Department of Computer Science
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M.Sc. Thesis Proposal Presentation

Enhancing Functional Alignment of fMRI Data Using Principal Component Pursuit

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Human brains have a similar overall structure, but how they process information can still differ between people. Even after using standard methods to align brain scans anatomically—known as structural alignment—differences in how the brain responds to tasks remain. This thesis aims to improve functional alignment methods, which build on structural alignment by aligning brain activity patterns into a shared space for better comparison across individuals.

Our goal is to improve this alignment by first reducing the complexity of the data using a technique called Principal Component Pursuit (PCP). PCP acts as a feature reduction method, helping us isolate the most important, stable patterns in each person's Functional Magnetic Resonance Imaging (fMRI) data while reducing noise. This step makes the data cleaner and more comparable across individuals, setting the stage for more accurate alignment.

We then use Optimal Transport (OT) to map each person's brain responses, focused on the ventral temporal cortex during visual tasks, into a common space. OT treats these responses as probability distributions and calculates the most efficient way to align them across people while preserving the meaningful structure of the data. This helps account for individual differences in brain function and allows us to better predict what stimulus a person is viewing based on their neural activity.

To assess how well the alignment worked, we looked at classification performance and how similar the aligned brain patterns became across subjects. Our findings show that combining PCP-based feature reduction with OT alignment leads to more accurate and consistent results compared to traditional methods