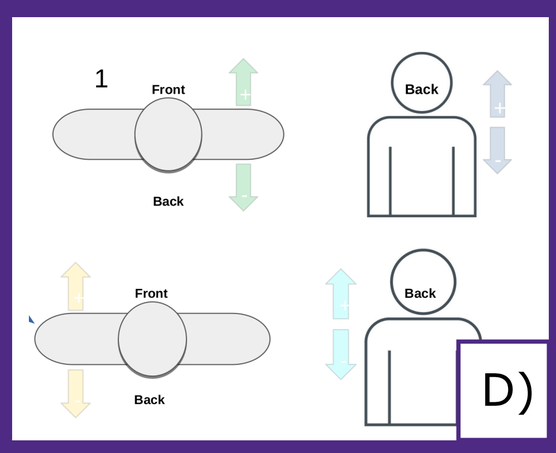
Principal Component Analysis In Accessible Control

Maximus N. McCune Andrew Thompson Brenna Argall

In a world where human-robot interactions are becoming increasingly common, it is important to ensure that our ability to interface with those robots is fully accessible to people with a wide variety of levels of ability. In noisy systems where the robot's motion is not state-dependent, Principal Component Analysis serves as a data-driven test to determine if a system is controllable, and to what degree it is. Its data-driven nature is applicable in cases where analytical models of the controller are very complex, such as neural networks or other machine learning models.

Sensor Placements:

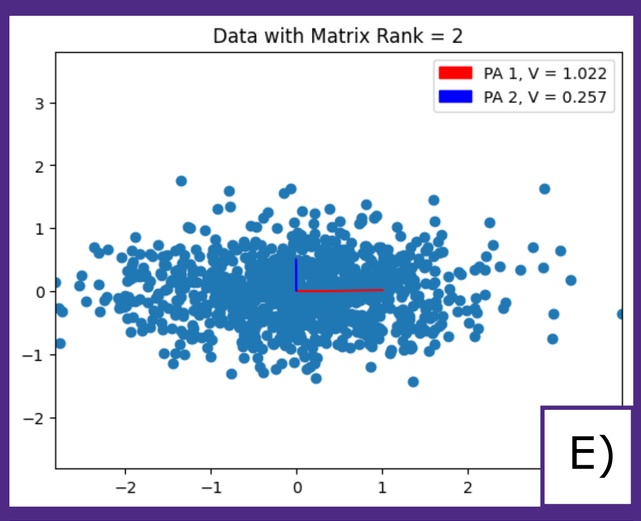
A) Left View B) Back View C) Front View



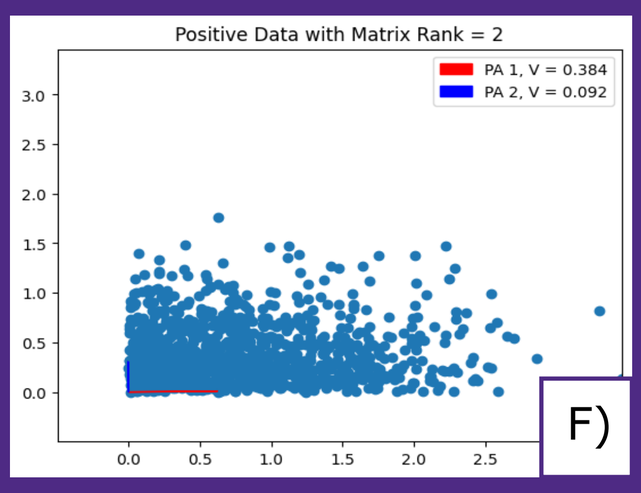
D) Four Degrees of Freedom

In the parent study, participants were originally intended to wear the sensors in the configuration shown in A-C, and would use the movements shown in D. This study hypothesized that the limited degrees of freedom of the input space would prevent the end effector of a robot from being fully controllable.

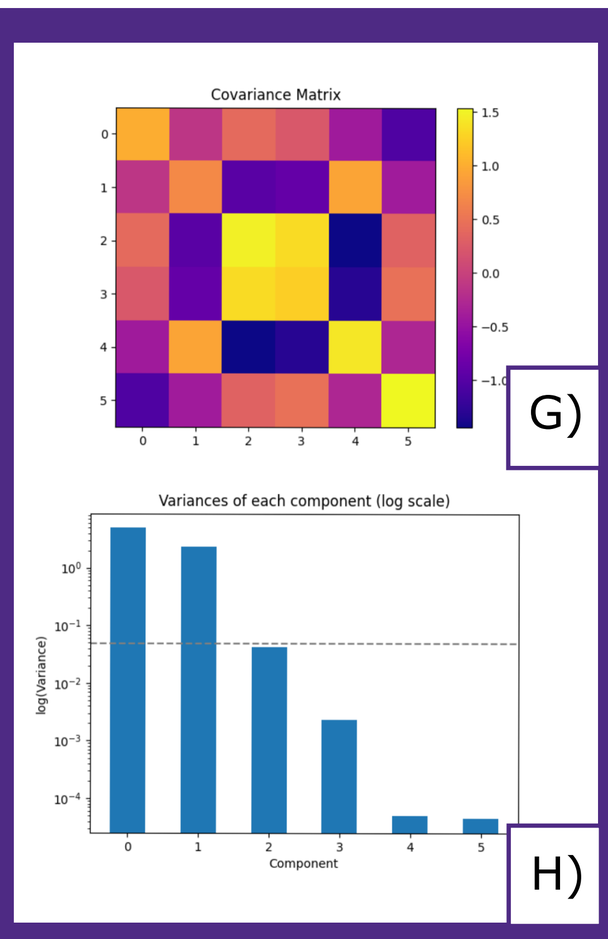
PCA on Hypothetical Output Data

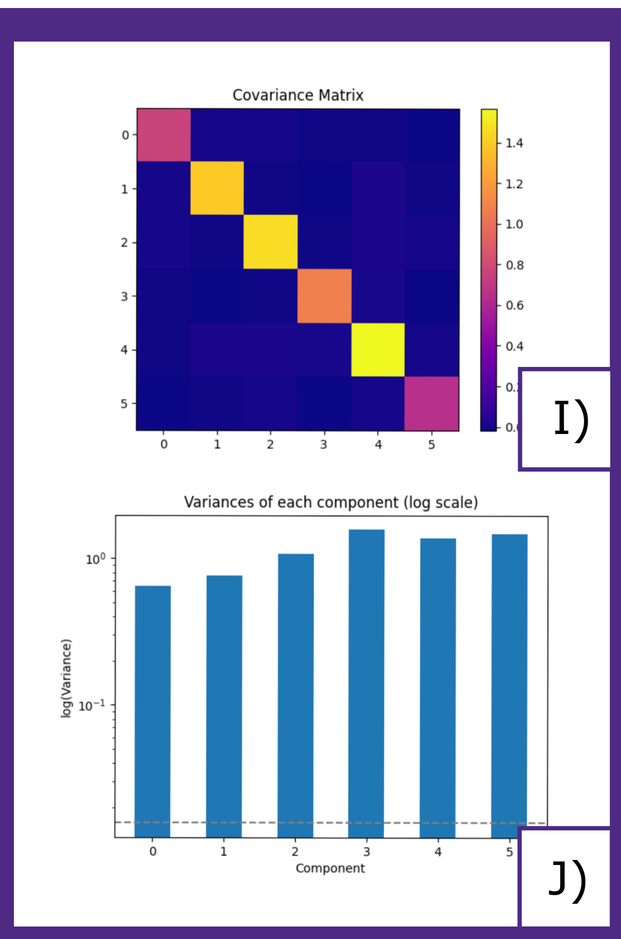


E) PCA identifies a controllable data distribution. Variances indicate degree of controllability



F) PCA identifies an uncontrollable data distribution where an MRT fails





G) Shows the covariance matrix of an uncontrollable signal, and H) shows the corresponding variances along each principal axis. Likewise, I) shows the covariance matrix of a controllable signal, and J) shows the correspond variances along each principal component.

CONTACT US:

maxmccune2024@u.northwestern.edu
athompson@u.northwestern.edu

brenna.argall@northwestern.edu

National Institutes of Health
Shirley Ryan Abilitylab
Northwestern University