

# Autoencoders

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# Problem Statement

## Given

A set  $S$  of objects based on their qualities

- Images of faces, handwritten numbers, DNA?

## Goal

Group elements of  $S$  such that objects with 'similar' qualities belong to the same group

# Problem Statement

## Given

A set  $S$  of objects based on their qualities

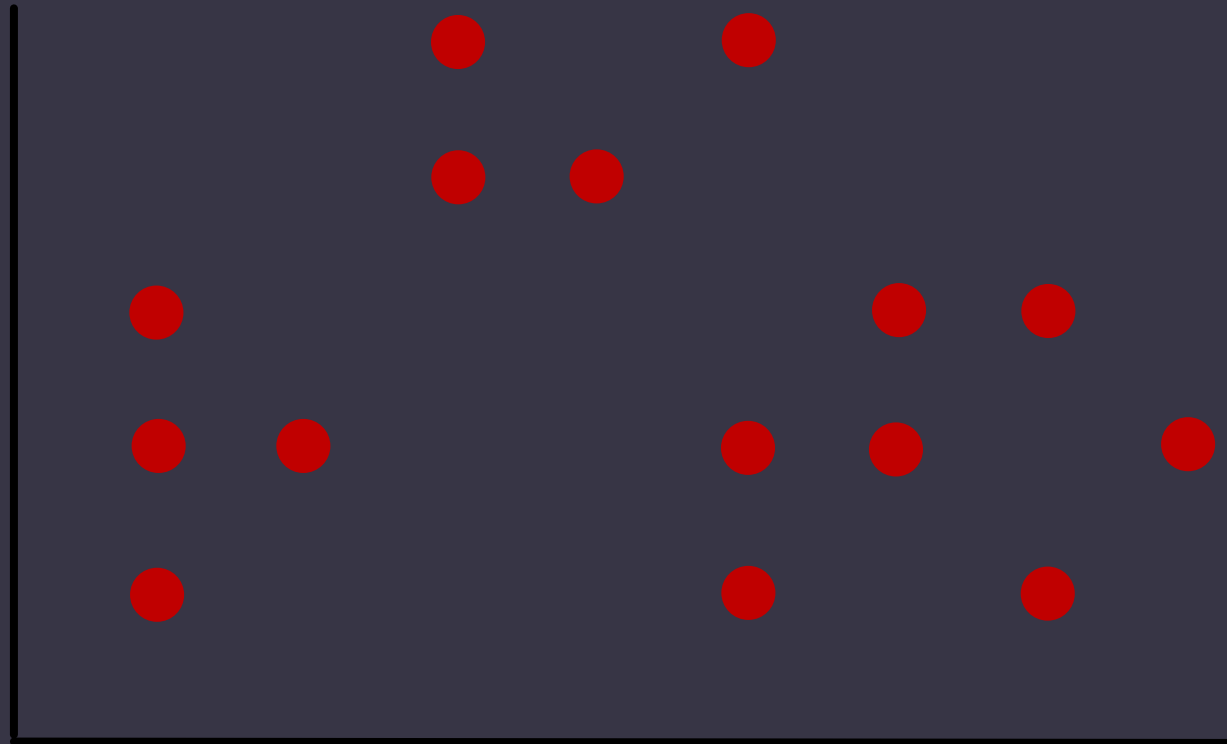
- Images of faces, handwritten numbers, DNA?

## Goal

Group elements of  $S$  such that objects with 'similar' qualities belong to the same group

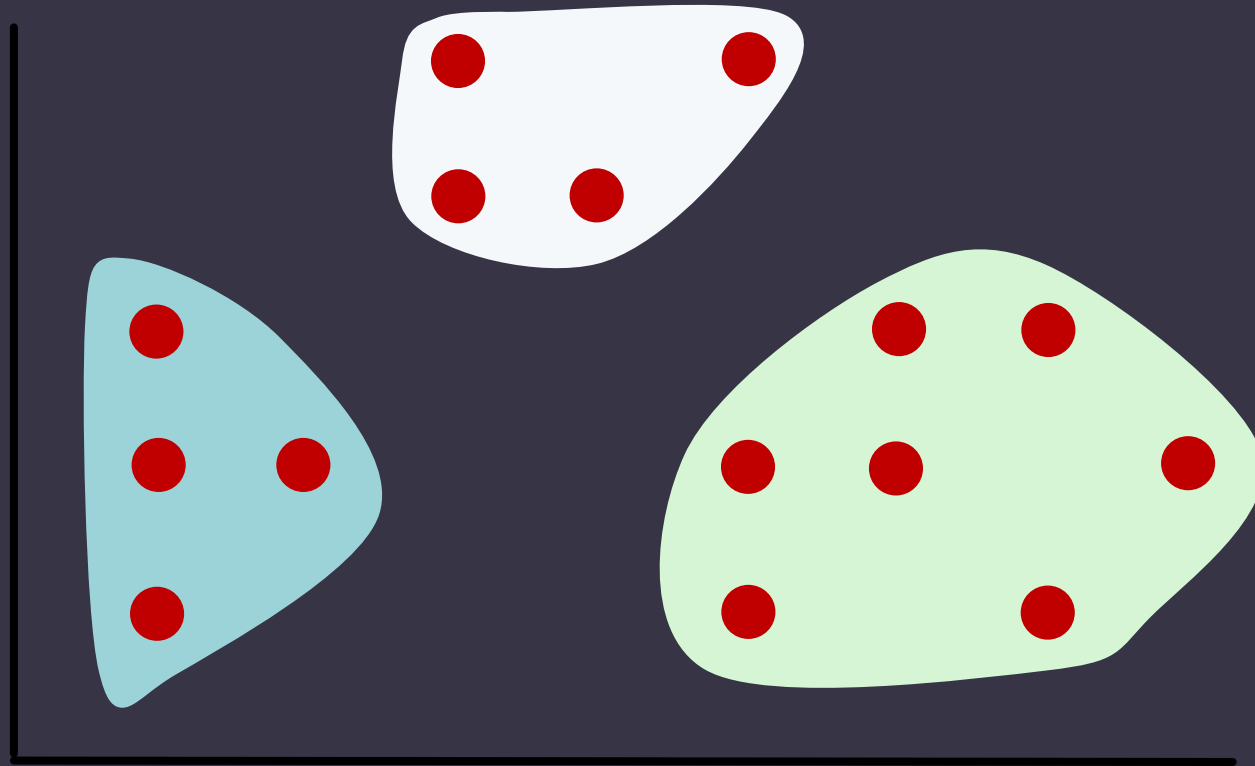
- **Unsupervised Learning** can be used for this

# Example: Points in space



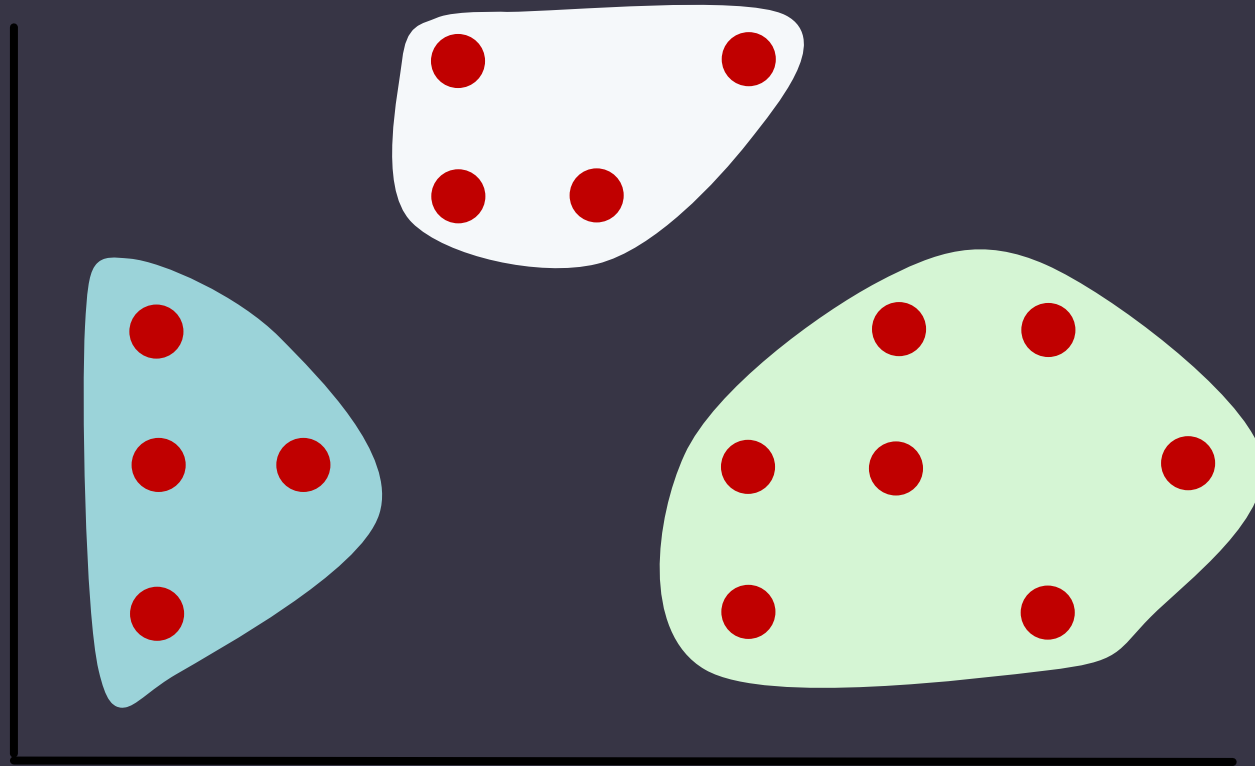
How can we group, or cluster, the points above?

# Example: Points in space



One possible way is shown above

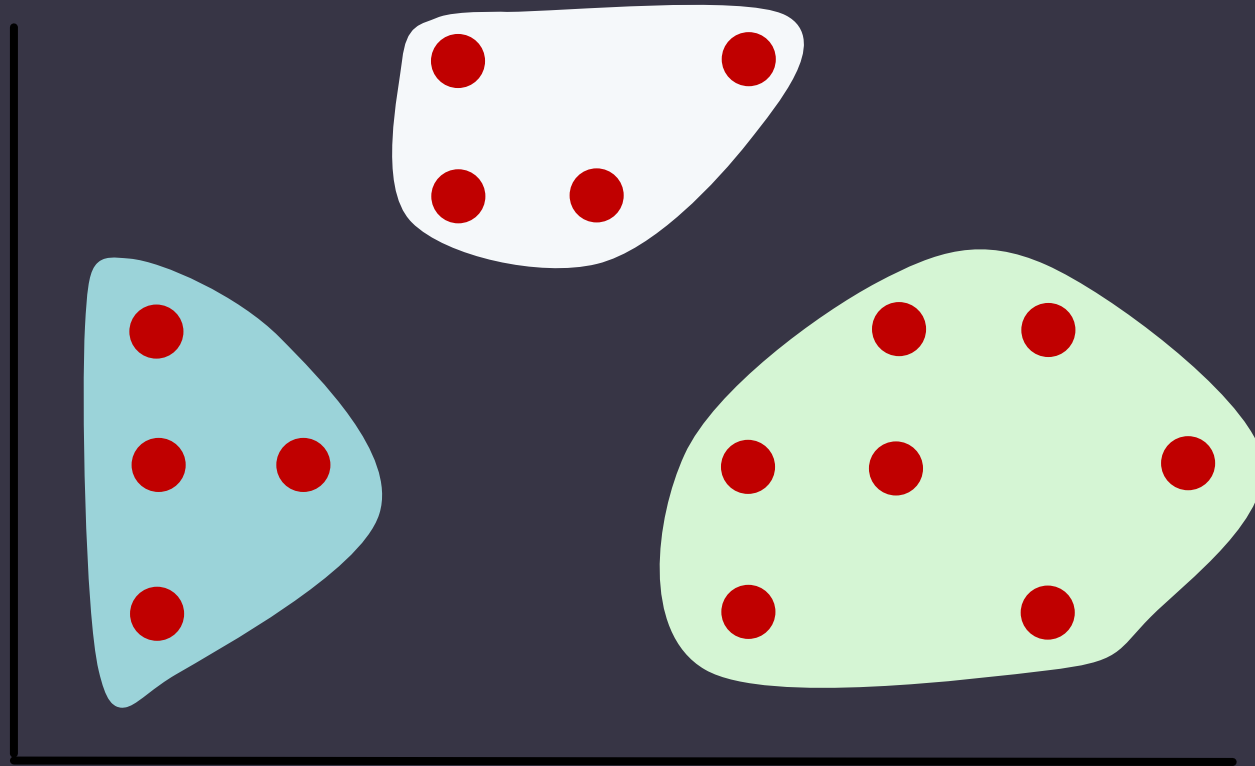
# Example: Points in space



# dimensions small

→ **k-means clustering**

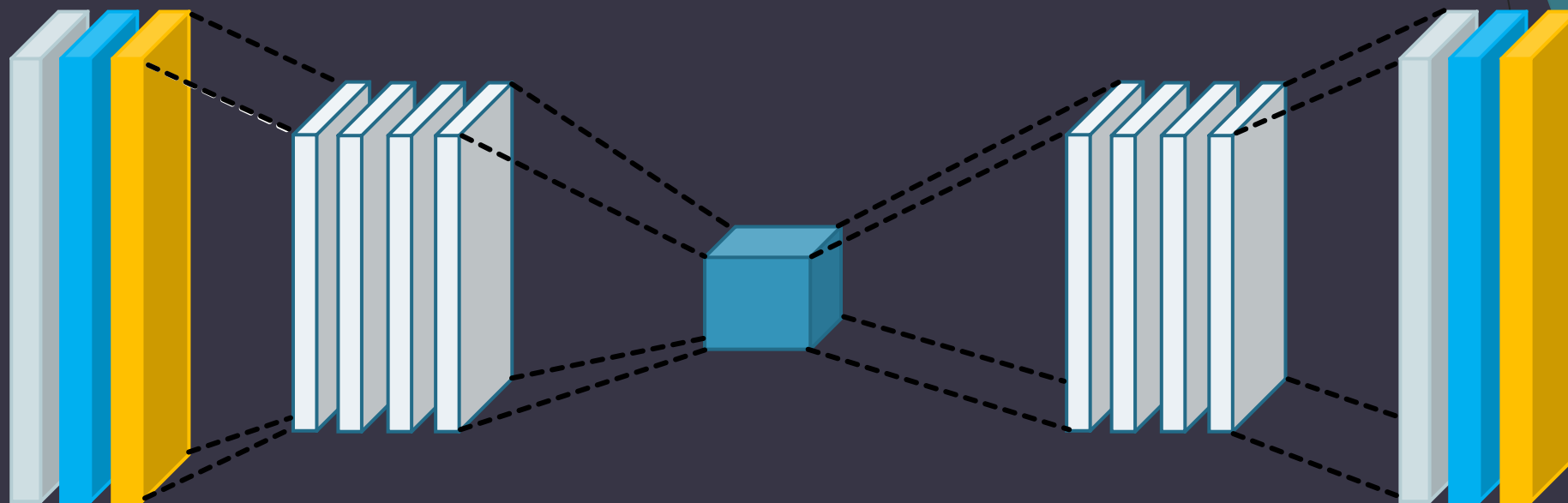
# Example: Points in space



# dimensions large

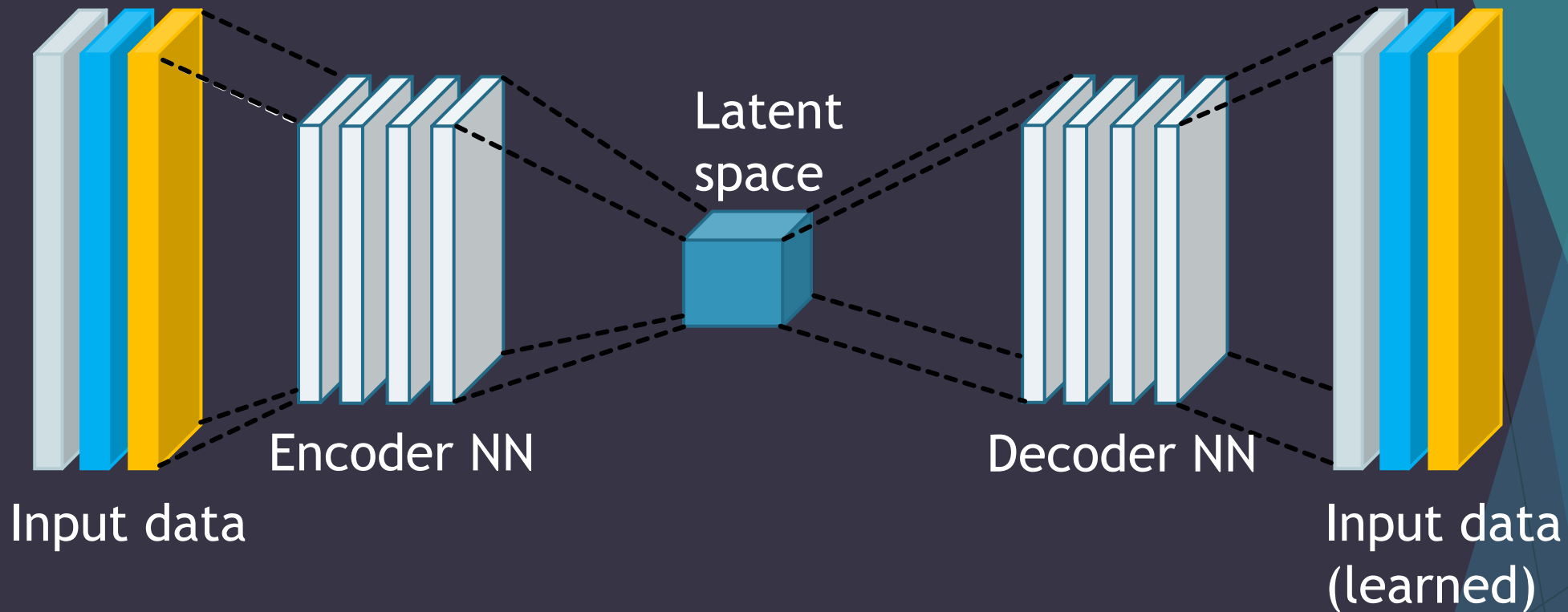
→ **autoencoders** to reduce dimension

# Autoencoders





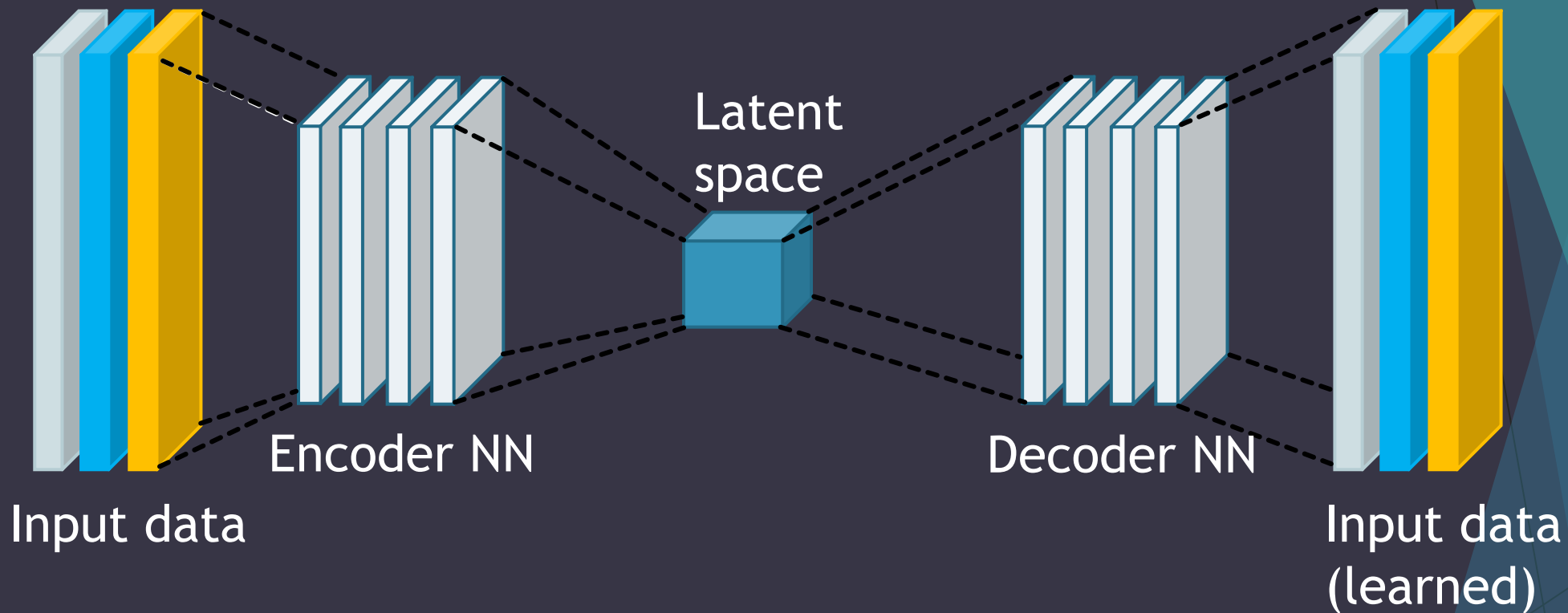
# Autoencoders



Learns unlabeled data

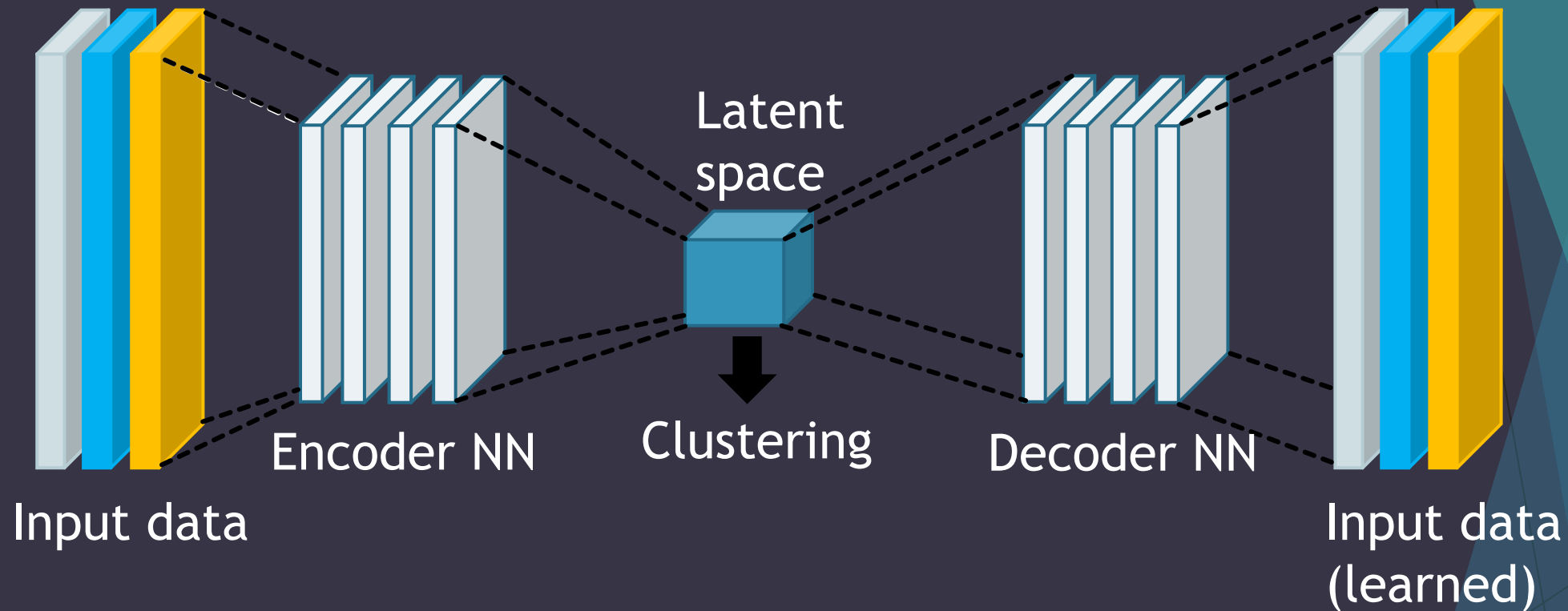
- **Encoder** to transform input data to latent space
- **Decoder** to recreate input data from latent space

# Autoencoders



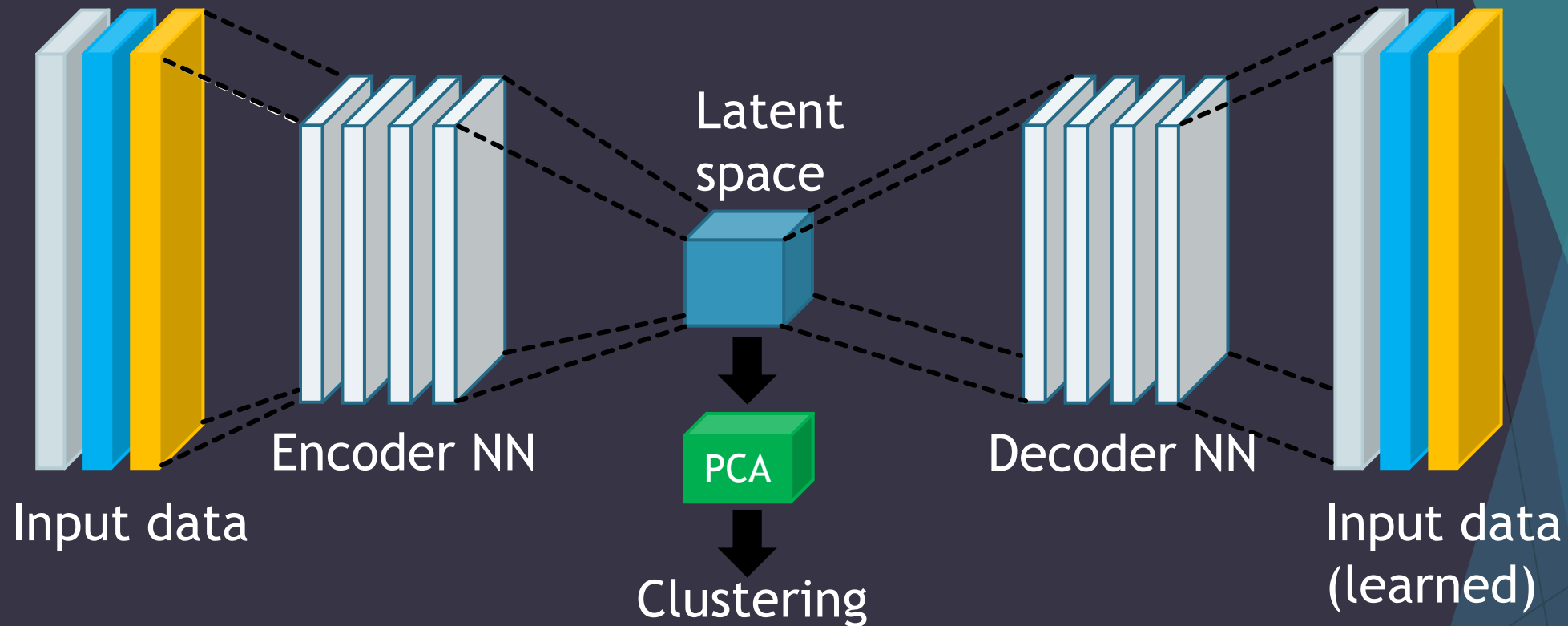
Small **latent space** captures essence of input data

# Autoencoders



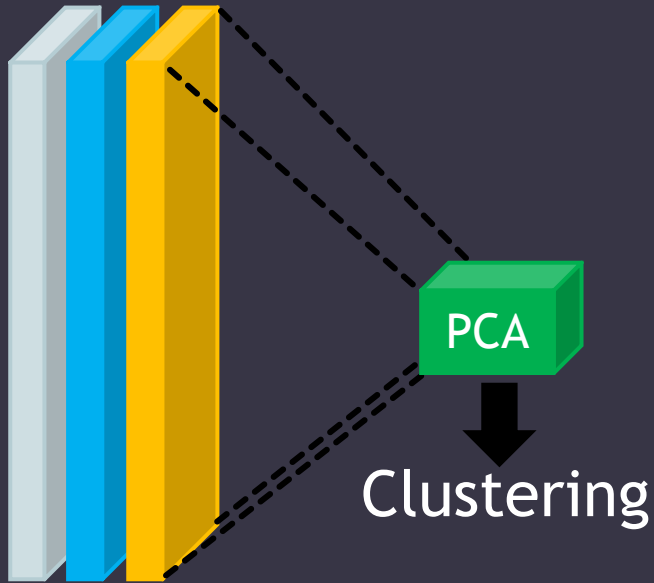
Small latent space captures essence of input data  
Clustering can be performed **on latent space**

# Autoencoders



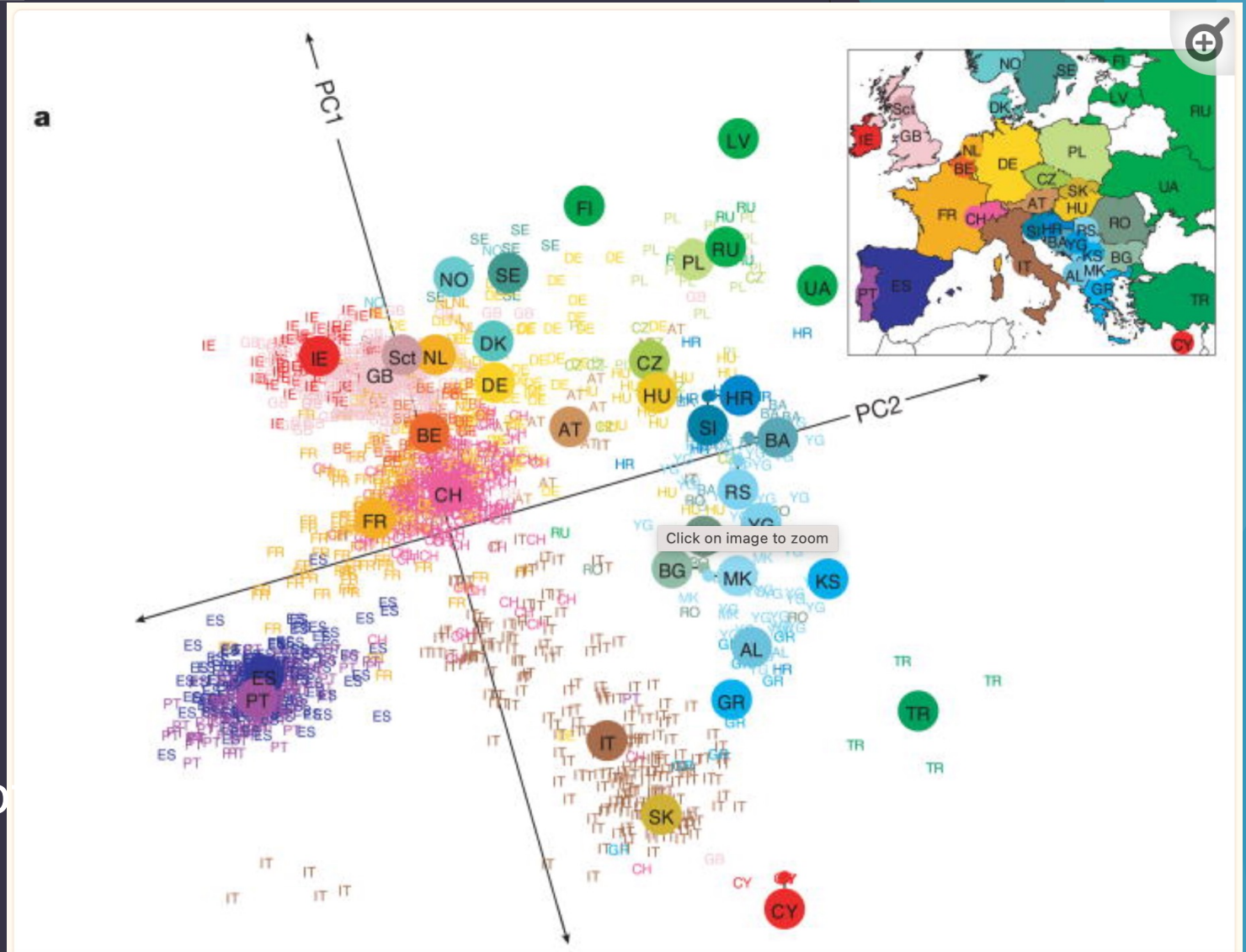
Small latent space captures essence of input data  
Clustering can be performed on PCA of latent space

# PCA Example



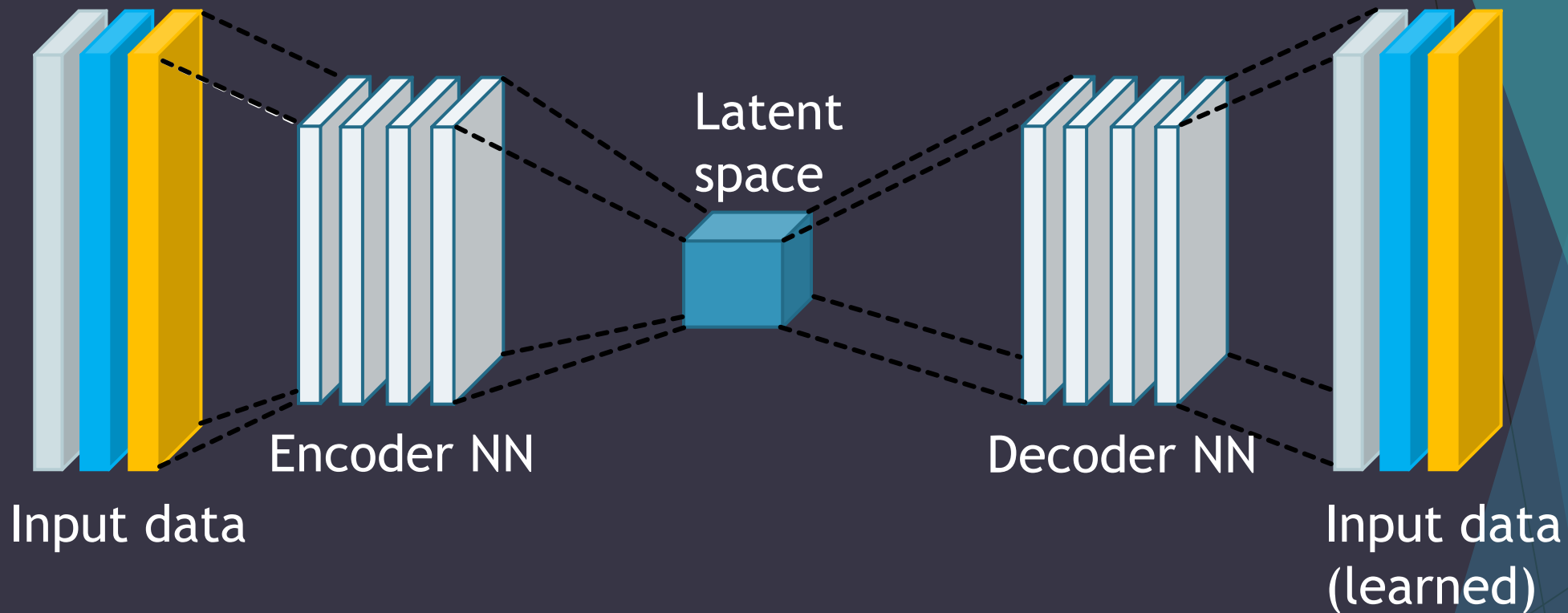
197146 gene loci of 1387 people

PCA of gene loci &  
Geographical proximity (on map of Europe)  
Highly correlated!



\* Nature, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2735096>

# Autoencoders



Example today: MNIST images of handwritten digits

Go to [hhscs.club](https://hhscs.club)