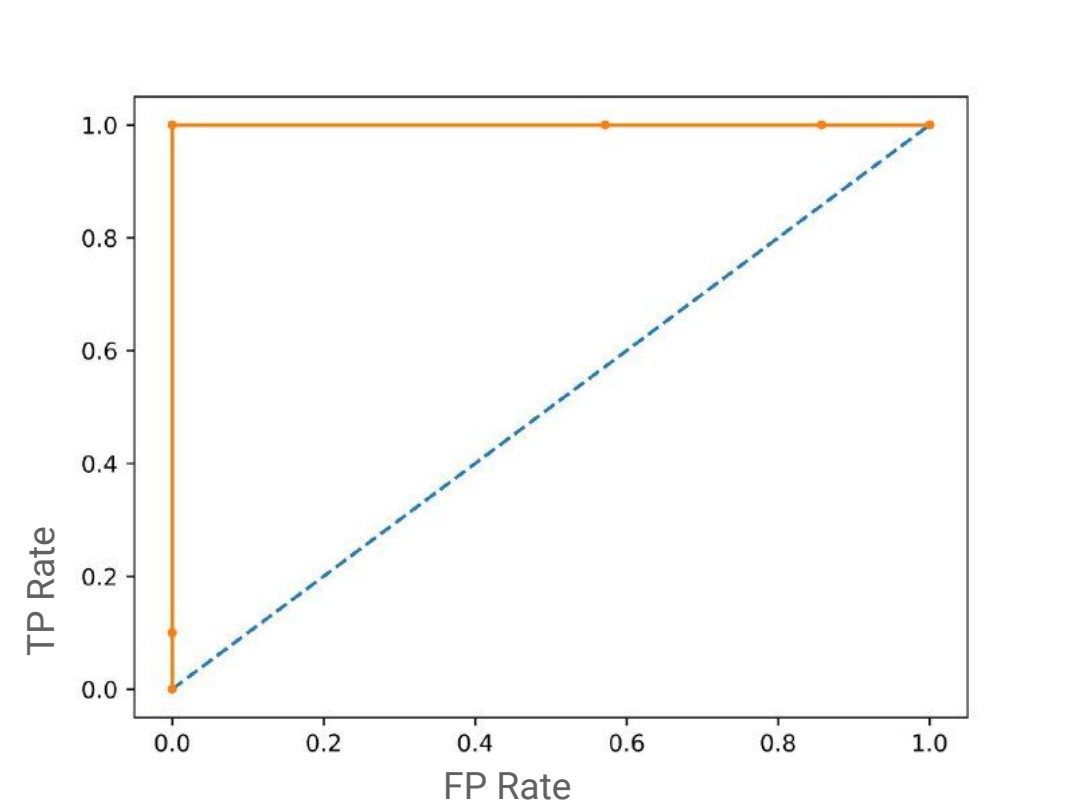
Evaluation: Confusion matrix

SAE with 10D



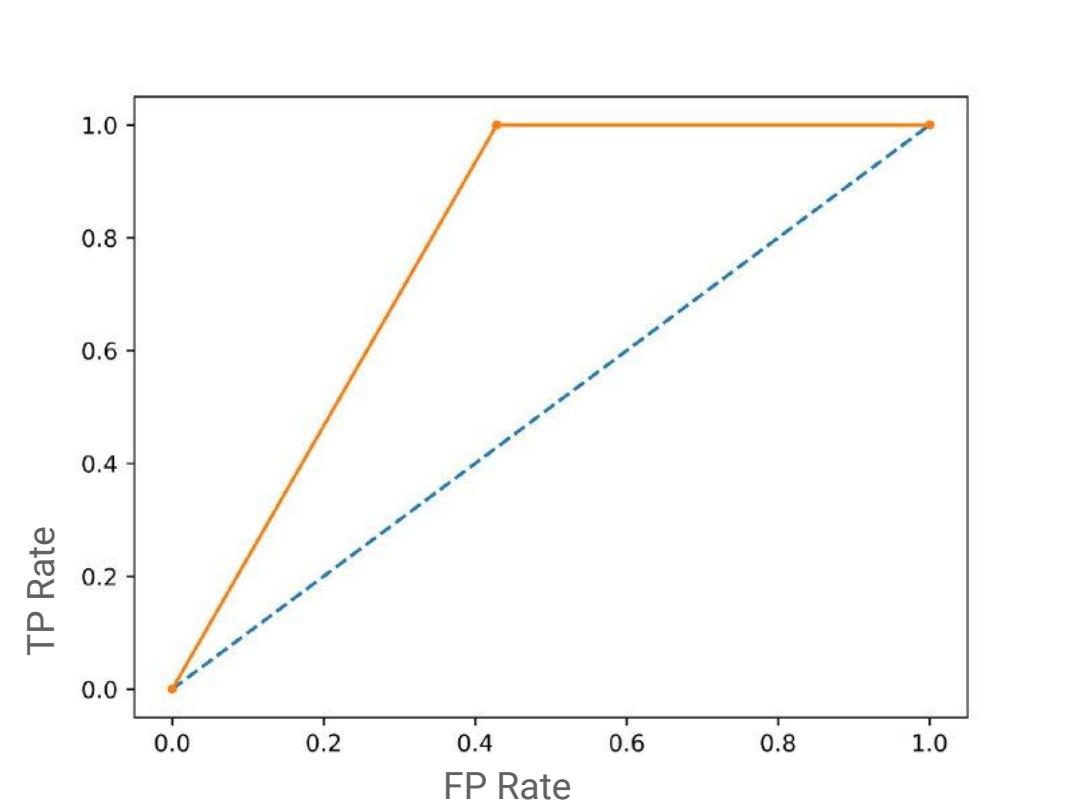
Evaluation: ROC AUC curve

CNN with 2D



Evaluation: ROC AUC curve

SAE with 10D



Conclusion

1- week-successes:

- pipeline setup on multiple systems
- promising deep-learning-methods
- exciting knowledge extraction through analysis

future work:

- improve single misclassifications
- more experiments