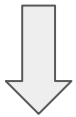
Autoencoders Explained Easily

Valerio Velardo

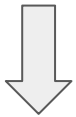
Autoencoders

Autoencoders



Unsupervised learning

Autoencoders



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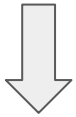

Representation learning

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Representation learning
Learning patterns in data
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Autoencoders: The sneaky idea

Create an architecture with a bottleneck, which ensures a lower-dimensional representation of the original data.

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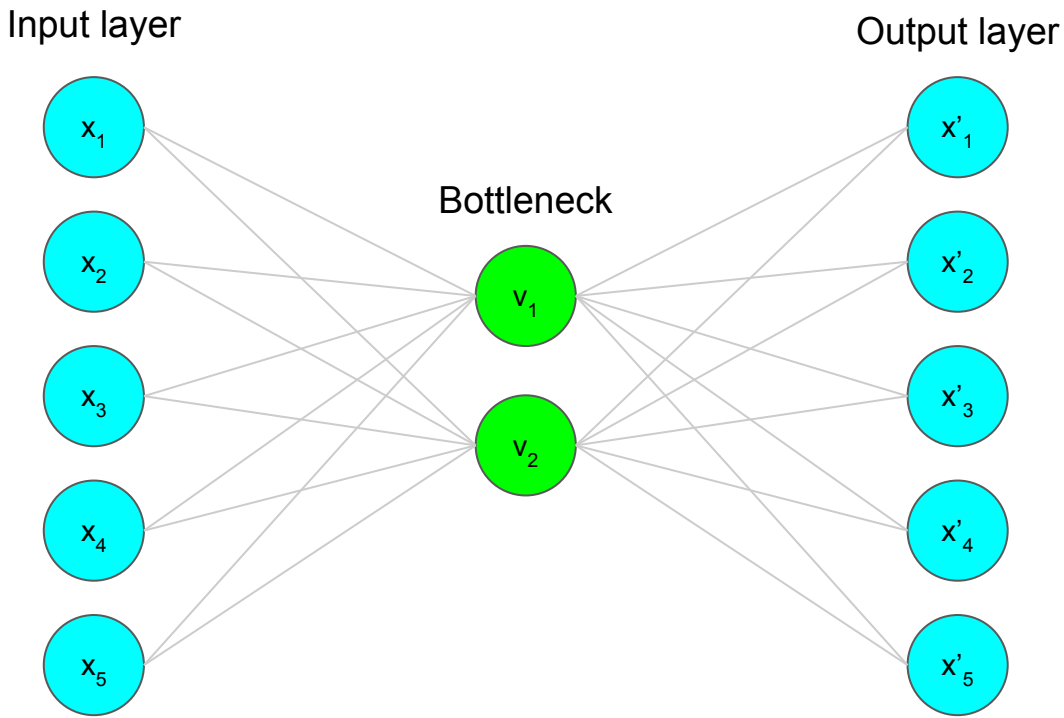
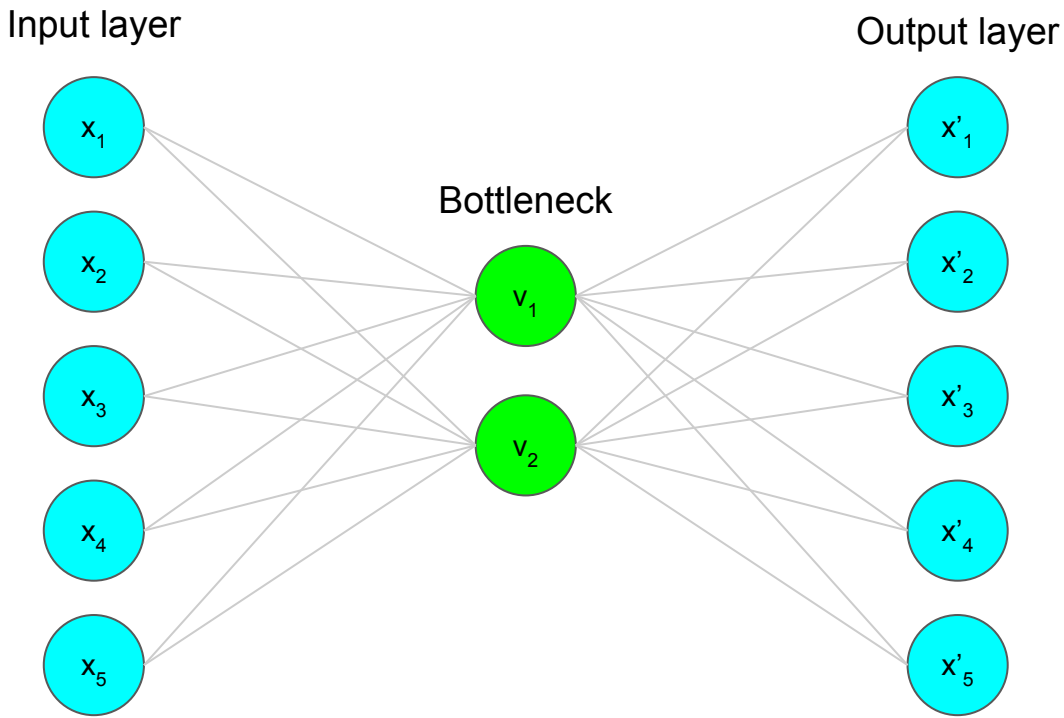

Input layer
Output layer
Bottleneck
x1
x2
x3
x4
x5
v1
v2
x'1
x'2
x'3
x'4
x'5

Autoencoder = Encoder + Decoder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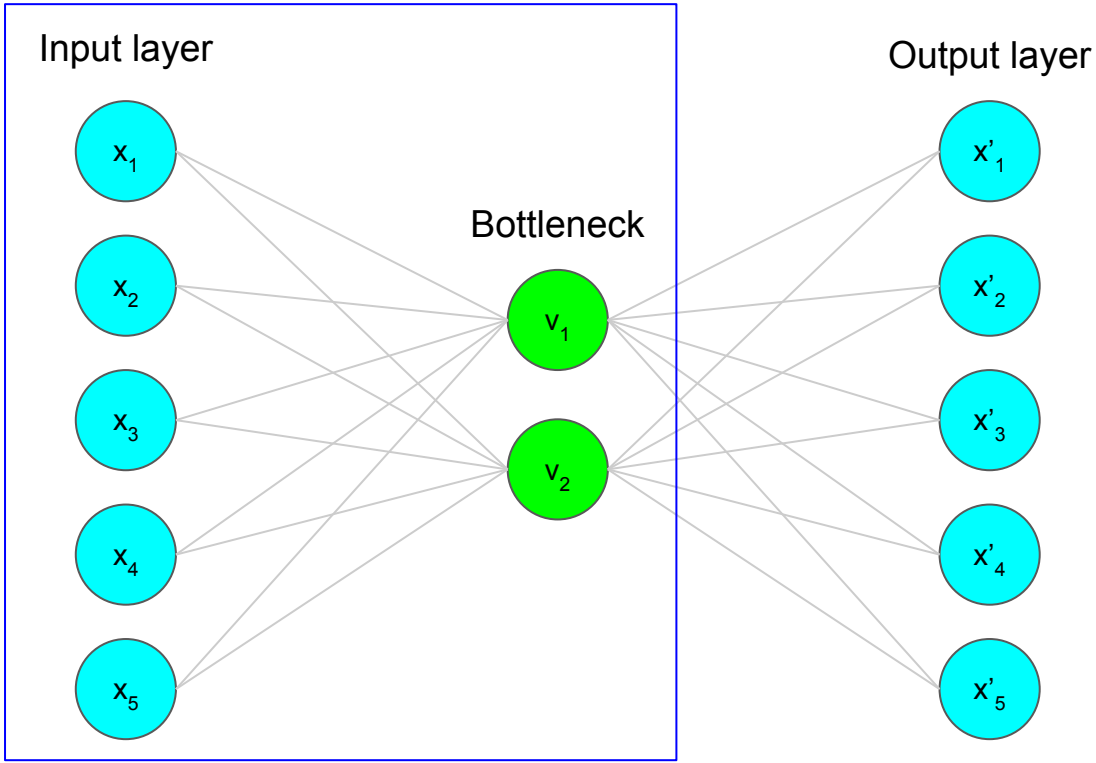

Encoder = compress data into lower-dimensional representation (*latent* space)

Necessary condition to learn a representation

- Data should have dependencies across dimensions

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- Data should have dependencies across dimensions
- If dimensions are all independent -> impossible to learn lower-dimensional representation

PCA vs Encoders

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- Both perform dimensionality reduction

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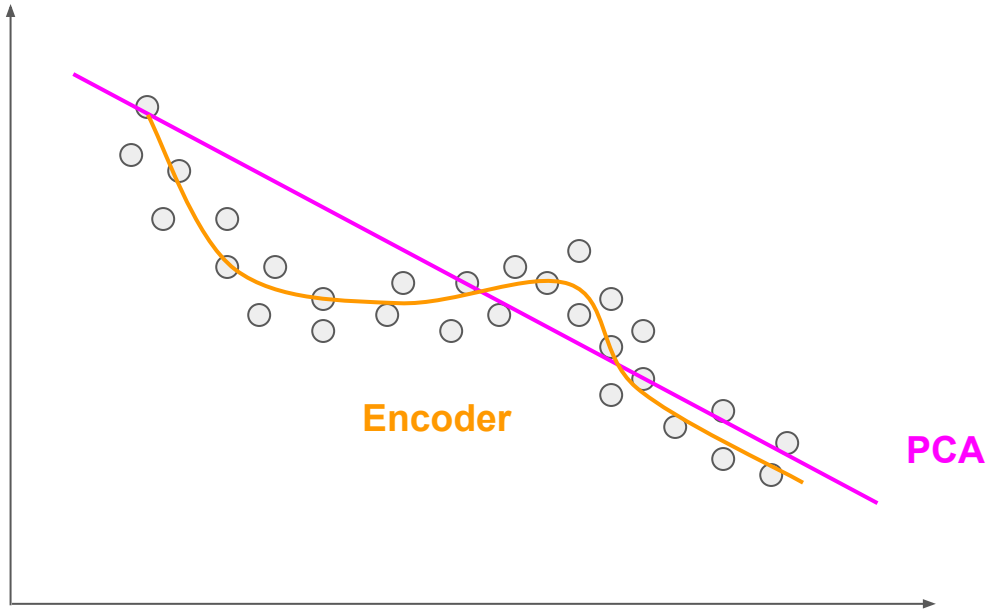
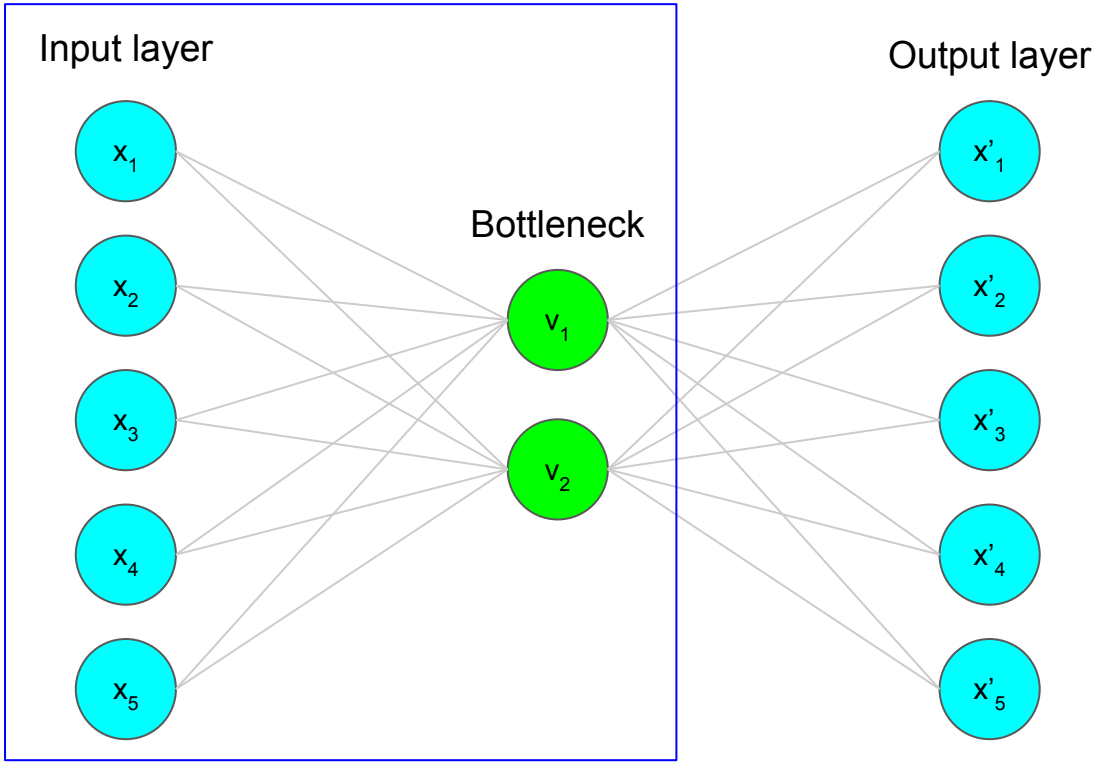


PCA vs Encoders

- Both perform dimensionality reduction
- PCA learns linear relationships
- Encoders can learn non-linear relationships
- Encoder = PCA, if it uses linear activation functions



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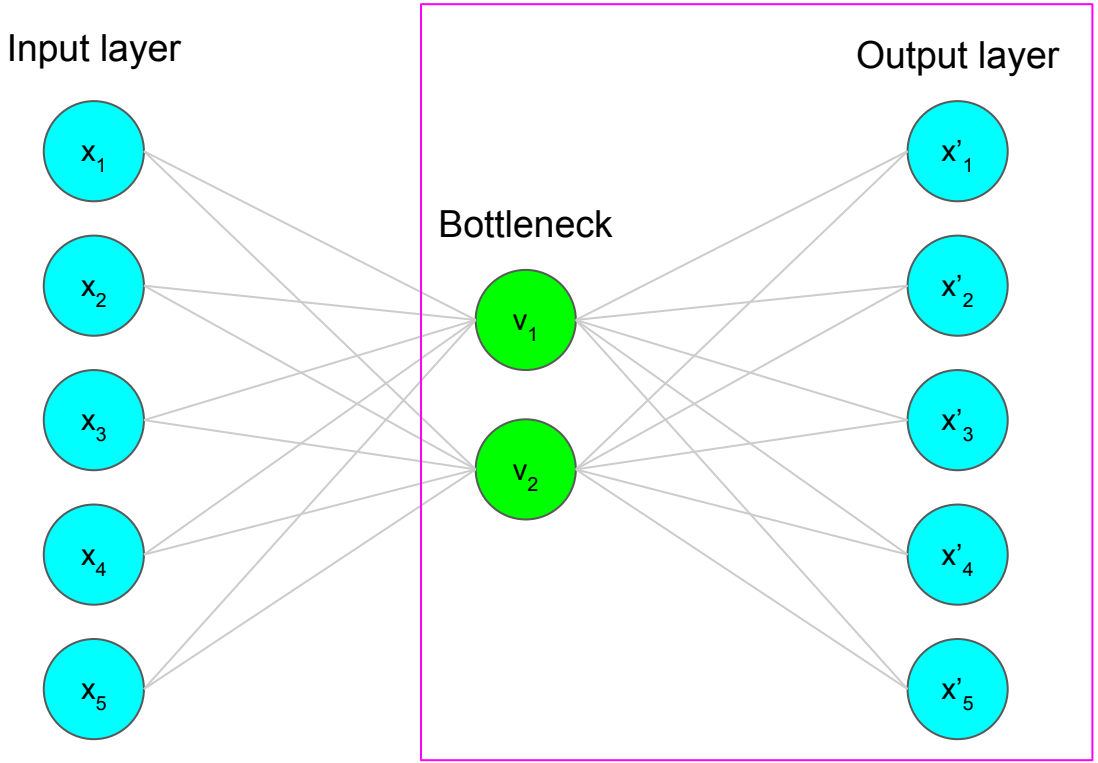
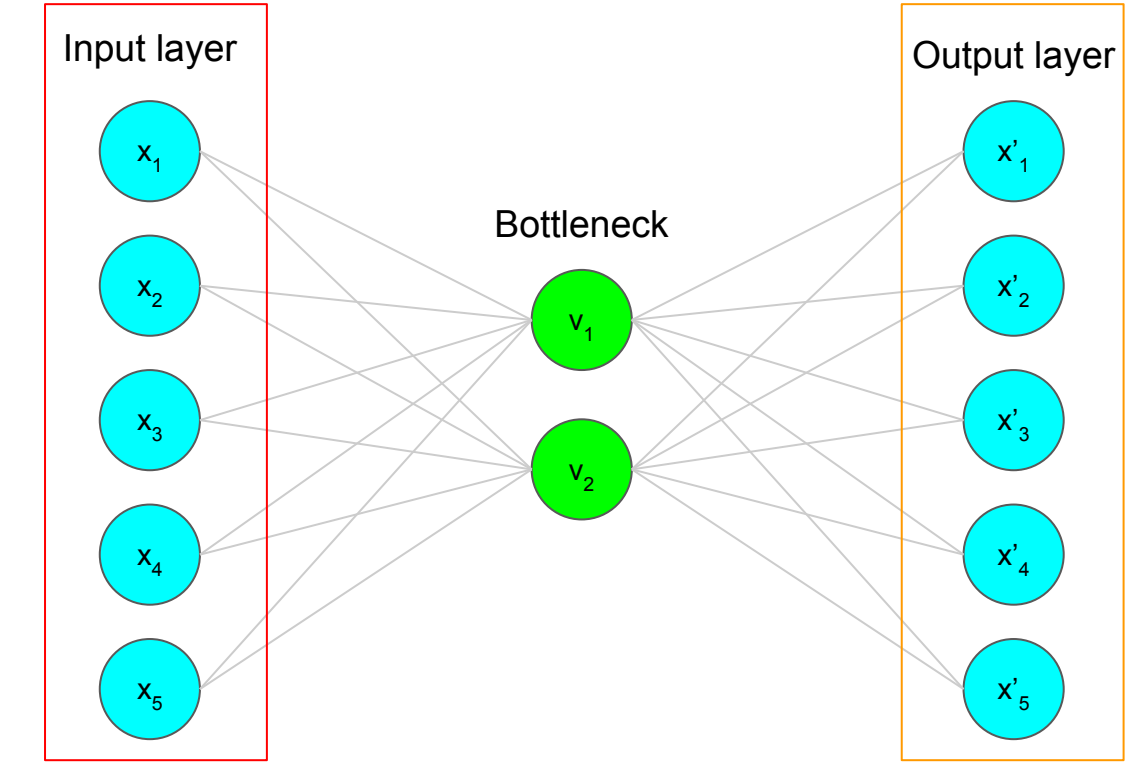


Decoder = Decompress representation back to original domain



Original data

Reconstruction

How can we train an autoencoder?

- Backpropagation

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- Minimise reconstruction error

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$$E(x, \hat{x})$$

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Original data Reconstructed data

What we ask an autoencoder...

- Sensitive enough to input data to reconstruct it
- Insensitive enough to input data **not** to overfit it

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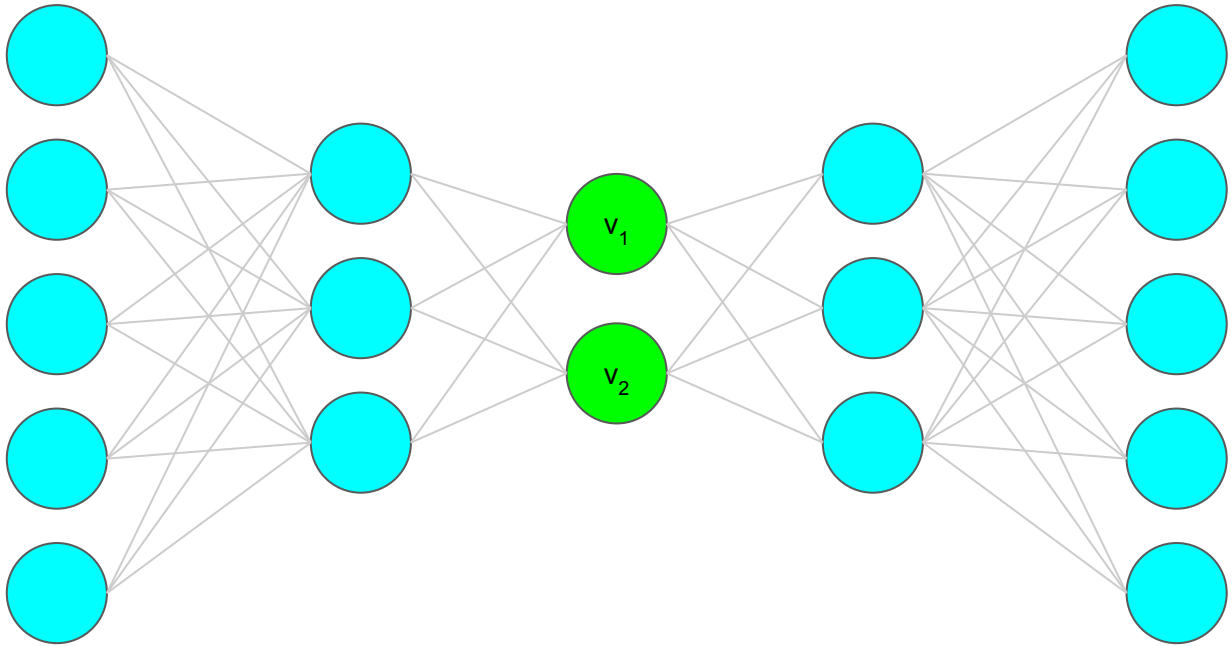
Deep Autoencoder



Deep Convolutional Autoencoder

- Similar architecture to AE
- Convolutional layers
- **Encoder**: Convolution + Leaky Relu +Batch normalization
- **Decoder**: Convolution transpose + Leaky Relu + Batch normalization


WHAT'S THE POINT OF
COMPRESSING / DECOMPRESSING DATA?
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The latent space keeps the most important attributes of the input data

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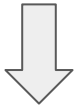
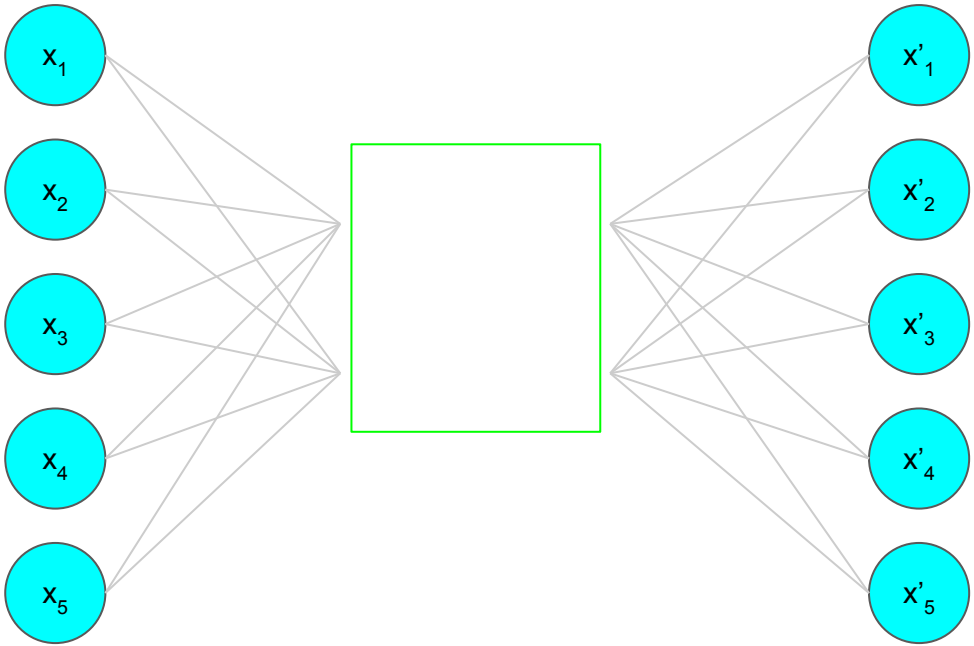


We can leverage the latent space to perform several interesting tasks

Autoencoder applications

- Generation
- Denoising
- Anomaly detection
- ...

Generation with AEs



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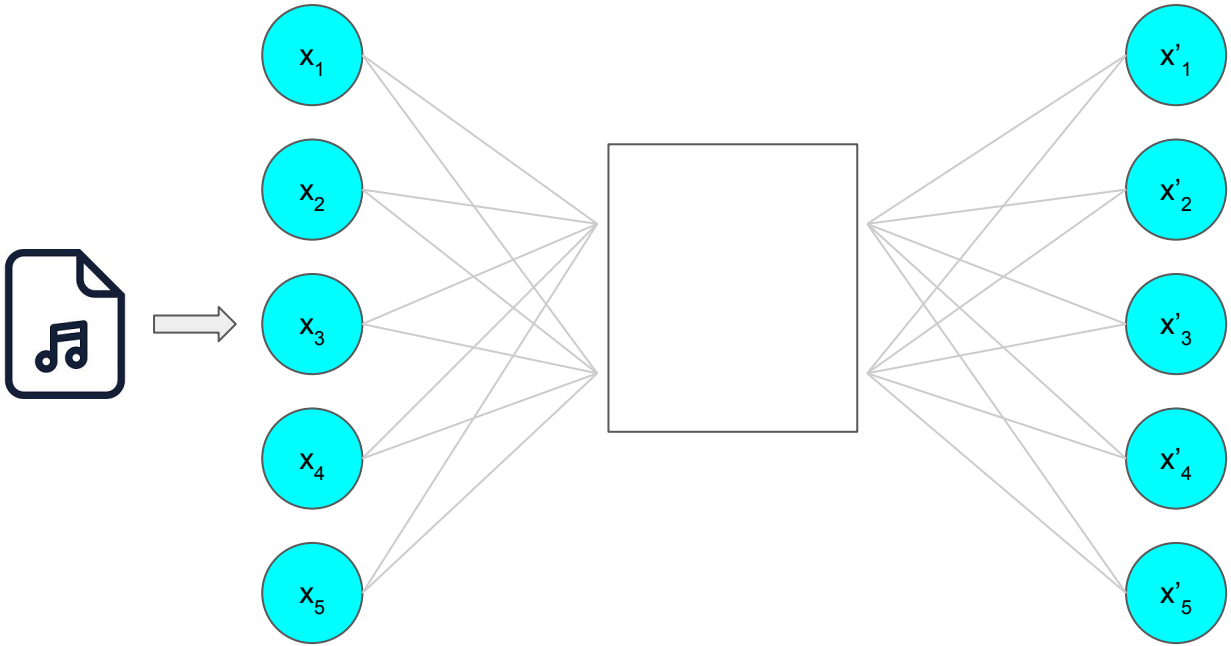
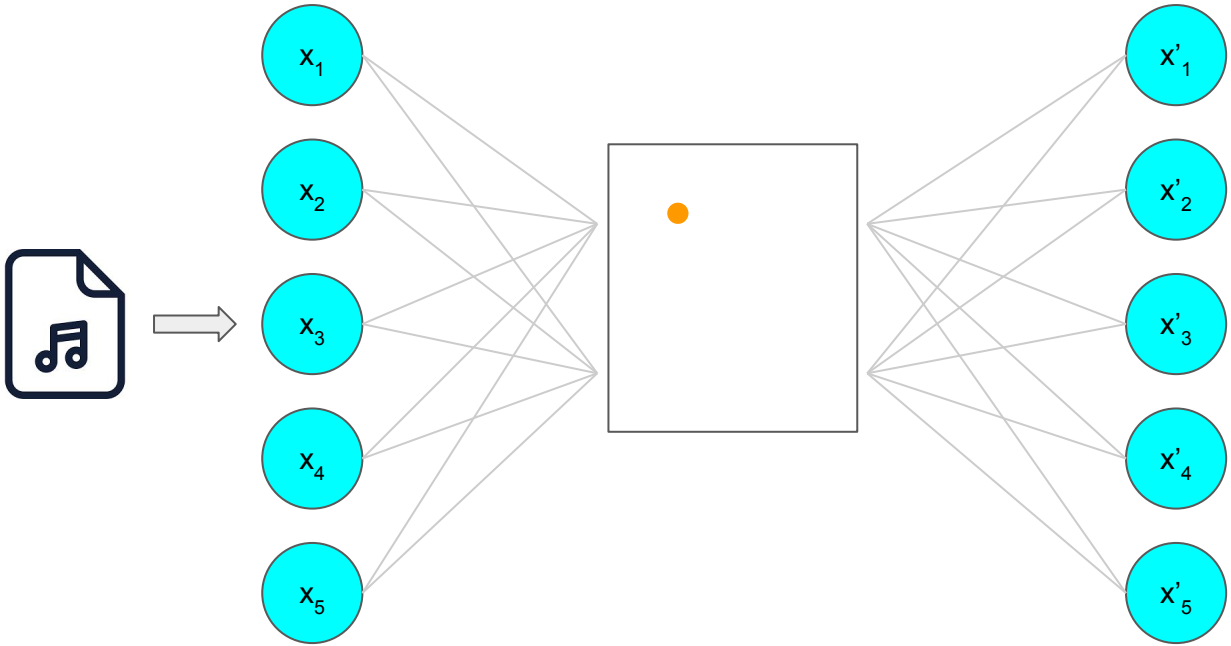
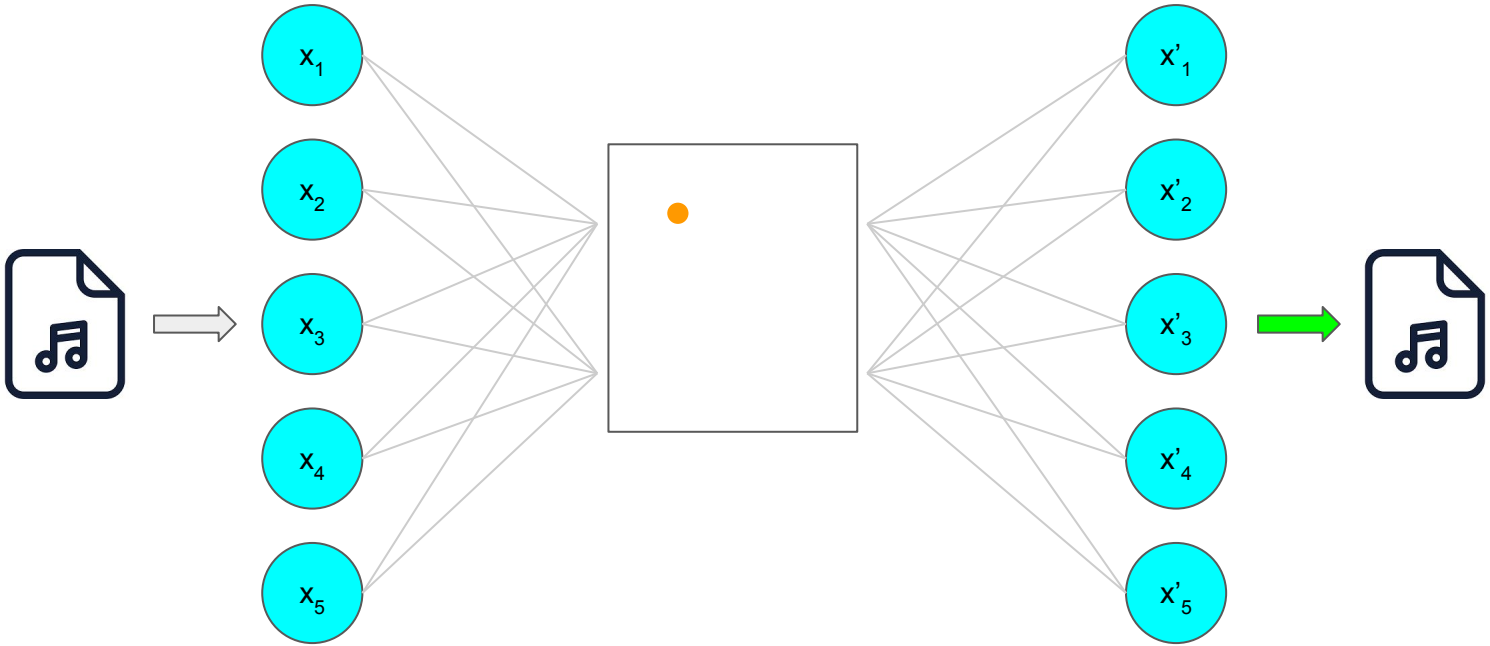


Generation with AEs



Generation with AEs



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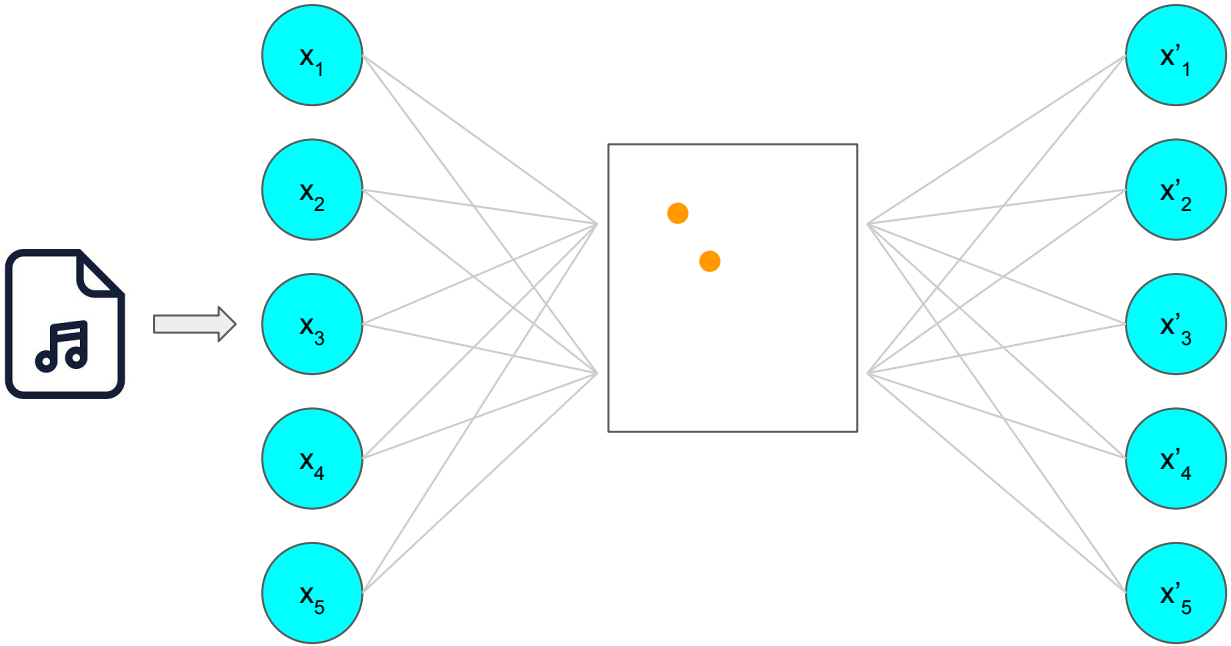

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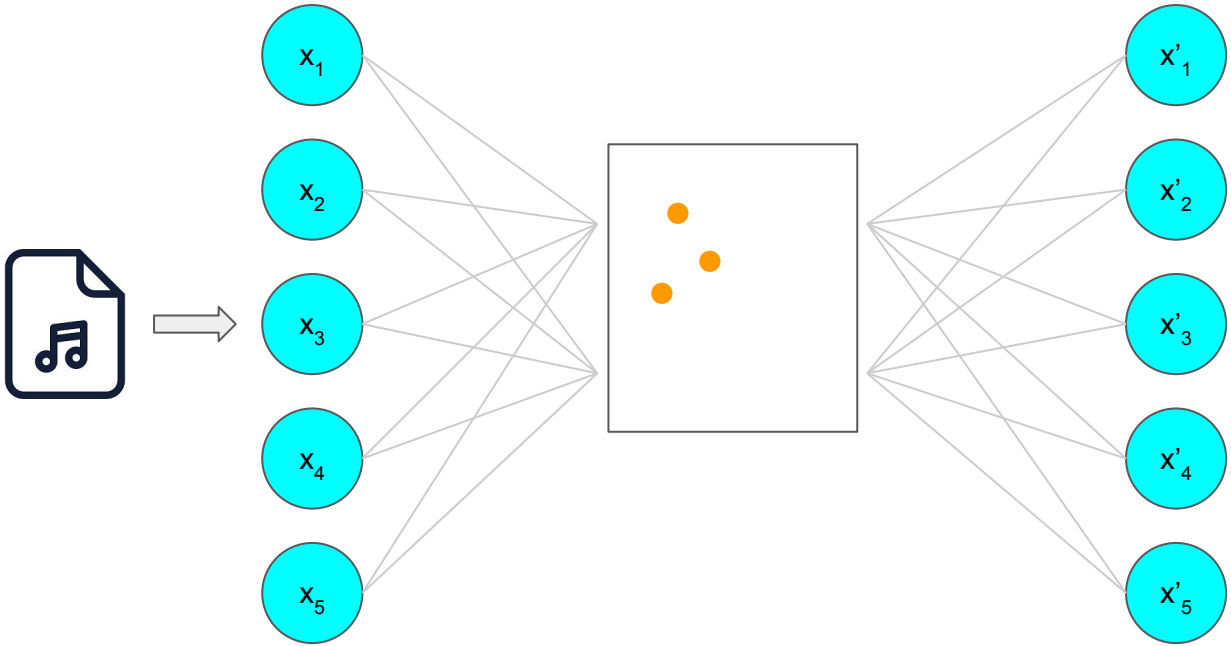

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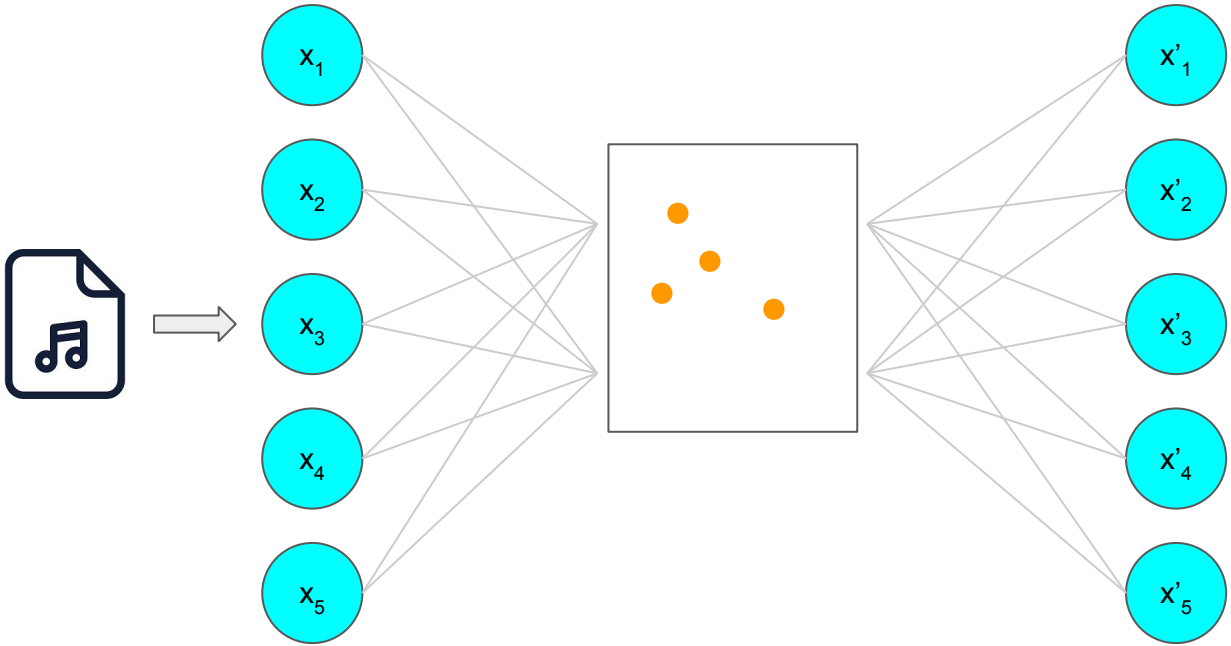

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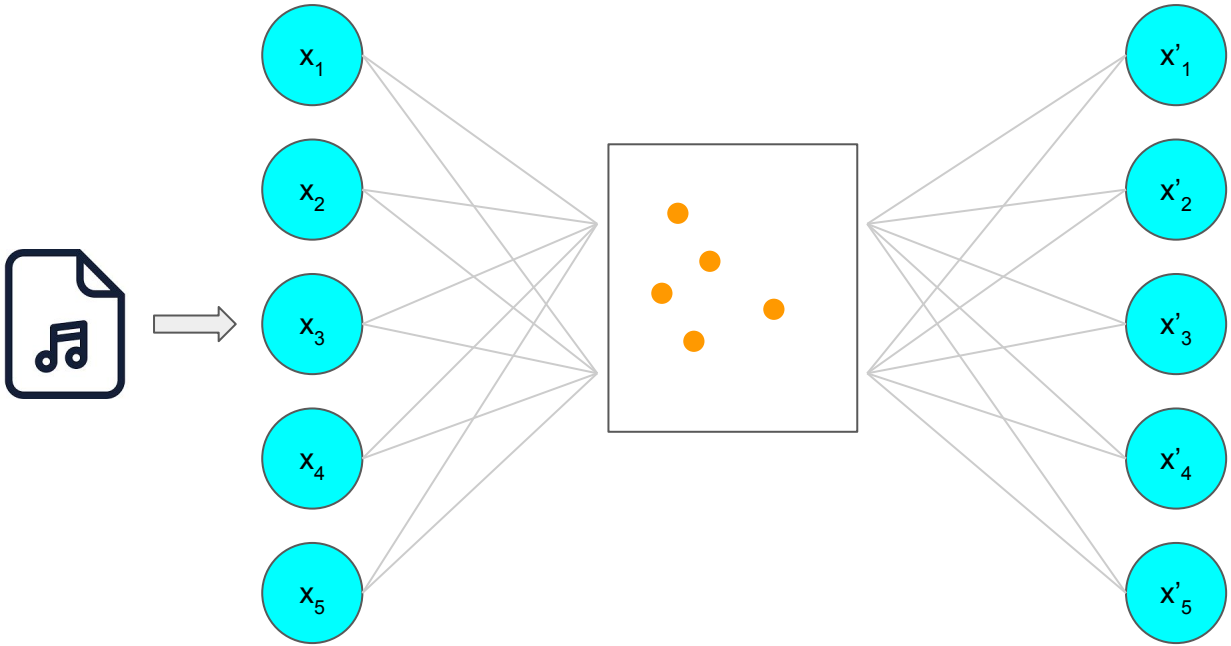

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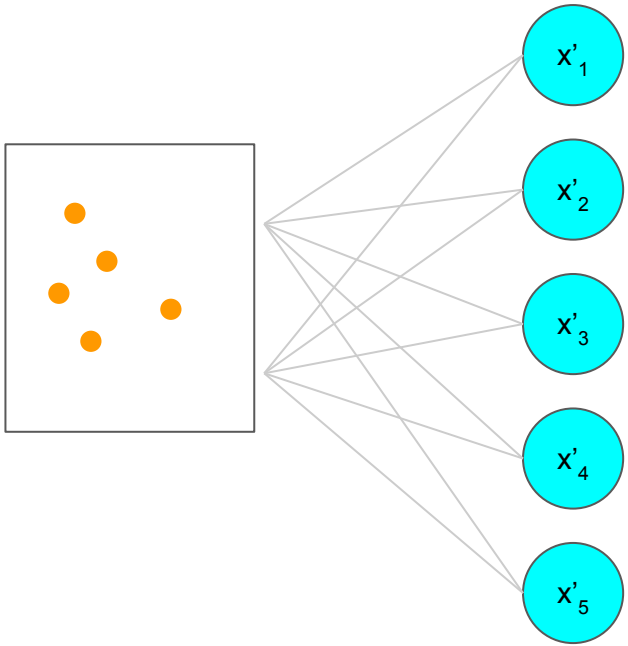
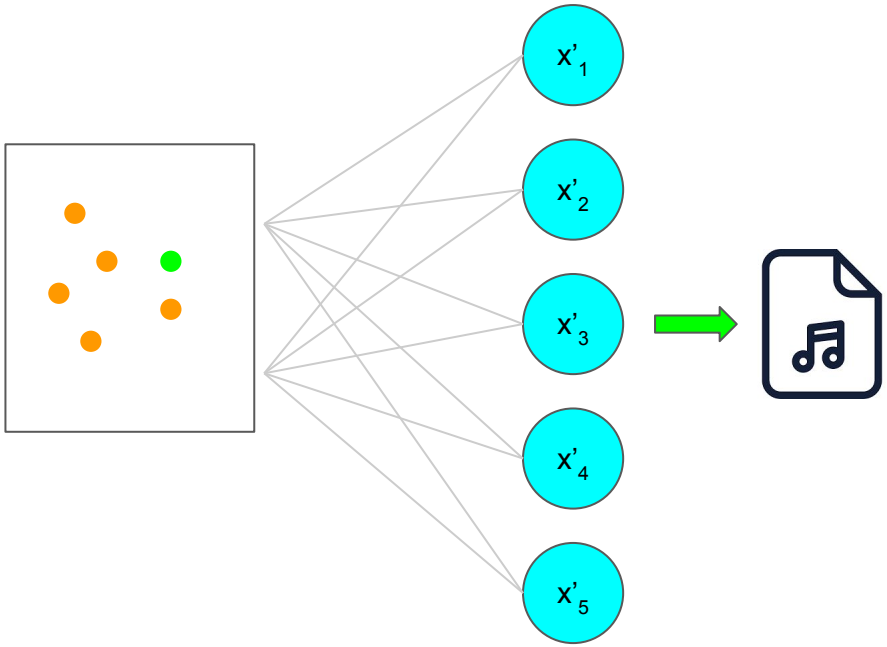
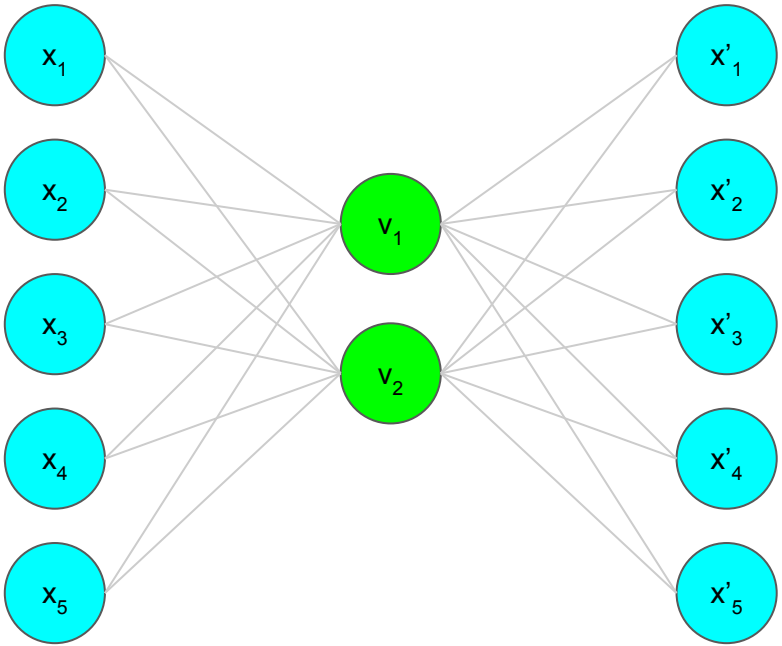


Generation with AEs

Sample a point in the latent space and pass it through the decoder



Denoising with AEs



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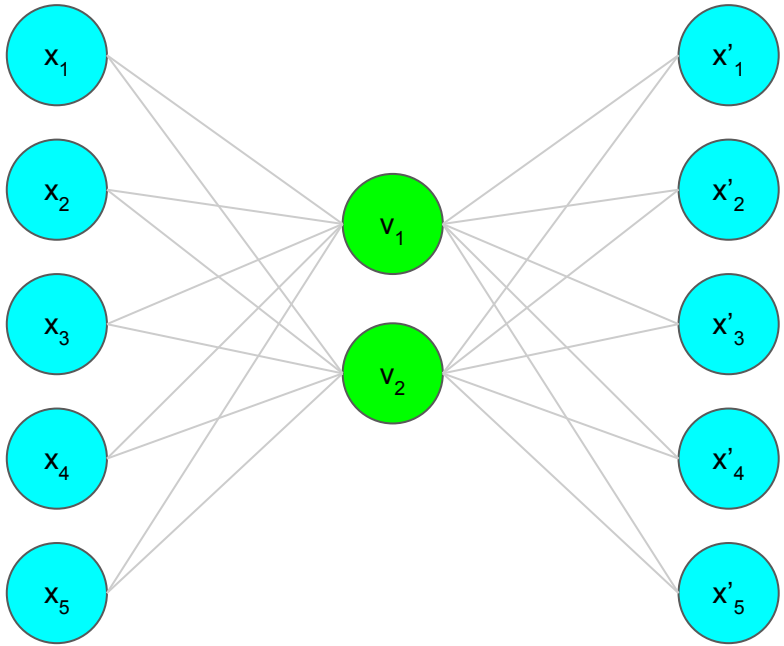
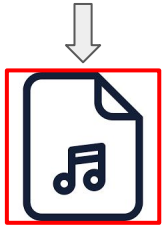
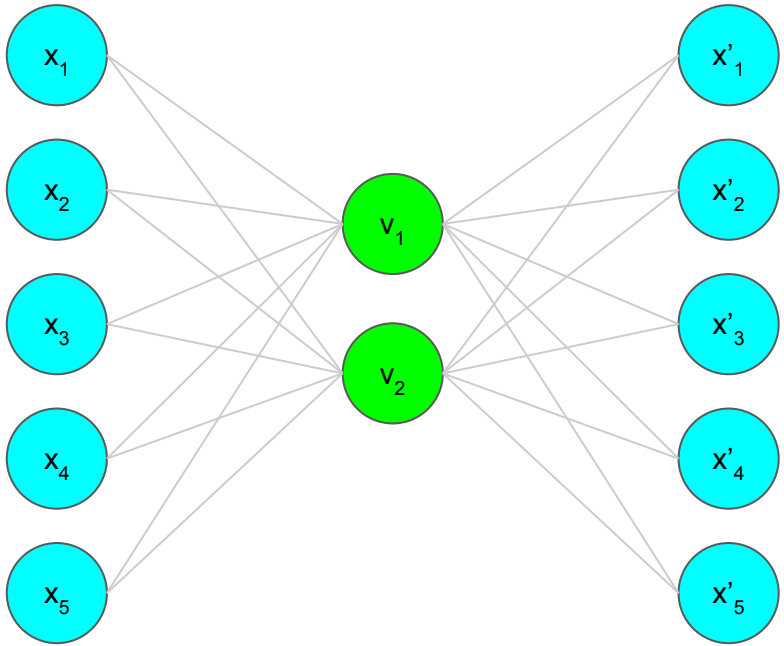


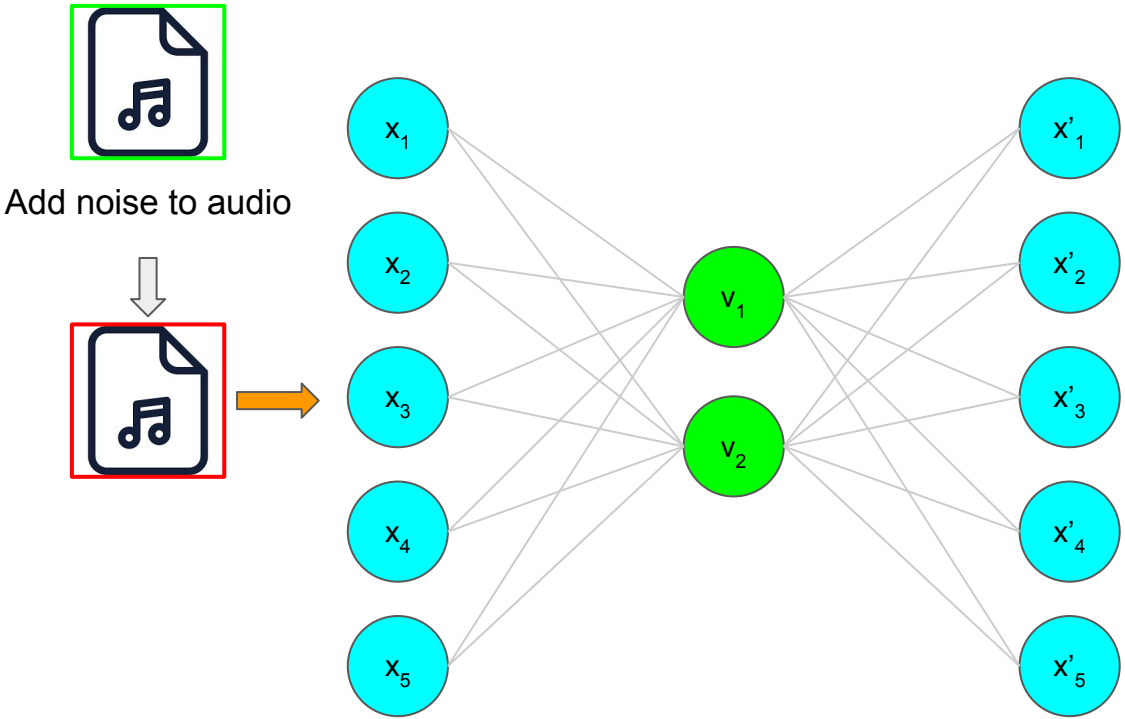
Denoising with AEs

Add noise to audio





Denoising with AEs



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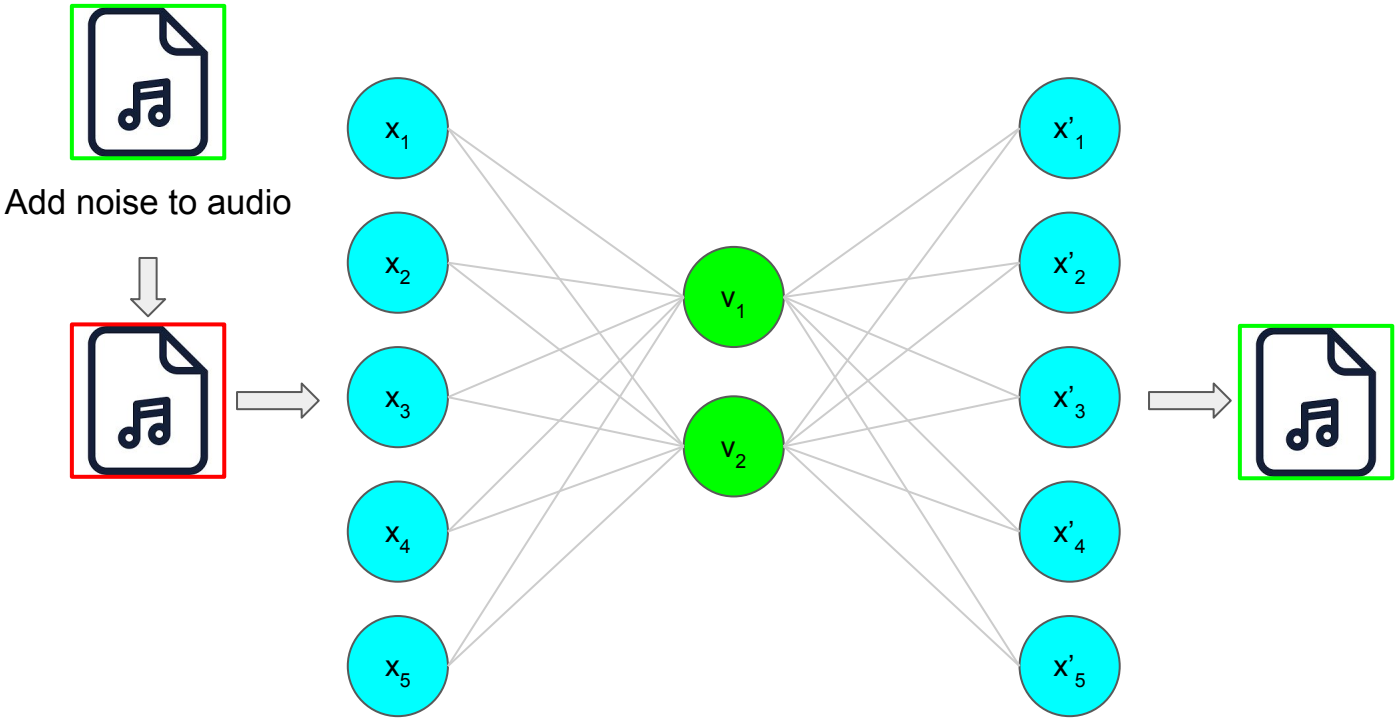

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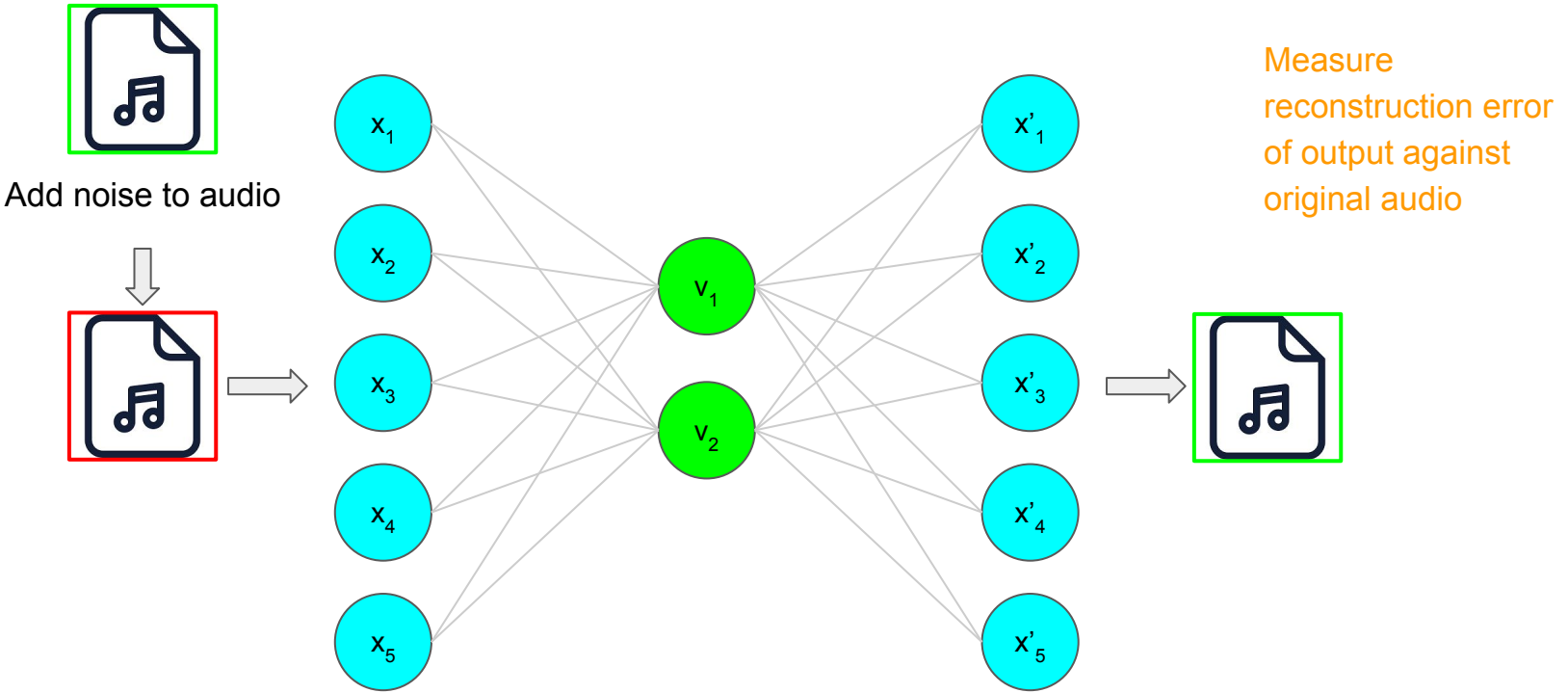

Anomaly detection with AEs


NEW VIDEO ON ANOMALY DETECTION WITH AUTOENCODERS
COMING SOON!
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What next?

- Building a Convolutional AE in Keras
- Discuss AE limitations