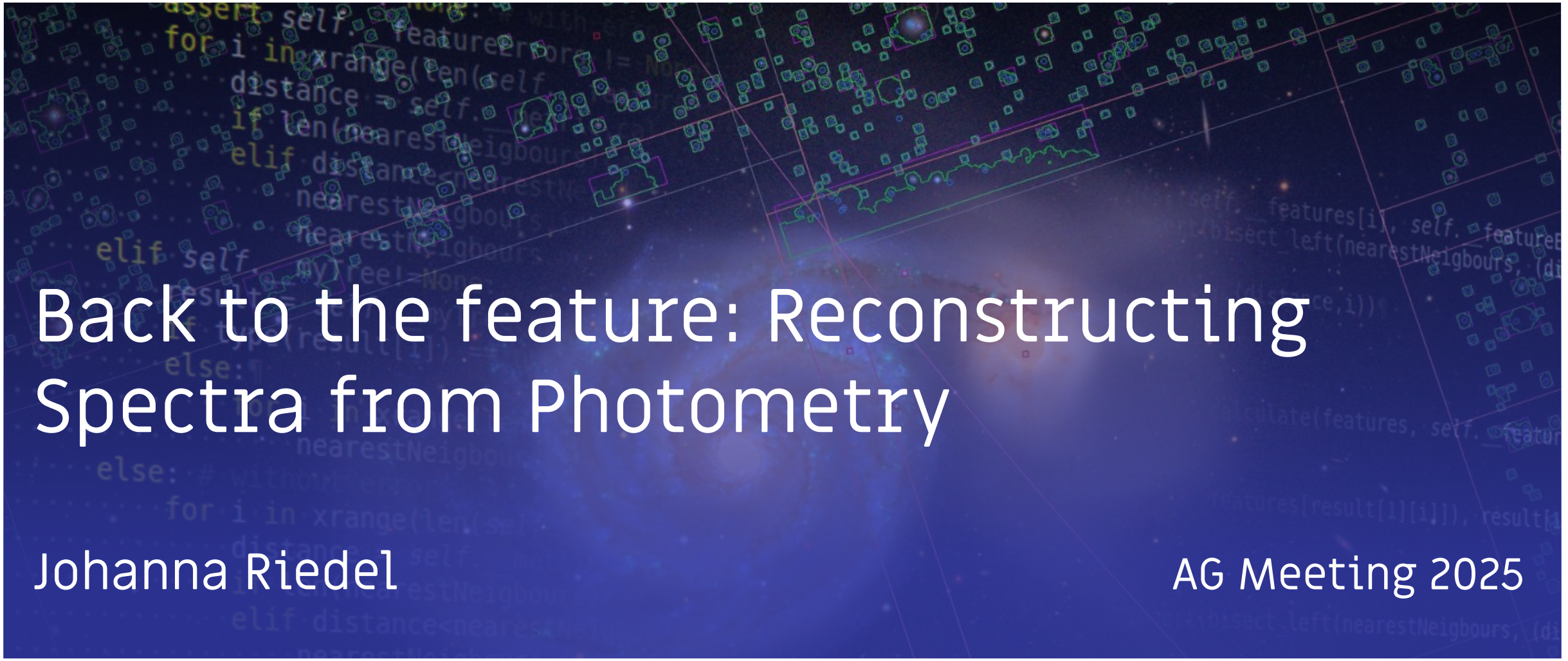
HITS
Heidelberg Institute for Theoretical Studies

AiN

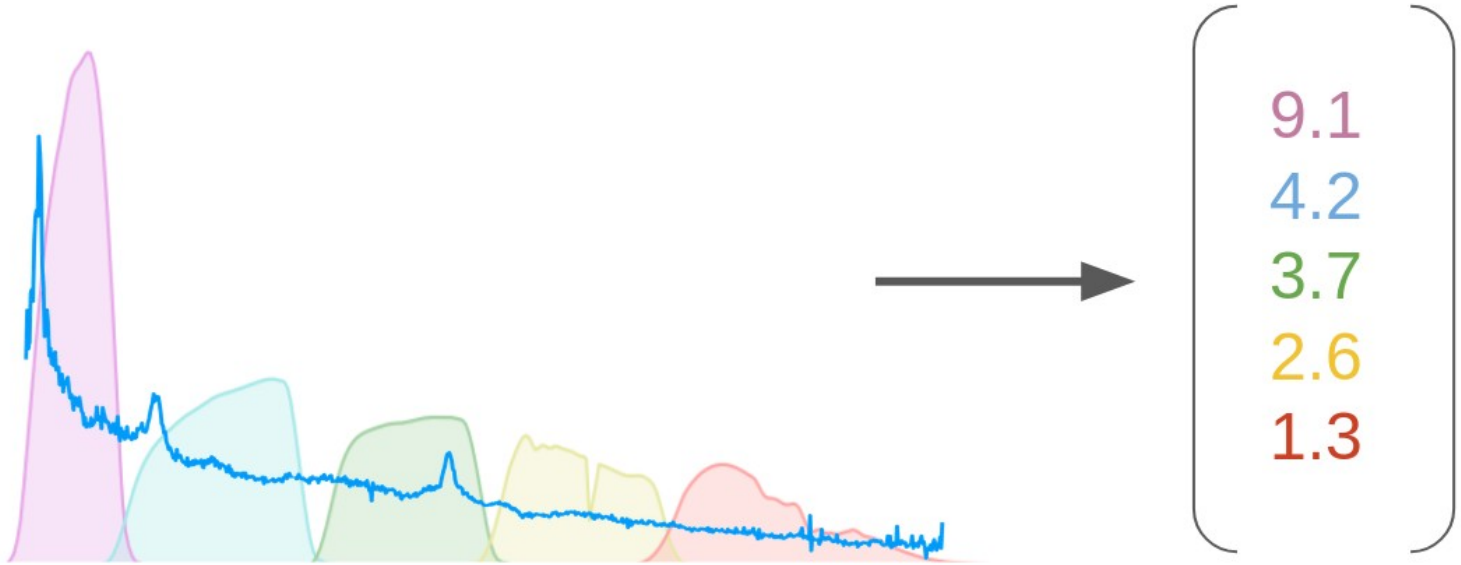


Back to the feature: Reconstructing Spectra from Photometry

Johanna Riedel

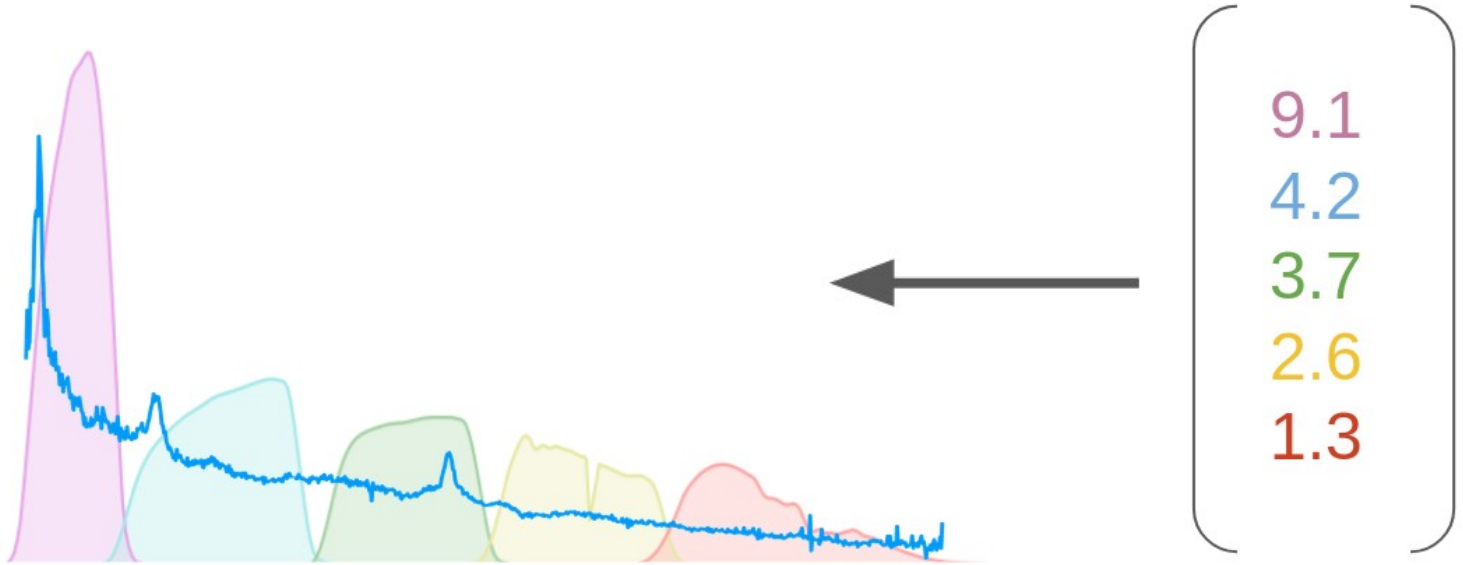
AG Meeting 2025

What is our goal?



Linear operation: $$Fy = \phi$$

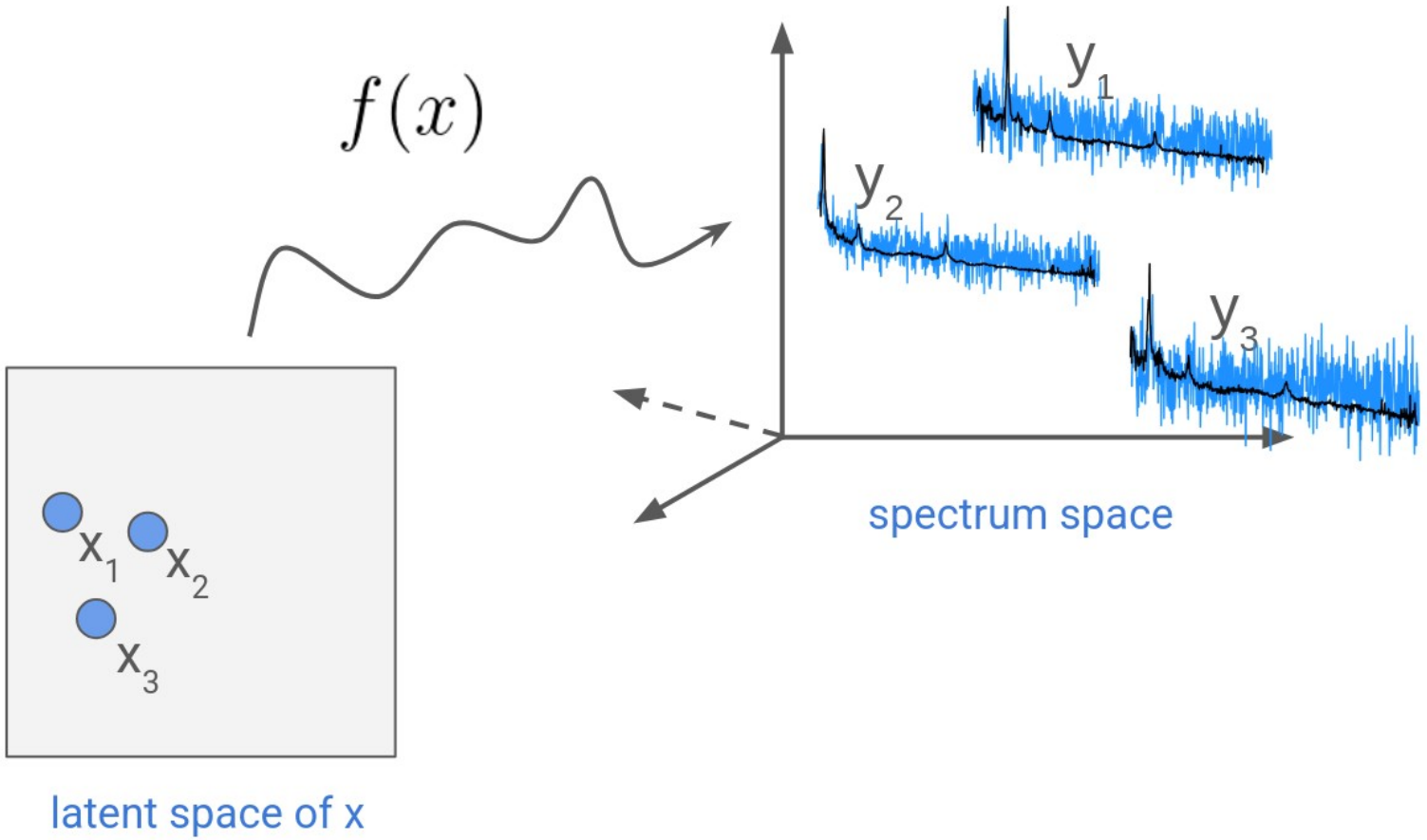
What is our goal?



Inverse problem: We have ϕ and the filter functions F. What is y ?

Two step solution - learn

Optimize: $||f(x) - y||^2$



Two step solution - learn

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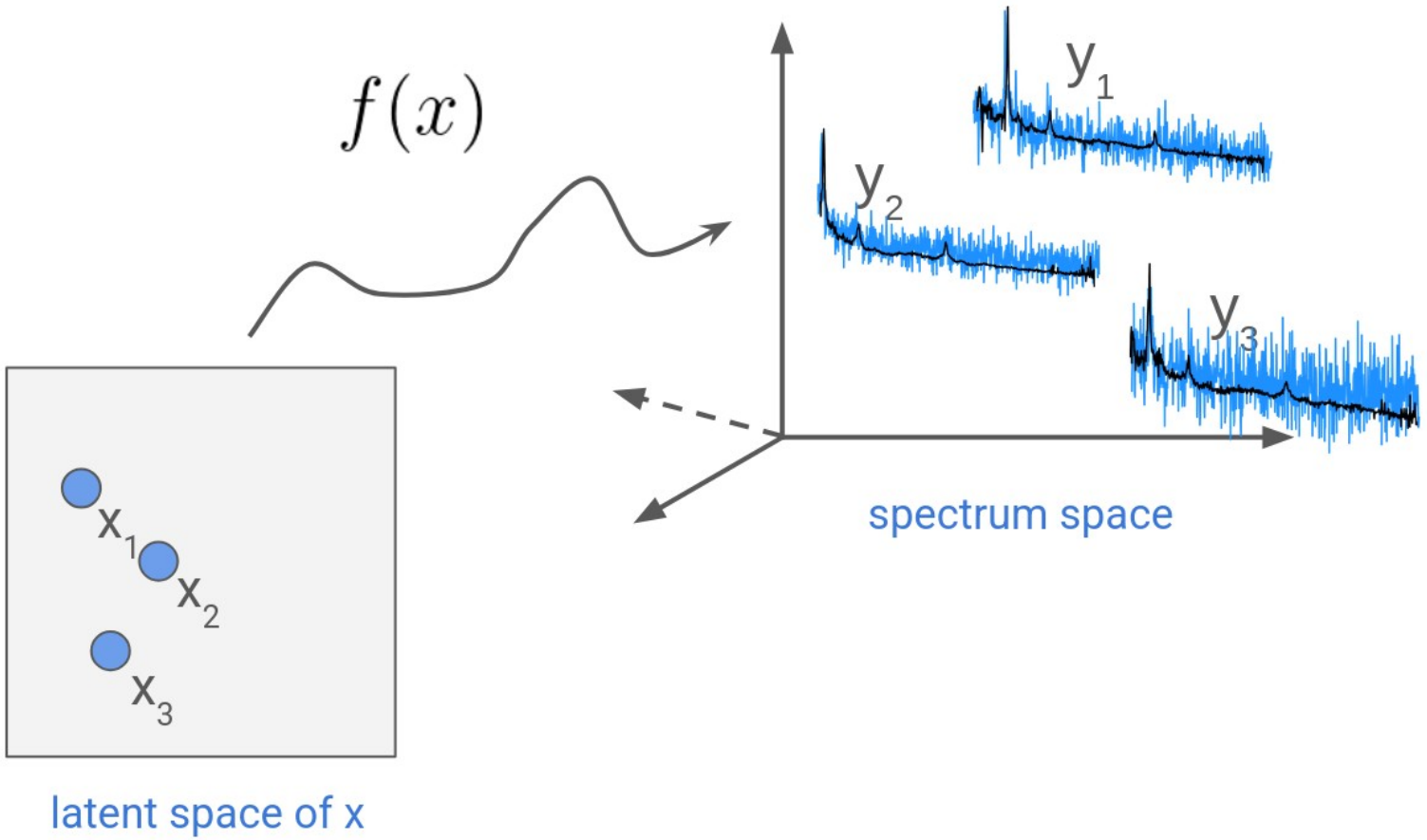

Two step solution - learn

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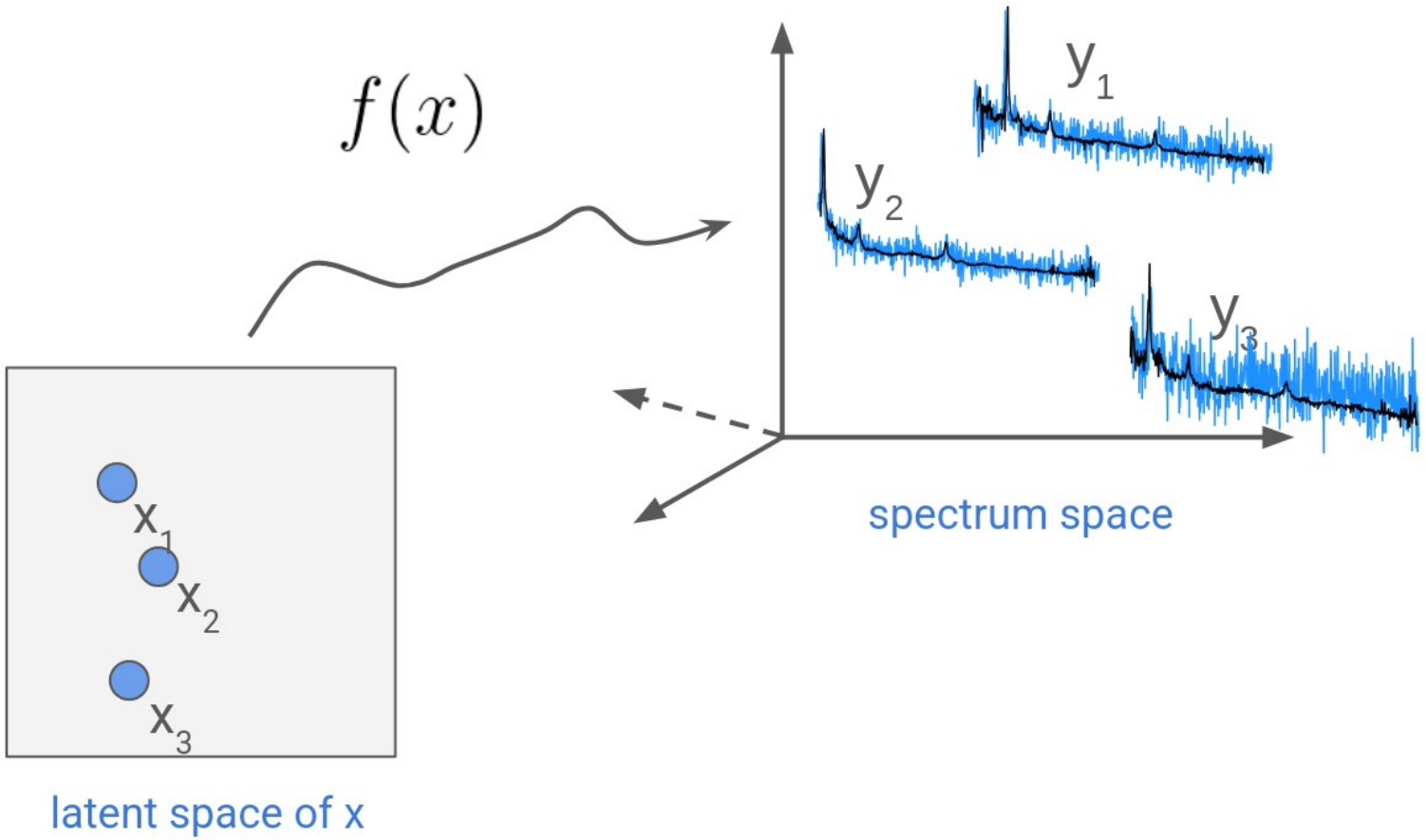

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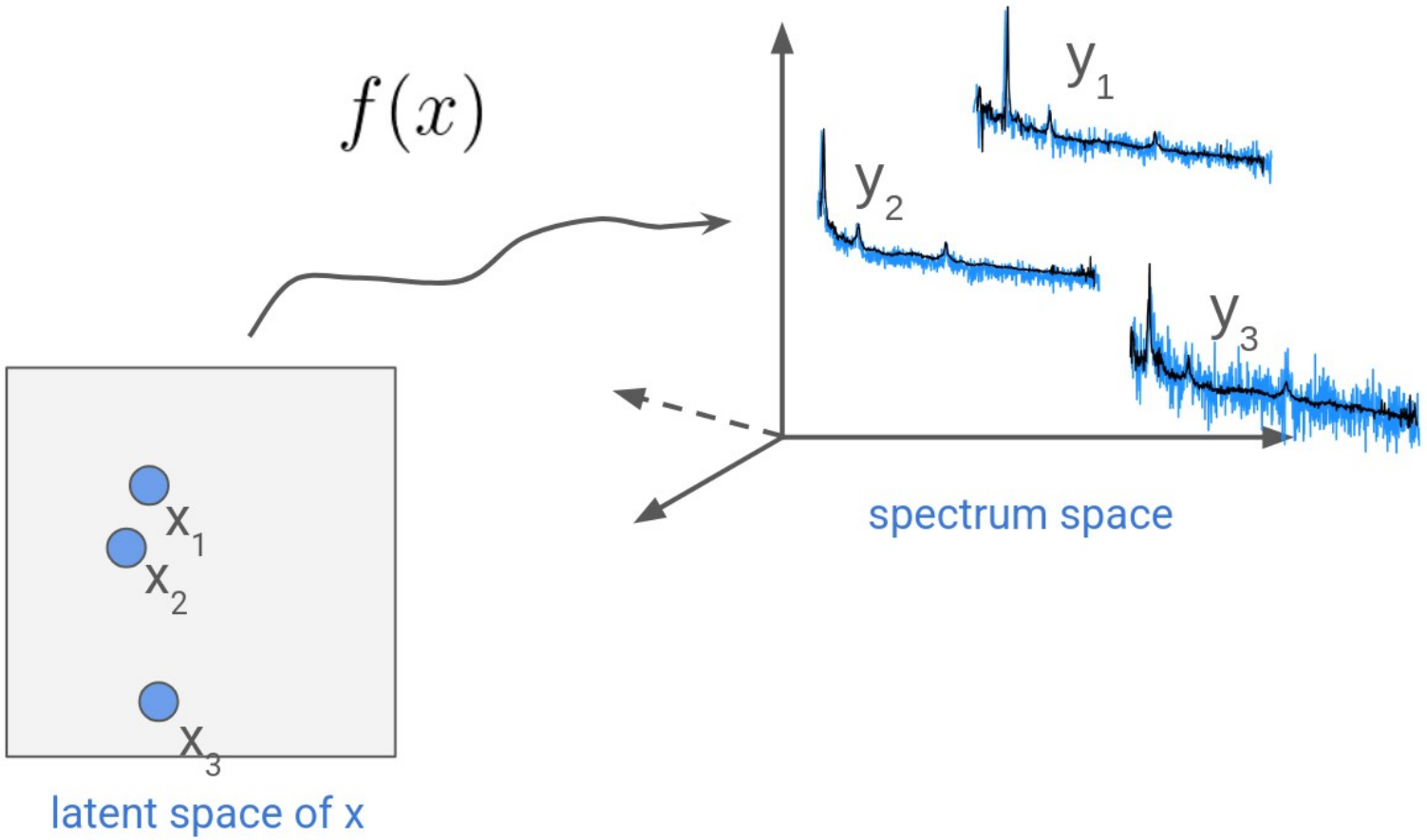
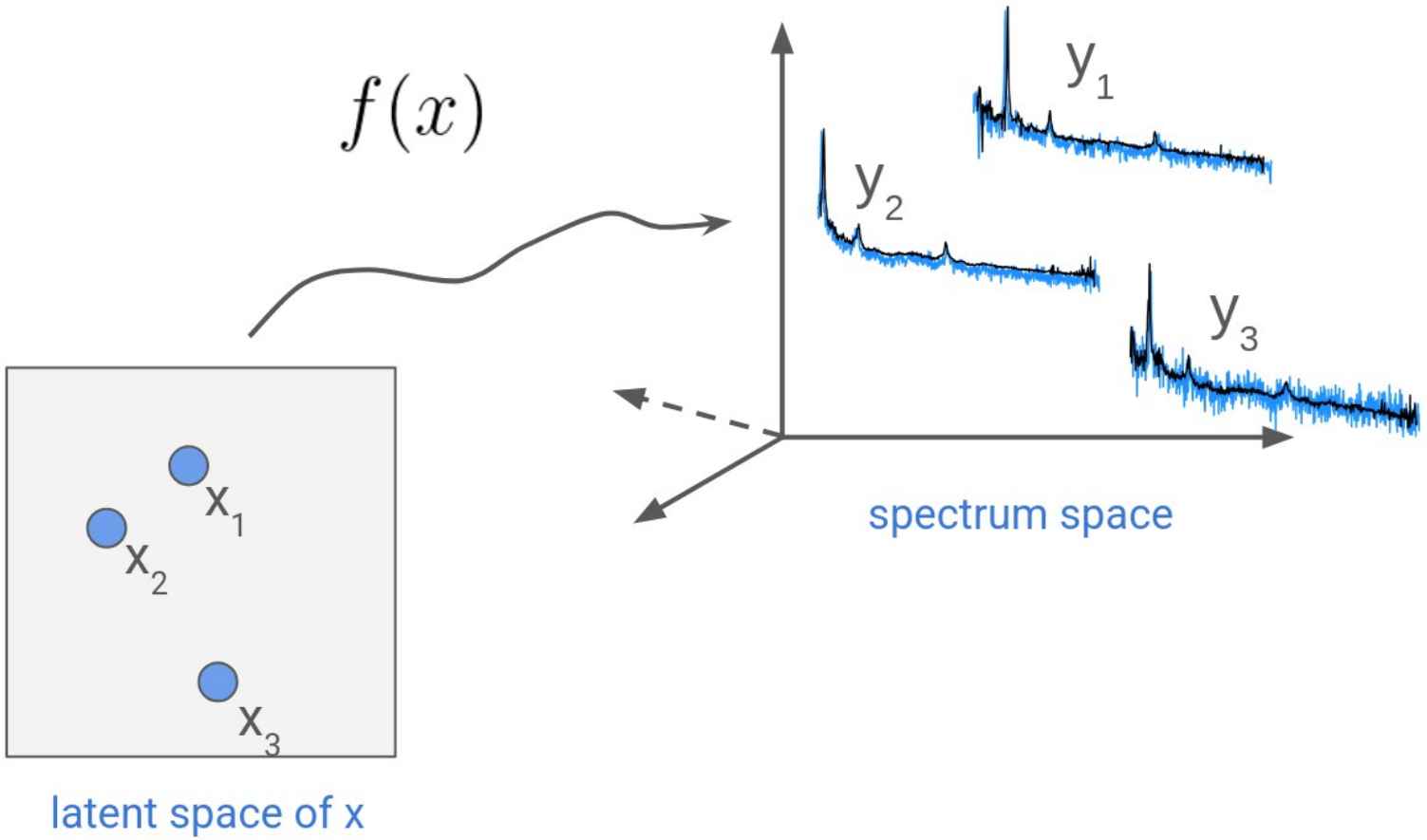


Two step solution - learn

Optimize: $||f(x) - y||^2$



Two step solution - learn

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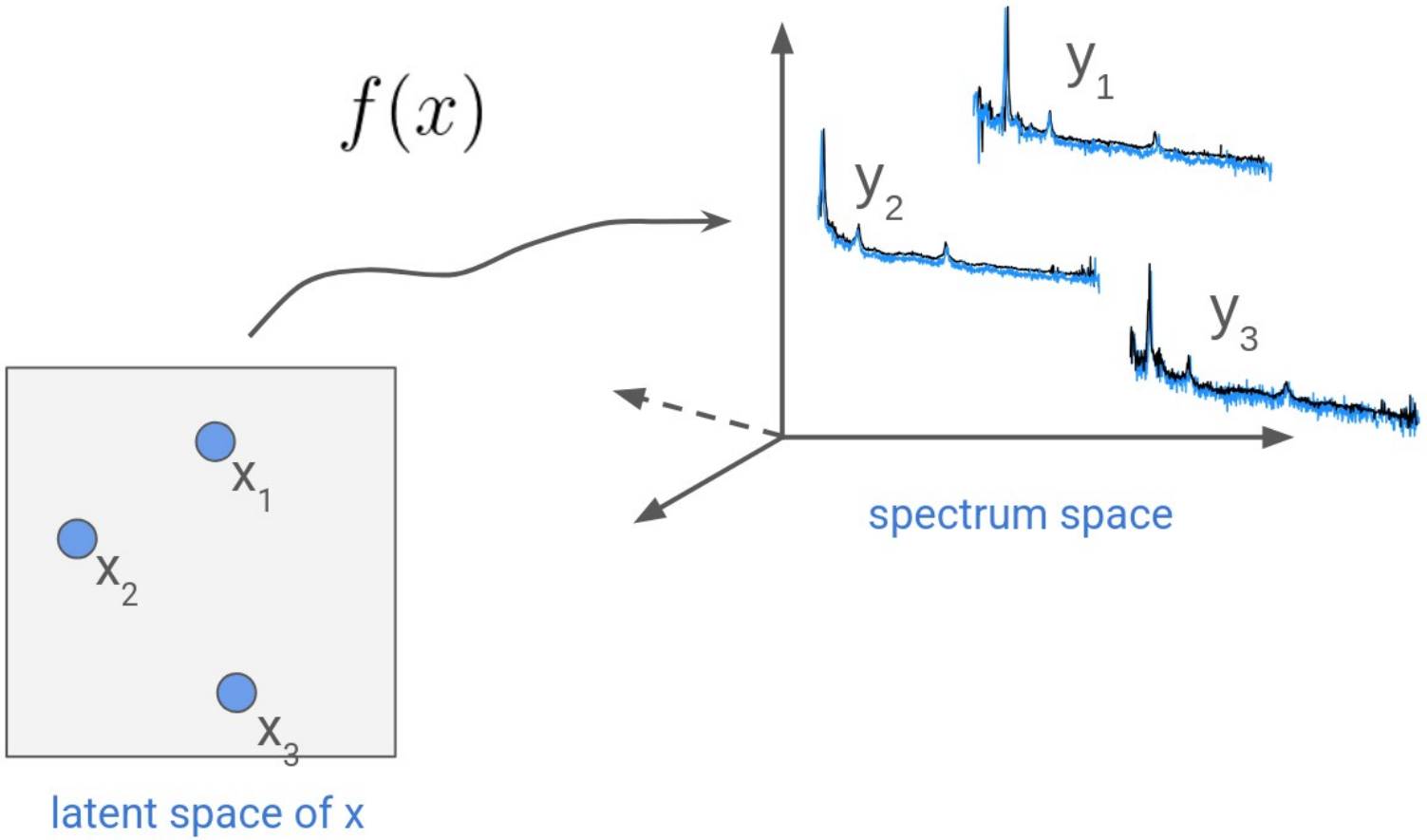
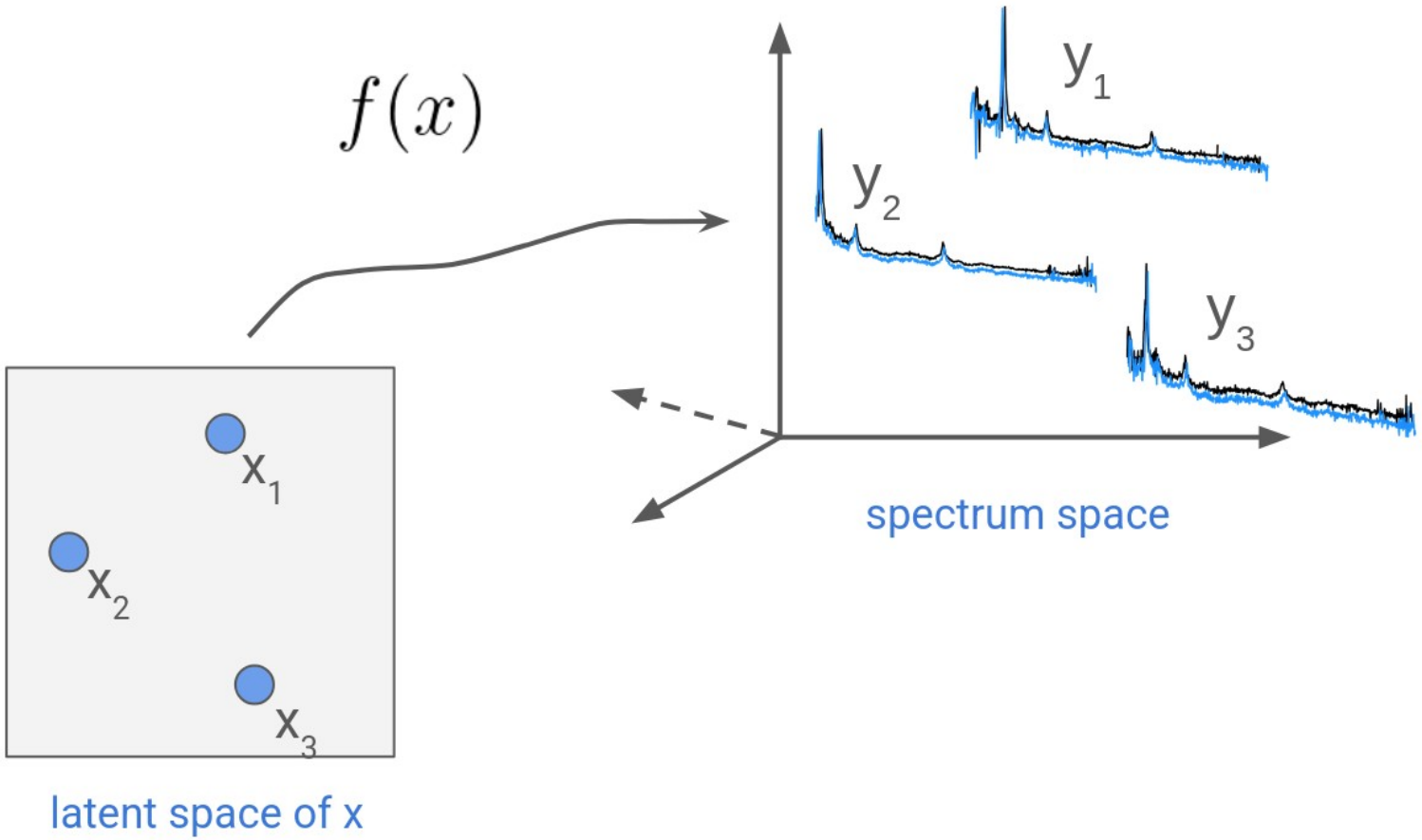


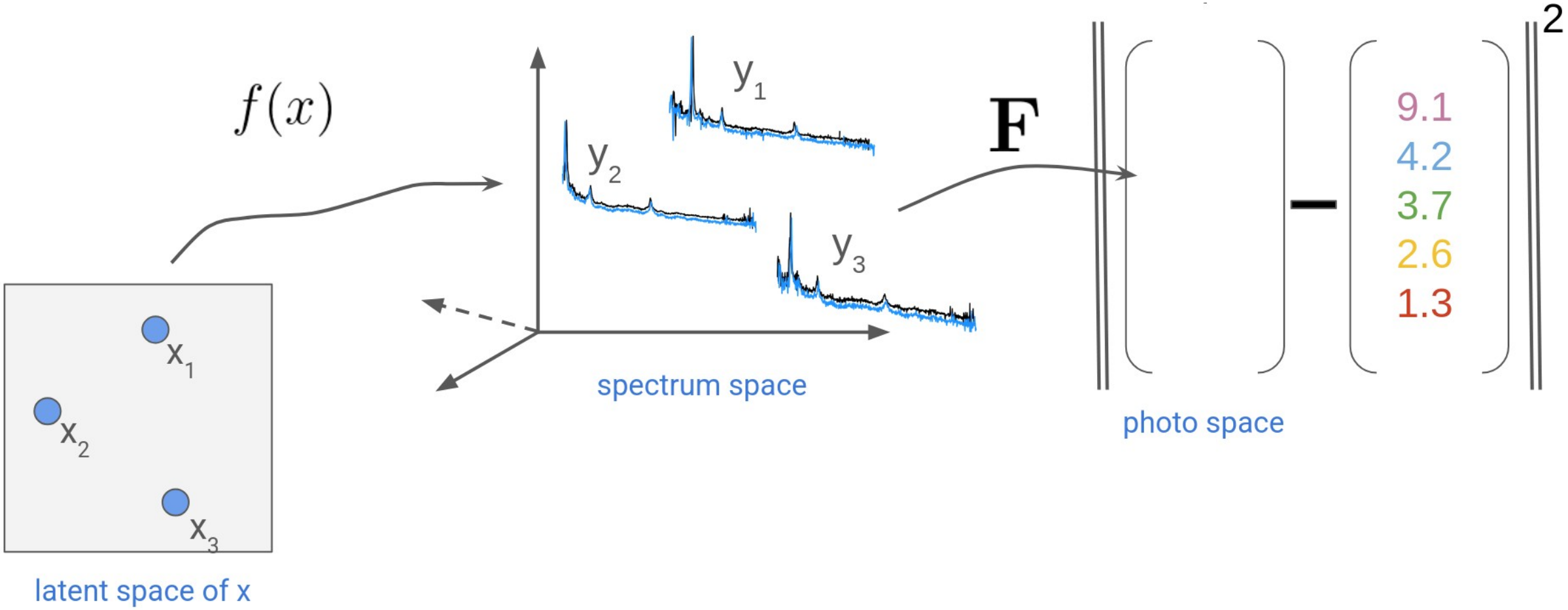
Two step solution - learn

Optimize: $||f(x) - y||^2$



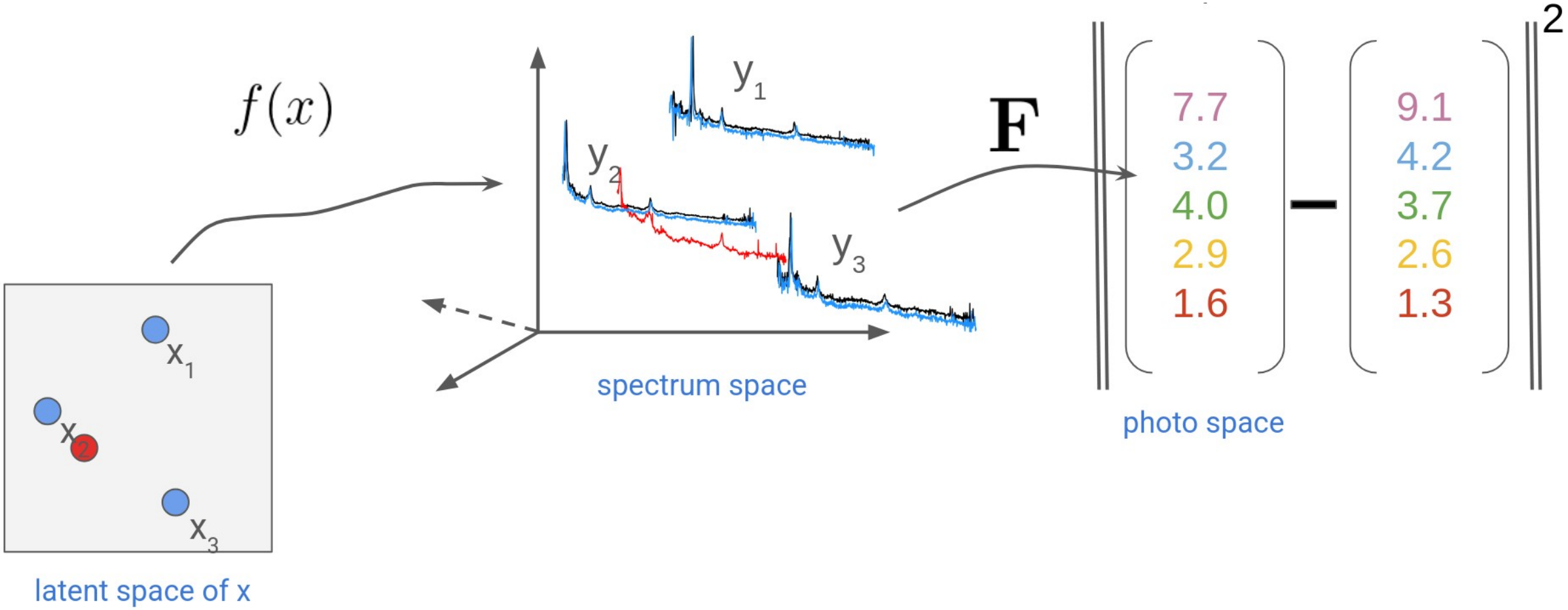
Two step solution - learn

Optimize: $||f(x) - y||^2$



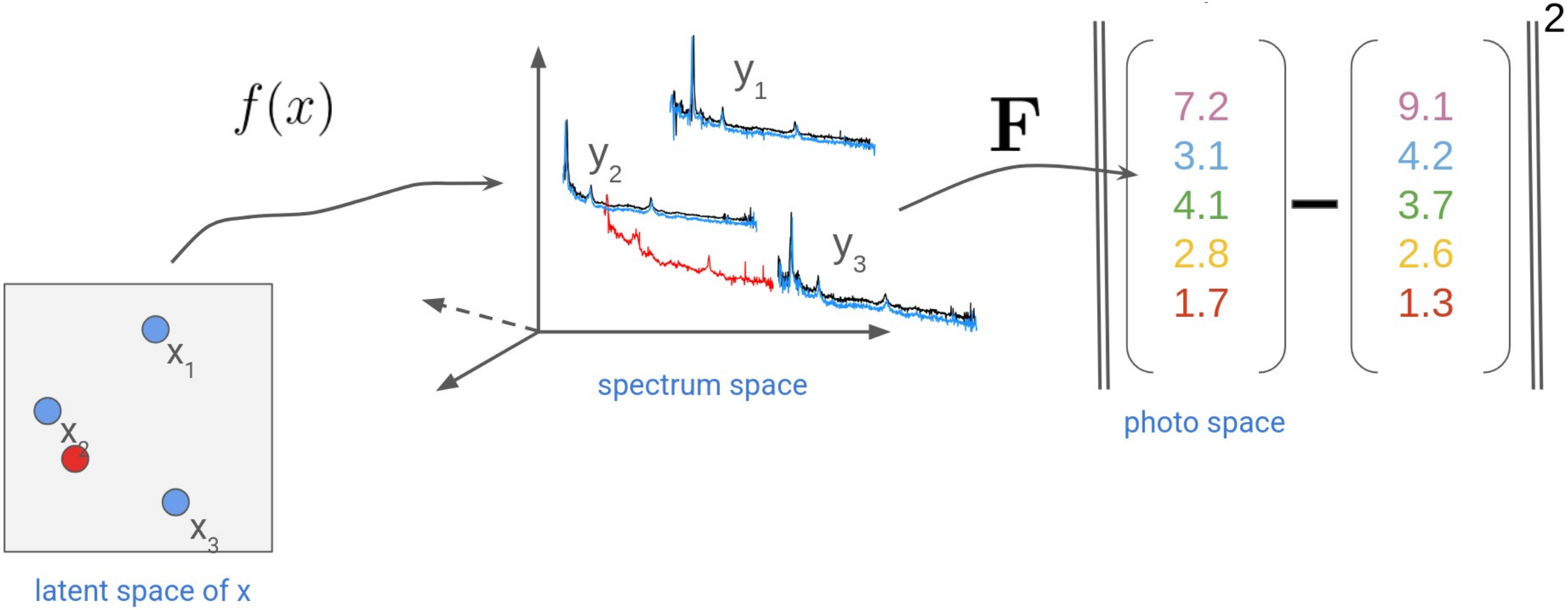
Two step solution - infer

Optimize: $||f(x) - y||^2$



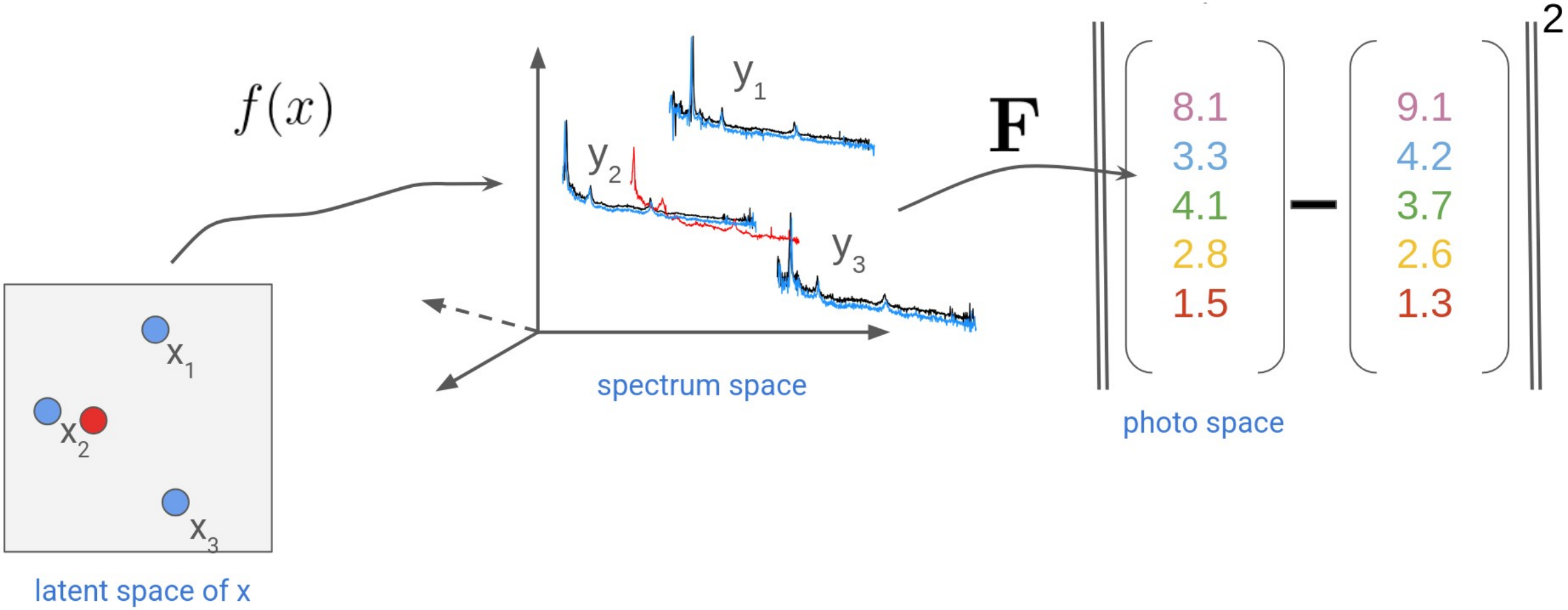
Two step solution - infer

Optimize: $\cancel{||f(x) - y||^2}$ $||Ff(x) - \phi||^2$



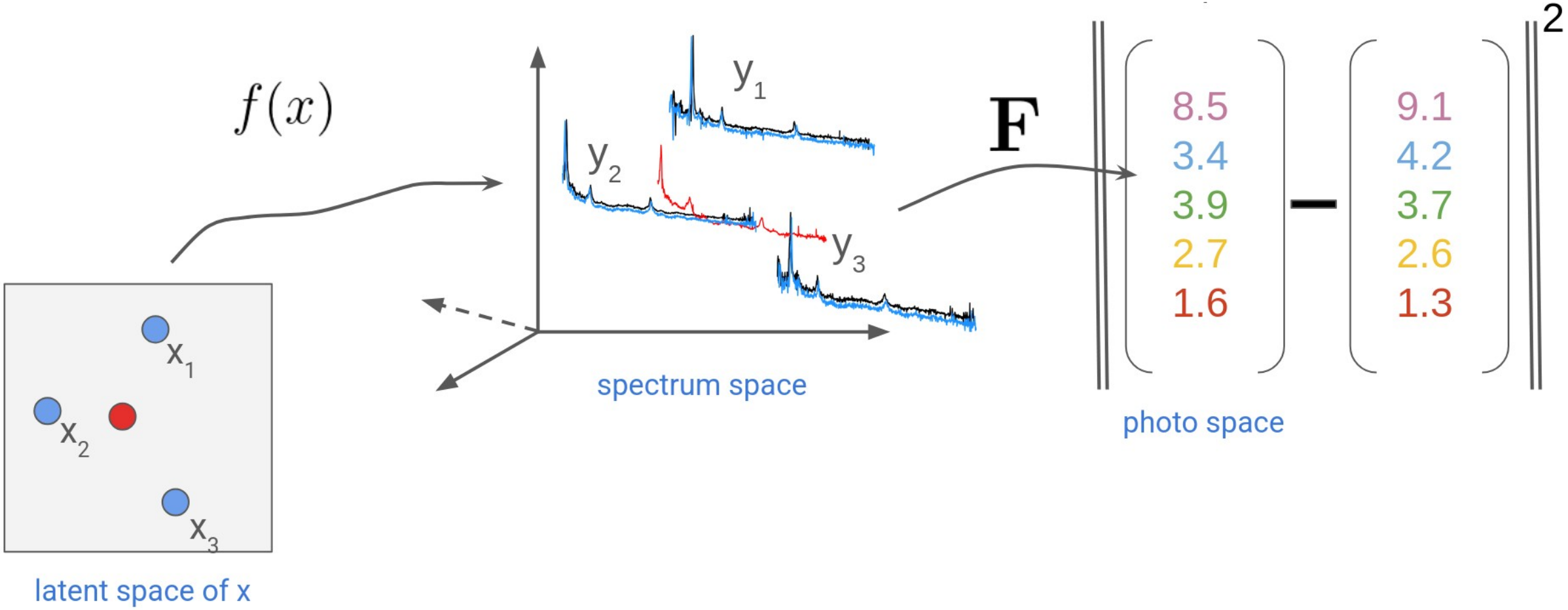
Two step solution - infer

Optimize: ~~$||f(x) - y||^2$~~ $||Ff(x) - \phi||^2$



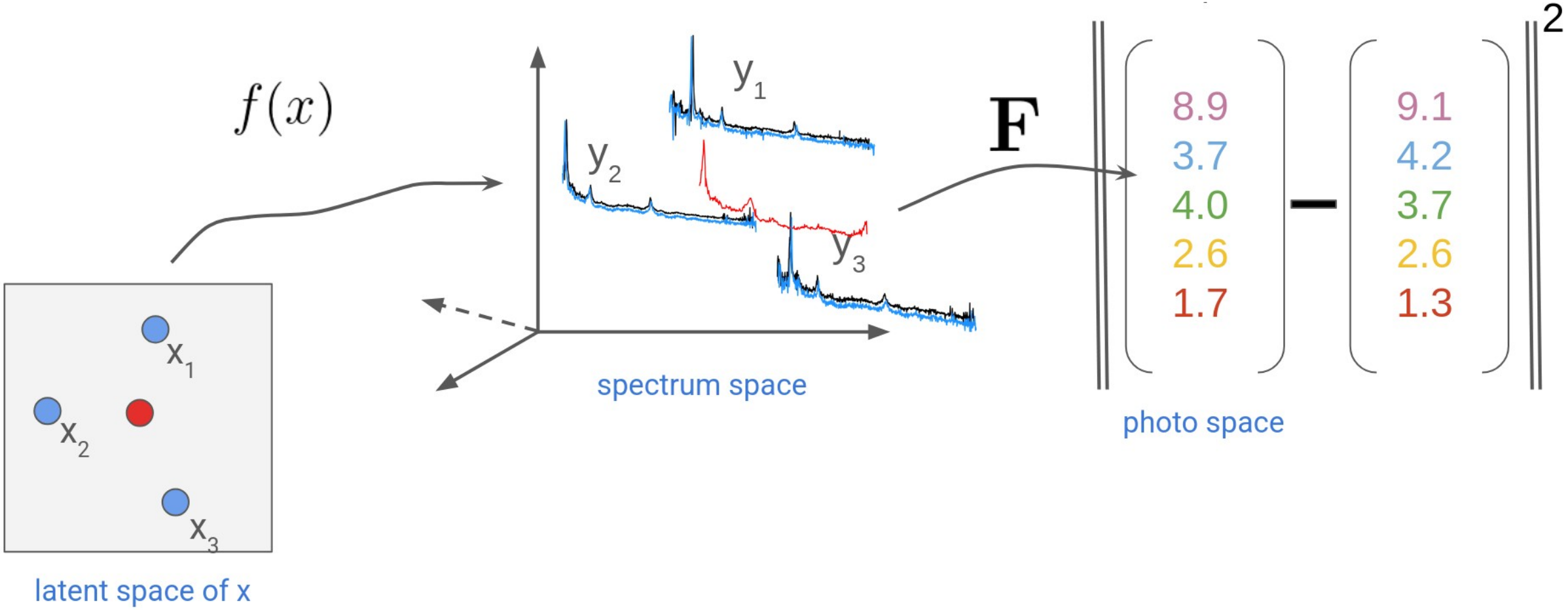
Two step solution - infer

Optimize: ~~$||f(x) - y||^2$~~ $||Ff(x) - \phi||^2$



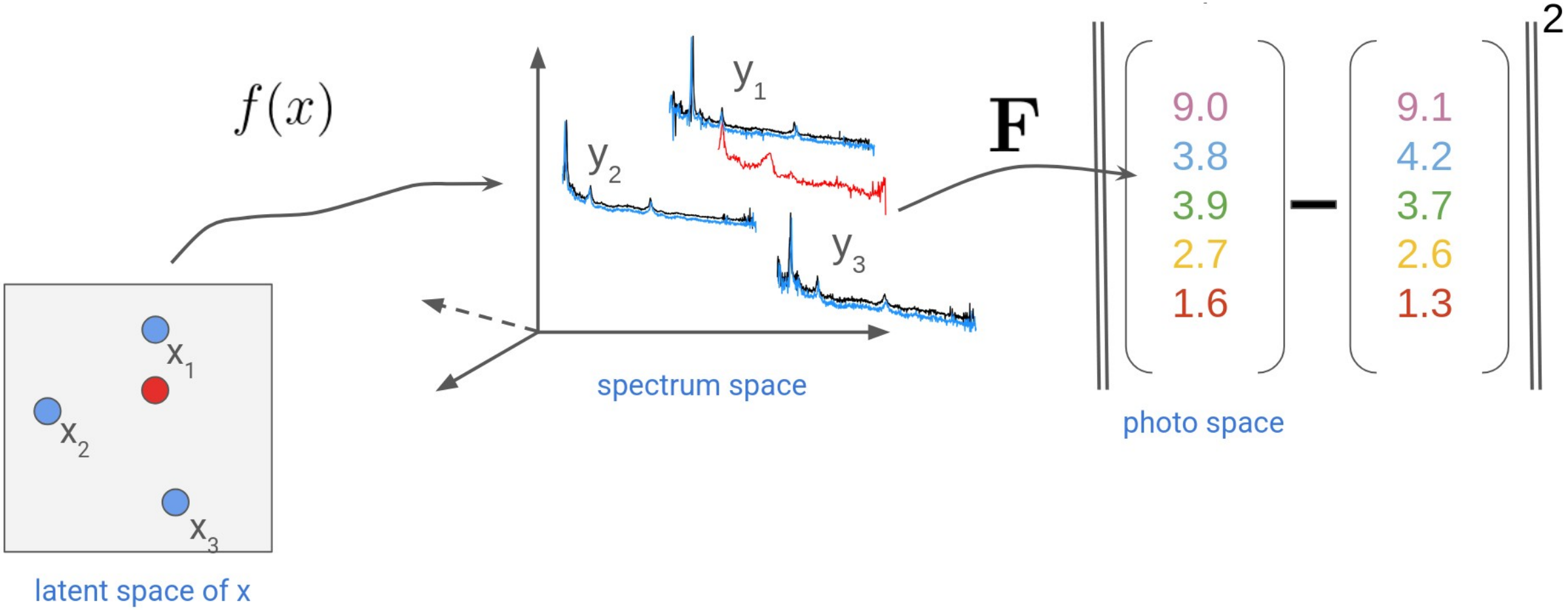
Two step solution - infer

Optimize: ~~$||f(x) - y||^2$~~ $||Ff(x) - \phi||^2$



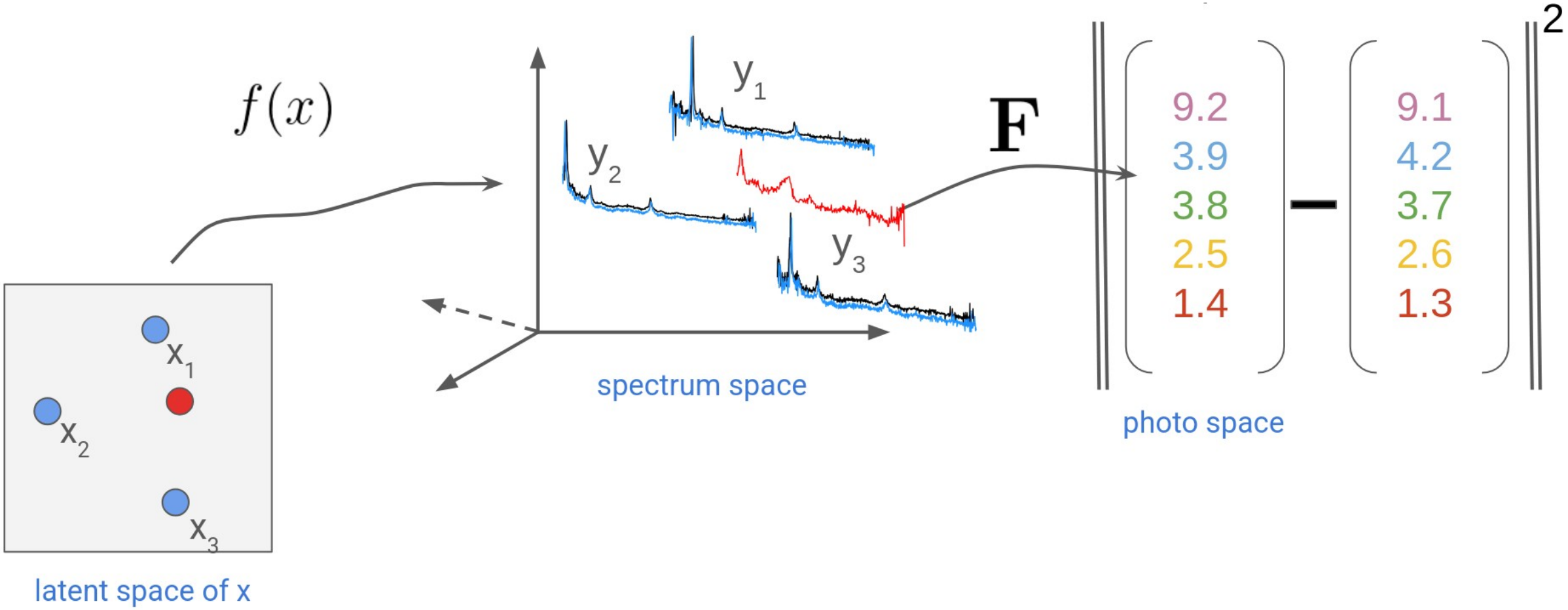
Two step solution - infer

Optimize: ~~$||f(x) - y||^2$~~ $||Ff(x) - \phi||^2$

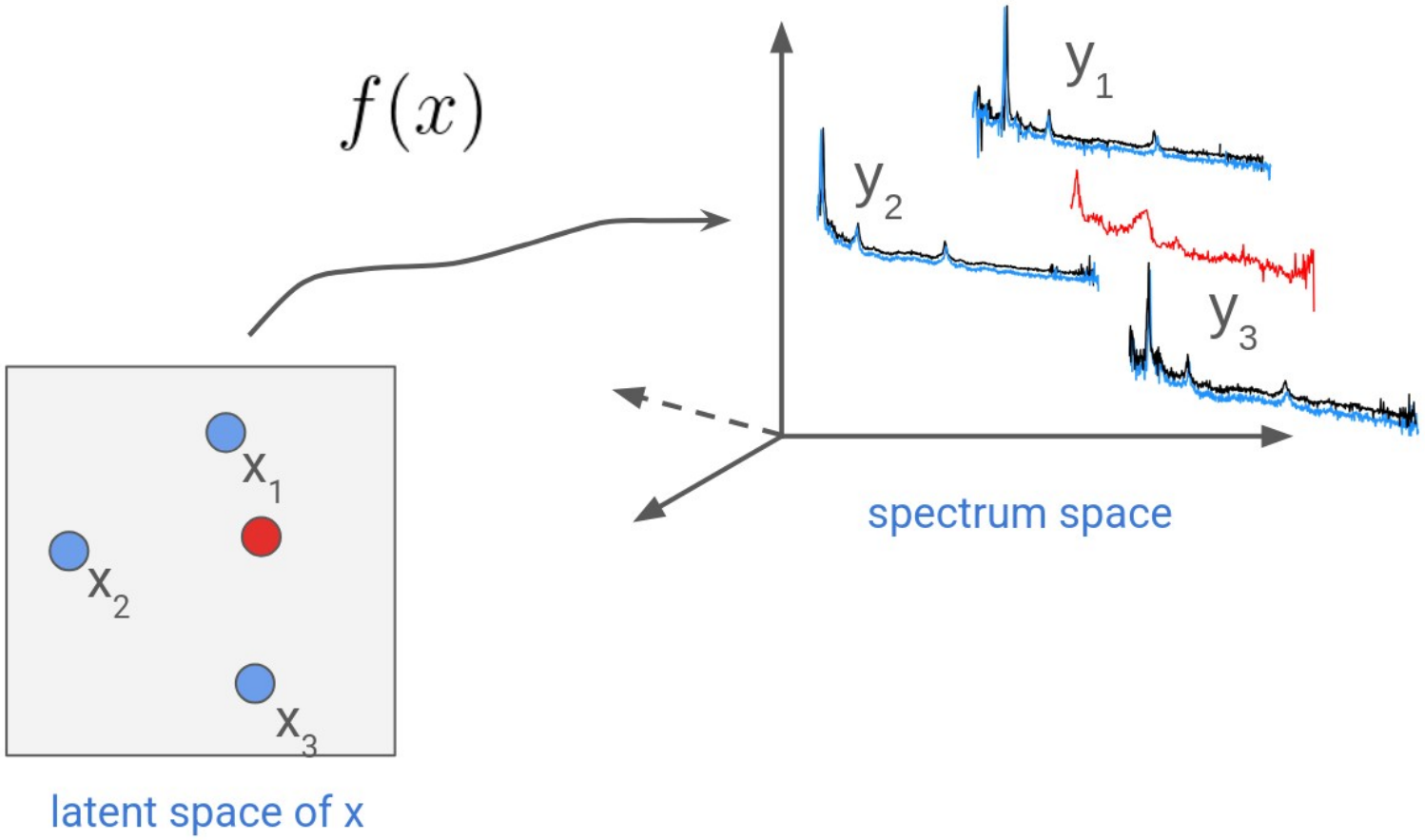


Two step solution - infer

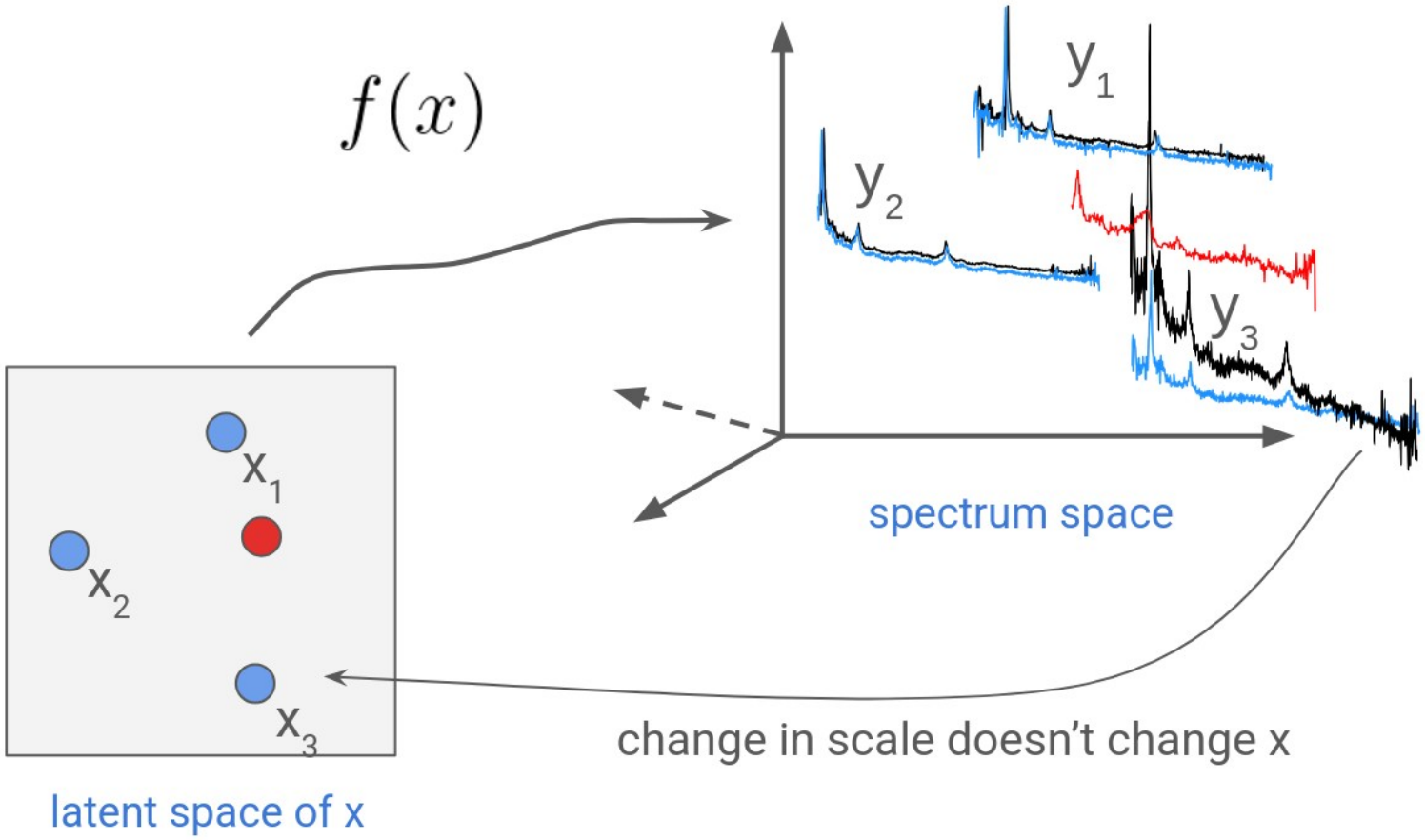
Optimize: ~~$||f(x) - y||^2$~~ $||Ff(x) - \phi||^2$



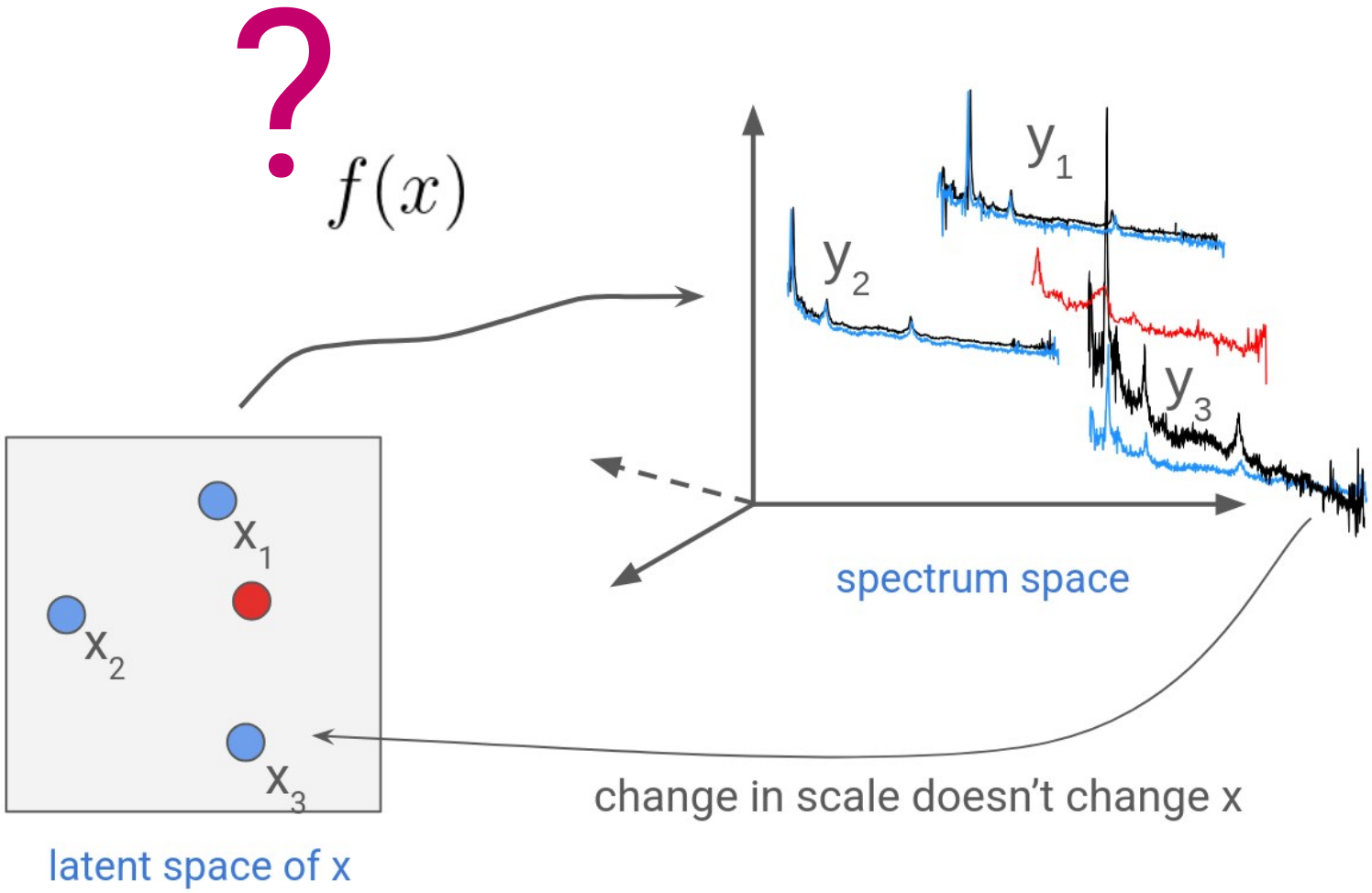
Scale invariance



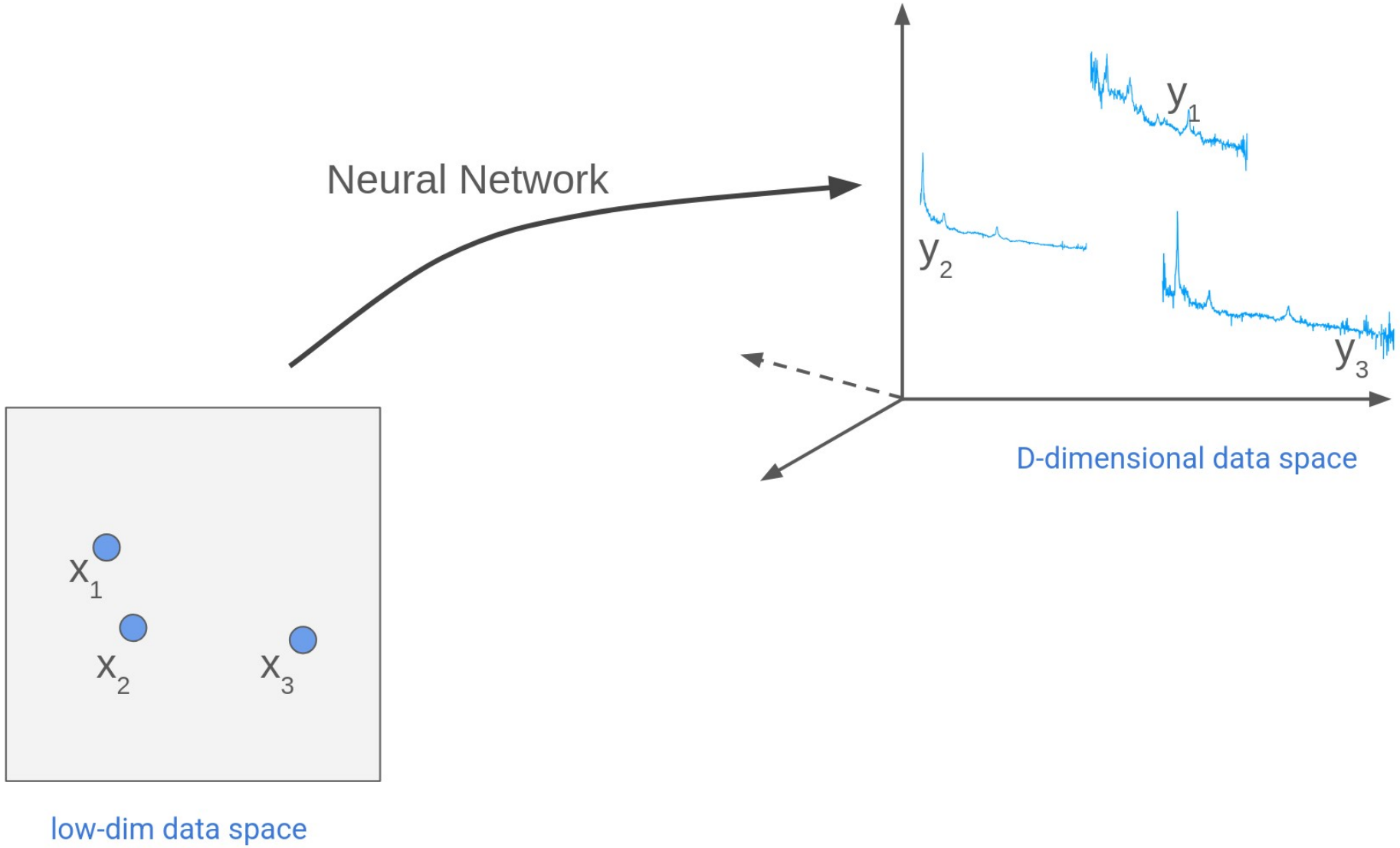
Scale invariance



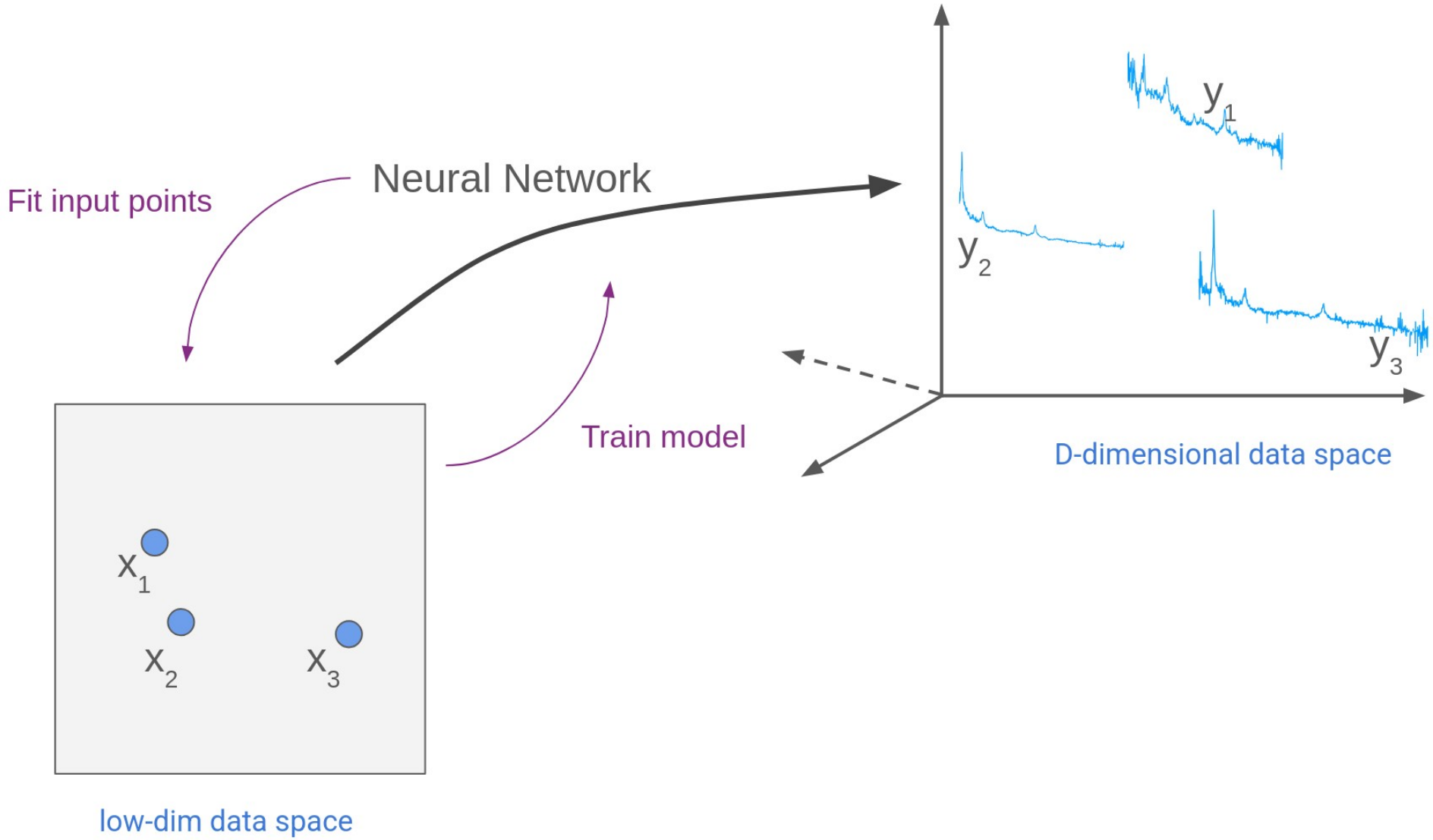
How to model f?



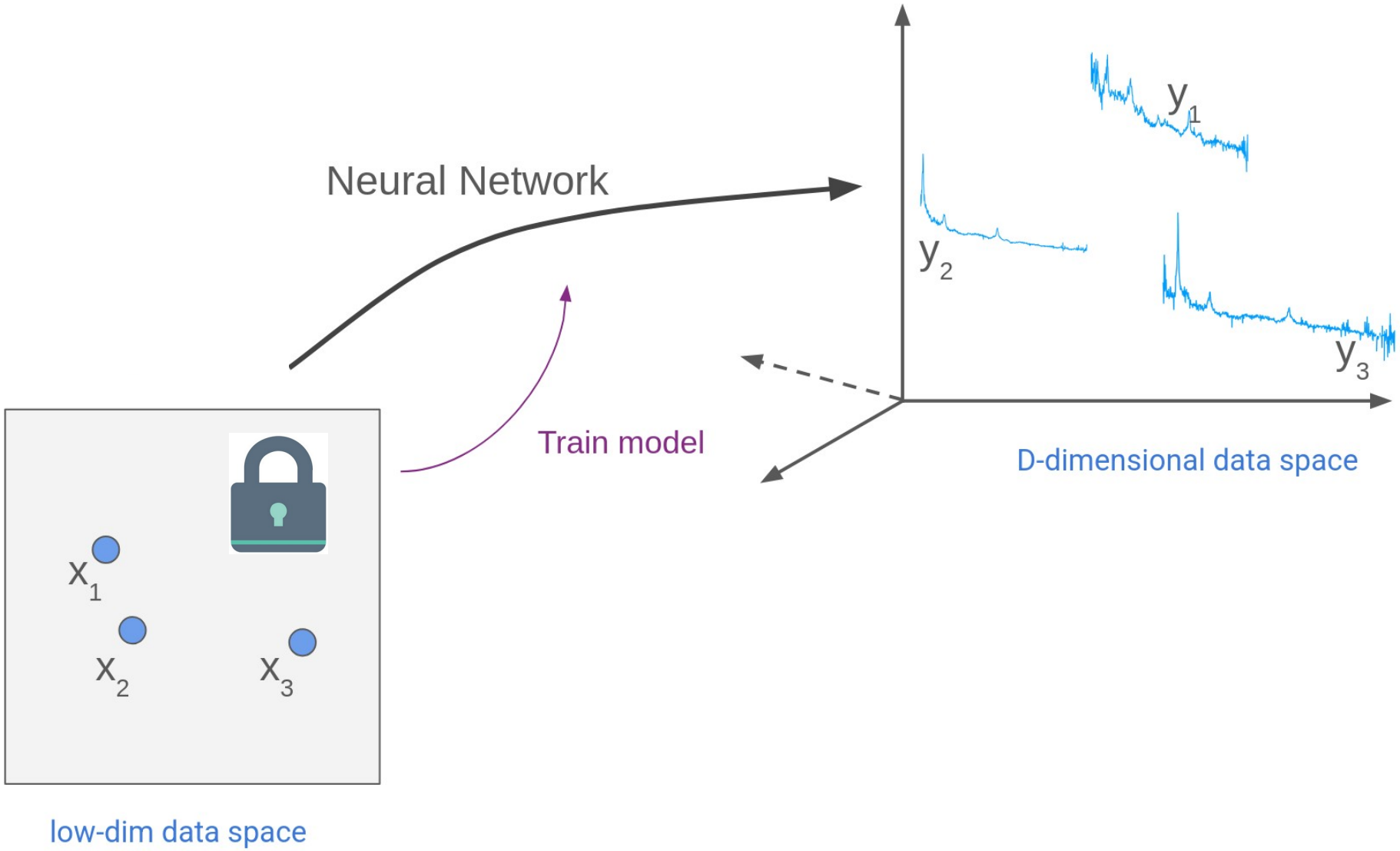
Latent variable modelling



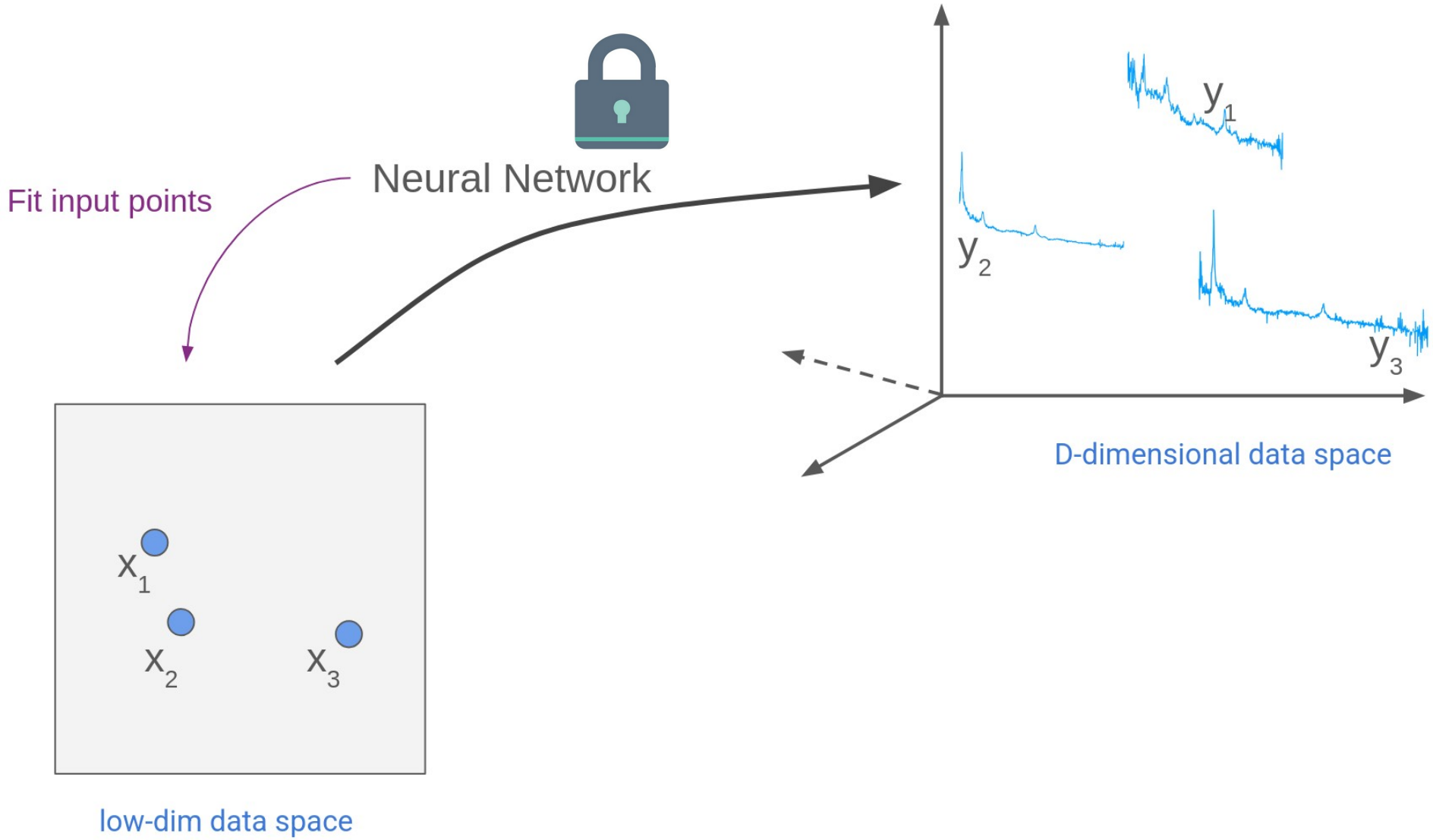
Latent variable modelling



Latent variable modelling

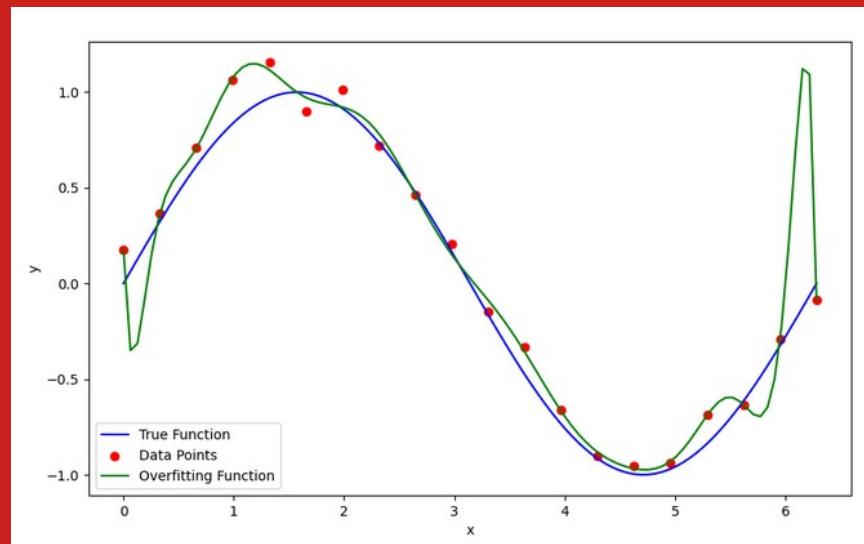


Latent variable modelling



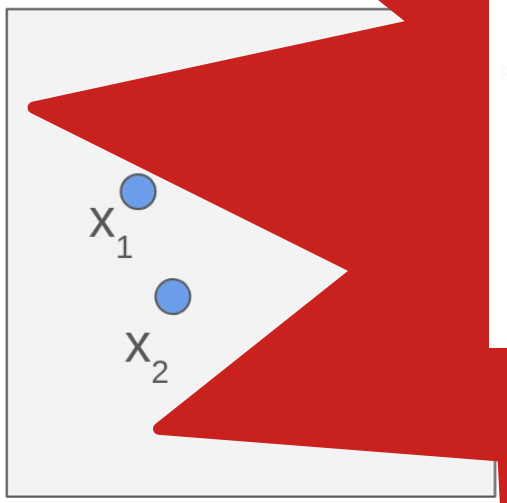
Latent variable modelling

Overfitting!



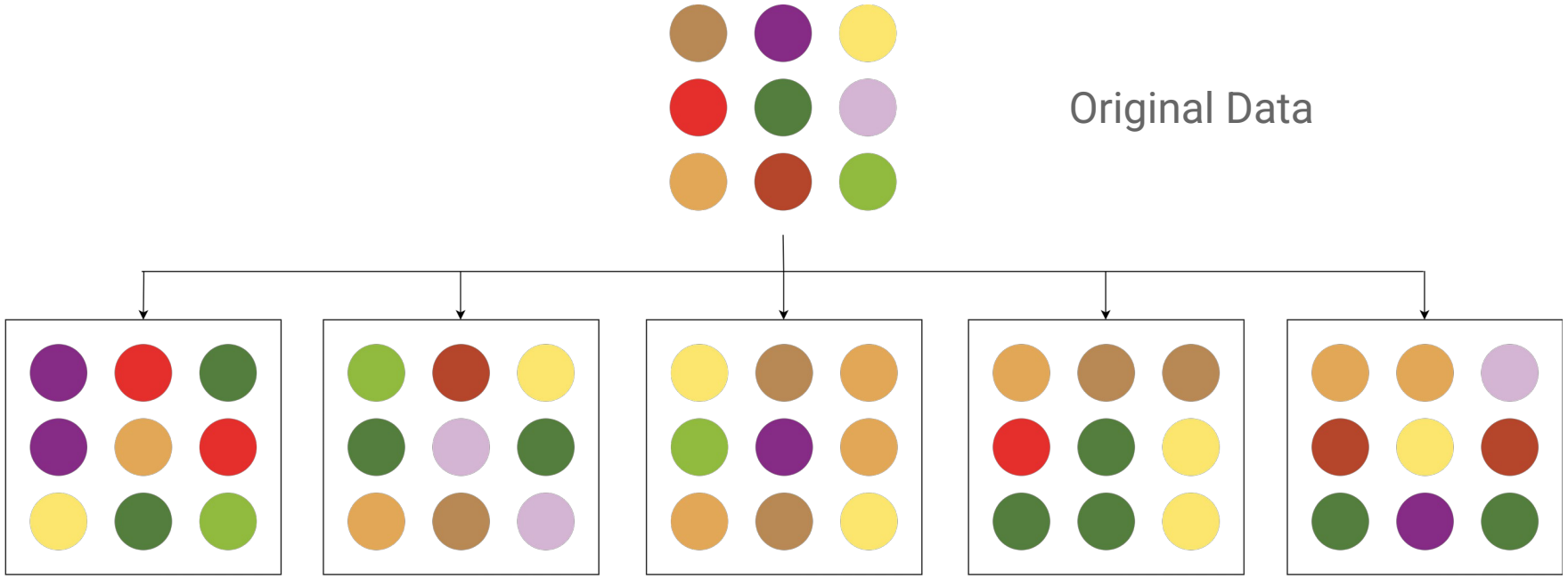
Neu

space



low-dim data space

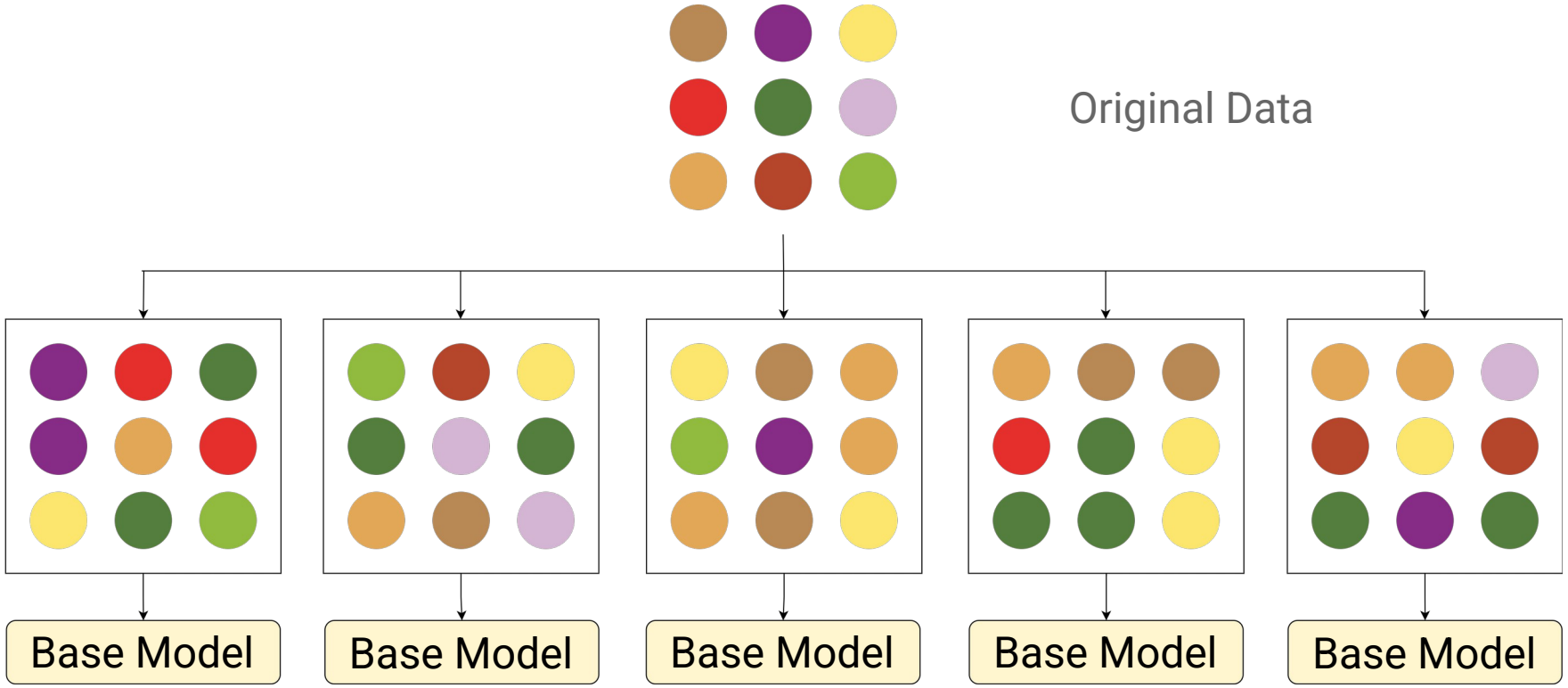
Bagging – **b**ootstrap **agg**regat**ing**



Sampling with replacement

~ 63.2% per sample

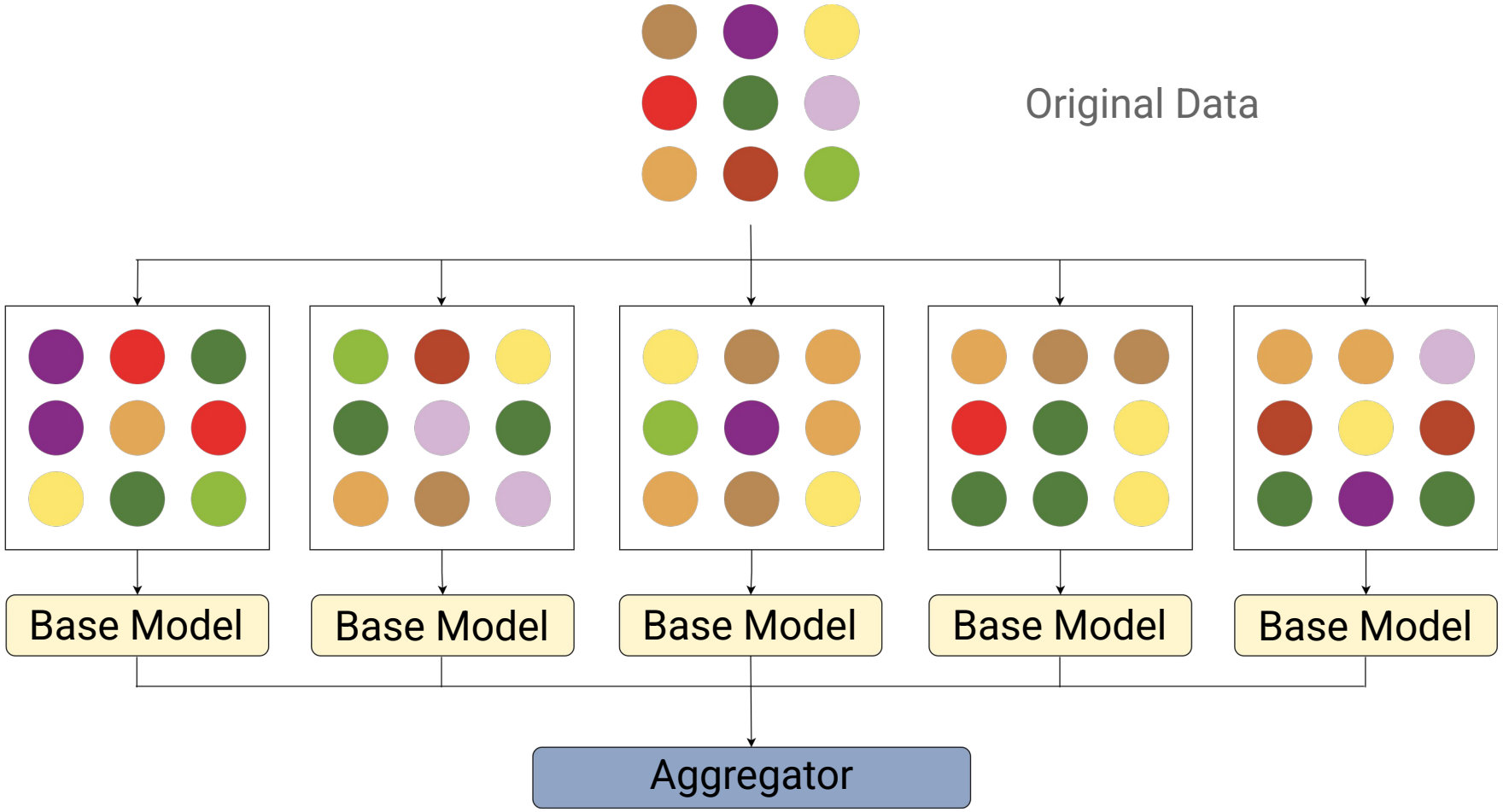
Bagging – **b**ootstrap **agg**regat**ing**



All trained separately

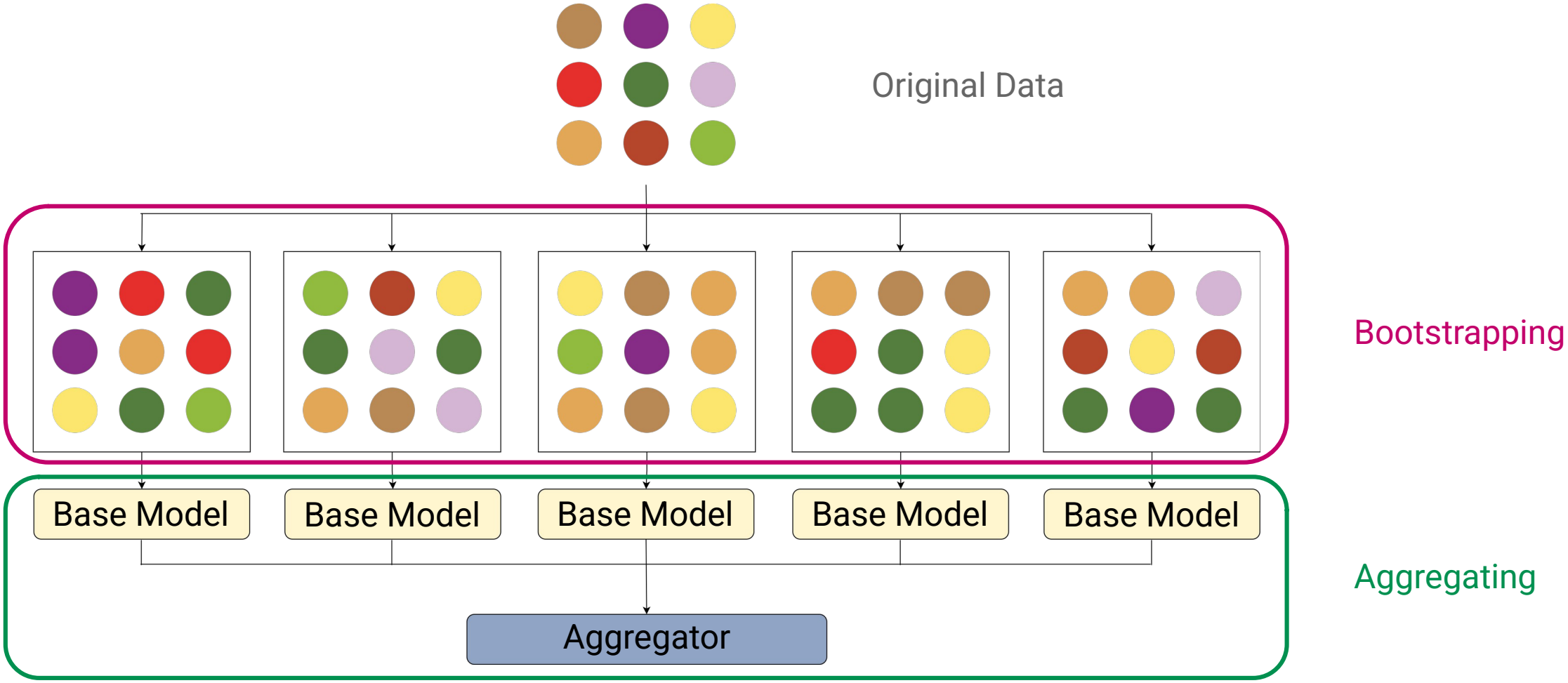
Ensemble of models

Bagging – **b**ootstrap **agg**regat**ing**

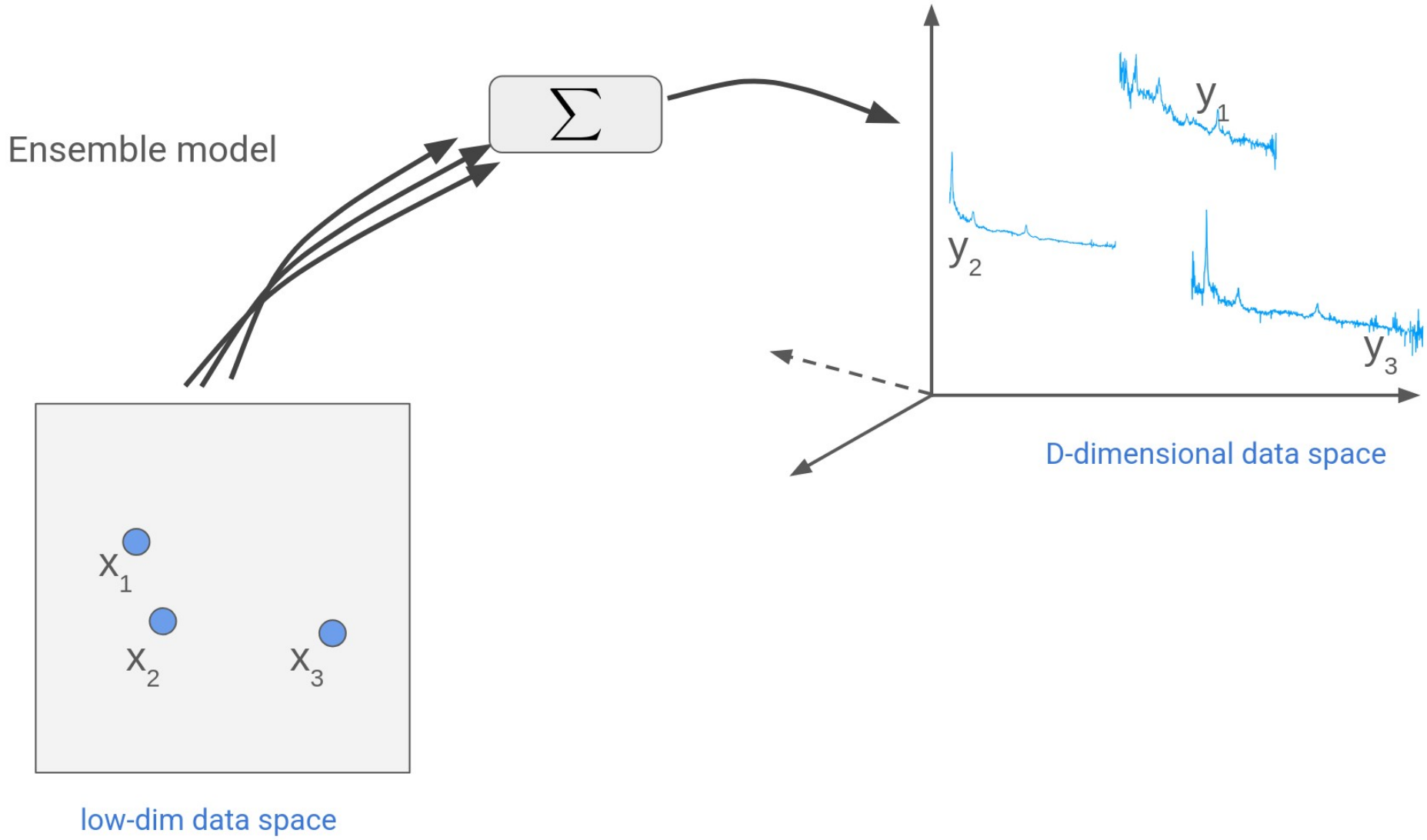


Combine to single prediction

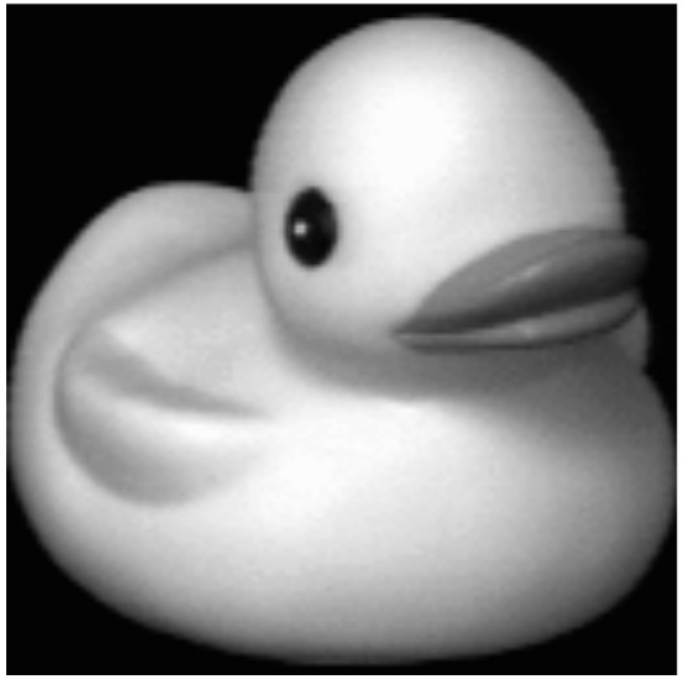
Bagging – **b**ootstrap **agg**regat**ing**

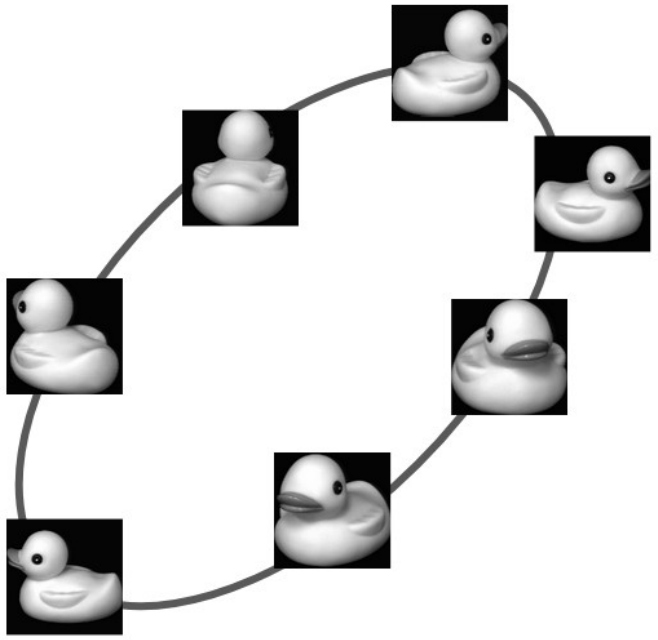


Latent variable modelling



Can it capture structure?

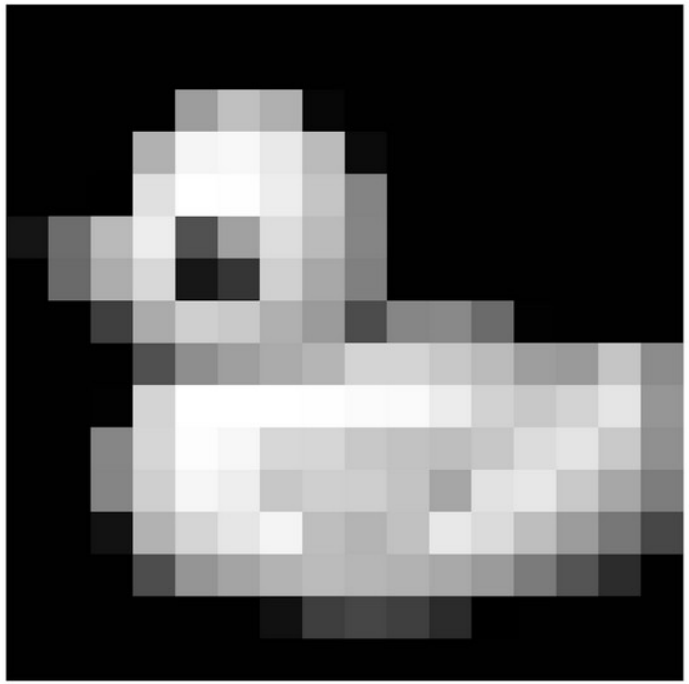


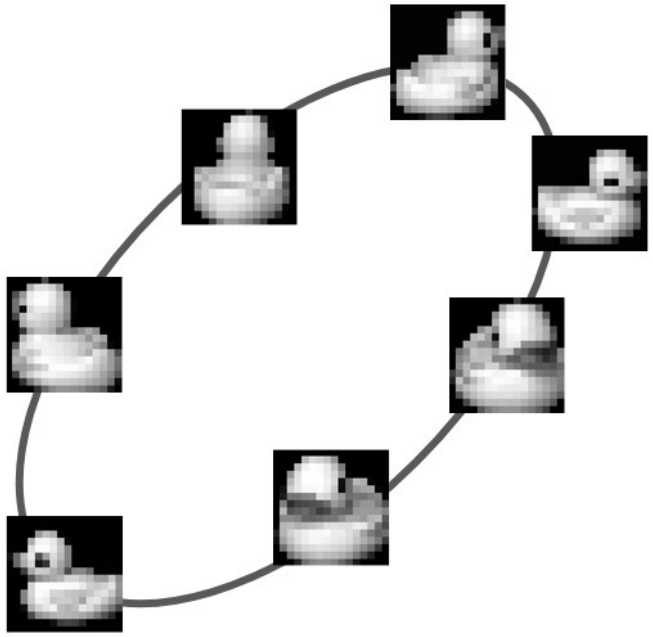


intrinsic structure

Rubber duck from 72 angles

Can it capture structure?

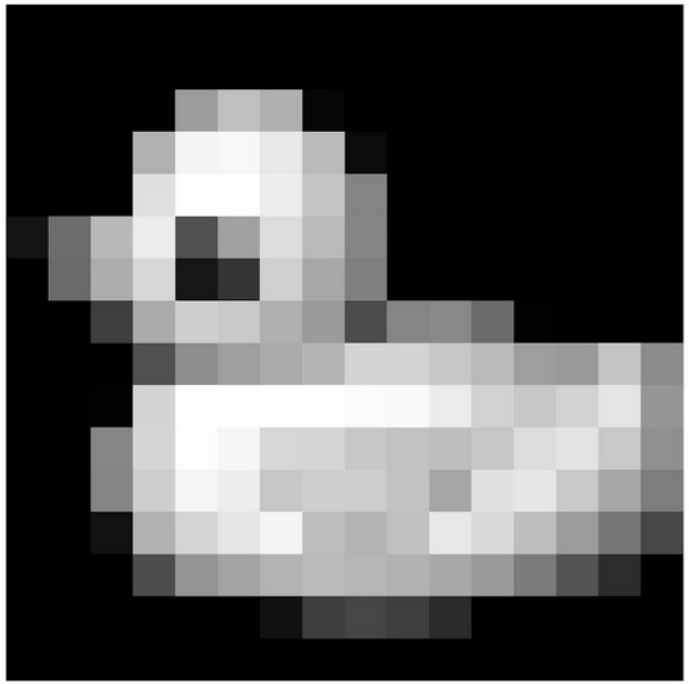


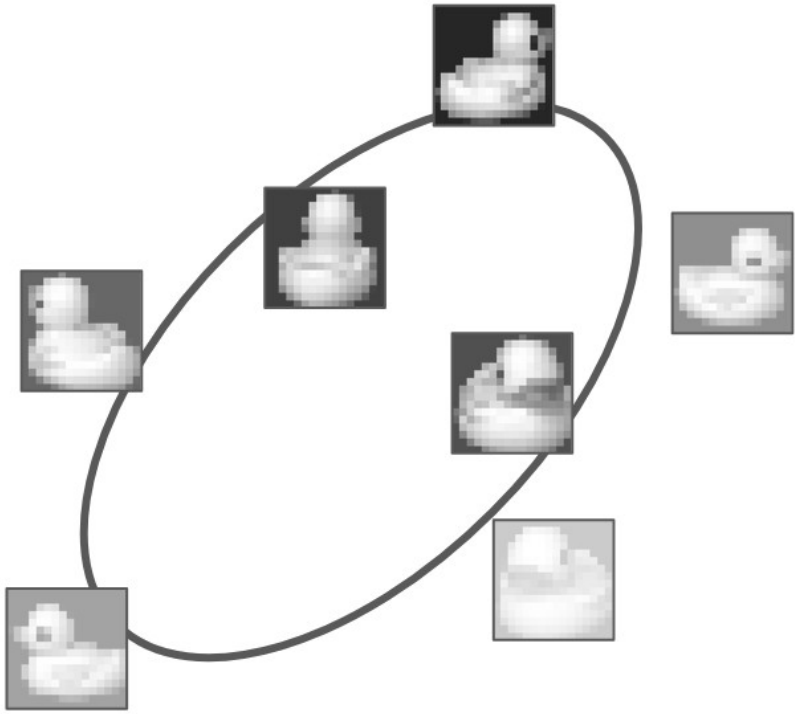


intrinsic structure

Downsampled to 16x16 pixels

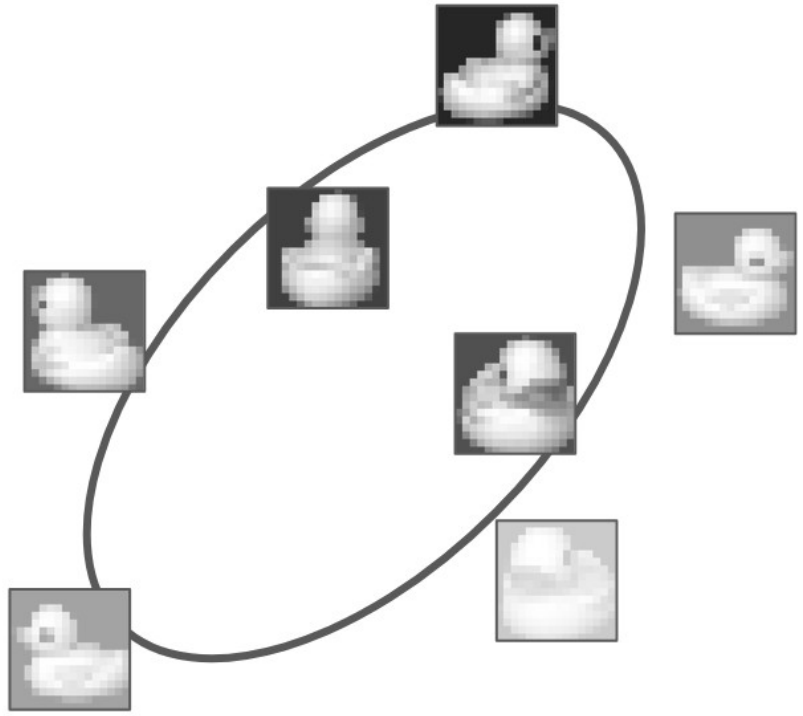
Can it capture structure?



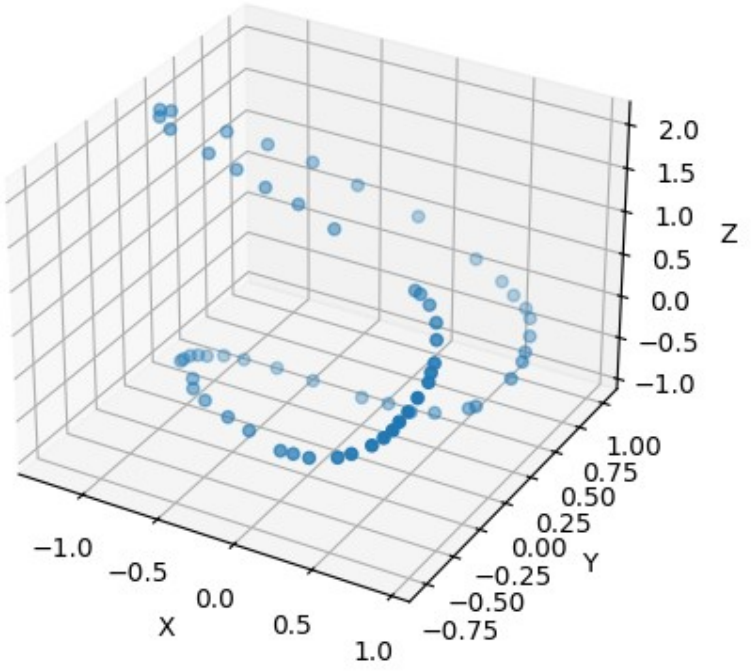


Downsampled to 16x16 pixels
Each image scaled with random factor

Can it capture structure?

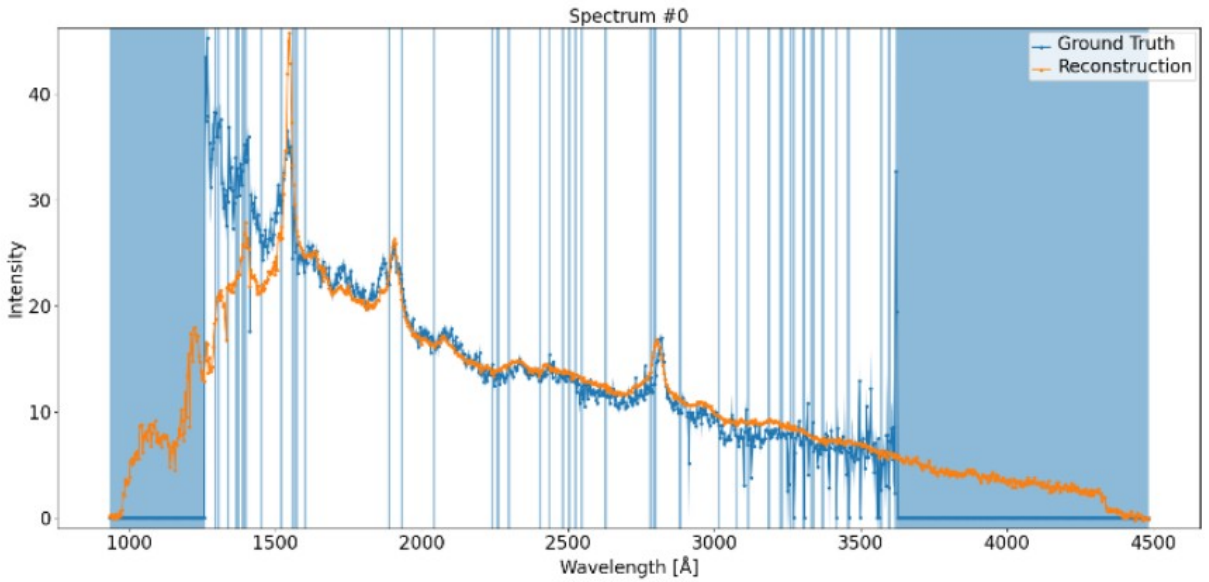


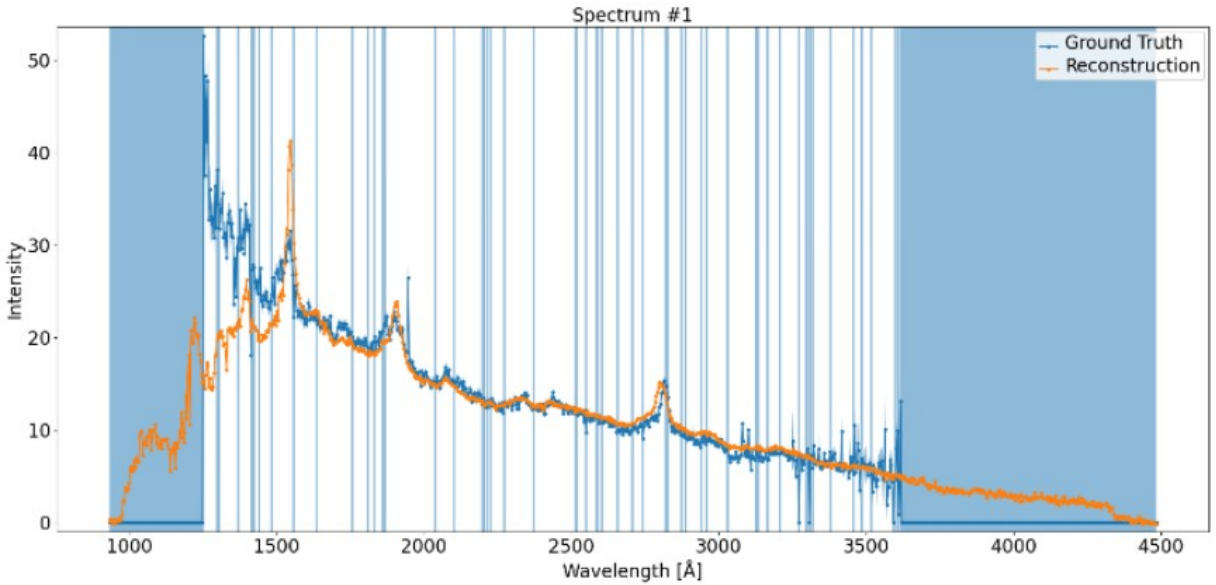
intrinsic structure



observed structure

Example reconstructions





Discussion

Ensemble Decoder Model ...

+ Adapts to spectra

+ Can scale to large datasets

- Needs parameter tuning

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