

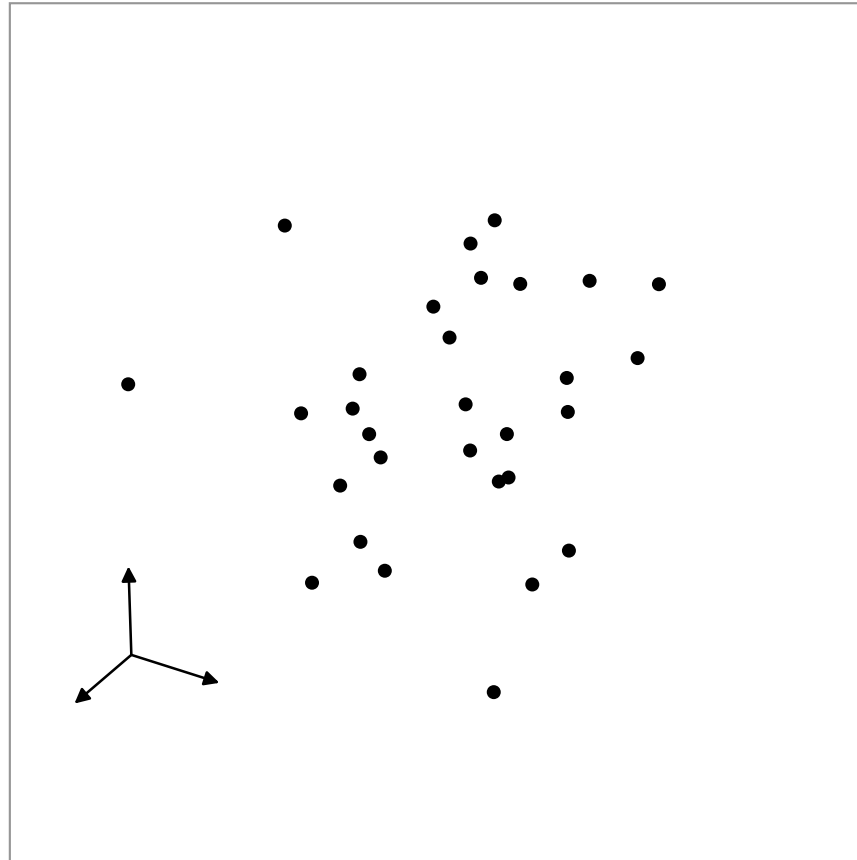


Uncertainty-Aware PCA Revisited

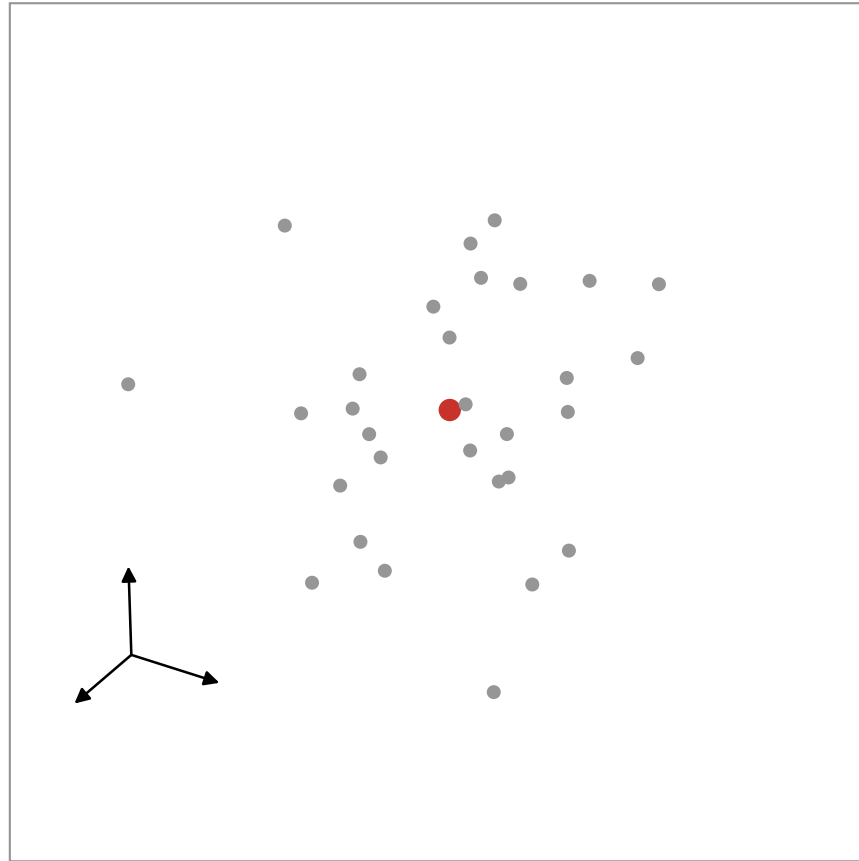
Lukas Friesecke, Christian Braune, Christian Rössl, Holger Theisel

Otto von Guericke University Magdeburg

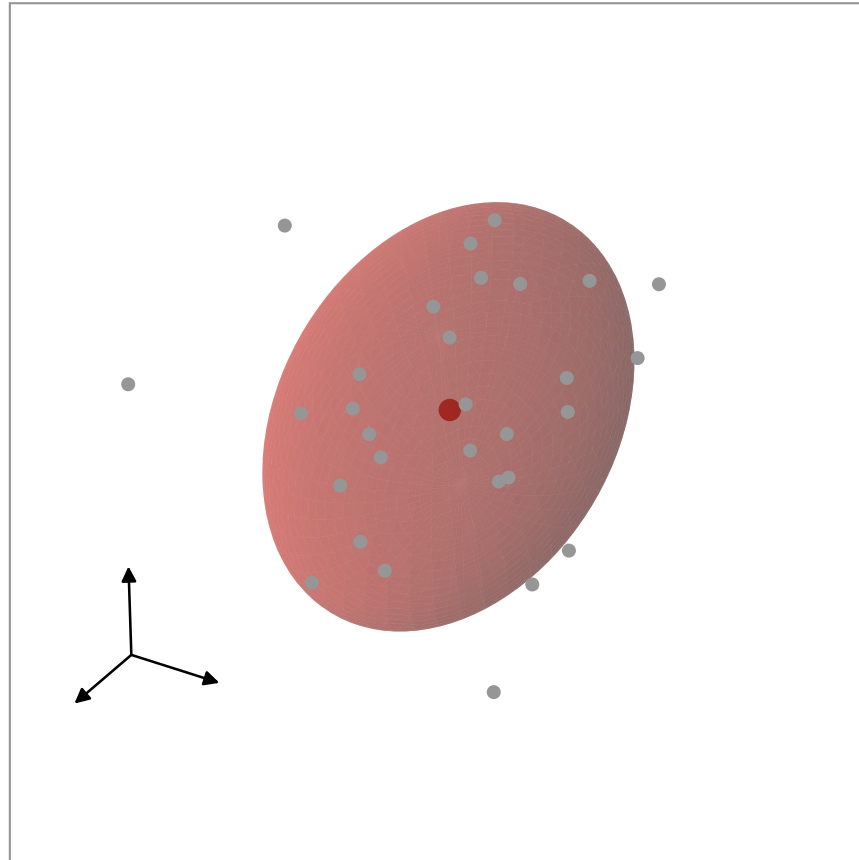
CLASSICAL PCA



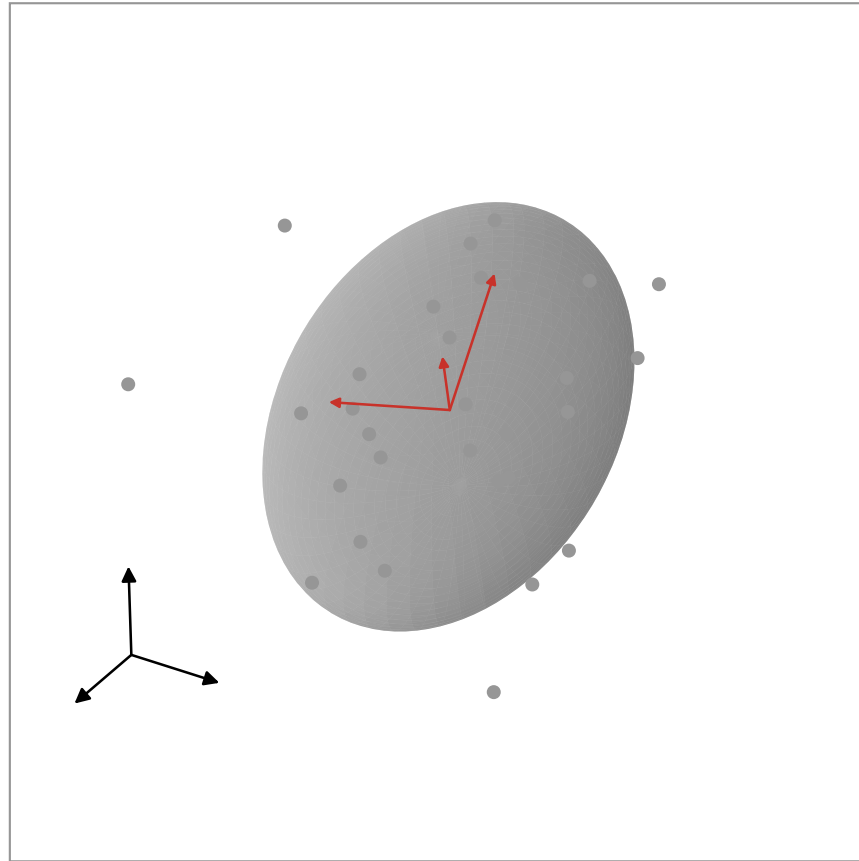
CLASSICAL PCA



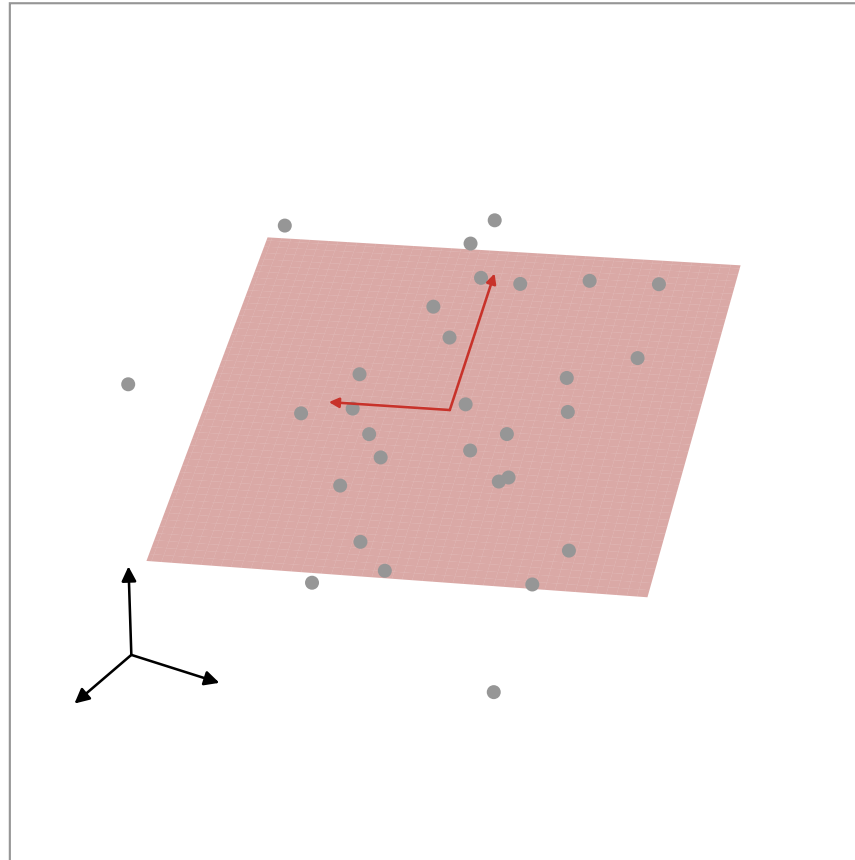
CLASSICAL PCA



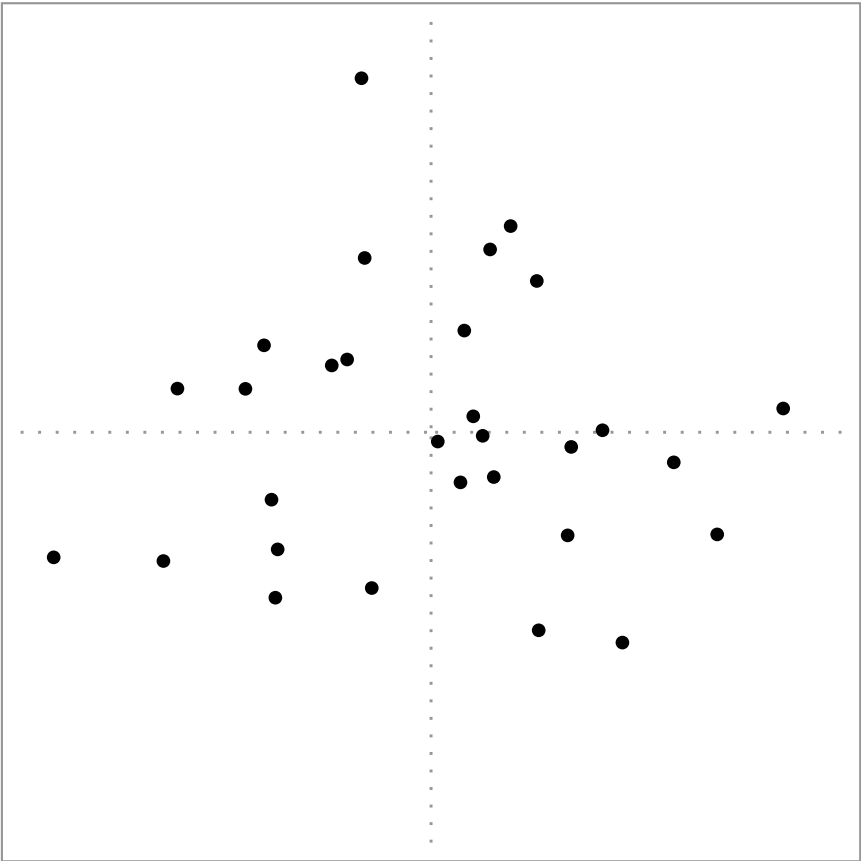
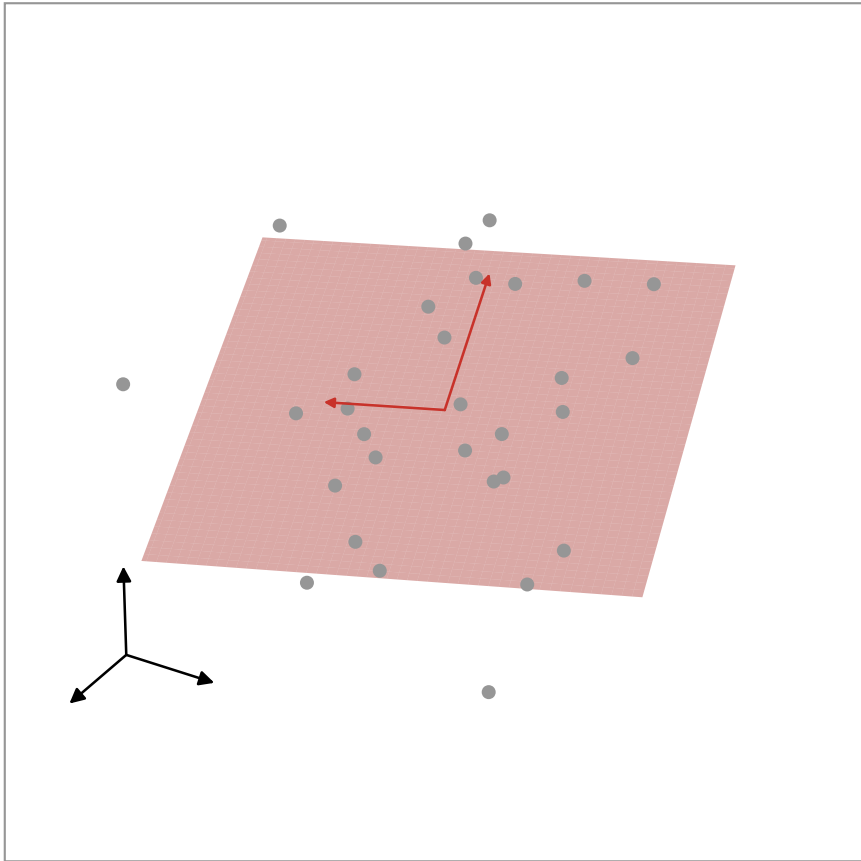
CLASSICAL PCA



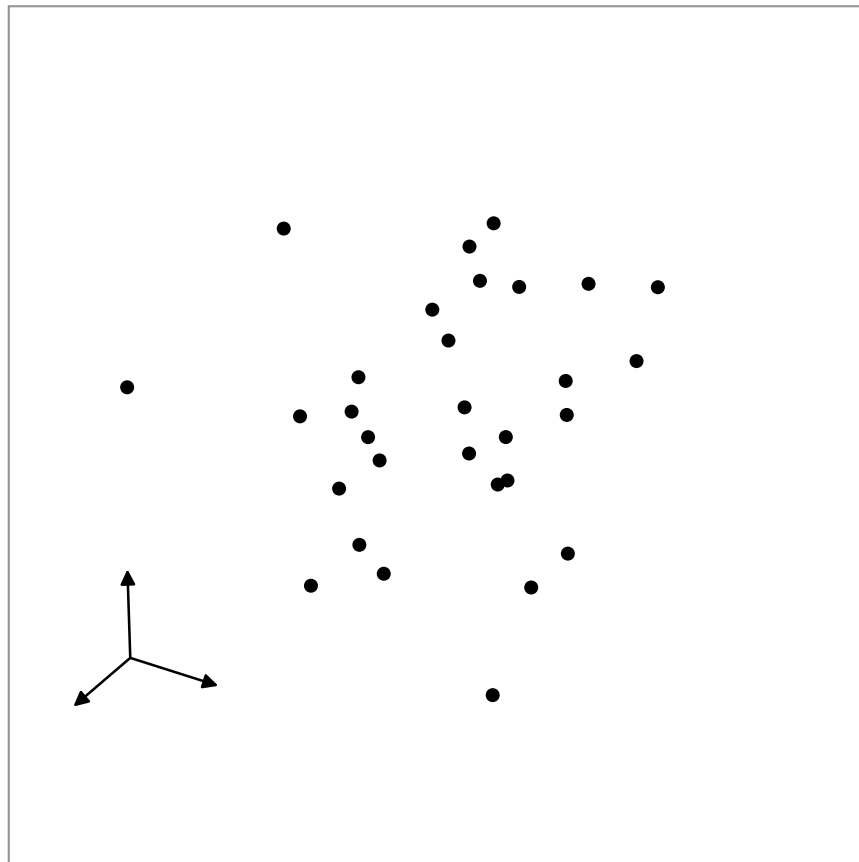
CLASSICAL PCA



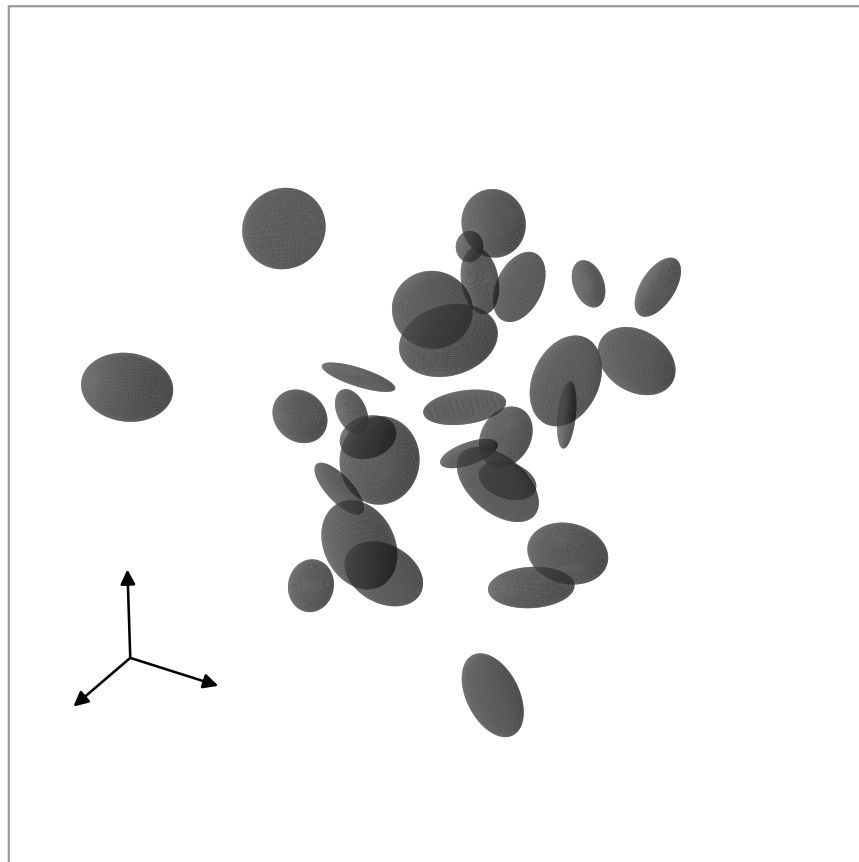
CLASSICAL PCA

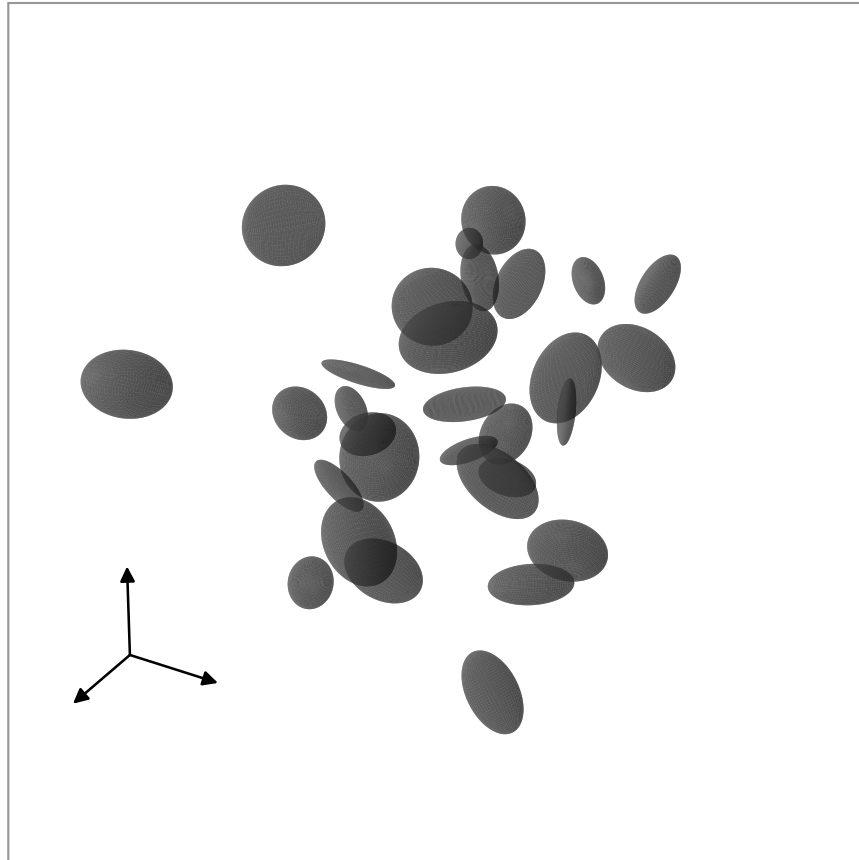


UNCERTAINTY-AWARE PCA



UNCERTAINTY-AWARE PCA

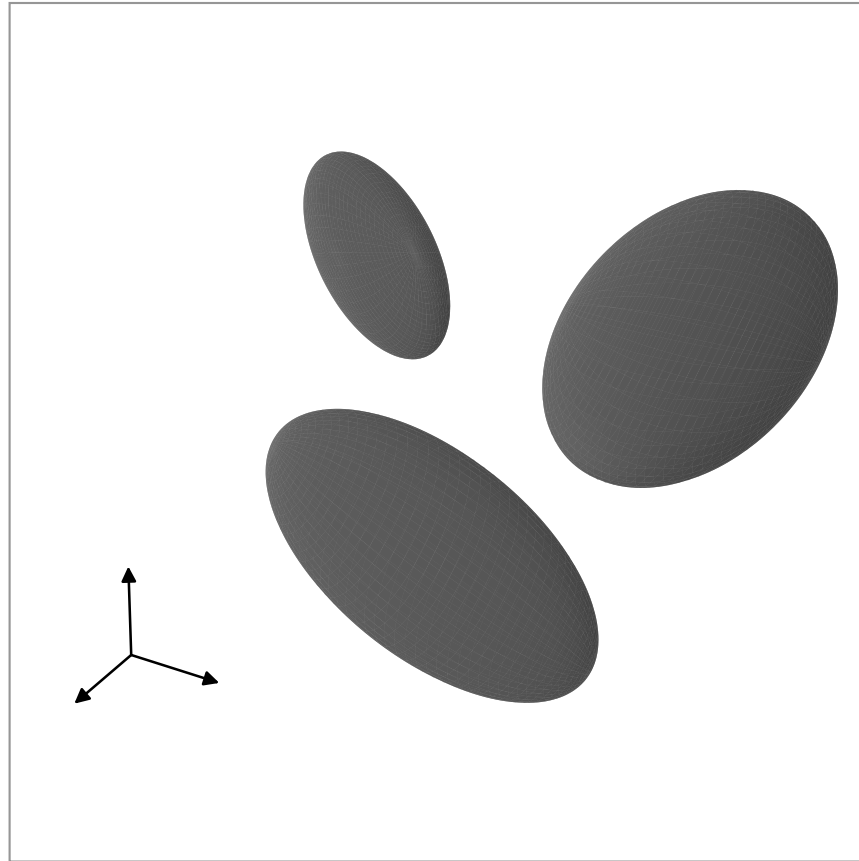


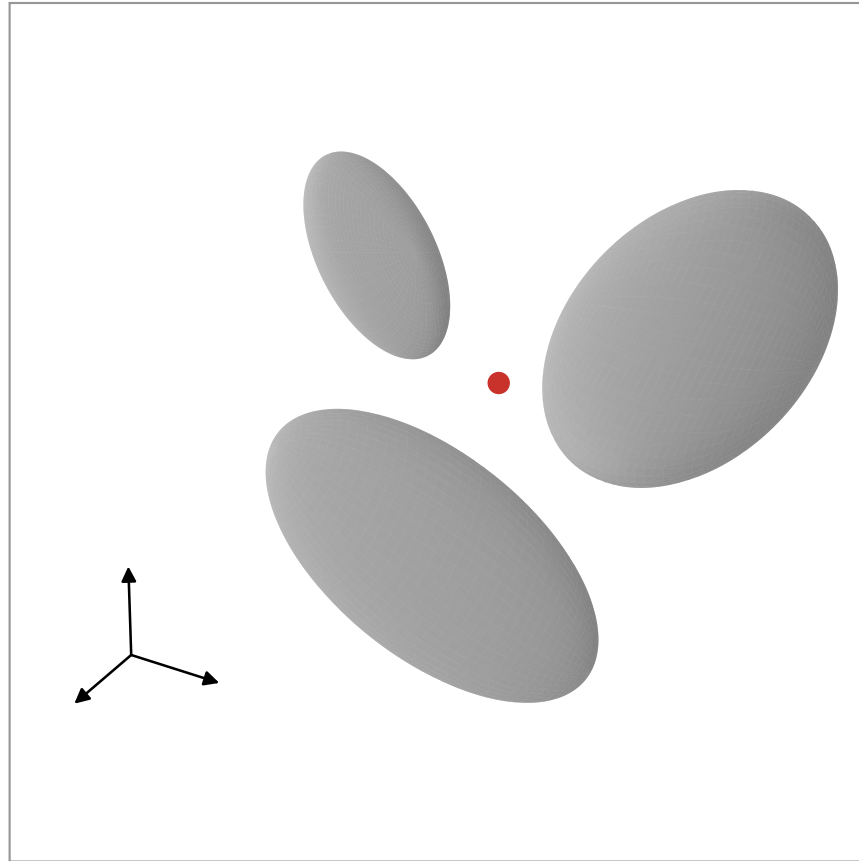


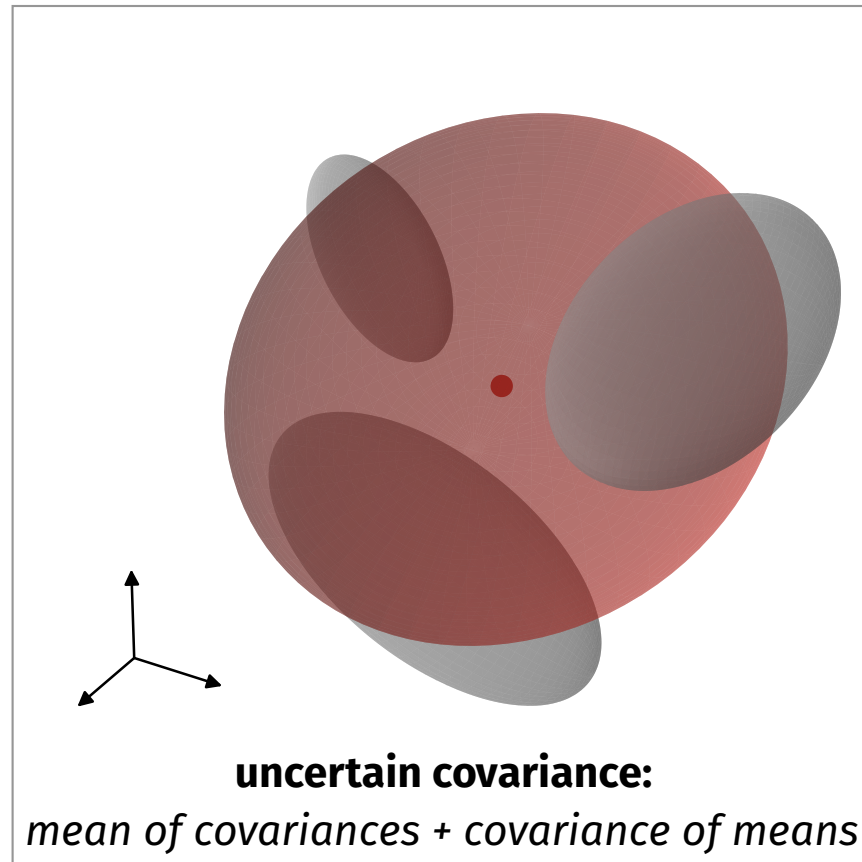
Uncertainty-Aware Principal Component Analysis

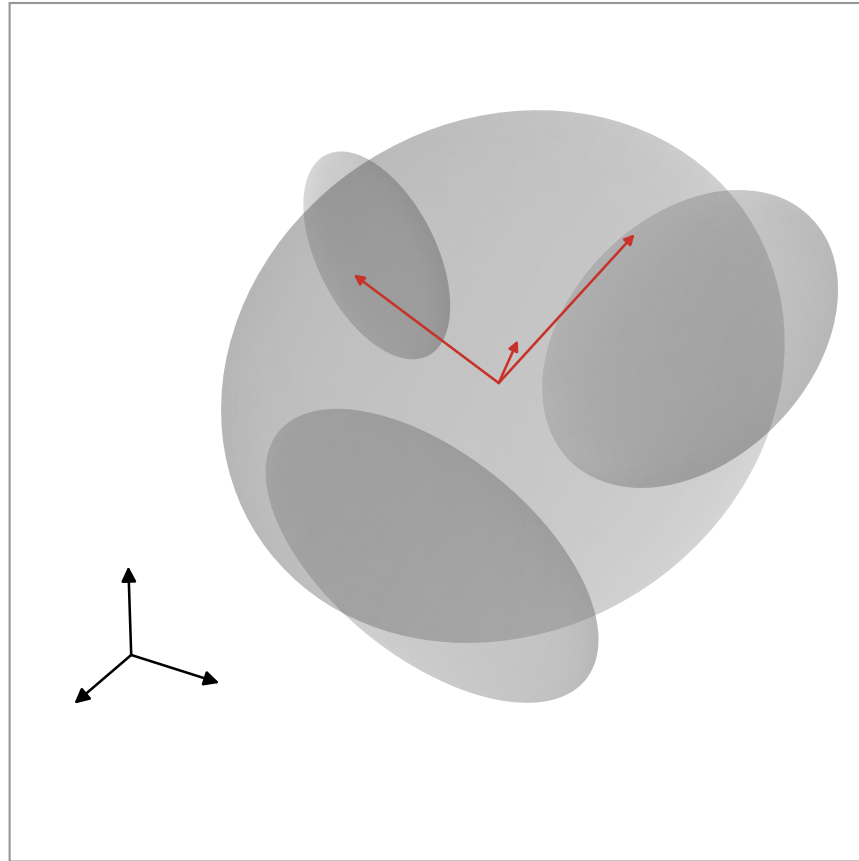
Jochen Görtler, Thilo Spinner, Dirk Streeb,
Daniel Weiskopf, and Oliver Deussen

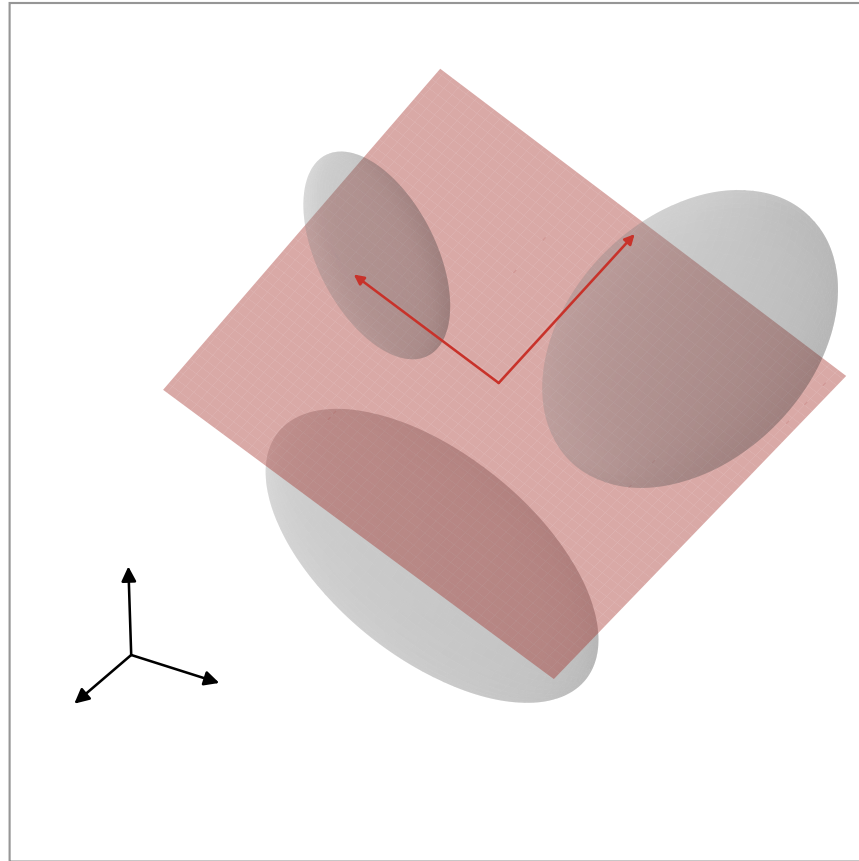
– 2020 –



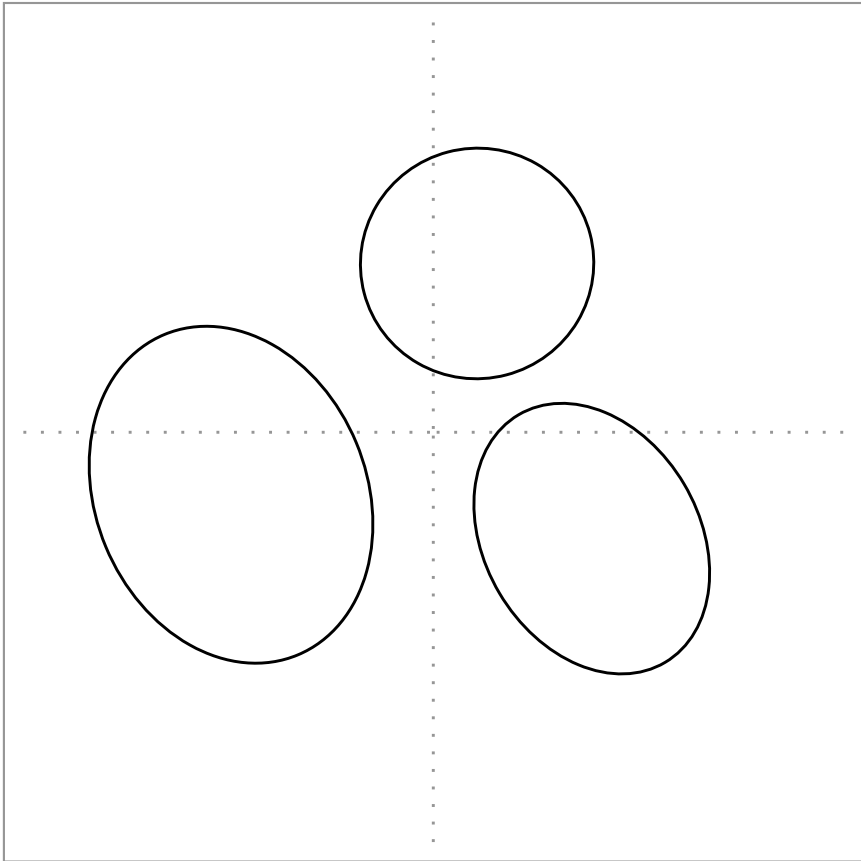
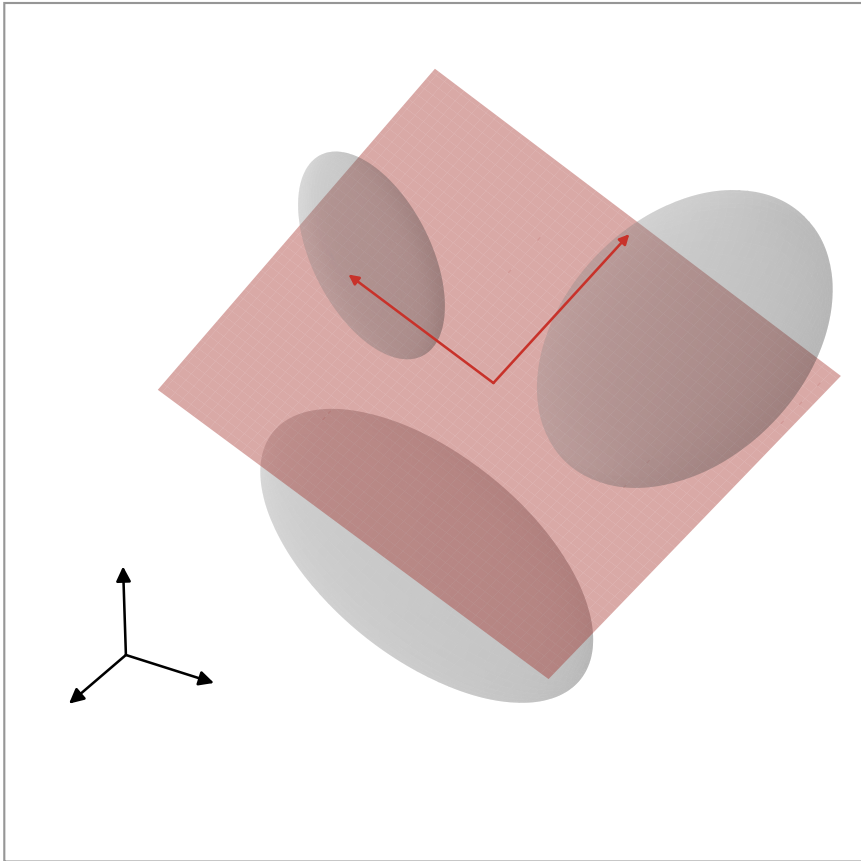






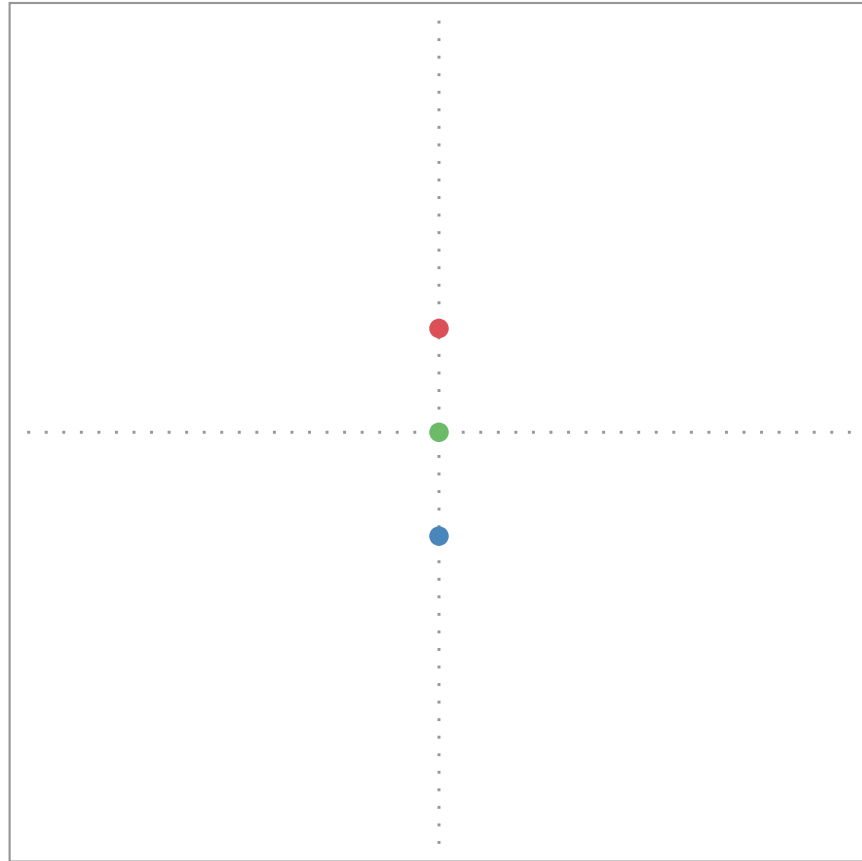


UNCERTAINTY-AWARE PCA: GÖRTLER ET AL.

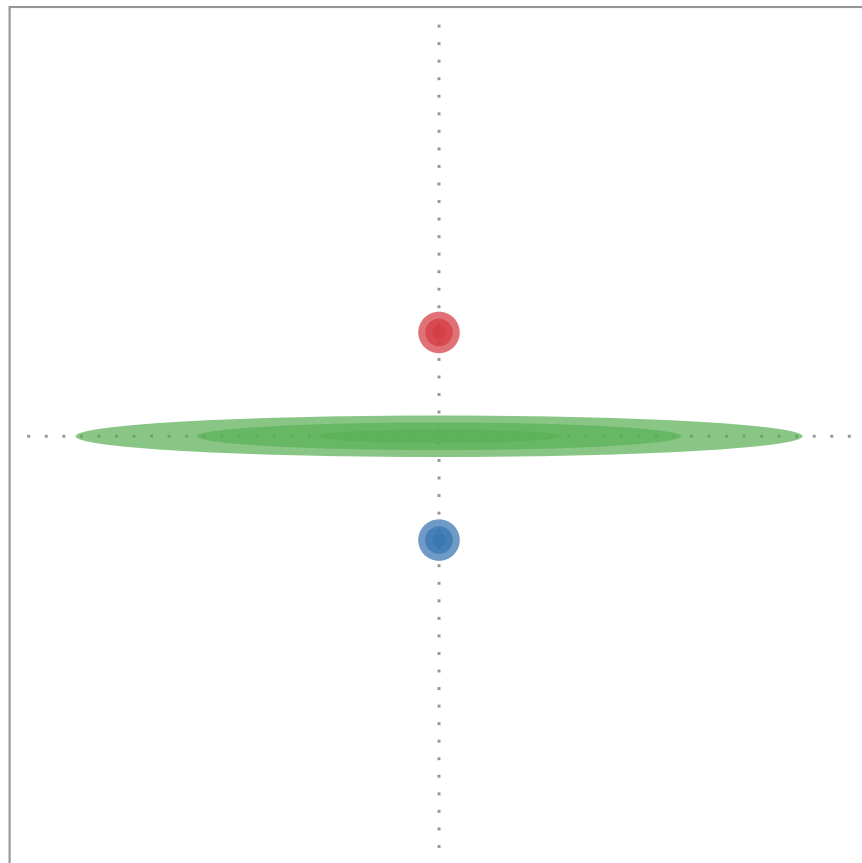


PCA is a discontinuous map.

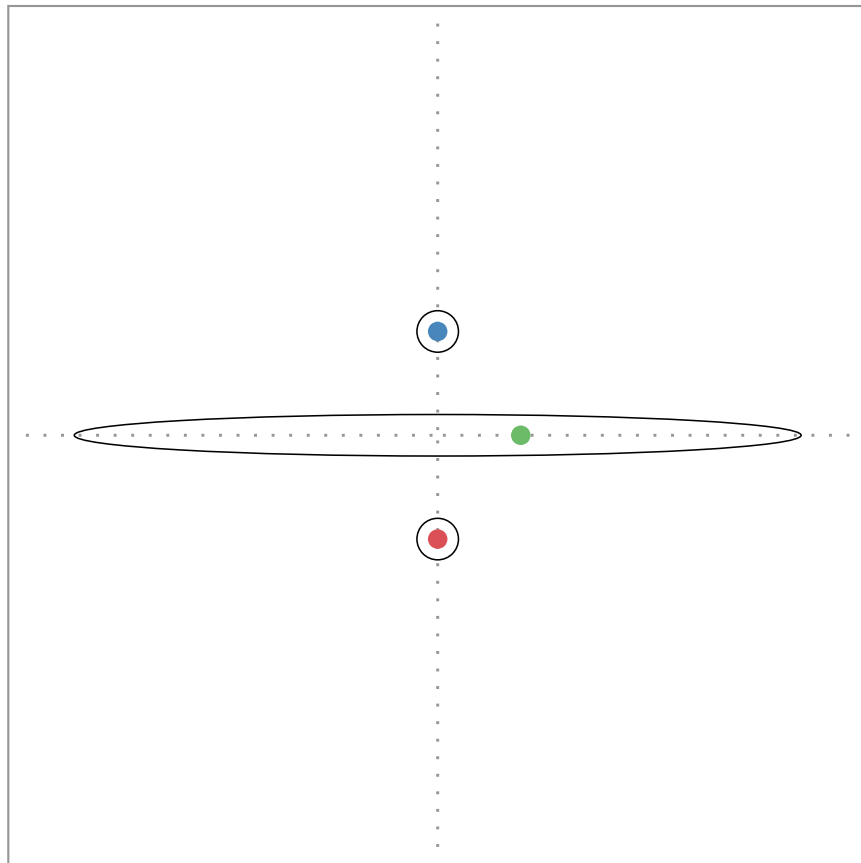
COUNTEREXAMPLE



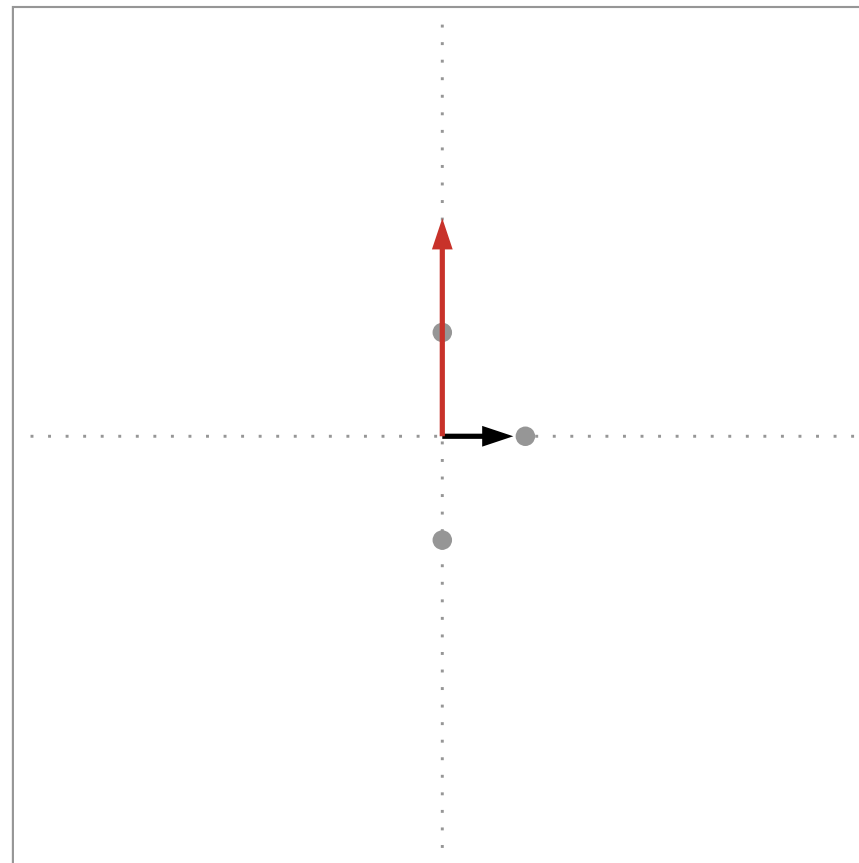
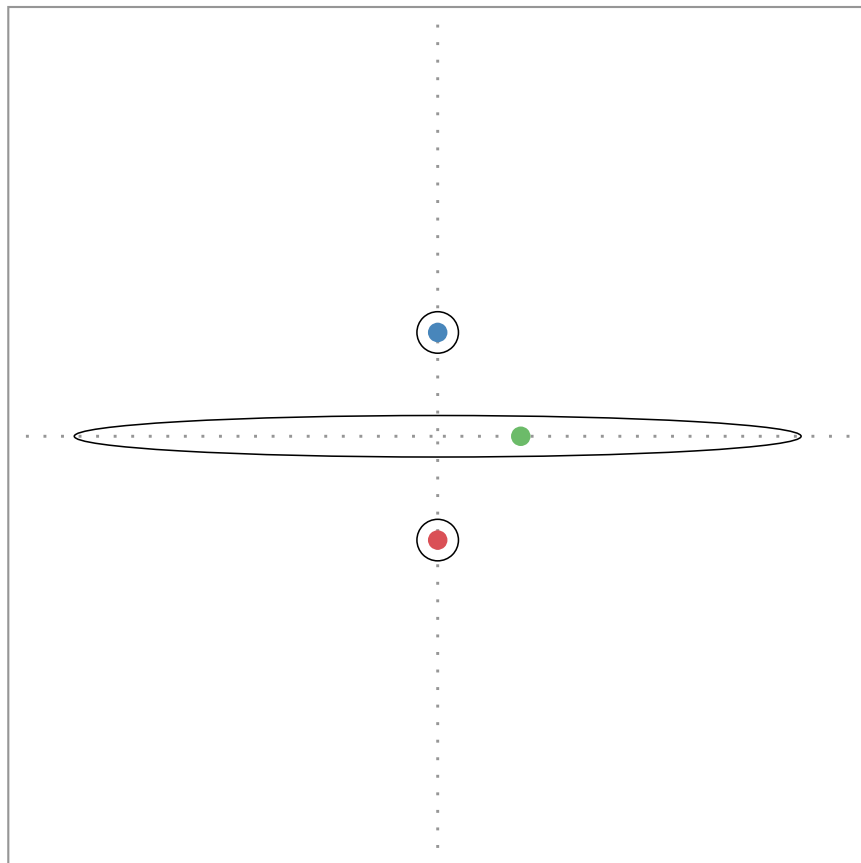
COUNTEREXAMPLE



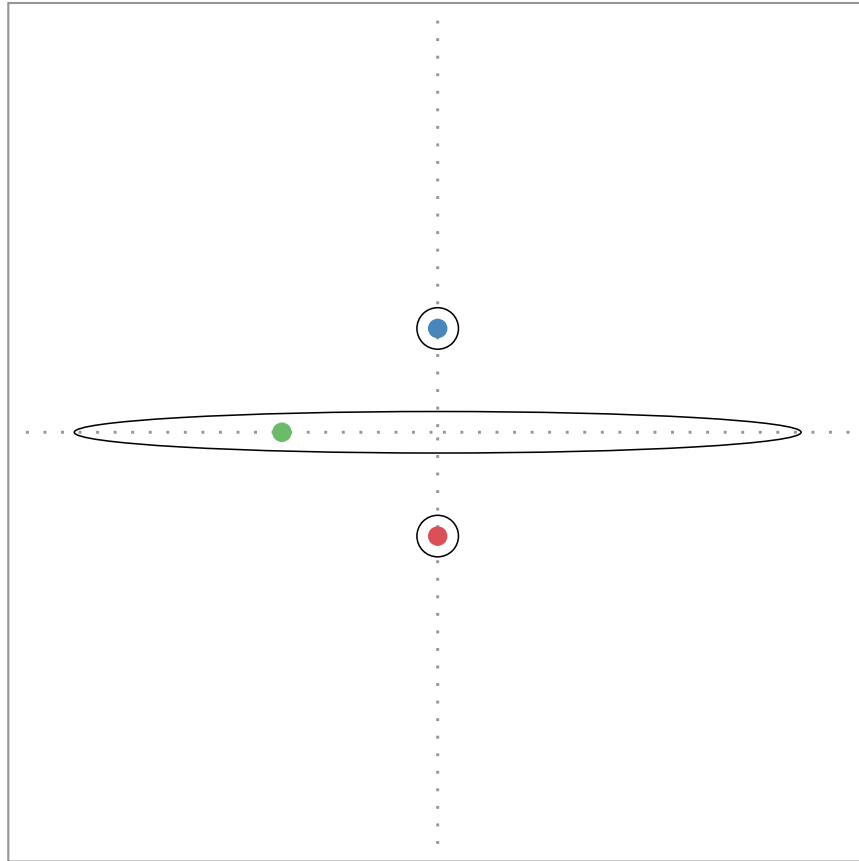
COUNTEREXAMPLE



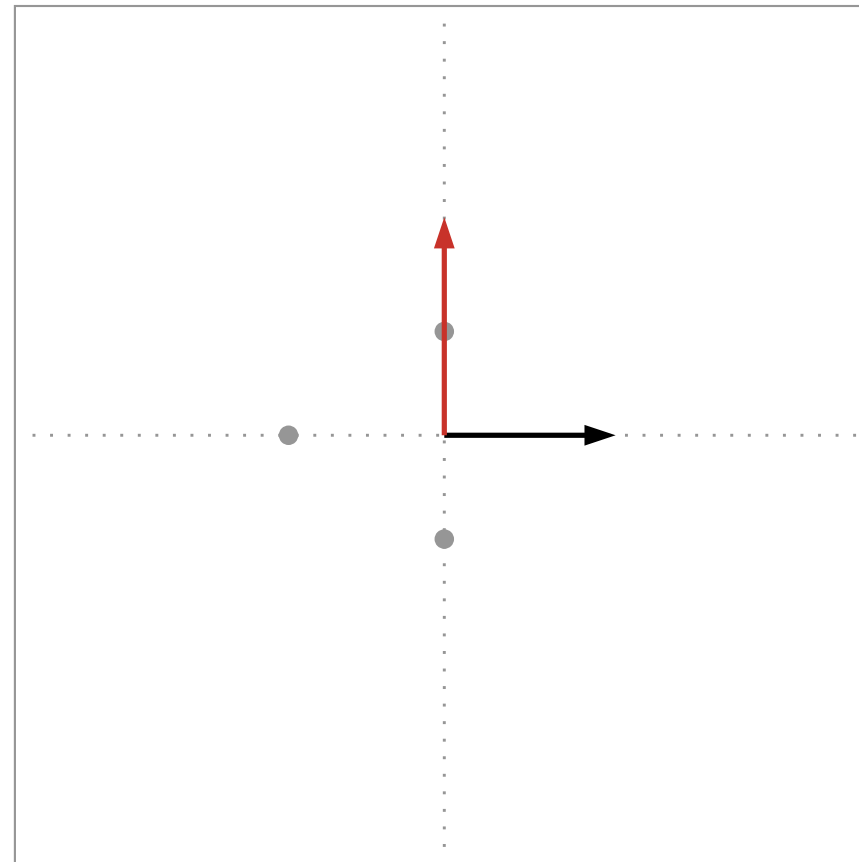
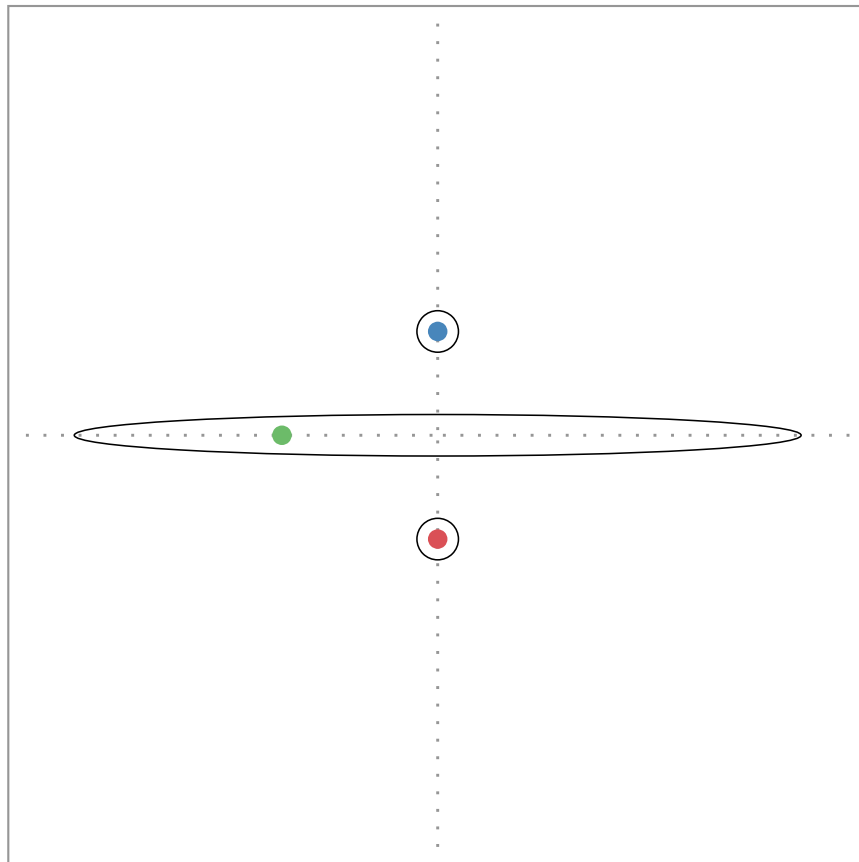
COUNTEREXAMPLE



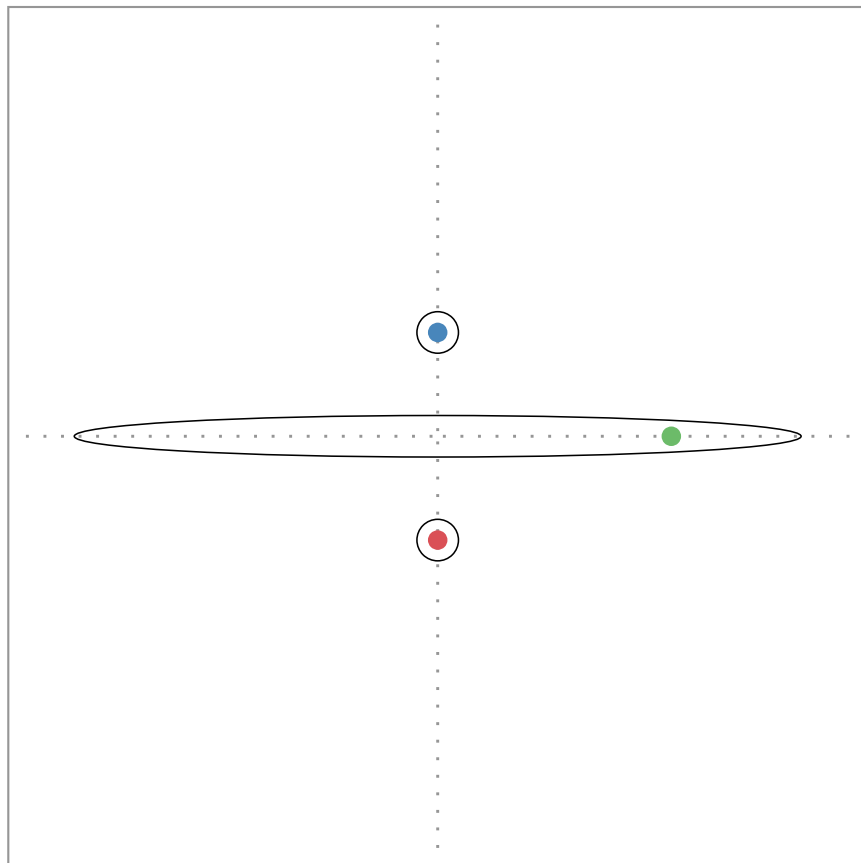
COUNTEREXAMPLE



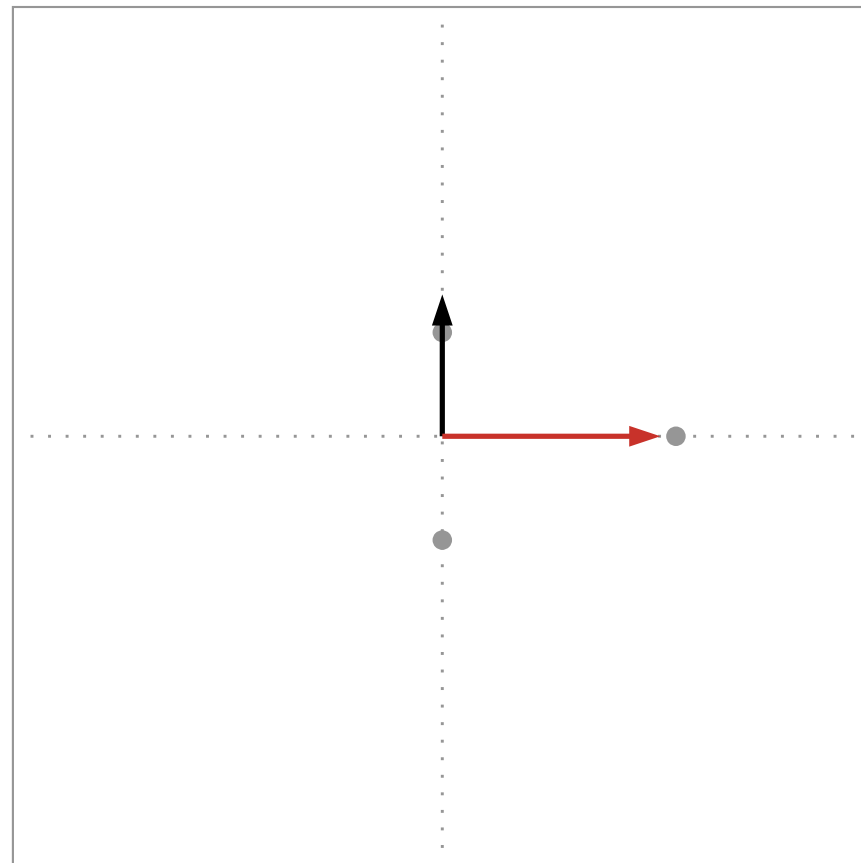
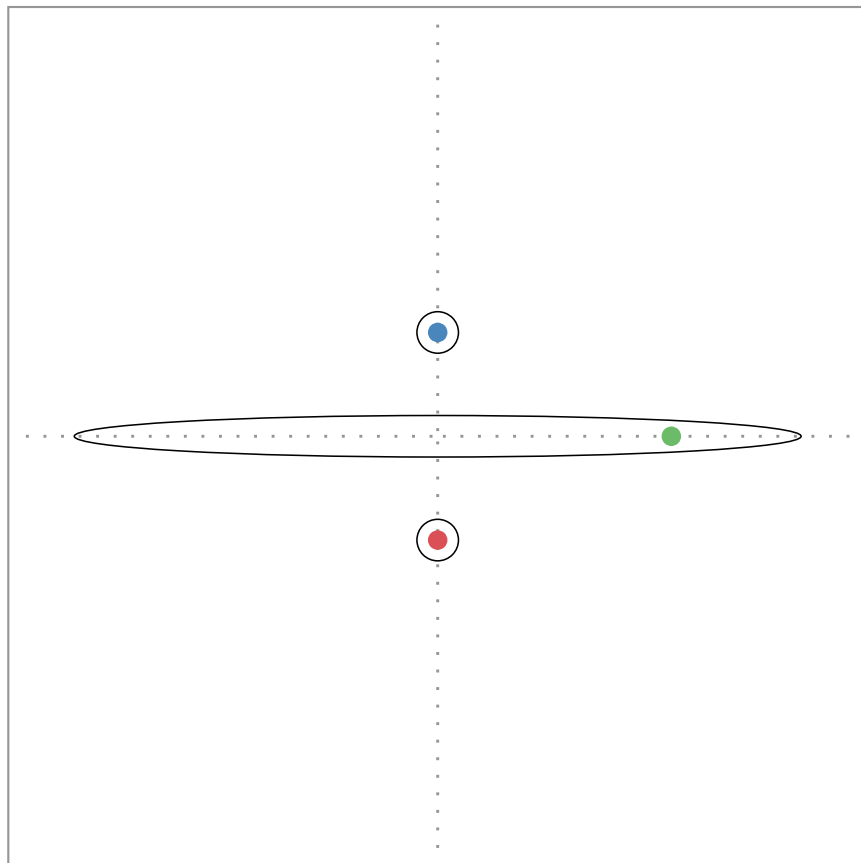
COUNTEREXAMPLE



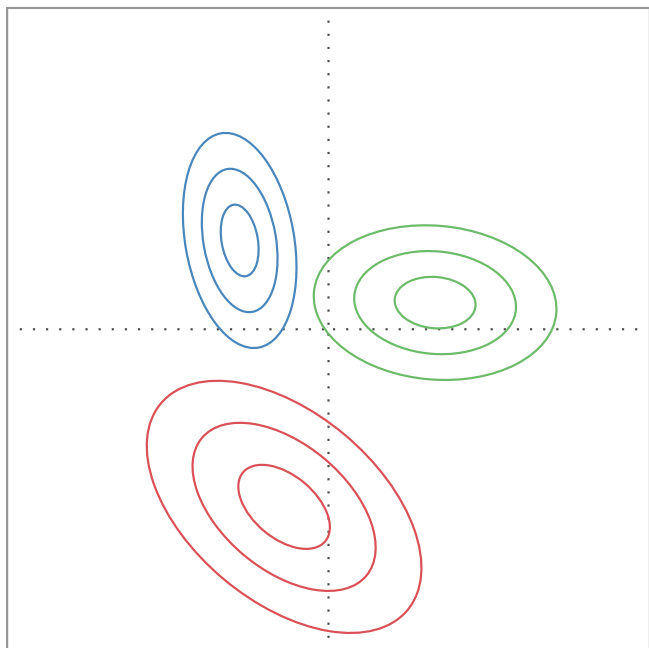
COUNTEREXAMPLE



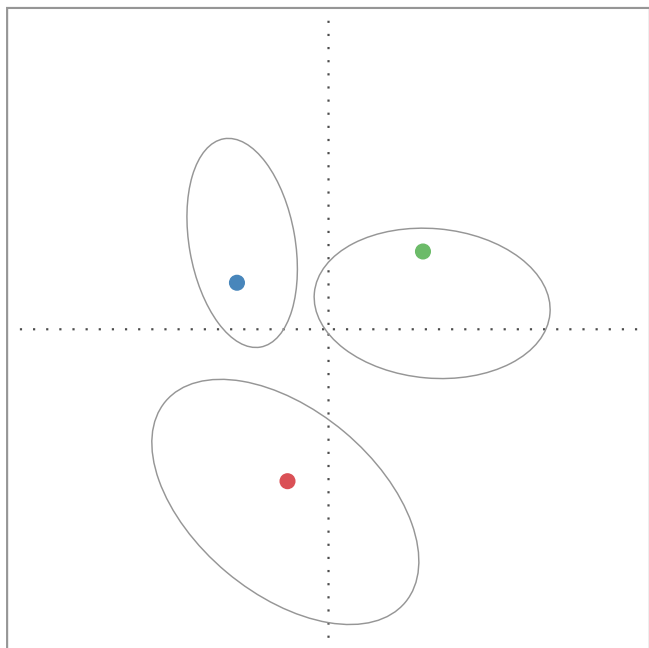
COUNTEREXAMPLE



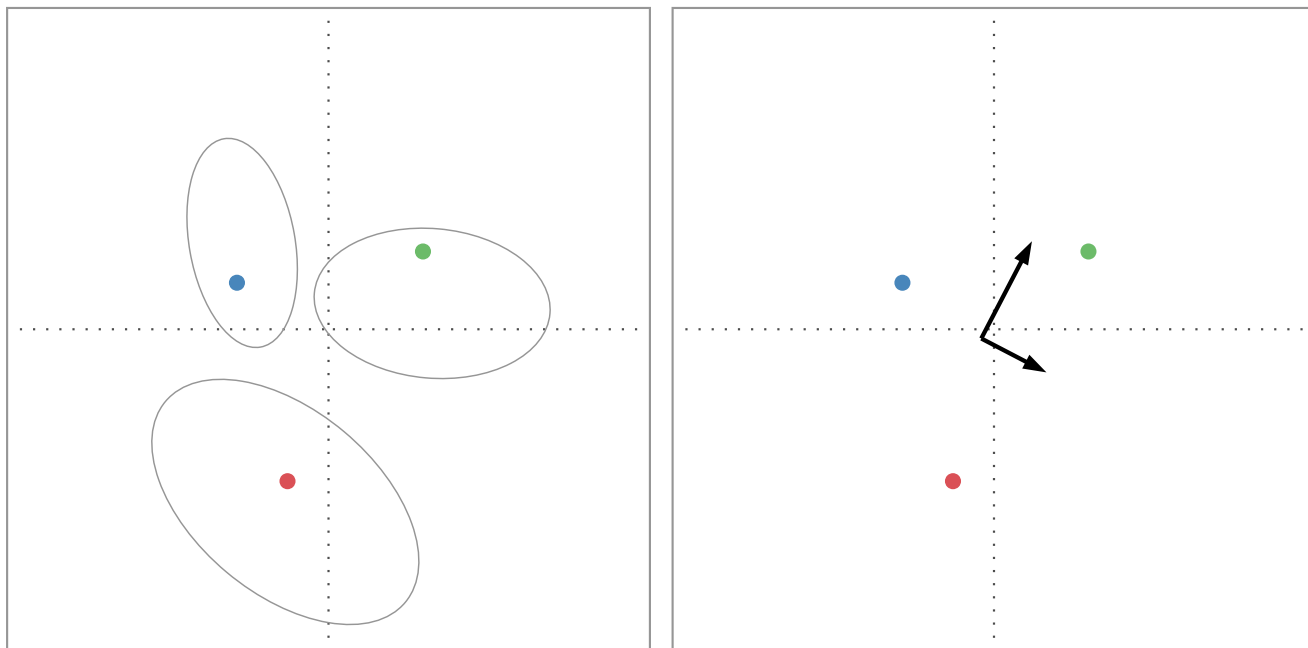
OUR APPROACH: SAMPLING-BASED



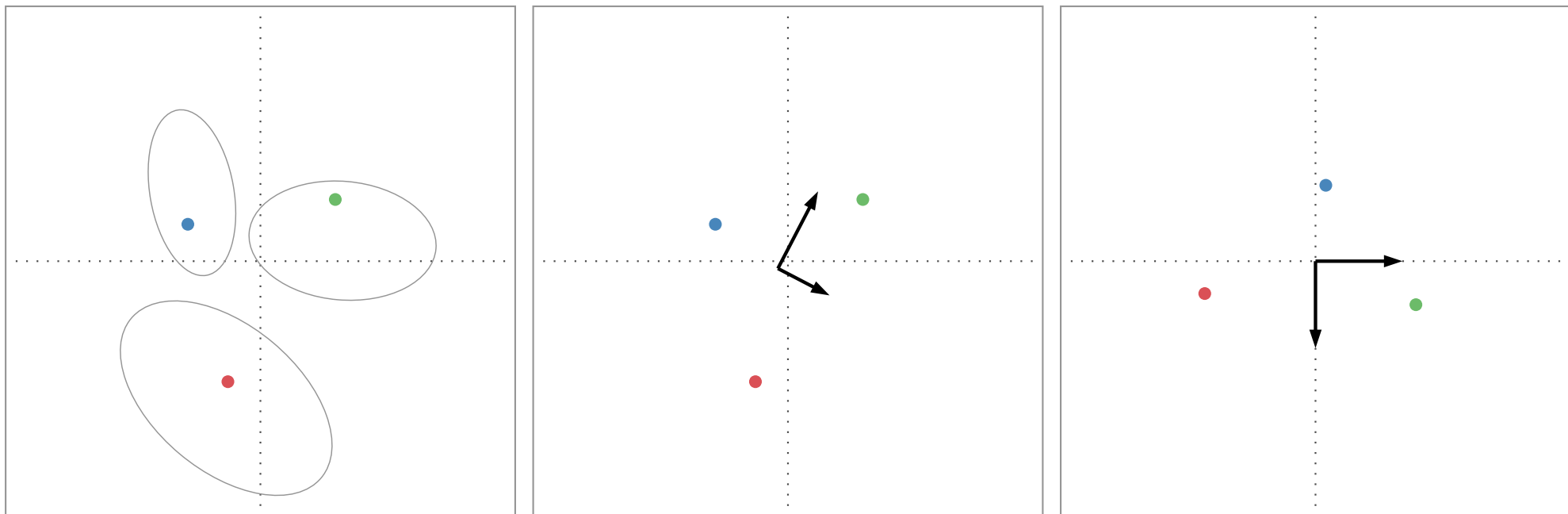
OUR APPROACH: SAMPLING-BASED



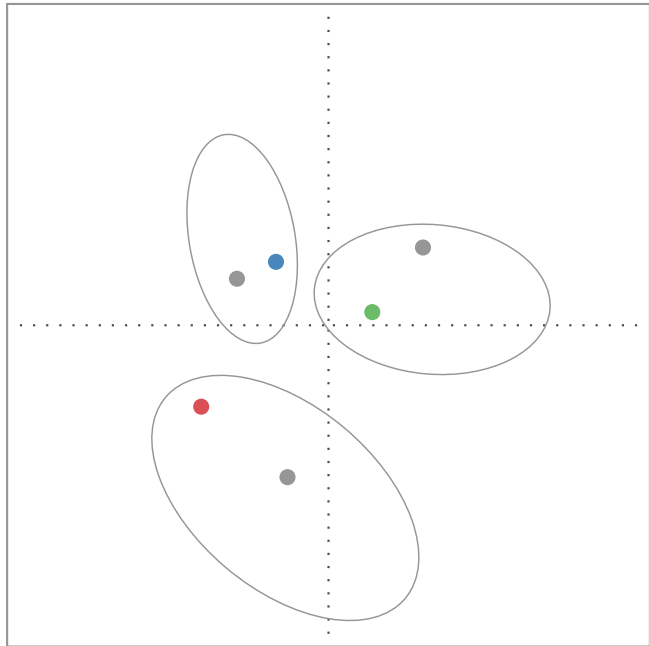
OUR APPROACH: SAMPLING-BASED



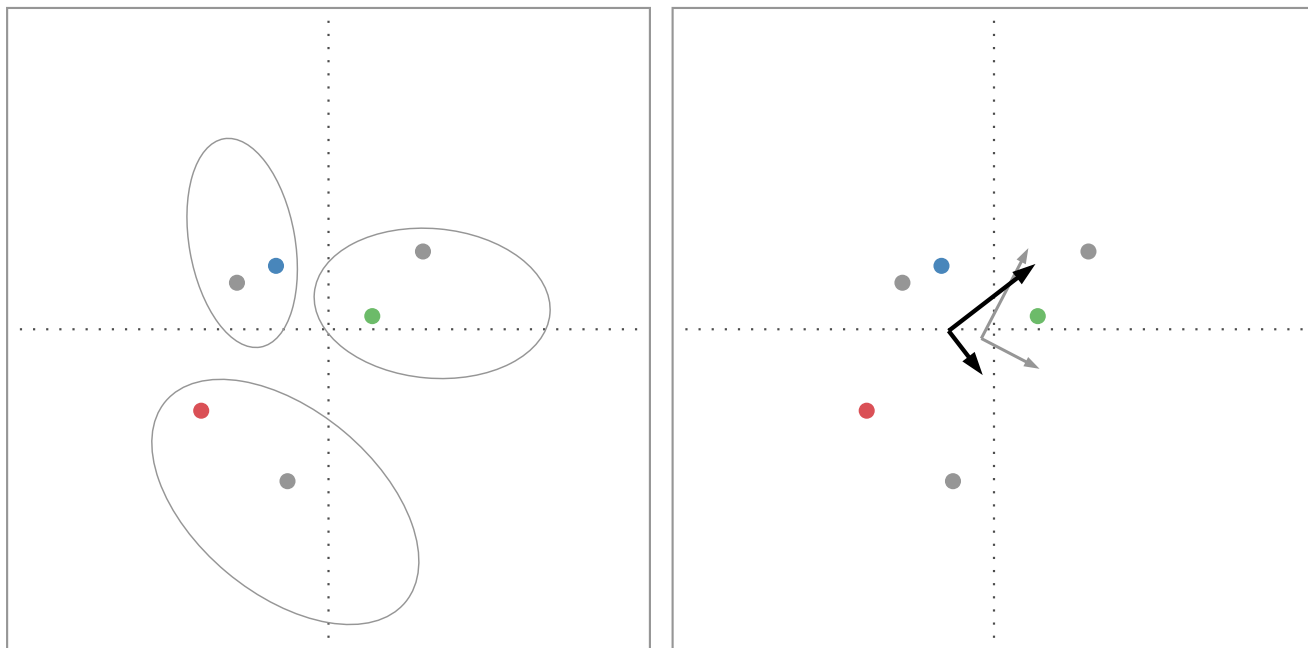
OUR APPROACH: SAMPLING-BASED



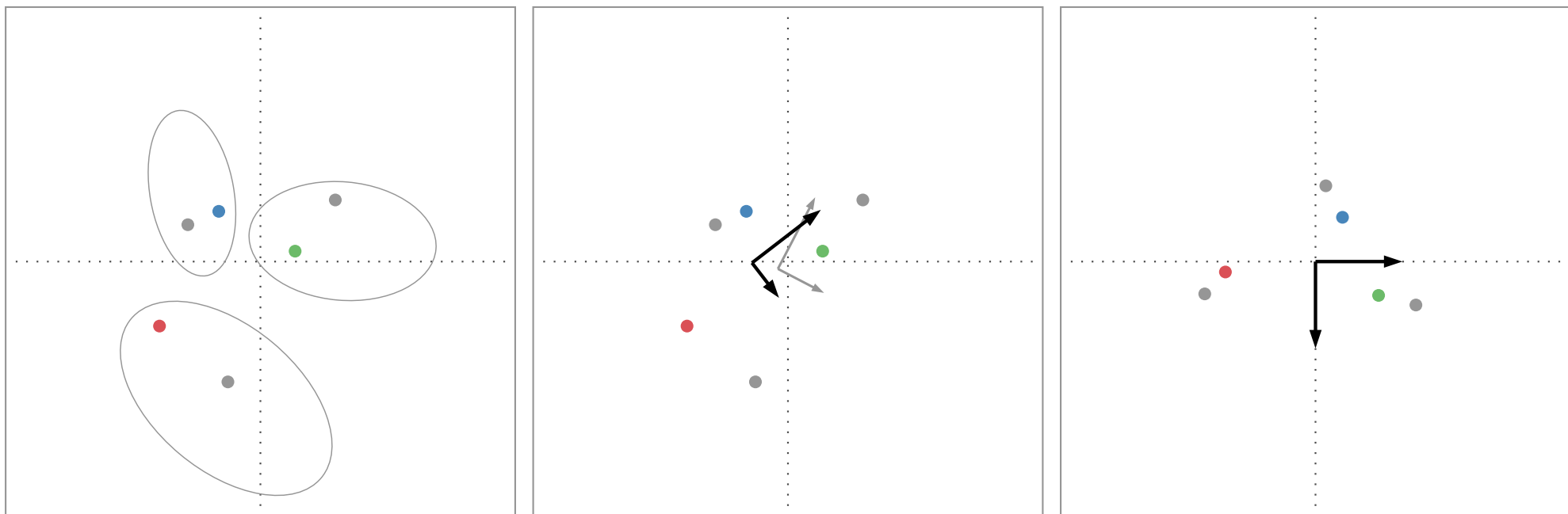
OUR APPROACH: SAMPLING-BASED



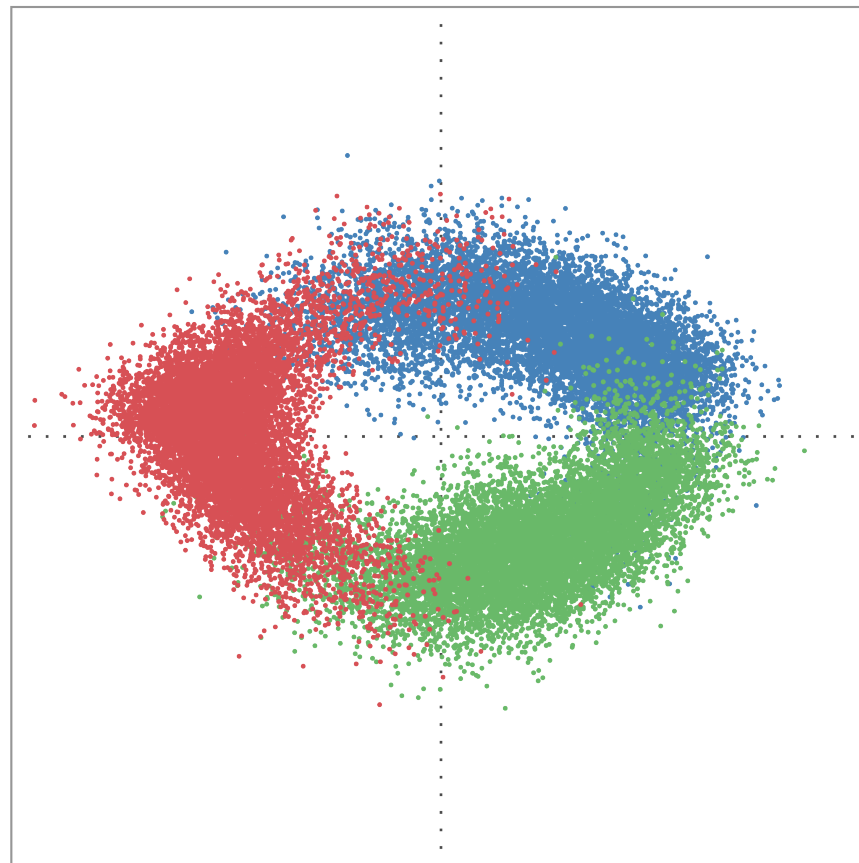
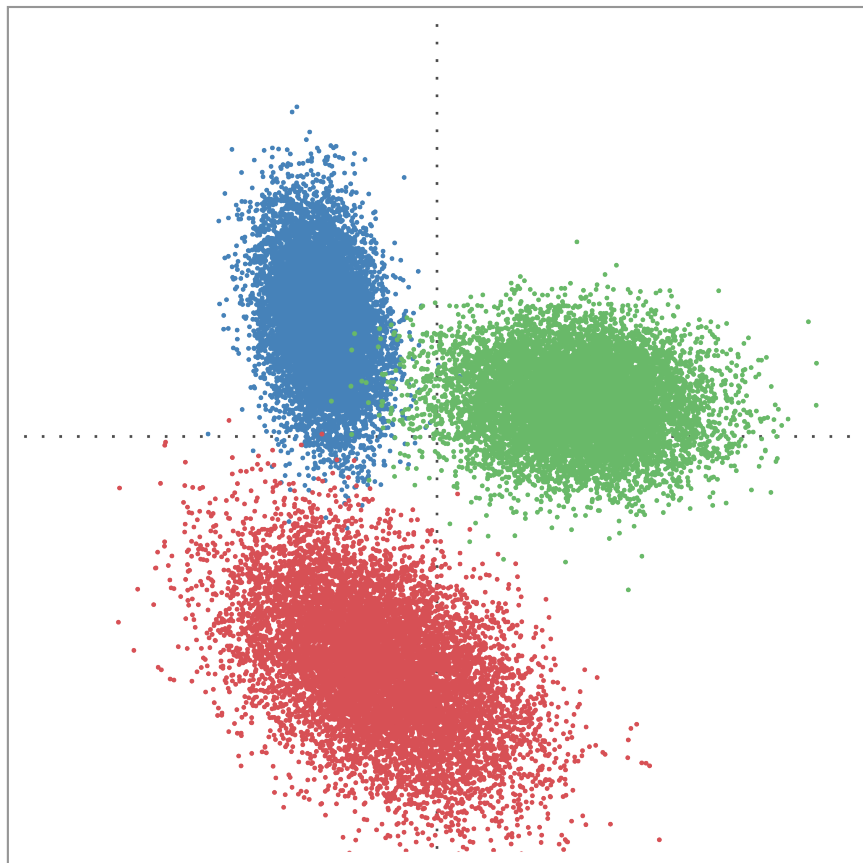
OUR APPROACH: SAMPLING-BASED



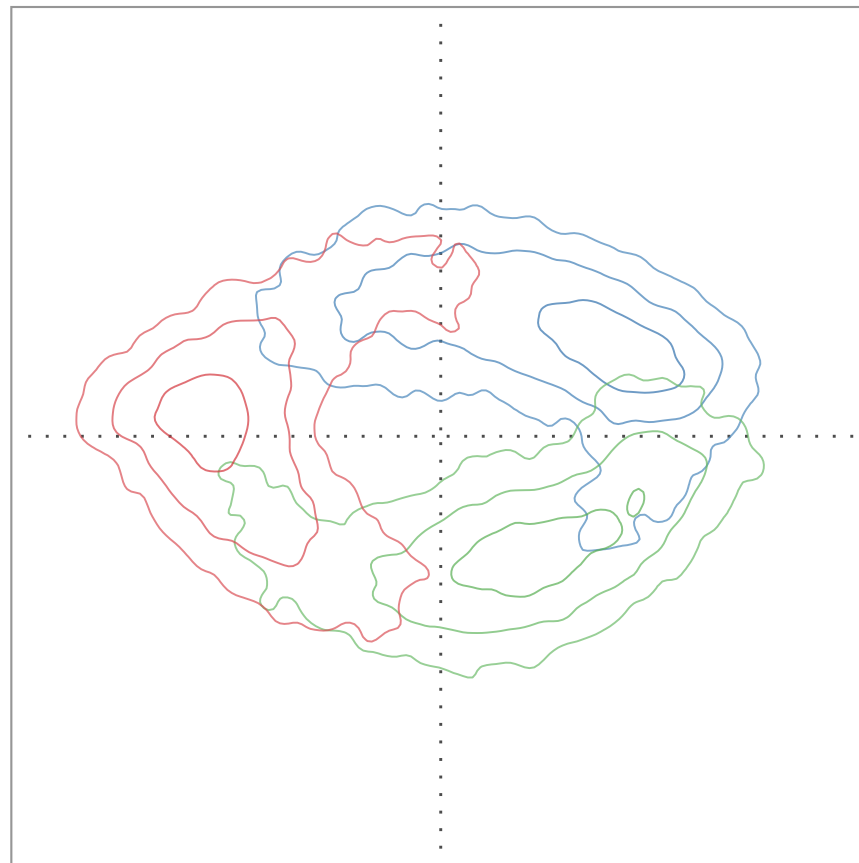
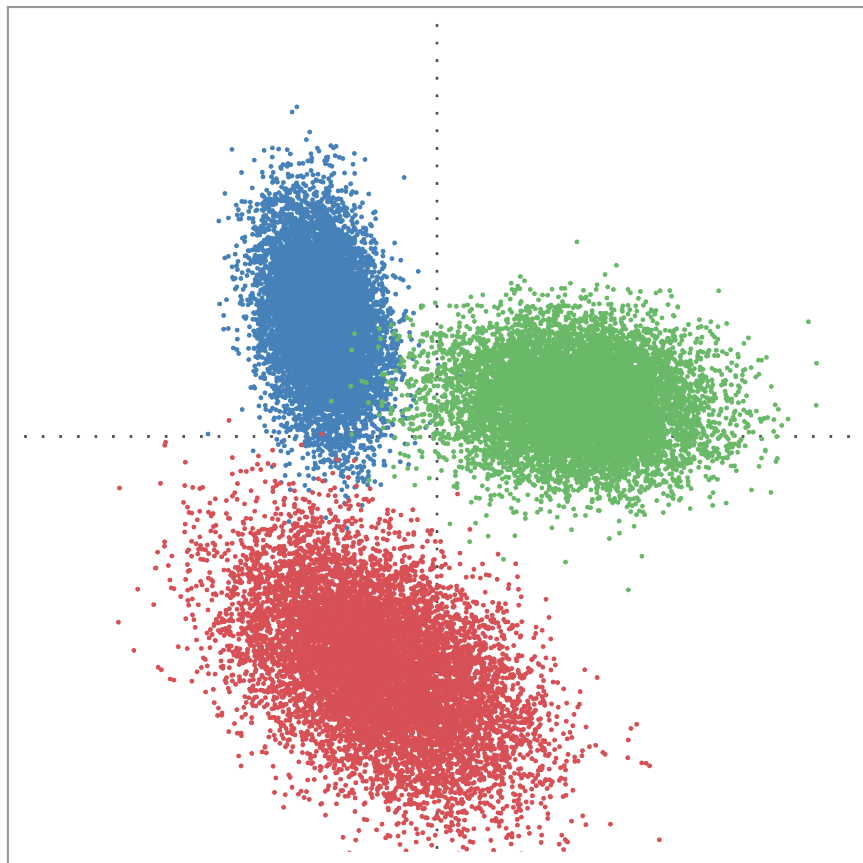
OUR APPROACH: SAMPLING-BASED



OUR APPROACH: SAMPLING-BASED



OUR APPROACH: SAMPLING-BASED



COMPARISON OF APPROACHES

existing approach
– Görtler et al. –

sampling-based approach
– ours –

low computing time

high computing time

may result in bad projections

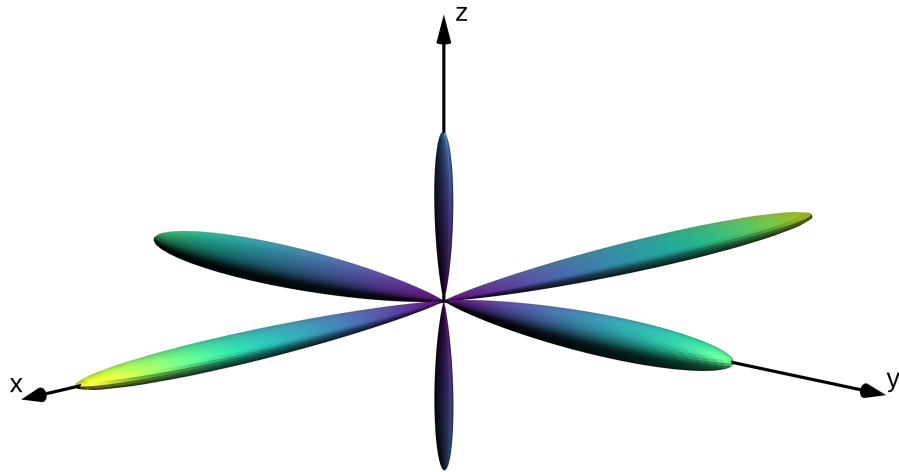
always results in correct projections

UNCERTAINTY OF PROJECTION

1. uncertainty in direction of eigenvectors
2. uncertainty in eigenvalues

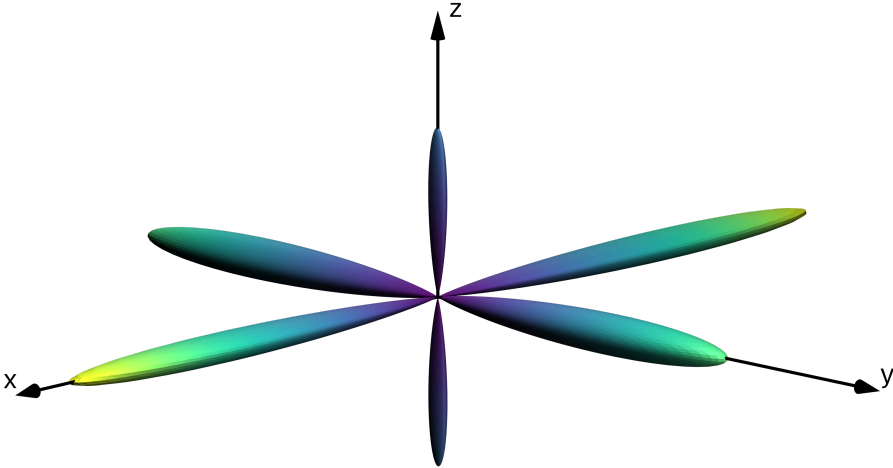
What is the likelihood that an arbitrary high-dimensional vector is an eigenvector of the uncertain covariance matrix?

COVARIANCE STABILITY GLYPH

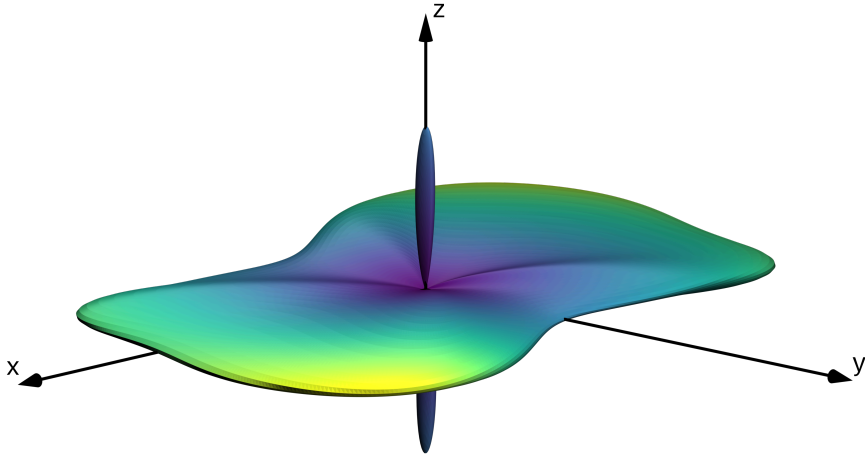


– low uncertainty –

COVARIANCE STABILITY GLYPH

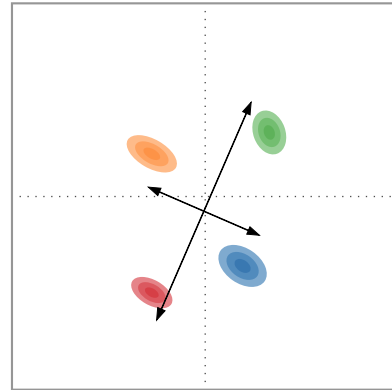


– low uncertainty –

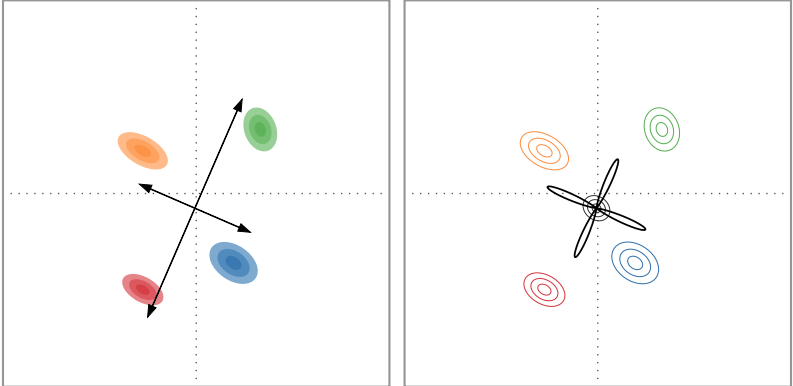


– high uncertainty –

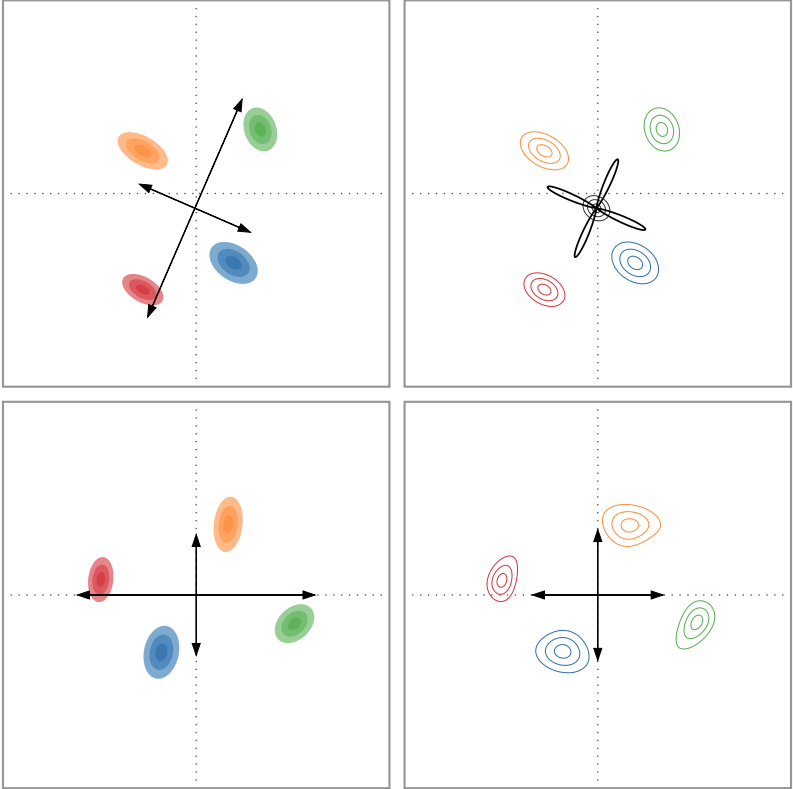
COVARIANCE STABILITY GLYPH: 2D EXAMPLE



COVARIANCE STABILITY GLYPH: 2D EXAMPLE



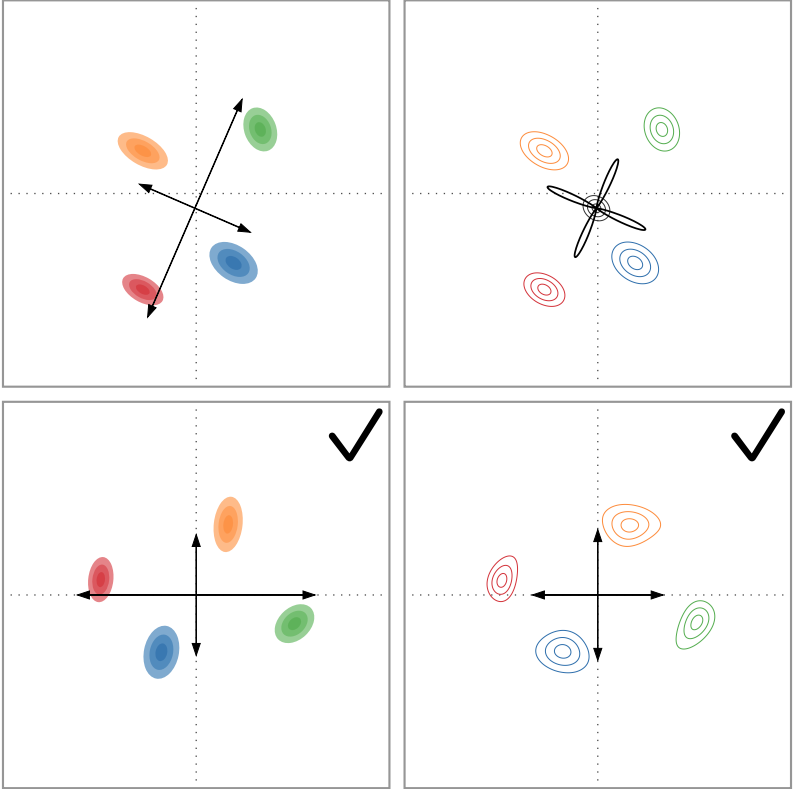
COVARIANCE STABILITY GLYPH: 2D EXAMPLE



- Görtler et al. -

- ours -

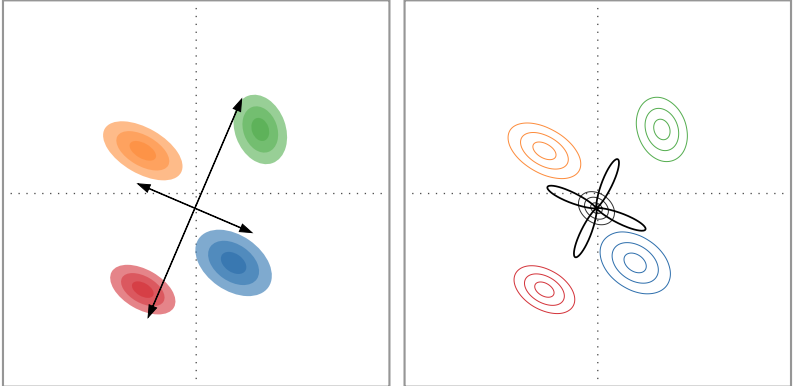
COVARIANCE STABILITY GLYPH: 2D EXAMPLE



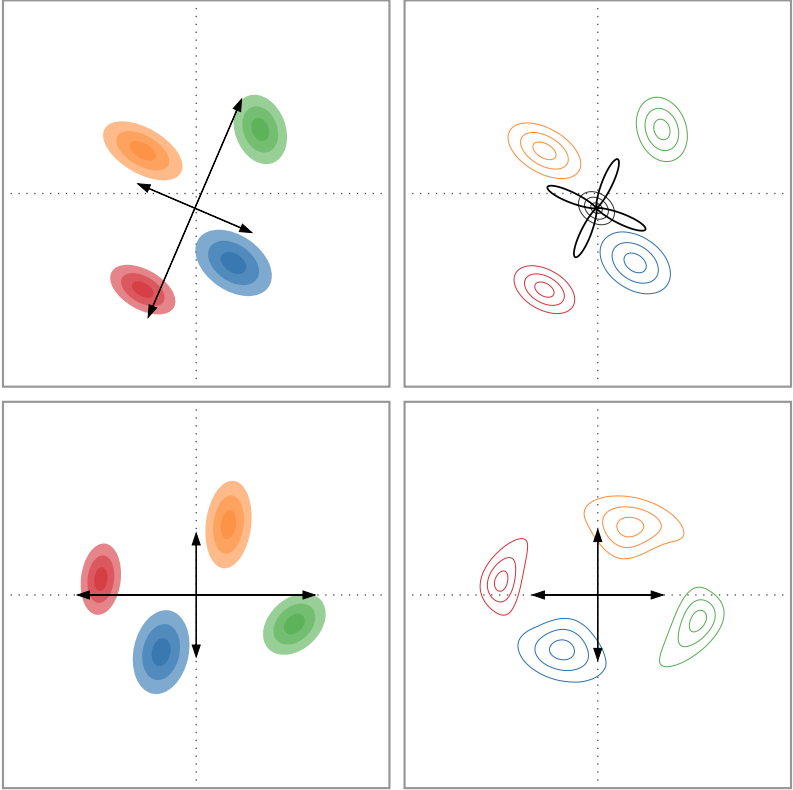
- Görtler et al. -

- ours -

COVARIANCE STABILITY GLYPH: 2D EXAMPLE



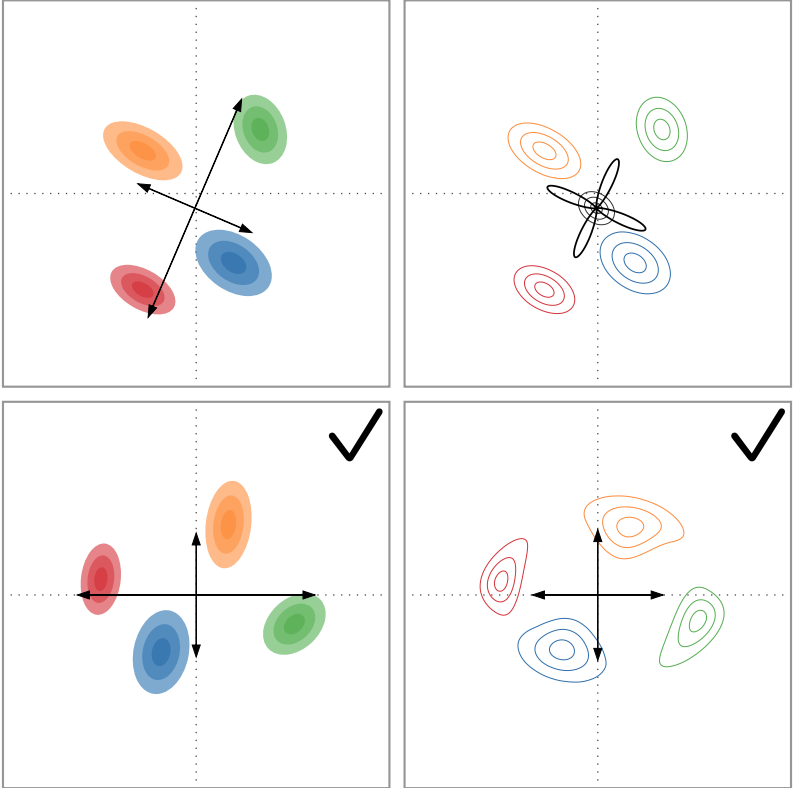
COVARIANCE STABILITY GLYPH: 2D EXAMPLE



- Görtler et al. -

- ours -

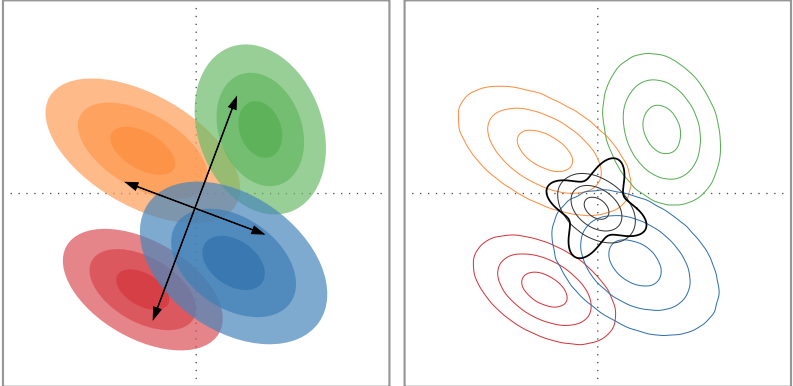
COVARIANCE STABILITY GLYPH: 2D EXAMPLE



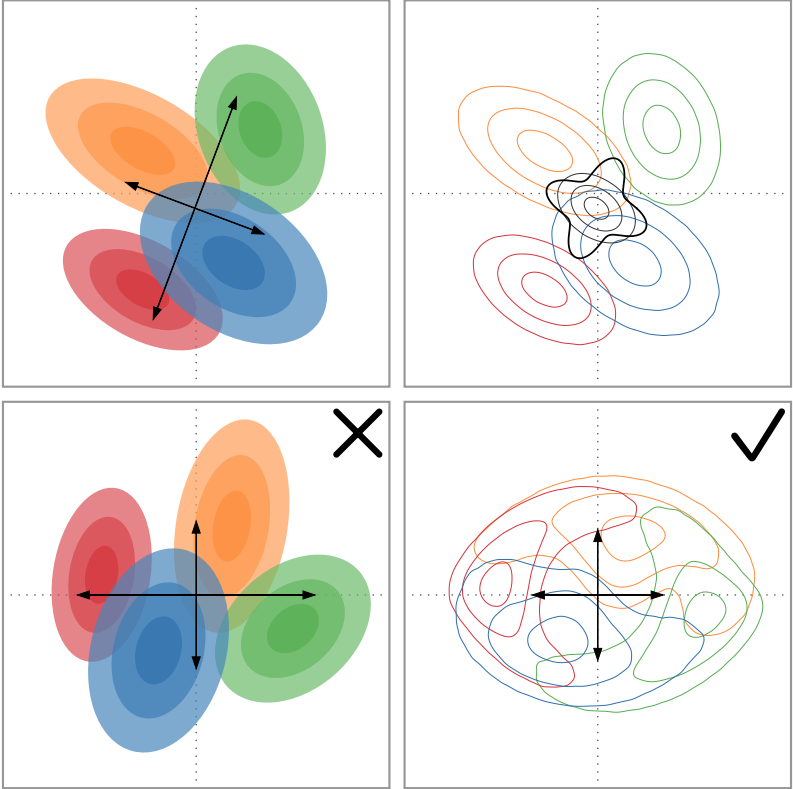
- Görtler et al. -

- ours -

COVARIANCE STABILITY GLYPH: 2D EXAMPLE



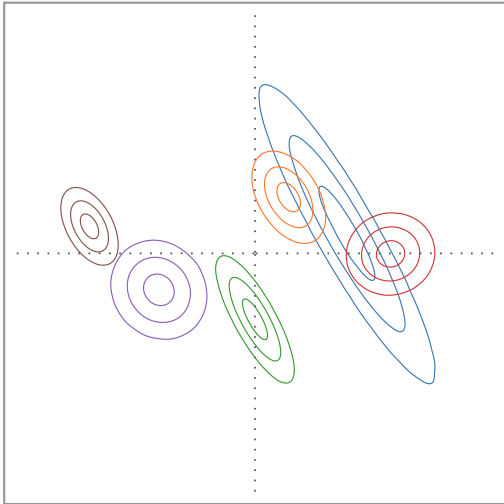
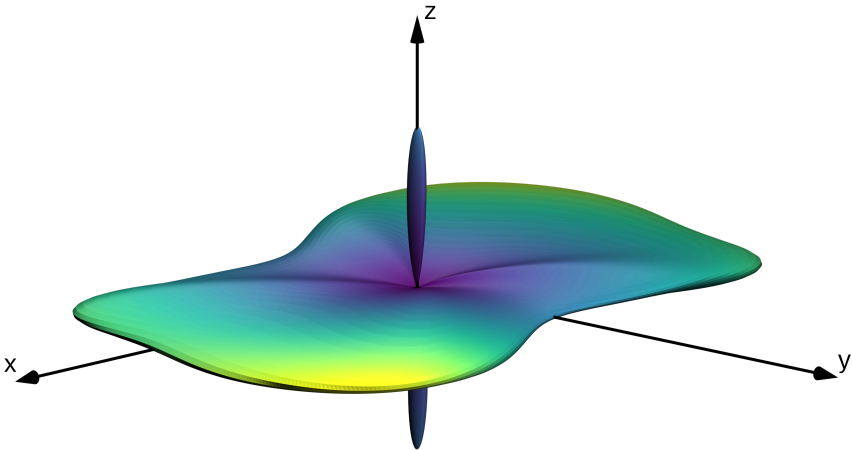
COVARIANCE STABILITY GLYPH: 2D EXAMPLE



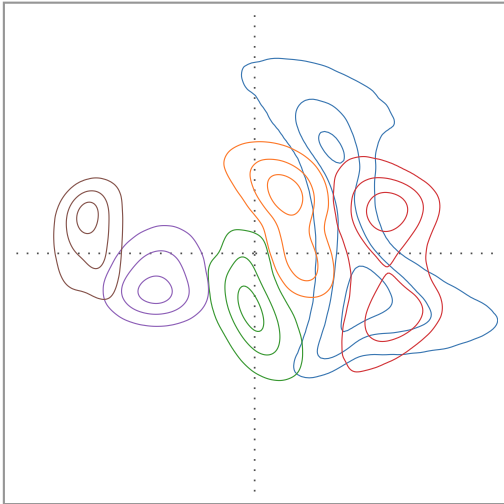
- Görtler et al. -

- ours -

COVARIANCE STABILITY GLYPH: STUDENT GRADES DATASET

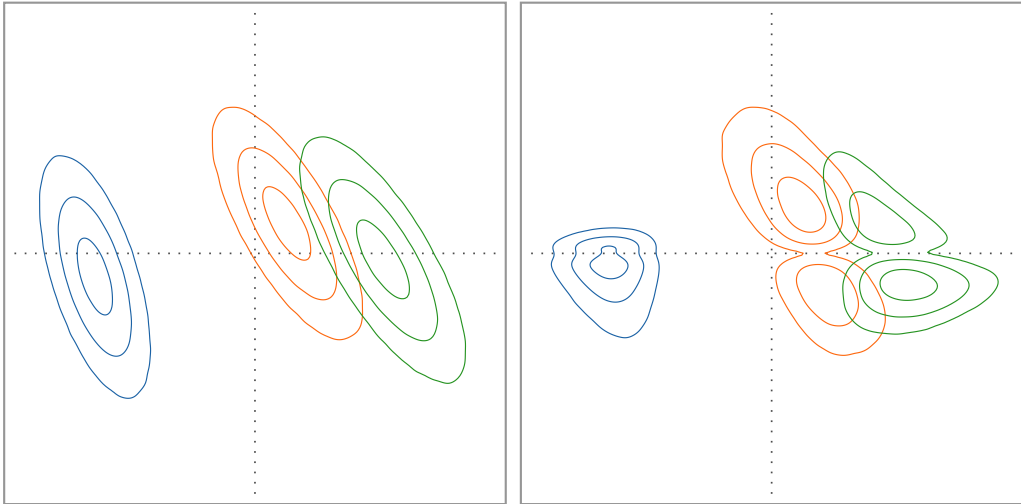
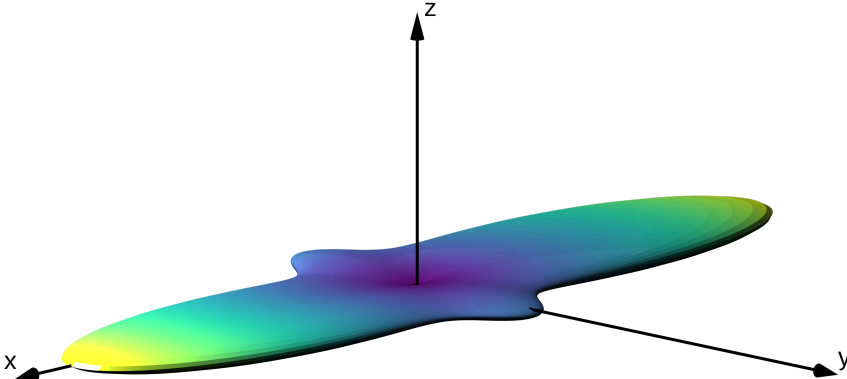


- Görtler et al. -



- ours -

COVARIANCE STABILITY GLYPH: IRIS DATASET



- Görtler et al. -

- ours -

MAIN CONTRIBUTIONS

- addressed the fact that PCA is discontinuous map
- introduced sampling-based technique for uncertainty-aware PCA
- introduced covariance stability glyph and closed-form solution

MAIN CONTRIBUTIONS



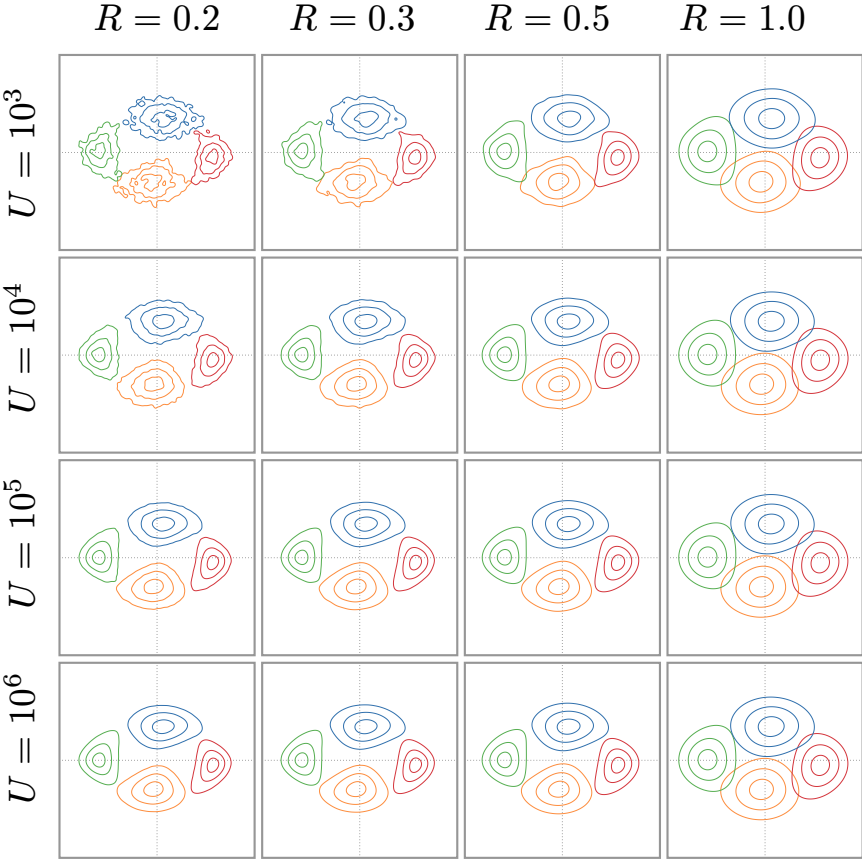
– GitHub –

Uncertainty-Aware PCA Revisited

Lukas Friesecke, Christian Braune, Christian Rössl, Holger Theisel
Otto von Guericke University Magdeburg



PARAMETERS OF SAMPLING-BASED APPROACH



R – radius of Hann function

U – number of samples

PERFORMANCE MEASURES

	$R = 0.2$	$R = 0.3$	$R = 0.5$	$R = 1.0$
$U = 10^3$	1.56s	1.54s	1.52s	1.50s
$U = 10^4$	15.44s	15.34s	15.49s	15.28s
$U = 10^5$	2min 35s	2min 35s	2min 33s	2min 30s
$U = 10^6$	25min 49s	25min 43s	25min 27s	25min 0s

R – radius of Hann function

U – number of samples