



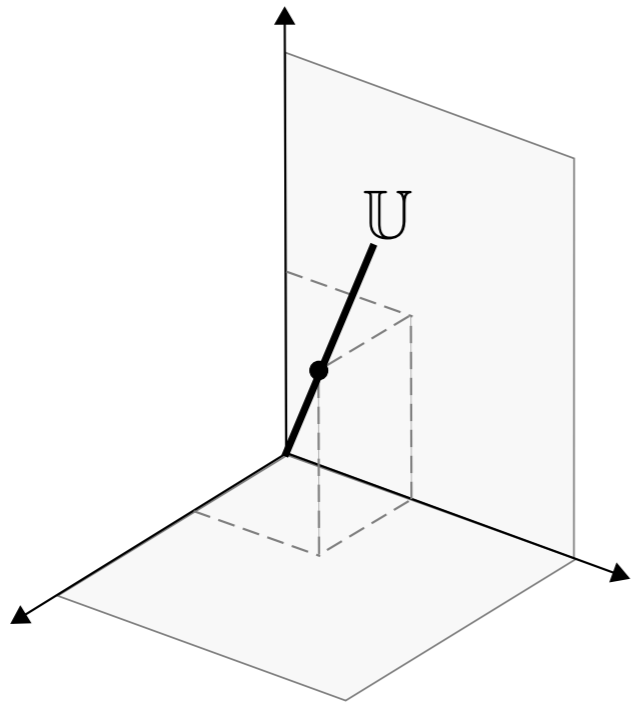
Karan Srivastava
The person you're looking at



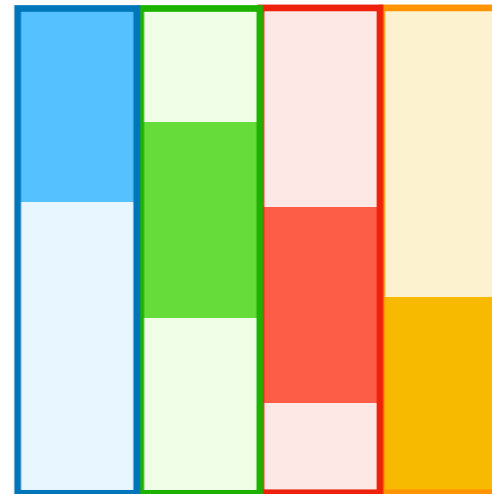
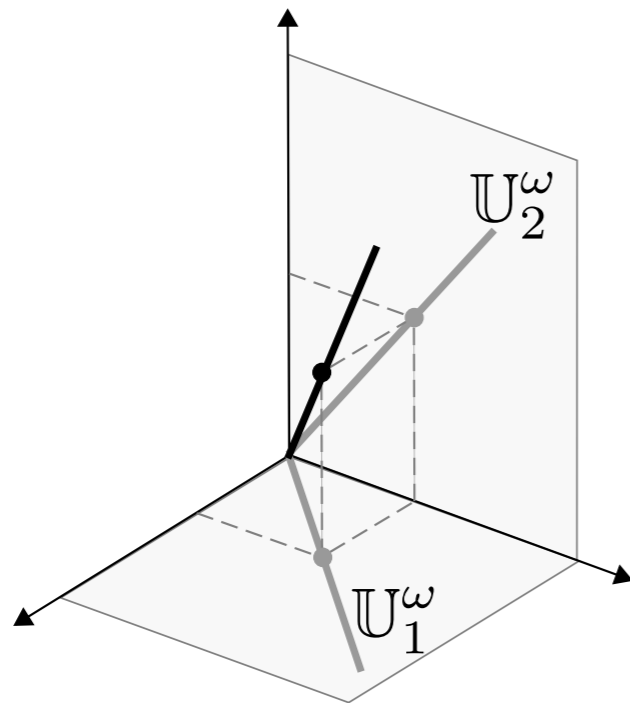
Daniel Pimentel-Alarcón
Not the person you're looking at

Subspace Reconstruction

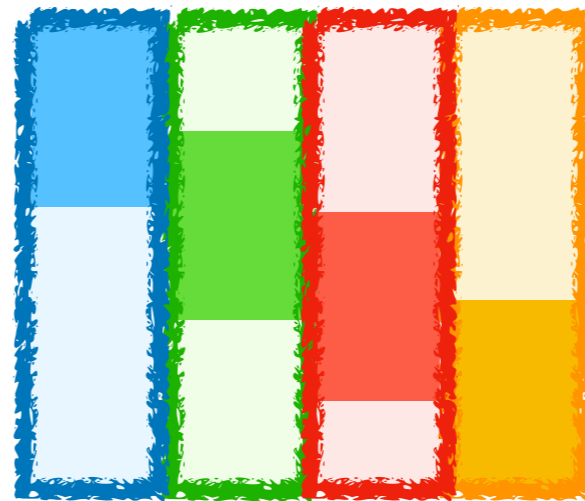
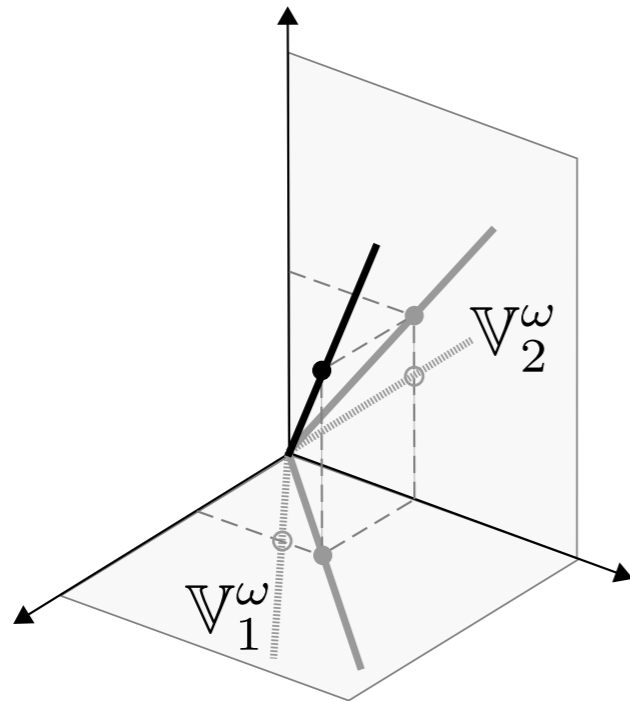
Problem Description



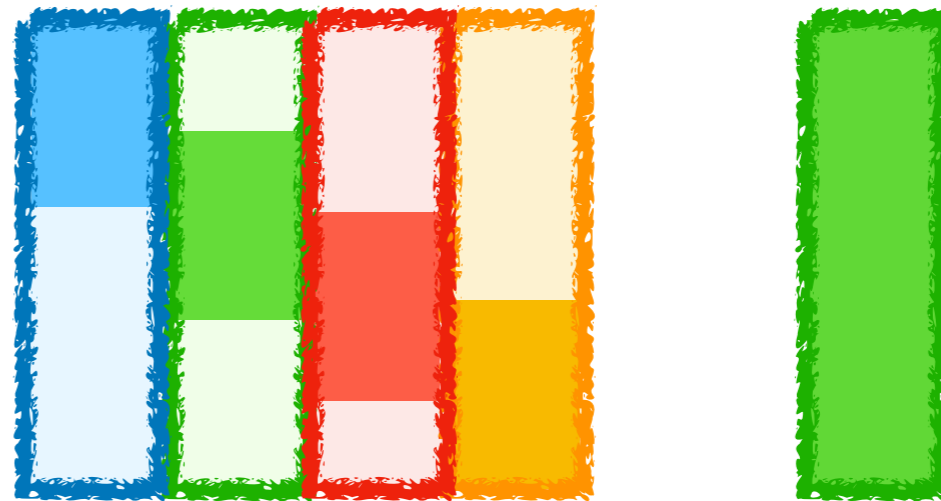
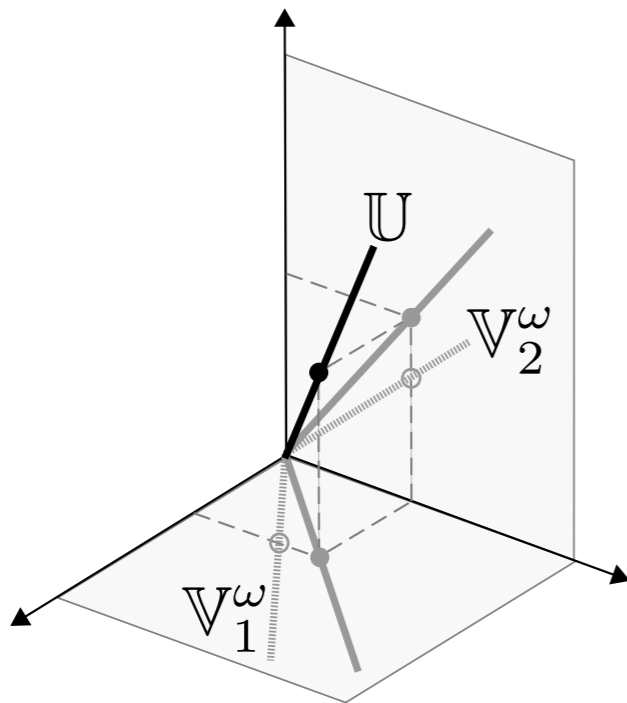
Problem Description



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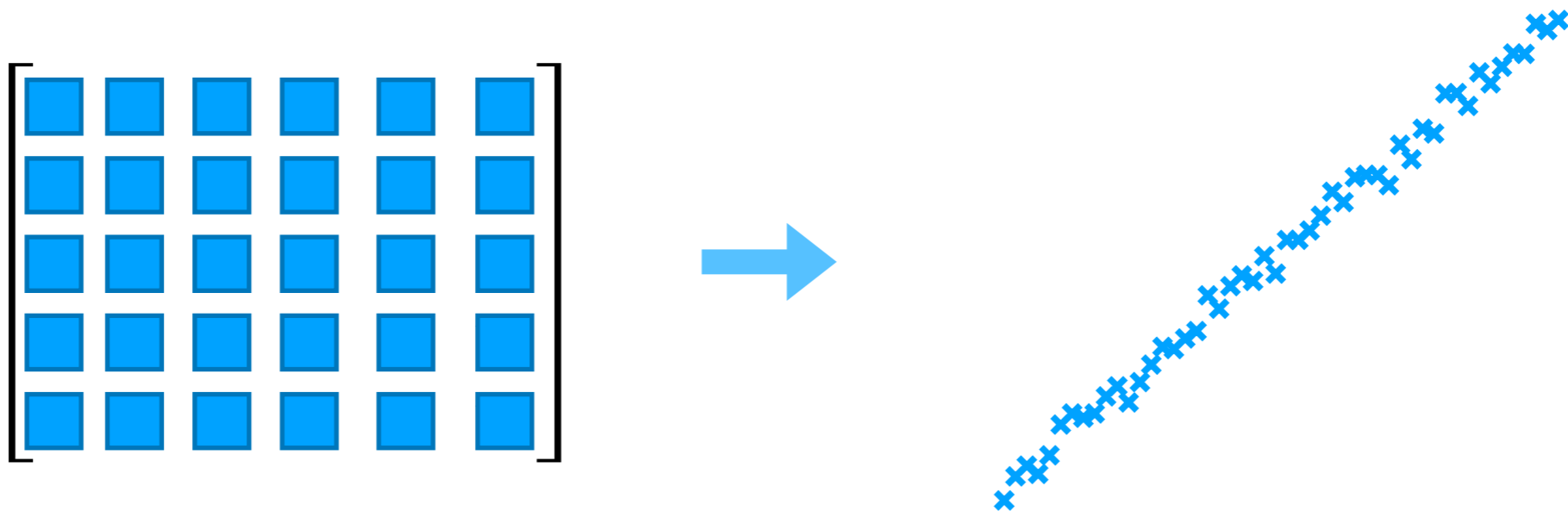
Problem Description



Goal: To estimate the line (or linear shape) from the noisy pieces and bound the error?

Motivation

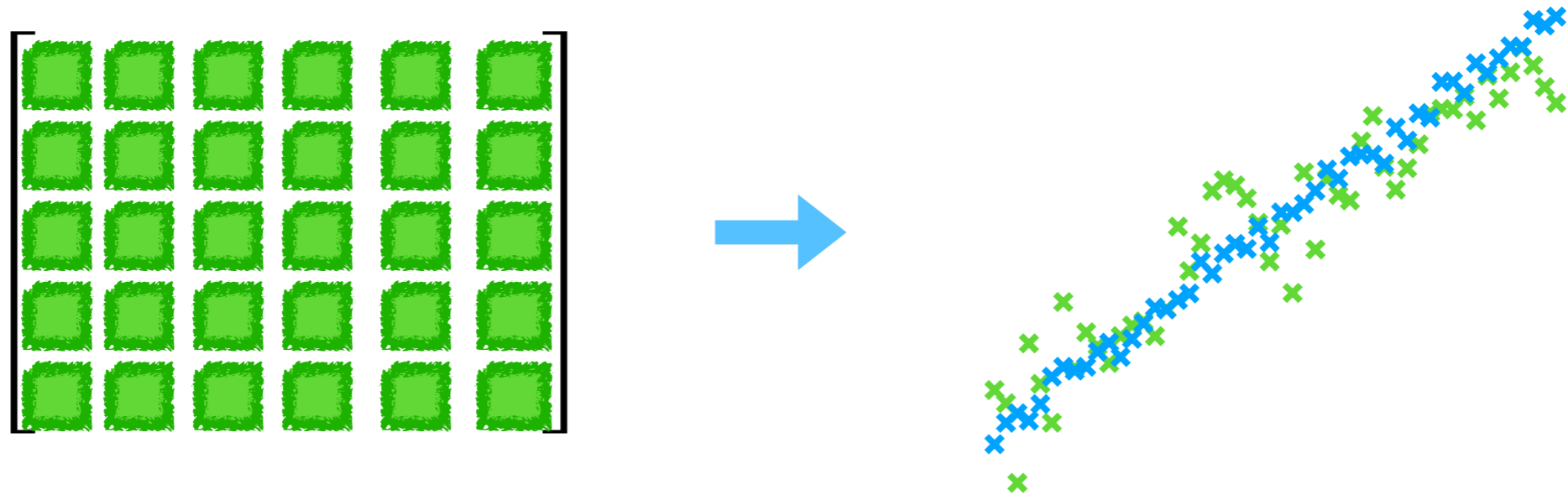
Our main tool for modelling data is linear algebra



Since data is often best modelled by [subspaces](#)

Motivation

Our main tool for modelling data is linear algebra

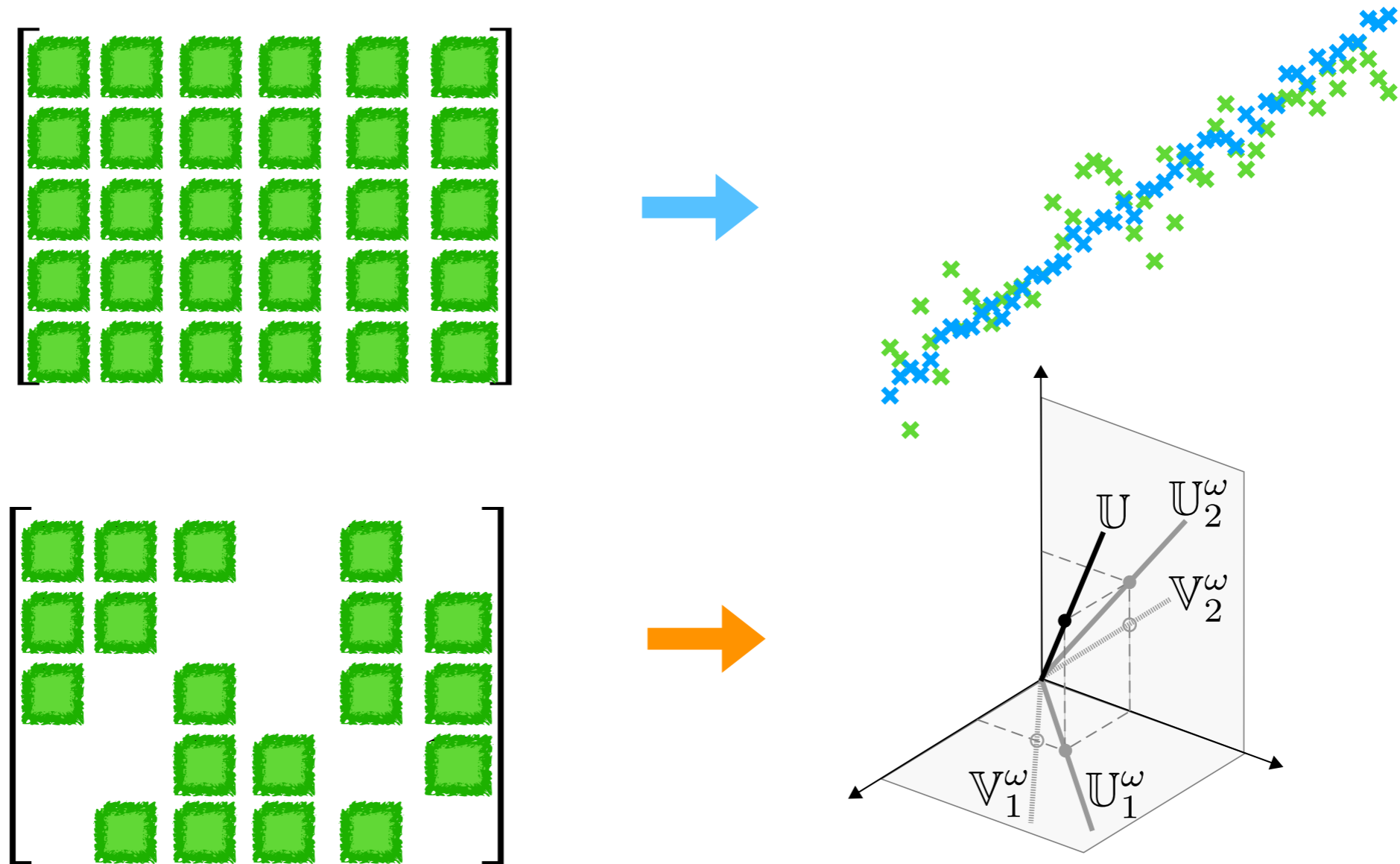


Since data is often best modelled by **subspaces**

But data is often **noisy**

Motivation

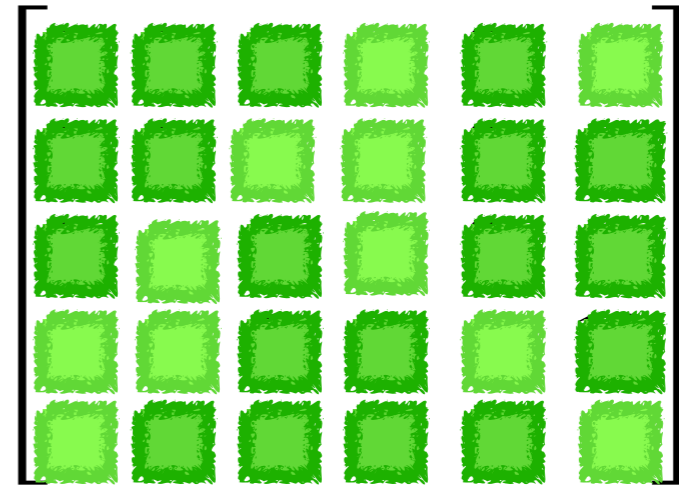
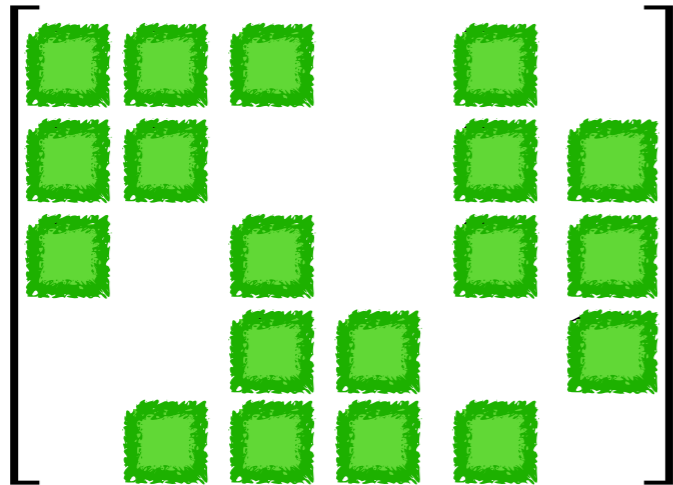
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Since data is often best modelled by **subspaces**

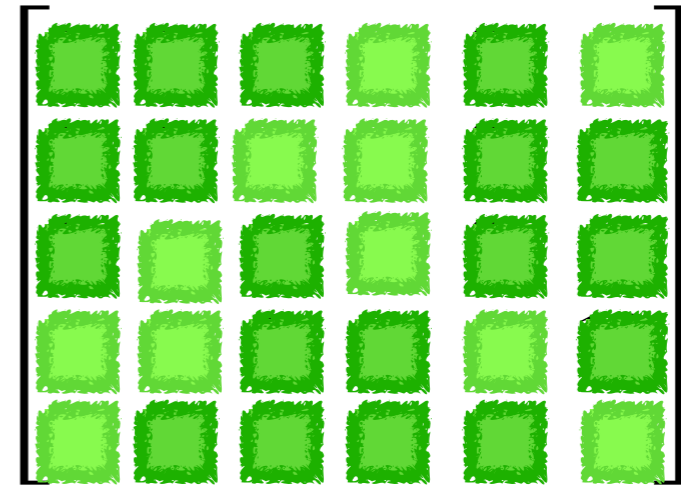
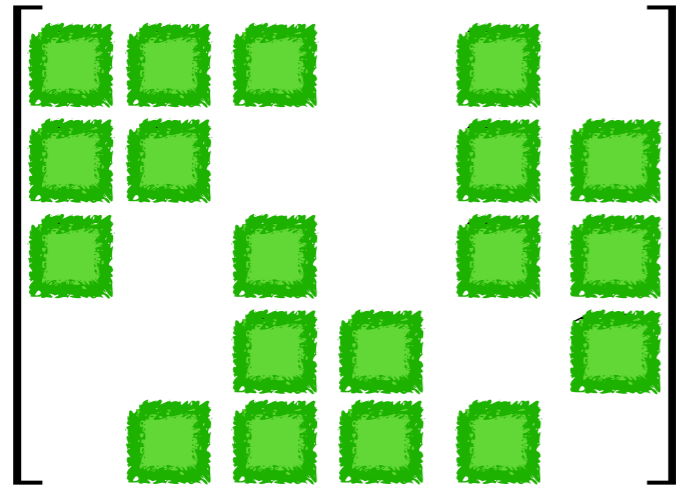
But data is often **noisy** and **missing**

Motivation

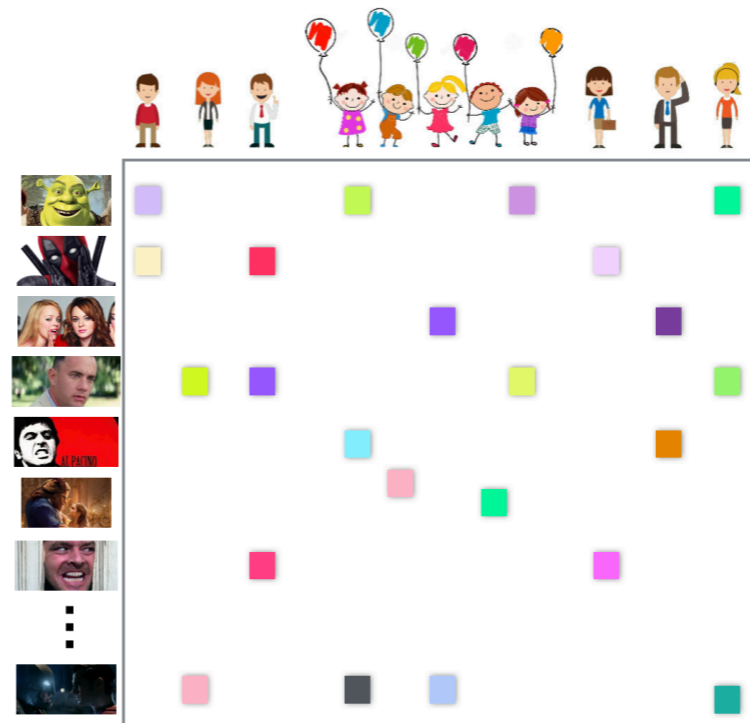
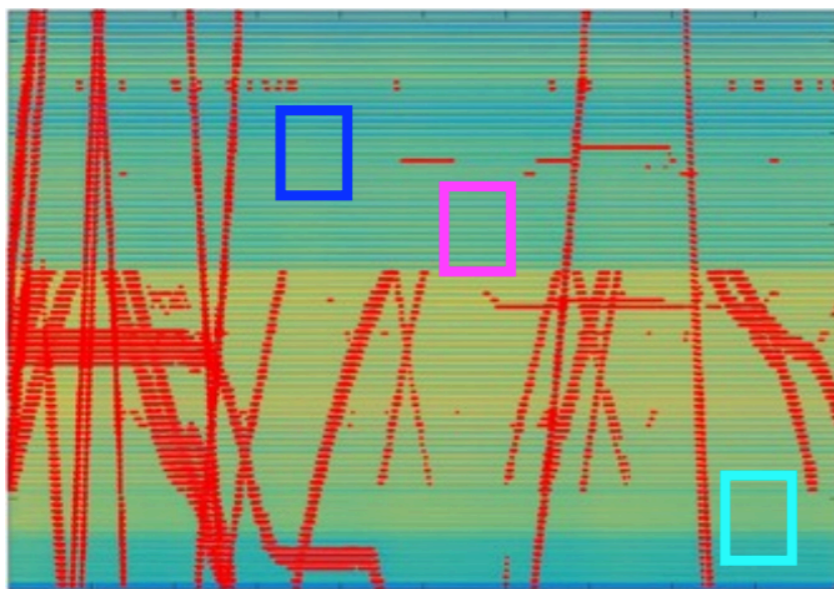


The problem of completing matrices is
Matrix Completion

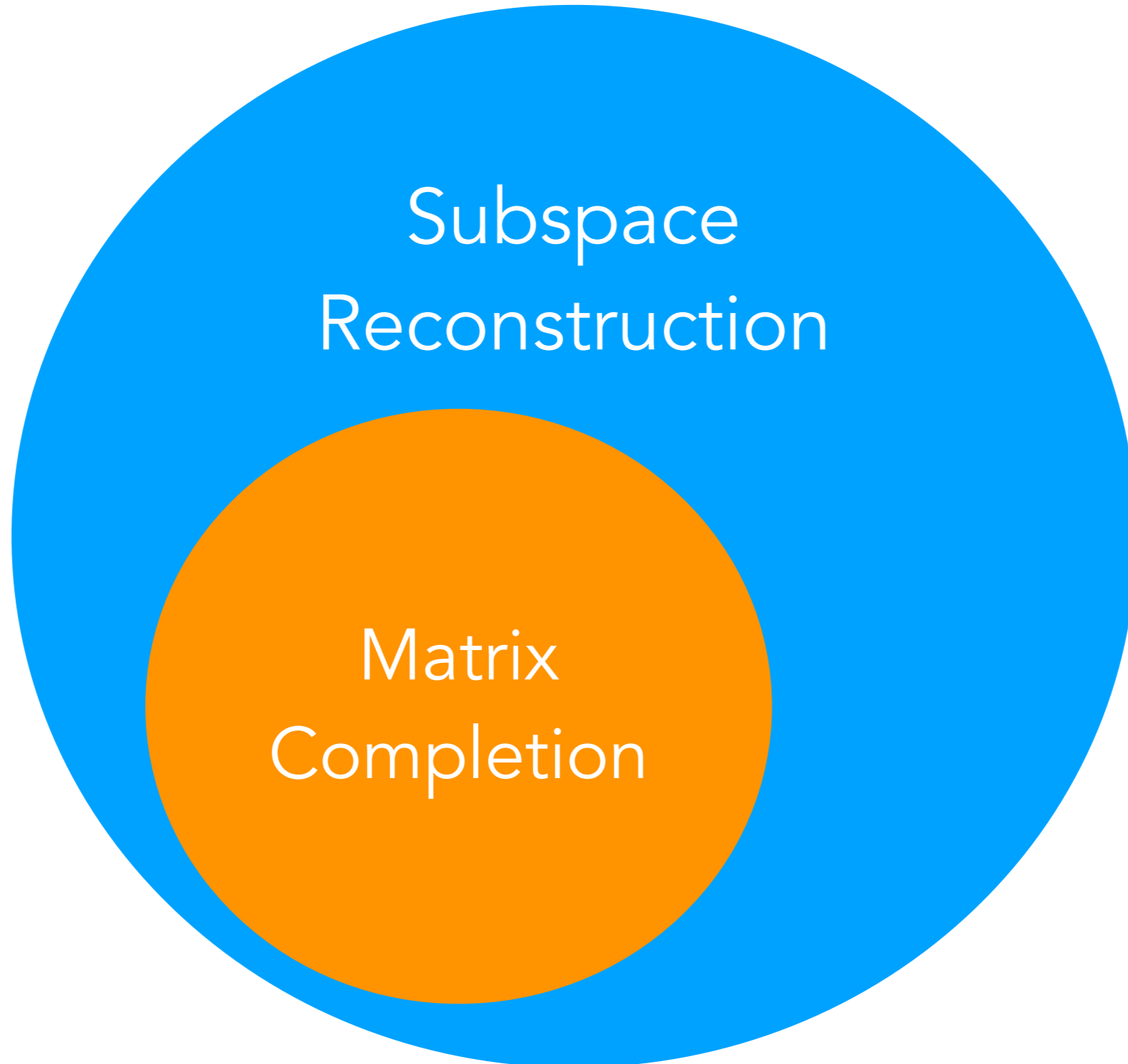
Motivation



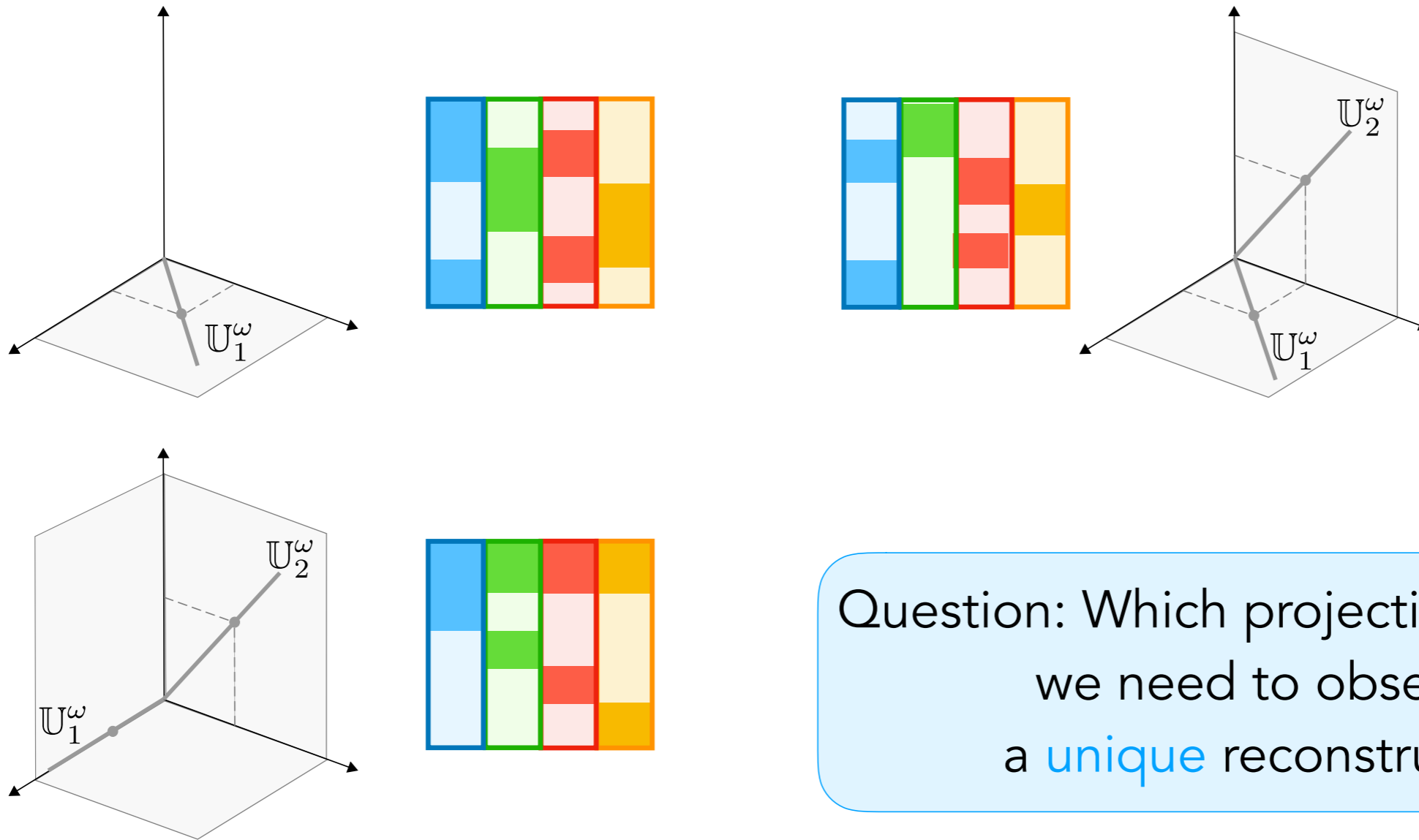
The problem of completing matrices is
Matrix Completion



Motivation



Previous Work - Noiseless Case



D. L. Pimentel-Alarcón, N. Boston, and R. D. Nowak, "Deterministic conditions for subspace identifiability from incomplete sampling," in *Information Theory (ISIT), 2015 IEEE International Symposium on*. IEEE, 2015, pp. 2191–2195.

Our Work - Noisy Case

Theorem (S., P.-A.)

For almost every \mathbb{U} ,

$$d_G(\mathbb{U}, \hat{\mathbb{U}}) \leq \frac{\epsilon \sqrt{2r(d-r)}}{\delta \cdot \sigma(B)}$$

Measure of how good
the guess is

The cool bound we found

Applications - LRMC Theory

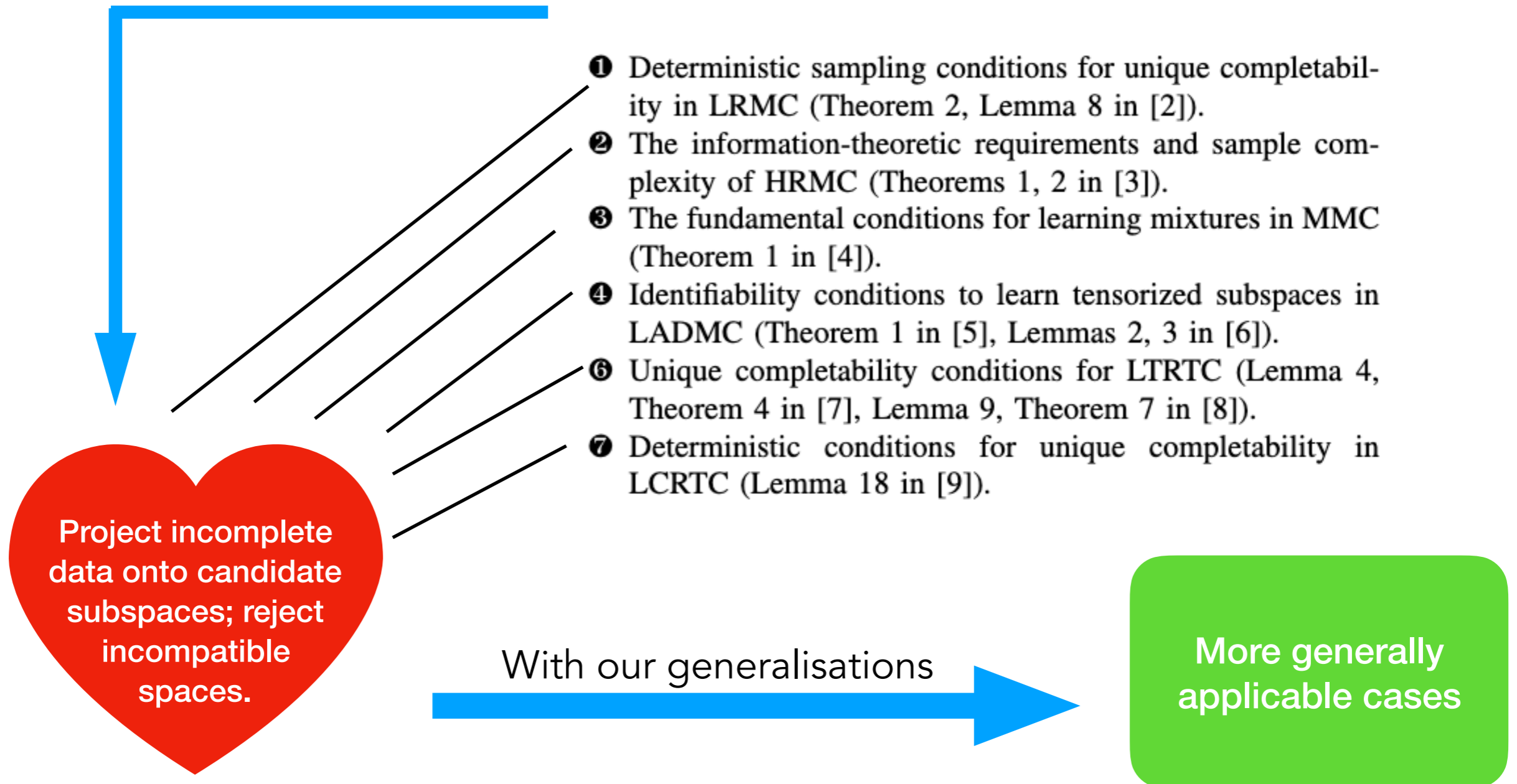
Noiseless Theory

- ① Deterministic sampling conditions for unique completability in LRMC (Theorem 2, Lemma 8 in [2]).
- ② The information-theoretic requirements and sample complexity of HRMC (Theorems 1, 2 in [3]).
- ③ The fundamental conditions for learning mixtures in MMC (Theorem 1 in [4]).
- ④ Identifiability conditions to learn tensorized subspaces in LADMC (Theorem 1 in [5], Lemmas 2, 3 in [6]).
- ⑥ Unique completability conditions for LTRTC (Lemma 4, Theorem 4 in [7], Lemma 9, Theorem 7 in [8]).
- ⑦ Deterministic conditions for unique completability in LCRTC (Lemma 18 in [9]).

Project incomplete data onto candidate subspaces; reject incompatible spaces.

With our generalisations

More generally applicable cases



Applications - RPCA

Original Frame



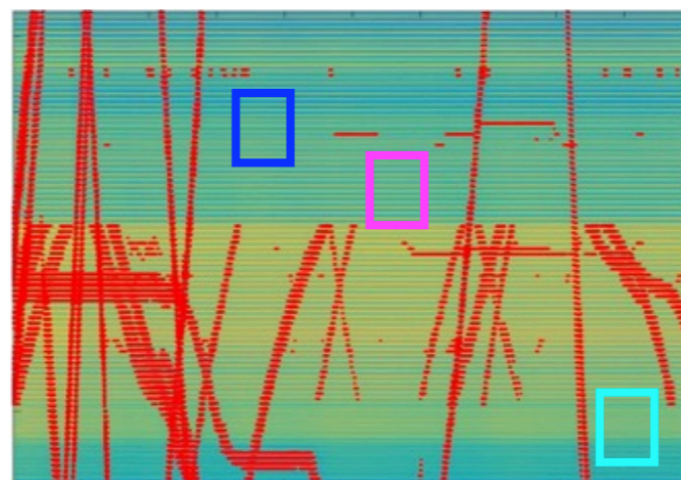
**Subspace Reconstruction
Based Background Segmentation**



RPCA-ALM
(Lin et.al 2011-206)



D. Pimentel-Alarcón and R. Nowak, "Random consensus robust pca,"
Electronic Journal of Statistics, vol. 11, no. 2, pp. 5232–5253, 2017.



Future Directions

- Line -> Curved Shapes - Can we do this in a computationally feasible way?
- How to find these projections - Can we find an algorithm to find projections given sparse data?
- Can we generalize these bounds to cases where we have multiple subspaces?

THANKS A BUNCH!



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