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“Explore tissue-specificity of genetic regulation using matrix factorization”

Abstract: Genetic regulation differs and coordinates across tissues in the human body. This project is trying to systematically investigate the pattern of tissue-specificity for the genetic regulation, and to explore the potential mechanism. Expression quantitative loci (eQTL) capture the association between genetic variants and gene expression levels, thus give direct information about how the genetic code could affect the gene performance. GTEx project has provided a rich resource of eQTL across 44 human tissues. Here we use the eQTL results from GTEx project to do the analysis. We use matrix factorization to decompose the matrix of eQTL effect across tissues $A$, such that $A = PQ$. $P$ captures the genetic association across meta-tissues, or organ systems. $Q$ presents composition of tissues in the human body. It is expected that $P$ be sparse, and $Q$ be non-negative. The two matrices are updated iteratively until convergence. From the resulting $P$, we quantitatively define tissue-specificity for eQTL. Then we look into the genomic features that are enriched for tissue-specific eQTL compared to tissue-sharing eQTL. We also build machine learning models to use the features to predict tissue-specificity.

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“Model-Based Material Decomposition in CT for Arbitrary Systems and Geometries”

Abstract: Material decomposition is a technique used in computed tomography (CT) to produce density images of multiple materials, as opposed to traditional CT which produces an image of attenuation values. Material decomposition allows materials with similar attenuation values (e.g., calcium and iodine, which appear similar in traditional reconstructions) to be easily distinguished. Accurate material density images are useful in clinical applications involving contrast agents (e.g., iodine) or where quantitative accuracy is critical (e.g., bone mineral density calculations). Traditional material decomposition methods split the reconstruction and decomposition steps by relying on relatively simple models or constraints on the acquisition protocol. We present a method which simultaneously performs the reconstruction and material decomposition. This method can utilize data acquired using non-traditional/exotic acquisition protocols (e.g., multiple X-ray sources of different energies). The presented method of simultaneously reconstruction and decomposing the materials is able to produce accurate material density images, while traditional methods fail. The presented method has the potential to better utilize CT data to improve material density image accuracy in clinical applications.